iST POWER

INSTALLATION, COMMISSIONING, OPERATION, AND MAINTENANCE

INSTRUCTIONS

MIDEL COOLED EARTHING AUXILIARY TRANSFORMER

LINXON

for

SEAGREEN OFFSHORE WIND FARM

TRANSFORMER SPECIFICATION: 0105392

PURCHASE ORDER NUMBER: 17396-2019-8

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102287/28-01

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Revision Record

Issue	Change	By	Date
01	Preliminary Issue	PWJ	06/10/2020
02	Title page: Serial numbers were 102287/1-01, 102287/2-01 & 102287/3-01 changed to 102287/26-01, 102287/27-01 & 102287/28-01. Contents page: Site acceptance tests and breather pipe installation added to section 3.0. Section 16 Appendix J Site Acceptance Test Plan added. Page 4: HV Impulse test level was shown as 350kVp. Weight of Core & Coils was 4150kg. Page 5: Neutral Coupler core & coil weight was 513kg.Volume of Midel was 5475 litres. Total Weight was 14100kg Page 8: Paragraph 2.2 modified to correctly describe the method of despatch. Paragraph 2.7 modified to include statement regarding packing/shimming. Page 9: Base Fixing Angle welding procedures added. Page 10: Breather pipe connection instructions modified. Page 11: Site Acceptance Test Plan added in section 3.3. Page 12: Breather pipe installation instruction added to section 3.8. Pages 14-17: In section 4.2, photographs added, and procedure changed to incorporate the use of earth links in the disconnection chamber. Page 17: The vacuum level for refilling the disconnection chamber corrected to state 550 – 500 mbar absolute.	PWJ	31/09/2021

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SECTION 1

DESCRIPTION

1.1 Introduction

The transformer units manufactured by IST Power Limited, is supplied as follows: -

The earthing auxiliary transformer is a three-phase interconnected star/star, outdoor, Midel 7131 cooled transformer for 66000Volts 50Hz 3 phase supply. The secondary output voltage is 420 volts 3 phase.

1.2 Technical Description

Type	Midel cooled double wound earthing auxiliary transformer with secondary neutral coupler in a KNAN ground mounted tank.
Cooling	KNAN, Midel 7131 to IEC 61099
Main Transformer	
Continuous Rating	850kVA
Rated Primary Voltage	66000 volts
Rated Primary Current	7.44 Amps
Rated Secondary Voltage	420 volts
Rated Secondary Current	1169 Amps
Neutral Fault Current	2720 Amps for 3 seconds.
Zero Sequence Impedance	42 Ohms/phase -0% +20% (The measured value on test is engraved on the rating and diagram plate).
Number of Phases	3 phase + neutral
Frequency	50Hz
Vector Group	ZNyn1
Impedance	5% ± 10% (The measured value on test is engraved on the rating & diagram plate).
HV Insulation Level	Um 72.5 / LI 325 / AC 140kV
Weight of Core and Coils	4290kg
Neutral Coupler	
Continuous Rating	283.3kVA
Rated Voltage	420 volts
Rated Current	389 Amps

Number of Phases	3 phase + neutral
Frequency	50Hz
Vector Group	ZN
Insulation Level	Um <1.1 / LI - / AC 3kV
Weight of Core and Coils	510kg
<u>Complete Assembly</u>	
Volume of Midel	5455 litres
Total Weight	14230kg
HV Phase Termination	3 x 72.5kV 2000Amp Pfisterer Size 4 HV-Connex Sockets, mounted in the base of the disconnection chamber for connection from below.
Neutral Termination	1 x 72.5kV 2000Amp Pfisterer Size 4 HV-Connex Sockets, mounted in the base of the disconnection chamber for connection from below.
LV Termination	1600A ABB E2B16 3 pole ACB, Withdrawable and Motorised fitted with PR121 Control Unit mounted in an air-filled enclosure with output busbars suitable for 6 cables per phase.
HV Phase Current Transformer	200/1A 30VA Class 1/5P20. One per phase. Each CT is fitted with a test loop for testing purposes.
HV Neutral Current Transformers	1600/800/1A Class PX-B. $V_K \geq 460/230V$. $R_{CT} \leq 1.85/0.95$. $I_E \leq 0.025/0.05$ @ V_K. 1600/800/1A 30VA Class 1/5P20/5P10. Each CT is fitted with a test loop for testing purposes.
Fittings	Name Rating and Diagram Plate Earthing Terminals Pressure Relief Device Buchholz Relay Self-Dehydrating Breather Liquid Temperature Indicator Liquid Level Indicator Lifting Lugs Drain and Filter Valves Common Skid Base
Specification	IEC 60076 Linxon Specification L-018-016-T-508

1.3 Detailed Description

The earthing auxiliary transformer consists of three single phase coil assemblies mounted on a common 3 phase core assembly.

The coils are wound from paper insulated copper strip conductor. The HV coils are disc windings, and the LV coils are spiral windings. All coils are ducted for insulation and cooling purposes. The coils have been dried out prior to immersion in Midel 7131.

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The stepped leg/stepped yoke core is built up from laminations of cold rolled silicon steel. The laminations are interleaved with mitred corners and clamped with fabricated steel frames.

The transformer is contained within a fully welded steel tank with a bolted-on cover. The tank is complete with pressure relief device, drain & filter valves, conservator, Buchholz relay and self-dehydrating breather.

The HV phase and neutral winding leads are internally connected onto 72.5kV Pfisterer HV-Connex sockets via a disconnection link that is removable to enable cable testing.

The LV phase leads are connected to the neutral coupler and the transformer output terminals.

The LV neutral coupler consists of three single phase coil assemblies mounted on a common 3 phase core assembly. The windings are connected interstar and form the LV neutral. Use of a neutral coupler prevents secondary voltage displacement and over-voltages during an earth fault.

The unit is filled with Midel 7131. See Appendix A for Product Data Sheet and the Material Safety Data Sheet.

1.3.1 Transformer Tank and Termination Boxes

The transformer tank is of sheet steel welded construction. The tank has been zinc sprayed and painted with a heavy-duty C5M(VH) corrosion protection system to IST Power specification 704-60180.

The HV line and neutral HV-Connex sockets are mounted in a separate Midel filled disconnection chamber. The chamber is fitted with removable access covers, drain, and fill valves.

The LV output bushings are connected to a 3-pole ABB ACB. The ACB output is connected to phase busbars that are drilled to accept 6 cables per phase. The neutral and earth bushings are connected through removable links. The neutral and earth busbars will accept 3 cables per phase. Cable entry is through a bottom undrilled gland plate. Access to the ACB and busbar terminations is through a front mounted padlockable door.

1.3.2 Auxiliary Equipment

The transformers are fitted with the following equipment: -

1) A Pressure Relief Device with trip contacts is mounted on the tank side with a duct to direct any expelled Midel towards ground level.

2) A Buchholz Relay with alarm and trip contacts is fitted in the conservator pipework.

3) A liquid temperature gauge with alarm contacts to monitor the top liquid temperature.

2) A liquid level gauge with alarm and trip contacts is fitted to the conservator tank to monitor the liquid level.

SECTION 2

INSTALLATION INSTRUCTIONS

2.1 Introduction

These instructions are intended to give guidance and assistance in the installation and maintenance of the Midel 7131 filled 3 phase earthing auxiliary power transformer.

2.2 Method of Despatch

Every precaution is taken to ensure that the equipment will arrive at its destination in perfect condition.

The units are despatched completely assembled, finished, and tested on dedicated road transport to the designated packing company. The transformers are then individually packed in wooden crates suitable for sea transport.

2.3 Unpacking and Examination upon Arrival

Immediately upon arrival the equipment should be thoroughly examined externally. Any damage should be reported at once to the Carrier and to IST Power Ltd quoting the Advice Note details to enable a claim to be lodged with the responsible party. Any deficiencies of material should also be notified to the Carrier and to IST Power Ltd immediately.

2.4 Handling

When lifting the equipment use the four lifting points, painted yellow, provided with the correct lifting slings through each lifting point. Great care must be taken not to knock or damage the equipment. Lifting weight of complete unit is 14290kg. Lifting should be supervised by trained, experienced personnel. Jacking lugs are provided on each side of the transformer tank. Jacking the transformer should only be undertaken by experienced installation personnel.

2.5 Storage

The unit is suitable for storing outdoors, if required, until commissioned.

2.6 Location

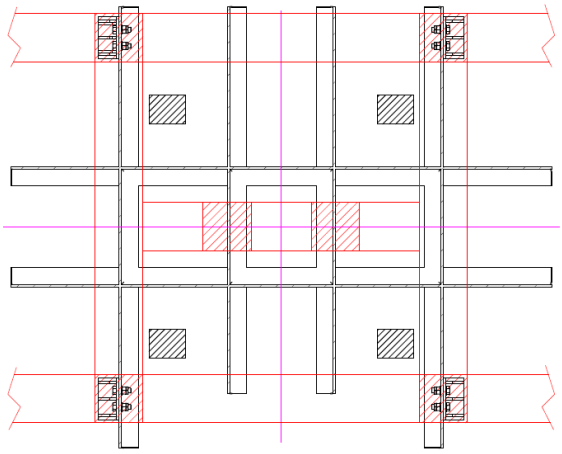
As this transformer is a static unit the location is of course fixed. Care must be taken to protect the unit from severe environments i.e., pollution from active chemicals, hot air blasting unit or any elements not deemed normal. The unit is despatched filled with Midel to the correct operating level for use outdoors with heavy duty paint finish.

2.7 Foundation and Connections

1) The transformer must be mounted on a flat level surface. If necessary, the transformer must be packed/shimmed at the six mounting points to ensure that the transformer is properly supported. The transformer feet are bolted to the transformer. After positioning, the transformer feet must be welded to the deck plate. This arrangement enables the transformer to be subsequently removed from the installation.

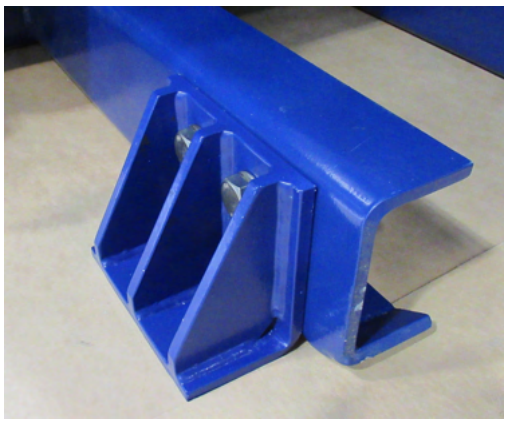
Base Fixing Angle Welding

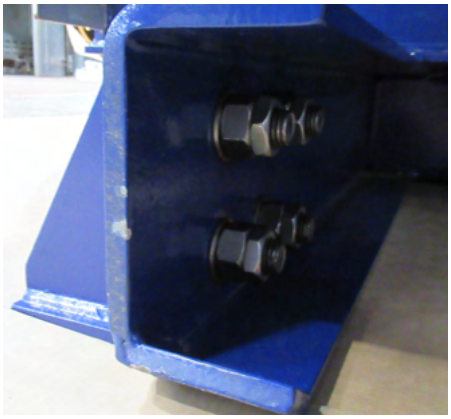
2) Lift and position the transformer on the platform. Pack/shim the transformer as necessary under the six mounting points to ensure the transformer is properly supported.



Extract from drawing 011703 showing the six mounting pads

3) Remove each base fixing angle in turn and remove the paint from the bottom flange to enable the angle to be fully welded to the platform.
NOTE Each screw is coated with and anti-seize grease. This must not be removed.





View of Base Fixing Angle showing 4 x M20 screw arrangement

4) Replace each base fixing angle onto the transformer and fix with the four mounting screws. Tighten to 100Nm.

5) Weld each angle to the platform on the three accessible sides. The weld should be 10mm fillet minimum.

6) Remove all the base fixing angle mounting screws and lift the transformer away.

7) Weld the remaining side of each base fixing angle to the platform pads.

8) Check the welds and paint as required for the platform.

9) Reposition the transformer in place, fit the four M20 fixing screws to each base fixing angle and tighten in two stages. Stage 1: 100Nm. Stage 2: 300Nm.

10) All damaged paintwork must be repaired.

11) The LV connection leads to the MCCB should be taken through cable entries provided by others and the connections fastened securely to the terminals. The gland plate is non-magnetic. Approved glands and cable terminations should be used. Ensure the internal earth connections to the gland plate and the box cover are made and secure.

12) The HV leads are connected to the Pfisterer HV-Connex sockets.

13) Ensure that an efficient earth connection is made to the earth terminals on the tank. Each earth pad is coated with protective grease, 3M Molykote 111, to provide long term protection. If this is removed or damaged during installation, then it should be recoated with the same or similar grease.

14) The transformer breather is shipped attached to the transformer but not connected to the conservator breather pipe.

The breather pipe must not be connected to the conservator until the platform assembly is in its Offshore location and all movement of the transformer has been completed.

Refer to Section 3.9 for the pipe installation instruction.

2.8 Schedule of Erection Drawings

011700	858-1106-4009-001	Outline and General Arrangement
011701	858-1106-4010-001	Rating and Diagram Plate
011702	858-1106-4020-001	Auxiliary Schematic Diagram
011703	858-1106-4019-001	Foundation Plan

SECTION 3

COMMISSIONING INSTRUCTION

3.1 General

Check the equipment for any obvious signs of damage, loose items and contamination by water or other substances. Check the Midel level.

3.2 Transformer Commissioning

The following electrical tests should be carried out on the equipment.

NOTE: – Testing must be carried out by a suitably qualified and experienced test engineer.

NOTE: - Under no circumstances is any HV testing to be carried out on the transformer without the HV Phase and Neutral connectors or Pfisterer dummy plugs being fitted. Testing without these fittings may damage the bushings irreparably.

3.3 Site Acceptance Tests

Site Acceptance tests should be carried out in accordance with the Site Acceptance Test Plan in Appendix J.

3.4 Paintwork

The exterior paintwork should be inspected, and any damage caused through transport, installation or commissioning should be made good immediately. This step is essential given the offshore location of the transformer.

The final colour is Roundel Blue to BS381C Shade 110, Full Gloss. The paintwork repair procedure is detailed in specification 704-60180 in Appendix H.

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3.5 Pressure Relief Device

An auto re-setting pressure relief device is mounted on the side of the main tank. It is set to release any pressure built up above 5.8psi (40kPa). A change-over contact indicates operation.

Operation of this device is usually an indication of major failure with the tank.

See appendix B for manufactures details

3.6 Buchholz Relay

A Buchholz relay type BS50LA is fitted in the pipework between the conservator and the main tank. This gas detection device is fitted with normally open switches factory set.

See Appendix C for manufacturing details

3.7 Output ACB

The output is a 1600A ABB E2B16 3 pole ACB, Withdrawable and Motorised fitted with PR121 Control Unit. Refer to the manufacturer's instruction manual for commissioning instructions.

Refer to Appendix D for manufacturers details.

3.8 Dehydrating Breather

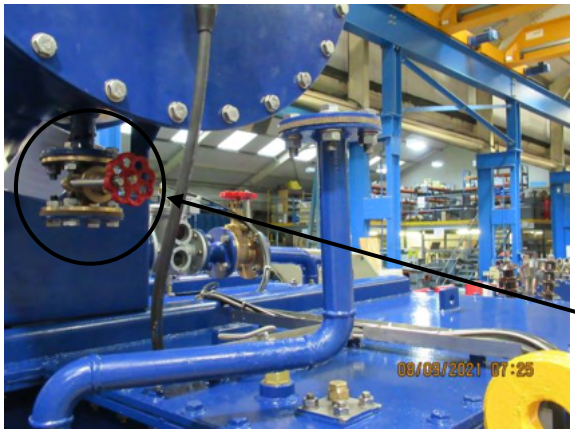
The dehydrating breather is an ABB/Comem SDB-14C Refer to the manufacturer's instruction manual for commissioning instructions.

Refer to Appendix E for manufacturers details

3.9 Dehydrating Breather Pipe Installation

Note: This installation must only be done when the transformer is in its final Offshore location when no further movement of the transformer will occur.
If the pipework is installed before this, Midel will be able to enter the dehydrating breather and the breather will be damaged.

a) Undo the four screws holding the cover plate on the breather pipe stop valve. Remove and discard the cover plate and gasket.

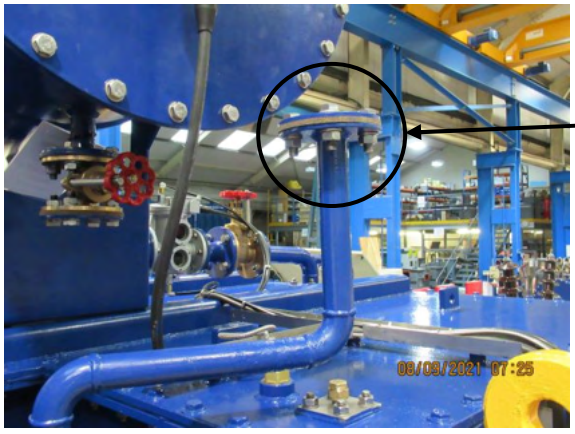


b) Place a 5-litre container beneath the stop valve. Undo the valve and allow any Midel to drain into the container.

c) When completely drained, remove the four screws holding the stop valve in place and remove the valve and gasket. Discard the valve; this will not be required.

d) Ensure that the breather pipe is fully drained. Use a lint free cloth to remove any internal liquid if necessary.

e) Remove the four screws holding the cover plate and gasket at the top of the breather pipe. Discard the plate but retain the gasket.



f) Remove the four screws from the flange at the bottom of the breather pipe and rotate the pipe 90° to bring the pipe top flange under the conservator breather pipe flange.

Breather pipe bottom flange fixing screws

Top breather pipe flange correctly fitted to conservator pipe flange. Note correct orientation of the fixing screws.

g) At the bottom, ensure that the gasket is in place and refit the four screws hand tight only.

h) At the top, fit a gasket between the two flanges and fit four screws hand tight only.

i) Check that the breather pipe properly fits both flanges, then tighten all fasteners.

j) Wipe down any Midel spillage.

k) Repair any damaged paintwork.

SECTION 4

OPERATING INSTRUCTIONS

4.1 Unit Isolation

The transformer has no inherent means of input isolation. The supply to the transformer of 66000 Volts 3 phase must therefore be isolated remotely and the terminals earthed down.

ISOLATE ALL SUPPLIES PRIOR TO WORKING ON THIS EQUIPMENT.

4.2 HV Disconnection Links

Removal and replacement of the HV disconnection link for cable testing involves draining and refilling the disconnection chamber. To ensure the complete filling of the Disconnection Chamber the filling must be done under vacuum.

The quantity of Midel involved is 1500 litres and the storage container(s) used must be new, clean, and dry and be capable of being sealed whilst containing the Midel to prevent the ingress of debris and, particularly, moisture.

All equipment used must be new, clean, and dry to prevent cross contamination.

Valves, access plates, etc. are referenced on the Outline general Arrangement drawing 011700, 858-1106-4009-001.

All applicable HSE and site rules must be followed. All supplies to the transformer should be isolated.
Spill kits should be always on hand during this operation.

4.2.1 Connect a flexible hose to the Disconnection Chamber drain valve, 22. The hose requires a DN25 PN16 adaptor to fit the valve and must be used with a gasket. Connect free end of the hose to the Midel containers. The Midel quantity is 1500 litres.

4.2.2 Remove the cover plate & gasket from the Disconnecting Chamber Filling valve, 21.

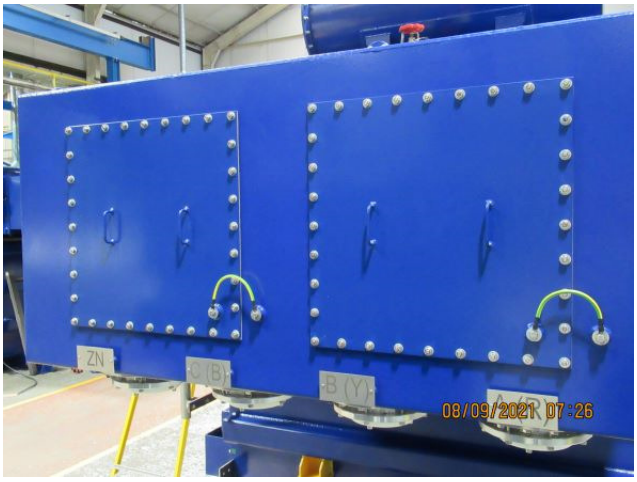
4.2.3 Close the Disconnection Chamber isolating valve, 20.

4.2.4 Open the Disconnection Chamber drain valve, 22.

4.2.5 Open the Disconnecting Chamber filling valve, 21. Control the flow of Midel with the drain valve, 22.

4.2.6 When the chamber is empty, close the drain valve, 22, remove the drain hose from the drain valve, 22, and close the filling valve, 21. Seal the Midel containers.

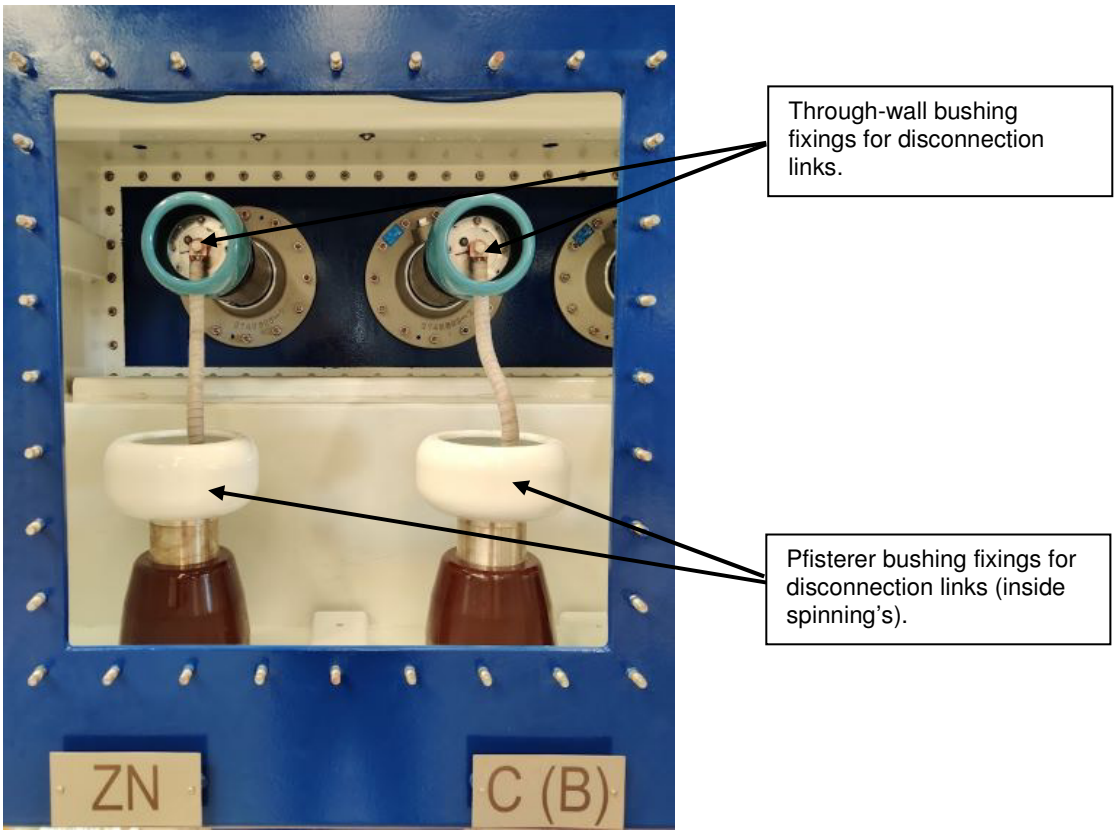
4.2.7 Disconnect the earth straps and remove the two front access covers, 19. Take care not to damage the gaskets. It is acceptable to reuse the gaskets at this stage if they are not damaged. If there is any doubt, use a new gasket when reassembling.



View of Disconnection Chamber front covers with earth straps

4.2.8 Undo and remove the four-disconnection link fixing screws from the through-wall bushings.

4.2.9 Undo and remove the four-disconnection link fixing screws from the Pfisterer HV-Connex sockets.



Internal View of Disconnection Chamber with disconnection links in place

4.2.10 Carefully remove the four-disconnection links and all fixing screws and place in a sealable clean container or bag ready for re-use.

4.2.11 Earth straps are provided for earthing both the transformer and the Pfisterer bushings. These are to be used as required.

Internal View of Disconnection Chamber with all earth links in place

4.2.12 Each earth link is labelled. Use only in the designated position. To withstand the test voltages, the earth links must be assembled as in the photograph so that clearances are maintained.
The labels must not be left in place while testing. Remove the labels before testing.
When testing is complete, attach each label to the correct lead before the lead is removed.

4.2.13 Re-fit both access covers, 19, with new gaskets if required.

4.2.14 Attach a filling hose, fitted with a DN25 PN16 adaptor, to the Conservator drain valve, 14. The free end of the filling hose must be below the surface of the Midel in the container.

4.2.15 Remove the cover plate from the Conservator filling flange, 13.

4.2.16 Attach a vacuum hose fitted with a DN50 PN16 flange adaptor to the filling flange, 13. The flange adaptor should be fitted with an isolation valve and an air release valve.

4.2.17 Disconnect and seal the conservator breather pipe.

4.2.18 The conservator stop valves, 15, remain open.

4.2.19 Open the Disconnection Chamber isolation valve, 20. This will allow the Midel in the conservator to flow into the Disconnecting Chamber. The free end of the filling hose must be below the surface of the Midel in the storage container(s).

4.2.20 Switch on the vacuum and reduce the pressure in the conservator and disconnection chamber to 550 – 500 mbar absolute.

WARNING: The pressure must not go below 500 mbar absolute.

4.2.21 Open the drain valve, 14, and suck the Midel into the conservator and disconnection chamber. The fill rate should be controlled with the drain valve to 1500-2000 litres per hour.

4.2.22 WARNING. At no time should the free end of the filling hose be allowed to be out of the Midel. If a second container has been used then the drain valve, 14, must be closed during the changeover of containers.

4.2.23 Fill until the conservator has reached its normal level.
NOTE: It may be necessary to add additional Midel to that which was drained as some will be 'lost' in the draining equipment.

4.2.24 Close the drain valve, 14. Close the vacuum pump isolation valve and switch off the vacuum pump.

4.2.25 Open the vacuum bleed valve and allow the pressure in the conservator to rise to atmospheric pressure.

4.2.26 Remove the conservator pipe seal and reconnect the breather.

4.2.27 Allow 12 hours after filling before energising the Disconnecting Chamber.

To refit the Disconnection Links, follow the procedure from 4.2.1 to 4.2.26 but noting the following: -

a) Cleanliness is always vital. No dust or debris can be allowed into the chamber.

b) The procedure should be carried out in dry conditions.

c) New gaskets should always be used.

4.2.28 After 24 hours check for Midel leaks.

4.2.29 Repair any damaged paintwork in accordance with the repair procedure in paint specification 704-60180.

SECTION 5

MAINTENANCE INSTRUCTIONS

MAINTENANCE MUST ONLY BE CARRIED OUT WHEN THE EQUIPMENT HAS BEEN TOTALLY ISOLATED.

5.1 Transformer

The insulating liquid is Midel 7131 synthetic ester. See Appendix A for the safety data sheet. Midel samples should be taken via sampling valve provided for DGA analysis.

Midel Sampling

Following commissioning Midel samples should be taken at the following intervals:-

a) after 6 months
b) after 12 months
c) after 60 months
d) thereafter every 10 years

The samples should have physical analysis, DGA, water content and breakdown strength measured and recorded for on-going monitoring. Any trend that indicates a deterioration of the transformer should be noted and the frequency of sampling increased as required.

After taking any Midel sample check that the liquid level is correct via the liquid level gauge. Taking a liquid sample will remove 2.5 - 3 litres of Midel.

Replace or top up with Midel to BS EN/IEC 61099: 2010

5.2 Pressure Relief Device

The rating of the micro switch is such that no maintenance of the contacts will be required during the life of the transformer. However, it is advisable that the contacts be checked every twelve months for correct switching by manual operation of the switch. See Appendix B for manufacturer's data.

5.3 Buchholz Relay

The rating of the micro switches is such that no maintenance of the contacts will be required during the life of the transformer. However, it is advisable that the contacts be checked every twelve months for correct switching by manual operation of the switches. See Appendix C for manufacturer's data.

5.4 Output ACB

The output 600A ABB E2B16 3 pole ACB, Withdrawable and Motorised fitted with PR121 Control Unit should be maintained in accordance with the manufacturer's instructions.

Refer to Appendix D for manufacturers details.

5.5 Dehydrating Breather

The ABB/Comem SDB-14C self-dehydrating breather should be maintained in accordance with the manufacturer's instructions.

Refer to Appendix E for manufacturers details.

5.6 General

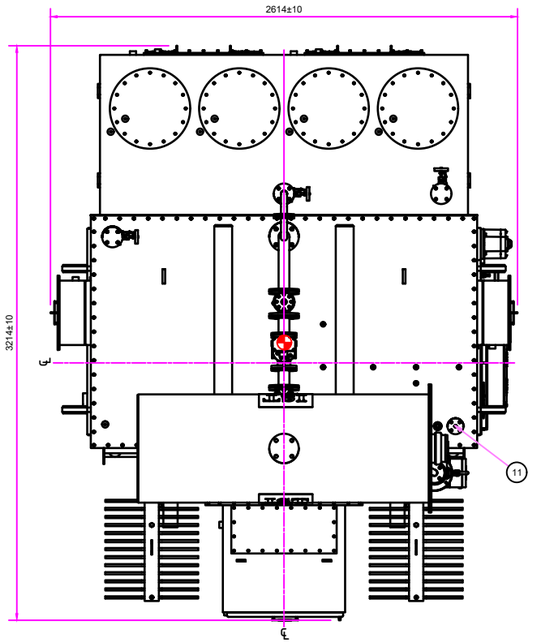
The paintwork should be touched up where required. Refer to paint specification 704-60180 in Appendix H.

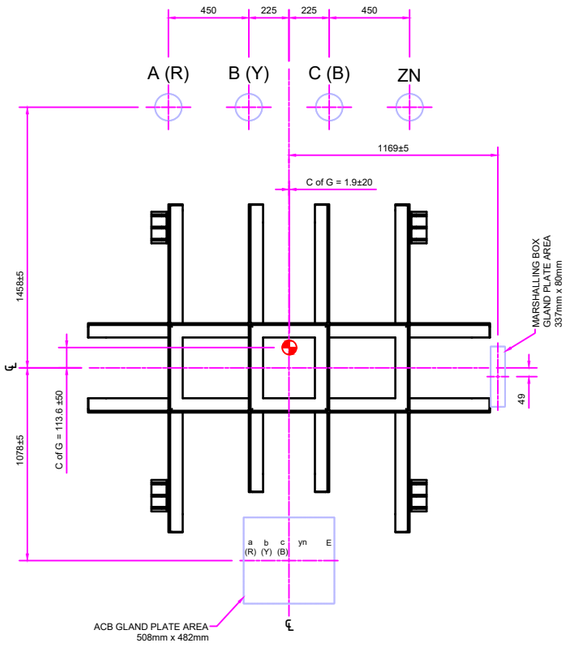
The transformer liquid level should be checked at the oil level gauge. The level will be affected by the ambient temperature and the operating load on the transformer. The whole transformer should be checked for oil leaks.

SECTION 6

LIST OF DRAWINGS

011700	858-1106-4009-001	Outline and General Arrangement
011701	858-1106-4010-001	Rating and Diagram Plate
011702	858-1106-4020-001	Auxiliary Schematic Diagram
011703	858-1106-4019-001	Foundation Plan





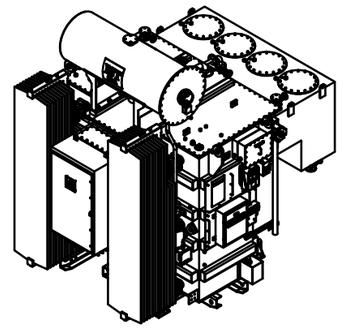
TRANSFORMERS TAG & SERIAL NUMBERS			
DESCRIPTION	TRANSFORMER 1	TRANSFORMER 2	TRANSFORMER 3
TRANFORMER	EAT-OBT-0301	EAT-OBT-0302	EAT-OBT-0303
MARSHALLING BOX	EATMB-OBT-0301	EATMB-OBT-0302	EATMB-OBT-0303
IST SERIAL NUMBER	102287/1-01	102287/1-02	102287/1-03

LV CABLE ALLAWANCE	
PHASES	6 x 300mm2 EACH
NEUTRAL	3 x 300mm 2
EARTH	3 x 300mm2

ESTIMATED WEIGHTS	
CORE AND COILS	4800 KG
COOLING LIQUID - MIDEL 7131	5455 LT
TOTAL WEIGHT (+-1000KG)	14230 KG

850kVA 66kV 420V EARTHING AUXILIARY TRANSFORMER	
ITEM	DESCRIPTION
1	LINE AND NEUTRAL CONNECTIONS - SIZE 4 PFISTERER
2	1600A 3 POLE MCCB. ABB TYPE E2B16 CAT No 1SDA055810R1
3	LOW MAINTENANCE BREATHER
4	PRESSURE RELIEF DEVICE WITH OIL DIRECTION DUCT
5	OIL TEMPERATURE INDICATOR
6	OIL LEVEL INDICATOR
7	BUCHHOLZ RELAY
8	MARSHALLING BOX C/W TAG NUMBER LABEL
9	CT TEST LOOP TERMINAL BOX
10	CORE EARTH BUSHING C/W GUARD
11	THERMOMETER WELL
12	CONSERVATOR
13	CONSERVATOR OIL FILLING FLANGE - DN50
14	CONSERVATOR DRAIN VALVE - DN25
15	CONSERVATOR INSOLATING VALVE
16	GAS SAMPLING AND BUCHHOLZ TEST VALVES
17	DRAIN / SAMPLING VALVE - DN25 C/W GUARD
18	TOP FILTER VALVE - DN25
19	DICONNECTING CHAMBER ACCES COVER
20	DISCONNECTING CHAMBER INSOLATING VALVE
21	DISCONNECTING CHAMBER FILLING VALVE - DN25
22	DISCONNECTING CHAMBER DRAIN VALVE - DN25
23	EARTH LUGS WITH 14DIA HOLES
24	JACKING POINT
25	SKID UNDERPASE WITH 45DIA HAULAGE HOLES
26	LASHING EYE
27	MAIN LIFTER WITH 45DIA HOLE
28	RATING AND DIAGRAM PLATE
29	RADIATOR C/W INSOLATING VALVES
30	TRANSFORMER TAG NUMBER LABEL

TRANSFORMER RATING	
kVA	850
VOLTS	66000 / 420
AMPS	7.44 / 1168.4
CONNECTION	ZNyn1
POSITIVE SEQUENCE IMPEDANCE	5% ±10%
ZERO SEQUENCE IMPEDANCE	42Ω/PH - 50.4Ω/PH
ZERO SEQUENCE RESISTANCE	5.625Ω/PH - 6.85Ω/PH
ZERO SEQUENCE IMPEDANCE	42.4Ω/PH - 50.9Ω/PH



PAINT SPEC:

IST POWER SPECIFICATION 704-60180 C5M(H)
(REF No LF000009-PET001-SPF-E12-512-01)

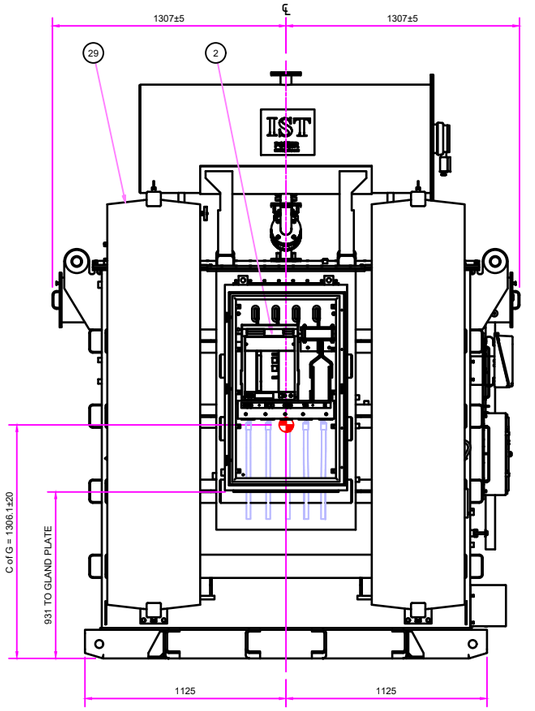
FINAL COLOUR: ROUNDEL BLUE TO BS381C SHADE 110

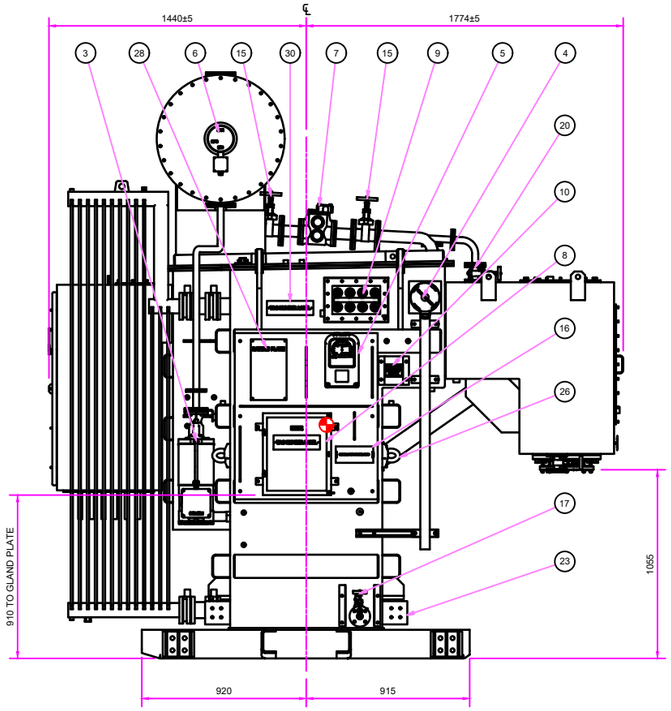
NOTES:

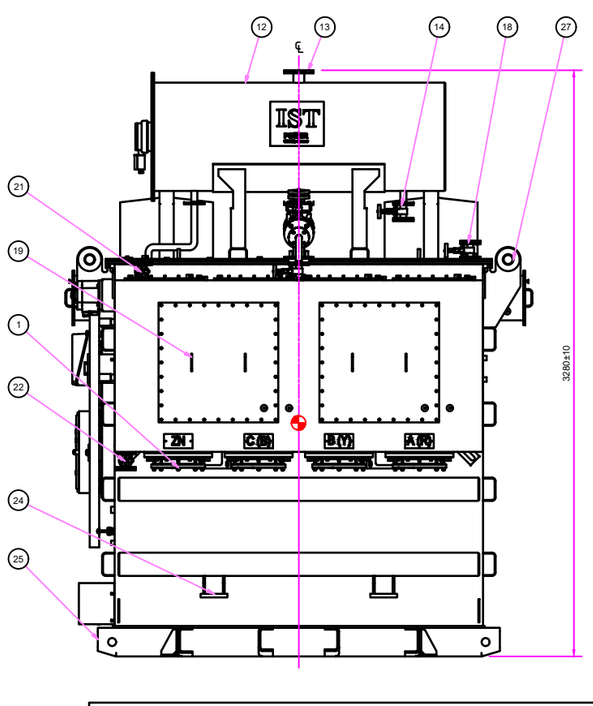
1. ALL DIMENSIONS ARE IN MM AND ELEVATIONS ARE IN M UNLESS OTHERWISE SPECIFIED.

DRAWINGS ASSOCIATED WITH TRANSFORMER:

- 011701 - RATING & DIAGRAM PLATE (REF No. 858_1106_4010_001)
- 011702 - AUXILIARY WIRING DIAGRAM (REF No. 858_1106_4020_001)
- 011703 - FOUNDATION PLAN (REF No. 858_1106_4019_001)
- 011704 - TRANSPORT OUTLINE (REF No. 858_1106_4022_001)







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REV	DATE	REASON FOR ISSUE	BY	CHK	APP
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02	04/08/2020	FOR REVIEW	MK	PWJ	PWJ
01	03/08/2020	FRO REVIEW	MK	PWJ	PWJ

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10 Holliday Street
Birmingham
B1 1TF

iST POWER
LONGLEY LANE
MANCHESTER
M22 4RU
+44 (0)161 428 9507

PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

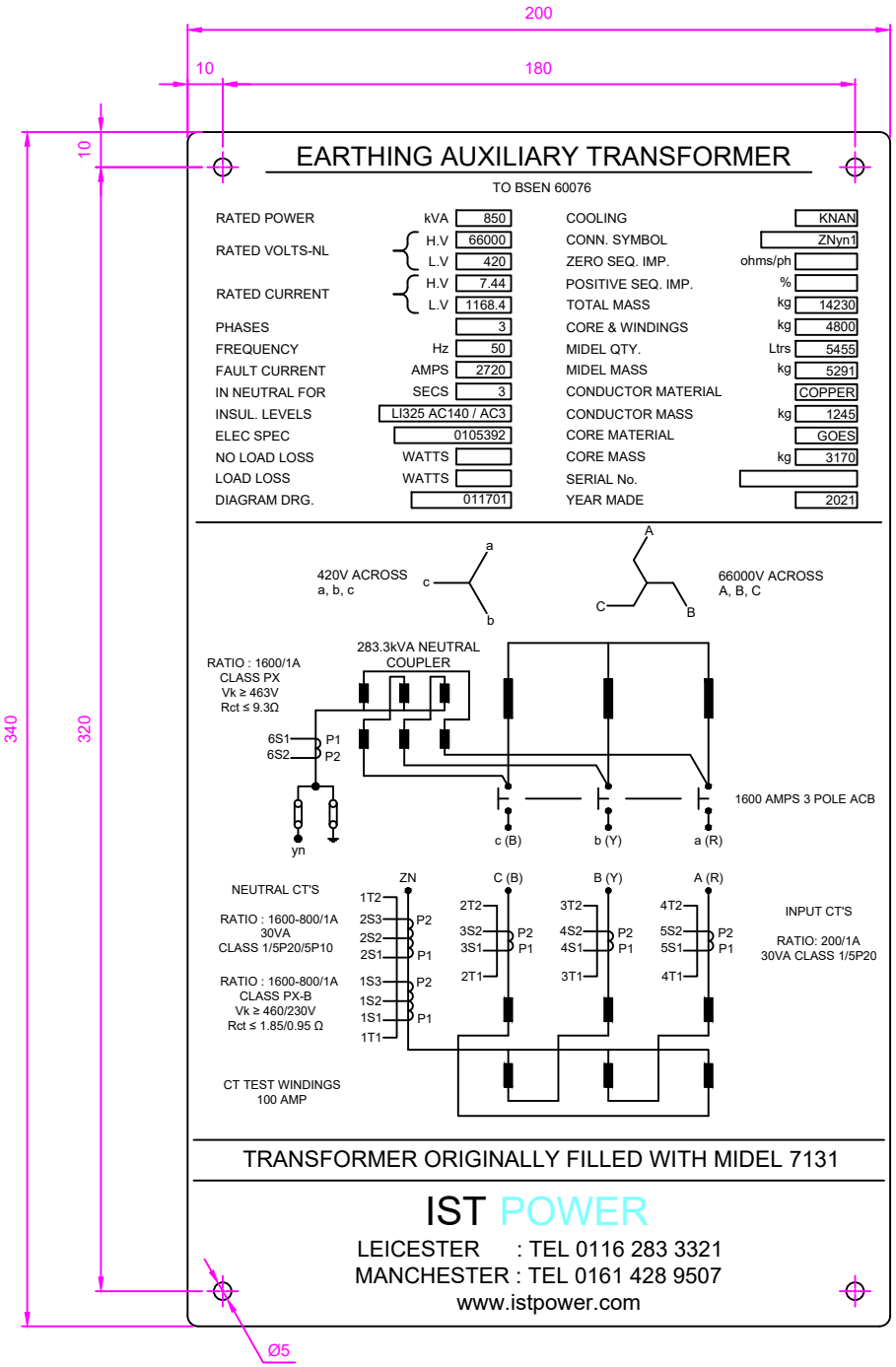
DRAWING TITLE
GENERAL ARRANGEMENT OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
1:16	22/07/2020	28/07/2020	28/07/2020	28/07/2020

CONTRACTOR DRAWING NUMBER	REVISION
011700	04

SWEL/SSE DRAWING NUMBER	SHEET No	REVISION
858_1106_4009_001	001 OF 001	04



EARTHING AUXILIARY TRANSFORMER

TO BSEN 60076

RATED POWER	kVA	850	COOLING		KNAN
RATED VOLTS-NL	H.V	66000	CONN. SYMBOL		ZNyn1
	L.V	420	ZERO SEQ. IMP.	ohms/ph	
RATED CURRENT	H.V	7.44	POSITIVE SEQ. IMP.	%	
	L.V	1168.4	TOTAL MASS	kg	14230
PHASES		3	CORE & WINDINGS	kg	4800
FREQUENCY	Hz	50	MIDEL QTY.	Ltrs	5455
FAULT CURRENT	AMPS	2720	MIDEL MASS	kg	5291
IN NEUTRAL FOR	SECS	3	CONDUCTOR MATERIAL		COPPER
INSUL. LEVELS	LI325 AC140 / AC3		CONDUCTOR MASS	kg	1245
ELEC SPEC	0105392		CORE MATERIAL		GOES
NO LOAD LOSS	WATTS		CORE MASS	kg	3170
LOAD LOSS	WATTS		SERIAL No.		
DIAGRAM DRG.	011701		YEAR MADE		2021

TRANSFORMER ORIGINALLY FILLED WITH MIDEL 7131

IST POWER

LEICESTER : TEL 0116 283 3321

MANCHESTER : TEL 0161 428 9507

www.istpower.com

TRANSFORMERS TAG & SERIAL NUMBERS			
DESCRIPTION	TRANSFORMER 1	TRANSFORMER 2	TRANSFORMER 3
TRANFORMER	EAT-OBT-0301	EAT-OBT-0302	EAT-OBT-0303
MARSHALLING BOX	EATMB-OBT-0301	EATMB-OBT-0302	EATMB-OBT-0303
IST SERIAL NUMBER	102287/26-01	102287/27-01	102287/28-01

MATERIAL : 1 THK STAINLESS STEEL GRADE 316

NOTE : REMOVE ALL SHARP EDGES AND CORNERS

ENGRAVE OR SCREEN PRINT.
TO BE SUITABLE FOR HARSH ENVIRONMENT.

ZERO SEQUENCE IMPEDANCE, POSITIVE SEQUENCE IMPEDANCE, NO LOAD LOSS, LOAD LOSS, YEAR MADE & SERIAL NUMBER ARE TO BE ENGRAVED AFTER TEST.

ALL LETTERS TO BE BLACK

DRAWINGS ASSOCIATED WITH TRANSFORMER:

- 011700 - GENERAL ARRANGEMENT / OUTLINE (REF No. 858_1106_4009_001)
- 011702 - AUXILIARY WIRING DIAGRAM (REF No. 858_1106_4020_001)
- 011703 - FOUNDATION PLAN (REF No. 858_1106_4019_001)
- 011704 - TRANSPORT OUTLINE (REF No. 858_1106_4022_001)

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Code 3 Rejected		Code 4 Information	

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02	04/08/2020	FOR REVIEW	MK	PWJ	PWJ
01	01/08/2020	FOR REVIEW	MK	PWJ	PWJ

Petrofac

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WWW.PETROFAC.COM

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AN ABB & SNC-LAVALIN COMPANY

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Axis Building
10 Holliday Street
Birmingham
B1 1TF

PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

DRAWING TITLE
RATING & DIAGRAM PLATE OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

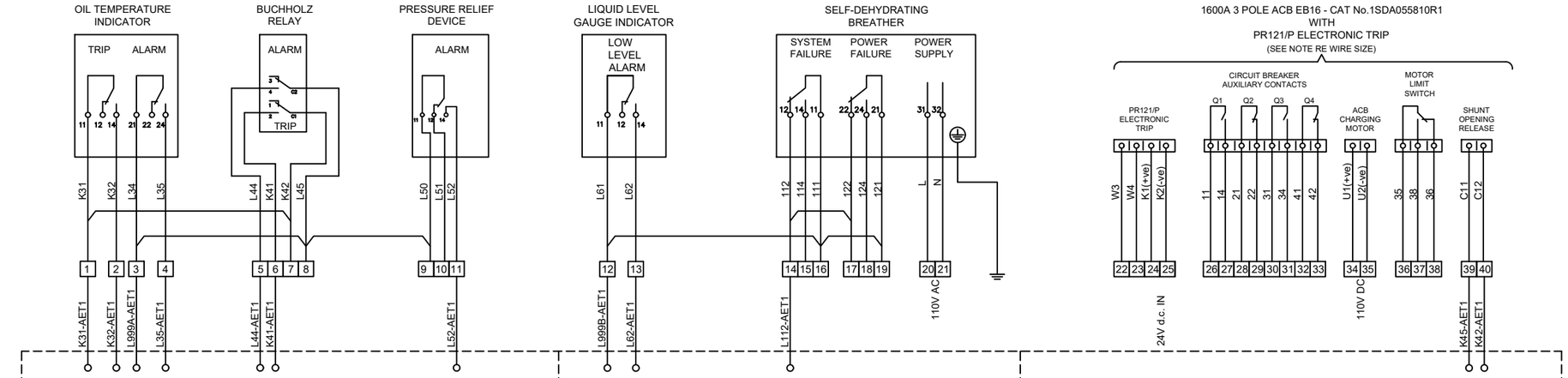
iST POWER
LONGLEY LANE
MANCHESTER
M22 4RU
+44 (0)161 428 9507

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A3	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
1:1.5	01/08/2020	01/082020	03/08/2020	03/08/2020

CONTRACTOR DRAWING NUMBER: 011701 — REVISION: 04

SWEL/SSE DRAWING NUMBER: 858_1106_4010_001 — SHEET No: 001 OF 001 — REVISION: 04

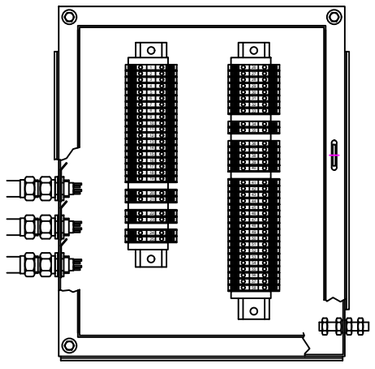


INSTRUMENT	CONTACTS	OPERATION	COMMENTS
OIL TEMP INDICATOR	1 N.O ALARM 1 N.O TRIP	CONTACT MADE WHEN SET TEMP EXCEEDED	ALARM 90°C TRIP 100°C
BUCHHOLZ RELAY	1 N.O ALARM 1 N.O TRIP	CLOSES ON EXCESS GAS CLOSES ON OIL SURGE	ALARM TRIP
PRESSURE RELIEF DEVICE PRD	1 N.O 1 N.C	CHANGE OVER ON RELEASE	RELEASE AT 5.8 P.S.I.
LIQUID LEVEL INDICATOR	1 N.O ALARM	CONTACT MADE WHEN LIQUID FALLS BELOW SET LEVEL	LOW LEVEL
DEHYDRATING BREATHER	1 N.C. ALARM (CONTACTS 11-12) 1 N.C. ALARM (CONTACTS 21-22)	CONTACT MADE IN ALARM CONDITION CONTACT MADE IN ALARM CONDITION	SYSTEM FAILURE POWER FAILURE

CONTROL WIRING - 2.5mm² P.V.C SWA CABLE (LSZH)
EXCEPT WIRING INTO 1600A 3 POLE ACB EB16 WHICH IS 1.5mm² PVC SWA CABLE

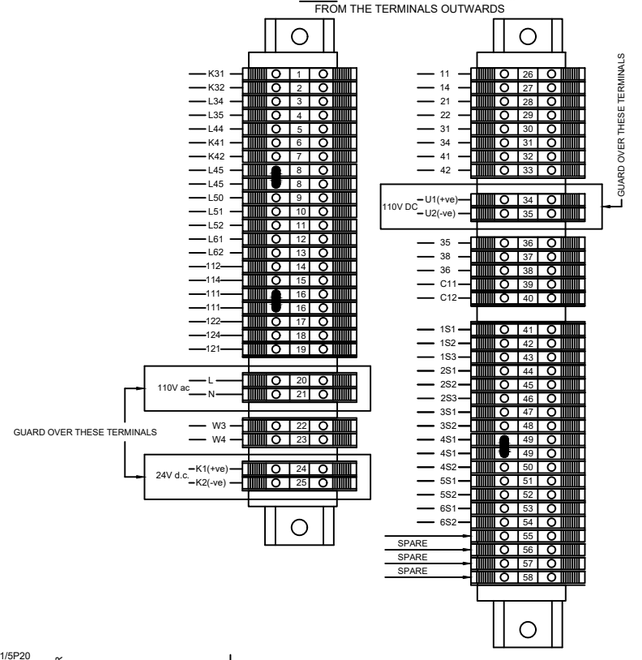
CT WIRING - 2.5mm² P.V.C. SWA CABLE (LSZH)

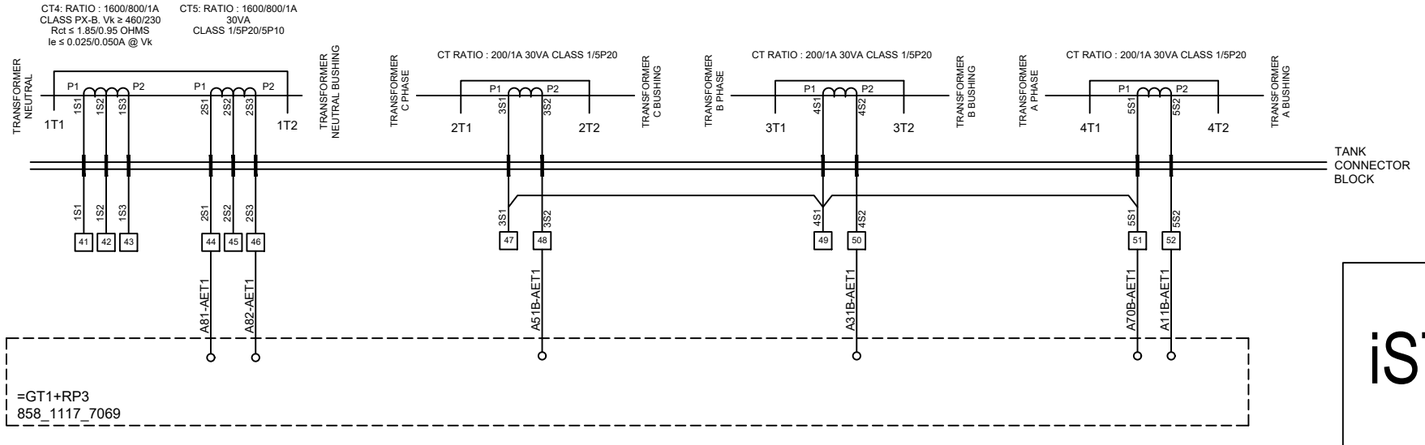
TRANSFORMER TAG & SERIAL NUMBER	
DESCRIPTION	TRANSFORMER 1
TRANFORMER	EAT-OBT-0301
MARSHALLING BOX	EATMB-OBT-0301
IST SERIAL NUMBER	102287/1-01

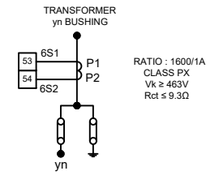


TERMINAL BLOCKS TO BE SPRING LOADED
WEIDMULLER TYPE WDU10SL/EN
WITH HOOK TYPE CABLE TERMINATION.
TERMINAL BLOCKS TO BE NUMBERED.
SEE ENLARGED VIEW.

NOTE : WIRE NUMBERS / FERRULES ARE FROM THE TERMINALS OUTWARDS







NOTES:

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DRAWINGS ASSOCIATED WITH TRANSFORMER:

- 011700 - GENERAL ARRANGEMENT / OUTLINE (REF No. 858_1106_4009_001)
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02	13/08/2020	FOR REVIEW	MK	RK	PWJ
01	12/08/2020	FOR REVIEW	MK	RK	PWJ

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PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

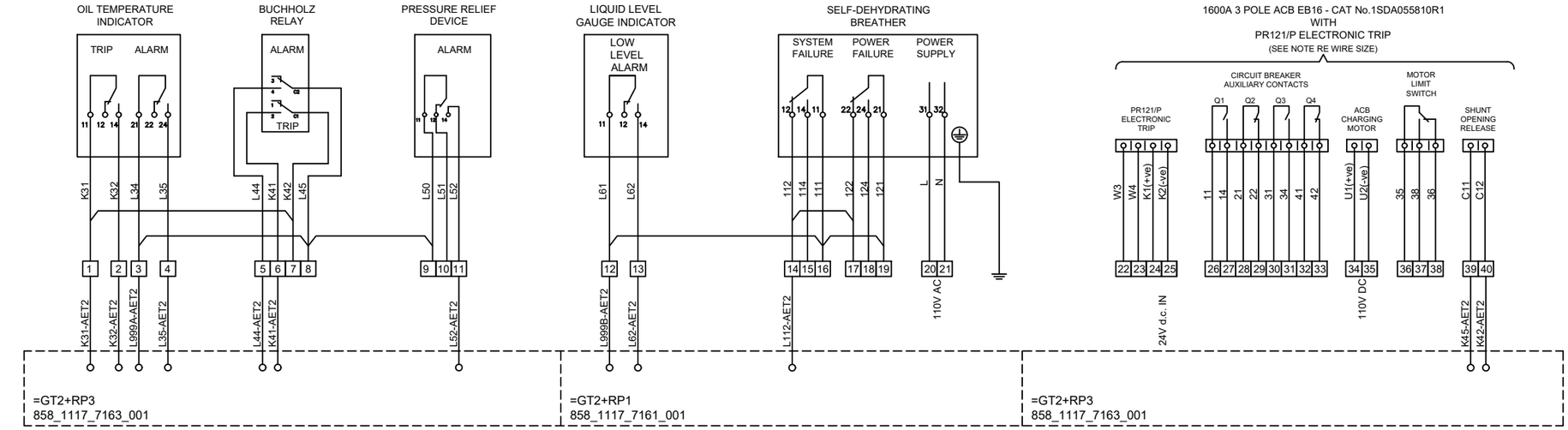
DRAWING TITLE
AUXILIARY WIRING DIAGRAM OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A2	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	12/08/2020	12/08/2020	12/08/2020	12/08/2020

CONTRACTOR DRAWING NUMBER	REVISION
011702	04

SWEL/SSE DRAWING NUMBER	SHEET No	REVISION
858_1106_4020_001	001 OF 003	04



NOTES:

1. ALL DIMENSIONS ARE IN MM AND ELEVATIONS ARE IN M UNLESS OTHERWISE SPECIFIED.

INSTRUMENT	CONTACTS	OPERATION	COMMENTS
OIL TEMP INDICATOR	1 N.O ALARM 1 N.O TRIP	CONTACT MADE WHEN SET TEMP EXCEEDED	ALARM 90°C TRIP 100°C
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LIQUID LEVEL INDICATOR	1 N.O ALARM	CONTACT MADE WHEN LIQUID FALLS BELOW SET LEVEL	LOW LEVEL
DEHYDRATING BREATHER	1 N.C. ALARM (CONTACTS 11-12) 1 N.C. ALARM (CONTACTS 21-22)	CONTACT MADE IN ALARM CONDITION CONTACT MADE IN ALARM CONDITION	SYSTEM FAILURE POWER FAILURE

CONTROL WIRING - 2.5mm² P.V.C SWA CABLE (LSZH)
EXCEPT WIRING INTO 1600A 3 POLE ACB EB16 WHICH IS 1.5mm² PVC SWA CABLE

CT WIRING - 2.5mm² P.V.C. SWA CABLE (LSZH)

TRANSFORMER TAG & SERIAL NUMBER	
DESCRIPTION	TRANSFORMER 2
TRANFORMER	EAT-OBT-0302
MARSHALLING BOX	EATMB-OBT-0302
IST SERIAL NUMBER	102287/1-02

TERMINAL BLOCKS TO BE SPRING LOADED
WEIDMULLER TYPE WDU10SL/EN
WITH HOOK TYPE CABLE TERMINATION.
TERMINAL BLOCKS TO BE NUMBERED.
SEE ENLARGED VIEW.

NOTE : WIRE NUMBERS / FERRULES ARE FROM THE TERMINALS OUTWARDS

DRAWINGS ASSOCIATED WITH TRANSFORMER:

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PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

DRAWING TITLE
AUXILIARY WIRING DIAGRAM OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A2	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	12/08/2020	12/08/2020	12/08/2020	12/08/2020

CONTRACTOR DRAWING NUMBER: 011702 — REVISION: 04

SWEL/SSE DRAWING NUMBER: 858_1106_4020_001 — SHEET No: 002 OF 003 — REVISION: 04

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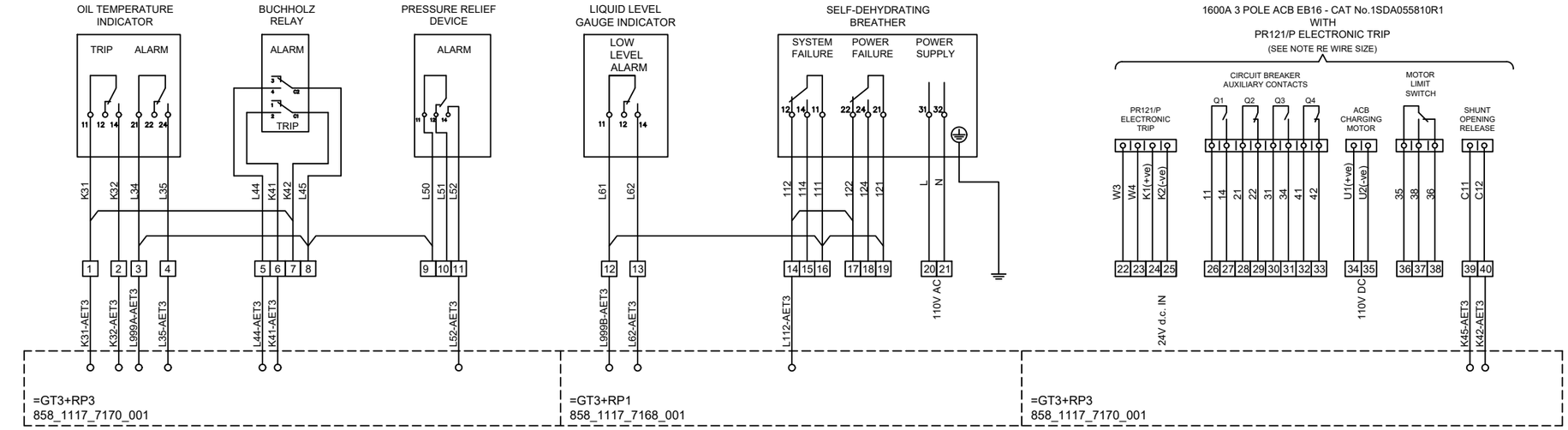

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INSTRUMENT	CONTACTS	OPERATION	COMMENTS
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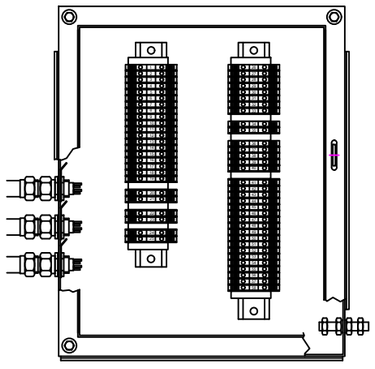
CONTROL WIRING - 2.5mm² P.V.C SWA CABLE (LSZH)
EXCEPT WIRING INTO 1600A 3 POLE ACB EB16 WHICH IS 1.5mm² PVC SWA CABLE

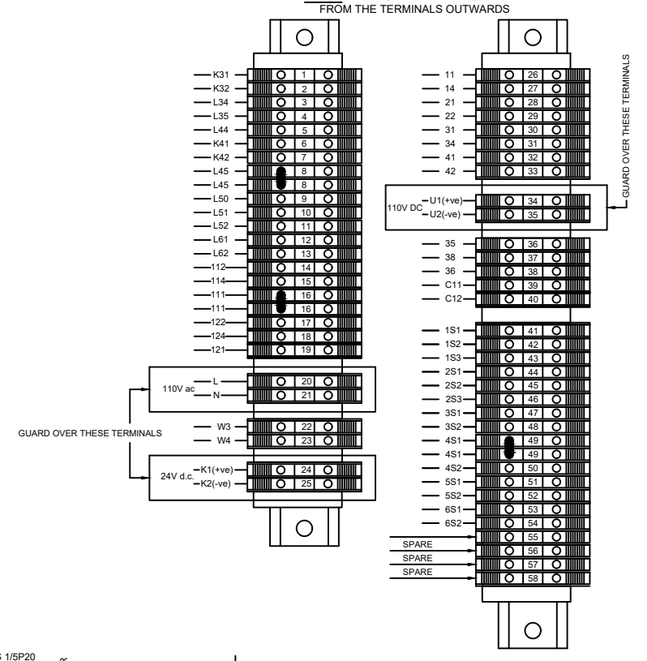
CT WIRING - 2.5mm² P.V.C. SWA CABLE (LSZH)

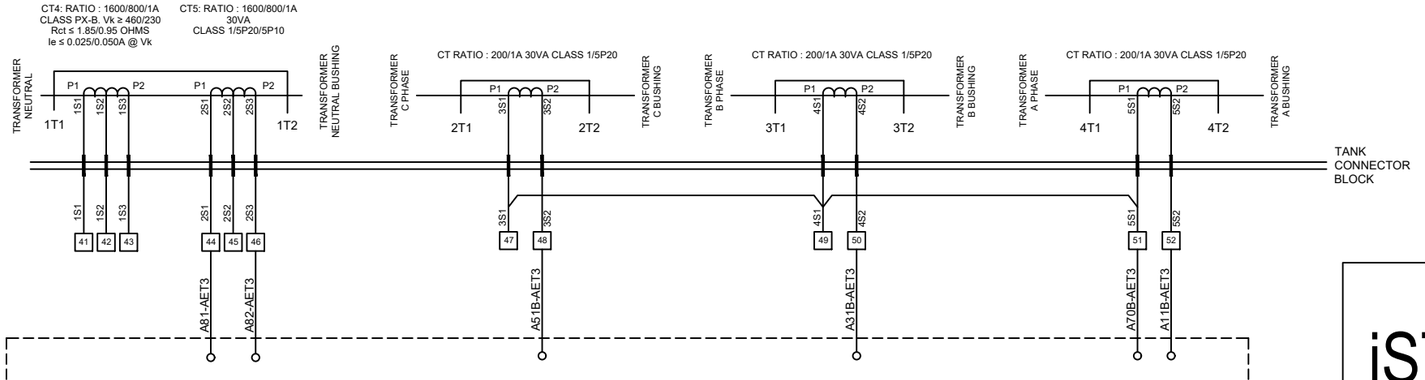
TRANSFORMER TAG & SERIAL NUMBER	
DESCRIPTION	TRANSFORMER 3
TRANFORMER	EAT-OBT-0303
MARSHALLING BOX	EATMB-OBT-0303
IST SERIAL NUMBER	102287/1-03

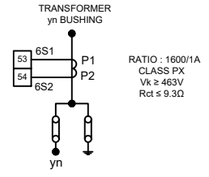


TERMINAL BLOCKS TO BE SPRING LOADED
WEIDMULLER TYPE WDU10SL/EN
WITH HOOK TYPE CABLE TERMINATION.
TERMINAL BLOCKS TO BE NUMBERED.
SEE ENLARGED VIEW.

NOTE : WIRE NUMBERS / FERRULES ARE FROM THE TERMINALS OUTWARDS







DRAWINGS ASSOCIATED WITH TRANSFORMER:

- 011700 - GENERAL ARRANGEMENT / OUTLINE (REF No. 858_1106_4009_001)
- 011701 - RATING & DIAGRAM PLATE (REF No. 858_1106_4010_001)
- 011703 - FOUNDATION PLAN (REF No. 858_1106_4019_001)
- 011704 - TRANSPORT OUTLINE (REF No. 858_1106_4022_001)

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Code 3 Rejected		Code 4 Information	

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01	12/08/2020	FOR REVIEW	MK	RK	PWJ

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PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

DRAWING TITLE
AUXILIARY WIRING DIAGRAM OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A2	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	12/08/2020	12/08/2020	12/08/2020	12/08/2020

CONTRACTOR DRAWING NUMBER: 011702 — REVISION: 04

SWEL/SSE DRAWING NUMBER: 858_1106_4020_001 — SHEET No: 003 OF 003 — REVISION: 04

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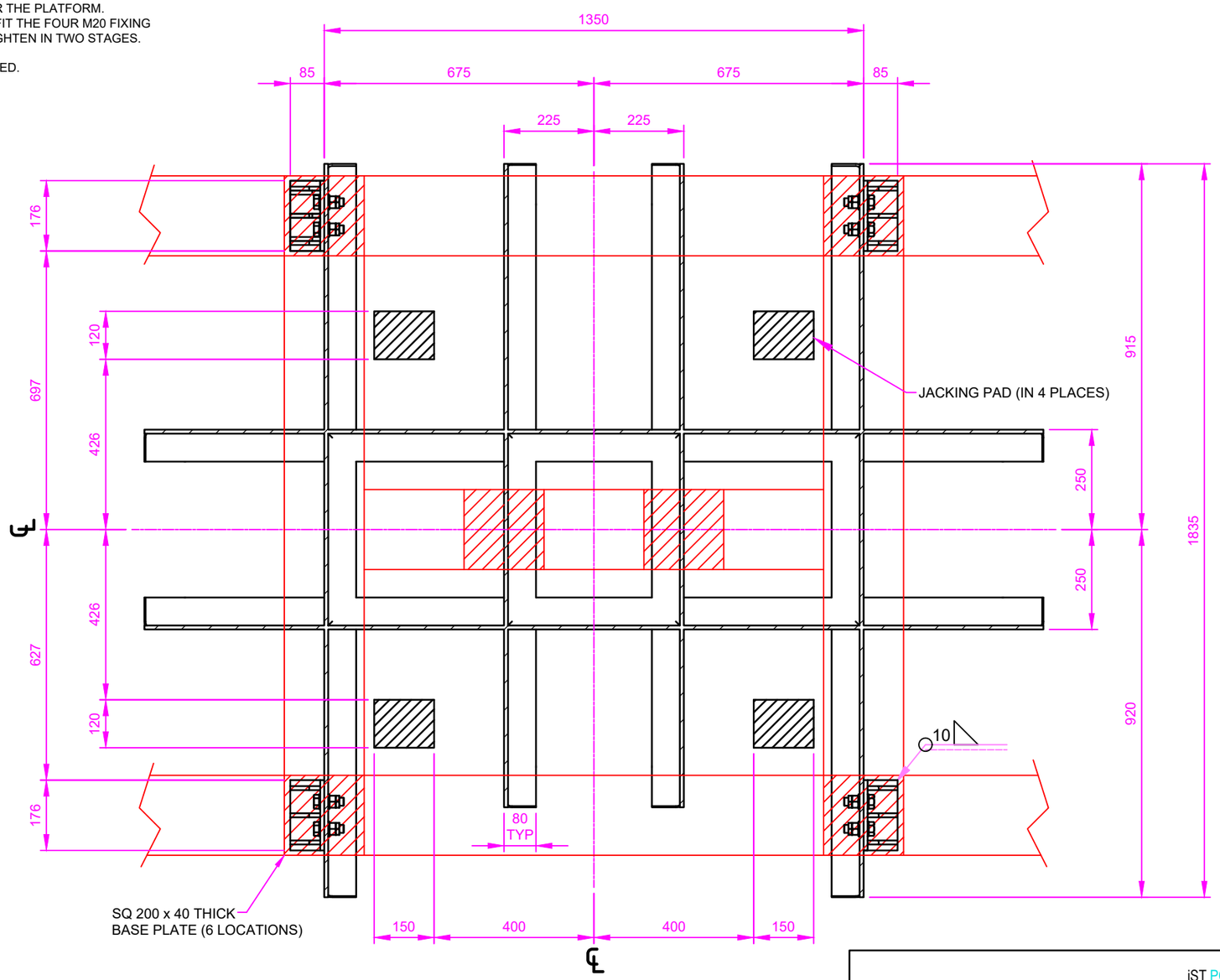
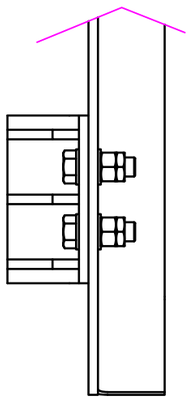
1. THE TRANSFORMER IS SUPPLIED WITH THE FOUR BASE FIXING ANGLES BOLTED IN POSITION.
2. LIFT & POSITION TRANSFORMER ONTO THE PLATFORM. PACK/SHIM THE TRANSFORMER AS NECESSARY UNDER THE SIX MOUNTING PADS TO ENSURE THE TRANSFORMER IS PROPERLY SUPPORTED.
3. REMOVE EACH BASE FIXING ANGLE IN TURN & REMOVE THE PAINT FROM THE BOTTOM FLANGE TO ENABLE THE ANGLE TO BE FULLY WELDED TO THE PLATFORM.
   NOTE: EACH BOLT IS COATED WITH AN ANTI SEIZE GREASE. THIS MUST NOT BE REMOVED.
4. REPLACE EACH BASE FIXING ANGLE AND FIX WITH THE FOUR MOUNTING SCREWS. TIGHTEN TO 100Nm.
5. WELD THE ANGLES TO THE PLATFORM PADS ON THE 3 ACCESSIBLE SIDES. THE WELD SHOULD BE 10mm FILLET MINIMUM.
6. REMOVE ALL BASE FIXING ANGLE BOLTS AND LIFT THE TRANSFORMER AWAY.
7. WELD THE REMAINING SIDES OF THE BASE FIXING ANGLES TO THE PLATFORM PADS.
8. CHECK WELDS AND PAINT AS REQUIRED FOR THE PLATFORM.
9. REPOSITION THE TRANSFORMER IN PLACE, FIT THE FOUR M20 FIXING BOLTS TO EACH BASE FIXING ANGLE AND TIGHTEN IN TWO STAGES. STAGE 1: 100Nm. STAGE 2: 300Nm.
10. ALL DAMAGED PAINTWORK MUST BE REPAIRED.

TRANSFORMERS TAG & SERIAL NUMBERS			
DESCRIPTION	TRANSFORMER 1	TRANSFORMER 2	TRANSFORMER 3
TRANFORMER	EAT-OBT-0301	EAT-OBT-0302	EAT-OBT-0303
MARSHALLING BOX	EATMB-OBT-0301	EATMB-OBT-0302	EATMB-OBT-0303
IST SERIAL NUMBER	102287/1-01	102287/1-02	102287/1-03



NOTE:
MAXIMUM ALLOWANCE FOR BASE PLATE LOADING IS 2350kg EACH

MAXIMUM ALLOWANCE FOR JACKING PAD LOADING IS 14100kg EACH



NOTES:

1. ALL DIMENSIONS ARE IN MM AND ELEVATIONS ARE IN M UNLESS OTHERWISE SPECIFIED.

DRAWINGS ASSOCIATED WITH TRANSFORMER:

- 011700 - GENERAL ARRANGEMENT / OUTLINE (REF No. 858_1106_4009_001)
- 011701 - RATING & DIAGRAM PLATE (REF No. 858_1106_4010_001)
- 011702 - AUXILIARY WIRING DIAGRAM (REF No. 858_1106_4020_001)
- 011704 - TRANSPORT OUTLINE (REF No. 858_1106_4022_001)

Acceptance Codes - to be signed by Seagreen designated signatory only

Code 1 Accepted		Code 2 Accepted with comments	
Code 3 Rejected		Code 4 Information	

REV	DATE	REASON FOR ISSUE	BY	CHK	APP
04	01/09/2021	FOR REVIEW	MK	PWJ	PWJ
03	07/10/2020	FOR REVIEW	MK	PWJ	PWJ
02	04/08/2020	FOR REVIEW	MK	PWJ	PWJ
01	03/08/2020	FOR REVIEW	MK	PWJ	PWJ

sse | Sea green WIND ENERGY

Petrofac

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Linxon UK
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Axis Building
10 Holliday Street
Birmingham
B1 1TF

PROJECT TITLE
SEAGREEN OFFSHORE WIND FARM

DRAWING TITLE
FOUNDATION PLAN OF
850kVA 66kV 420V OFFSHORE
EARTHING AUXILIARY TRANSFORMER

DRAWING STATUS
REVIEW

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	MK	MK	PWJ	PWJ
SHEET SCALE	DATE	DATE	DATE	DATE
1:6 / 1:3	03/08/2020	03/08/2020	03/08/2020	03/08/2020

CONTRACTOR DRAWING NUMBER: 011703 — REVISION: 03

SWEL/SSE DRAWING NUMBER: 858_1106_4019_001 — SHEET No: 001 OF 001 — REVISION: 03

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SECTION 7

Appendix A

Midel 7131 Cooling Liquid

Midel technical Information Pack (18 pages)

MIDEL® 7131
Transformer Fluid

Technical Data Sheets

MIDEL®

MIDEL® 7131

Dielectric Insulating Fluid Overview

MIDEL 7131 Product Overview

MIDEL 7131 is a synthetic ester-based dielectric fluid that has been serving the global transformer market for over 30 years. MIDEL 7131 has been specifically formulated to provide a safe, superior alternative to traditional fluid and dry-type transformers and can be used in indoor or outdoor locations.

MIDEL 7131 is a high performance fluid that offers increased fire safety, greater environmental protection and superior moisture tolerance. Testing has also proven that MIDEL 7131 has excellent dielectric properties.

IEC 61099 Conformity

MIDEL 7131 conforms to IEC 61099 “Specifications for Unused Synthetic Organic Esters for Electrical Purposes”. It is classified as type T1, a halogen-free pentaerythritol ester.

Areas of Application

MIDEL 7131 filled transformers are available from all major transformer manufacturers. MIDEL 7131 is suitable for a wide range of transformer applications, including sealed and breathing.

- Distribution transformers
- Power transformers
- Traction transformers
- Rectifier transformers
- Pole-type transformers
- Tapchangers
- Thyristor cooling

Retrofilling

MIDEL 7131 has been used to retrofill thousands of distribution transformers to improve service life, reduce environmental hazards or increase fire safety.

Corrosive Sulphur

MIDEL 7131 has been tested by independent laboratories to ASTM D1275 B and IEC 62535, it was found to be non-corrosive.

Increased Fire Safety

MIDEL 7131 has a high fire point and a low net calorific value (<32 MJ/kg) and is therefore classified as a K3 class liquid.

- 100% fire safety record
- High fire point (>300°C)
- K-class to IEC 61100 / 61039
- FM Global® approved transformer fluid
- Reduced fire safeguarding costs

Greater Environmental Protection

MIDEL 7131 is an environmentally friendly alternative to conventional transformer fluids because it is classified as readily biodegradable and non-water hazardous.

- Readily biodegradable (OECD 301)
- Fully biodegradable (IEC 61039)
- Classified as non-water hazardous by (UBA)
- Non-toxic
- Will not evaporate into the environment
- Not detrimental to activated sludge in biological treatment plants
- RoHS compliant

High Performance

MIDEL 7131 is an extremely robust fluid that delivers long-term stability even when exposed to extreme temperature variations. MIDEL 7131 also has excellent oxygen stability allowing it to be used in breathing transformers.

- Robust and stable at high temperatures over long periods
- Suitable for compact transformer design
- Superior oxygen stability
- Excellent lubricant
- No sludge formation

Moisture Tolerance

MIDEL 7131 is moisture tolerant and can absorb far more water than alternative fluids, without compromising the breakdown voltage.

- No reduction of breakdown voltage (up to 600ppm / 20°C)
- Allows moisture to migrate from cellulose into the fluid
- Potentially keeps the cellulose drier and slows the rate of ageing
- Very high saturation limit making condensation virtually impossible
- Reduced risk of bubble formation

Delivery

MIDEL 7131 can be delivered in 24.5kg, 195kg or 1000kg sealed containers; bulk tanker deliveries available for >20 tonnes.

Disposal

For disposal, it is recommended that used MIDEL 7131 or remains of the insulating fluid be burnt in a suitable installation.

Dielectric Insulating Fluid Overview

Table 1 - Characterisation of Type T1 Transformer Ester According to IEC 61099 and DIN VDE 0375

	Unit	Test Method	Requirement	MIDEL 7131
Physical Properties According to IEC 61099				
Colour	HU	ISO 2211	max. 200	125
Appearance	-	IEC 61099 7.1.2	clear, free from suspended matter and sediment	clear, free from suspended matter and sediment
Density at 20°C	kg/dm^3	ISO 3675	max. 1.00	0.97
Kinematic Viscosity at 40°C	mm^2/s	ISO 3104	max. 35.0	28
Kinematic Viscosity at -20°C	mm^2/s		max. 3000	1400
Flash Point	°C	ISO 2719	min. 250	260
Fire Point	°C	ISO 2592	min. 300	316
Pour Point	°C	ISO 3016	max. -45	-60
Crystallisation	-	IEC 61099 (2010) Annex A	No crystals	No crystals
Chemical Properties According to IEC 61099				
Water Content	mg/kg	IEC 60814	max. 200	50
Neutralisation Value	mg KOH/g	IEC 62021-2	max. 0.03	<0.03
Oxidation Stability - Total Acid Content - Total Sludge Content	 mg KOH/g % mass	IEC 61125	 max. 0.3 max. 0.01	 0.01 <0.01
Net Calorific Value	MJ/kg	ASTM D 240-02	<32	31.6
Dielectric Properties According to IEC 61099				
Breakdown Voltage	kV	IEC 60156	min. 45	>75
Dielectric Ddissipation Factor Tan δ at 90°C and 50 Hz	-	IEC 60247	max. 0.03	<0.008
Volume Resistivity DC at 90°C	Gohm-m	IEC 60247	min. 2	>30

Data quoted above are typical values, may be altered without notice and do not constitute a specification

Increased Fire Safety

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Increased Fire Safety

Experience shows that transformer fires can be particularly unforgiving, spreading at frightening speeds and causing expensive damage. Unfortunately, these potentially catastrophic fires are all too common in today's modern power distribution networks.

MIDEL 7131 offers the perfect solution to avoiding the unnecessary risk of a fire. Used and respected worldwide, MIDEL 7131 has an impeccable 100% fire safety record spanning over three decades.

FM Global®, a large internationally recognised insurance company, has approved MIDEL 7131 as a less flammable fluid, requiring less stringent fire safety measures. This can lead to lower safeguarding costs and insurance premiums. In addition MIDEL 7131's fire safe properties allow for use in transformers inside buildings and other critical areas where mineral oil would not be acceptable.

FM APPROVED

Flash and Fire Point

MIDEL 7131 has been specifically formulated to give a high flash and fire point, in excess of those required for K-class rating (IEC 61100 / 61039) and far superior to mineral oil (Table 1).

Ignition Resistance

Method

The flame from an oxy-acetylene torch (>2000°C) is directed onto the surface of a shallow pool of liquid in a metal pan. A thermocouple close to the base of the pan measures the temperature of the bulk liquid away from the surface of the pool.

Table 1 - Flash and Fire Points - IEC 61039 Class K3

Parameter	Test Method	Required	MIDEL 7131	Mineral Oil
Flash Point	ISO 2719	min. 250°C	260°C	150°C
Fire Point	ISO 2592	min. 300°C	316°C	170°C
Net Calorific Value	ASTM D240-02	<32	31.6MJ/kg	46.0MJ/kg

Data quoted above are typical values

Once the torch has been ignited, the temperature of the liquid is recorded. A comparison of the results for mineral oil and MIDEL 7131 are shown in Figure 1.

Results

The temperature of the mineral oil increased quickly and set on fire after only 4 minutes. The mineral oil continued to burn even after the ignition source was removed, emitting a thick black smoke.

In comparison, the temperature of the MIDEL 7131 rose at a much slower rate. After 70 minutes and a temperature of >260°C, the fluid still did not ignite. MIDEL 7131's low heating rate is due to its high specific heat and thermal conductivity, which combines with the high fire point to give MIDEL 7131 an excellent resistance to ignition.

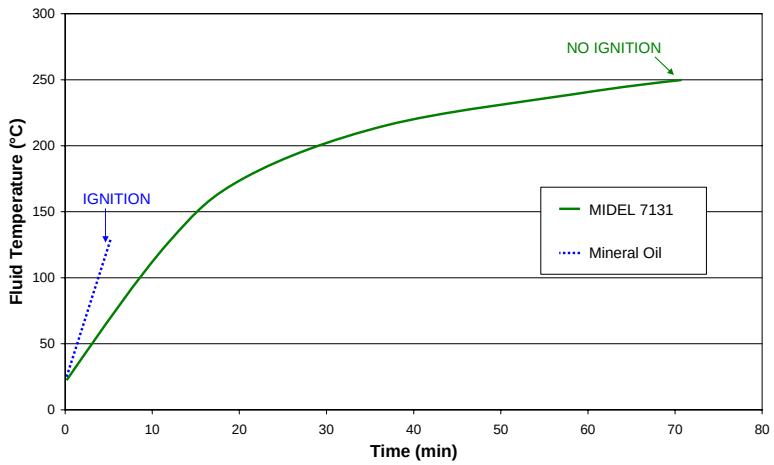
Smoke and Combustion Products

In the extremely unlikely event of MIDEL 7131 igniting it would produce a non toxic, much lighter smoke in comparison to that of burning mineral oil. MIDEL 7131's smoke is also not as dense as the white silica smoke produced by silicone liquid fires. This is very pertinent when considering evacuation and rescue procedures.

Method

The quantity of smoke produced by transformer fluids is measured using Tewarson apparatus fitted with a light source and a photocell. This is designed to have response characteristics similar to those of the human eye.

Figure 1 - Ignition Resistance Comparison between MIDEL 7131 and Mineral Oil



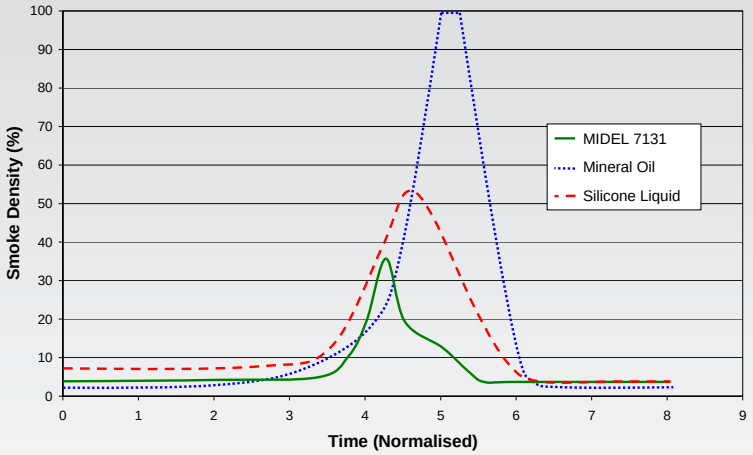
Increased Fire Safety

Results

The results in Figure 2 clearly demonstrate the low smoke properties of MIDEL 7131. The time axis is normalised to the start of ignition to provide an easy comparison of the smoke density figures. Predictably, mineral oil produced thick black smoke, silicone liquid produced a grey smoke and both were denser than the thin white smoke produced by MIDEL 7131. It should also be noted that in the test, MIDEL 7131 took over twice as long as mineral oil to ignite.

The results of the tests summarised in this data sheet confirm MIDEL 7131 is a fire safe alternative to mineral oil. Further fire testing has been conducted by M&I Materials and external laboratories and details are available on request. In terms of protection of personnel and property MIDEL 7131 is the obvious choice when specifying a fire safe fluid.

Figure 2 - Smoke Density Comparison for MIDEL 7131, Silicone Liquid and Mineral Oil



MIDEL®

MIDEL® 7131

Greater Environmental Protection

December 2010 Page 1 of 2

Greater Environmental Protection

Companies are under increasing pressure to ensure their activities cause as little damage as possible to the environment. A call for change is evident from the introduction of strict governing standards and legislation designed to encourage best practice and punish the neglect of our communities.

Companies with progressive thinking have realised that as well as helping to save the planet, they can also benefit from the positive PR and cost advantages associated using 'greener options'.

MIDEL 7131 has been proven to be non-toxic and readily biodegradable, and as such is an environmentally friendly alternative to mineral oil and silicone liquid. MIDEL 7131's classification as non-water hazardous by UBA further supports this assertion.

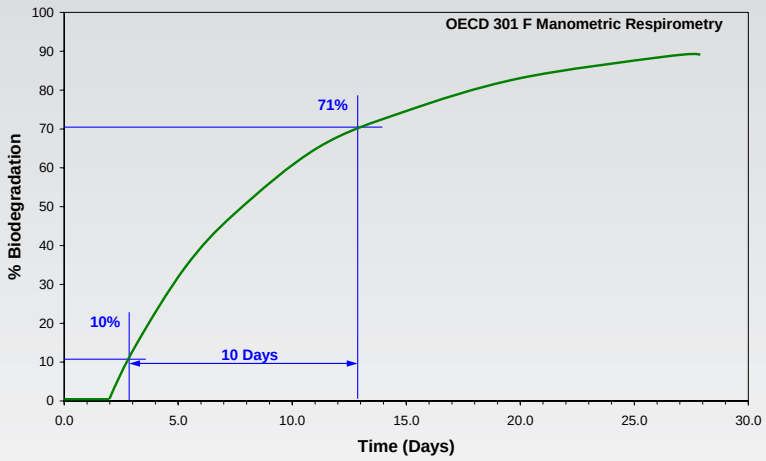
Biodegradation

Biodegradation is the process by which organic substances degrade and become harmlessly absorbed by the environment. The biodegradation of MIDEL 7131 has been assessed by an accredited laboratory using a standard test method developed by the Organization for Economic Cooperation and Development (OECD), a worldwide standard-setting body.

Method

Tests for biodegradation use micro-organisms, of the type present in wastewater treatment plants. These organisms are put into glass jars with the test compound for 28 days. Measurements are taken of the oxygen consumed, or carbon dioxide produced, to determine the biodegradation percentage.

Figure 1 - Biodegradation of MIDEL 7131



Results

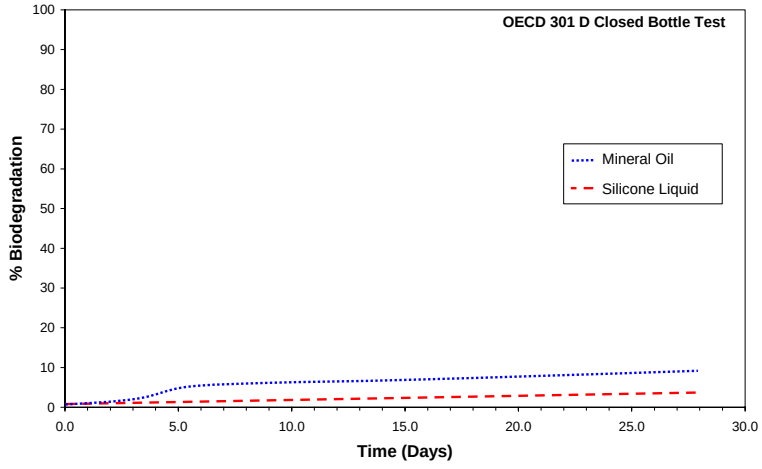
Figure 1 demonstrates that MIDEL 7131 achieved 10% degradation by day 3 and 10 days later it was 71% degraded. On the 28th day MIDEL 7131 reached 89% degradation, putting it comfortably in the Readily Biodegradable OECD and the Fully Biodegradable IEC 61039 categories.

MIDEL 7131 will not biodegrade in a transformer. This is due to the fact that the conditions within the transformer are too hot and dry to sustain microbial life.

Comparative independent studies examining the biodegradation of mineral oil and silicone liquid show a stark contrast to the environmentally friendly MIDEL 7131.

In Figure 2, the graph clearly demonstrates that neither of MIDEL 7131's counterparts managed to achieve even a 10% level of degradation at the end of the 28 day test period. Therefore MIDEL 7131's excellent biodegradable properties make it the sensible solution for use in a transformer.

Figure 2 - Biodegradation of Mineral Oil and Silicone Liquid



Greater Environmental Protection

UBA Water Hazard Classification

Germany's central environmental authority, Umwelt Bundes Amt (UBA), evaluates chemicals and provides them with ratings, either as non-water hazardous (nwg) or one of three hazard levels.

The UBA classification is based on the biodegradability of the chemical combined with the potential effect on aquatic life. The classification for various transformer fluids is shown in the Table 1. MIDEL 7131 is classified as non-water hazardous, while silicone liquid and mineral oils do present some hazard and therefore require extra containment measures incurring further costs.

Effect on Aquatic Life

In addition to the importance of biodegradability, it is favourable if a transformer fluid does not represent a hazard to the ecosystem. In extreme concentration levels of 1000mg/l it has been demonstrated that MIDEL 7131 will have no ill effects on aquatic life in the event of a spillage into a watercourse.

Table 1 - Common Test Parameters and Guidance Limits

Fluid	CAS Number	UBA Classification
MIDEL 7131	68424-31-7	nwg
Silicone Liquid	63148-62-9	1
Mineral Oils	Variety	1

Wastewater

Biological sewage treatment plants use 'activated' or microbially active sludge to break down organic matter within sewage. Contaminating chemicals can destroy these micro-organisms and a total cessation of the sewage treatment process may result. This is a very costly and time consuming problem for the sewage treatment industry.

Tests carried out by the global chemical company, BASF; demonstrate that MIDEL 7131 has no effect on the respiratory inhibition of activated sludge even at very high concentrations of up to 1000mg/l. The conclusion is that MIDEL 7131 does not represent a risk to biological treatment plants.

Advantages of Using Biodegradable MIDEL 7131

Local regulations and insurance companies usually determine the containment requirements for transformers. Over the years it has become more common for insurance companies to identify reduced containment requirements for transformers containing safer alternatives to mineral oils.

FM Global® is an internationally recognised insurance company. In its loss prevention datasheets for MIDEL 7131 filled outdoor transformers, containment is not required until the fluid volume exceeds 2640 gal (10,000 litres). In contrast for mineral oil bunding is required when the fluid volume exceeds 500 gal (1900 litres).

High Performance

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High Performance

On average the service life of a transformer is forty years and subsequently the fluid used to insulate and cool the system is expected to perform reliably for an equivalent length of time. Oxidation and ageing are two factors that can seriously affect the dependability of some fluids. The lubrication properties of fluids are also important to ensure long equipment life time.

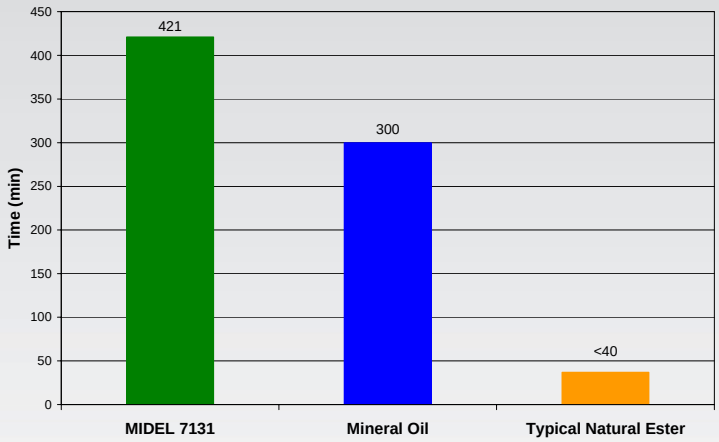
Oxidation Resistance

Oxygen has been shown to contribute to the ageing of mineral oil in transformers. This in turn causes sludging and degradation of the fundamental characteristics of the oil. In addition, at high temperatures the effects of oxidation are accelerated and even in sealed systems, the oil can age.

MIDEL 7131's resistance to oxidation has been demonstrated in high temperature breathing applications, such as traction transformers, where variable loads and compact designs highly stress the transformer fluid.

One way to compare transformer fluid oxidation stability is using the ASTM D 2112 Pressurised Vessel Oxidation Test. It measures the time taken for oxygen to be consumed and hence indicates the reactivity of the fluid. Figure 1 shows the time in minutes for a set pressure drop in the test vessel. The longer the time for this pressure drop, the more oxidation stable the fluid. MIDEL 7131 gives the longest time in this example, demonstrating its excellent oxidation stability. Natural ester gives the lowest numbers, showing that it has poor oxidation stability.

Figure 1 - Oxidation Stability Pressurised Vessel Test Results



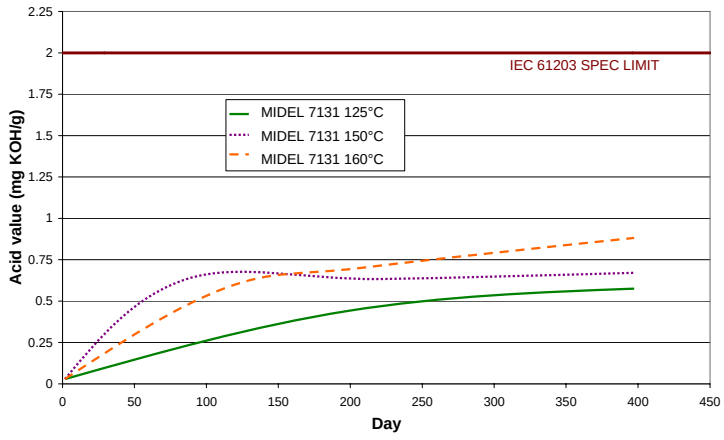
High Temperature Performance

Extensive testing has demonstrated that MIDEL 7131 is a robust and stable fluid which is suitable for both sealed and breathing transformers.

One key indicator of ageing in transformer fluids is the acid value. Figure 2 shows the acid value of MIDEL 7131 over a period of more than one year, in a sealed system with common transformer materials such as copper. The fact that the acid value remains well below the IEC 61203 specification limit throughout the trial, shows that MIDEL 7131 is very resistant to ageing.

A number of other parameters were monitored during the sealed ageing trial, such as viscosity, density and fire point. There was no significant change in any of these, further demonstrating the high temperature stability of MIDEL 7131.

Figure 2 - Acid Value of MIDEL 7131 during Sealed Ageing Experiment



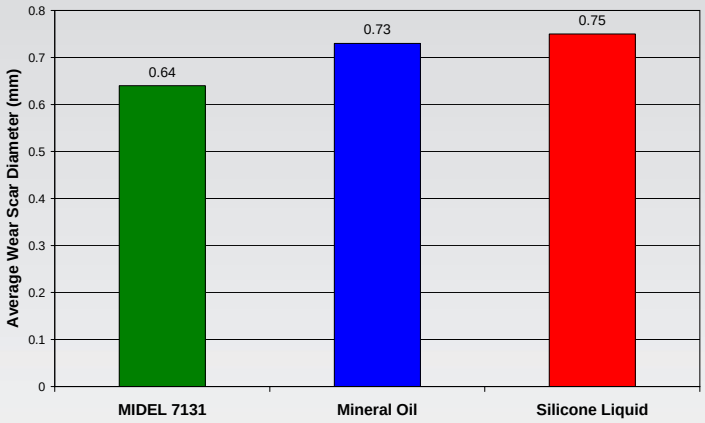
High Performance

Lubrication Properties

MIDEL 7131 is an excellent lubricant as well as being a high quality dielectric and cooling fluid. Lubrication is important in many transformers for continuous efficient working. For example, in tap-changer contacts, if the fluid does not prevent a metal to metal seizure or even a small increase in friction, it is likely that the system would be prone to early failure. Similarly, in systems with more demanding lubrication requirements, such as high speed pumping devices used in circulating cooler systems, efficient lubrication is also needed to prevent a breakdown.

Figure 3 shows the results of a Four Ball Wear Test with the lower wear scar number indicating better lubricity. MIDEL 7131 gave the lowest result demonstrating that it has the best lubrication properties of the three fluids compared. This gives assurance that when used in tap changers and pumped systems MIDEL 7131 will provide excellent longevity for components.

Figure 3 - Four Ball Wear Test



Moisture Tolerance

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Moisture Tolerance

MIDEL 7131 has a very high moisture tolerance. This means it can absorb far greater amounts of water than mineral oil and silicone liquid without compromising its dielectric properties. MIDEL 7131 can also trap more water which may slow down cellulose ageing. In the case of mineral oil, there is a danger that this water will be released as condensation.

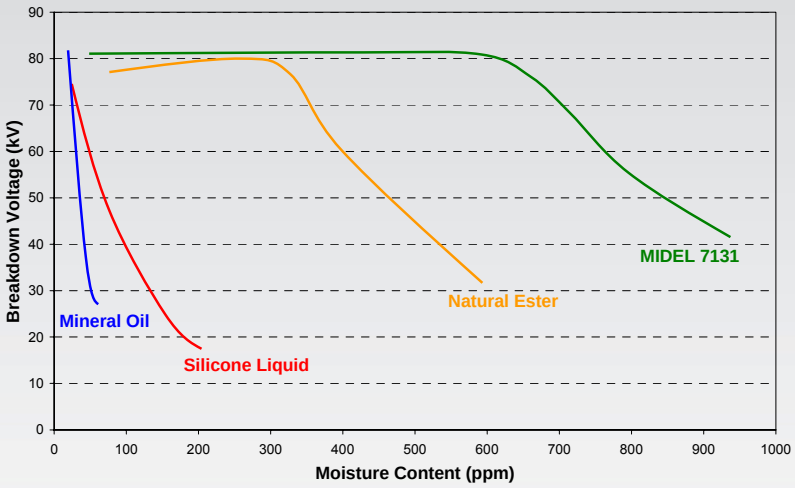
Why Moisture Tolerance Is Important in Transformers:

- Dielectric strength - reduces as moisture content increase
- Rate of paper ageing - increases with higher moisture content
- Bubble formation during overloads - bubbles form at a lower temperature when there is a high moisture content in the paper
- Condensation during cool down - risk of release of free water from mineral oil

Dielectric Strength

Figure 1 shows the breakdown voltage at ambient temperature of MIDEL 7131, mineral oil and silicone liquid with increasing moisture levels. It clearly illustrates that even a small amount of water in mineral oil and silicone liquid cause a rapid deterioration in breakdown voltage. In contrast, MIDEL 7131 maintains a high breakdown voltage of >75kV even when moisture levels exceed 600ppm.

Figure 1 - Breakdown Voltage vs. Moisture Content at 20°C



Rate of Paper Ageing

The rate of paper ageing is directly related to the water content. Various studies have shown that the lifetime of the paper reduces by as much as a factor of ten for each extra 1% of water content in the cellulose. As the cellulose ages it releases water, thus accelerating the ageing process. Therefore it is vital that cellulose is kept as dry as possible.

MIDEL 7131 has the ability to trap more moisture than mineral oil, which can reduce the amount of water in the paper and hence reduce the ageing rate.

Using moisture equilibrium curves it is possible to show that for MIDEL 7131 at 60°C, water content in fluid of 200ppm would equate to water content in the cellulose of 1.1%. At the same temperature, mineral oil with a water content of 20ppm would lead to water content in the cellulose of 2.6%. The extra 1.5% of moisture would equate to at least a ten fold decrease in the life of the cellulose.

Bubble Evolution During Overloads

Bubbles in dielectric fluids are undesirable since they are electrically weak. According to IEC 60076-14, bubble evolution temperature is directly related to the moisture content of cellulose. During overload conditions the temperature of paper wrapped conductors will rise, increasing the risk of reaching critical temperatures for bubble evolution. For example, with a paper water content of 2.6% the temperature at which bubbles form will be 130°C. With a water content of 1.1% the bubble evolution temperature is 165°C. Since MIDEL 7131 has the ability to keep paper drier it gives a greater margin of safety during overloads.

Moisture Tolerance

Condensation During Cool Down

With mineral oil there is a potential for water to be released when a transformer cools from operating temperature to ambient. This is due to the fact that mineral oil has a low moisture saturation limit which reduces as the temperature drops. MIDEL 7131 has a much higher saturation limit, which means that it is far more difficult to reach the saturation point.

For example if a transformer with mineral oil and a paper water content of 1.5% was running at 90°C the water content of the mineral oil would be 65ppm. If the transformer then shut down the water would tend to stay in the mineral oil. At 20°C the saturation limit of mineral oil is 55ppm, so the mineral oil would be 118% saturated, releasing free water into the transformer. The breakdown voltage of the mineral oil will also be very low, increasing risk of failure when restarting.

Using the same example for MIDEL 7131 at 90°C the water content would be 700ppm. The saturation limit for MIDEL 7131 at 20°C is 2700ppm, so even if all the water stays in the MIDEL 7131 it will only be 26% saturated. This means there is no free water and still an excellent breakdown voltage.

Table 1 - Standards for Moisture Content

Standard	Moisture Content
IEC 61099 - New Esters	max. 200ppm
IEC 61203 - In-service Esters	max. 400ppm
BS 148 - New Mineral Oil	max. 30ppm
BS 5730 - In-service Mineral Oil	max. 30ppm

Note: The typical value for new MIDEL 7131 is 50ppm

Moisture Content Testing

The standards relating to moisture content for new and in-use fluids are shown in the Table 1. New MIDEL 7131, as delivered, is manufactured to very high standards with typical moisture content of 50ppm.

MIDEL 7131 will still be within specification up to 400ppm. In contrast, mineral oil will be out of specification above just 30ppm. This has practical implications for the interpretation of moisture level analysis. Also, if moisture-monitoring equipment is integrated within a transformer, its tolerance settings should be adjusted accordingly.

Please contact M&I Materials Limited for further advice.

Moisture Removal

Should the moisture content rise above the maximum in-service limit, the same methods and equipment that are used for removing moisture from mineral oil can also be used to remove moisture from MIDEL 7131. For example molecular sieves and vacuum filtration units.

Comparison to Alternative Technologies

MIDEL 7131 versus Alternative Fluids

MIDEL 7131 is a high performance fluid that offers the advantages of increased fire safety, greater environmental protection and excellent moisture tolerance. Research carried out over many years by the Technical Department at M&I Materials Limited has proven the superior behaviour of MIDEL 7131 in comparison to other fluids.

Table 1 compares the main properties of MIDEL 7131 with mineral oil, natural ester and silicone fluid.

Table 1 - Comparison of Main Properties of MIDEL 7131 with Alterative Fluids

	Units	MIDEL 7131	Silicone Liquid	Mineral Oil	Natural Ester
General Properties General Properties					
Density at 20°C	kg/dm^3	0.97	0.96	0.88	0.92
Specific Heat at 20°C	J/kg K	1880	1510	1860	1848
Thermal Conductivity at 20°C	W/m K	0.144	0.151 (@ 50°C)	0.126	0.177
Kinematic Viscosity at 20°C	mm^2/s	70	50 (@ 25°C)	22	85
Kinematic Viscosity at 100°C	mm^2/s	5.25	15	2.6	8.4
Pour Point	°C	-60	<-50	-50	-21
Expansion Coefficient	/°C	0.00075	0.00104	0.00075	0.00074
Flash Point to ISO 2719	°C	260	260	150	316
Fire Point to ISO 2592	°C	316	>350	170	360
Fire Hazard Classification to IEC 61100/ IEC 61039		K3	K3	O	K2
Biodegradability at 28 Days - OECD 301 F - OECD 301 D	 % %	 89 N/A	 N/A <5	 N/A <10	 97 N/A
Chemical Properties					
Neutralisation Value	mg KOH/g	<0.03	<0.01	<0.03	<00.03
Net calorific Value	MJ/kg	31.6	28.0	46.0	37.5
Dielectric Properties					
Breakdown Voltage	kV	>75	50	> 70	>75
Dielectric Dissipation Factor Tan ð at 90°C		<0.008	<0.001	<0.002	<0.003
Permittivity at 20°C		3.2	2.7 (@ 25°C)	2.2	3.1

Data quoted above are typical values, may be altered without notice and do not constitute a specification

Comparison to Alternative Technologies

MIDEL 7131 versus Cast Resin

Cast resin transformers are sold as a fire safe solution for indoor installations and used in applications such as wind turbines. Although these types of transformers have found wide application they do have some disadvantages and their reliability record has been called into question in some of the more demanding transformer applications. MIDEL 7131 filled transformers can offer a fire safe solution, without the drawbacks associated with cast resin transformers.

Table 2 - Comparison of Main Properties of MIDEL 7131 with Cast Resin

Property	MIDEL 7131	Cast Resin
Fire Resistance	Excellent	Moderate
Environmental Impact	Excellent	Moderate
Life Expectancy	High	Moderate
Efficiency	High	Low to Moderate
Sound Level	Low	Moderate
Operating Temperature	Low	Moderate
Contamination Resistance	Excellent	Moderate
Overload Capacity	Excellent	Moderate
Maintenance	*None on sealed transformers	Regular cleaning and crack detection
Fault Diagnosis (DGA)	Yes	No
Repair Possible	Yes	Difficult

*Subject to transformer manufacturer's recommendations

Table 3 - Efficiency and Recycling Cost Comparison of 20 kV Fluid Filled Compact Transformer Design with a Typical Cast Resin Transformer

	Fluid Filled	Cast Resin
Dimensions, mm	2210 x 770 x 2200	2000 x 840 x 2170
Mass, kg	4500	4600
No Load Loss, kW	2.1	3.9
Load Loss @125°C, kW	19	19.2
Recycling Cost, €/kg	0.07	0.14

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MIDEL® 7131

Fluid Maintenance Guide - Distribution Transformers

December 2010 Page 1 of 1

General

MIDEL 7131 is a very robust fluid which is capable of giving long service, even in the most demanding of applications. As with mineral oil, in order to ensure that MIDEL 7131 gives continued good service it is possible to monitor a number of the fluid parameters throughout the life of the transformer. Testing the fluid also has the added benefit of picking up any potential problems with the transformer before a failure occurs.

Generally, for distribution transformers, sampling of the fluid is recommended before energising, after the first year of service and at five year intervals from then on. For larger power transformers, highly loaded or critical units, the frequency of testing may be increased.

It is important to understand some fundamental differences between MIDEL 7131 and mineral oils when carrying out fluid testing for maintenance. Many laboratories are now experienced in the testing of MIDEL 7131, but at times a failure can be logged against a sample when the incorrect mineral oil limits are applied.

Table 1 shows the typical fluid testing parameters and the limits according to IEC 61203 'Synthetic organic esters for electrical purposes - Guide for maintenance of transformer esters in equipment'. It should be noted that this guide and the IEC 61203 standard do not apply to retrofilled transformers, i.e. those that have previously been filled with another fluid.

Table 1 - Common Test Parameters and Guidance Limits

Parameter	Test Method	IEC 61203
Appearance	IEC 61203 3.1	Clear, without visible contamination
Water Content*	IEC 60814	max. 400 ppm
Neutralisation Value	IEC 61099 9.11	max. 2.0 mg KOH/g
Breakdown Voltage	IEC 60156	min. 30 kV
Fire Point	ISO 2592	min. 300 ºC

*At ambient temperature

Breakdown Voltage Testing

The breakdown voltage of new MIDEL 7131 is typically in excess of 75kV when tested to the IEC 60156 2.5mm gap method. Testing has demonstrated that even after long term ageing of the fluid there is little deterioration of the breakdown voltage. In addition, even at very high moisture contents, up to 1000ppm at ambient temperature, testing has shown that the breakdown voltage will be preserved well above the 30kV lower limit.

There are some issues that can cause a drop in breakdown voltage and the first is particulate matter in the fluid. Particles can float between the test probes and cause a localised weakness when carrying out the breakdown test. This can usually be identified by erratic results when comparing a series of breakdowns. If particles are suspected to be causing a breakdown issue then the fluid can be filtered through a fine paper filter and re-tested.

Another issue that can arise is if enough settling time is not allowed between each breakdown test. In this case gas bubbles formed by the breakdown arc are not given sufficient time to dissipate and can cause a weak link between the probes. Typically an average of six breakdown tests are taken and it is recommended to leave a minimum settling time of ten minutes before the first breakdown test and then five minutes between each subsequent breakdown test to ensure that gas bubbles have sufficient time to disperse.

DGA and Furan Analysis

Diagnosis of transformer performance by traditional DGA and Furan analysis is still applicable to MIDEL 7131 filled transformers. The methods used to diagnose faults with DGA in mineral oil can be used with MIDEL 7131 provided minor adjustments are made to Duval triangle boundaries and table ratios. For further information contact M&I Materials Ltd technical department.

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MIDEL® 7131

Storage & Handling Guide

December 2010 Page 1 of 1

Introduction

MIDEL 7131 is a very robust fluid and studies have demonstrated its long term stability, even at elevated temperatures. For years, it has been successfully used worldwide in breathing and sealed transformer systems. It is still necessary, however to take precautions when handling and storing MIDEL 7131 to ensure that it is kept in optimum condition.

Table 1 - Viscosity Values Versus Temperature

Temperature °C	Absolute Viscosity mPa s	Kinematic Viscosity mm^2/s
0	236	240
20	68	70
40	27	28
60	13	14

Data quoted above are typical values

Receiving New MIDEL 7131

MIDEL 7131 can be delivered in 24.5kg, 195kg or 1000kg sealed containers; bulk tanker deliveries are available for >20 tonnes. Prior to filling the containers the fluid is dried and degassed. On receipt of the fluid users may notice a slight deformation of the containers. This is due to the degassed fluid absorbing the small amount of air in the headspace, thus creating a vacuum. This is perfectly normal and a good indication that the seal has not been compromised.

The vacuum seal in 1000kg IBCs needs to be broken and the recommendation is to contact IBC supplier Schütz to obtain the correct lid removal tool (part no. 16659).

Storage

If kept in the unopened containers MIDEL 7131 has an indefinite shelf life. Once opened precautions should be taken to avoid contact with moist air for prolonged periods because the fluid is hygroscopic and will absorb atmospheric moisture. If a partially emptied container is used for storage the head space should ideally be back-filled with dry nitrogen or dry air prior to resealing. If this is not possible, then ensuring the lid is properly sealed will help keep the fluid dry.

If the fluid is kept in intermediate bulk containers the ideal location will be indoors to avoid extremes of temperature and exposure to the weather. Where outdoor storage is unavoidable exposure to direct sunlight should be prevented using a simple covering.

Storage tanks which are suitable for standard mineral oil can be used for MIDEL 7131. It is recommended that the tank headspace has a dry nitrogen blanket to keep out moisture. If this is not possible then dry air should be used in the headspace and a suitable breather unit fitted to any vent system. If a silica gel breather is used to dry the headspace air then this must be properly maintained to ensure that the fluid quality is preserved.

Pumping

MIDEL 7131 is an excellent lubricant, so no specialist pumping equipment is required. The viscosity of MIDEL 7131 is slightly higher than mineral oil at ambient temperatures and this must be taken into account when specifying pumping systems. A higher capacity pump is will be needed to maintain the same flow rate as mineral oil at a given temperature. Table 1 shows viscosity values versus temperature for reference.

As with any dielectric fluid there is a possibility of static charge build up when MIDEL 7131 is flowing through the pipes. The user should ensure that all pumps, lines and vessels are adequately bonded and earthed during pumping operations.

Transformer Filling and Cellulose Impregnation

To avoid air entrapment in the transformer cellulose the tank should be filled from the bottom or if possible under vacuum.

In order to aid impregnation of the cellulose it is recommended that MIDEL 7131 be heated to approximately 60°C when filling. At 60°C the viscosity of the fluid is very close to that of mineral oil at 20°C, and a similar impregnation rate has been observed in laboratory testing. It is further recommended that the transformer is filled slowly to aid impregnation and left for at least 24 hours prior to energising for the first time.

Throughout all stages of the filling operation it is essential that the introduction of moisture or particulate matter be avoided. The outlet side of any pump used during filling should be protected by a fine mesh or paper element filter.

The use of degassing and vacuum filling is possible with MIDEL 7131, using the same type of equipment and methods employed with mineral oil.

MIDEL®

MIDEL® 7131

Safety Data Sheet

1. Substance/Company Identification

Product Name:	MIDEL® 7131.
Product Type:	Dielectric fluid.
REACH No:	01-2119542596-31-0000.
CAS No:	68424-31-7.
Substance Name:	Fatty acids, C5-10 (linear and branched), mixed esters with pentaerythritol.
Company Details:	M&I Materials Ltd. Hibernia Way, Trafford Park, Manchester, M32 0ZD, UK.
Telephone: +44 (0)161 864 5411	Fax: +44 (0)161 864 5444.
Emergency Telephone:	+44 (0)161 864 5439.
Email:	RussellMartin@mimaterials.com.

2. Hazards Identification

Not classified under Directive 67/548/EEC or Regulation (EC) no. 1272/2008 (CLP).

3. Composition/Ingredients

Composition:	Fatty acids, C5-10 (linear and branched), mixed esters with pentaerythritol.
Hazardous Ingredients:	None.

4. First Aid Measures

Eyes:	Wash immediately with plenty of water for at least 15 to 20 min. Obtain medical attention if irritation develops.
Skin:	Wash with soap and water for at least 15 to 20 min. Obtain medical attention if irritation develops.
Ingestion:	Do not induce vomiting. Obtain medical attention.

5. Fire Fighting Measures

Suitable Extinguishing Media:	Carbon dioxide, dry powder, foam or water fog. Do not use water jets.
Protective Equipment:	Self-contained breathing apparatus may be required.

6. Accidental Release Measures

Personal Precautions:	Spilt product can constitute a slip hazard. Avoid contact with skin and eyes.
Environmental Precautions:	Do not contaminate any lakes, streams, ponds, groundwater or soil. Avoid flushing into drains. In the event of a large spillage contain product as thoroughly as possible and dispose of in accordance with local regulations.
Cleaning Procedures:	Use an inert absorbent material (e.g. sand, earth, etc.) and place in labelled containers.

7. Handling and Storage

Handling:	Avoid eye and prolonged skin contact.
Storage:	Store in a cool dry place.
Specific Use:	Exposure to air should be minimised. Opened containers should be properly resealed.

8. Exposure Controls/ Personal Protection

Respiratory Protection:	Not required for normal use.
Hand Protection:	Wash hands after use. For prolonged or repeated skin contact gloves are recommended.
Eye Protection:	If splashes are likely to occur wear safety glasses.
Skin Protection:	Wear coveralls.

Safety Data Sheet

9. Physical & Chemical Properties

Physical State:	Organic liquid.
Odour:	Faintly sweet.
Melting Point/ Freezing Point:	-57°C.
Boiling Point:	>300°C.
Flash Point (Closed Cup):	260°C.
Flammability:	Non flammable.
Vapour Pressure at 20°C:	<0.001Pa.
Relative Density @ 20°C:	970kg/m^3.
Water Solubility:	<1mg/l.
Partition Coefficient, log K_{ow}.	>6.74.
Explosive Limits:	Not determined.
Auto-ignition Temperature:	No auto-ignition expected.
Viscosity @ 40 °C:	28mm^2/s.
Explosive Properties:	Non-explosive.
Oxidising Properties:	Non-oxidising.

10. Stability & Reactivity

Stability:	Stable under normal ambient conditions.
Conditions to Avoid:	Temperatures >250°C.
Materials to Avoid:	Strong oxidising agents.
Hazardous Decomposition Products:	None known.

11. Toxicological Information

Eyes:	May cause transient irritation.
Inhalation:	Low volatility makes inhalation unlikely.
Ingestion:	May cause nausea, vomiting and diarrhoea.
Skin:	Repeated and prolonged skin contact may cause irritation.
Acute Toxicity	
Oral LD50, OECD 401:	>2000mg/kg bw.
Dermal LD50, OECD 402:	>2000mg/kg bw.
Irritation	
Skin, OECD 404:	Not irritating.
Eye, OECD 405:	Not irritating.
Sensitisation	
Skin, OECD 406:	Non sensitising.

12. Ecological Information

Biodegradation, OECD 301 F:	Readily biodegradable, 89% after 28 days.
Acute Aquatic Toxicity	
Salmo Gairdneri LC50 (96h), OECD 203:	>1000 mg/l.
Daphnia Magna EL50 (48h), OECD 202:	>1000 mg/l.
Bioaccumulation Potential:	No potential for bioaccumulation.

13. Disposal Considerations

Product and packaging must be disposed of in accordance with local and national regulations. May be incinerated. Unused product may be returned for reclamation.

14. Transport Classification

Not classified as hazardous under air (ICAO/IATA), sea (IMDG), road (ADR) or rail (RID) regulations.

15. Regulatory Information

Substance is registered under the REACH regulation, EU directive 1907/2006/EC and included in the TSCA Inventory of Chemical Substances.

Safety Data Sheet

16. Other Information

Compiled according to EU Commission Regulation (EU) 453/2010.	
Changes from last issue:	Total rewrite following REACH registration.

The information provided in this Safety Data Sheet is correct to our best knowledge, information and belief at the date of its publication. It is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not be construed as guaranteeing any specific property of the product.

Appendix B

Pressure Relief Device

ABB/Comem 50M PRD (8 pages)

Pressure Relief Device - M

COMEM "M" pressure relief devices are used to control pressures inside tanks. They are used where accidental, instantaneous and uncontrolled increases in pressure may create the danger of explosion. They are designed to discharge the pressure increases that have taken place to the exterior in a very short time period (a few thousandths of a second).
They are widely used in the metal tanks of oil-cooled electric transformers. Sudden and violent short circuits inside these tanks, in fact, instantly generate an enormous amount of gas with a great increase in interior pressures. If the pressure cannot discharge to the exterior there is danger that the transformer may explode, with all the possible harm and damages this may cause. This danger can be prevented by installing one or more pressure relief device with discharge sizes proportional to the volume of oil contained in the transformer. It is always good practice to install these pressure relief devices in all situations where internal pressure values must not exceed specific safety limits.

M

They are widely used in large distribution transformers and traction transformers.

Total pressure relief completely opening

Pressure relief device opening is total each time the pressure relief device operates for pressure settings between 20 and 90 kPa. The discharge opening area, for each pressure relief device operation, is equal to that for higher pressure settings even when pressure settings are lower than 20 kPa. If, however, pressures are generated inside the tank that are much higher than the setting then the spring, further compressed, allows the closing disk to create even larger discharge areas when it operates.

Operating performance

Nominal operating pressure: the pre-fixed overpressure value shall be agreed between supplier and purchaser within the standard range from 20 up to 90 kPa, with 10 kPa steps, with a tolerance of - 5 kPa to + 7 kPa. For model 50M the standard operating pressure range comes up to 200kPa, with 10kPa steps.

Construction

Our pressure relief devices are totally protected against external corrosion and against penetration of foreign bodies between cover and protective cap. This ensures perfect operating efficiency even for extended periods of time.

"M" pressure relief device

These consist of a flanged body and a corrosion-proof aluminium alloy disk. A brass rod that holds the spring is applied to the central part of the disk. There are two gaskets in the pressure relief device: a special shaped upper gasket and a lip seal.
When the pressure relief device is closed the upper gasket is pressed against the disk. The shape of the gasket permits a perfect seal even if the disk lifts 1-2 mm. The disk also makes a seal against the lip seal gasket as it moves upwards. If, due to interior pressure, the disk rises beyond this amount then the upper seal is no longer maintained while the lip seal remains.

At this instant the surface of the washer invested by internal pressure is multiplied in area as is the total force applied on the spring. This causes total and instantaneous opening of the pressure relief device which consequently discharges excess pressures to the exterior.
When pressure has been discharged the disk, pushed back by the spring, lowers down and closes the valve. As the disk moves downwards it first closes against the side gasket and then against the upper gasket.
This latter gasket, because of its special shape, is pressed down 1- 2 mm. and the disk moves further down, breaking the seal on the lip seal gasket. This releases any pressure that may have been trapped between the two gaskets. Now the pressure relief device is ready to work.

Routine tests

It is necessary to carry on operational tests, with compressed air:

- to check the correct functioning of the device at operating pressure values
- to check the functioning of the optic signal and of the electric contacts.

Installation guidelines

Our "M" pressure relief devices come in 2 sizes and have different discharge areas. This allows users to select the type that is best suited for the volume of oil contained in the tank. The following table gives guideline values:

Volume of oil tank:	Type of pressure relief device
up to 3000 dm^3	50 M*
up to 25000 dm^3	125 M*

* These guideline sizes are based on experience.

We recommend using multiple pressure relief devices when oil volumes exceed these levels. It is always good practice to use multiple pressure relief device with smaller discharge areas rather than a single pressure relief device with a large area. The reason for this, in the case of transformers, is that it is better to install one pressure relief device above each winding column since these are the points where maximum interior pressures are generated in case of a short circuit. Instantaneous pressure relief device opening implies direct contact between the closing disk and oil. For this reason the pressure relief device are equipped with a screw to bleed out air that may accumulate during oil tank filling procedures.

Oil tightness duct

It is a good practice to prevent harm to persons or property from violent jets of hot oil evacuating from the pressure relief device, for pressure relief device discharges to be ducted towards points properly designed to receive the hot oil. The protection of the environment is also another important target which has to be pursued by everybody. Our protection duct allows to drain the oil evacuated by the pressure relief device. The perfect hydraulic tightness of the system guarantees that not any drop of oil is dispersed in the environment, but collected through a pipe in a tank (pipe and tank are not supplied). The sealing oil duct is made of die-casted aluminium; a terminal flanged tube made of steel is also provided if someone wants to weld the pipeline. O-ring gaskets have been adopted for the duct sealing. Detailed assembling instructions are supplied with the equipment.

Pressure Relief Device - M

Visual signal that the pressure relief device is open

Pressure relief devices are equipped with a visual signal that shows when they have opened. This signal consists of a red knob that protrudes from the central part of the duct when the pressure relief device has opened. Just press it down in order to make it go back to its normal position and reset the switches, too.

Electrical signalling switch

Maximum 3 "pressure relief device open signal" contacts can be mounted on request. These are a fast tripping limit switch with switching contact contained inside a watertight room IP 65. The contacts simultaneously act with the visual signal.

The switches have the following characteristics:

Specifications:

Breaking and making capacity (NO and NC contacts)		
Voltage	**Uninterrupted current (making capacity)**	**Interrupted current (breaking capacity)**
24 VDC to 220 VDC	2 A	100 mA L/R<40 ms
230 VAC	2 A	2 A cos φ>0.5

Other characteristics:

- The pressure relief device is supplied with a "locking system" which allows the pressure relief device to be blocked during the transformer oil leakage test. The locking system has been tested to withstand max 2 bar pressureand can also be used during the transformer transport.
  WARNING!: the locking system must be removed before powering-up the transformer.
- The pressure relief device is supplied with a M25x1.5 cable gland.
- Colour: RAL 7001.

Outer surface protection

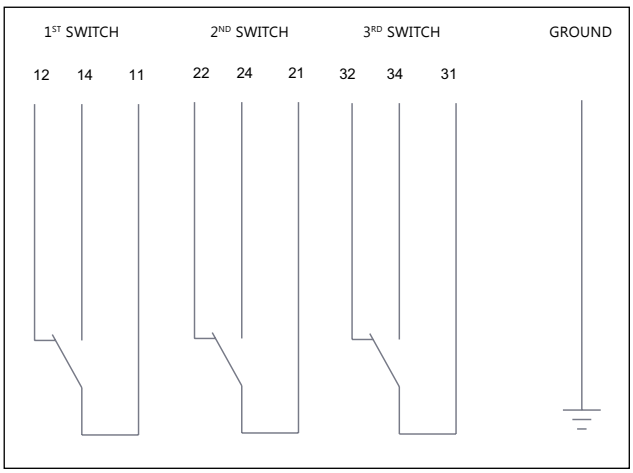
External surfaces are protected against weather corrosion. Aluminum alloy components are non-corroding and their surfaces are protected with a double layer of paint offering high level protection against all atmospheric agents and resisting temperature variations between -40 °C and +100 °C. Special painting for severe climate applications is also available on request.

Contact diagram

- FIRST SWITCH (terminals 12-14-11)
  change-over contact:
  – 14-11 normally open
  – 11-12 normally closed

- SECOND SWITCH (terminals 22-24-21)
  change-over contact:
  – 23-21 normally open
  – 21-22 normally closed

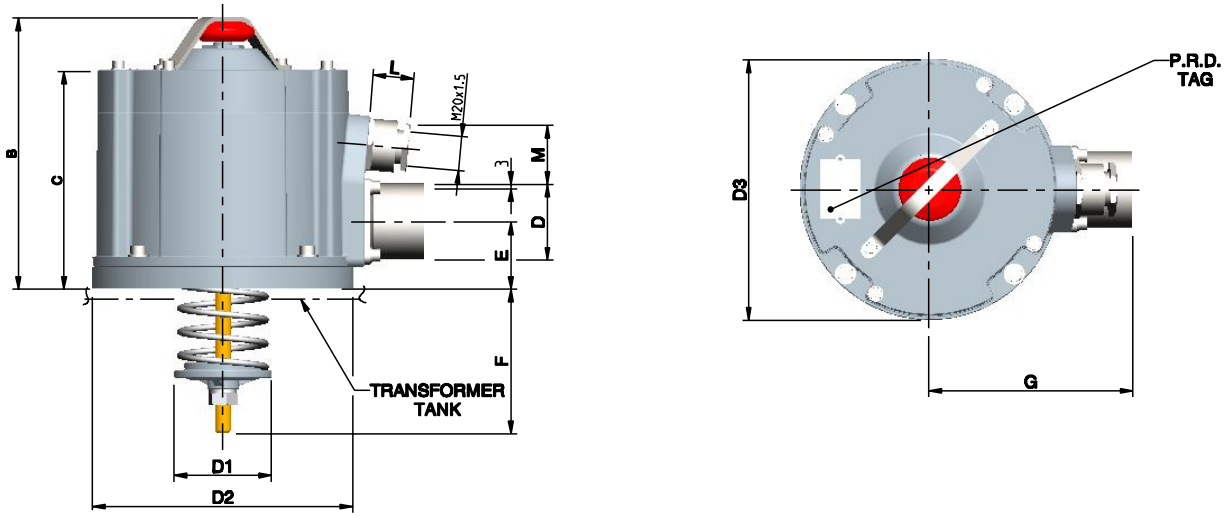
- THIRD SWITCH (terminals 32-34-31)
  change-over contact:
  – 34-31 normally open
  – 31-32 normally closed



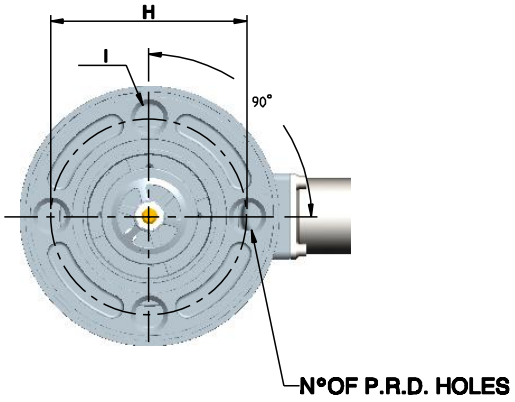
Pressure Relief Device - M

Overall dimensions

Type 50M



50M

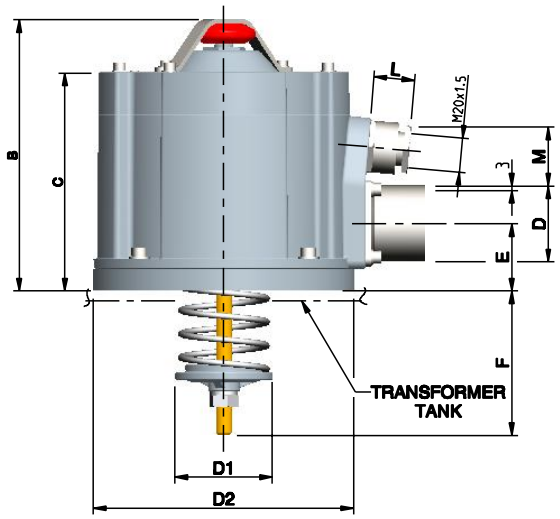


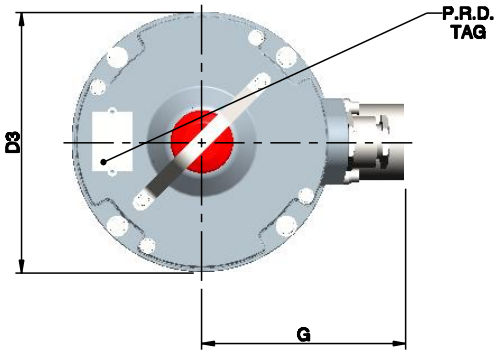
Type	B	C	D	D1	D2	D3	E	F20KPA *	F70KPA *	G	H	I	L	M	kg
50 M	170	139	Ø48.3	Ø62	Ø165	Ø166	41.5	95	60	130	Ø125	Ø18	23	38	2.1

* F = the dimension varies with set pressure

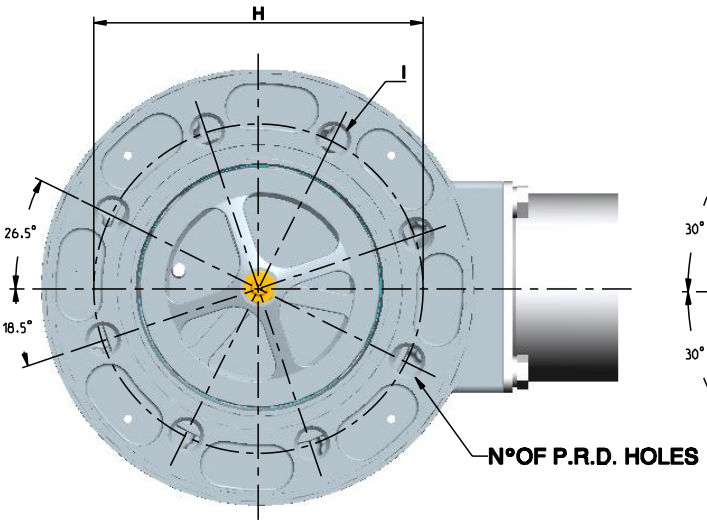
Overall dimensions

Type 125 M8 and 125 M6

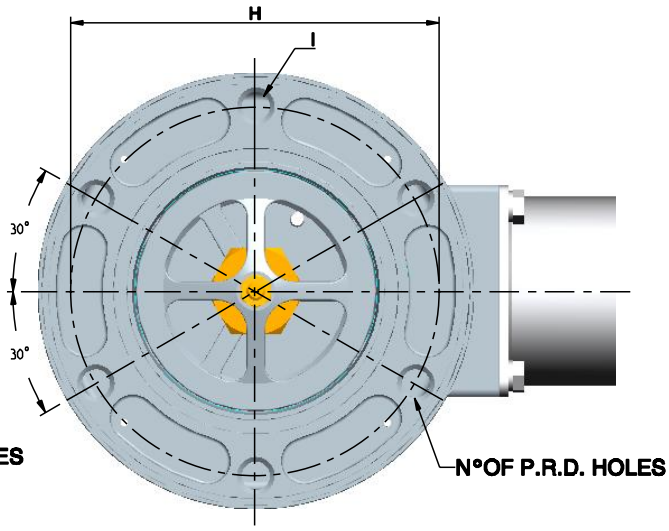




125M-8



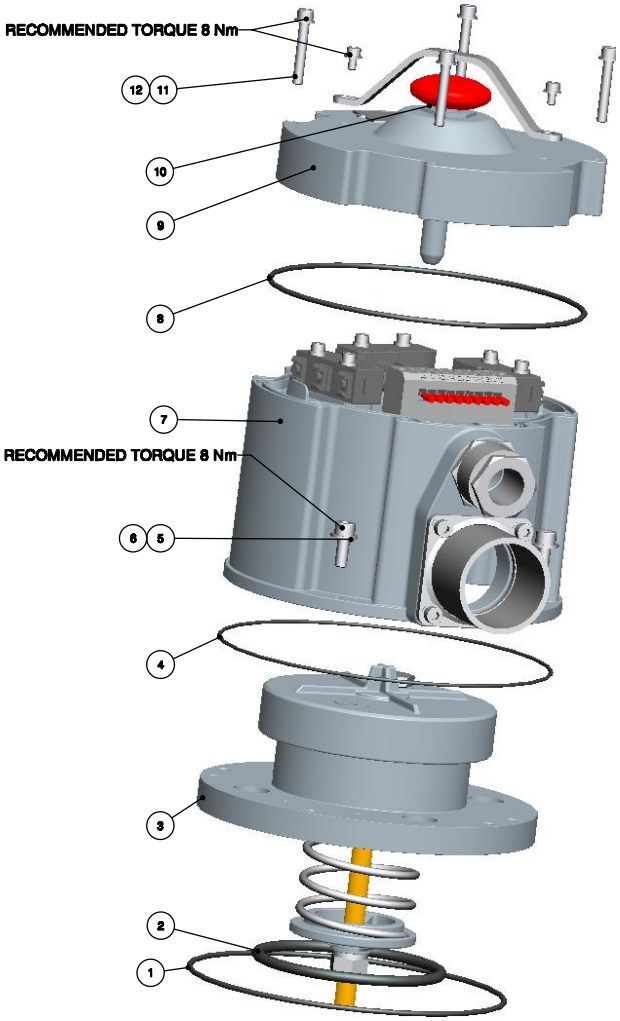
125M-6

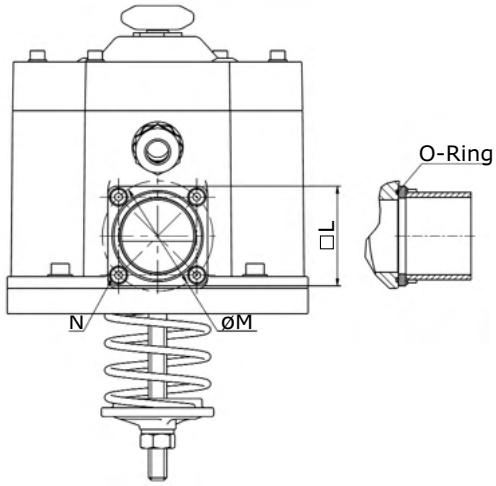


Type	B	C	D	D1	D2	D3	E	F20KPA	F70KPA	G	H	I	No. of holes
125 M-8	278	228	Ø120	Ø153	Ø278	Ø278	86	175	80	230	Ø210	Ø18	8
125 M-6	278	228	Ø120	Ø153	Ø278	Ø278	86	175	80	230	Ø235	Ø18	8

Pressure Relief Device - M

Assembling sequence





Type	□L	ØM	N	O-Ring
50 M	55	61	4 Screws M5x12	5G0D002187
125 M-8	135	152	4 Screws M12x25	5G0D004475
125 M-6	135	152	4 Screws M12x25	5G0D004475

Type 50 M

Ref.	Q.ty	Code	Description
1	1	5G0D003600*	GASKET O.R. 3600
2	1	5G0D000183*	GASKET O.R. 6337
3	1	-	50M SAFETY VALVE
4	1	5G0D002637	GASKET O.R. 2637
5	1	5V51106012	UNI 5931 M6X12 FIXING SCREW
6	1	5400800861	WASHER
7	1	-	OIL DUCT 50M
8	1	5G0D003600	GASKET O.R. 3600
9	1	-	OIL DUCT COVER 50M
10	1	-	VISUAL SIGNAL
11	1	5V50605035	UNI 5931 M5X35 FIXING SCREW
12	1	5RG0600050	WASHER

Type 125 M-8

Ref.	Q.ty	Code	Description
1	1	5G0D041050**	GASKET O.R. 41050
2	1	5G0L000227**	GASKET O.R. 8650
3	1	-	125M-8 SAFETY VALVE
4	1	5G0D041050**	GASKET O.R. 41050
5	1	5V50606060	UNI 5931 M6X60 FIXING SCREW
6	1	5400800861	WASHER
7	1	-	OIL DUCT 125M
8	1	5G0D041100	GASKET O.R. 41100
9	1	-	OIL DUCT COVER 125M
10	1	-	VISUAL SIGNAL
11	1	5V50605035	UNI 5931 M5X35 FIXING SCREW
12	1	5RG0600050	WASHER

Type 125 M-6

Ref.	Q.ty	Code	Description
1	1	5G0D041050**	GASKET O.R. 41050
2	1	5G0L000227**	GASKET O.R. 8650
3	1	-	125M-6 SAFETY VALVE
4	1	5G0D041050**	GASKET O.R. 41050
5	1	5V50606060	UNI 5931 M6X60 FIXING SCREW
6	1	5400800861	WASHER
7	1	-	OIL DUCT 125M
8	1	5G0D041100	GASKET O.R. 41100
9	1	-	OIL DUCT COVER 125M
10	1	-	VISUAL SIGNAL
11	1	5V50605035	UNI 5931 M5X35 FIXING SCREW
12	1	5RG0600050	WASHER

* ALTERNATIVE PLANE GASKET CODE 5C0V412501
** ALTERNATIVE PLANE GASKET CODE 5C0V452900

Order sheet

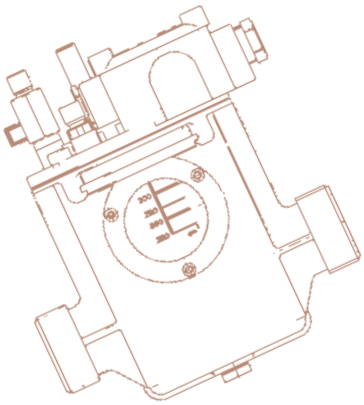
Number of pieces			
Model	50 M ☐	125 M-8 ☐	125 M-6 ☐
Contacts	**1** ☐	**2** ☐	**3** ☐
Pressure setting 20÷90 kPa Up to 200kPA for 50M only	Value ..... kPa		
For use in:	Moderate salinity areas acc. to ISO 12944 ☐		
	Off-shore areas acc. to ISO 12944 ☐		
Gaskets type	Viton ☐	silicone oils and/or high temperature -10°C up to + 150°C	
	NBR -40°C ☐	mineral oils and low temperature -40°C up to + 120°C	

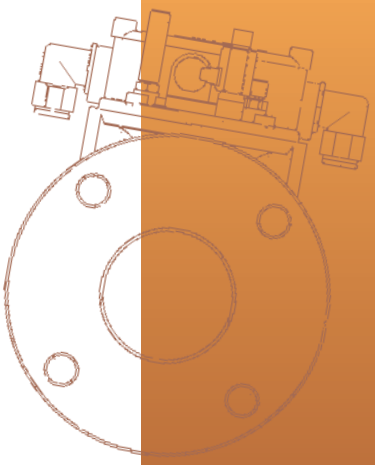
SECTION 9

Appendix C

Buchholz Relay

Comem BS50LA (18 pages)





GAS-ACTUATED RELAYS

BUCHHOLZ TYPE

ACCORDING TO

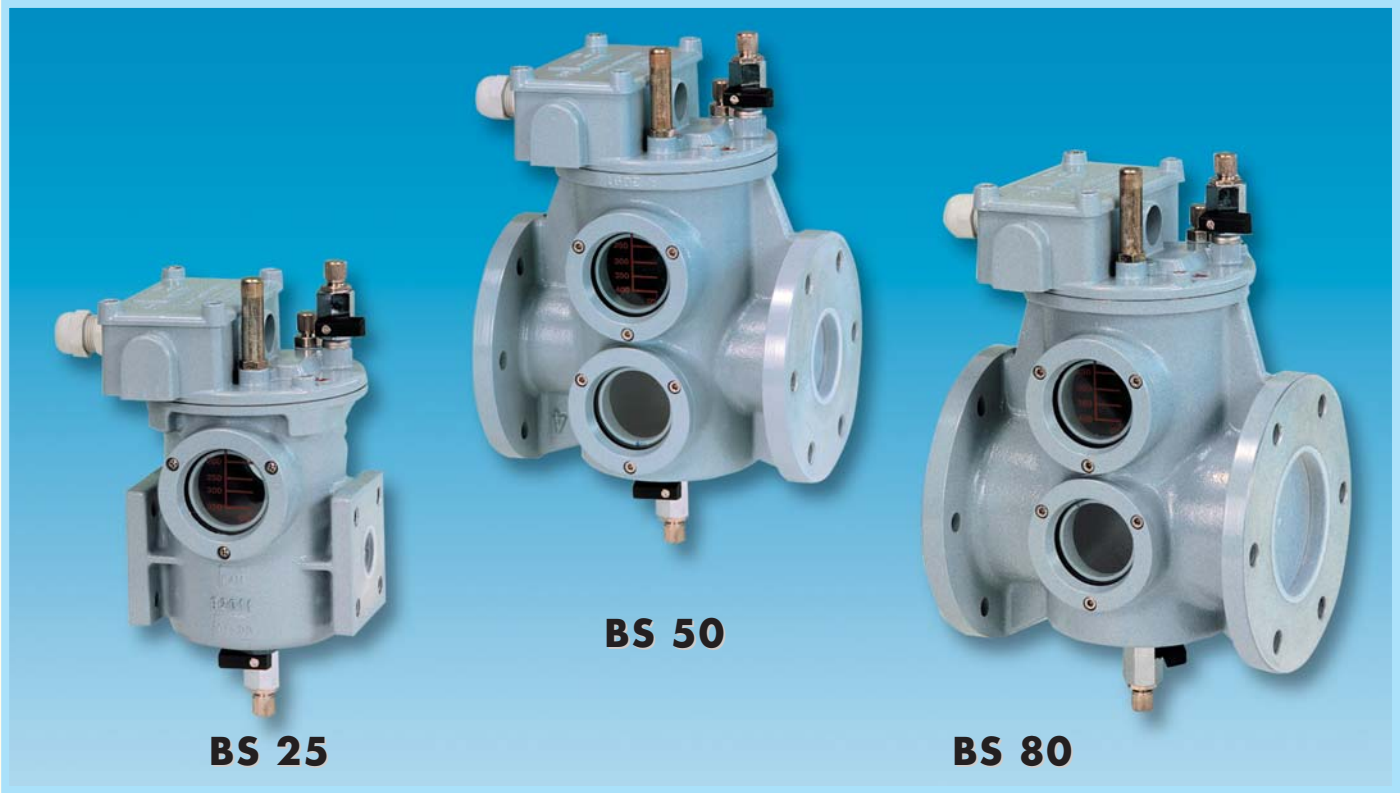
CENELEC EN 50216-2 STANDARD

AND

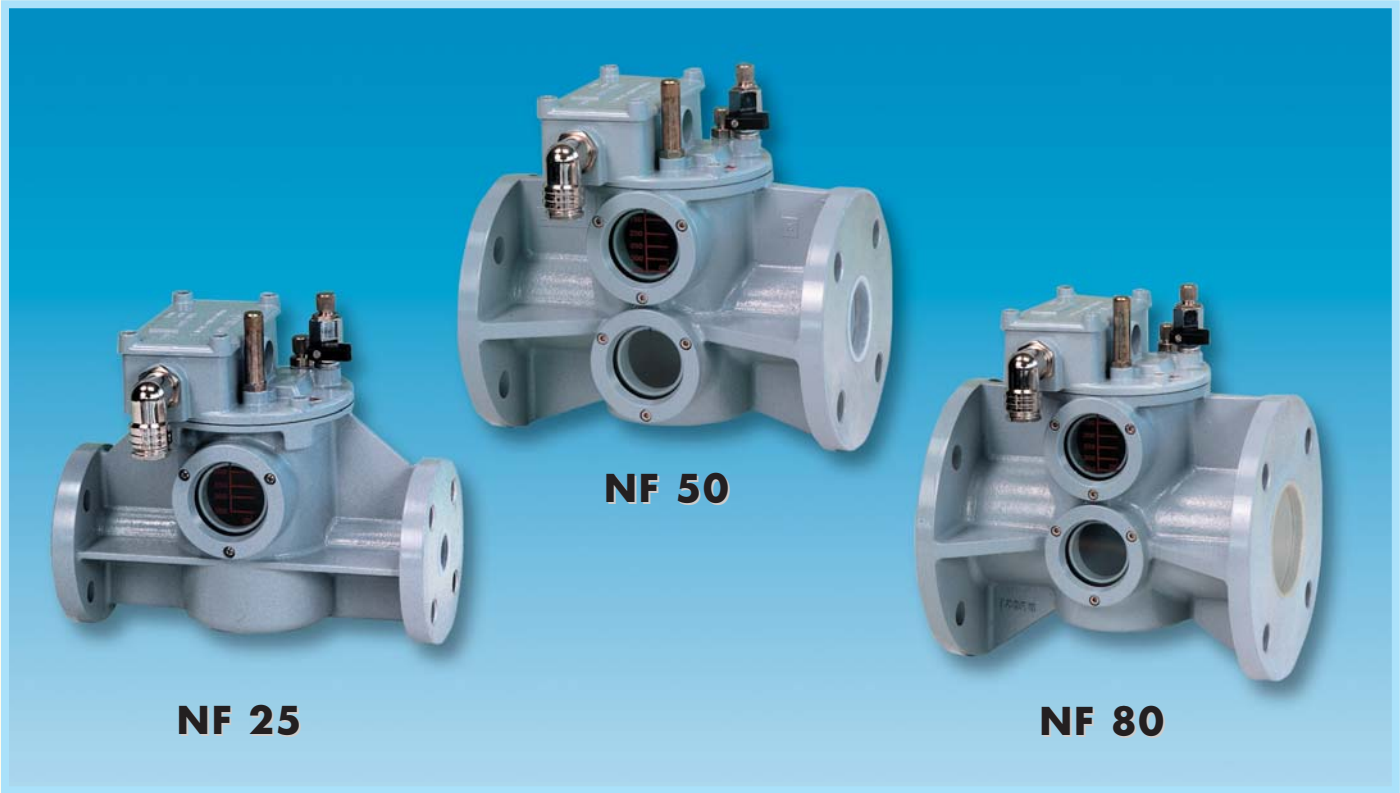
GAS SAMPLING DEVICE

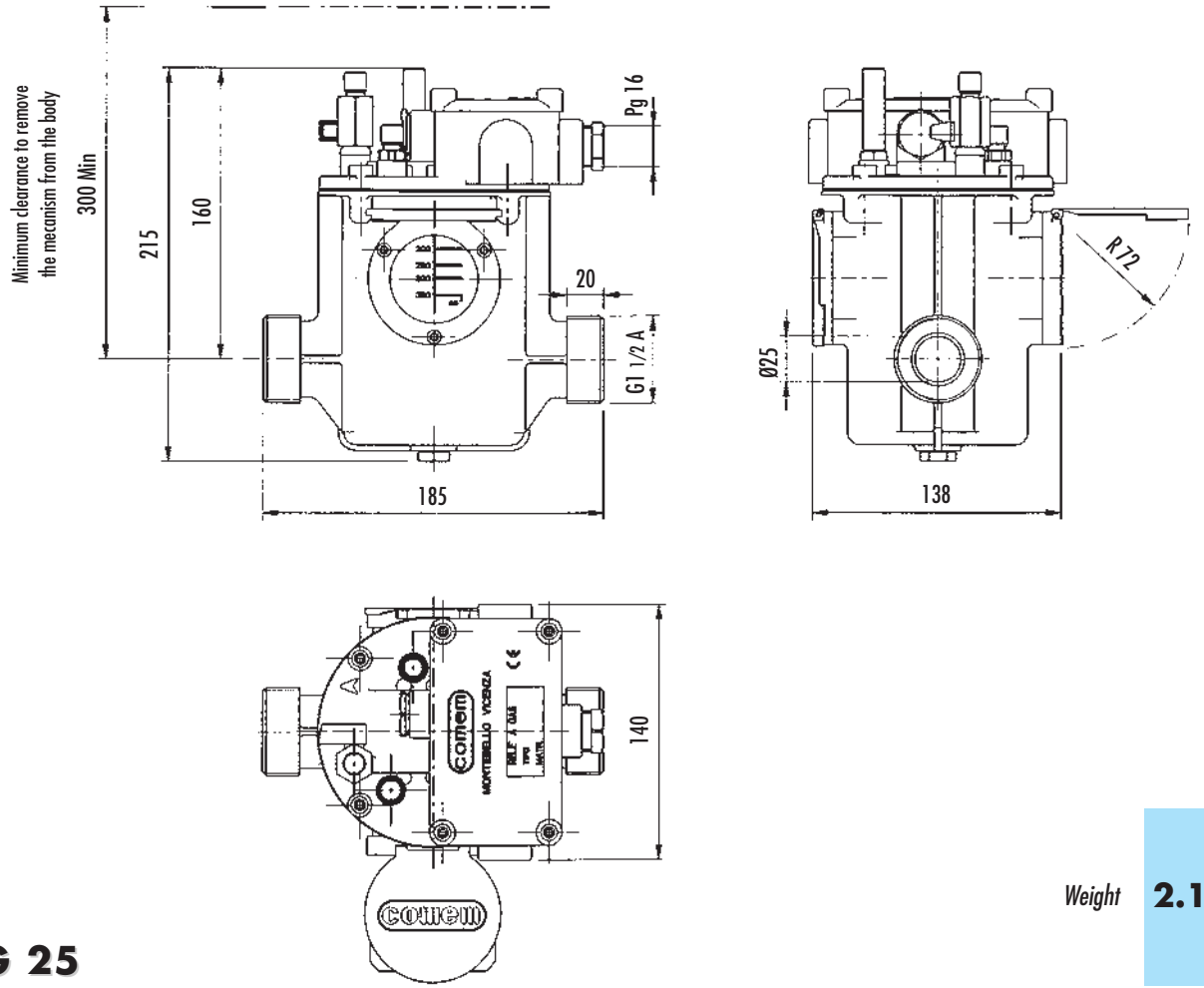
comem®

GAS-ACTUATED RELAYS BUCHHOLZ TYPE



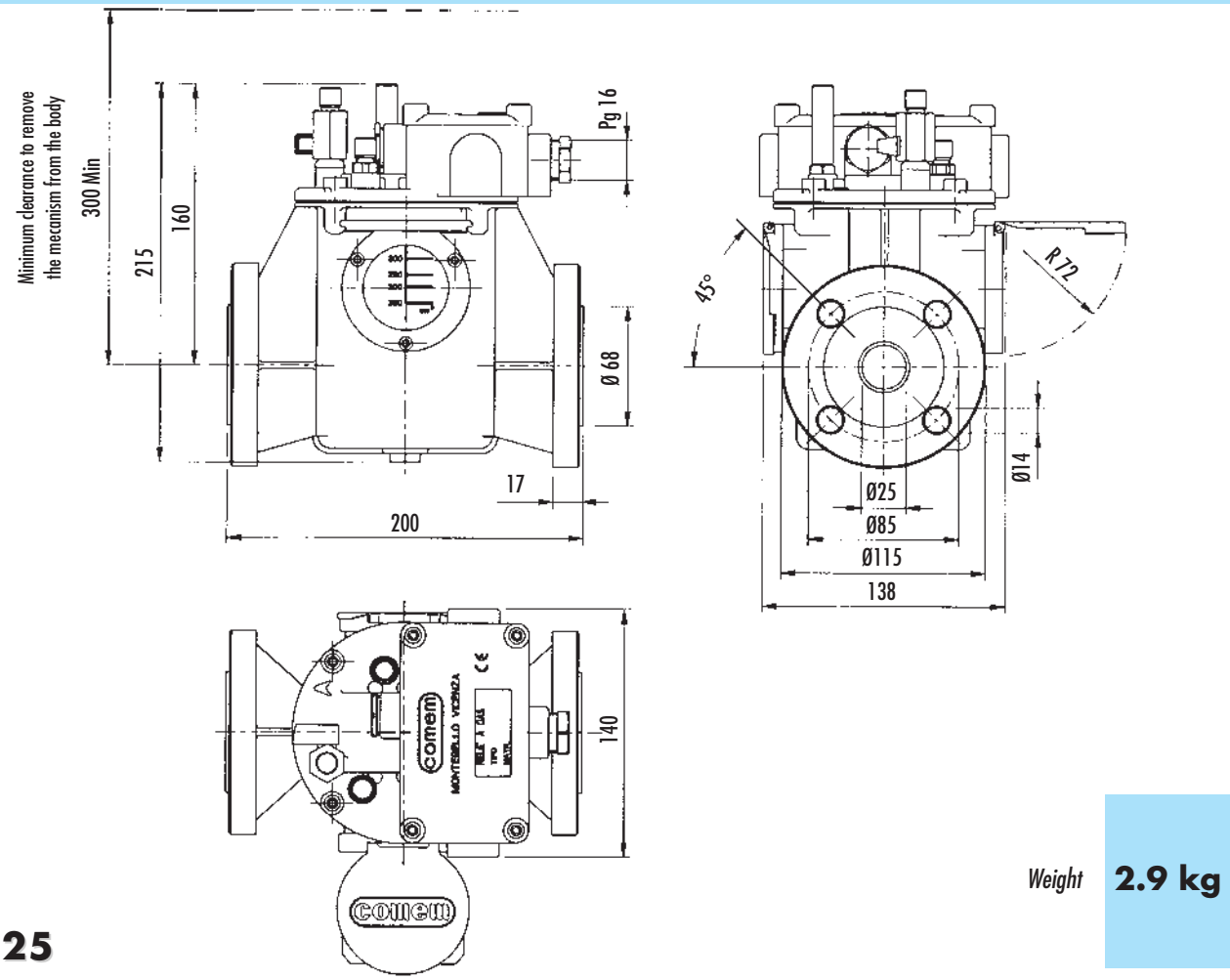
GAS-ACTUATED RELAYS BUCHHOLZ TYPE





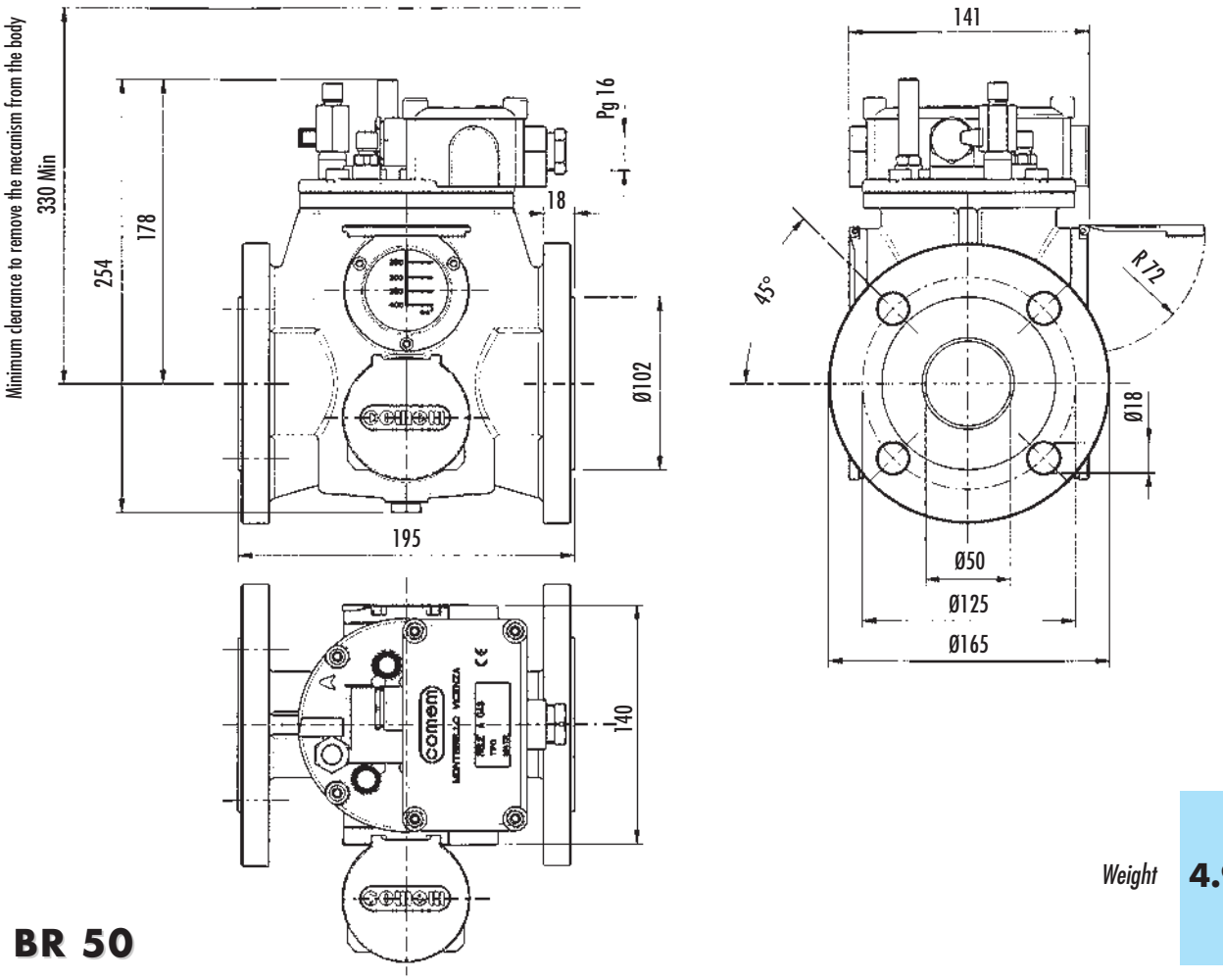
BG 25

Weight **2.1 kg**



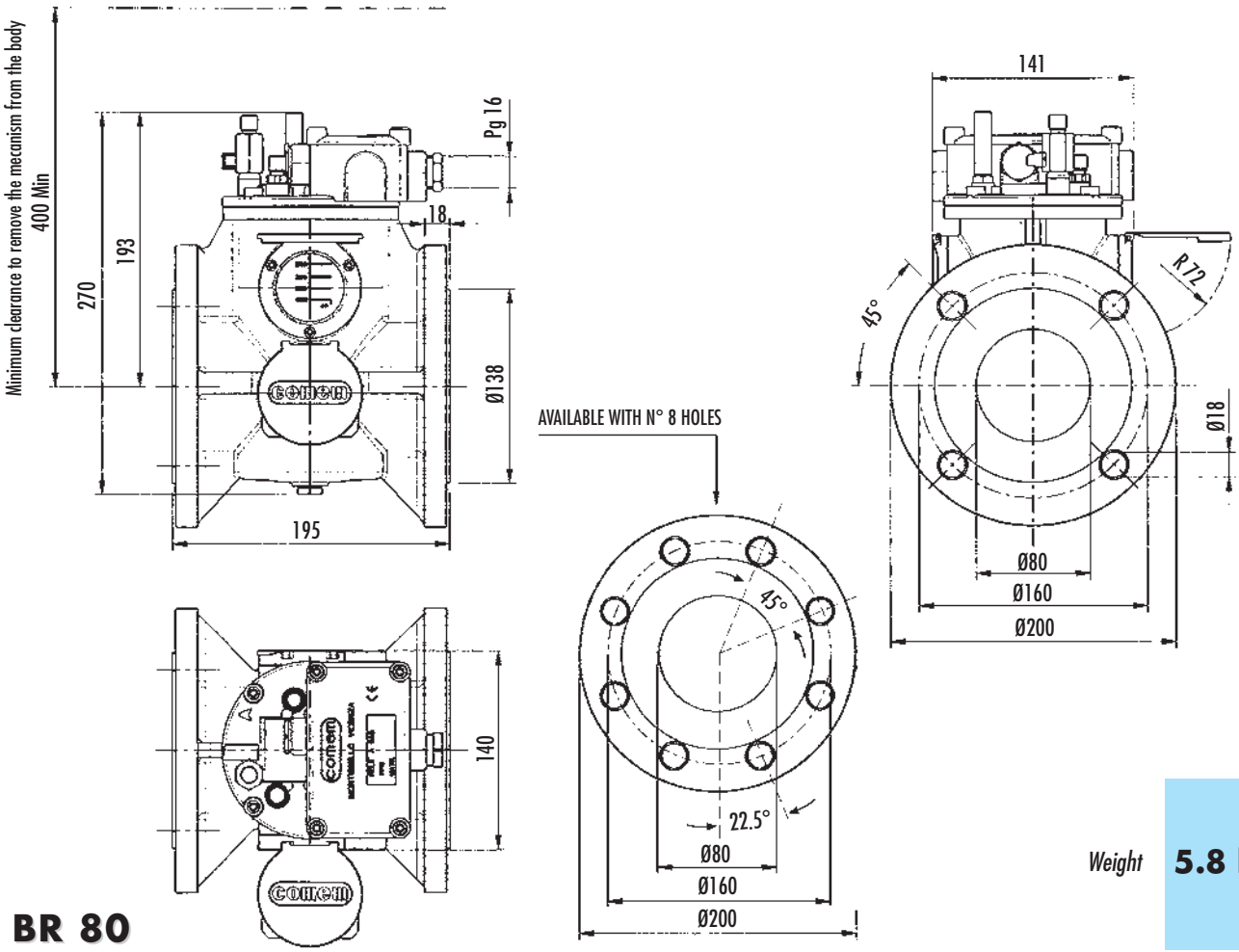
BR 25

Weight **2.9 kg**



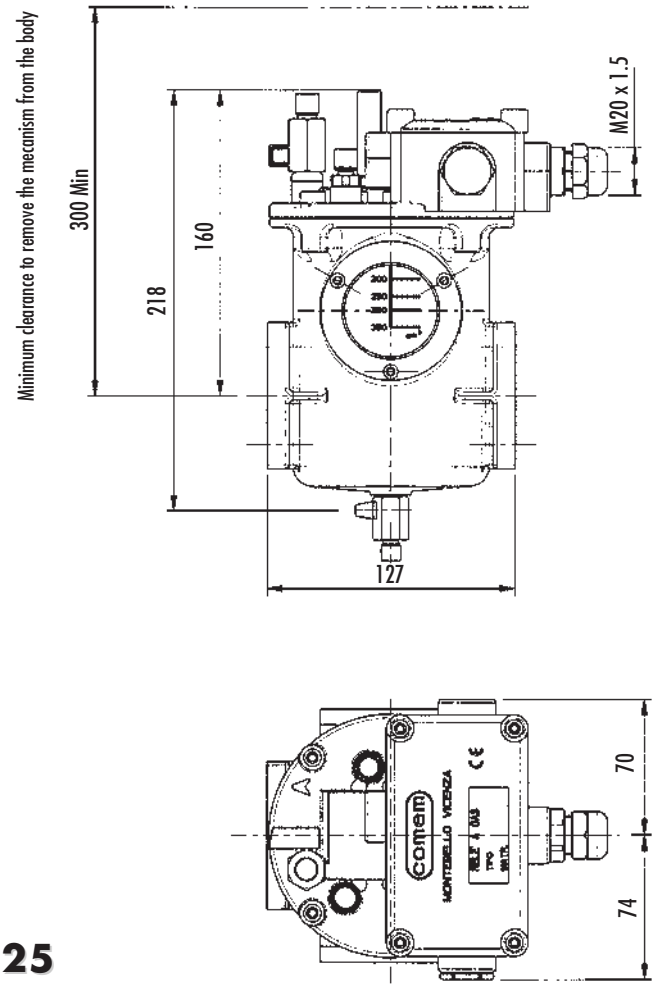
BR 50

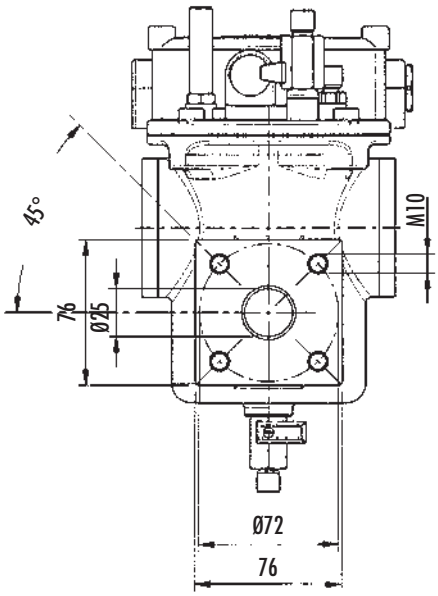
Weight **4.9 kg**



BR 80

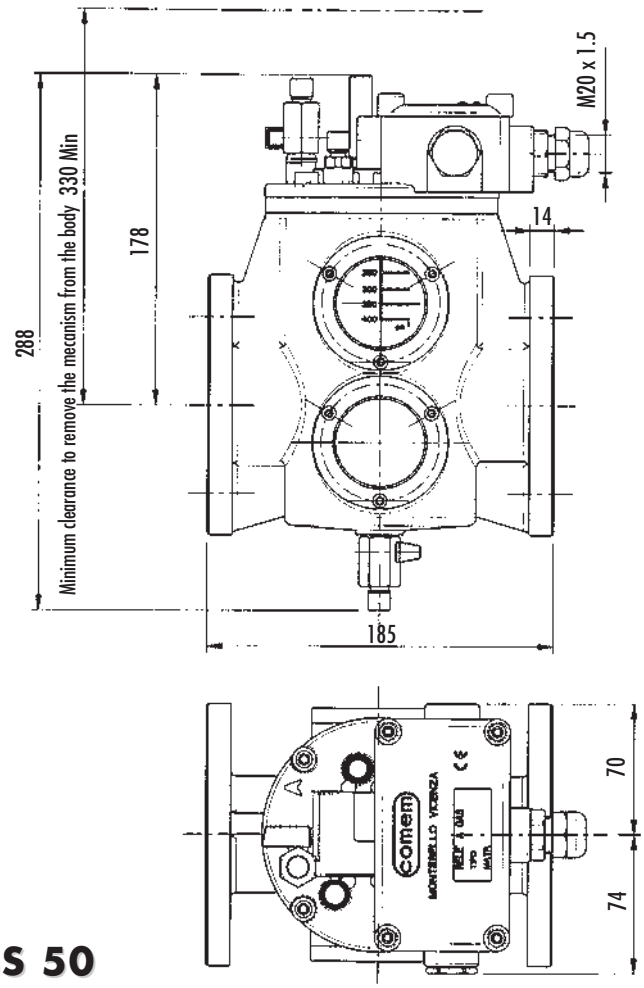
Weight **5.8 kg**

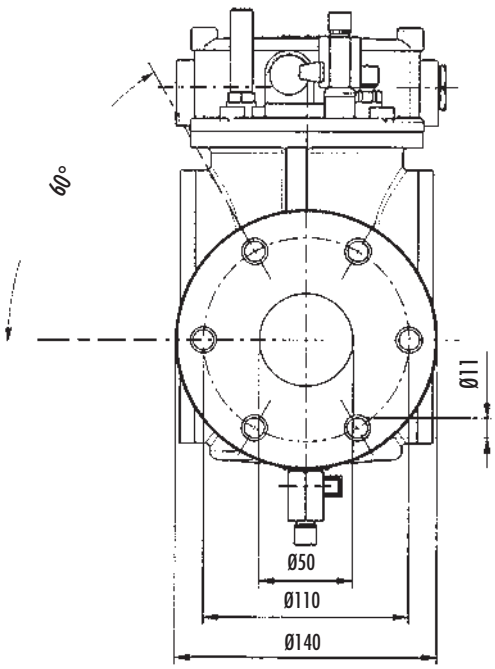




BS 25

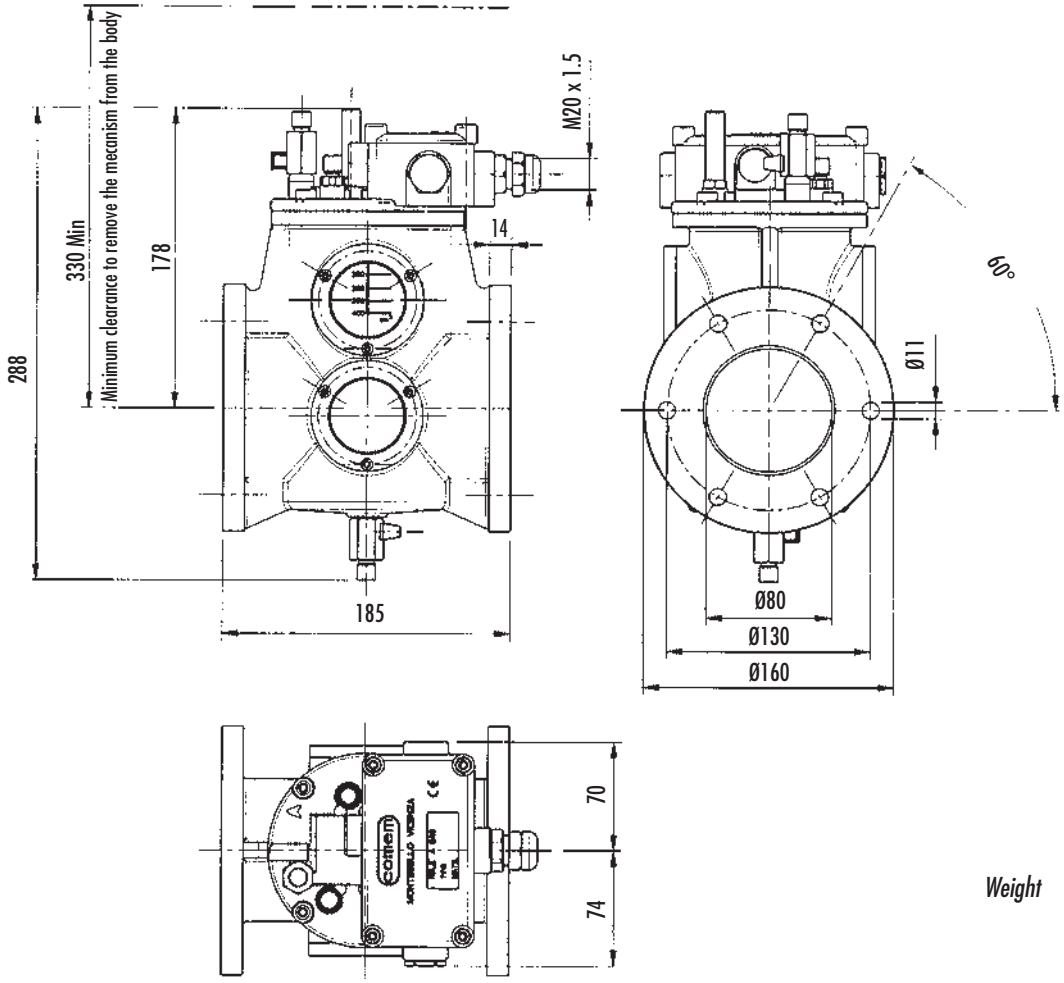
Weight **2.2 kg**





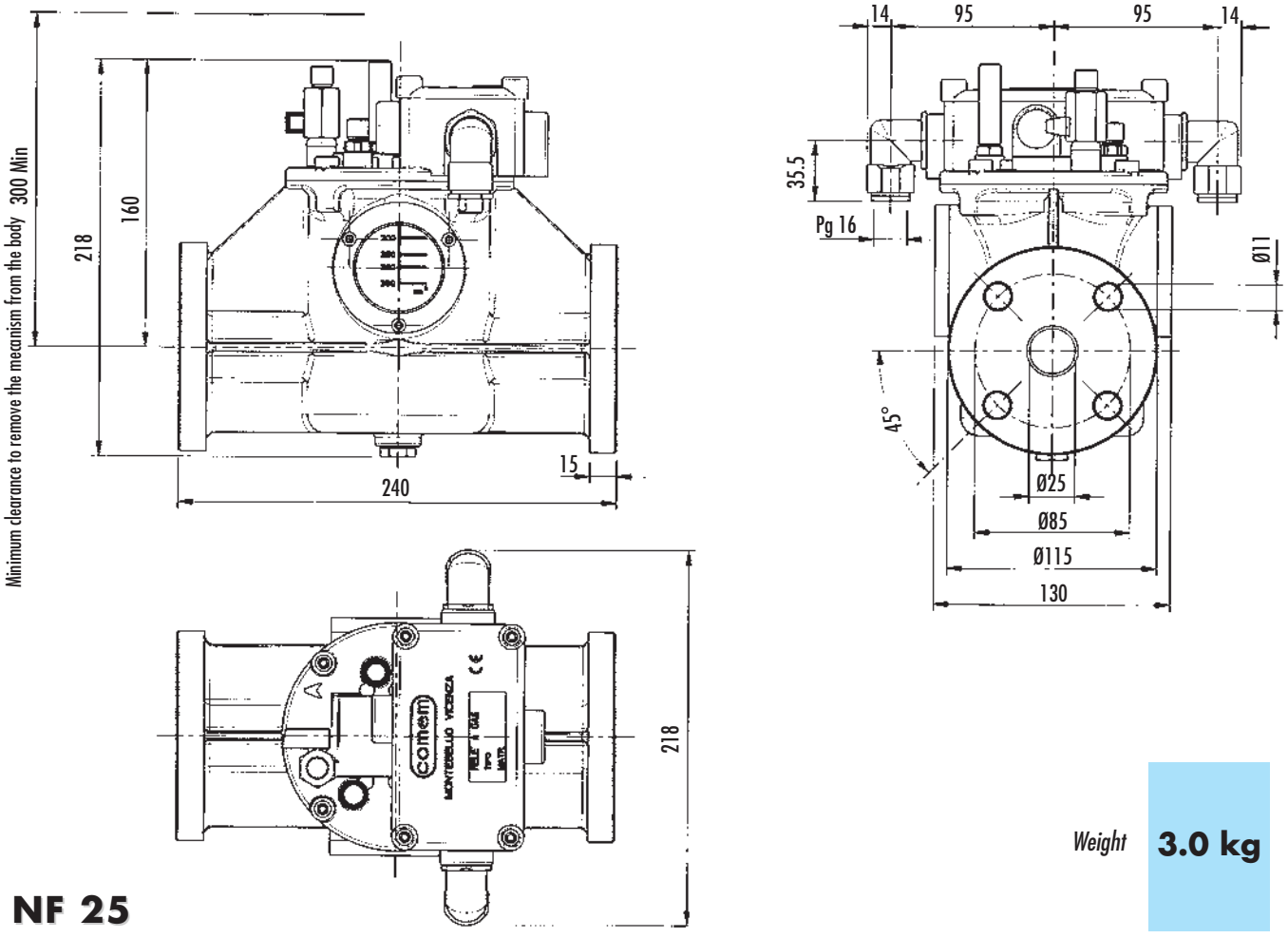
BS 50

Weight **4.1 kg**



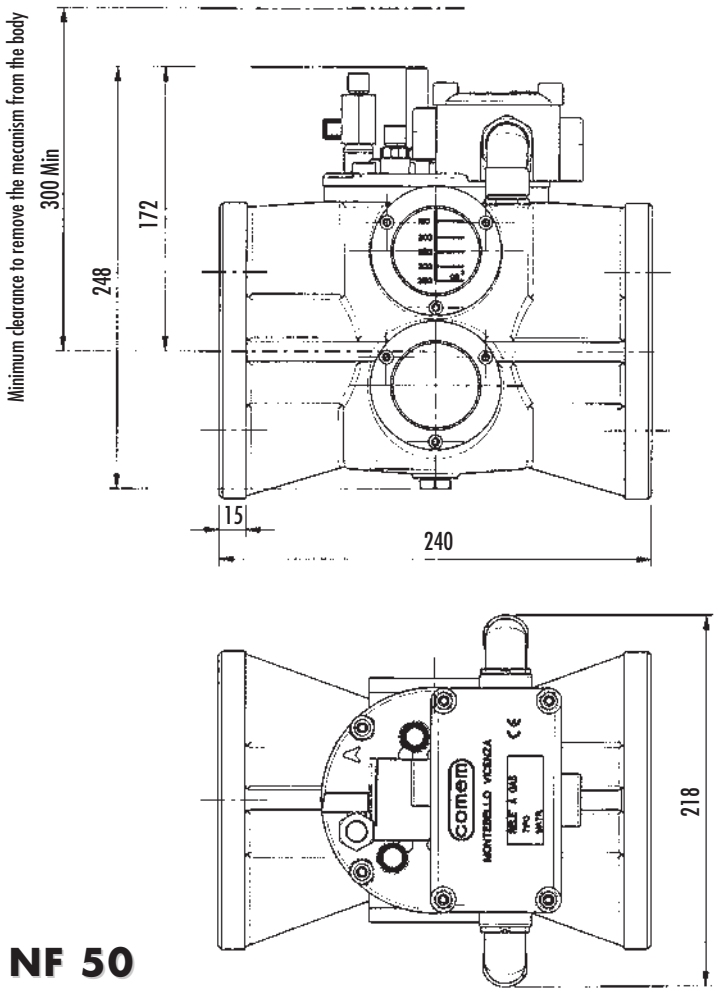
BS 80

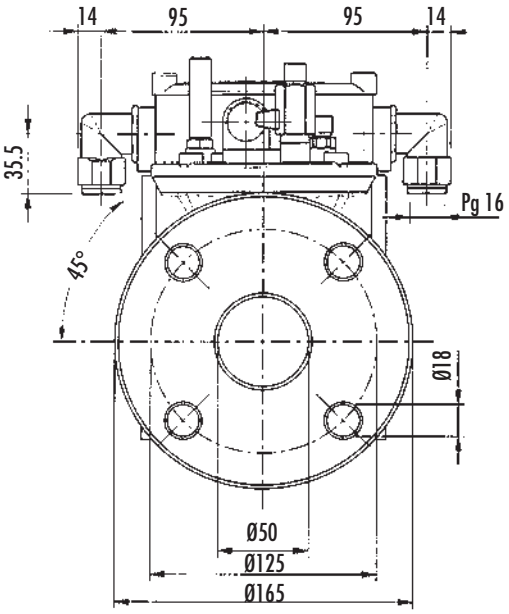
Weight **4.3 kg**



NF 25

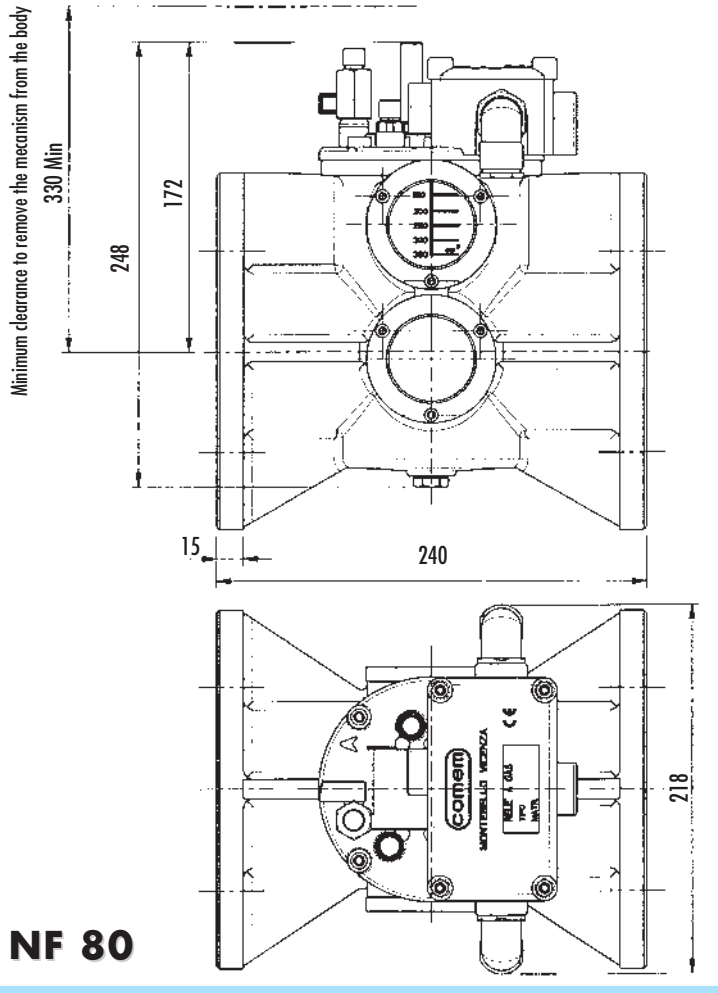
Weight **3.0 kg**

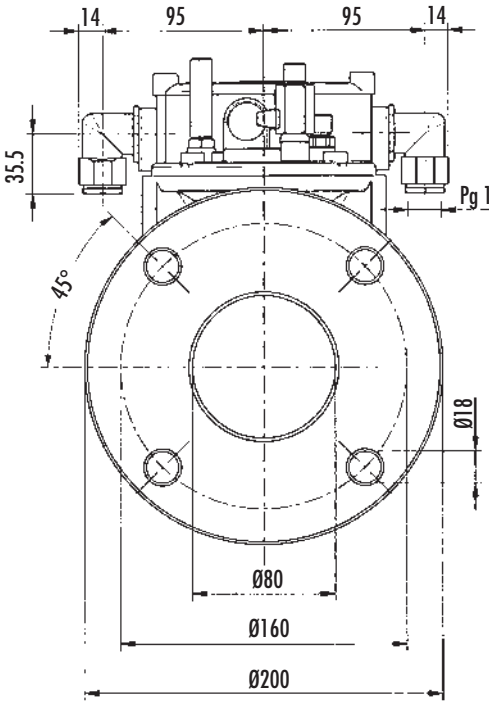




NF 50

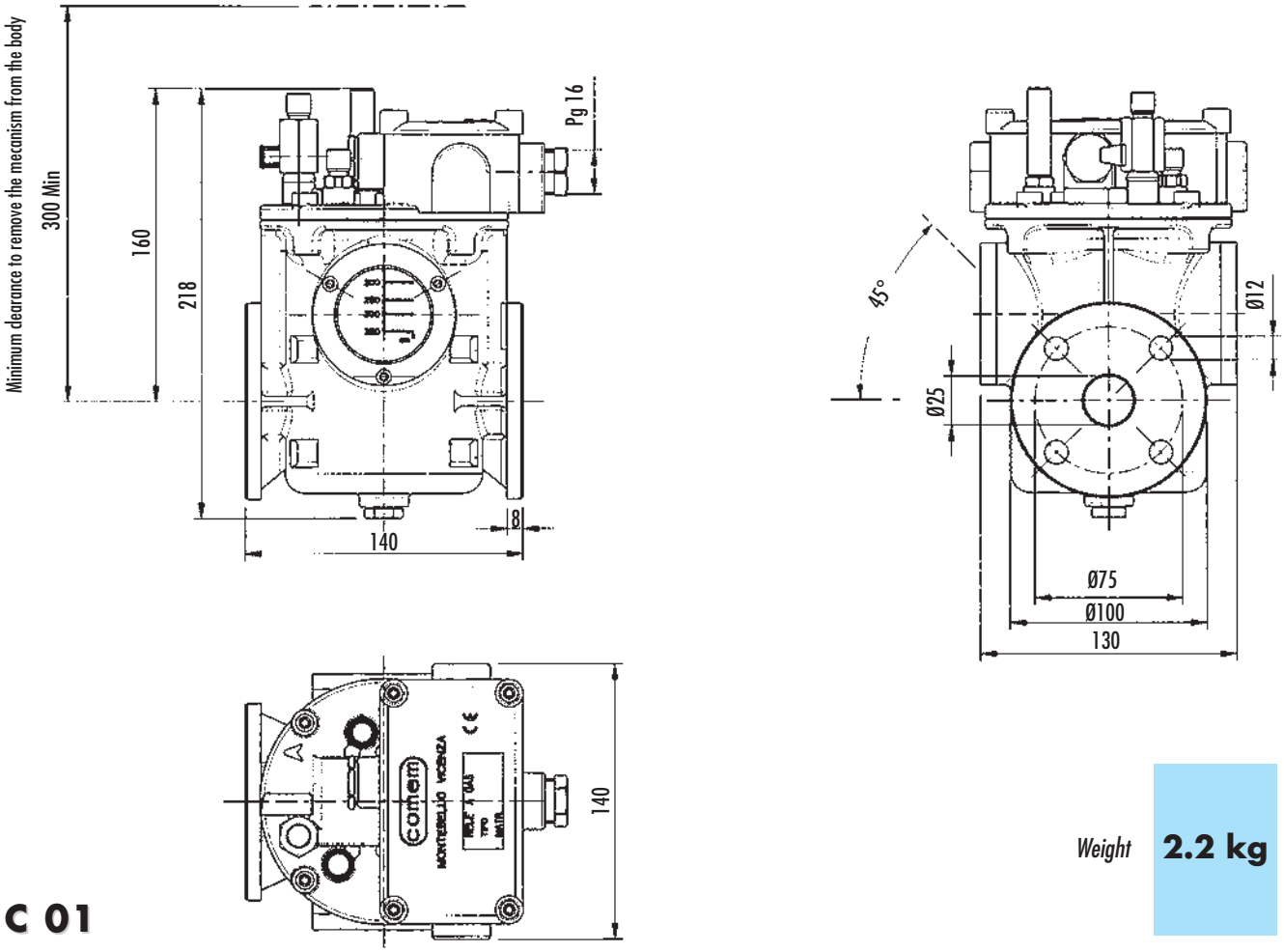
Weight **4.8 kg**





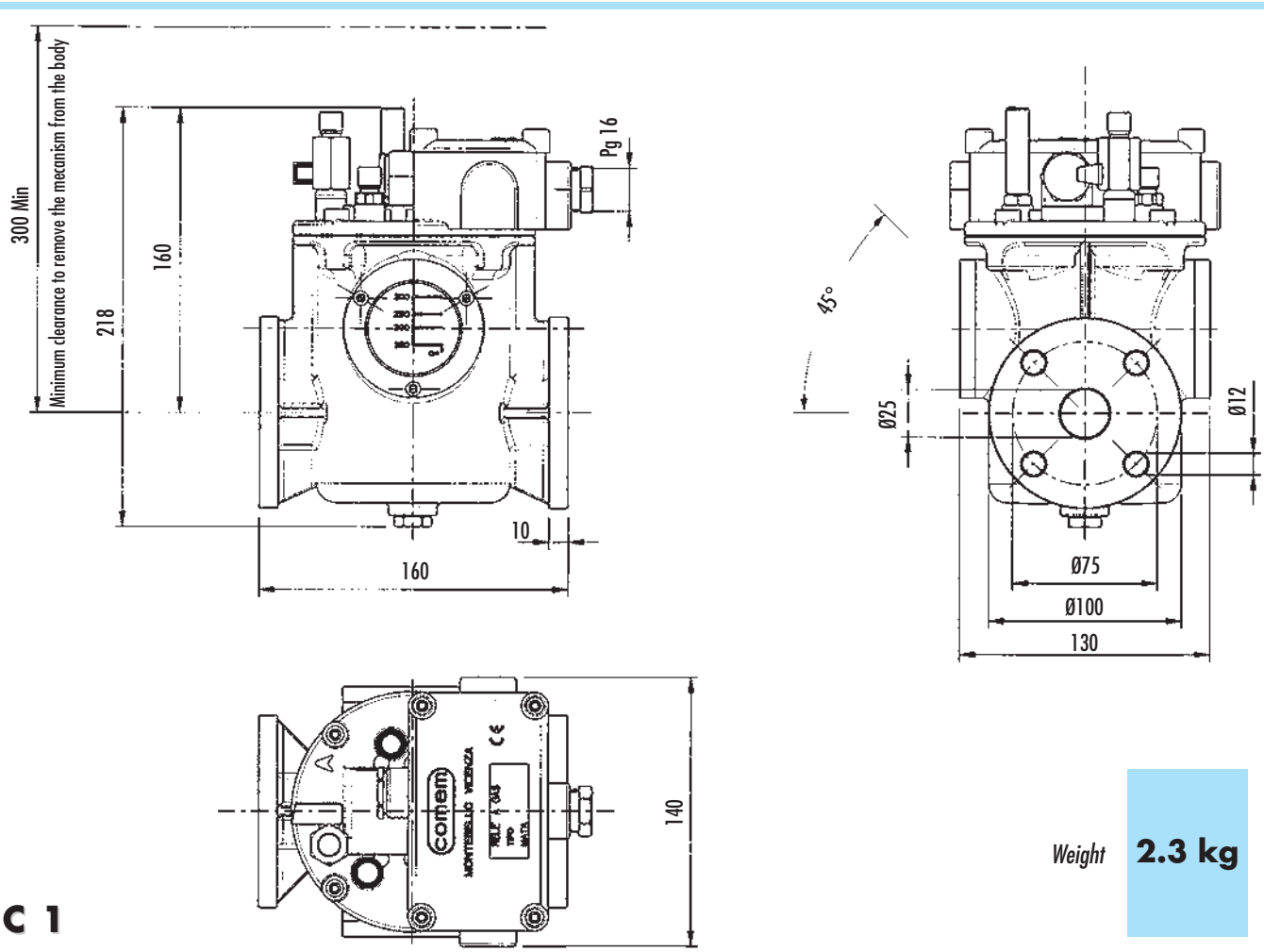
NF 80

Weight **5.5 kg**



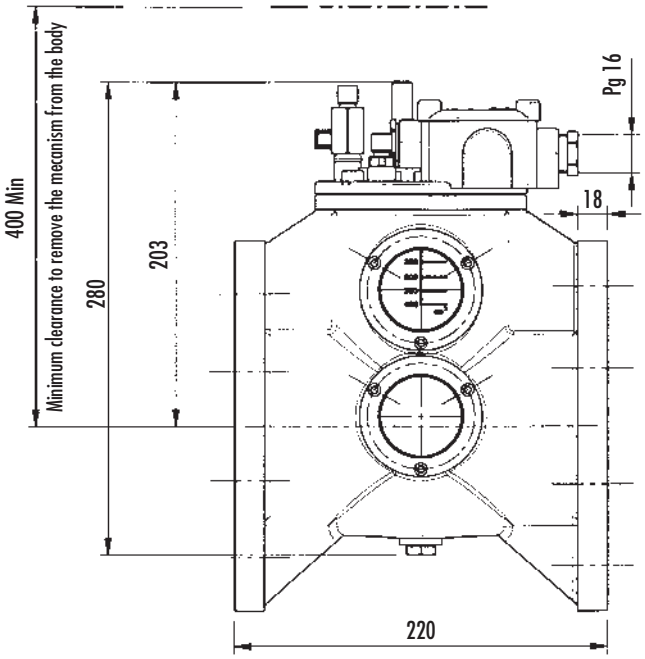
C 01

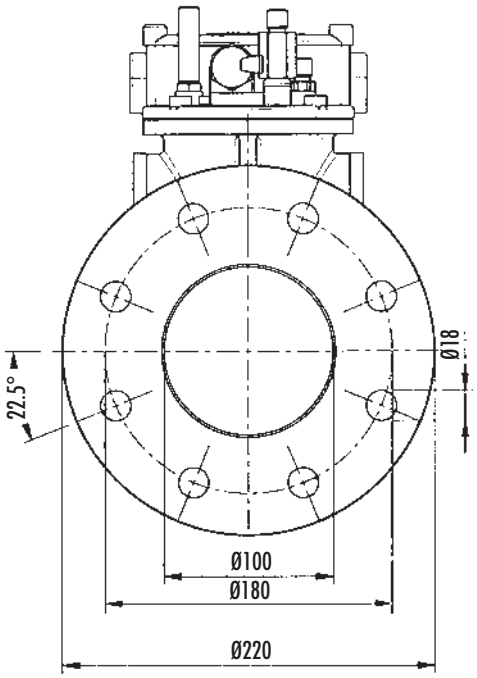
Weight **2.2 kg**

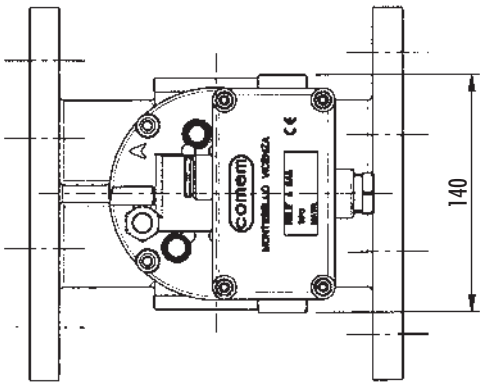


C 1

Weight **2.3 kg**







C 4

Weight **5.9 kg**

BUCHHOLZ GAS-ACTUATED RELAY
to CENELEC EN 50216-2 standard

The generation of gas in an oil filled trasformer is a clear indication of a problem. The gas may be a result of the following:

- Decomposition/degradation of solid, or liquid insulation inside the transformer due to overheating, or arcing.
- From the outside towards the pipeline.
- From the oil itself due to unsatisfactory de-gassing prior to filling.

Rapid oil movement in the pipeline towards the conservator is caused by an internal arc, short circuit, or hot spot which must be correctely addressed.

Oil leaks from the transformer are environmentally unacceptable and a fire hazard will lead to transformer failure.

To indicate any of the above malfunctions Comem as the result of 40 years experience with these products has developed a new "Buchholz" relay to comply fully with the latest CENELEC EN 50216-1 and EN 50216-2 standards.

The new relay incorporates the very latest technology in its construction.

PRINCIPLE OF OPERATION

The Buchholz relay is sited in the pipework between the transformer and its conservator and it is filled with oil during normal transformer operation. When gas is generated in the transformer it rises towards the conservator and collects in the upper chamber of the relay.

The oil level drops and the top float triggers alarm switch.

Gas shall not freely pass from the relay body and escape into the pipewoek before the alarm contact has operated.

The trip contact shall operate at a steady oil flow as indicated in Table 3.

This operation shall not be adversely affected when the alarm contact has already closed and gas is escaping freely.

In the event of an oil leak the Buchholz relay will only operate after the conservator has exhausted all of its oil. In order to check this eventuality it is recommended that an RDR MK II automatic shutter valve is fitted between the Buchholz and the conservator.

Specific information on this product are available on request.

CONSTRUCTION

The new Comem Buchholz relay is an assembly of two machined aluminium alloy castings that effect a perfect oil seal.

1) The main body of the relay is fitted with tempered glass inspection windows with graduated scale markings in cubic centimetres to indicate the internal volume. The oil drain plug is located at the bottom of the main body.

2) The top cover carries the frame which contains the moving parts of the relay. These comprise the two floats and their associated switches encapsulated in glass bulbs, one calibrated flow valve and two permanent magnets.

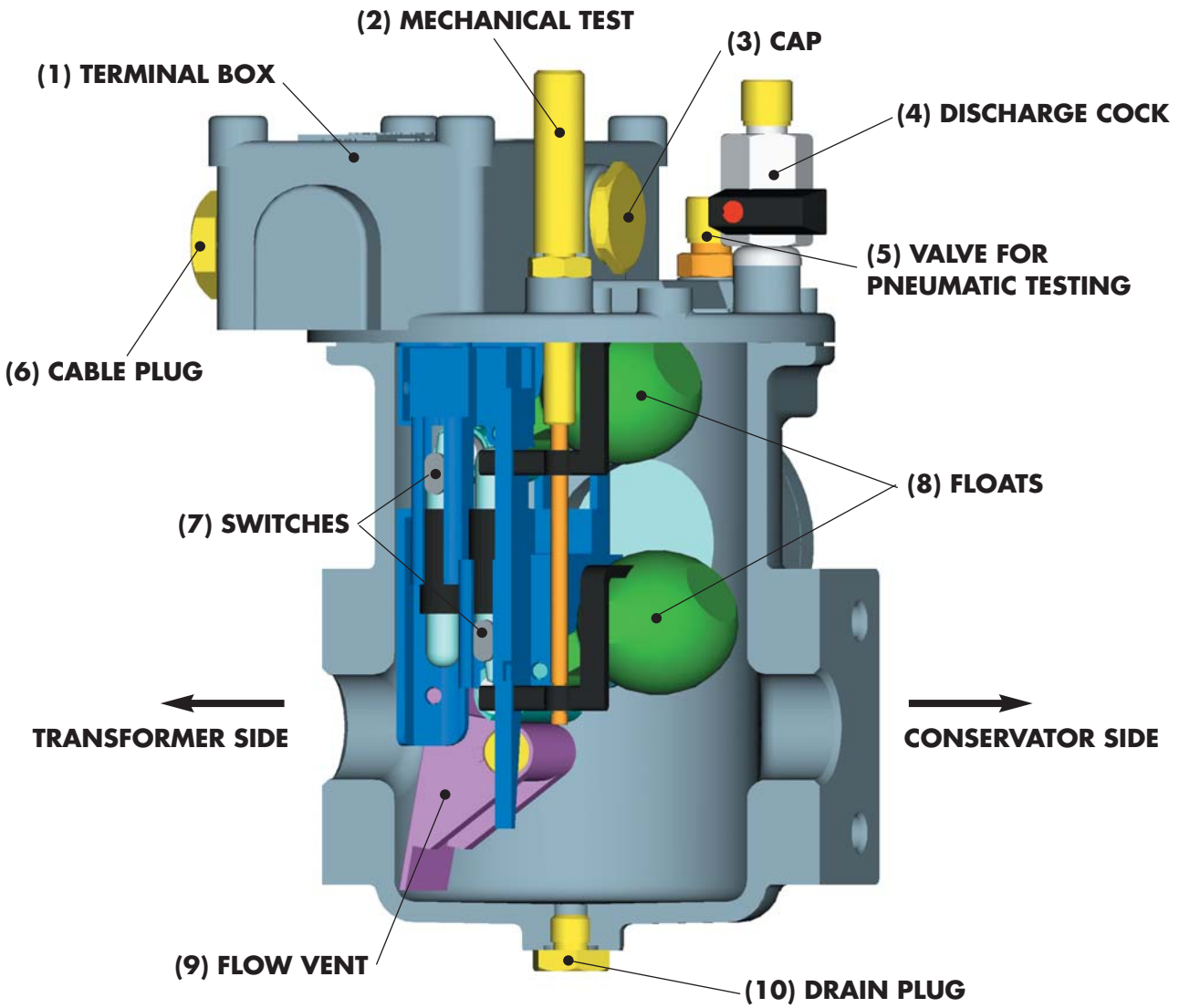
The cover also carries:

(4) a gas discharge valve with G1/8" in male thread with protective cap.

(5) A valve for pneumatically testing the alarm and insulation circuits, with protective cap.

(2) A push rod for mechanically tripping the alarm and the insulation circuits, with protective cap.

A terminal box which as standard contains 4 numbered M6 terminals and one earth terminal.



EXTERNAL COATING AND PROTECTION

To the external aluminium alloy parts is given a phosphate treatment prior to applying one coat of vinyl enamel, colour RAL 7001. This treatment has proved more than satisfactory over the years for the majority of applications including desert and tropical situations. However, in particularly severe applications (>500h salt fog) such as applications in corrosive atmospheres (acids) a suitable epoxy primer is recommended. (This should be discussed at the time of selection).

All external brass fittings are plated and all nuts are made in stainless steel.

RELAY SELECTION

The size and type of relay to be used will depend on the transformer rating and oil volume. Suggestions are given in the following table but the final choice is often as a result of the transformer manufacturers experience.

MVA TRANSFORMER POWER	NOMINAL DIAMETER
Up to 5	25
From 5 up to 20	50
From 20 up to 50	80
Over 50	100

tab. 1

TECHNICAL DATA

- The relay pipework is typically mounted at 2,5 degrees to the horizontal. A positive inclination of up to 5 degrees to the horizontal axis is admissible.
- Operating pressure - 1 bar, tested to 2,5 bar for 2 minutes at 100 deg C.
- Gas volume to trip alarm:

BUCHHOLZ RELAY TYPE	GAS VOLUME NECESSARY TO TRIP THE ALARM
BG 25, BR 25, NF 25, C 01 , C 1	100÷200
NF 50, NF 80	100÷200
BR 50 , BR 80, C 4	150÷250
BS 25	170÷230
BS 50, BS 80	250÷300

tab. 2

- Rate of oil flow in m/s to trip insulation. In the following table standard values are highlighted with an '**O**' available, on request with an '**X**' and not available with a '**//**'. +/- 15% tolerance at 20°C with oil viscosity according to IEC296.

INSIDE PIPE DIAMETER	1,0 m/s	1,5 m/s	2,0 m/s
25	**O**	**X**	**X**
50	**O**	**X**	**X**
80	**O**	**X**	**X**
100	//	**O**	**X**

tab. 3

- The relay operates within 0,5 seconds.
- Oil temperature between -25 and +115 deg C.
- Ambient temperature between -25 and +60 deg C.
- Degree of Protection IP65 to EN 60529.

SWITCH ELECTRICAL DATA

Rated switch current is **2 A r.m.s**. with max. **10 A r.m.s.** as short term 30 ms current value.
Breaking power is specified in the following table:

VOLTAGE	CURRENT	BREAKING POWER	
220 V d.c. (min. 12 V)	2 A for 10000 maneuvers	250 W	L/R < 40 ms
230 V a.c. (min. 12 V)	6 A for 1000 maneuvers	400 VA	cos φ > 0,5

tab. 4

Dielectric contact voltage as specified in the following table:

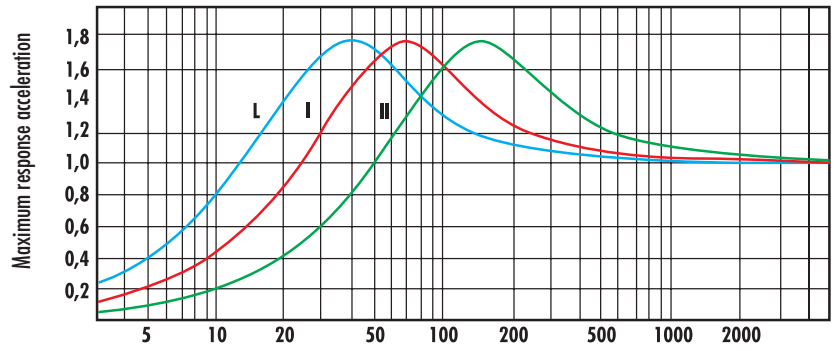
	SHORT TERM INDUSTRIAL FREQUENCY LEAKAGE TEST kV/1 min. (r.m.s)	RESISTANCE VOLTAGE PER PULSE kV (peak)
Between circuits and ground	2.5	5
Across open contacts	1	3

tab. 5

TESTING

The following Type Tests have been performed on the relay.

- Measurement of the volume of gas necessary to trip the alarm.
- 500 hr salt fog.
- Electromagnetic Field Test. Relay does not trip in field strength up to **25 mT** (ref EN 50216-2).
- Stationary sinusoidal mechanical vibrations. Tests according to EN 60721-3-4 standards have been performed.
  a) class **4M4** (4M6 on request) vibration test applied in sites where vibrations are transmitted from machinery and vehicles. Not suitable for machines exposed to high vibration and shock levels. Three-axis movement was impressed to the relay using special equipment with stationary sinusoidal vibrations from **2** to **200 Hz.** Movement had a constant **3 mm** (6 mm peak-peak) amplitude in the range from **2** to **9 Hz** whereas above this frequency it had constant **10 m/s²** acceleration. The alarm and release switches did not trip.
  b) non-stationary vibration tests with vertical shock with **100 m/s²** acceleration with type I spectrum (duration 11 ms) as shown in the graph below. Alarm and release contacts did not trip. On demand we are able to manufacture Buchholz relays with special features and test values higher than the ones stated above.



Example duration of a sinusoidal half pulse:

Type L spectrum: 22 ms duration

Type I spectrum: 11 ms duration

Type II spectrum: 6 ms duration

- A seismic test was also performed according to EN 50216-1 standards that refers to EN 60068-3-3 class 0, level 2 standards. The test consists of application of a **9 m/s²** horizontal acceleration and a **4.5 m/s²** vertical acceleration, increasing frequency one octave per minute. No activation of alarm or release switches was encountered.
- Pressure Withstand Test 2.5 bar for 2 minutes with oil at 100 deg C.
- Vacuum Withstand Test of 2500 Pa for 24 hrs.
- Rate of oil flow test to operate trip contcts, (as shown in table 3).
- Test to show the relay is insensitive to oil flow from conservator to transformer.
- Electrical tests per table 5.

ROUTINE TESTS

The following Routine Tests are applied to all relays.

- Hydraulic seal test in mineral oil at 90 deg C and 100 kpa pressure for 30 minutes.
- Contact operation via mechanical push rod.
- Contact operation by lowering the oil.
- Rate of oil flow to trip contacts.
- Electrical withstand test between contacts (as table 5).
- Electrical withstand test between contacts and earth (as table 5).

An individual routine Test Report is shipped with each relay

RELAY OPERATING TEST

The following site Tests can be performed when the relay is installed on the transformer
The Alarm and Trip contacts can be tested manually by the push rod (2) - mechanical test, or (only for alarm contact) by the introduction of air into the relay through valve (5) - pneumatic test.
A bicycle pump can be utilised for this test or a kit article n° **5400806002** is available from Comem.
To effectively test the rate of flow of oil is a complex test requiring specialised equipment. Should this test be required other than as a type test then Comem can perform this on request at the time of the order.

INSTALLATION INSTRUCTIONS

The following installation procedures must be observed for proper relay operation:

- The red arrow on the relay must point towards the conservator.
- The relay must always be full of oil, which means that the minimun oil level in the conservator must be higher than the relays breather valve.
- The recommended inclination of the relay pipework is 2.5 degrees from the horizontal.
- The pipe from the transformer to the relay must exit the transformer at the highest point.
- The pipeline upstream from the relay has to be straight and with a length equal to **5-10 times** the pipeline diameter, at least. Down stream from the relay, pipeline length has to be **3 times** the pipeline diameter, only. It must rise up towards the conservator.

RELAY ORDER FORM

Chosen size and model (see drawings and table 1):

BG 25	BR 25	BR 50	BR 80	BR 80 8 holes	BS 25	BS 50	BS 80	NF 25	NF 50	NF 80	C 01	C 1	C 4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Electric contact layout (meaning with relay filled with oil and operating):

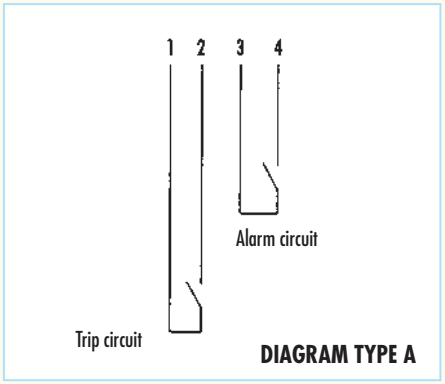
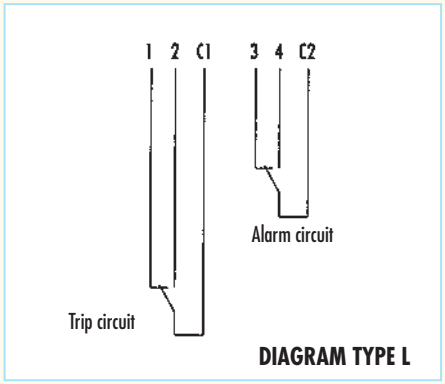


DIAGRAM TYPE A



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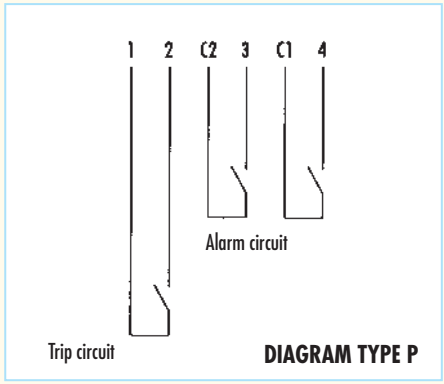

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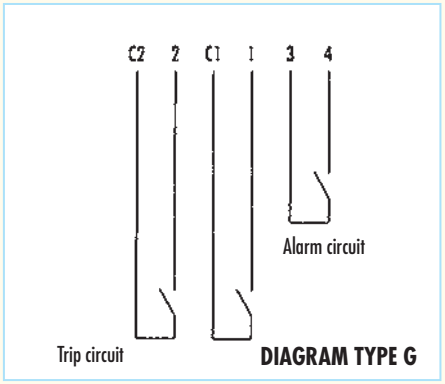

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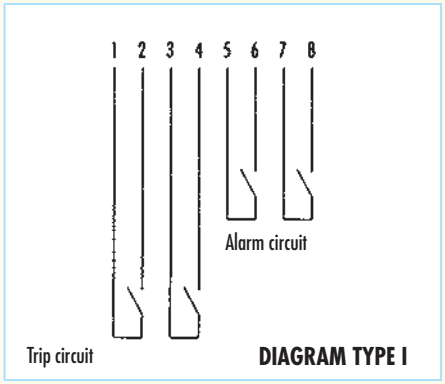

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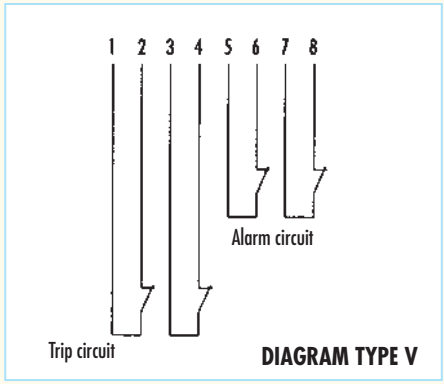


DIAGRAM TYPE V

A	L	P	G	I	V	Other
☐	☐	☐	☐	☐	☐	☐ _____

Chosen seals:

A	B	C	Other
☐	☐	☐	☐

	TYPE OF DIELECTRIC / AMBIENT TEMPERATURE/OIL		MINERAL	SILICONE	ESTERIZED
A	Ambient -25° ÷ 60° C Oil -25° ÷ 115° C	Standard version	NBR	VITON/NBR	//
B	Ambient -10 ÷ 60° C Oil -10° ÷ 115° C	Special version	//	VITON	VITON
C	Ambient -40° ÷ 60° C Oil -40° ÷ 115° C	Special version	NBR/VITON	NBR/VITON	NBR/VITON

(NBR/VITON: meaning: parts in contact with oil in VITON, parts not in contact with oil in NBR) tab. 6

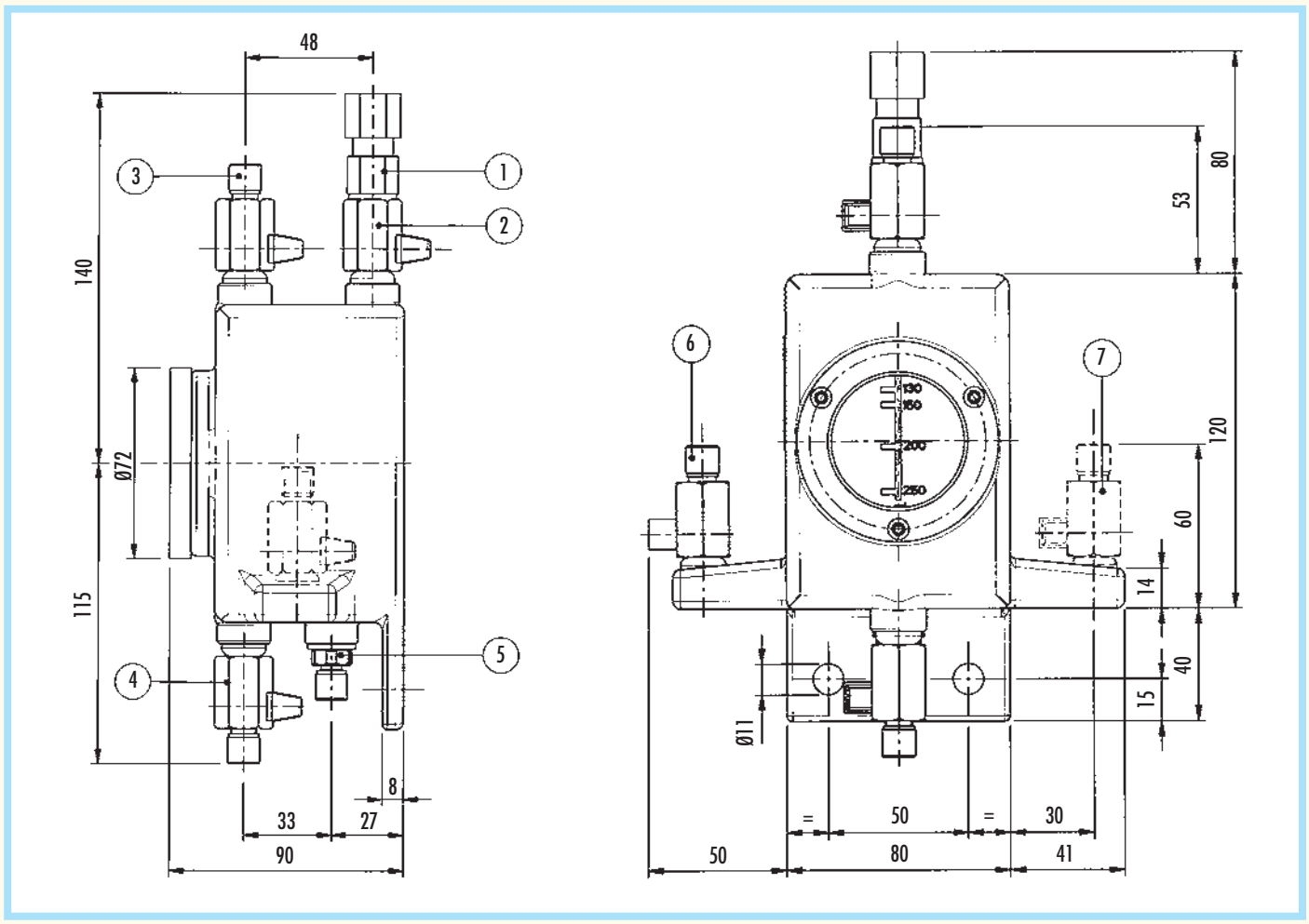
Paint finish:

Standard	Corrosive environments	Other special finishes
☐	☐	☐ _____

GAS SAMPLING DEVICE WITH APPLICATION OF THE BUCHHOLZ RELAY OIL DRAIN COCK

PRINCIPLE OF OPERATION

The presence of gas inside an oil filled transformer is always a sign of malfunction and one of the tasks of the Buchholz relay is to signal this presence. Analysis of the evolved gas can often give good indication of the type of malfunction but accessing the Buchholz relay during live operation of the transformer can be hazardous.
The gas sampling device has been designed to overcome this problem by siting the unit remote from the Buchholz and in a readily accessible position typically on the side of the transformer.

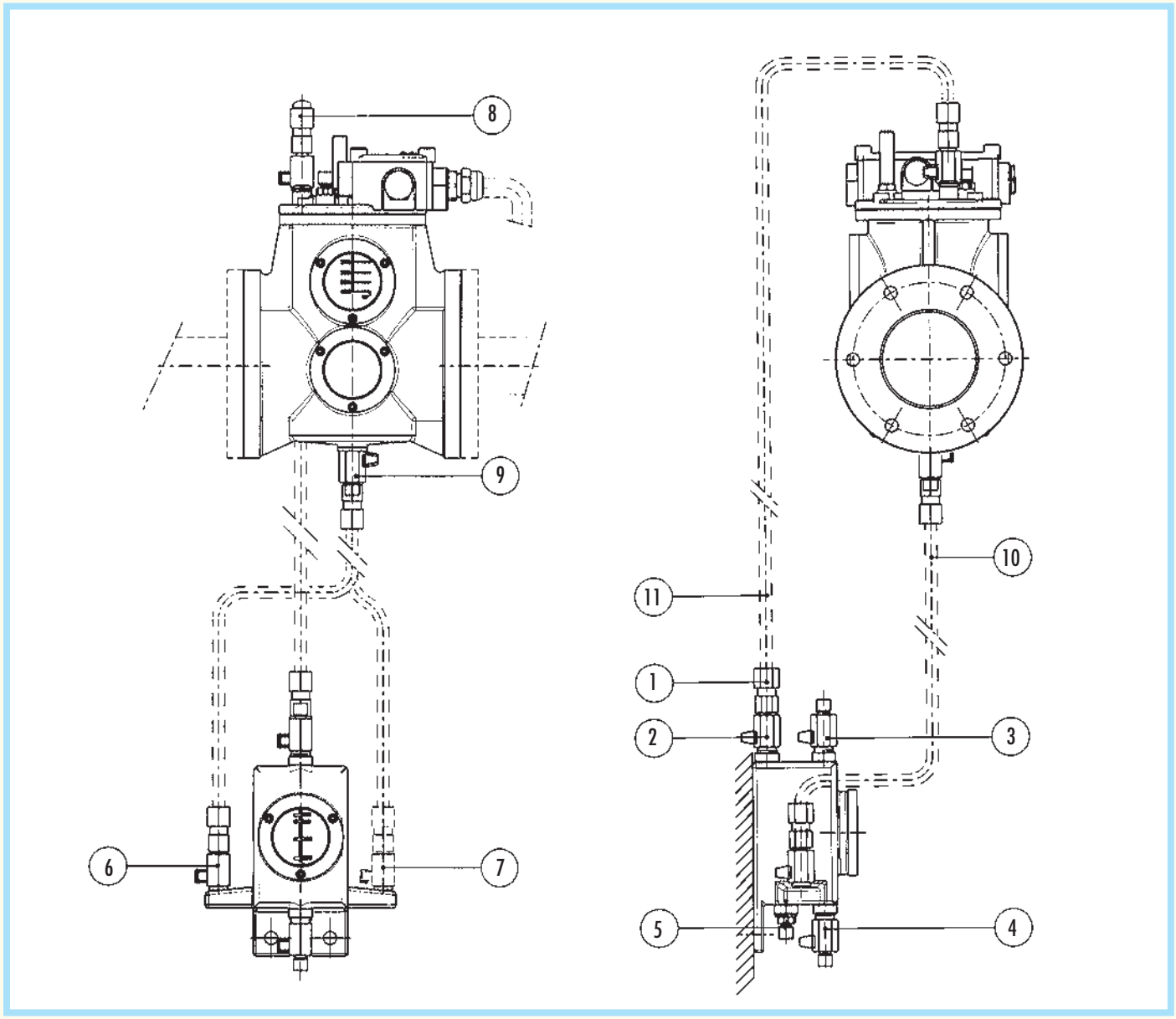


CONSTRUCTION

The Comem gas sampling device is manufactured from an aluminium alloy casting with the following fittings:
- A tempered glass inspection window with graded markings for volume indication.
- A gas sampling valve (2).
- A bleed valve (3).
- A gas inlet valve for pneumatic testing (5).
- A valve for draining oil from the relay (this can be mounted on the right or left hand side of the body (6) or (7).

As a routine test all castings are tested by injecting ambient air at 2.5 bar for 2 minutes.
A certificate to this effect is supplied with the unit.

For the sake of standardisation the device is fitted with the left and right hand valve supports but only one valve.
Customer can then choose which side he prefers.
- With fittings for outside dia. 10 tubes, code **1RDPG00005** (standard);
- with fittings for outside dia. 6 tubes, code **1RDPG00006** (on request);
- with fittings for outside dia. 8 tubes, code **1RDPG00007** (on request).



DESCRIPTION OF OPERATION

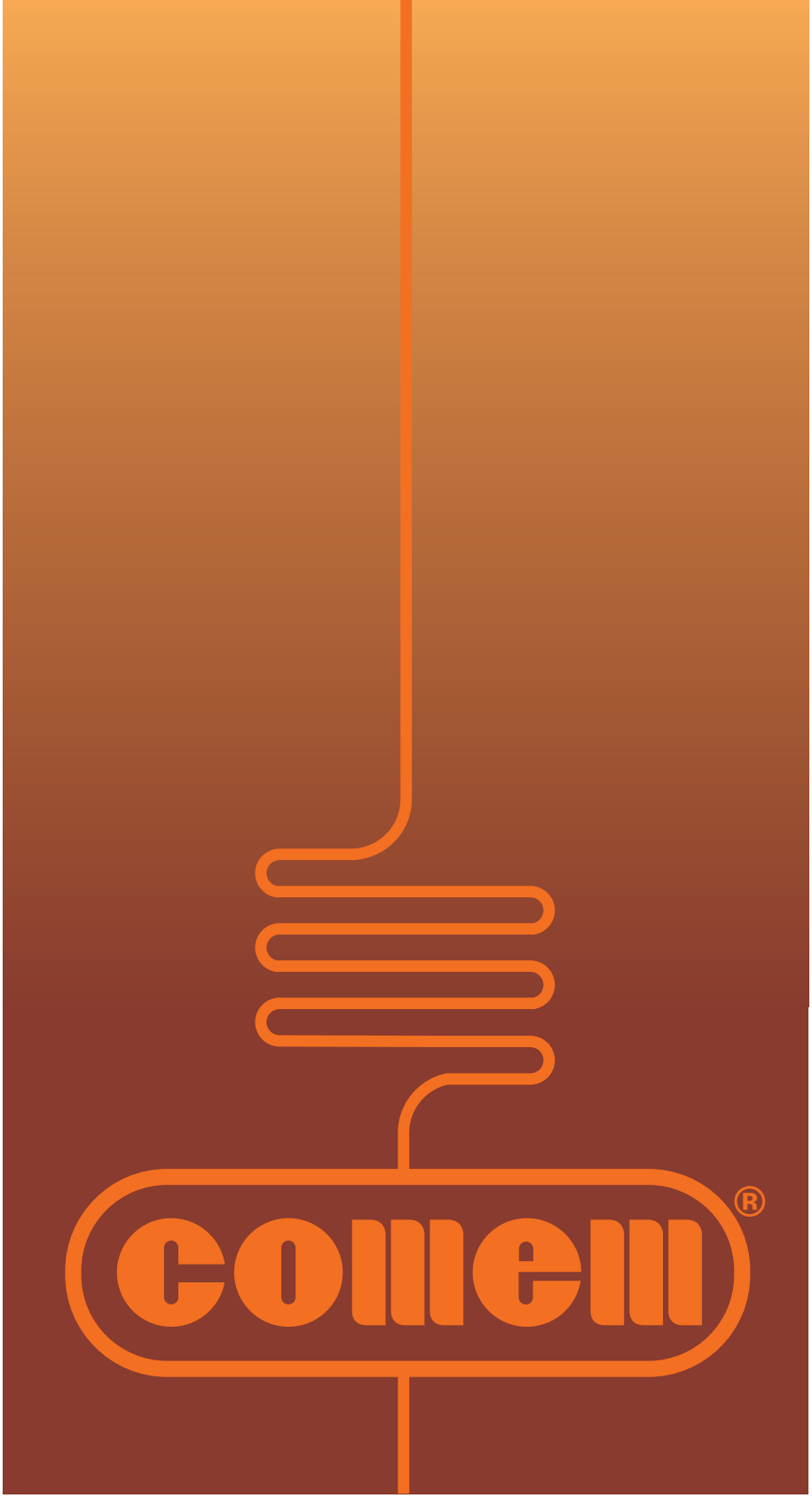
During normal operation the Buchholz relay is full of oil and is connected to the gas sampling device via pipelines 10 and 11.
Valves (8), (2) and (9) are open.
Valves (3), (4), (6) or (7) are closed.
The gas sampling device is consequently also full of oil.
Sampling procedures are as follows:
A- To sample oil: open valve (6) or (4).

B- To sample gas if the relay has signalled alarm or tripped the transformer:
Open valve 4 and let the oil in the device flow out. This draws any gas from the relay via valve (8), tube (11) and valve (2) into the body of the gas. The progress of this operation can be checked through the inspection window. When the desired amount of gas has been collected close valves (2) and (4) and open valve (3) to take the sample.

C- To test satisfactory operation of the alarm and trip circuits proceed as follows:
Close valve (2) then drain all the oil from the device by opening valves (3) and (4). Attach an air pump (bicycle pump) or kit from Comem 5400806002) to valve (5). Close valves (3) and (4) and pump fast whilst simultaneously opening valve (2). The air will then pass into the upper chamber of the Buchholz relay via pipeline (11) lowering the floats and consequently closing their contacts. If you wish to test the lower float then first the valve between the relay and the conservator must be closed to prevent air from flowing directly into the conservator.

OPERATION STARTING

Caution: After commissioning ensure the Buchholz relay and the sampling device are both filled with oil.



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SECTION 10

Appendix D

Output ACB

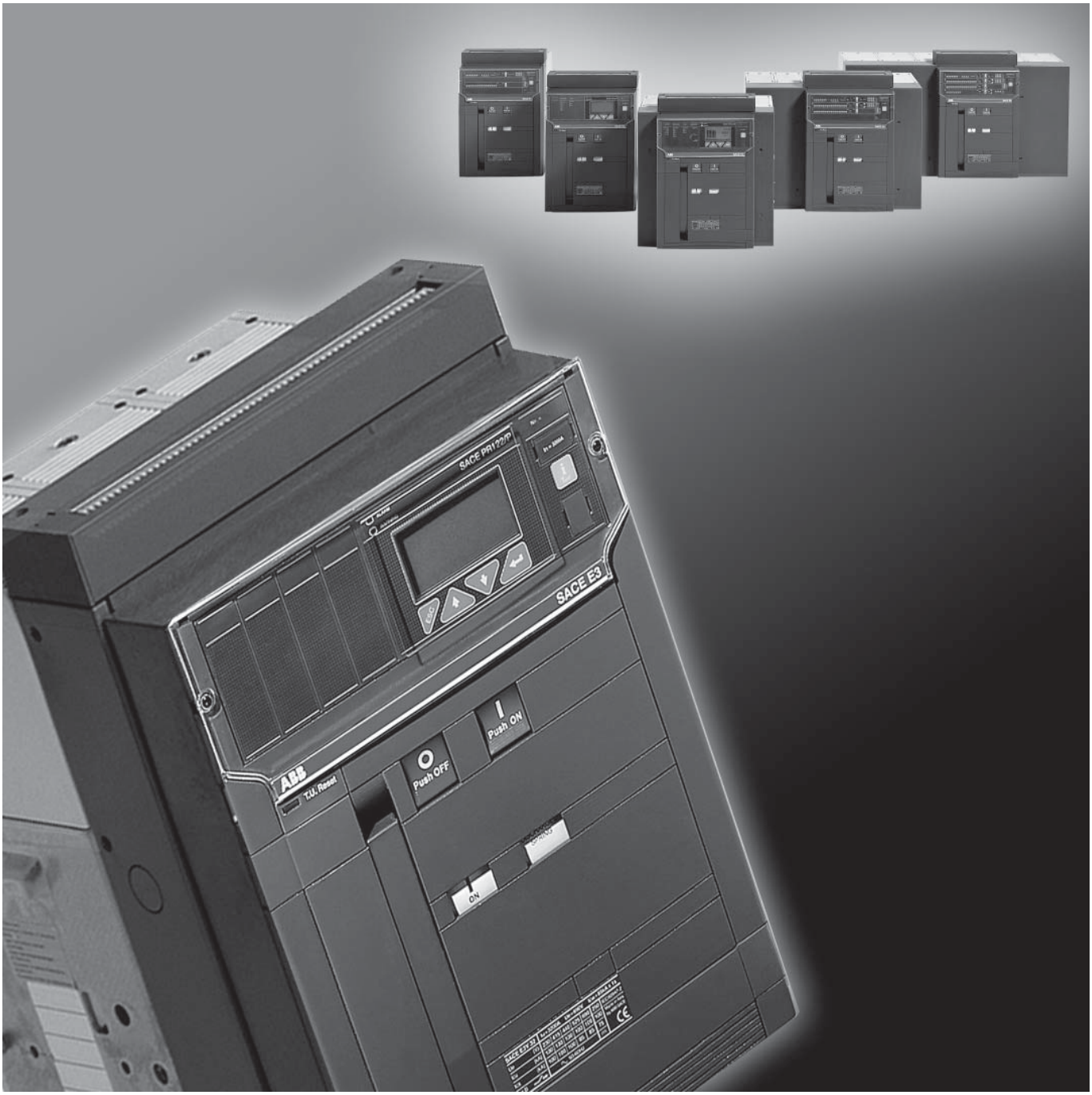
ABB Type E2B16 (74 pages)

Installation and
service instructions

Installation, service and maintenance instructions for low voltage air circuit-breakers

1SDH000460R0002 L6555

Emax



⚠ WARNING

HAZARDOUS VOLTAGE
CAN SHOCK, BURN
OR CAUSE DEATH.

Do not attempt to handle, install, use or service this product before reading instruction book

- READ THIS DOCUMENT AND THE INSTRUCTION MANUAL CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THIS CIRCUIT BREAKER.
- File these instructions with other instruction books, drawings and descriptive data of the circuit breaker.
- Keep this documents available for the installation, operation and maintenance about this equipment. Use of these instructions will facilitate proper maintenance of the equipment.
- Install the Circuit breaker within the design limitations as described in the Installation instructions shipped with the circuit breaker. These circuit breakers are designed to operate within the current and voltage limitations on the switch nameplate. Do not apply these switches to systems with current and/or voltages that exceed these limits.
- Follow your company's safety procedures.
- **Do not remove covers, open doors or work on equipment unless power has been turned off and all circuits de-energized, and after making sure of that with a measuring instrument.**

⚠ WARNING:

- Detailed descriptions of standard repair procedures, safety principles and service operations are not included. It is important to note that this documents contain warnings and cautions against certain specific service methods that could cause personal injury to service personnel, damage equipment, or render it unsafe. These warnings do not cover all conceivable ways in which service, whether or not recommended by ABB, might be performed, or the possible hazardous consequences of each conceivable way, nor could ABB investigate all such ways.
- Anyone using service procedures or tools, whether or not recommended by ABB, must satisfy himself thoroughly that neither personal safety, nor equipment safety, will be jeopardized by the service method or tools selected. Should further information be required or specific problems arise that are not sufficiently covered, refer the matter to an ABB service representative.
- This publication is written only for qualified persons and is not intended to be a substitute for adequate training and experience in the safety procedures for this device.
- The purchaser, installer or ultimate user is responsible for ensuring that warning signs are attached and all access doors and operating handles are securely locked when the gear is left unattended, even momentarily.
- All information contained in this document is based on the latest product information available at the time of printing. We reserve the right to make changes at any time and without prior notice.

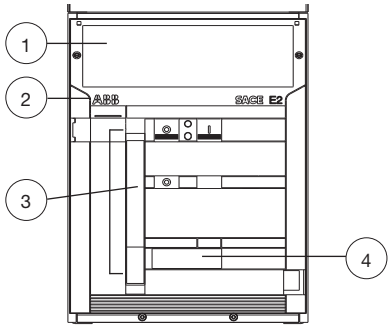
Index

1. Description

1.1. General characteristics

The SACE Emax series of circuit-breakers and disconnectors consists of a steel sheet structure which houses the operating mechanism, the poles and the auxiliary parts. Each pole, insulated from the others, contains the circuit-breaking parts and the current transformer of the corresponding phase.
The structure of the poles differs according to whether the circuit-breaker is selective or current-limiting.
The fixed version circuit-breaker has its own terminals for connection to the power circuit; in the withdrawable version the circuit-breaker comprises the moving part of the apparatus, which is completed with a fixed part fitted with the terminals for connection to the power circuit of the installation. The moving part and the fixed part coupled by means of special contacts installed in the fixed part.

1.2. External front view of the circuit-breaker



1 PR121, PR122 or PR123 electronic microprocessor-based release
2 Trade mark
3 Operating and control parts of the operating mechanism and release tripped signals
4 Rating plate

Fixed circuit-breaker

Fig. 1

1.3. Rating plate

1.3.1. Circuit-breaker rating plate

Switch example

SACE E2B 16		Iu=1600A Ue=690V Icw=42kAx1s					
Ue	(V)	230	415	440	525	690	IEC 60947-2 made in Italy by ABB-SACE
Icu	(kA)	42	42	42	42	42	
Ics	(kA)	42	42	42	42	42	
cat.B		~ 50-60Hz					

Fig. 2a

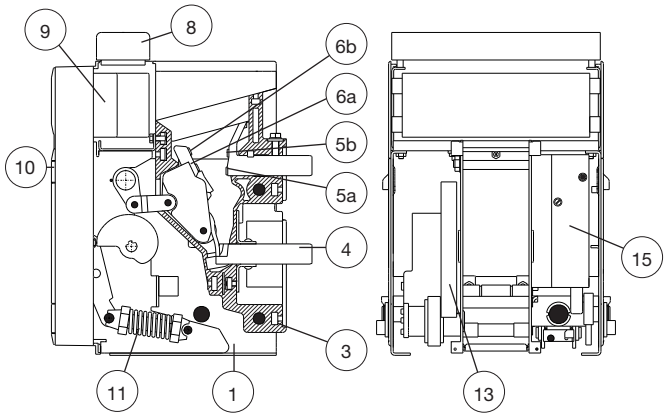
1.3.2. Disconnector rating plate

Circuit-breaker example

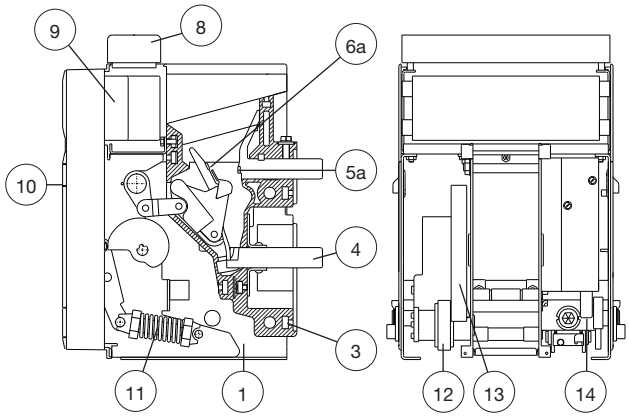
SACE E2B/MS 16		Iu=1600A Ue=690V Icw=42kAx1s				
Ue	(V)	400/415	690	250	500	IEC 60947-3 made in Italy by ABB-SACE
Ie	(kA)	1600	1600	1600	1600	
Cat.		AC - 23A		DC - 23A		
		~ 50-60Hz		1P ⎓ 2P		

Fig. 2b

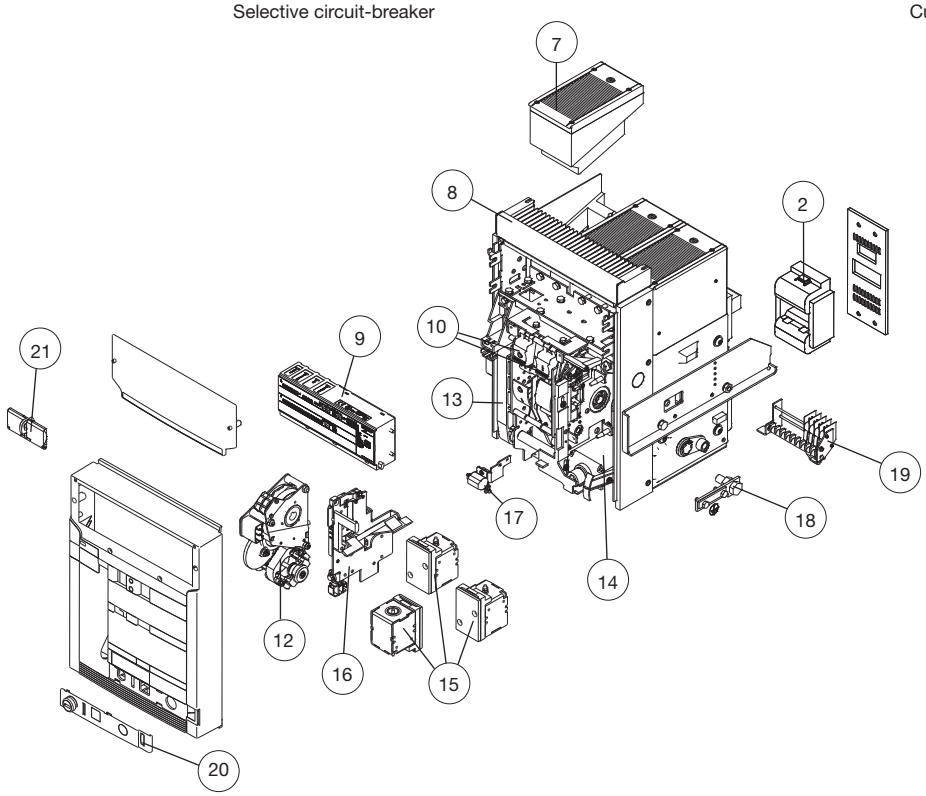
1.4. Moving part construction characteristics



Selective circuit-breaker



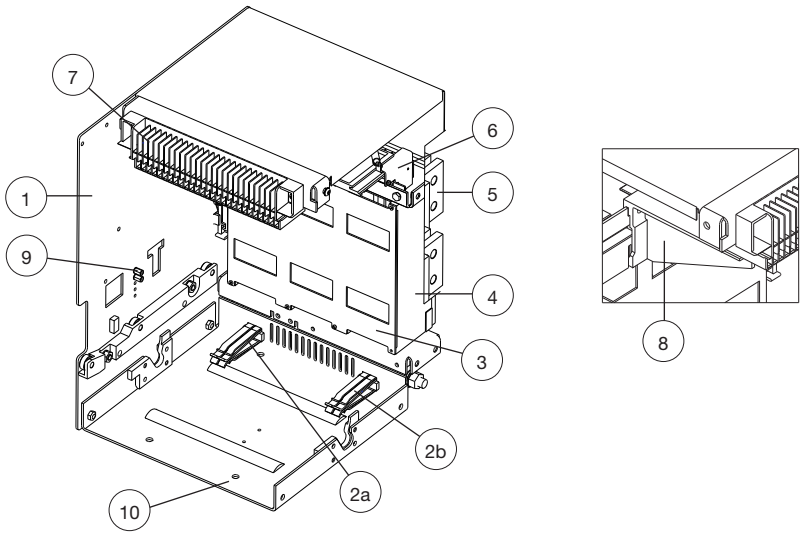
Current-limiting circuit-breaker



1 Supporting structure made of steel sheet
2 Current sensor for protection release
3 Terminal supporting insulating box
4 Horizontal rear terminals
5a Main fixed contact plates
5b Fixed arcing contact plates
6a Main moving contact plates
6b Moving arcing contact plates
7 Arcing chamber
8 Terminal box for the fixed version-Sliding contacts for the withdrawable version
9 Protection release
10 Circuit-breaker closing and opening mechanism
11 Closing springs
12 Spring loading geared motor (on request)
13 Lever for manually loading the closing springs
14 Racking-out device (only for withdrawable circuit-breakers)
15 Service releases (shunt closing release, shunt opening release, undervoltage release)(on request)
16 Support for releases
17 Operation counter
18 Earthing
19 Auxiliary contacts
20 Key lock and padlocks in the open position – extracted test – extracted
21 Key lock in the open position

Fig. 3

1.5. Fixed part construction characteristics



1 Steel sheet supporting structure
2 Earthing contacts (a: for all versions; b: for E4, E6)
3 Safety shutters (IP20 degree of protection)
4 Insulating terminal support base
5 Terminals
6 Contacts for signalling connected/test isolated/disconnected (on request)
7 Sliding contacts
8 Padlock for safety shutters (on request))
9 Anti-racking-in lock for circuit-breakers of different size
10 Fixing holes (qty 4 for E1, E2, E3, 6 for E4, E6)

Fig. 4

2. Checking on receipt

Examine the state of the material received and its consistency with the content of the order. Should any damage or errors be found on unpacking, which must be carried out carefully, make the relative notification within and not over 5 days from the receipt of the material. The notification must indicate the number of the shipping note.

3. Storage, lifting and weights

The circuit-breaker, protected by an external wooden crate, is fixed by means of screws to the transport pallet or to the bottom of the packing case.
If the circuit-breaker has to remain in the warehouse even for a short time before being put into service, after checking it on receipt, it must be put back in its container and covered with a waterproof sheet.

CAUTION:
- **Use a dry, dust-free room free of aggressive chemical agents as a storage room,**
- **Storage temperature: -40°C ... +70°C**
- **Position the circuit-breaker and any fixed part on a horizontal surface, not in direct contact with the floor, but on a suitable support surface (Fig. 5);**
- **The maximum number of stackable circuit-breakers is indicated in figure 6,**
- **Keep the circuit-breaker in the open position and with the closing springs unloaded to avoid unnecessary stresses and the risk of accidents to the person.**

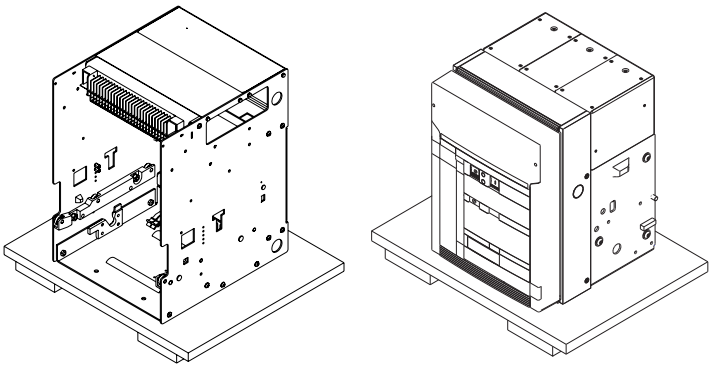


Fig. 5

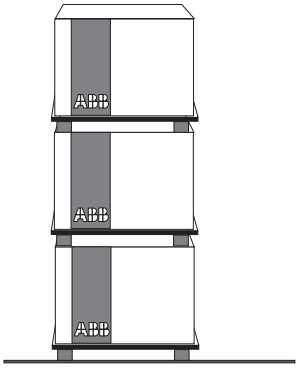


Fig. 6

With regard to lifting, follow the instructions: the circuit-breakers must be placed on a sturdy supporting surface and lifted, preferably, by means of a special fork-lift truck. However, the use of ropes is allowed. In this case, the lifting ropes must be hooked up as shown in the figures (the lifting plates are always supplied with the circuit-breaker).

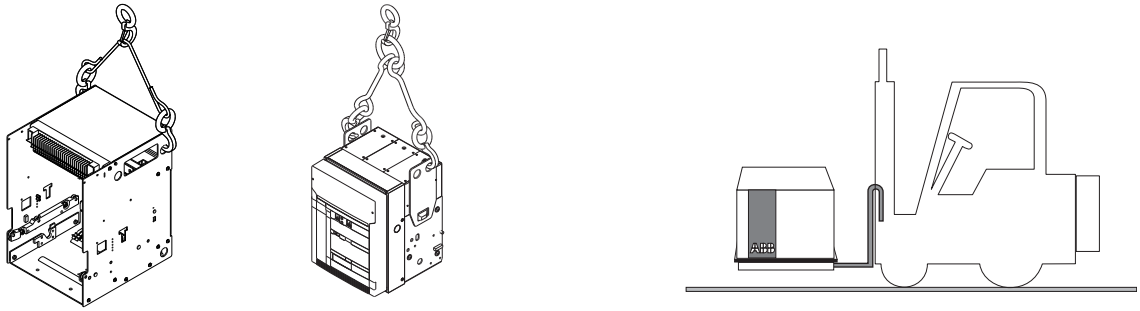


Fig. 7

Table of the circuit-breaker weights (Kg.)

Selective circuit-breaker	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E1	45	54	70	82
E2	50	61	78	93
E3	66	80	104	125
E4	97	117	147	165
E4/f		120		170
E6	140	160	210	240
E6/f		165		250

Current limiting	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E2L	52	63	80	95
E3L	72	83	110	127

Notes:
- The weights indicated in the table are intended for circuit-breakers complete with PR121, PR122 or PR123 releases and relative current sensors, excluding the accessories.
- The withdrawable version includes the moving part in the same conditions as above, and the fixed part with horizontal rear terminals.

4. Installation

4.1. Installation room

Install the circuit-breaker in a dry, dust-free, non-corrosive room, and in such a way that it is not subject to shocks or vibrations. Where this is not possible, install it inside a switchboard with a suitable degree of protection.
For the preparation of the installation room, please refer to the "Overall dimensions" paragraph, which gives information on the following points:
- minimum installation volumes of the circuit-breakers and derived versions
- distances to be respected for circuit-breakers in compartments
- overall dimensions of the circuit-breakers
- fixing drillings
- compartment door drillings.

The installation, commissioning and any ordinary and extraordinary maintenance have to be done by skilled personnel, with a detailed knowledge of the apparatus.

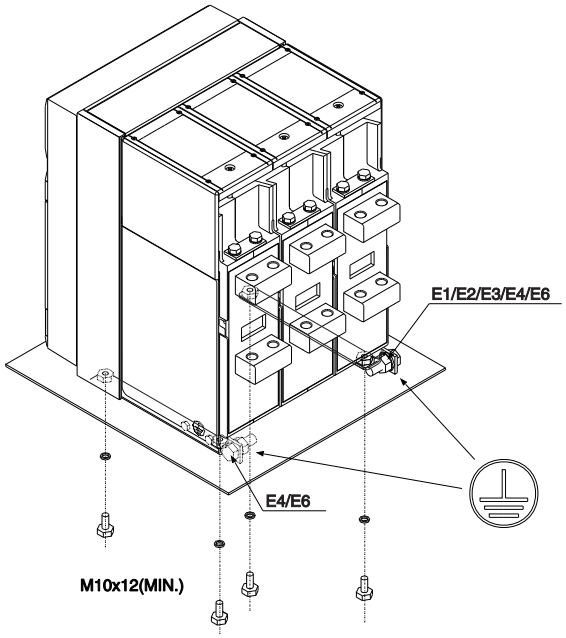


Fig.8

WARNING: The installation, commissioning and any ordinary and extraordinary maintenance of the circuit-breaker and accessories must be performed by skilled personnel, with a detailed knowledge of the equipment.

WARNING ELECTRICAL SHOCK HAZARD:
Disconnect and lock and tag out all electrical power feeds to avoid any potential shock hazard when you are assembling, installing maintaining or removing the circuit breaker from service. Some operations must be performed when the circuit-breaker is energized. In this case, reasonable care and compliance with all safe working practices is required.

4.2. Installation of the fixed circuit-breaker

Fix the circuit-breaker to a horizontal surface using the screws (M10 x 12 min.).

4.3. Installation of the fixed part of the withdrawable circuit-breaker

4.3.1. Preparation of the fixed part

Assembly of the anti-racking-in lock
Before installing the fixed part, it is necessary to check the presence of the anti-racking-in lock for circuit-breakers with different electrical characteristics from those of the fixed part. If the anti-racking-in lock has been supplied separately, proceed to assemble it as follows.
- On the self-adhesive plate (4), find the assembly position of the stop bolts in relation to the circuit-breaker which has to be housed in the fixed part.
- Insert the hexagonal-head screws (1) in the holes found in the previous item as shown in the figure.
- Fix the screws with the washers (2) and the hexagonal stops (3).

Make sure that the anti-racking-in lock corresponding to the one installed on the fixed part is present on the circuit-breaker (moving part).
- Anti-racking-in plate on the moving part (5).

Example for E1B 08 according to the nameplate diagram

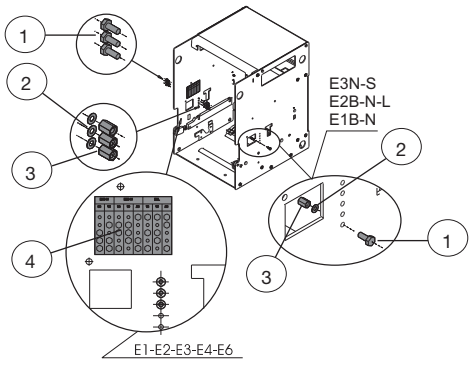


Fig. 9

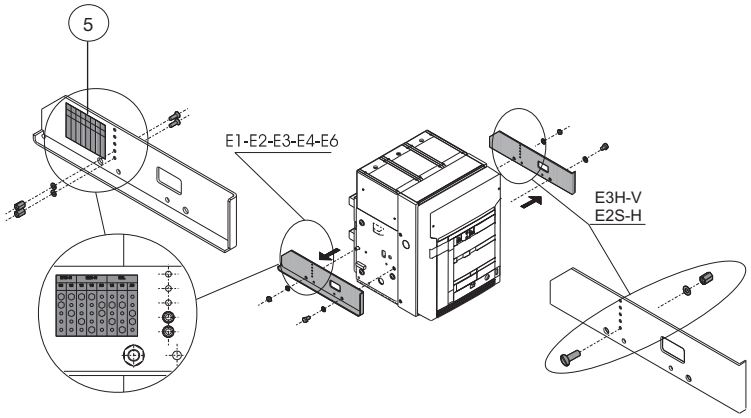


Fig. 10

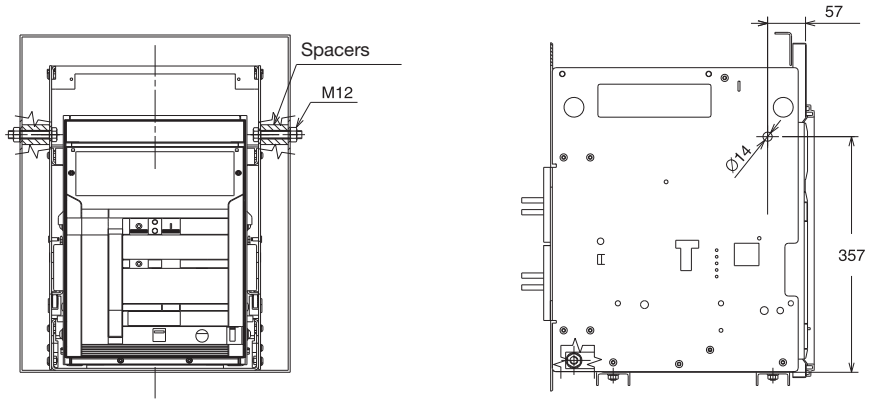
4.3.2. Installation of the fixed part (Fig. 12)

Attach the fixed part by means of the screws (1), washers (2) and nuts (3) (M8 x 16), supplied by ABB SACE. if other screws are used, make sure that the head of the screws does not extend more than 5.5 mm from the base of the fixed part.

4.3.3. Installation of the fixed part on board a ship (Fig. 11)

Regarding the fixing points of the SACE Emax withdrawable version air circuit-breakers, for applications on board a ship, additional fixing on the sides of the fixed part itself is recommended (the M12 screws and the spacers are not provided in the supply).

E1 - E2 - E3



E4 - E6

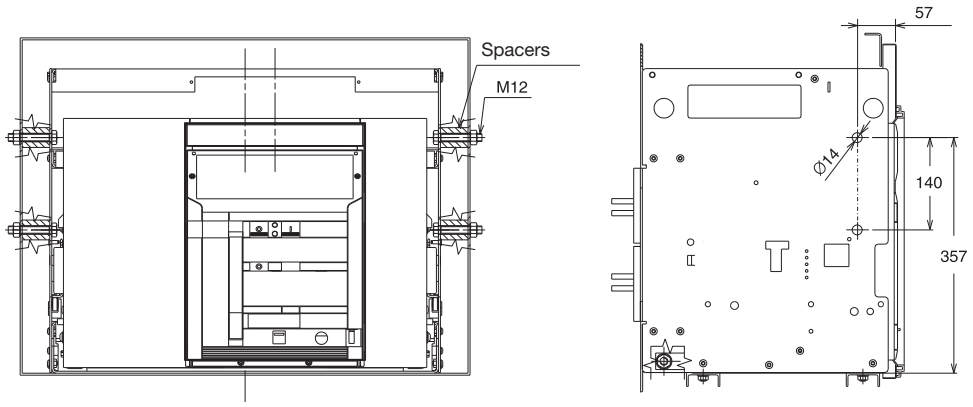
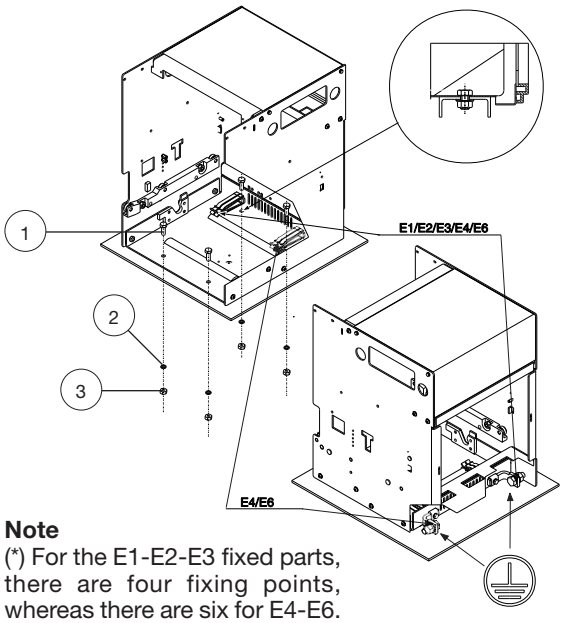


Fig. 11

4.4. Installation of the flange on the compartment door (Fig. 13)

- Make the compartment door drillings specified in the “Overall dimensions” paragraph.
- Attach the flange (1) on the front of the compartment door, fixing it from the inside by means of the self-tapping screws (2).



Note

(*) For the E1-E2-E3 fixed parts, there are four fixing points, whereas there are six for E4-E6.

Fig. 12

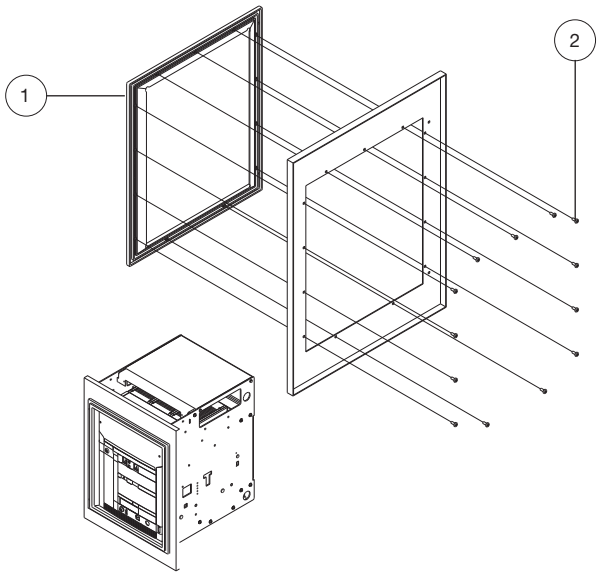


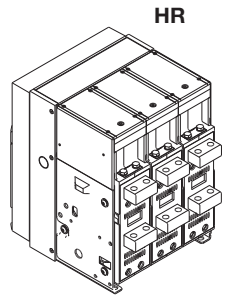
Fig. 13

5. Electrical connections

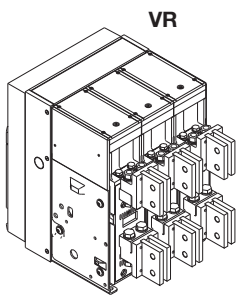
5.1. Connections to the power circuit

5.1.1. Shapes of the terminals

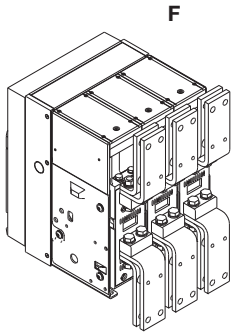
Fixed circuit-breaker



Horizontal rear terminals



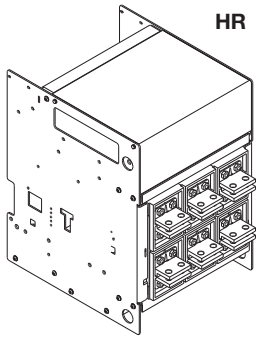
Vertical rear terminals



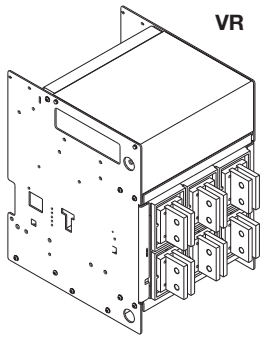
Front terminals

Fig. 14

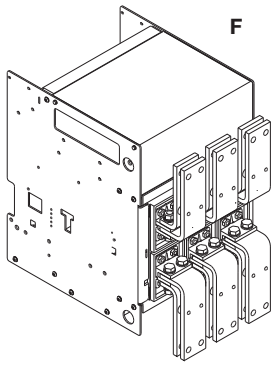
Fixed part for withdrawable circuit-breaker



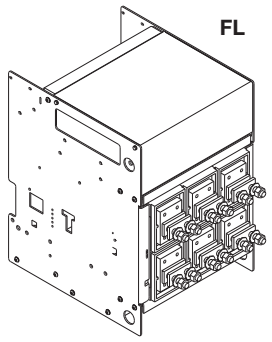
Horizontal rear terminals



Vertical rear terminals



Front terminals



Flat terminals

Fig. 15

Note
The drawings are provided to show the type of terminal in graphic form. The exact shape of the terminals is given in the “Overall dimensions” chapter.

5.1.2. Examples of positioning the connection busbars according to the types of terminals

The connection busbars enable the connection between the terminals of the circuit-breakers and the busbars of the switchgear. Their sizing must be carefully studied by the switchgear designer. Some examples of possible constructions in relation to the shape and size of the circuit-breaker terminals are given in this paragraph. The various types of terminals are of constant dimensions for each size of circuit-breaker: it is normally advisable to exploit the whole contact surface of the terminal, so the width of the connection busbars should be the same as that of the terminal. Different connection capacities can be obtained by adjusting the thickness and number of busbars in parallel. In some cases, reductions in the width of the connection in relation to that of the terminal are allowable as shown in the following examples.

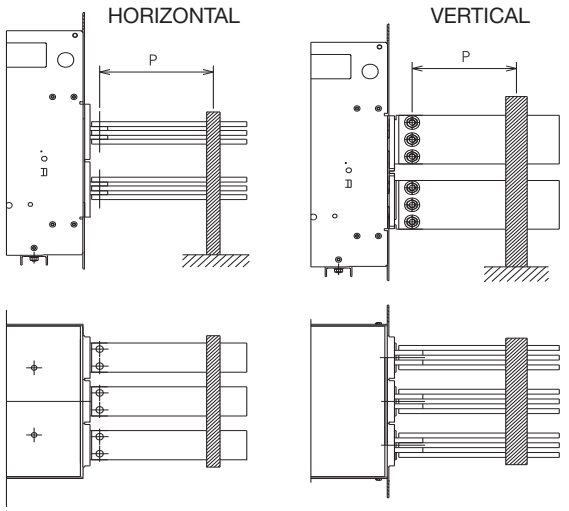
		Vertical terminals				**Horizontal and front terminalsi**			
Circuit-breaker	Iu [A]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]
		35°C	45°C	55°C		35°C	45°C	55°C	
E1B/N 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E1B/N 10	1000	1000	1000	1000	1x(80x10)	1000	1000	1000	2x(60x8)
E1B/N 12	1250	1250	1250	1250	1x(80x10)	1250	1250	1200	2x(60x8)
E1B/N 16	1600	1600	1600	1500	2x(60x10)	1550	1450	1350	2x(60x10)
E2S 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E2N/S 10	1000	1000	1000	1000	1x(60x10)	1000	1000	1000	1x(60x10)
E2N/S 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2B/N/S 16	1600	1600	1600	1600	2x(60x10)	1600	1600	1530	2x(60x10)
E2B/N/S 20	2000	2000	2000	1800	3x(60x10)	2000	2000	1750	3x(60x10)
E2L 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2L 16	1600	1600	1600	1500	2x(60x10)	1600	1500	1400	2x(60x10)
E3H/V 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E3S/H 10	1000	1000	1000	1000	1x(60x10)	1000	1000	1000	1x(60x10)

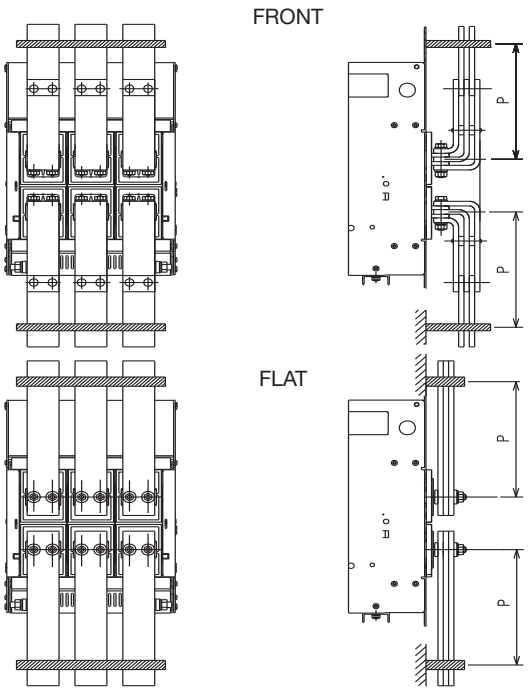
Circuit-breaker	Iu [A]	Vertical terminals				Horizontal and front terminalsi			
		Continuous current-carrying capacity [A]			Busbar cross-section [mm²]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]
		35°C	45°C	55°C		35°C	45°C	55°C	
E3S/H/V 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E3S/H/V 16	1600	1600	1600	1600	1x(100x10)	1600	1600	1600	1x(100x10)
E3S/H/V 20	2000	2000	2000	2000	2x(100x10)	2000	2000	2000	2x(100x10)
E3N/S/H/V 25	2500	2500	2500	2500	2x(100x10)	2500	2450	2400	2x(100x10)
E3N/S/H/V 32	3200	3200	3100	2800	3x(100x10)	3000	2880	2650	3x(100x10)
E3L 20	2000	2000	2000	2000	2x(100x10)	2000	2000	1970	2x(100x10)
E3L 25	2500	2500	2390	2250	2x(100x10)	2375	2270	2100	2x(100x10)
E4H/V 32	3200	3200	3200	3200	3x(100x10)	3200	3150	3000	3x(100x10)
E4S/H/V 40	4000	4000	3980	3500	4x(100x10)	3600	3510	3150	6x(60x10)
E6V 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3200	3x(100x10)
E6H/V 40	4000	4000	4000	4000	4x(100x10)	4000	4000	4000	4x(100x10)
E6H/V 50	5000	5000	4850	4600	6x(100x10)	4850	4510	4250	6x(100x10)
E6H/V 63	6300	6000	5700	5250	7x(100x10)	--	--	--	-

Fig. 16

Positioning the first anchoring baffle of the busbars according to the short-circuit current

Anchoring to the switchgear





P	E1-E2	E3-E4-E6	E1-E6
HORIZONTAL	250	150	–
VERTICAL	250	150	–
FRONT	–	–	250
FLAT	–	–	250

Fig. 17

5.1.3. Assembly procedure for the connection busbars

Check the state of the contact surfaces of the connections very carefully: they must be very clean with no burrs, dents or traces of rust which must be eliminated using a fine file or an emery cloth to prevent localized increases in temperature. On completion of the operation, remove all traces of grease or dust with a cloth soaked in a suitable solvent. When alluminium connections the contact surfaces must be tinned.
The connections must not exert any strain on the terminals in any direction.
Always insert a large-diameter flat washer and a spring washer between them (to spread the tightening pressure over a greater area).
Make the contact between connection and terminal and tighten the fixing screws completely.
Always use two wrenches (so as not to strain the insulating parts excessively), applying the tightening torque indicated in Fig. 18. Check tightness after 24 hours.

M12 high strength screws
Tightening torque of the main terminals: 70 Nm

Fixed part terminals	No. of screws for phase	No. of screws for neutral
E1/E2	2	2
E3	3	3
E4	4	2
E4/f	4	4
E6	6	3
E6/f	6	6

Fixed circuit-breaker terminals	No. of screws for phase	No. of screws for neutral
E1/E2	2	2
E3	3	3
E4	4	2
E4/f	4	4
E6	6	3
E6/f	6	6

Fig. 18

5.2. Earthing

The fixed circuit-breaker and the fixed part of the withdrawable circuit-breaker have one or two terminals on the rear, marked with the special symbol, for connection to earth (Fig. 9 and Fig. 12).
Each terminal is complete with a bolt for fixing the connection. A conductor with a cross-section conforming to current standards must be used for the connection.
Before assembling the connection, clean and degrease the area around the screw.
After the assembly, tighten the bolt with a torque of 70 Nm.

5.3. Wiring the circuit-breaker auxiliary circuits

5.3.1. Interfacing elements for fixed circuit-breakers

A special terminal box is provided, fitted with screw terminals for connecting the auxiliary circuits.
The terminals are marked with alphanumerical identification codes as for the electrical circuit diagram.
The terminal box is identified by code XV on the electrical circuit diagram.
The terminal box is immediately accessible when the compartment door is open.

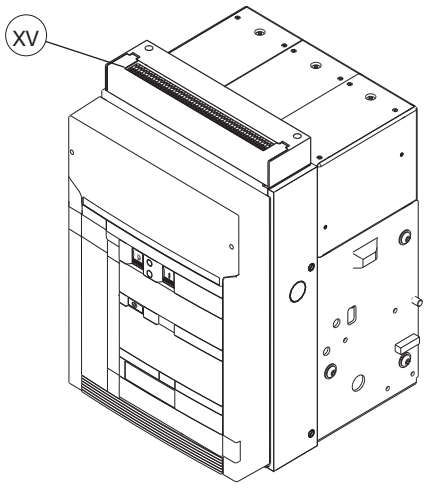
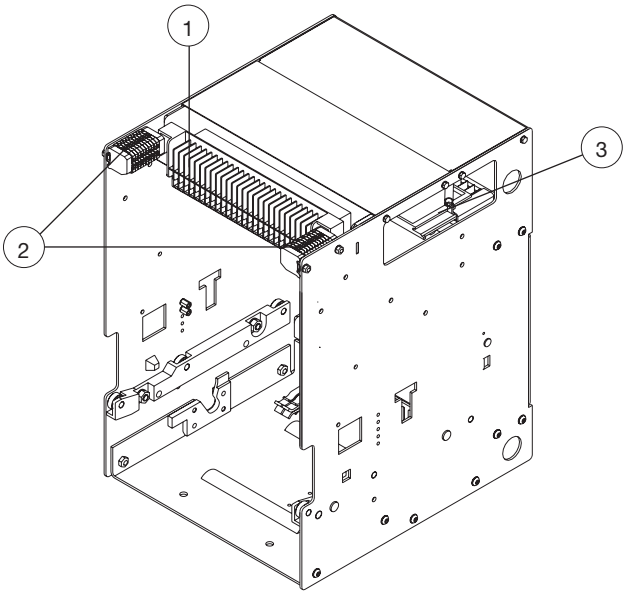


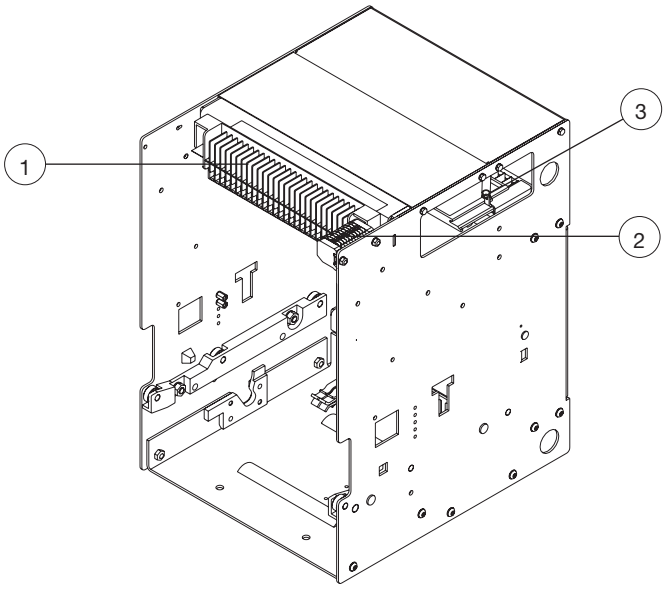
Fig. 19

5.3.2. Withdrawable circuit-breaker

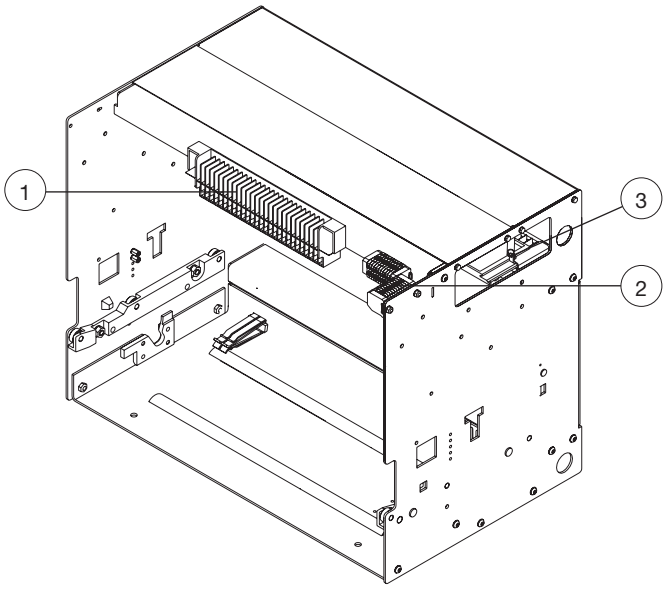
For connection of the moving part to the auxiliary circuits, a connection with sliding contacts is available on the fixed part (see figure), identified by code X on the electrical circuit diagram.
The terminals of the fixed connector are immediately accessible when the compartment door is open.
Furthermore a terminal box identified by code XF is available for connecting the position contacts of the moving part in relation to the fixed part.
The connector and terminal box have screw terminals.



E1 - E2 - E3
10 contacts in position



E1 - E2 - E3 - E4 - E6
5 contacts in position



E4 - E6
10 contacts in position

Caption

1 Sliding contacts (X)
2 Terminal box for position contacts (XF)
3 Position contacts

Fig. 20

5.4. Conversion of the auxiliary contacts or of the signalling contacts (disconnected - test isolated - connected), from normally closed (opening) to normally open (closing) or vice versa

The contacts are wired at the factory as shown on the electrical circuit diagram. If it is necessary to change their state for installation requirements, proceed as follows.

a) Auxiliary contacts
To access the auxiliary contacts, carry out the following operations:

- remove the front protection (3) of the release by taking action on the blocks (1) as shown in the figure
- remove the protection release (4) removing the side nuts (2) and then sliding the release out from the front of the circuit-breaker.

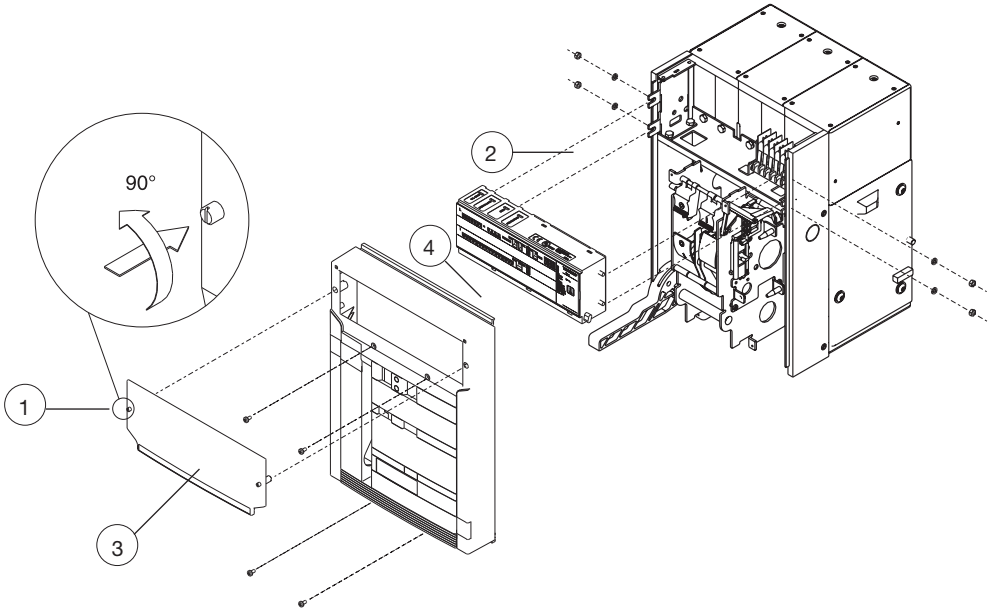
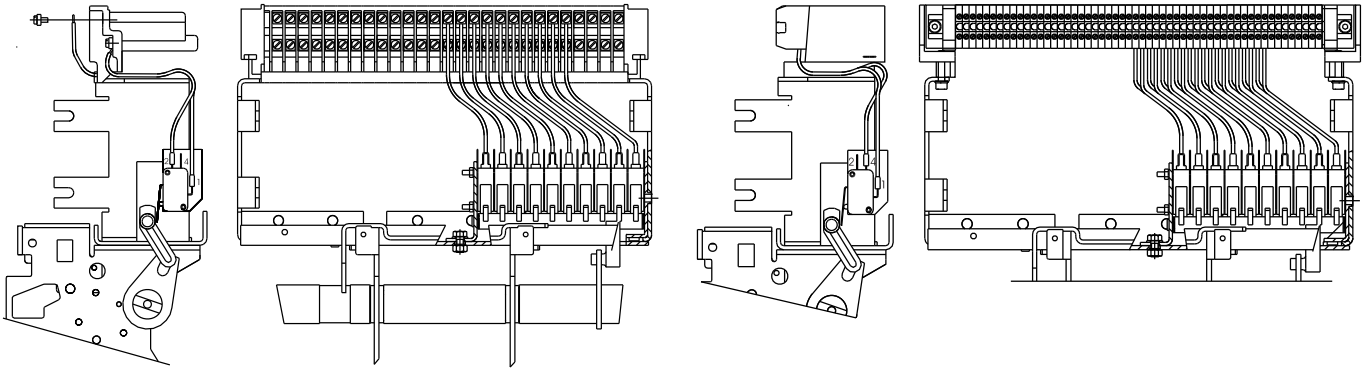


Fig. 21

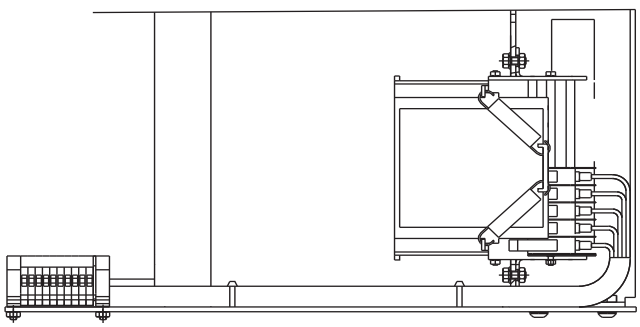
Being of the two-way type (changeover contacts), the auxiliary contacts can be modified from break contacts to make contacts and vice versa simply by moving the output conductor from one position to the other, as shown in the figure (example for PR121).



N.C. contact Sliding contacts N.O. contact Terminal box

Fig. 22

b) Signalling contacts disconnected - test isolated - connected
To change the state of the position contact, proceed in the same way as explained for the auxiliary contacts.



6. Putting into service

6.1. General procedures

- Check tightness of the power connections at the circuit-breaker terminals
- Carry out all the preparatory operations on the release
- Make sure that the value of the auxiliary circuit power supply voltage is between 85 and 110% of the rated voltage of the electrical applications
- Make sure that there is an adequate air circulation in the place of installation to avoid overheating
- Also carry out the checks specified in the following table.

	Item inspected	Procedure	Positive check
1	Manual operating mechanism	Carry out some opening and closing operations (see the chapter 7.2). **CAUTION** **When there is an undervoltage release, the circuit-breaker can only be closed after the release has been electrically energized.**	The spring loading lever moves correctly
2	Geared motor (if any)	Supply the spring loading geared motor at the corresponding rated voltage. Carry out some closing and opening operations. Note. Supply the undervoltage release at the corresponding rated voltage (if any).	The springs are loaded correctly. The signals are correct. The geared motor stops with the springs loaded. The geared motor reloads the springs after each closing operation.
3	Undervoltage release (if any)	Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation. Disconnect voltage to the release. Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation.	The circuit-breaker closes correctly. The signals are correct. The circuit-breaker opens. The signal changes over..
4	Shunt opening release (if any)	Close the circuit-breaker. Supply the shunt opening release at the corresponding rated voltage.	The circuit-breaker opens correctly. The signals are correct..
5	Shunt closing release (if any)	Open the circuit-breaker. Loading the springs. Supply the shunt closing release at its rated voltage.	The circuit-breaker closes correctly. The signals are correct.
6	Circuit-breaker lock in the open position (with key or padlocks)	Open the circuit-breaker, turn the key and remove it from its seat. Attempt circuit-breaker closing operation.	Both manual and electrical closing are prevented.
7	Auxiliary contacts of the circuit-breaker	Insert the auxiliary contacts in suitable signalling circuits. Carry out some circuit-breaker closing and opening operations.	The signals are given correctly..
8	Auxiliary contacts for signalling circuit-breaker connected, test isolated and disconnected	Insert the auxiliary contacts in suitable signalling circuits. Then put the circuit-breaker in the connected, test isolated and disconnected position.	The signals due to the relative operations are given correctly..
9	Lock devices for circuit-breakers connected and disconnected. Interlocking devices between circuit-breakers side by side and one on top of another (if any)	Carry out the operating tests.	The locks function correctly.
10	For withdrawable circuit-breakers: racking -in/out device	Carry out some racking-in and out operations.	Racking-in operation: the circuit-breaker racks in correctly. The first turns of the crank handle do not meet with particular resistance.

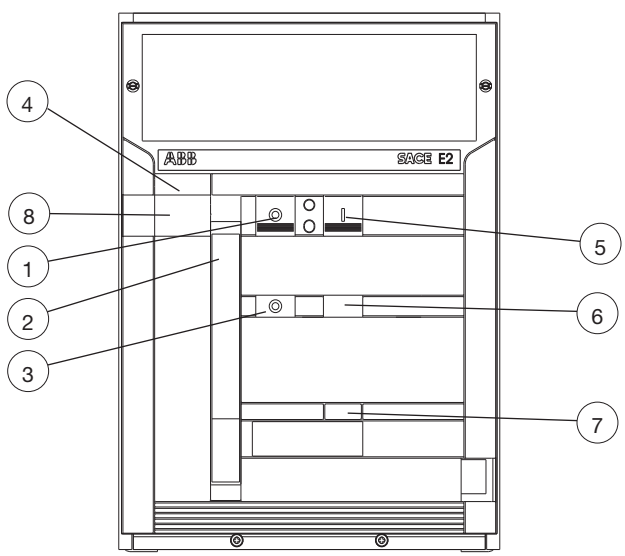
WARNING: When undervoltage release has been activated by an undervoltage event, the circuit-breaker can only be closed after the release has been electrically energized. Ensure that an undervoltage condition existed at the time the release was activated. If not, investigate circuit-breaker and associated equipment to ensure they are in proper working order. If application is critical, investigate immediately.

7. Instructions for use

7.1. Operating and signalling parts

1 Pushbutton for the manual opening operation
2 Lever for manual loading of the closing springs
3 Mechanical indicator for circuit-breaker open “O” and closed “I”
4 Mechanical indicator for protection release tripped (on request)
5 Pushbutton for the manual closing operation
6 Signalling device for springs loaded - unloaded
7 Operation counter (on request)
8 Key lock on the closing operation
9 Mechanical indicator for circuit-breaker connected, test isolated and disconnected
10 Seat for the racking-in/out lever
11 Lever releasing the racking-in/out operation
12 Key lock on the racking-in/out operation (on request)
13 Padlock on the manual closing operation (on request)
14 Padlock on the racking-in/out operation (on request)

Fixed circuit-breaker



Withdrawable circuit-breaker

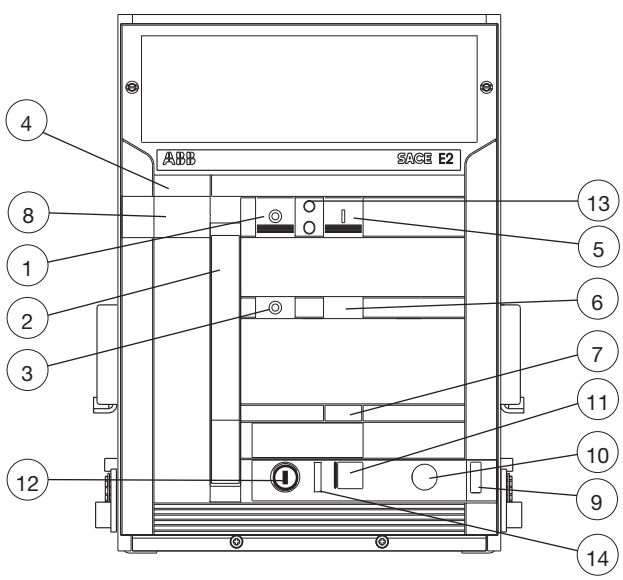


Fig. 23

Note On request, a transparent cover can be installed on the front of the circuit-breaker to increase the degree of protection to IP54. The cover has a locking key.
As an alternative to the transparent cover, a protection can be mounted on the manual closing and opening controls, which only allows operation of the pushbuttons by means of a special tool..

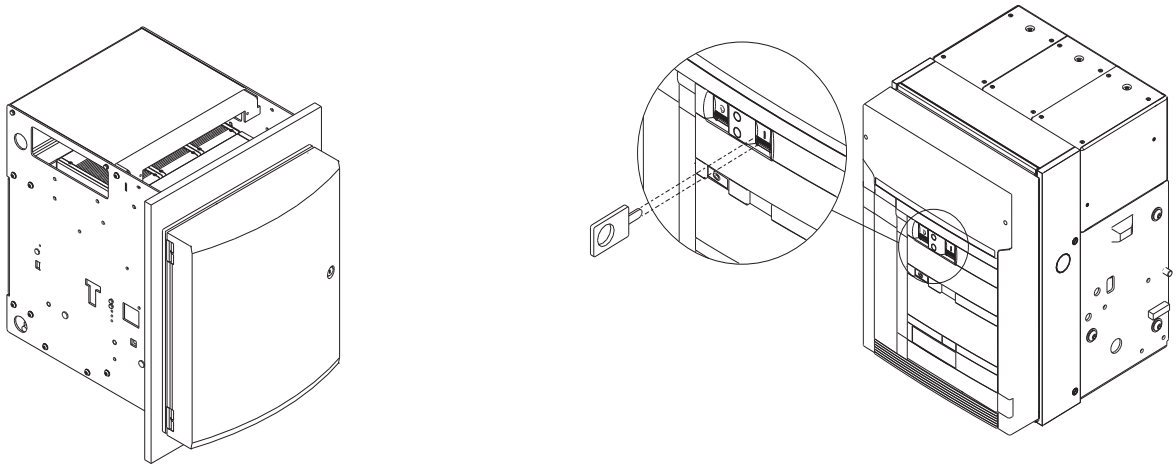


Fig. 24

7.2. Circuit-breaker closing and opening procedures

The operation of the circuit-breaker can be either manual or electrical.

a) Manual loading of the closing springs
- Make sure that the indicator (3) shows "O" (circuit-breaker open)
- Make sure that the indicator (6) is WHITE (springs unloaded)
- Repeatedly activate the lever (2) until the indicator (6) changes its color to YELLOW

b) Electrical loading of the closing springs
The electrical loading of the circuit-breaker is possible when the following accessories (supplied on request) are present:
– geared motor for automatic loading of the closing springs
– shunt closing release
– shunt opening release.
The geared motor automatically reloads the springs after each closing operation until the yellow indicator appears (6, Fig. 25). When the power is cut off during loading, the geared motor stops and automatically starts reloading the springs again when the power returns. It is, in any case, always possible to complete the reloading operation manually.

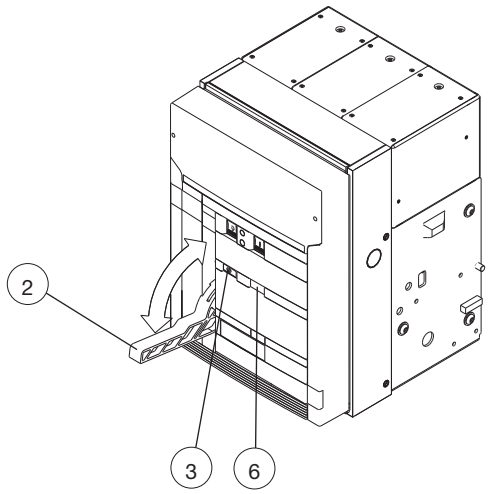


Fig. 25

c) Closing the circuit-breaker
The operation can only be carried out with the closing springs fully loaded. For manual closing, press the pushbutton (5) marked with the letter "I". When there is a shunt closing release, the operation can be carried out remotely by means of the special control circuit. The special indicator (3) changes to indicate "I" to signal that the circuit-breaker has closed. Furthermore, the indicator of the state of the springs (6) goes to the WHITE position. Even with the closing springs unloaded, the operating mechanism retains enough energy for the opening operation. The geared motor, if any, immediately starts the automatic spring reloading operation.

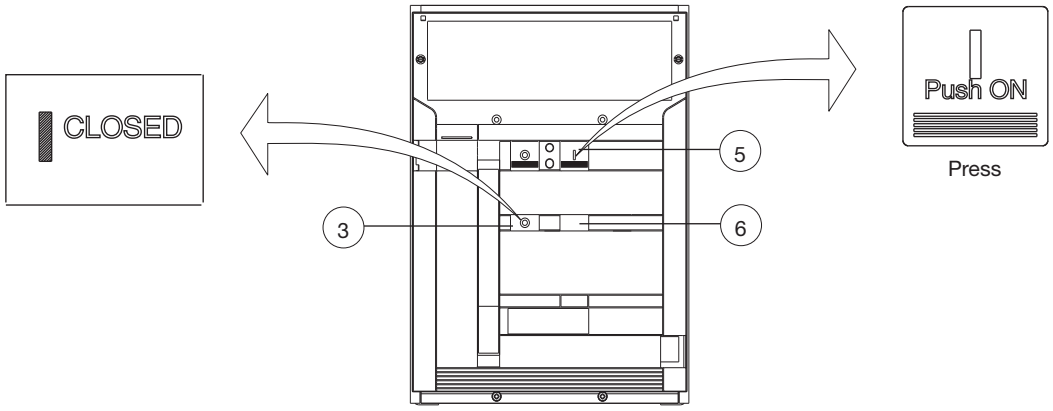


Fig. 26

d) Opening the circuit-breaker
For manual opening of the circuit-breaker, press pushbutton "O" (1). When there is a shunt opening release, the operation can also be carried out remotely by means of the special control circuit. Opening having taken place is signaled by the letter "O" appearing in the indicator (3).

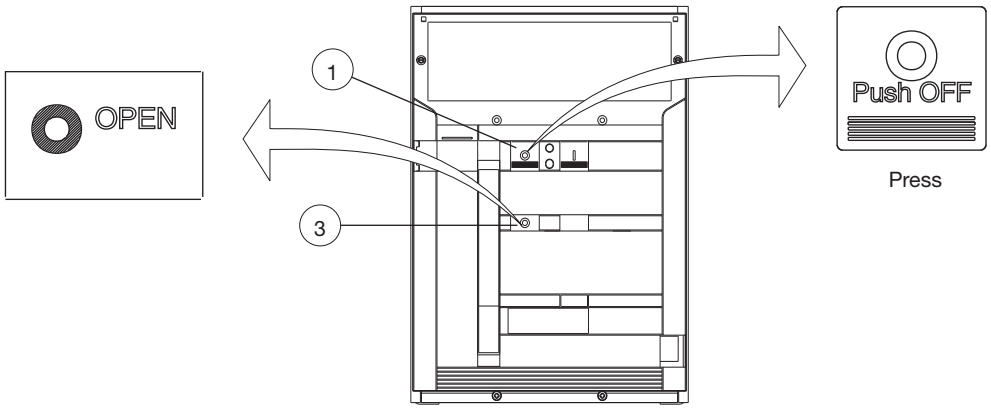


Fig. 27

7.3. Racking-in/out operation

WARNING:
A) Open the circuit-breaker before carrying out any racking-in/out operation.
B) The circuit-breaker (moving part) and fixed part are fitted with a lock which prevents the fixed part from being racked into the circuit-breakers with a different rated current: the congruence of the anti-racking-in lock must be checked by the operator before carrying out the racking-in operation to avoid any unnecessary stress.
C) Before the racking-in operation, remove any padlock on the segregation shutter of the isolation terminals on the fixed part.

WARNING ELECTRICAL SHOCK HAZARD: Ensure that the circuit-breaker is either disconnected from all power sources and that the circuit breaker is open before performing any racking-in/out operation.

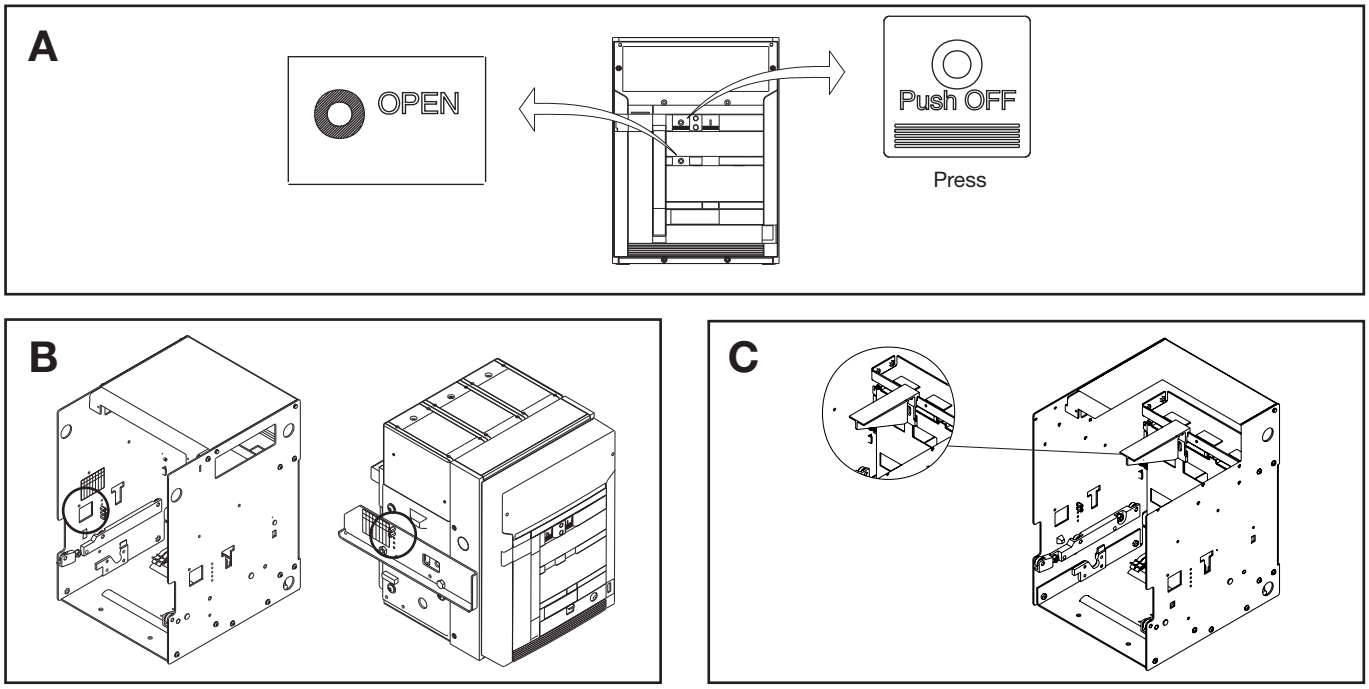


Fig. 28

NOTE
In relation to the fixed part, the circuit-breaker (moving part) can take up different positions, identified as follows:
- DISCONNECTED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals and WITHOUT coupling the sliding contacts for the auxiliary circuits: in this position all electrical operation of the circuit-breaker is prevented. On the front the indicator (9, Fig. 23) indicates DISCONNECTED. The switchgear compartment door can be closed.
- TEST ISOLATED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals, but WITH the sliding contacts coupled for the auxiliary circuits. In this position, the circuit-breaker can be operated for the offline tests. The indicator (9, Fig. 23) indicates TEST ISOLATED.
- CONNECTED: the moving part is fully inserted in the fixed part WITH the connection of both the power terminals and the sliding contacts for the auxiliary circuits. The circuit-breaker is operational. The indicator (9, Fig. 23) indicates CONNECTED.

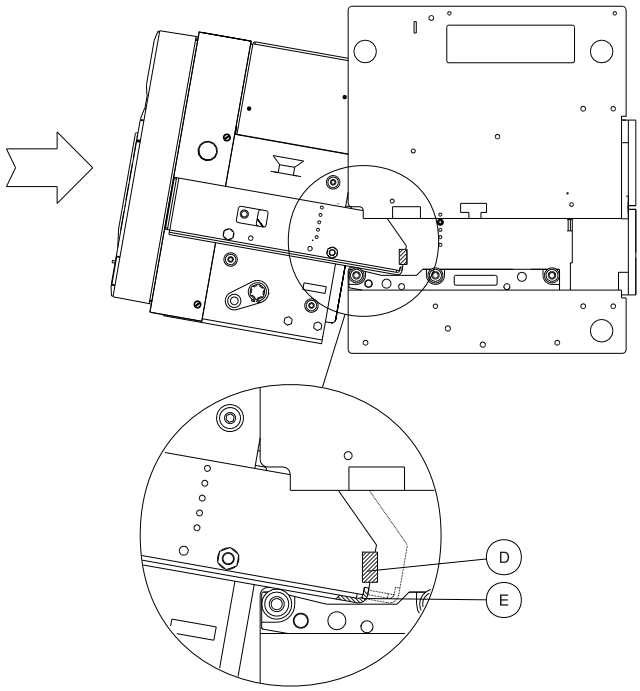


Fig. 29

a) Positioning the moving part in the fixed part in the DISCONNECTED position

Lift the moving part as shown in the paragraph (3) and insert it in the fixed part guide, tilting it as shown in figure 2.
The manual connection must allow the edge (E) of the circuit-breaker guide to slide under the blocks (D) of the fixed part. Remove the lifting devices.
The position reached is stable and allows for any inspections of the circuit-breaker.
Push the moving part as far as the stop in the fixed part.
Close the compartment door.

b) Passing from the DISCONNECTED to the TEST ISOLATED position.

- Make sure that the indicator (9) is in the DISCONNECTED position.
- For the connection procedure, make sure that the key (12) is in the correct position and/or the padlock (14), if any, has been removed.
- Make sure that the circuit-breaker is open.
- Push the moving part right into the fixed part.
- Lower the releasing lever (11).
- Insert the crank handle in the corresponding coupling (10).
- Proceed to turn the crank handle clockwise until the TEST ISOLATED indication appears on the indicator (9). During the initial turns, the crank handle must oppose no any particular resistance to rotation.
- Should it be necessary to carry out offline circuit-breaker operations, the crank handle must be removed.

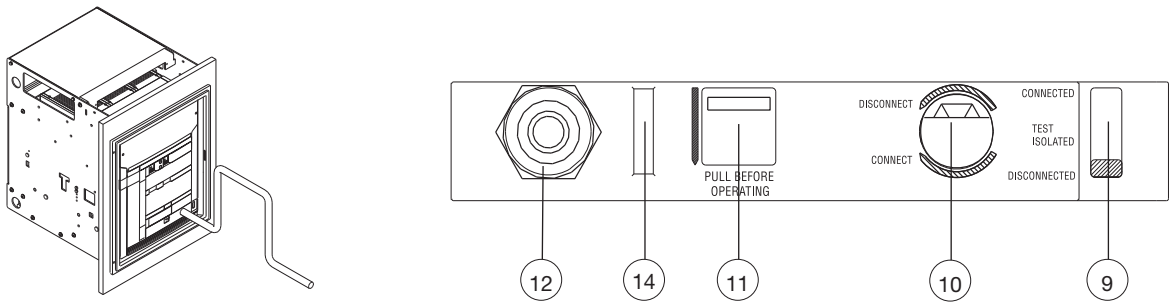


Fig. 30

c) Passing from the TEST ISOLATED position to the CONNECTED position

- Make sure that the circuit-breaker is open.
- Lower the releasing lever (11).
- Insert the crank handle in the corresponding coupling (10).
- Proceed to turn the crank handle clockwise until the CONNECTED indication appears on the indicator (9).
- Remove the crank handle to enable the circuit-breaker to close.

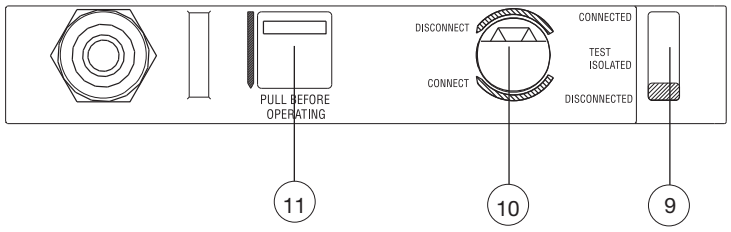


Fig. 31

d) Passing from the CONNECTED position, to the TEST ISOLATED position, to the DISCONNECTED position

- Repeat the connection procedures changing the direction for turning the crank handle to anti-clockwise. Open the door in the disconnected position.

8. Maintenance

8.1. Warning

WARNING: Before carrying out any maintenance task, you must:
- **Open the circuit-breaker and check that the operating mechanism springs are unloaded;**
- **In the case of withdrawable circuit-breakers, work with the circuit-breaker racked-out (DISCONNECTED) of the fixed part;**
- **For action on fixed version circuit-breakers or on fixed parts disconnect the power circuit and the auxiliary circuits and visibly earth the terminals both on the power supply side and on the load side;**
- **Make safe in compliance with current laws.**

WARNING ELECTRICAL SHOCK HAZARD: Shock Hazard or Injury.

ABB declines all responsibility for damage to things and injury to people due to failure to comply with the instructions contained in this document. Maintenance tasks must be performed by qualified staff who are thoroughly familiar with the equipment.

8.2. Maintenance programme

8.2.1. Switch life

With regular maintenance, SACE Emax circuit-breakers, either with or without opening or closing releases, can withstand the following operation without replacement of parts. (1)

Rated uninterrupted current		Mechanical life (2)		Electrical life (2)		
Iu (40 °C) [A]		No. of operations x 1000	Frequency operations/hour	440 V ~ No. of operations x 1000	690 V ~ No. of operations x 1000	Free operations/hour
E1 B-N	800	25	60	10	10	30
	1000-1250	25	60	10	8	30
	1600	25	60	10	8	30
E2 B-N-S	800	25	60	15	15	30
	1000-1250	25	60	15	15	30
	1600	25	60	12	10	30
	2000	25	60	10	8	30
E2 L	1250	20	60	4	3	20
	1600	20	60	3	2	20
E3 N-S-H-V	800	20	60	12	12	20
	1000-1250	20	60	12	12	20
	1600	20	60	10	10	20
	2000	20	60	9	9	20
	2500	20	60	8	7	20
	3200	20	60	6	5	20
E3 L	2000	15	60	2	1,5	20
	2500	15	60	1,8	1,3	20
E4 S-H-V	3200	15	60	7	7	10
	4000	15	60	5	4	10
E6 H-V	3200	12	60	5	5	10
	4000	12	60	4	4	10
	5000	12	60	3	2	10
	6300	12	60	2	1,5	10
Emax LTT - Low temperature version						
E1 B-N	800-1600	8	60	8	8	30
E2 B-N-S	800-1600	8	60	8	8	30
E2 L	1250-1600	8	60	3	2	20
E3 N-S-H-V	800-2000	8	60	8	8	20
E3 N-S-H-V	2500	8	60	8	7	20
E3 N-S-H-V	3200	8	60	6	5	20
E3 L	2000-2500	8	60	1,6	1,3	20

(1) Data referring to standard installation conforming to product standards. For other applications, consult ABB Sace.
(2) Extreme atmospheric conditions, polluted atmosphere or vibrations may shorten the application's life. Consult ABB Sace.

8.2.2. Maintenance program

The table shows the maintenance intervals and the frequency of periodical intervention and routine maintenance tasks. The following rules should also be followed:

- Even circuit-breakers that are little used or remain on or off for long periods should be subject to the maintenance programme.
- For circuit breakers fitted with SACE PR121 installation of the mechanical operation counter (supplied on request) is recommended; the SACE PR122 and SACE PR123 releases with Vaux enable the number of operations performed by the circuit breaker in use to be displayed at any moment on the display.
- During operation, inspect the switch from the outside to check for dust, dirt or damage of any kind.

Maintenance operations	Interval	
	Installation in normal environments	Installation in dusty environments (1)/(2) and low temperature enviroment (3) [(1) = level of measured dust > 1 mg/m³]
First level	One year or 20% mechanical life or 20% electric life	6 months or 10% mechanical life or 10% electric life
Second level	Three years or 50% mechanical life or 50% electric life or after intervention on short circuit	18 months or 25% mechanical life or 25% electric life or after intervention on short circuit

(1) Data referring to standard installation in accordance with product standards. For other applications, consult ABB Sace.

(2) Extreme atmospheric conditions, polluted atmosphere or vibrations may shorten the life of the application. Consult ABB Sace.

(3) Emax LTT for low temperature enviroment application (-40°C ... +70°C)

8.3. First level maintenance operations

8.3.1. Preliminary operations:

- open the switch and check that the control springs are unloaded
- in the case of a circuit-breaker, work on the circuit breaker after it has been extracted (disconnected) from the fixed part

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

8.3.2. Checks and general cleaning:

- Check that the apparatus (switching part) is clean, removing dust and any traces of excess oil or grease using dry and clean rags (possibly using non-corrosive detergent.
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that the rating plates of the apparatus are in place.
- Clean the rating plates with dry and clean cloths.
- Eliminate any dust, mould, traces of condensation or oxidation also inside the fixed part of the apparatus if the switch is extractable.
- Check that there are no foreign bodies in the switch cabinet.

8.3.3. Switch connections and connections between the switch and the control panel

- Use brushes and dry cloths to remove any dust or dirt (if necessary, use non-corrosive detergent.
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that there are no traces of overheating on the terminals. This problem is due to discolouring of the contact parts; the contact parts are normally silver in colour.
- Check that the bolts fixing the connections to the terminals are tight (M12 - 70Nm).

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

- Check that the connecting screws of the cables of the terminal boards are tight (0.7 Nm).

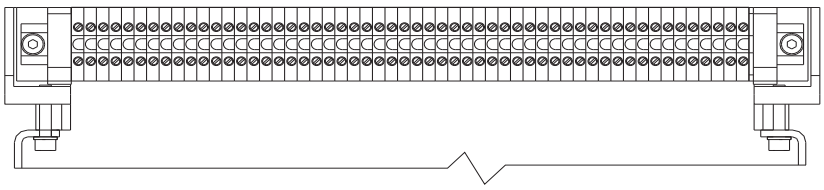


Fig. 32

8.3.4. Dismantling tab and cap

- The tab (1) of the release by rotating the screws (2) as shown in figure 33.
- Remove the front cap (3) by loosening the four screws (4).

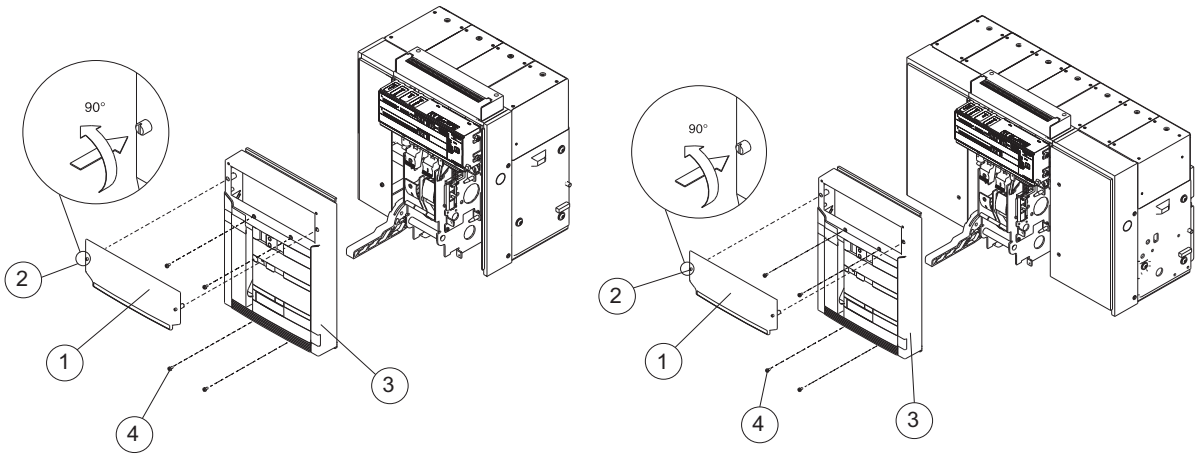


Fig. 33

- If there is a minimum release, remove the coils support and release the control springs, closing and opening the switch.

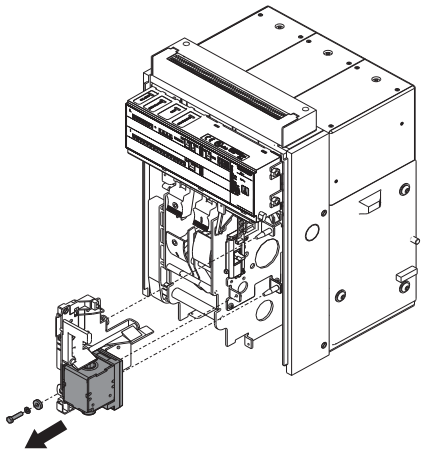


Fig. 34

8.3.5. Mechanical control

- Clean at the points indicated in figure 35. For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Lubricate, at the points indicated in fig. 35, the opening-closing shafts and hooks with MOBILGREASE 28 (EXXON MOBIL).
- Check that the opening and closing shafts are free to rotate.

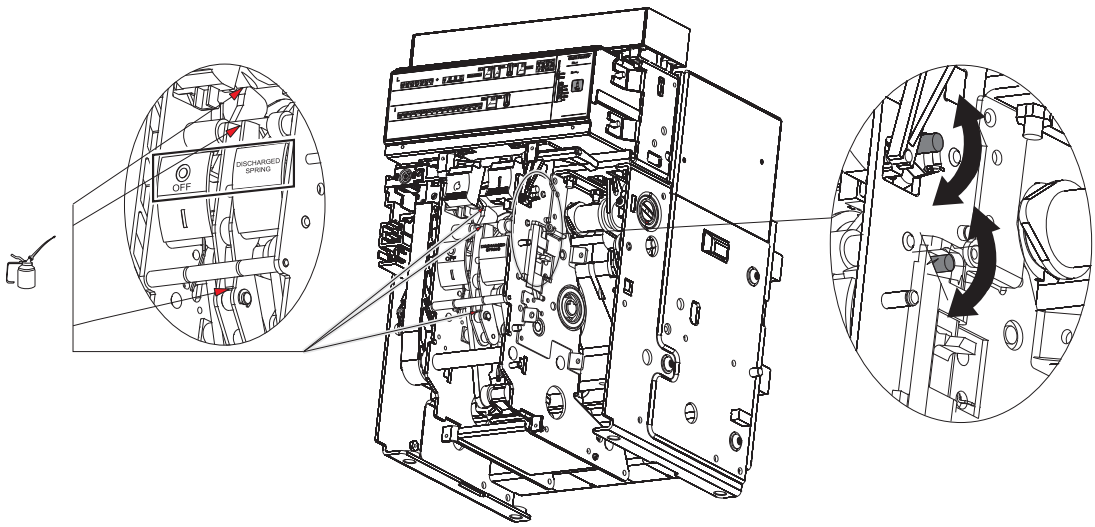


Fig. 35

8.3.6. Electrical and mechanical accessories

- Check that the accessories are fixed to the switch
- Check that the electrical accessories are connected to the switch
- Reduction gear: after 10000 operations check brushes for wear and replace the reduction gear if necessary.
- Check that the releases (SOR-UVR-SRC) are in good condition (no excessive wear, overheating, breakages) Fig. 36.
- Check that the mechanical operation counter is operating correctly (if applicable) by running an operation on the switch.

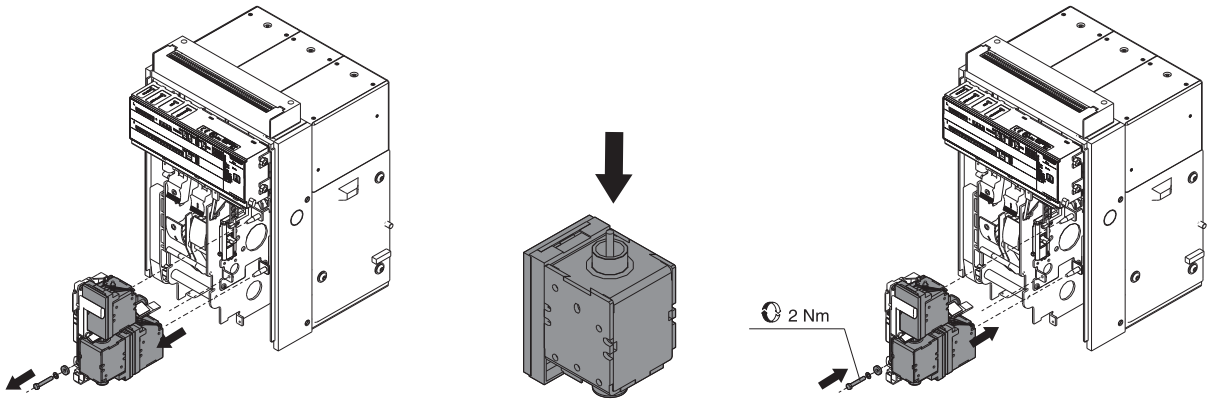


Fig. 36

8.3.7. Protection releases

- Supply the protection release from a PR030/B battery unit.
- Check that the protection release is working correctly: run “Trip Test” (PR121, PR122, PR123) and “Autotest” (PR122, PR123) for release.
- Use release PR122 or PR123 to check that there are no alarms on the display and via front LEDs.
- Use release PR121 to check that there are no alarms via front LEDs.
- Check that the cables are correctly connected to the release modules and to the release (if applicable).
- On PR122 and PR123 check the wear percentage to the switch contacts.
- At the end, remove the battery unit PR030/B from the relay.

Consult this manual for details about release PR121.
Consult manual 1SDH000460R0102 for details about releases PR122-PR123.

8.3.8. Test with SD Testbus2 (optional)

- Connect unit BT030 or BT030-USB to the relay to be tested.
- Run the programme SD.TestBus2 on a PC with a Bluetooth or USB connection, depending on the version of BT030 used.
- Once the connection between the relay and PC has been installed, check that there are no alarm signals from the relay; otherwise, consult the paragraphs ‘Error Messages’ and/or ‘Troubleshooting’ in this manual.
- In normal operating conditions the trip test and the autotest can be run (depending on the type of relay); for future checks, we advise inserting the current date in the User Data and/or Tag Name area. These data will be stored inside the relay.
- Remove the BT030 or BT030-USB from the relay.

Consult this manual for details about release PR121.
Consult manual 1SDH000460R0102 for details about releases PR122-PR123.

8.3.9. Maintenance operations; final checks

- Refit all parts and if necessary reconnect the auxiliary supply.
- Refit the cap as indicated in figure 37.

- Return the movable part to the TEST-ISOLATED position.
- Use the different auxiliaries in turn to run the following 10 operations:
  - Opening (both local and remote as applicable)
  - Closing (both local and remote as applicable)
  - Release by trip test from the relay

- Check the operations according to this sequence:
  - Open - Springs unloaded
  - Open - Springs loaded
  - Closed - Springs unloaded
  - Closed - Springs loaded

  - Check operation of the accessories, if present
  - Check operation of reduction gear (if present)
  - Check operation of minimum voltage release (if present)
  - Check operation of opening release (if present)
  - Check operation of closing release (if present)
  - Check operation of auxiliary contacts of switch (if present)
  - Check operation of lock of switch in open position (with key or padlocks) (if present)

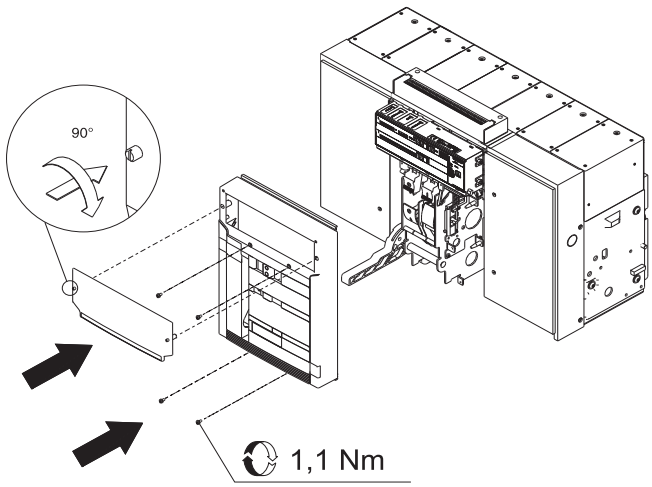


Fig. 37

8.3.10. Interlock

- Check that the interlock devices have been correctly installed and operate correctly between adjacent and superimposed switches (if present). The operating test cannot be run in the Test or Extracted positions.

8.4. Second level maintenance operations

8.4.1. Preliminary operations:

- open the switch and check that the control springs are unloaded
- in the case of a circuit breaker, remove the circuit breaker from the fixed part before working on it

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

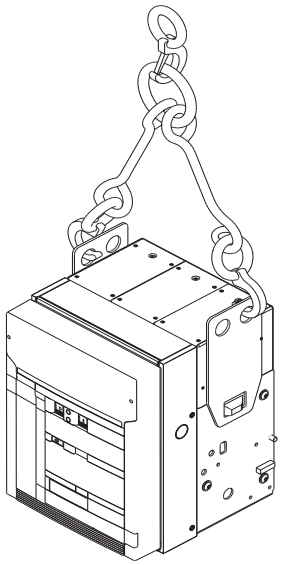


Fig. 38

8.4.2. General checks and cleaning:

- Check the cleanliness of the apparatus (switch part), removing dust and any traces of excess oil or grease with dry cloths (if necessary, use non-corrosive detergent)
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that the rating plates of the apparatus are in place
- Clean the rating plates with dry and clean cloths
- Eliminate any dust, mould, traces of condensation or oxidation also inside the fixed part of the apparatus if the switch is extractable
- Check that there are no factors such as overheating or cracks that may compromise switch insulation
- Check the circuit-breaking couple for damage (for the extractable switch, see feature A, fig 39).
- The couple must be silver in colour without trace of erosion or smoke
- Check that there are no foreign bodies in the switch cabinet
- Check that the fixing screws are tightened on the fixed side to the control panel (M8 - 25Nm).

8.4.3. Connections between the switch and the control panel

- Use brushes and try cloths to remove dust or dirt on the insulating parts (if necessary, use non-corrosive detergent - For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used).
- Check that there are no traces of overheating on the terminals. The problem is detected by discoloration of the parts in contact; the contact points are normally silver in colour.
- Check the tightness of the bolts fixing the connections to the terminals (M12 - 70Nm).

WARNING:
Before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

- Check that the connecting screws of the cables of the terminal boards are tight (0.7 Nm).

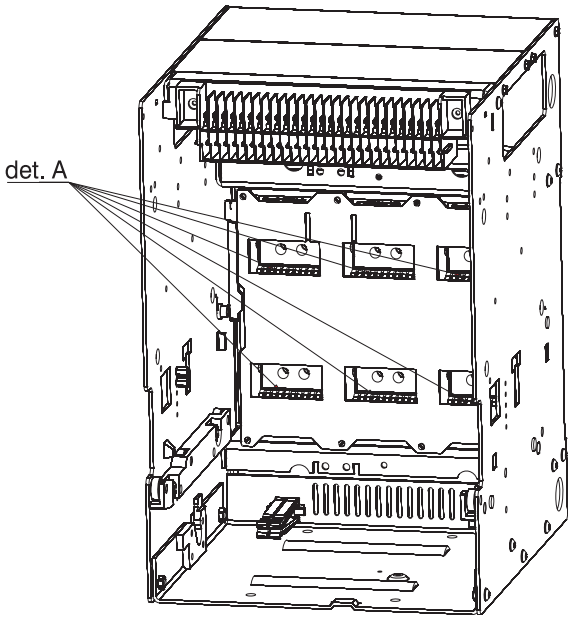


Fig. 39

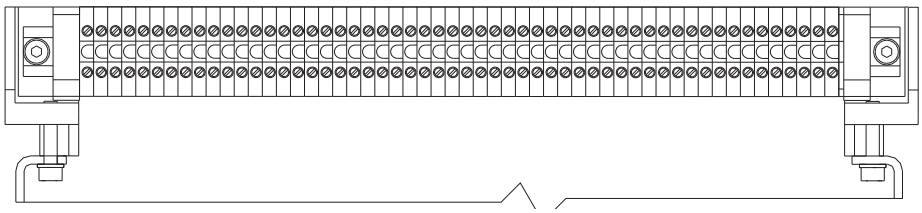


Fig. 40

8.4.4. Dismantling the tab, cap and arcing chambers

- Remove the flange (1) of the release, turning the screws (2) as shown in the figures
- Remove the front escutcheon plate (3) by removing the four screws (4)
- Remove, if present, one or both side guards (5) by removing the front (6) and lateral (7) screws
- Remove the arcing chambers (8) by removing the screws (9).

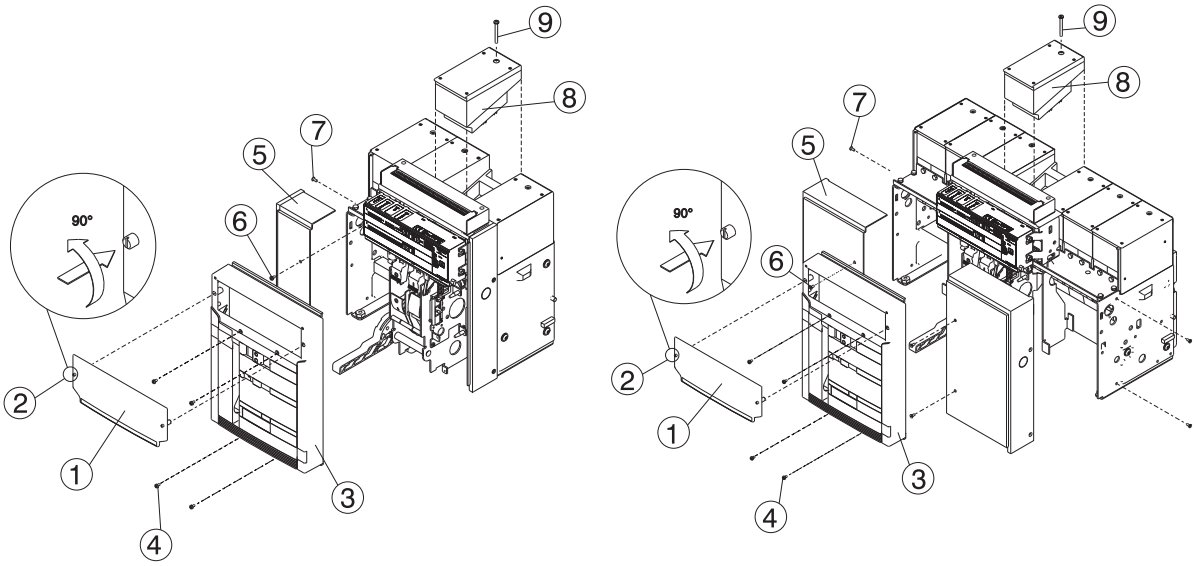


Fig. 41

- If there is a minimum release, dismantle the coil support and unload the control springs by opening and closing the switch.

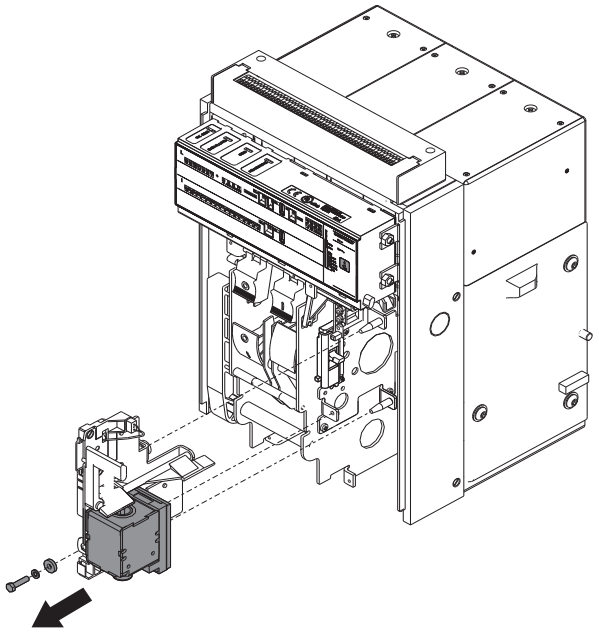


Fig. 42

8.4.5. Mechanical control

- Cleaning (for excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used) and lubricate, at the points indicated in fig. 43, part A, as for First Level, the opening and closing shafts and hooks with MOBILGREASE 28 (EXXON MOBIL).
- Cleaning (for excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used) and lubricate with MOBILGREASE 28 (EXXON MOBIL) the supports of the operating shaft, including those on the sides of the switch (see fig. 43 part B).
- Check that the opening and closing shafts are free to rotate.

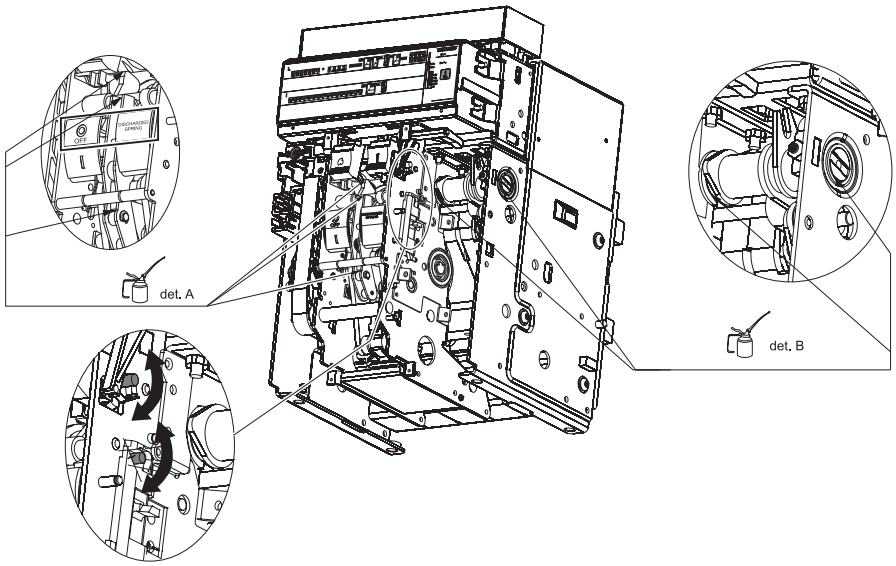


Fig. 43

- In the case of deformed or oxidated springs, missing rings or serious wear to the controls contact ABB Sace (*).

(*) Subject to the customer's approval, ABB can replace "A" type parts.

8.4.6. Electrical and mechanical accessories

- Check that the accessories are tightly fixed to the switch.
- Check that the electrical accessories are wired correctly to the switch.
- Reduction gear: after 10000 operations check brushes for wear and replace the reduction gear if necessary.
- Check that the releases (YO, YU, YC)) are in good condition (no excessive wear, overheating, breakages) fig 44.
- Check that the mechanical operation counter is operating correctly (if applicable) by running an operation on the switch.

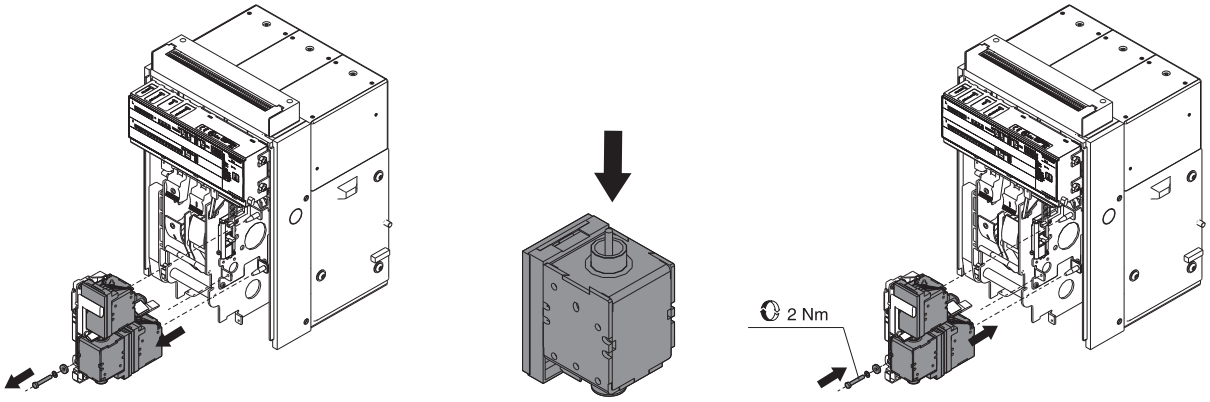


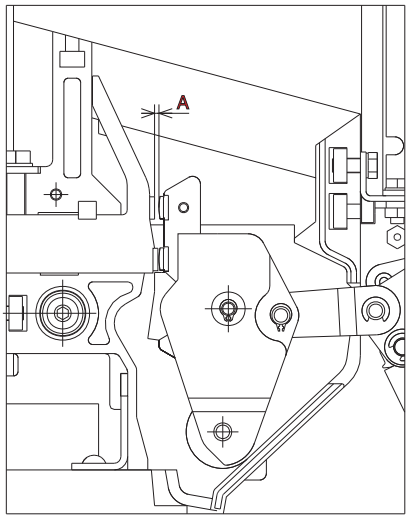
Fig. 44

8.4.7. Checking contact wear

With the switch open and arcing chambers removed:

1) Check the state of the blowout magnet chambers: the body of the chamber must be undamaged and the plates must not be corroded or damaged.
2) Remove the dust with compressed air and remove traces of smoke and any waste with a brush of appropriate type.
3) Check the state of the contacts.
4) Visually check that the main plates and the blowout magnets are in place.
5) Check for oxidation or beads and if they are detected, request help from the qualified ABB technician (*).

6.1) Check the blowout magnets distances (distance A fig 45).



Circuit Breaker	A
E1 - E2 - E3	≥ 1mm -->OK
E4 - E6	≥ 0,8mm -->OK

Fig. 45

6.2) close the circuit-breaker and check the gap A
- If the gap A is not correct, contact ABB Sace (*)
- If the gap A is correct, open the circuit breaker and refit the arc chambers.

(*) Subject to the customer's approval, ABB can replace "A" type parts.

8.4.8. Protection releases

- Supply the protection release with a PR030/B battery unit.
- Check operation of the protection release: release test with "Trip Test" (PR121, PR122, PR123) and "Autotest" (PR122, PR123).
- Use release PR122 or PR123 to check for the absence of alarms on the display and via front LEDs.
- Use release PR121to check that there are no alarm signals via front LEDs.
- Check correct wiring of the cables to the modules of the release and to the release (if applicable).
- On PR122 and PR123 check the percentage of wear to the contacts of the switch.
- At the end, remove the battery unit PR030/B from the relay.

Consult this manual for details about release PR121.
Consult manual 1SDH000460R0011 for details about releases PR122-PR123.

8.4.9. Test with SD Testbus2 (optional)

- Connect unit BT030 or BT030-USB to the relay to be tested.
- Run the programme SD.TestBus2 on a PC with a Bluetooth or USB connection, depending on the version of BT030 used.
- Once the relays and the PC have been connected, check that there are no alarm signals from the relay. If there are alarm signals, consult the paragraphs 'Error Messages' and/or 'Troubleshooting' in this manual
- In normal operating conditions, the trip test and the autotest can be run (depending on the type of relay),
- For future checks, we advise inserting the current date in the User Data and/or Tag Name area.
- Remove the BT030 or BT030-USB from the relay.

Consult this manual for details about release PR121.
Consult manual 1SDH000460R0102 for details about releases PR122-PR123.

8.4.10. Maintenance operations; final checks:

- Refit each part and if necessary reconnect the auxiliary supply.
- Refit the cap as indicated in figure 46.

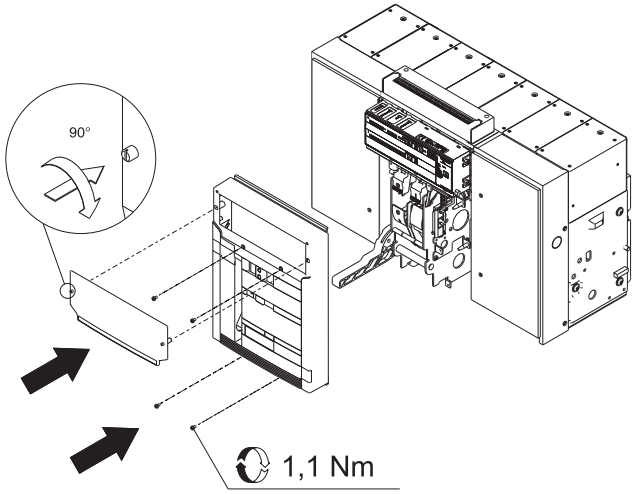


Fig. 46

- Return the movable part to the position TEST-ISOLATED.

- Use the different auxiliaries in turn to run the following 10 operations:
  - opening (both local and remote as applicable)
  - closing (both local and remote as applicable)
  - release by trip test from the relay
- Check the operations according to this sequence:
  - Open - Springs unloaded
  - Open - Springs loaded
  - Closed - Springs unloaded
  - Closed - Springs loaded

  - Check operation of the accessories, if present
  - Check operation of reduction gear (if present)
  - Check operation of minimum voltage release (if present)
  - Check operation of opening release (if present)
  - Check operation of closing release (if present)
  - Check operation of auxiliary contacts of switch (if present)
  - Check operation of lock of switch in open position (with key or padlocks) (if present)

8.4.11. Interlock

Check that the interlock devices have been correctly installed and operate correctly between adjacent and superimposed switches (if present). The operating test cannot be run in the Test or Extracted positions.

8.4.12. Extractable

In the extractable versions, check the operational efficiency of the insertion and extraction of the switch from the fixed part, performing the movement by means of the operating lever supplied and checking that the shutters for segregating the parts carrying live voltage are closed after extraction. Check correct operation of the inserted and extracted switch lock devices (if present).

9. Measures to be taken for any operating anomalies

The switch does not open when the opening button is pressed	The switch does not open when the YO operating release is tripped	The switch does not open when the YU minimum voltage release is tripped	The switch does not open when the protection relay release test is run	The switch does not shut when the close button is pressed	The switch does not shut when the YC closing coil is tripped	The closing springs cannot be loaded by the manual loading lever	The closing springs cannot be loaded by the spring loading motor	The crank does not fit in the moving part	The moving part does not rack into the fixed part	The switch cannot be locked in the open position	Anomalies: Possible causes	Checks and remedies
			•								The opening solenoid of the relay is not inserted correctly	Check that opening solenoid is connected correctly
			•	•	•						Warning that tripped relay has not been reset	Press the mechanical pushbutton to reset signal relay tripped
	•				•						Auxiliary circuit power supply voltage too low	Measure the voltage: it must not be less than 85% of the rated nominal coil voltage
	•				•						Different power supply voltage from the one indicated on the rating plate of the releases	Check the rating plate voltage of the releases
					•						Operating circuit faulty	Check connections, fuses, interlocks, protection circuit-breakers and consent contacts
	•				•		•				Screws for clamping loose wires and auxiliary circuits	Check tightness of the screws connecting the wires
	•				•		•				Incorrect electrical connections in the power supply circuit	Check the connections with the corresponding circuit diagram
	•				•						Damaged coil	Replace the coil
		•			•						Operating mechanism blocked	Operate by hand. If the fault persists please contact ABB SACE
				•	•						Key locked in open position	Unlock by inserting the key
				•	•						Circuit-breaker in intermediate position between connected and test	Complete the insertion operation
				•	•						Undervoltage release not energized	Check the corresponding power supply circuit and the power supply voltage
				•	•						Shunt opening release permanently energized	Check the power supply circuit
								•			Racking-in or out operation not carried out correctly	See paragraph 7.3
•		•				•					Locked control	Contact ABB SACE
				•	•						Extraction crank inserted	Extract crank
							•				Switch in extracted position	Turn switch to test or inserted position
							•				Protection fuse tripped, spring-loading motor	Replace fuse
							•				Reduction gear fault due to automatic loading of springs	Replace reduction gear
								•			Movable part incompatible with the fixed part	Check that the movable part is compatible with the fixed part
									•	•	Switch closed	Press the opening button and activate the lock
										•	Faulty open lock	Contact ABB SACE

WARNING: Is lit and circuit-breaker's misoperation or nonoperation in your application could cause bodily injury, property damage or is otherwise critical, remove the circuit-breaker immediately until it can be inspected or repaired.

10. Accessories

10.1. Electrical accessories

Shunt opening/closing (YO/YC) and second shunt opening release (Y02)
This allows remote opening or closing control of the apparatus. Given the characteristics of the circuit-breaker operating mechanism, opening (with the circuit-breaker closed) is always possible, whereas closing is only possible when the closing springs are loaded. Most of the releases can operate with either direct or alternating current. This release carries out an instantaneous service (*), but can be supplied permanently (**).
In uses where the shunt closing release is supplied permanently, to carry out the circuit-breaker reclosing operation after opening, it is necessary to momentarily de-energize the shunt closing release (the circuit-breaker operating mechanism reclosing is, in fact, fitted with an antipumping device).
In some versions it is necessary to have a very high degree of safety for the remote opening control of the circuit-breaker, and, in particular, the duplication of the control circuit of the shunt opening release is required. In order to achieve this, you can fit the SACE Emax circuit-breakers with a second shunt opening release. The second shunt opening release is located in the same seat as the undervoltage release and its technical characteristics are the same as the standard shunt opening release
(*) In the case of instantaneous service, the minimum duration of the current impulse must be 100 ms.
(**) In the case of permanent power supply to the shunt opening release, you must wait for at least 30 ms before giving the opening control to the shunt closing release.

Reference figures in the electrical circuit diagrams: YO (4) - YC (2) - YO2 (8)

Power supply (Un)	24 V DC
	30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-120 V AC/DC
	120-127 V AC/DC
	220-240 V AC/DC
	240-250 V AC/DC
	380-400 V AC
	440 V AC

Operating limits (CEI EN 60947-2 Standards)	(YO-YO2) : 70…110% Un
	(YC) : 85…110% Un
Inrush power consumption (Ps)	DC = 200 W
Inrush power time ~100 ms	AC = 200 VA
Continuous power (Pc)	DC = 5 W
	AC = 5 VA
Opening time (YO - YO2)	(max) 60 ms
Closing time (YC)	60 ms ± 10 ms
Insulation voltage	2500V 50 Hz (for 1 min.)

Undervoltage release (YU)
The undervoltage release opens the circuit-breaker in the case of a considerable drop or lack of its power supply voltage. It can be used for remote tripping (by means of normally closed type pushbuttons), as a lock on closing or to control the voltage in the primary and secondary circuits. The release power supply is therefore branched on the supply side of the circuit-breaker or from an independent source. Circuit-breaker closing is only allowed with the release powered (the closing lock is carried out mechanically). Most releases can operate with either direct or alternating current.

Power supply (Un)	24 V DC
	30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-120 V AC/DC
	120-127 V AC/DC
	220-240 V AC/DC
	240-250 V AC/DC
	380-400 V AC
	440 V AC

Circuit-breaker opening takes place with power supply voltage values of the release equivalent to 35 - 70% Un.
Circuit-breaker closing is possible with power supply voltage of the release equivalent to 85-110% Un.

it can be fitted with a signalling contact for undervoltage release energized (C. aux YU)..

Reference figures in the electrical circuit diagrams: YU (6)

Inrush power consumption (Ps):	DC = 200 W
	AC = 200 VA
Continuous power (Pc):	DC = 5 W
	AC = 5 VA
Openting time (YU):	≤ 80 ms
Insulation voltage	2500V 50 Hz (per 1 min.)

Time delay device for undervoltage release (D)
The undervoltage release can be combined with an electronic time-delay device for installing outside the circuit-breaker, which enables a delay in the tripping of the release with preset, adjustable times. The use of the delayed undervoltage release is recommended when the power supply network of the release can be subject to power cuts or short-lived voltage drops, in order to avoid trips.
When it is not supplied, circuit-breaker closing is prevented.
The time-delay device has to be combined with an undervoltage release with the same voltage as the time-delay device.
Reference figures in the electrical circuit diagrams: YU + D; (7).

The characteristics of the time-delay device are:

Power supply (D):	24-30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-127 V AC/DC
	220-250 V AC/DC
Adjustable opening time (YU+D):	0,5-1-1,5-2-3 s

Geared motor for automatic closing spring loading (M)
This automatically loads the circuit-breaker operating mechanism closing springs. After circuit-breaker closing, the geared motor immediately sees to reloading the closing springs.
When there is no power supply or during maintenance work, the closing springs can still be loaded manually (by means of the special lever on the operating mechanism).

Power supply	24-30 V AC/DC
	48-60 V AC/DC
	100-130 V AC/DC
	220-250 V AC/DC
Operation limits:	85…110% Un (Norme CEI EN 60947-2)
Inrush power consumption (Ps):	DC = 500 W
	AC = 500 VA
Rated power (Pn):	DC = 200 W
	AC = 200 VA
Inrush time	0,2 s
Loading time:	4-5 s
Insulation voltage	2500 V 50 Hz (per 1 min.)

It is always supplied with limit contacts and microswitch for signalling closing springs loaded.

Reference figure in the electrical circuit diagrams: M (1)

Mechanical and electrical trip signalling for overcurrent releases
The following signals are available following tripping of the overcurrent release:

a) Mechanical trip signalling for overcurrent releases
This enables a visual signalling on the operating mechanism by pushing the trip pushbutton in when the circuit-breaker has been opened following tripping of an overcurrent release. The circuit-breaker can only be closed again by putting the pushbutton back into its normal position included in the standard configuration.
Reference figure in the electrical circuit diagrams: S51 (13).

b) Electrical and mechanical trip signalling for overcurrent releases
This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit-breaker being opened following a trip of the overcurrent releases. To reset the circuit-breaker, it is necessary to reset the mechanical indicator pushbutton.
Reference figure in the electrical circuit diagrams: S51 (13).

c) Coil for resetting the mechanical release trip indicator
This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit- breaker being opened following a trip of the overcurrent releases. With this accessory, you can reset the mechanical indicator with an electronic relay using a remote control and this enables the circuit-breaker to be reset.

Power supply:	24-30 V AC/DC
	220-240 V AC/DC
	110-130 V AC/DC

Reference figure in the electrical circuit diagrams: S51 (14)

Auxiliary contacts
Auxiliary contacts installed on the circuit-breaker are available to enable an indication of the circuit-breaker's status. A special version of the auxiliary contacts is also available (gold plated contacts) for a rated voltage under 24 V (digital signal).

Un	In max	T
125 V DC	0,3 A	10 ms
250 V DC	0,15 A	10 ms

Un	In max	cosφ
250 V AC	5 A	0,3

The versions available are:

a) Electrical signalling for circuit-breaker open/closed
It is possible to have electrical signalling of the circuit-breaker status (open/closed) 4, 10 or 15 auxiliary contacts.
The auxiliary contacts can have the following configurations:
- 4 break/make contacts for PR121 (2 normally open + 2 normally closed)
- 4 + 2 break/make contacts for PR122/ PR123 (2 normally open + 2 normally closed + 2 for the release)
- 10 break/make contacts for PR121 (5 normally open + 5 normally closed);
- 10 + 2 break/make contacts for PR122/ PR123 (5 normally open + 5 normally closed + 2 for the release)
- 15 supplementary break/make contacts which can be mounted outside the circuit-breake

The basic configuration described above can be modified by the user to indicate normally open or normally closed by repositioning the faston connector on the microswitch. When 10 contacts for PR122/ PR123 are required, zone selectivity and the PR120/K module are not available.
Reference Fig. in the electrical circuit diagrams: Q/1÷10 (21-22)

b) Electrical signalling for circuit-breaker connected/test isolated/disconnected
In addition to mechanical signalling of the position of the circuit-breaker, it is possible to have electrical signalling by means of 5 or 10 auxiliary contacts which are installed on the fixed part.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.
The auxiliary contacts can have the following configurations:
- 5 contacts; group consisting of 2 connected signalling contacts, 2 disconnected signalling contacts and 1 test position signalling contact (main contacts isolated, but sliding contacts connected)
- 10 contacts; group consisting of 4 connected signalling contacts, 4 disconnected signalling contacts and 2 test position signalling contacts (main contacts isolated, but sliding contacts connected)

Reference figure in the electrical circuit diagrams: S75I (31-32) - S75T (31-32) - S75E (31-32)

c) Contact for signalling closing springs loaded
This consists of a microswitch which allows remote signalling of the state of the circuit-breaker operating mechanism closing springs. The contact is always supplied with the spring loading geared motor.
Reference figure in the electrical circuit diagrams: S33 M/2 - (11)

d) Contact for signalling undervoltage release energized (C.aux YU)
The undervoltage releases can be fitted with a contact (by choise, normally closed or open) for signalling undervoltage energized for remote signalling of the state of the undervoltage release.
Reference figure in the electrical circuit diagrams: (12)

Transformers and operation counters

a) Current sensor for the neutral conductor outside the circuit-breaker
The sensor allows neutral protection by means of connection to the overcurrent release and is available only for three-pole circuit-breakers. It is supplied on request.
Reference figure in the electrical circuit diagrams: UI/N

b) Homopolar toroid for the power supply earthing conductor (star center of the transformer)
PR122 and PR123 microprocessor-based electronic releases may be used in combination with an external toroid located on the conductor, which connects the star center of the MV/LV transformer (homopolar transformer) to earth: in this case, the earth protection is defined as Source Ground Return.
The In of the toroid can be regulated to 100 A, 250 A, 400 A, 800 A by using different combinations of the connections.
Reference figure in the electrical circuit diagrams: UI/0.

c) Homopolar toroid for residual current protection
The toroid enables the residual current protection to be activated and can be combined with the PR122/P LSIRc, PR122/P LSIG releases (with PR120/V) and PR123/P. The accessory is for installation on the busbars and is available in different sizes: up to 3200A for three- and four-pole circuit-breakers, up to 4000A for three-pole circuit-breakers.

d) Mechanical operations counter
This is connected to the operating mechanism by means of a simple lever mechanism. It indicates the number of circuit-breaker mechanical operations. The indication is visible on the front of the circuit-breaker from the outside.

a-b) Lock in open position
Different mechanisms are available which enable the circuit-breaker to be locked in the open position.
These devices can be controlled by:
- a key (a): a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers). In the latter case, up to four different key code numbers are available.
- padlocks (b): up to 3 padlocks (not supplied): Ø 4 mm..

c) Circuit-breaker lock in connected - test isolated - disconnected position
This device can be controlled by a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers available up to four different key code numbers) and by padlocks (up to 3 padlocks, not supplied - Ø 4 mm). Only available for circuit-breakers in withdrawable versions for installing on the moving part.

d) Accessories for lock in test isolated - disconnected position
In addition to the circuit-breaker lock in the connected - test isolated - disconnected position, this allows locking only in the disconnected or test isolated positions. Only available for circuit-breakers in withdrawable versions for installing on the moving part.

e) Accessories for shutter padlocks
They enable the shutters to be padlocked (installed on the fixed part) in the closed position.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.

f) Mechanical lock on compartment door
This prevents the compartment door from being opened when the circuit-breaker is closed (and connected in the case of withdrawable circuit-breakers) and prevents circuit-breaker closing with the compartment door open.

Transparent protection covers

a) Protection covers for opening and closing pushbuttons
These protection covers, applied over the opening and closing pushbuttons, prevent the corresponding circuit-breaker operations except by using a special tool.

b) IP54 door protection
This is provided by means of a transparent plastic escutcheon plate which fully protects the front of the circuit-breaker and ensures a degree of protection to IP54. Mounted on hinges, it is fitted with a key lock.

Interlock between circuit-breakers
This mechanism makes the mechanical interlock between two or three circuit-breakers (even of different sizes and in any fixed/withdrawable version) by means of a flexible cable. The electrical circuit diagram for the electrical changeover by means of a relay (to be provided by the customer) is supplied with the mechanical interlock. The circuit-breakers can be installed vertically or horizontally.
4 types of interlocks are available:
type A: between 2 circuit-breakers (power supply + emergency)
type B: between 3 circuit-breakers (2 power supplies + emergency)
type C: between 3 circuit-breakers (2 power supplies + bus-tie)
type D: between 3 circuit-breakers (3 power supplies / a single closed circuit-breaker)
The emergency power supply is generally supplied in order to substitute the normal power supply in two cases:
- to supply safety services for people.
- to supply essential parts of the installation for other than the safety services.

The change over from the normal supply to the emergency supply, can be done manually (with a local or remote control) or automatically. For the change over, the circuit-breakers must be supplied with the necessary accessories for the electrical remote control and for electrical and mechanical interlocks provided for the changing over.
The accessories can be for example:
- the shunt opening release
- the shunt closing release
- the motor operator
- the auxiliary contacts

For the change over, the customer can use a suitable electronic relay, whose diagram is supplied by ABB SACE. The mechanical interlocks between two or three circuit-breakers are made by means of cables that can be used for circuit-breakers installed, either side-by-side or one over the other.

Table of feasible mechanical interlocks between two or three circuit-breakers

Type of interlock	Number of circuit-breakers	Type of circuit-breaker	Possible interlocks
A	TWO	A normal power supply unit and an emergency unit.	The first circuit-breaker can be closed only if the second (emergency) breaker is open.
B	THREE	Two normal power supply units and an emergency unit.	The first and third circuit-breakers can be closed only if the second (emergency) breaker is open. The latter can be closed only if the first and third are open.
C	THREE	A unit of 2 supplies and a bus-tie. The two half-busbars can be supplied by a single transformer (bus-tie closed) or simultaneously by both (bus-tie open).	One or two circuit-breakers out of three can be closed at the same time.
D	THREE	A unit of 3 supplies / a single closed circuit-breaker. Three supplies (generators or transformers) on the same busbar for which parallel operation is not allowed.	Only one of the three circuit-breakers can be closed.

10.3. Notes for Emax LTT Low Temperature accessories

The SACE Emax VF LTT, circuit breaker designed for low temperature environment, is accessoriable only with the standard opening, closing and undervltage releases at 220V AC/DC.
The geared motor for the automatic charging of the spring is available with a special version for low temperature at 220V AC/DC.
Mechanical and electrical signalling for overcurrent releases accessories, auxiliary contacs, terminals and fixed parts are in common to the Emax VF product.
Transparent pushbuttons protection covers, IP54 door protection, interlocks, homoploar toroid, time delay device for undervoltage release and external neutral current sensors are not available (1).

(1) Consult ABB SACE

10.4. Spare parts and retrofitting

Spare parts
The spare parts available are:
- Complete single pole (*) (Type “A”)
- Arcing chamber
- Stored energy operating mechanism (*) (Type “A”)
- Closing springs kit (*) (Type “A”)
- Current sensors and release connecting cables
- Contact kits for clamp disconnection for a fixed part of the removable circuit breaker
- Creeping earth contacts (for withdrawable version)
- Frontal shield kit complete with caps and side shields
- Safety shutters fixed part shutters
- Transparent protection for PR121, PR122 and PR123 releases
- Opening solenoid for maximum current release PR121 / PR122 / PR123
- Testing front connecting cap for relay
- SACE PR030/B power supply unit
- Lubricating grease for stored energy operating mechanism
- Terminal board for fixed
- Creeping contacts, fixed part
- Creeping contacts, movable part
- Dust tab for door of cell
- Extraction crank
- Lifting plates pair
- Front escutcheon plate for Ronis-type key lock

For further details, ask for the ABB SACE spare parts catalogue.
(*) Subject to the customer’s approval, ABB can replace “A” type parts.

Retrofitting kits
The kits enable SACE Otomax and Novomax G30 circuit-breakers to be replaced, coupling the new circuit-breaker in the old switchboard.

11. Protection releases - General notes

The ABB SACE Emax series of air circuit-breakers can be equipped with electronic relay PR121/P.

The available accessories and functions are listed in the table below.

Function/Unit	PR121
Current protections (L, S, I, G)	**S**
Thermal memory	**S**
Local bus for external accessory units	**S**
Front connector for test unit and temporary power supply	**S**
Compatibility with Ekip Connect	**S**
HMI030 (Display via switchgear for ABB SACE relay)	**O**
Flex Interface (External signalling unit)	**O**
PR030/B (External power supply unit)	**T**
BT030-USB (External Bluetooth and USB powering and communication unit)	**T**
Ekip T&P (External unit for power supply, communication and testing via USB)	**T**
PR010/T (External unit for tests)	**T**

Key:
S : standard function/unit
O : optional fixed unit
T : optional unit for temporary connection.

The main characteristics of relay PR121 are:
1. Highly accurate current reading (up to 1.5%).
2. Continuous control of the connection of the current sensors and trip coil.
3. Recording of the cause for tripping, also in the self-supply condition.
4. Extended neutral selection.
5. Connection to a PC via wireless Bluetooth (with BT030-USB) or USB (with BT030-USB or Ekip T&P).
6. Serial connection for external modules HMI030 and Flex Interface.
7. “Real time” date and time (adjustable with BT030-USB or Ekip T&P).
8. Software applications available for relay maintenance and tests.

11.1. Safety notes

WARNING: this symbol gives information about operations, actions or circumstances that can cause injuries to the personnel, damage to the unit or economic losses.

Read this manual carefully and completely.
The use of this device should be reserved for qualified and expert personnel only.

If in doubt, about its safe usage, the unit must be put out of service to prevent any accidental use.

You must assume that safe usage is impossible if:
1. the unit shows visible signs of damage.
2. the unit does not function (for example with autotest or with the trip test unit).
3. the unit has been damaged in transit.

WARNING: Prior to servicing and/or replacing, the circuit-breaker must be open.
Also remember to disconnect all power supplies connected.

11.1.1. Notes for dielectric stiffness tests

WARNING: Dielectric stiffness tests on the releases, inputs and outputs, are not permitted.

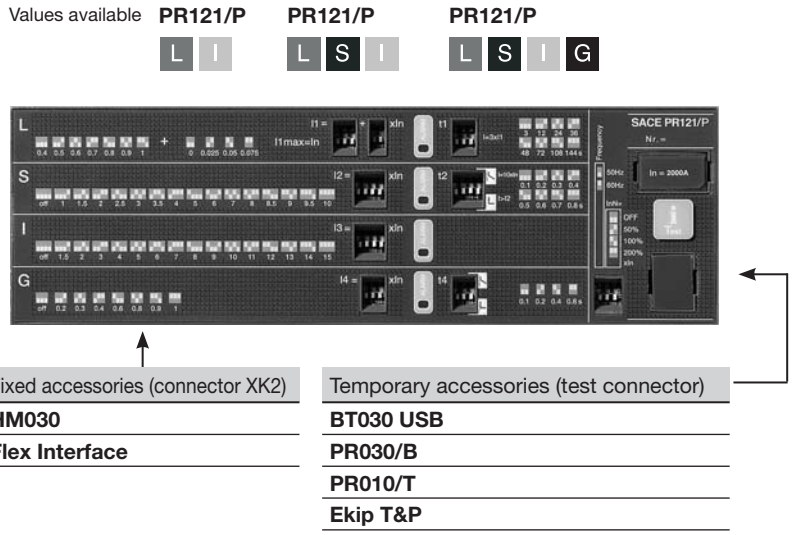
11.2.1. Abbrevations

Abbreviations	Meaning
YO	Opening coil
YC	Closing coil
CB	Circuit-Breaker (for example Emax)
CS	Current Sensor (current transformer)
Ekip Connect	Communication software for PC, for electronic devices installed in ABB SACE CB
Emax	Series of ABB SACE air circuit-breakers
HW	Hardware
i-Test	"i-Test" button on the front of relay
In	Rated current of the Rating Plug installed in the circuit-breaker
LTT	Low Temperature Technology. Special CB version for low temperatures (-40°C ... +70°C)
MT	Thermal memory
Relè	also called “protection unit” or “protection release”
RMS	Root mean square value
SW	Software
TC	Trip Coil (opening solenoid)
Trip	CB opening, generated by the release
i-Test	"i-Test" button on the front of relay
Vaux	Auxiliary power supply

12. SACE PR121/P RELAY

12.1. IDENTIFICATION

The PR121/P units available, in accordance with the IEC Standards, with the various default and optional protections and modules, are illustrated in the figure below:



12.2. Specifications

12.2.1. General characteristics

Relay PR121/P is an electronic unit for Emax CB. Its function is to monitor and protect against abnormal current.

The unit installed on the CB is connected to the current sensors for primary current reading and to the Trip Coil for circuit-breaker opening control.
The sensors provide the primary current measurement and the energy for powering the relay, even in the absence of external power supply.
Connected directly to an opening mechanism, the Trip Coil allows the CB to open. The control is transmitted to the Trip coil in accordance with the protection settings.

Dip switches on the front allow the main protections and settings to be regulated, while the state of the relay is indicated by the leds of the front interface.

Depending on the version, the protections available are as follows:t

Symbol	Protection against
L	overload with inverse long time delay
S	short-circuit with adjustable delay
I	nstantaneous short-circuit
G	earth fault with adjustable delay

The relay unit also provides a fixed protection against instantaneous short-circuit at high current values, called linst protection.

A set of accessories adds optional functions to the basic version.
Temporary accessories:
- PR030/B powers the relay so as to display its state (by means of the LEDs) and allow the installation operations to be performed.
- BT030-USB for relay powering and communication, so as to allow different sorts of information to be supervised via a PC, such as the Trip and measurements log file, and for regulating settings and functions that cannot be adjusted by means of the front dip switches, such as the Thermal Memory.
- PR010/T allows the relay to be supplied, enables the protections to be tested and test reports to be saved.
- Ekip T&P, similarly to BT030-USB, can be used to power and communicate with the relay via a PC. It also allows units like PR010/T to be tested, again via a PC.
Communication with ABB SACE devices is facilitated by the Ekip Connect SW supplied with BT030-USB and Ekip T&P modules, or available from the Internet website.

Fixed accessories:
- The HMI030 panel interface expands the monitoring functions of the relay and displays the current measurements of all the phases in real time.
- Flex Interface modules allow the alarm or state signals of the relay to be matched to programmable electromechanical contacts. They also allow a complete network of several units to be created and can also be connected to external modules (e.g. HMI030).
Consult the following chapters or the dedicated manuals for details about each individual unit.

12.2.2. Compatibility CB

PR121/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole Emax CBs of any model.

The CB model establishes the rated uninterrupted current the circuit-breaker is able to support (Iu).

The adjustable protections (L, S, I and G) refer to the In model, defined by the interchangeable Rating plug module installed on the relay.

12.2.3. Standards

The PR121/P has been designed to work in accordance with the following international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

12.2.4. Environmental characteristics

Operating temperature (Standard version)	-25 °C ... +70 °C
Operating temperature (LTT version for low temperatures)	-40 °C ... +70 °C
Storage temperature	-40 °C ... +70 °C
Relative humidity	0% ... 98% with condensation
Degree of protection (with PR121/P installed in the circuit-breaker)	IP 30

12.2.5. Electrical characteristics

12.2.5.1. Primary current

Rated operating frequency	50/60 Hz ±10%
Peak factor	2,1 @ 2xIn in conformity to IEC 60947 Annex F (Consult ABB for a dedicated analysis if there are higher peak factors)

12.2.5.2. Power supply

The relay unit needs a power source: this can be supplied by current sensors installed on the internal poles of the circuit-breaker or by means of an auxiliary source:
- All that's needed to supply the relay by means of internal current sensors is the presence of minimum three-phase turn-on current, as shown in the table below.
- Provided by a galvanically-separated power supplier, the external auxiliary power supply ensures continuous for the unit (even when there is no current flow, or in the open circuit-breaker condition) and adds to the accessory functions of the relay allowing HMI030 and Flex Interface external devices to be used.

To improve the supply condition, ABB recommends use of the auxiliary supply source when there are low load current values and/or distorted signals.

Primary current characteristics	**Range**	
	CB E1, E2, E3	CB E4, E6
Minimum three-phase busbar current	>100 A (*)	>200 A
Frequency, Peak factor	see par. 12.2.5.1	

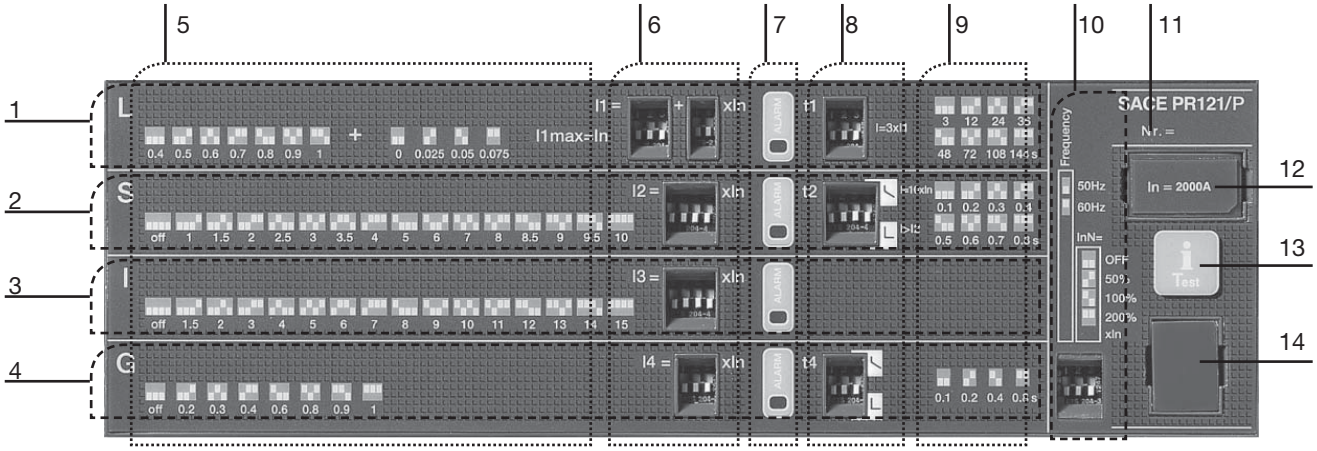
Auxiliary power supply characteristics	**Range**
DC voltage (galvanically separated)	24 Vdc ±20%
Maximum ripple	5%
Inrush current @ 24V	~10 A for 5ms
Rated power @ 24V	~1 W

NOTE:
(*): Emax E1 and E2 Iu=250A: minimum three-phase busbar current >30A.

WARNING: Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5 mA.

12.3. User interface

The graphic interface of relay PR121/P allows the protections and general state of the relay itself to be adjusted and displayed.



Rifer.	Description
1	Alarm indicator LED for protection function L
2	Section dedicated to protection S (not present for models PR121/P LI)
3	Alarm indicator LED for protection function I
4	Alarm indicator LED for protection function G (not present for models PR121/P LSI and PR121/P LI)
5	Dip switch position indications, with reference to the L, S, I, G protection thresholds
6	Dip switch for setting the thresholds of protections L (I1), S (I2), I (I3), G (I4)
7	LEDs for signalling Alarm state of protections L, S, I and G, Pre-alarm L, Power status indicator
8	Dip switch for setting the tripping times of protections L (t1), S (t2), G (tI4)
9	Dip switch position indications, with reference to the thresholds of the tripping times L, S, G
10	Position indicator for the DIP switches for setting the neutral protection
11	Serial number of the relay
12	Rating plug
13	"i Test" test and info button
14	Test connector for external modules PR030/B, BT030-USB, Ekip T&P, PR010/T)

12.3.1. Dip switches

IThe dip switches on the front of unit PR121/P are used for regulating the tripping thresholds of each protection and the tripping time. The available combinations are given alongside each group of dip switches.

The dip switches for regulating the tripping times of protections S (t2) and G (t4) can also be used for selecting the tripping curve:

L	Fixed time tripping curve. The following relation is used: t=k.
↘	Inverse time tripping curve. The relation between the tripping time and over-current is given by the formula: $t=k/I^2$

The dip switch settings can be changed when the relay unit is on and without alarms: updating is immediate. The unit need not be restarted.

WARNING: The settings are inhibited if the relay is in the alarm condition (signalled by LEDs): settings changed by the user when the relay is in the alarm condition will not be recorded until the alarm condition ceases.

An example of the dip switch setting for the protection L function, with 2000A Rating Plug (In= 2000A) is given below.

I1 = 0,4 + 0.025 x In
I1 = 850A

12.3.2. LED

The following table shows how the LEDs are managed in accordance with the IEC standard 60073 (and clause 4.2.3.2 in particular).

There are 2 to 4 red leds for checking the state of the protections: the number of leds depends on the way the relay has been configured and on the protections installed.
The led of protection L can also come on in the orange colour, thereby providing further information.

All the led combinations and the corresponding information are given in the table below.

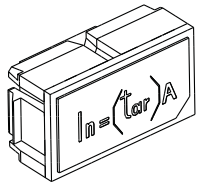
Type of information	Flashing slowly (0,5Hz)	Flashing fast (2Hz)			LED flashing with two 0.5 sec pulses every 2 sec		LED flashing with one pulse every 3 sec	LED on permanently		
	All LEDs	All LEDs	Single LED		All LEDs	LED	LED	All LEDs	Single LED	
	RED	RED	RED	ORANGE	RED	ORANGE	ORANGE	RED	RED	ORANGE
TC: Error or disconnected		☒								
CS: Error or disconnected	☒									
Rating Plug: Error or Installation not performed					☒					
Protection timing alarm (1).			☒							
Last trip (1)									☒	
Test button pressed and no failure detected (2)								☒		
Hardware Trip (3)									☒(4)	☒
L prealarm										☒
Configuration error (5)				☒						
Settings inconsistency						☒				
Normal operation of the relay (Alive LED ON)(6)							☒			

(1) The led of the protection that has tripped or is being timed comes on to display the information. If it is the last trip, the led remains on for 2 sec or with fixed light if power source is external (from PR030/B).
(2) The information is displayed with all the leds on for as long as the test button remains depressed, or for 2 seconds if it is pressed once.
(3) If enabled, the hardware trip causes the CB to open within 1 sec. It activates in the case of “Cs Error” or “Rating plug Error”, or when the protection of Ne is “ON” in the 3P circuit-breaker without Ne ext (wiring error).
The cause of tripping (CS Error, Rating Plug Error) is displayed in the presence of Vaux and/or PR030/B (connected during the event).
The generic “Hw trip” signal remains in the absence of Vaux and/or PR030/B and is displayed by pressing the “I-test” key.
(4) Orange L led and red I led on.
(5) The values entered differ from those stored. Therefore, the relay must be installed (see par. 12.7).
(6) In the absence of other information, correct operation of the unit is signalled 3 s after the unit itself has been powered. The “normal relay operation” signal can be disabled in units BT030-USB, Ekip T&P and PR010/T but in this case, the unit on signal (Alive LED OFF) will no longer be active.
(7) see par. 12.4.1.
(8) see par. 12.4.

WARNING: the leds only function when the relay is on: make sure that the minimum power supply conditions have been complied with in order to read the signals.

12.3.3. Rating Plug

The rating plug defines the rated current In, which is essential for regulating the protections. This is because the regulation of all the protections refers to In (e.g.: I1= 0.4 xIn).
The rating plug is installed on the relay on a dedicated front connector and is available to the user.



A relay can be equipped with various Rating Plug models, up to the value Iu (uninterrupted rated current Iu of the CB given on the rating plate of the front guard).
Example: CB E1B800 has Iu= 800 A, and can be fitted with a rating plug with In≤ 800A.

The module is interchangeable, with the relay off and the CB open.

The relay continuously checks for the presence of the rating plug and signals its absence or any assembly errors.

WARNING: Replacement of the rating plug with the relay on or the CB closed could lead to faulty relay operation or undesired opening of the CB.

12.3.4. iTest button

The itest button can be used for different functions:

- when the unit is off, it allows the last event recorded by the relay to be checked (when pressed for about 1 second). The function is available for 48 hours after the relay has been switched off (absence of internal or external poser supply).
- with the unit powered by PR030/B alone and with the CB off, it allows the relay to be installed in the CB (see sect. 12.6).
- with the unit powered by PR030/B and the CB closed, it allows the LED test (when pressed for 3 seconds) and the trip coil operating mechanism (when pressed for 7 seconds) to be tested, with consequent opening of the CB.
- It allows the Trip signal to be reset (when pressed for about 1 second) after a tripping event, with the unit on.

WARNING: in the case of operating temperatures between -40°C and -25°C, in versions where this is envisaged, the information only remains stored for 24 hours.

12.3.5. Test connector

Installed at the front on the relay, the connector allows PR030/B modules to be connected for temporary power supply of the relay, and BT030-USB, PR010/T, Ekip T&P for powering, communication and testing via a PC (or via the unit itself in the case of PR010/T). Consult the chapters dedicated to the accessory modules for further details.

12.4. PROTECTION FUNCTIONS

Depending on the model, relay PR121/P handles up to 5 independent protection functions.
Current signalling from the current sensors is processed by the microprocessor of the relay which, depending on the protection levels and time settings, gives alarms, accomplishes timing processes and sends commands.

All the adjustable protections process according to the true root mean square value of the current values read by means of the current sensors.
A time indication ("alarm" led) is available on the front of the unit and activates during an alarm for each protection.
It deactivates when the alarm ceases or if the protection trips.

WARNING: when activated, the protections must guarantee the following rule:
I_1(protection L) < I_2(protection S) and I_2(protection S) < I_3(protezione I).
Incorrect protection settings lead to an error signal from the relay (inconsistent settings).

The unit is equipped with a "protection-backup" function. If the first command transmitted to the trip coil fails to open the circuit-breaker immediately (TC partially faulty) further commands are transmitted to the trip coil until the circuit-breaker opens.

12.4.1. Protection L

- Protection L is the only adjustable protection that cannot be disabled since it is for self-protection against overloading of the relay itself.
- - The type of curve setting is t=k/I2 and the tripping time is calculated according to the value of If;
- - For fault currents If ≤12In, the tripping time of the protection is given by the expression: t(s)= $\frac{9 \cdot t_1}{(I_f/I_1)^2}$. If the calculated value is less than 1 second, the real tripping time is forced to 1 second (t(s)= 1s.)
- - For fault currents If > 12In, the tripping time is always t(s)= 1s.

NOTES:
- t(s)= envisaged tripping time;
- I_f= fault current; given in [In] (example: 0.7In)
- I_1 , t_1= protection L parameters set by the user, given in [In] and [s]

Protection L has 3 operation conditions established by the primary current level I_f and by the setting of the protection itself I_1:

$I_f \leq 0.9 \times I_1$	No alarm, all settings possible. No time setting in progress.
$0.9 \times I_1 < I_f < (1.05...1.2) \times I_1$	Prealarm L signal, all settings possible. No opening time setting in progress.
$(1.05...1.2) \times I_1 < I_f$	Alarm L signal, no setting possible. Opening time setting in progress.

WARNING: the protection L threshold range ensures that:
- **the relay does not set to the alarm status for current values of less than 1.05 xI_1;**
- **the relay will set to the alarm status for current values exceeding 1.2 xI_1.**

12.4.1.1. Thermal memory L

The thermal memory function can be enabled to protect the cables. It is based on the "τL" parameter defined as trip time of the curve (t1) selected @1.25xI1. This function can be enabled through PR010/T, or Ekip Connect.
The trip time of the release surely is 100% of the time selected after a τL time has elapsed from the last overload or last trip, or else trip time will be reduced depending on the overload and time elapsed.

IPR121/P is equipped with two instruments to make up this thermal memory. The first one is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release); the second operates even when the release is not powered, reducing any trip times when it closes again straight after and is enabled as soon as the circuit-breaker is tripped. The PR121/P release determines which one to use according to the situation.

12.4.2. Protection S

The protection, which can be disabled, can be the fixed time (t=k) or inverse time ($t=k/I^2$) type.

The tripping time with inverse time curve is given by the expression: t(s)= $\frac{100 * t_2}{(I_f)^2}$. If the calculated value is less than t_2, the

real tripping time is forced to t_2 (t(s)= t_2.)

NOTES:
- t(s)= envisaged tripping time;
- I_f= fault current; given in [In] (example: 1.7In)
- I_2 , t_2= protection S parameters set by the user, given in [In] and [s]

12.4.2.1. Thermal memory S

The thermal memory function can be enabled for cable protection when the curve with inverse time is selected. This is based on the "tS" parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L".

12.4.3. Protection I

This protection can be disabled; it is of the fixed time (t=k) type, and is designed for a nil intentional delay.

12.4.4. Protection G

The protection, which can be disabled, can be the fixed time (t=k) or inverse time ($t=k/I^2$) type.

The tripping time with inverse time curve is given by the expression: t(s)= $\frac{2}{(I_f/I_4)^2}$; If the calculated value is less than t_4, the real tripping time is forced to t_4 (t(s)= t_4).

NOTES:
- t(s)= envisaged tripping time;
- I_f= fault current; given in [In] (example: 3.7In)
- I_4, t_4= protection G parameters set by the user, given in [In] and [s]

The PR121/P unit can provide earth fault protection, achieved inside the relay by vectorially adding together the phase and neutral currents. The fault current is defined by the following formula:

$$\vec{I_G} = \vec{I_1} + \vec{I_2} + \vec{I_3} + \vec{I_N}$$

If there is no fault in the circuit, the modulo-sum of these currents is always nil.
Vice versa, the fault current will acquire an increasingly higher value, depending on the entity of the fault.

WARNING: protection G is disabled for current values exceeding 8In (for $I_4 \geq 0{,}8In$), higher than 6In (for $0{,}5In \leq I_4 < 0{,}8In$) and higher than 4In (for $I_4 < 0{,}5In$)

ATTENZIONE: With Iu≥800A: In the absence of Vaux and with I4<100A, the SW forces the minimum threshold to 100A and LED show "Settings inconsistency" error. With Iu≥250A: In the absence of Vaux and with I4<30A, the SW forces the minimum threshold to 30A and LED show "Settings inconsistency" error.

12.4.5. Neutral Protection

Unit PR121/P allows the current signal of the neutral pole to be processed with different ratios in relation to the phase values. The following values can be set for this protection: I_nN =Off - 50% - 100% - 200% * I_n. The neutral protection is set by default at a current value equal to 50% of the phase regulation.

Regulation of the neutral value (InN) must conform to the following formula: (I_1 x I_nN) ≤ Iu.
The relay performs the test automatically for four-pole circuit-breakers and transmits a fault signal following failure to conform to this formula. If the circuit-breaker is the three-pole type with external neutral, no tests will be performed by the relay and correction of the settings is at the user's charge.
E.g. With CB E1B800 (Iu=800A), Rating plug 400A (In=400A) and I1=1In, the I_nN setting can be: 50-100-200%.
With CB E1B800 (Iu=800A), Rating plug 800A (In=800A) and I1=1In, the I_nN can be: 50-100%.

The I_1=1I_n setting is the maximum setting of the protection against overload. The real permissible maximum setting must take account of derating due to the temperature, terminals used and the altitude.

WARNING: In some installations, where particularly high harmonics occur, the current circulating on the neutral may be higher than that of the phases.

WARNING: For three-pole circuit-breakers without external neutral, the Neutral protection setting must be Off, otherwise the sensor presence error will be signalled (Error CS).
In these cases, connect T5-T6 to the sliding contacts, as shown in the wiring diagrams.

WARNING: Failure to comply with the setting limits for "I_1" and "I_nN" can cause circuit-breaker damage with consequent risks even for the operator.

WARNING: the protection setting is automatically 100% when the current value exceeds 15.5xIn on the neutral.

12.4.6. Protection against instantaneous short-circuit “Iinst”

The purpose of this protection is to maintain the integrity of the circuit-breaker and installation in the case of particularly high current requiring shorter reaction times than those guaranteed by the instantaneous short-circuit protection.
The protection cannot be disabled. It has a single fixed time protection curve and the threshold level is exclusively at the charge of ABB personnel.

12.4.7. Summary table of protections

Protection	Disabling	Trip threshold		Trip time	Trip threshold tolerance (2)	Trip time tolerance (2)
L ($t=k/I^2$)	☐	**I1** =	0.4 - 0.425 - 0.45 - 0.475 - 0.5 - 0.525 - 0.55 - 0.575 - 0.6 - 0.625 - 0.65 - 0.675 - 0,7 - 0.725 - 0.75 - 0.775 - 0.8 - 0.825 - 0.85 - 0.875 - 0.9 - 0.925 - 0.975 - 1 x In	t1 = 3 - 12 - 24 - 36 - 48 - 72 - 108 - 144 s (1) @I_f=3I1	Release between 1.05 and 1.2 x I1	± 10% $I_f \leq 6$ x In ± 20% $I_f > 6$ x In
S (t=k)	☒	**I2** =	1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	Where $I_f >$ I2 t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s	± 7% $I_f \leq 6$ x In ± 10% $I_f > 6$ x In	The best of the two data: ± 10% o ± 40 ms
S ($t=k/I^2$)	☒	**I2** =	1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s @ 10 In	± 7% $I_f \leq 6$ x In ± 10% $I_f > 6$ x In	± 15% $I_f \leq 6$ x In ± 20% $I_f > 6$ x In
I (t=k)	☒	**I3** =	1,5 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 x In	≤ 30 ms	± 10%	
G (t=k)	☒	**I4** =	0,2 - 0,3 - 0,4 - 0,6 - 0,8 - 0,9 - 1 x In	Where $I_f >$ I4 t4 = 0.1 - 0.2 - 0.4 - 0.8 s	± 7%	The best of the two data: ± 10% o ± 40 ms
G ($t=k/I^2$)	☒	**I4** =	0,2 - 0,3 - 0,4 - 0,6 - 0,8 - 0,9 - 1 x In	Minimum trip time t4 = 0.1 - 0.2 - 0.4 - 0.8 s	± 7%	± 15%

(1)The minimum value of this trip is 1s regardless of the type of curve set (self-protection).

(2)These tolerances apply in the following conditions:
- Self-powered relay (no start-up) with 2 or 3 supplied phases and/or in presence of auxiliary supply. .
- operating temperature within the -25° ...70° range
- primary current values within the operating limits (see par. 12.2.5.1)

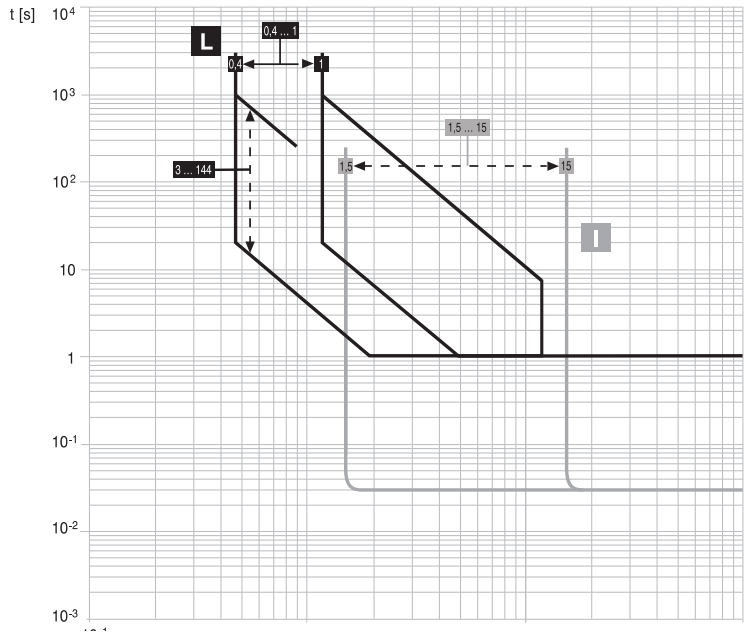
For all cases not covered by the above hypotheses, the following tolerances apply:

Protection	rip threshold	Trip time
L	Release between 1,05 e 1,25 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 10%	± 20%
Others	± 20%	

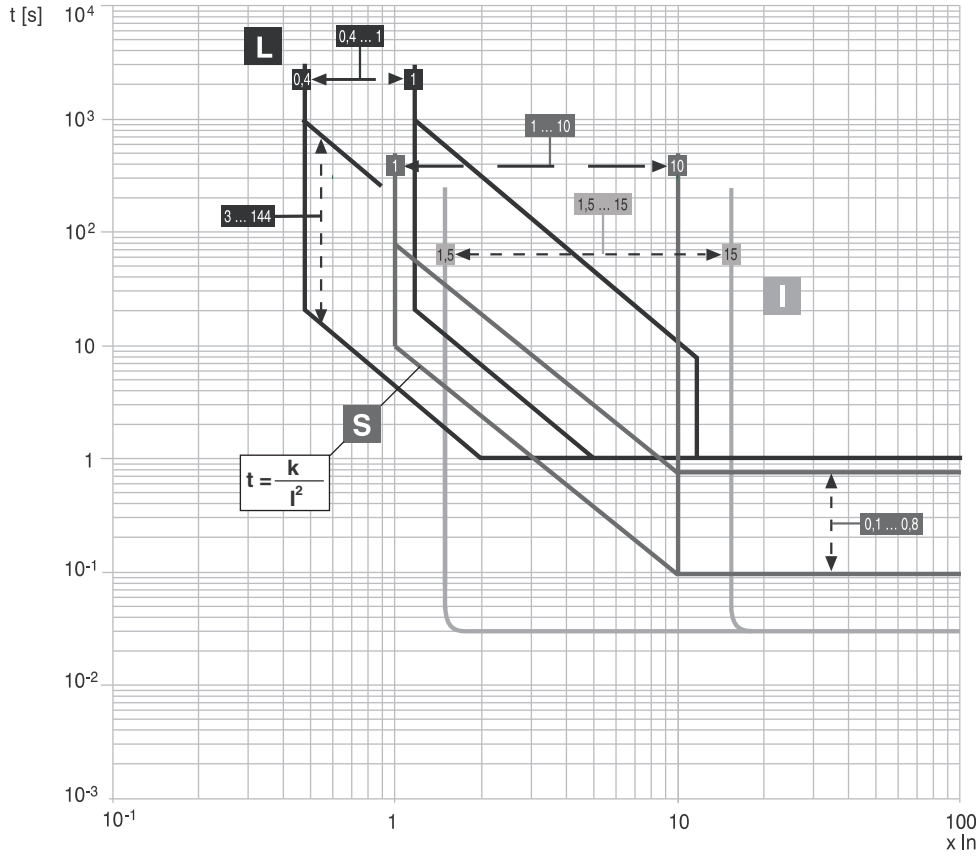
12.4.8. Trip curves

The trip curves provided are merely for guidance and only show a sub-group of the possible selections.

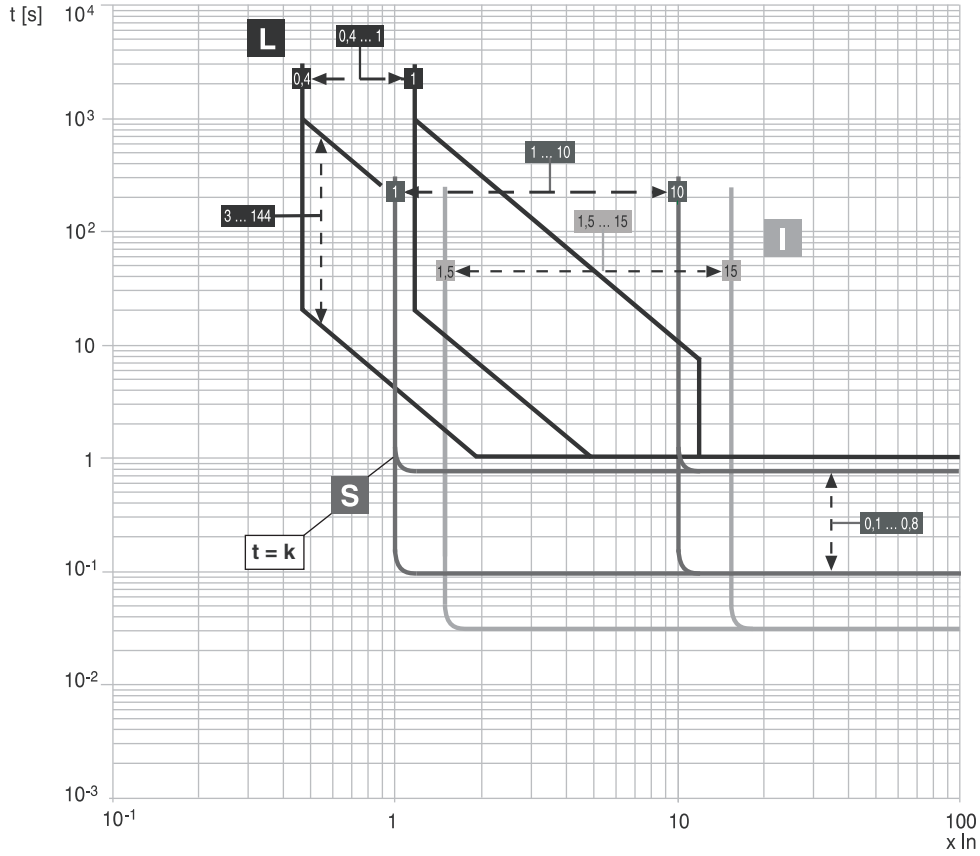
12.4.8.1. Trip curves for functions L-I



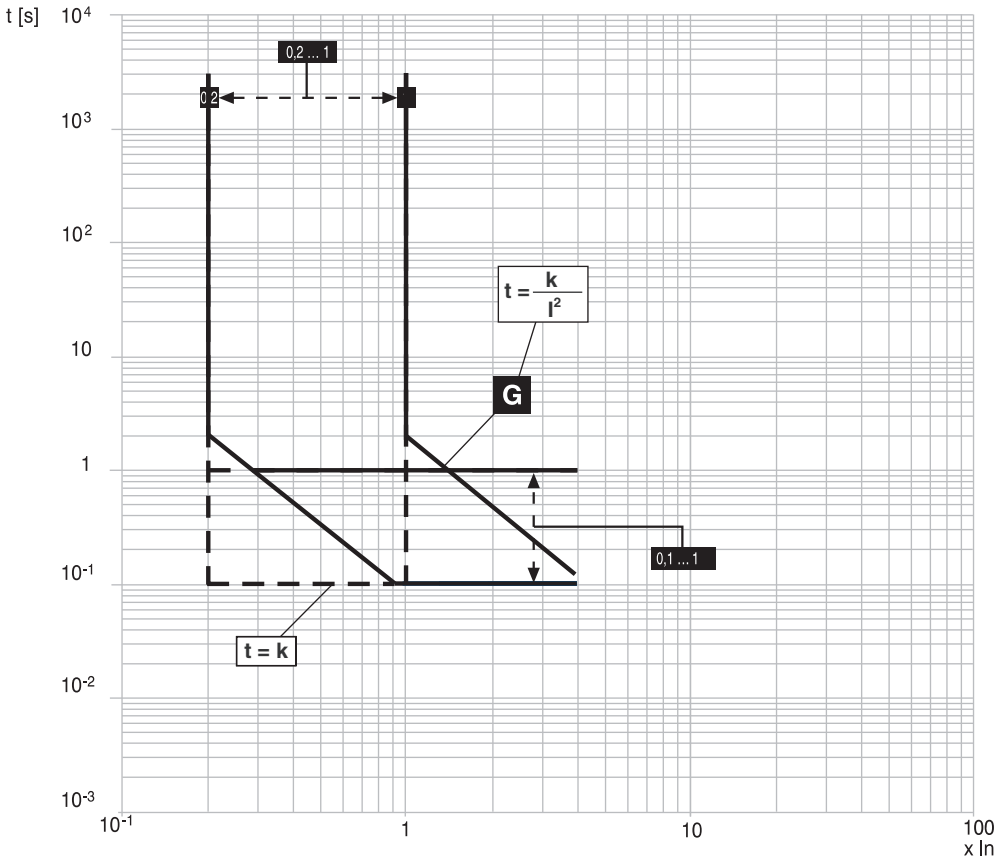
12.4.8.2. Trip curves for functions L-S(t =k/I²)-I



12.4.8.3. Trip curves for functions L-S(t=k)-I



12.4.8.4. Trip curves for function G



12.5. Main functions

12.5.1. Measurement

The current measuring (ammeter) function is available in all versions of the PR121/P unit.
This function is accessible by means of test unit BT030-USB, Ekip T&P (connected to a PC) and PR010/T, or by means of HMI030.
The measurement tolerance margins are:

Type of measurement	Range of values measured by the relay	Standard operation range	
		Range	Tolerance %
Phase and neutral current	0,05 ... 16 In	0,3 ... 6 In	± 1,5
Earth fault current	0,05 ... 4 In	0,3 ... 4 In	± 1,5

The relay allows the maximum current reading to be periodically recorded: this function must be enabled with test unit BT030-USB or Ekip T&P, and requires auxiliary voltage.

12.5.2. Self-monitoring

The PR121/P unit provides certain self-monitoring functions that allow faults or setting errors to be identified more easily. Faults are signalled by a combination of led lights.

The functions are as follows:

- ❑ Rating Plug validity.
- ❑ Checks to find out whether the current sensors (CS) are connected correctly.
- ❑ Watchdog for proper connection of the Trip Coil (TC).
- ❑ Hw Trip protection. If activated, a CB opening command is transmitted through activation of the TC if sensors are disconnected or if the Rating Plug is not connected/faulty. This function can be activated by means of test unit PR010/T, BT030-USB or Ekip T&P.

12.6. Putting into service and recommendations

12.6.1. nstallation

Circuit-breakers purchased with the relay unit assembled do not require this operation which is, however, necessary in the case of replacement.
Comply with the following instructions to install a PR121/P:

1. With the circuit-breaker open and possibly isolated, install the protection unit on the circuit-breaker by connecting all the cables as shown in the assembly documents.
2. Power the unit with PR030/B only.
3. If there are no other errors apart from the configuration one, press the “i Test” button for a few seconds until all the red leds flash to confirm that installation has taken place.
4. Remove the PR030/B.
5. Power the relay from any other source (Vaux, PR030/B, PR010/T).
6. Make sure that there are no configuration errors (check that the LEDs are on in the Alive LED ON configuration).
7. The circuit-breaker and relay can now be put into service.

WARNING: Consult ABB about the relay replacement and installation operations if the CB is the LTT version.

12.6.2. Connections

WARNING: Strict compliance with the instructions given in this document is required for the connections at the user’s charge.
This will ensure compliance with all the international reference standards and will ensure that the relay functions correctly even in heavy duty environmental and electromagnetic conditions. Pay particular attention to the earth connection.

12.6.3. CS and TC connection check

WARNING: If the PR121/P has been installed by the user, remember to check (with the CB open and Vaux or PR030/B), prior to putting the circuit-breaker into service, to make sure that the CS and TC cables have been connected correctly. Make the correct connections if this is not the case. If all the red leds come on, it means that there is an error in the CS and/or TC connections

12.6.4. Connection of current sensor for external neutral

WARNING: Remember to set the InN in the appropriate way if the current sensor for the external neutral conductor must be connected to a three-pole circuit-breaker.
During this phase, the circuit-breaker must be open and, if possible, isolated.

12.7. Parameter and default settings

Before the PR121/P is put into service, it is essential for the user to define and carefully adjust the editable parameters to suit his installation requirements.
ABB SACE will apply the adhesive rating plates of all the variables concerning the CB (e.g. Type of CB, Rating Plug size, etc.) so as to provide the user with all the information he needs to define the parameters.

IThe PR121/P is supplied by ABB SACE with the following preset parameters:

#	Protection	Threshold	Time
1	L	1 In	144 s
2	S	Off	0,1 s
3	I	4 In	--
4	G	Off	0,1 s
5	Mains frequency	50 Hz	
6	Neutral sel	*	

Note:
* = Off for 3-pole versions
* = 50% for 4-pole versions
* = 100% for full-size versions

12.8.1. Troubleshooting

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

N.B.:
1. Before consulting the following table, check for a few seconds for any optical signals provided by the LEDs.
2. FN indicates the normal operation of the PR121/P.
3. If the following suggestions fail to solve the problem, please contact the ABB SACE customer support service.
4. If possible, use the external communication units and supply a report downloaded by means of Ekip Connect.

N°	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is è > 0 2. The TC is not connected 3. PR030/B is not connected	1. Normal operation (FN) 2. Check TC connection (see par. 12.6.3) 3. Connect the PR030/B unit
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Incorrect neutral selection	1. Correct threshold 2. Correct curve 3. Correct neutral adjustment
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve type "t=k/I^2" 4. Incorrect neutral selection	1. Correct threshold 2. Correct curve 3. Select curve type "t=k" 4. Correct neutral adjustment
4	Rapid trip, with I3=Off	Iinst tripped	FN short-circuit with high I
5	Earth fault current beyond threshold	G function automatically inhibited but no trip occurs	FN
6	Expected trip does not happen	Function OFF	FN enable protection function
7	LEDs irregularly turned on		see par. 12.3.2
8	Unexpected trip		see par. 12.3.2
9	L LED (orange) flashing		FN

12.8.2. In the case of a fault

WARNING: If the PR121/P is suspected of being faulty, if there are signs of malfunctions or it has generated an unexpected trip, we advise you to strictly follow the recommendations below:

1. Press the “i Test” button (within 48 hours of CB opening or within 24 hours if the operating temperature is in the -40°..-25° range) and make a note of the led that comes on, the type of CB, the number of poles, any accessories connected, In, Serial Number. After 48 or 24 hours, depending on the case, the data are not cancelled. Just the LED display is inhibited.
2. Prepare a brief description of the opening (what LEDs were displayed?, when did it happen?, how many times?, was it always under the same conditions? what type of load? what current? is the event reproducible?).
3. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

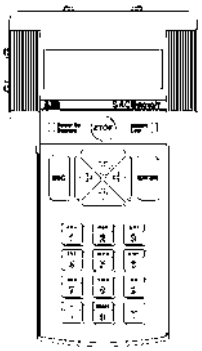
The more the information given to the ABB Customer Support service is complete and accurate, the easier the technical analysis on the problem encountered will be, enabling us to take all action to help the user without delay.

WARNING: Letting a switch run with a fault that has not been remedied may lead to an apparatus malfunction or shutdown. Remove the apparatus immediately until it can be inspected or repaired if this situation may lead to personal injury, damage or is otherwise critical.

12.9. External units

12.9.1. PR030/B

PR030/B is an external unit that allows the relay to be powered in order to perform installation, Autotest and Trip Test, and the verifications with the CB open. The unit is connected to the relay by means of the front connector.



12.9.2. PR010/T

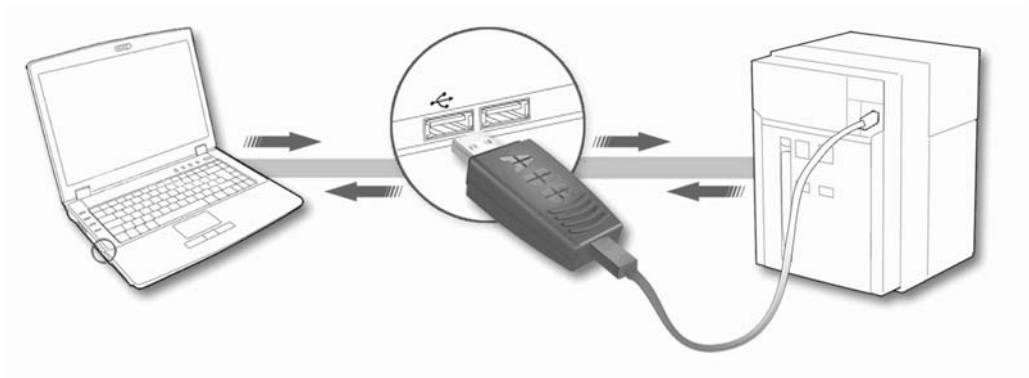
The SACE PR010/T unit allows the parameters and log data recorded by the relay to be checked.
It also allows threshold operation to be checked as well as the tripping times of the L-S-I-G protection functions.
The unit is supplied in a case containing the connection cables, external power supplier and rechargeable batteries, cable and SW for PC.
The SW in the PC allows several files corresponding to the devices with which it is possible to interface, to be loaded into PR010/T. It also allows test reports to be downloaded. Thus the corresponding file must be loaded into the PR010/T unit before it can be used with relay PR121.
The unit is connected to the relay by means of the front connector using a dedicated cable.
Consult the Operation Manual of the unit (RH0025) for further details.

12.9.3. BT030-USB

Using the BT030-USB unit, PR121/P can communicate with a PC via wireless link or USB flash drive, thereby extending the range of information available to the user.
Communication is enabled via Ekip Connect SW, the installation package of which is in the BT030-USB set.
This set also includes the USB cable and batteries for use in the wireless configuration.
The unit is connected to the relay by means of the front connector.

12.9.4. EKIP T&P

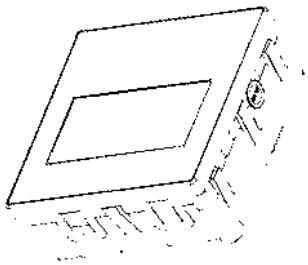
The Ekip T&P unit allows relay powering, communication and testing via a PC by means of a USB adapter.
Similarly to BT030-USB, communication is enabled via Ekip Connect SW, the installation package of which is in the Ekip T&P set. The set includes the USB module and a series of adapters for various types of relay.



WARNING: Ekip T&P must be used for PR121/P with USB module and a dedicated cable for PR121/P (the picture below is for explanatory purposes only). Consult the Ekip Connect SW Operation Manual (1SDH000891R0001) for further details.

12.9.5. HMI030

PR121/P can also be connected to the HMI030 switchgear front external unit so as to display the current values measured.
HMI030 connects to the connector on the rear side, on the relay, whose external connection is provided by the contacts on the terminal box in the CB.

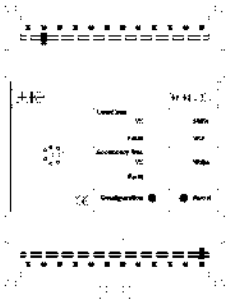


Auxiliary power supply for the relay and HMI030 is not required for this function.

HMI030 power supply	
Auxiliary power supply	24 V DC +/-20%
Maximum ripple	5%
Rated power @ 24 V	1,2W

Consult the Operation Manual of the unit (1SDH000573R0001) for further details.

12.9.6. Flex interface



Flex interfaces are electronic units that can be installed on DIN rail, with analog and/or digital inputs and outputs that can be connected to the PR121/P relay via Local Bus.

The Flex Interface family for PR121/P relays consists of the MM030 module (connected on one side to the Local Bus of the relay and on the other to all the modules used) and AD series modules. If connected to MM030, the HMI030 module is also part of the Flex Interface family.
All the configurations and connection solutions are described in the dedicated operation manuals (as shown in the attached table).

Auxiliary power supply for the relay and Flex Interface is required for this function.

Device	Characteristics	Description	Notes	Reference documentation
MM030		Controls exchanges of information between the relay and accessories of the Flex Interface family		1SDH000622R0001
AD030 DO	8 digital outputs	Receives information from MM03 and operates its digital outputs as a consequence		1SDH000672R0001
AD030 AO	4 analog outputs	Receives information from MM03 and operates its analog outputs as a consequence		1SDH000672R0001
AD030 MI	mixed inputs: 2 analog and 2 digital	Repeats the digital inputs following a request from the MM03		1SDH000672R0001
HMI030	Display	Displays the data received from the relay or MM030	note 1: after being configured in the appropriate way, it can be connected to the relay or straight to the MM030	1SDH000573R0001
			note 2: the HMI030 can be connected to MM030 from MM030 software releases 2.0 onwards	

12.9.6.1. Notes about the HMI030 and Flex Interface connection

Relay connection for HMI030 or Flex Interface units must be made with a shielded stranded two-wire cable (BELDEN 3105A for example) up to 15 m in length. The shield must be earthed on both the circuit-breaker and unit sides.

12.9.7. Ekip Connect

Ekip Connect is a software application for personal computers equipped with the Microsoft Windows® operating system, which allows data to be exchanged with one or more ABB low voltage devices.

Ekip Connect can be connected to ABB low voltage circuit-breakers equipped with electronic protection relays for the purpose of:
- Putting the CB into service.
- Monitoring the state of all the available signals.
- Reading information (alarms, measurements, parameters).
- Modifying the configuration parameters, especially for protection relays without displays.
- Executing commands.
- Troubleshooting for the relay and communication network.
- Performing tests.

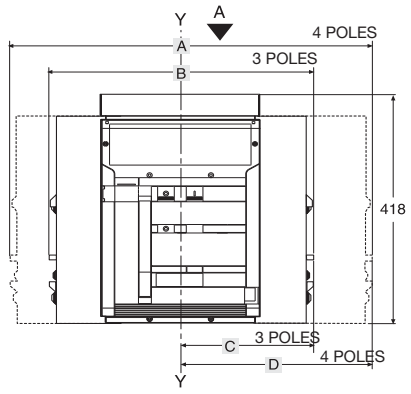
Operating tests in switchboards are facilitated since the parameters and test reports can be saved.

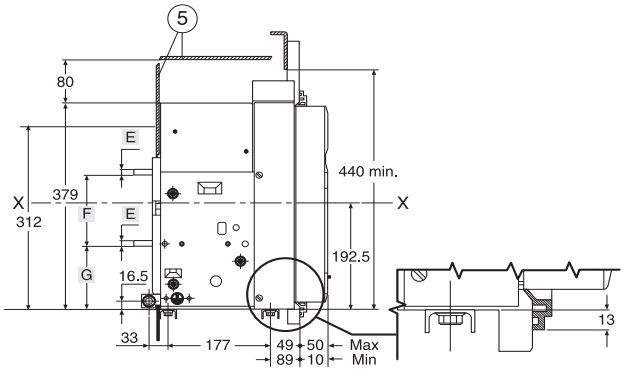
Ekip Connect is free of charge and is either supplied on an installation CD or can be obtained from the Internet address http://bol.it.abb.com in the section “Work Tools - Software for moulded case and air circuit-breakers”.

13. Overall dimensions

Fixed circuit-breaker

Basic version with horizontal rear terminals





Legend

① Inside edge of compartment door

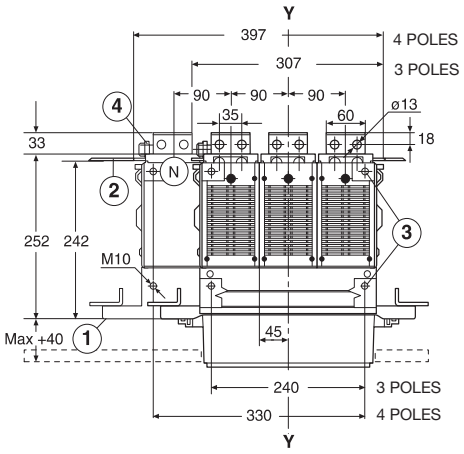
② Segregation (where foreseen)

③ Circuit-breaker M10 fixing drilling (use M10 screws)

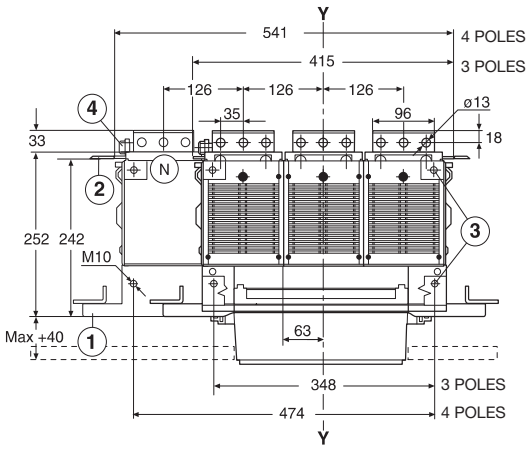
④ N° 1 M12 screw (E1, E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)

⑤ Insulating or metal-insulated wall

E1/E2
View A



E3
View A

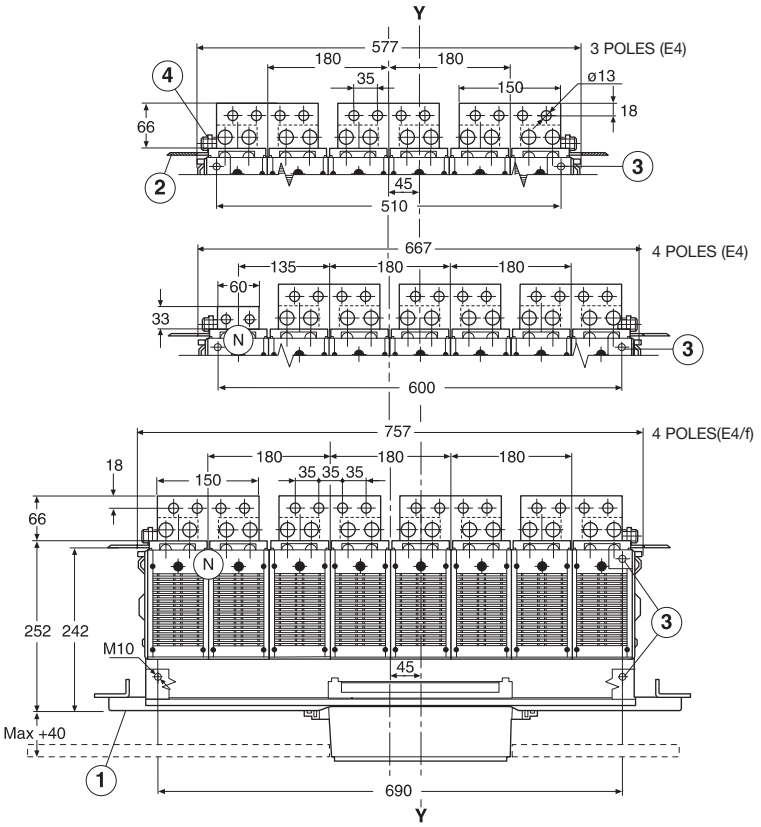


	A	B	C	D	E	F	G
E1	386	296	148	148	10	130	117,5
E2	386	296	148	148	26	114	117,5
E3	530	404	202	202	26	114	117,5
E4	656	566	238	328	26	166	91,5
E4/f	746	-	-	328	26	166	91,5
E6	908	782	328	454	26	166	91,5
E6/f	1034	-	-	454	26	166	91,5

Fixed circuit-breaker

Basic version with horizontal rear terminals

E4
View A



E6
View A

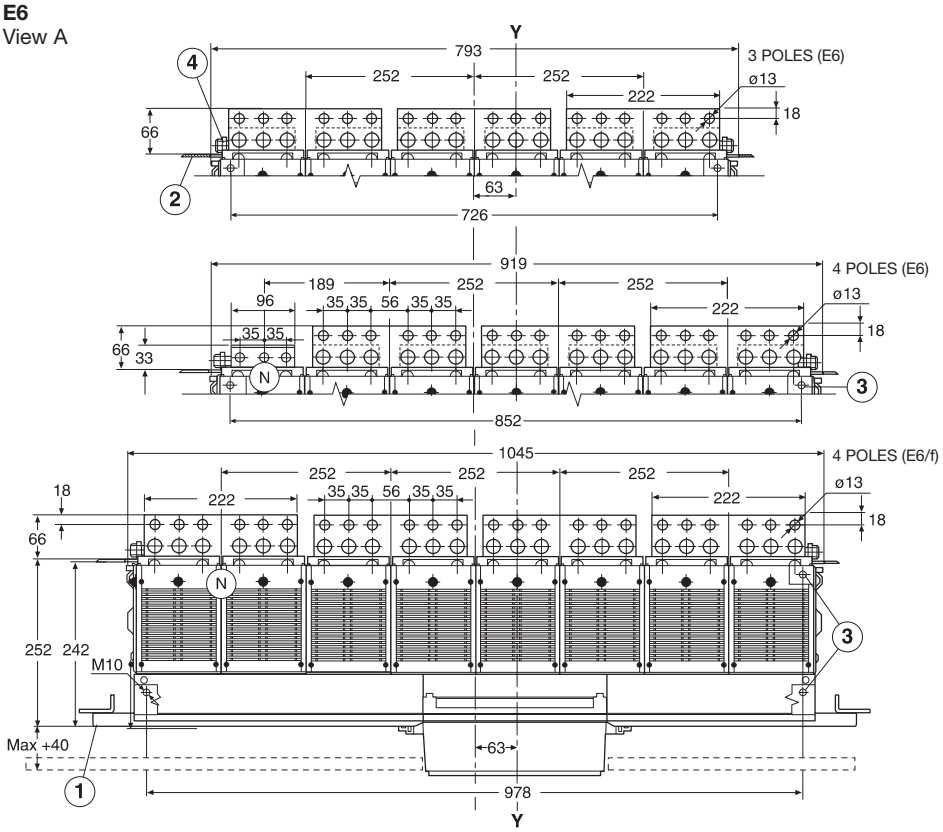
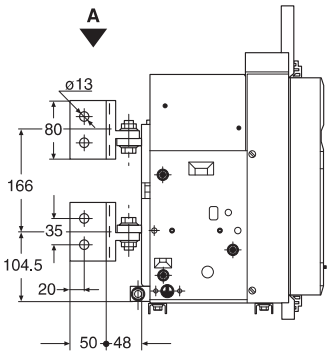


Fig. 36

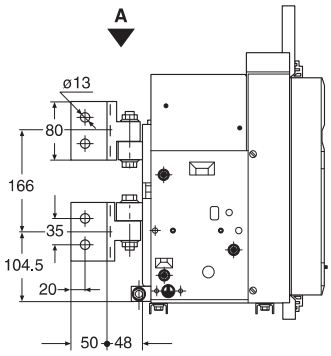
Fixed circuit-breaker

Basic version with vertical rear terminals

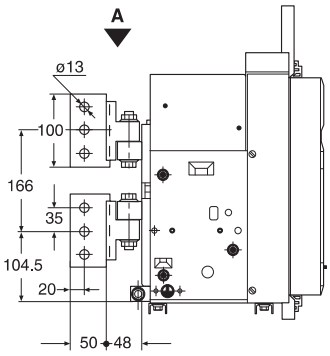
E1



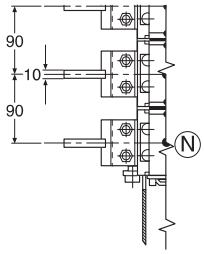
E2/E4



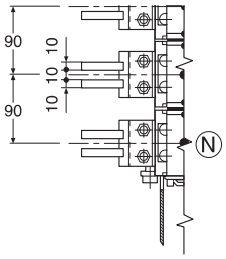
E3/E6



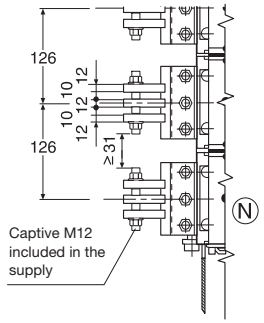
E1
View A



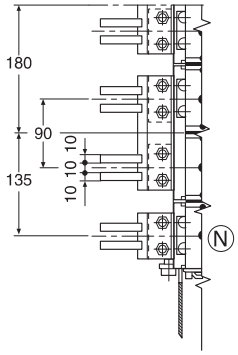
E2
View A



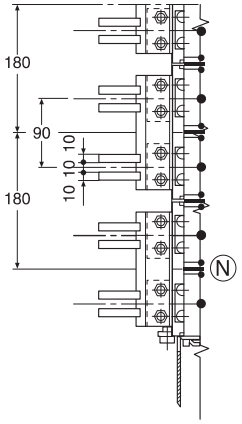
E3
View A



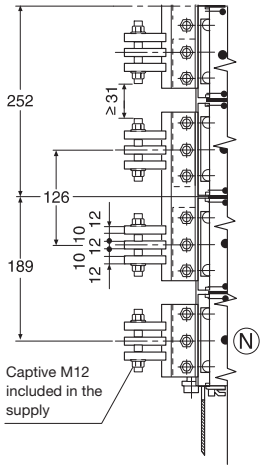
E4
View A



E4/f
View A



E6
View A



E6/f
View A

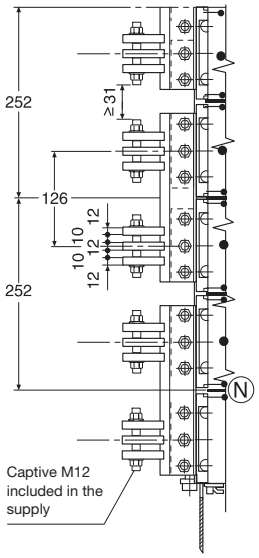
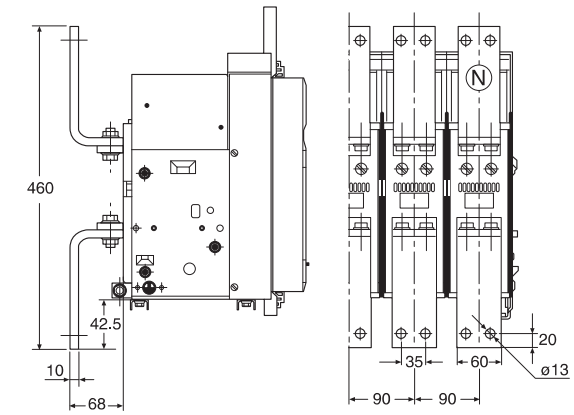


Fig. 36a

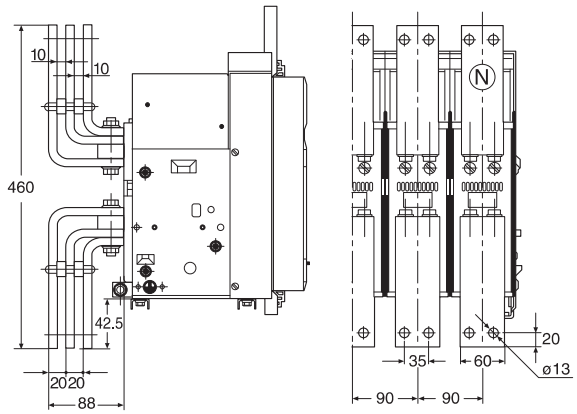
Fixed circuit-breaker

Basic version with front terminals

E1



E2



E3

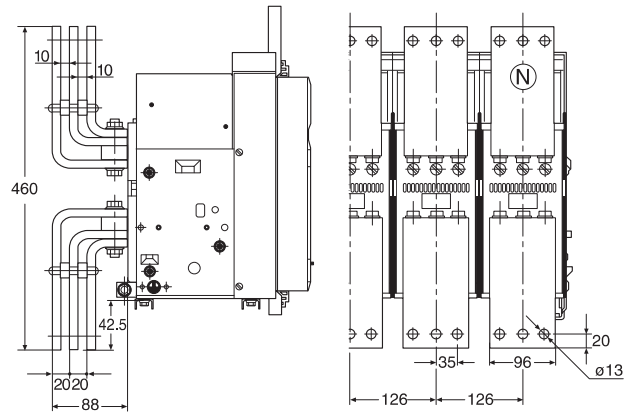
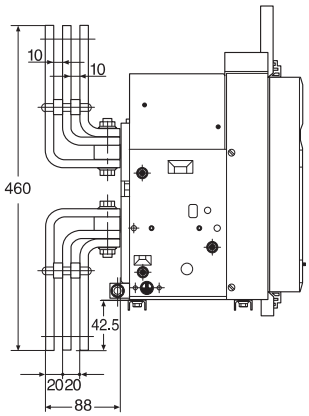


Fig. 37

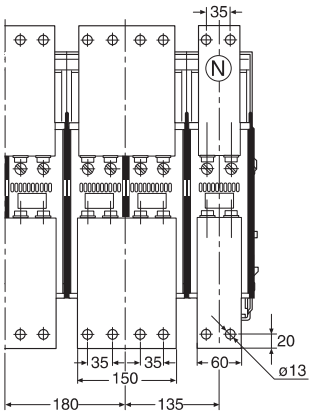
Fixed circuit-breaker

Basic version with front terminals

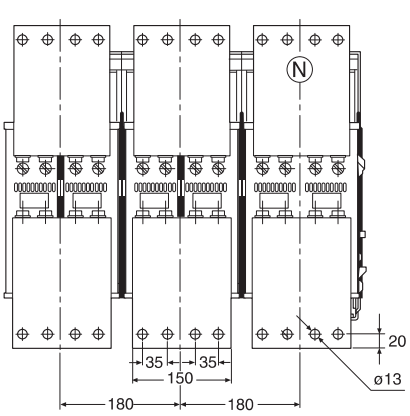
E4



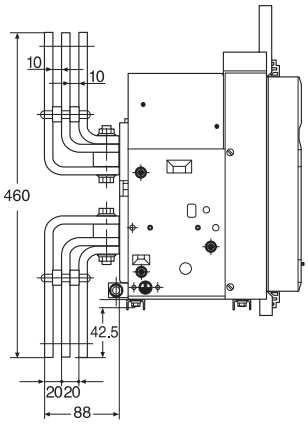
E4



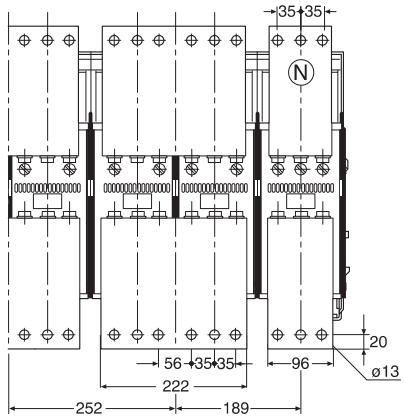
E4/f



E6



E6



E6/f

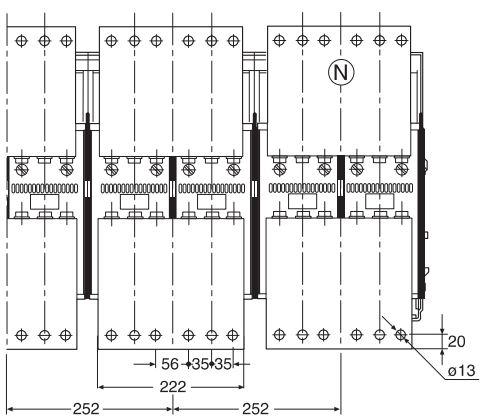
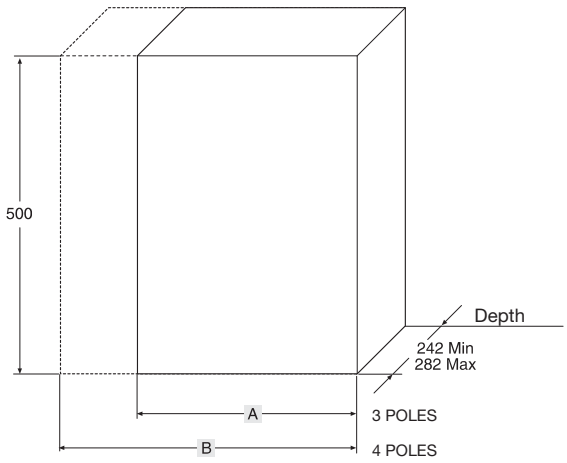


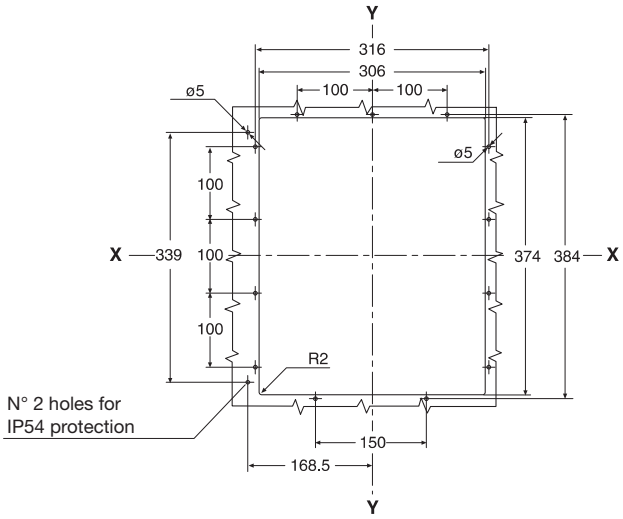
Fig. 38

Model	L6555			Apparatus	**Emax**	Scale
				Doc. No	**1SDH000460R0002**	Page No **53/74**

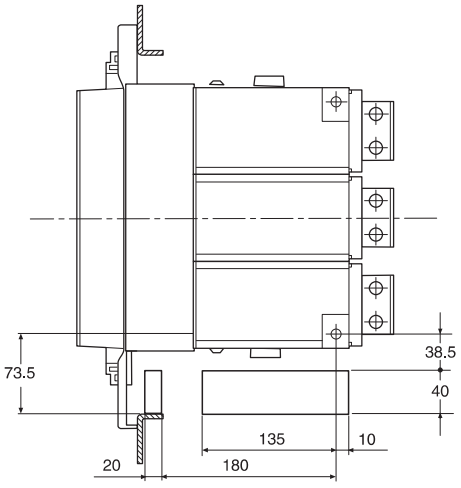
Compartment dimensions



Compartment door drilling



Holes for passing through flexible cables for mechanical interlocks



Tightening torque of the main terminals: Nm 70
Tightening torque of the earthing screw: Nm 70

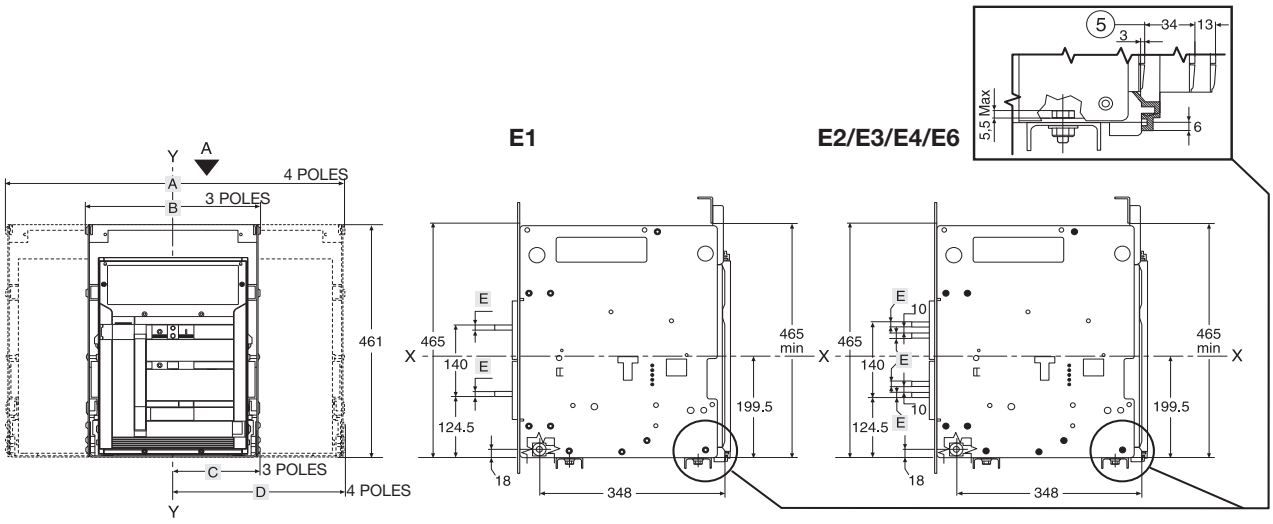
	High resistance M12 screw Quantity per terminal	
	PHASE	NEUTRAL
E1-E2	2	2
E3	3	3
E4-E4/f	4	2-4
E6-E6/f	6	3-6

	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

Fig. 39

Withdrawable circuit-breaker

Basic version with horizontal rear terminals



Legend

① Inside edge of compartment door

② Segregation (where foreseen)

③ Fixing fixed part Ø 10 drilling (use M8 screws)

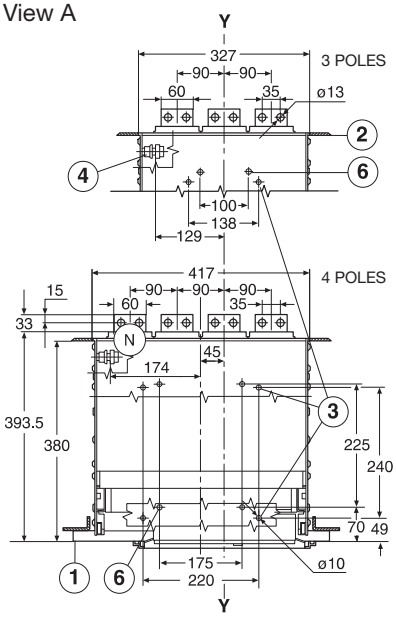
④ N° 1 M12 screw (E1, E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)

⑤ Run from connected for a TEST to isolated

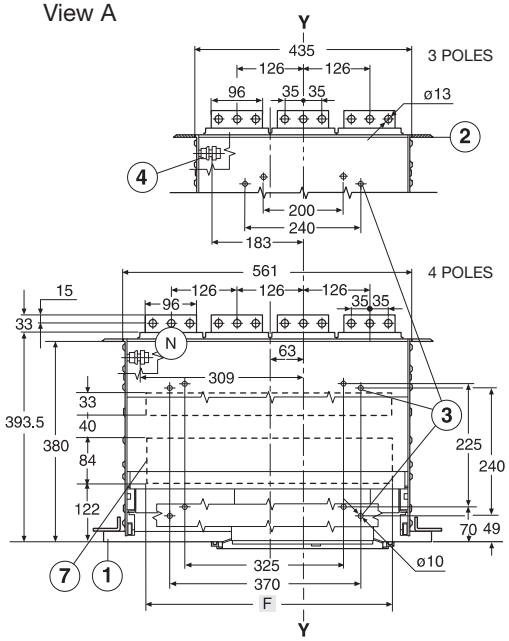
⑥ Alternative drilling with 25mm pitch for fixing fixed part

⑦ Ventilation drilling on the switchgear

E1/E2
View A



E3
View A



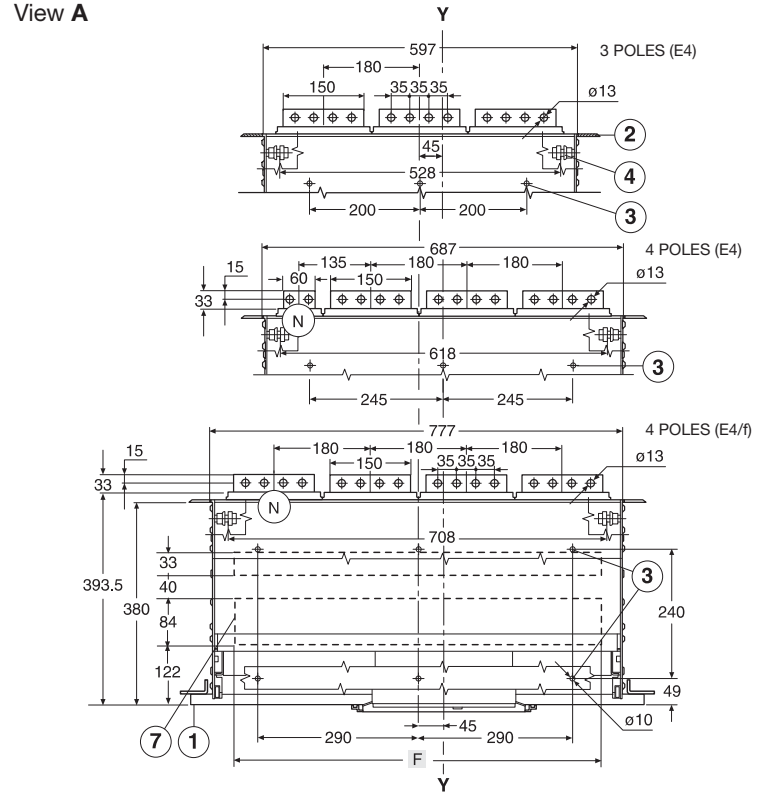
	A	B	C	D	E	F 3 poles	F 4 poles
E1	414	324	162	162	10	–	–
E2	414	324	162	162	8	–	–
E3	558	432	216	216	8	370	490
E4	684	594	252	342	8	530	610
E4/f	774	-	-	342	8	–	700
E6	936	810	342	468	8	750	870
E6/f	1062	-	-	468	8	-	1000

Fig. 40

Withdrawable circuit-breaker

Basic version with horizontal rear terminals

E4
View **A**



E6
View **A**

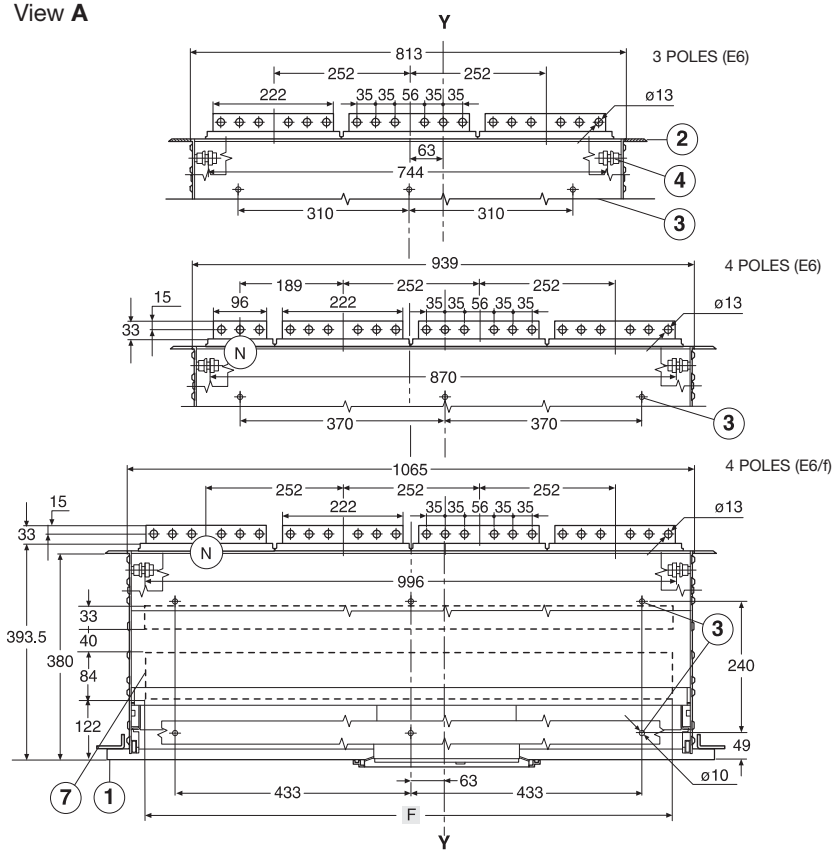
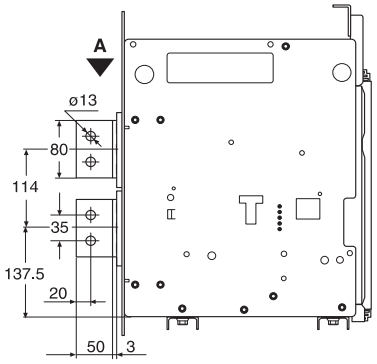


Fig. 41

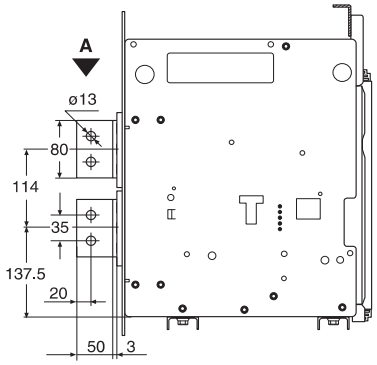
Withdrawable circuit-breaker

Basic version with vertical rear terminals

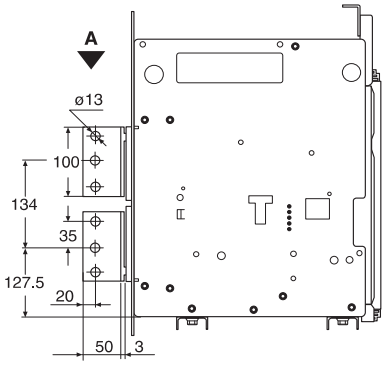
E1



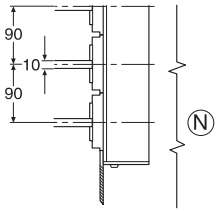
E2/E4



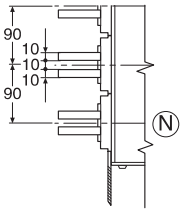
E3/E6



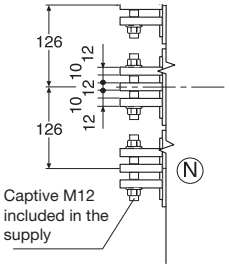
E1
View A



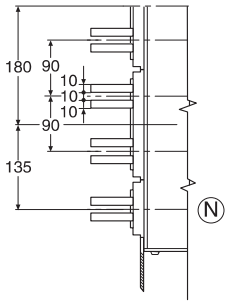
E2
View A



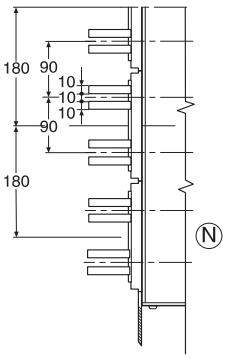
E3
View A



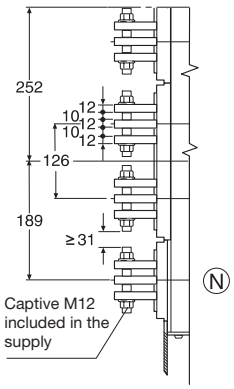
E4
View A



E4/f
View A



E6
View A



E6/f
View A

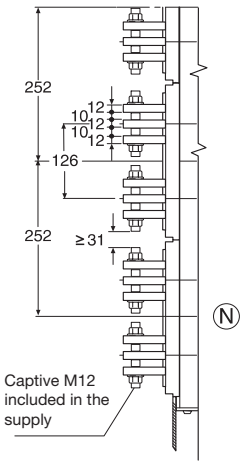
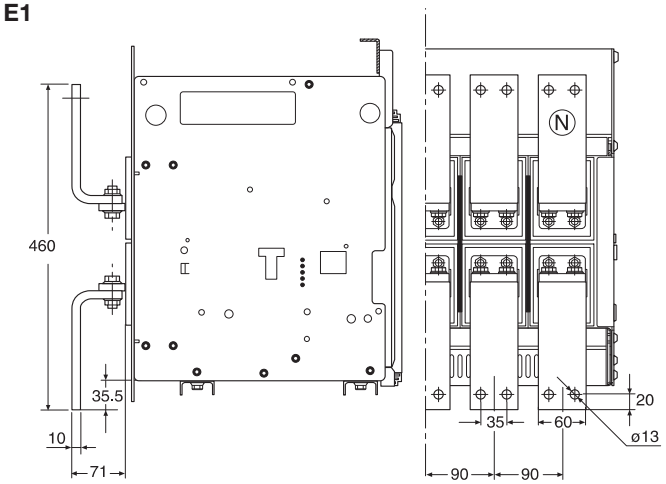


Fig. 42

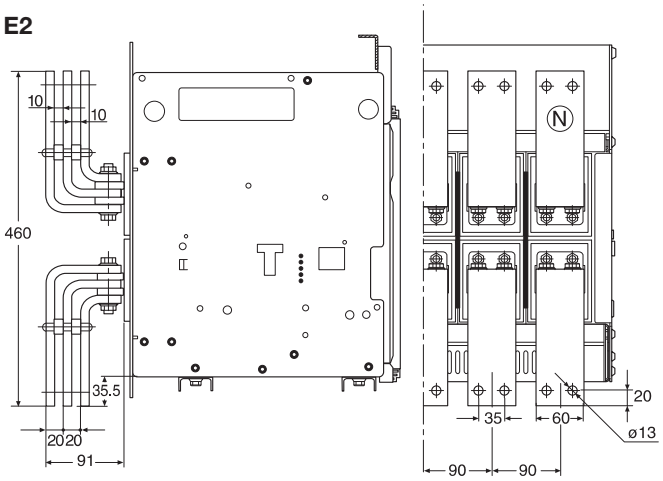
Withdrawable circuit-breaker

Version with front terminals

E1



E2



E3

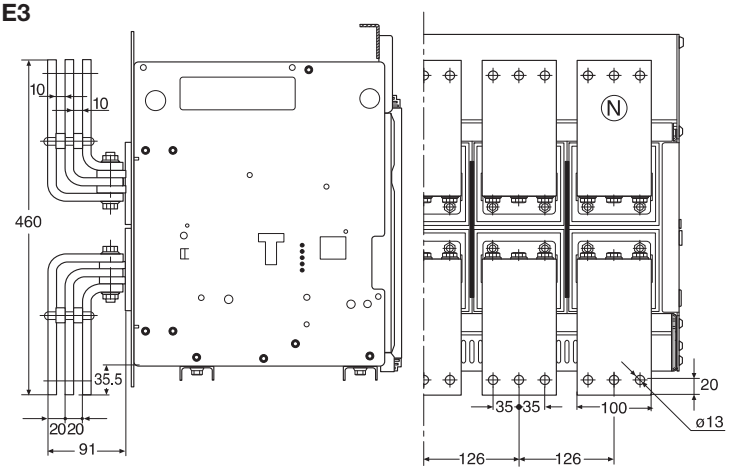
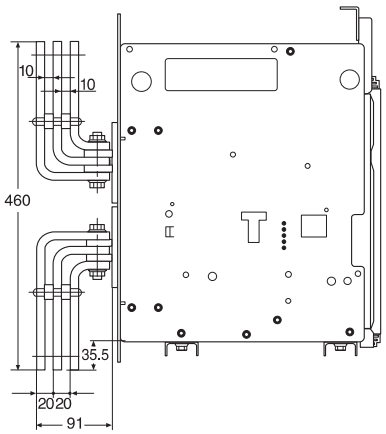


Fig. 43

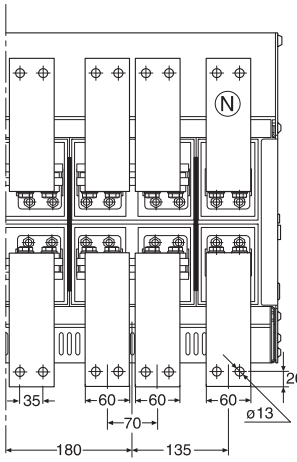
Withdrawable circuit-breaker

Version with front terminals

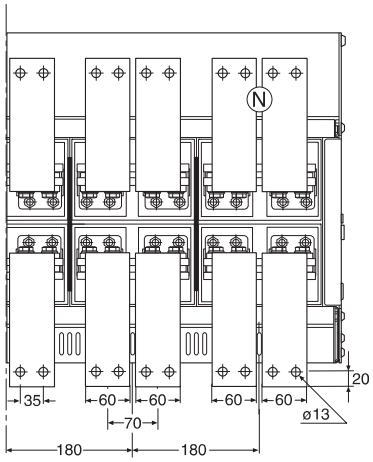
E4



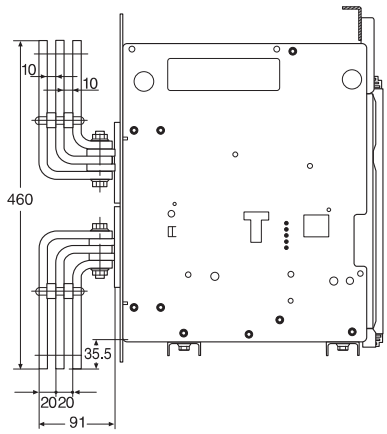
E4



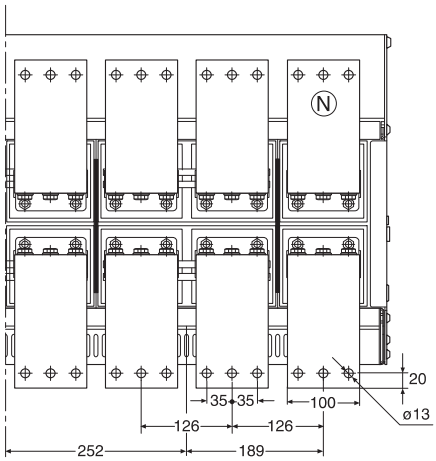
E4/f



E6



E6



E6/f

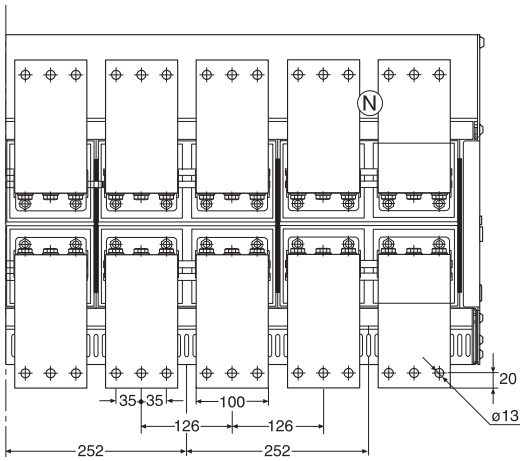


Fig. 44

Model	L6555			Apparatus	**Emax**	Scale
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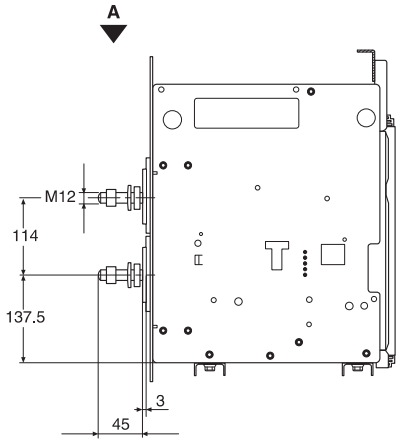
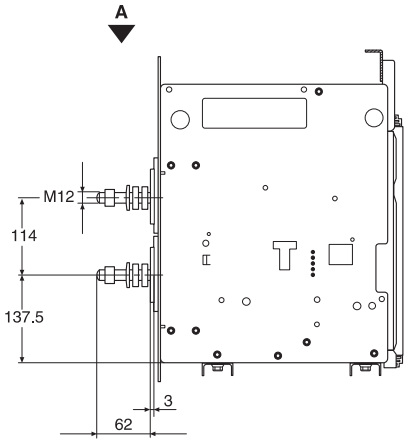
Withdrawable circuit-breaker

Version with flat terminals

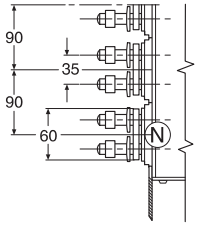
E1



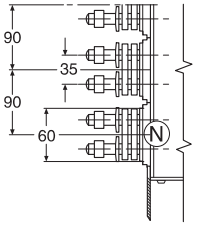
E2



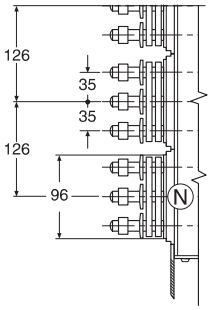
E1
View A



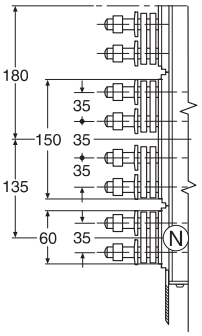
E2
View A



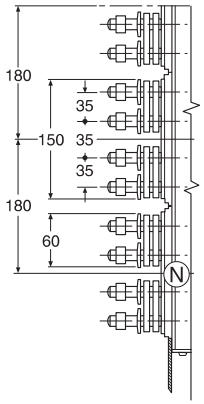
E3
View A



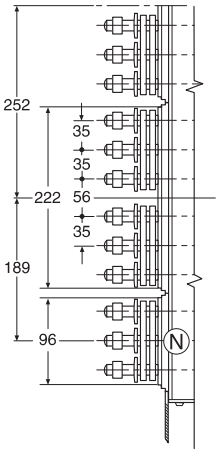
E4
View A



E4/f
View A



E6
View A



E6/f
View A

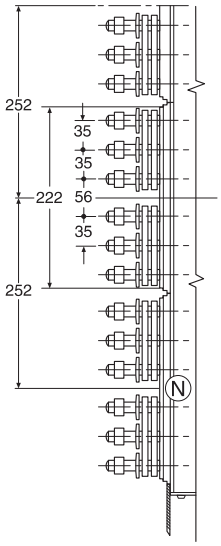
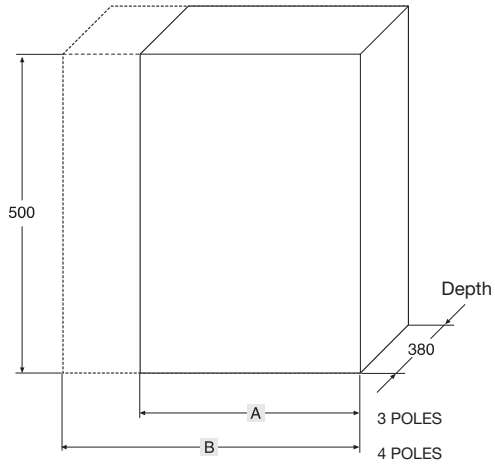
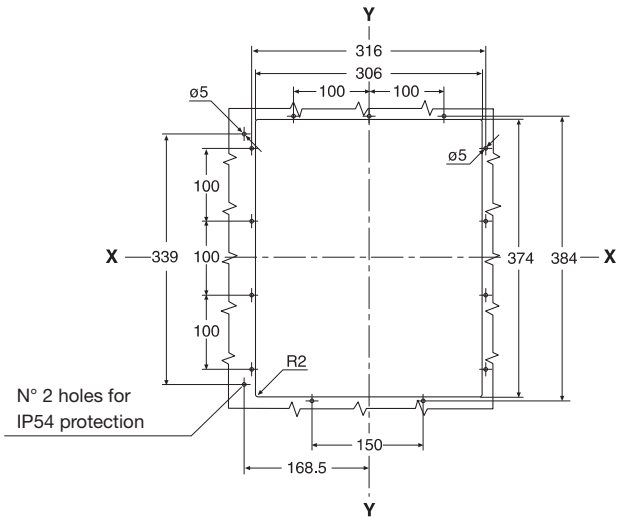


Fig. 45

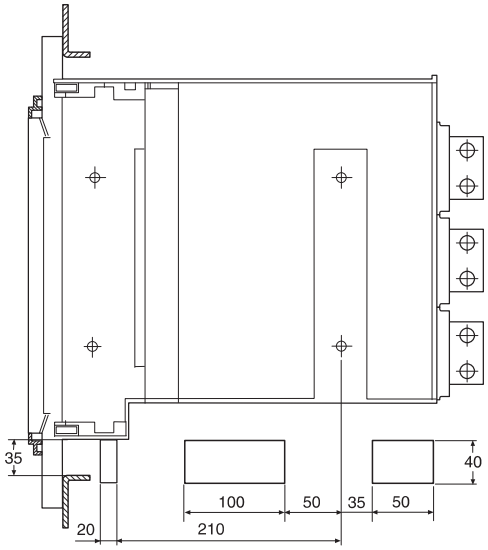
Compartment dimensions



Compartment door drilling



Holes for passing through flexible cables for mechanical interlocks



	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

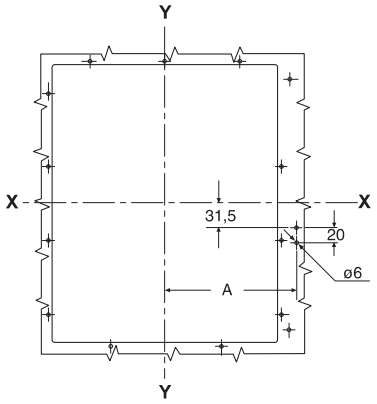
Tightening torque of the fixing screws: 20 Nm
Tightening torque of the main terminals: 70 Nm
Tightening torque of the earthing screw: 70 Nm

	High resistance M12 screw Quanty per terminal	
	PHASE	NEUTRAL
E1-E2	2	2
E3	3	3
E4-E4/f	4	2-4
E6-E6/f	6	3-6

Fig. 46

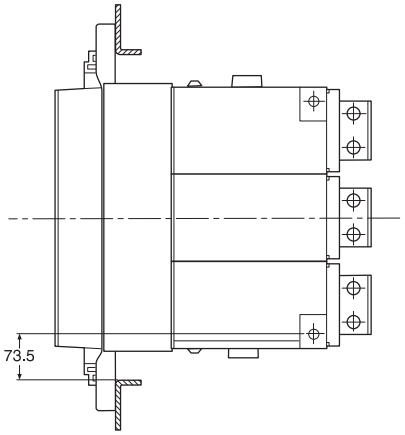
Compartment door mechanical lock

Door drilling

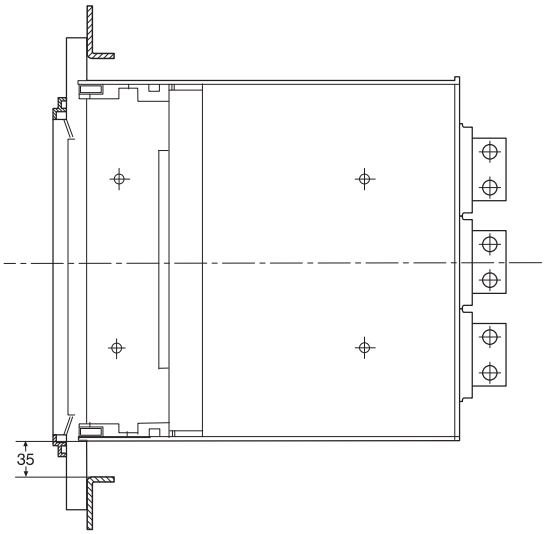


Minimum distance between the circuit-breaker and the switchgear wall

Fixed version



Withdrawable version



	A	
	3 POLES	4 POLES
E1	180	180
E2	180	180
E3	234	234
E4	270	360
E4/f	-	360
E6	360	486
E6/f	-	486

Fig. 47

14. Circuit diagrams

WARNING:
Before installing the circuit-breaker, carefully read notes F and O on the circuit diagrams.

Operating status shown

The circuit diagram is for the following conditions:
- withdrawable circuit-breaker, open and racked-in
- circuits de-energised
- releases not tripped
- motor operating mechanism with springs unloaded.

Versions

The diagram shows a circuit-breaker in withdrawable version; it can be applied to a fixed version circuit-breaker as well.

Fixed version
The control circuits are fitted between terminals XV (connector X is not supplied).
With this version, the applications indicated in figures 31 and 32 cannot be provided.

Withdrawable version
The control circuits are fitted between the poles of connector X (terminal box XV is not supplied).

Version without overcurrent release
With this version, the applications indicated in figures 13, 14, 41, 42, 43, 44, 45, 46, 47, 48, 62 cannot be provided.

Version with PR121/P electronic release
With this version, the applications indicated in figures 42, 43, 44, 45, 46, 47, 48 cannot be provided.

Version with PR122/P electronic release
With this version, the applications indicated in figure 41 cannot be provided.

Version with PR123/P electronic release
With this version, the applications indicated in figure 41 cannot be provided.

Caption

☐ = Circuit diagram figure number
* = See note indicated by the letter
A1 = Circuit-breaker accessories
A3 = Accessories applied to the fixed part of the circuit-breaker (for withdrawable version only)
A4 = Example switchgear and connections for control and signalling, outside the circuit-breaker
A13 = PR021/K signalling unit (outside the circuit-breaker)
AY = SACE SOR TEST UNIT Test/monitoring Unit (see note R)
D = Electronic time-delay device of the undervoltage release, outside the circuit-breaker
F1 = Delayed-trip fuse
K51 = PR121/P, PR122/P, PR123/P electronic release with the following protection functions:
- L overload protection with inverse long time-delay trip-setting I1
- S short-circuit protection with inverse or definite short time-delay trip-setting I2
- I short-circuit protection with instantaneous time-delay trip-setting I3
- G earth fault protection with inverse short time-delay trip-setting I4

K51/1...8 = Contacts for the PR021/K signalling unit
K51/GZin(DBin)= Zone selectivity: for protection G (only with Vaux and PR122/P or PR123/P release) or “reverse” direction input for protection D (only with Vaux and PR123/P release)
K51/GZout(DBout) = Zone selectivity: for protection G (only with Vaux and PR122/P or PR123/P release) or “reverse” direction output for protection D (only with Vaux and PR123/P release)
K51/IN1 = Digital programmable input (available only with Vaux and release PR122/P or PR123/P with indicator module PR120/K)
K51/P1...P4 = Programmable electrical signalling (available only with Vaux and release PR122/P or PR123/P with indicator module PR120/K)
K51/SZin(Dfin) = Zone selectivity: input for protection S or “direct” input for protection D (only with Vaux and PR122/P or PR123/P release)
K51/SZout(DFout) = Zone selectivity: output for protection S or “direct” output for protection D (only with Vaux and PR122/P or PR123/P release)
K51/YC = Closing control from PR122/P or PR123/P electronic release with communication module PR120/D-M
K51/YO = Opening control from PR122/P or PR123/P electronic release with communication module PR120/D-M
M = Motor for loading the closing springs
Q = Circuit-breaker
Q/1...27 = Circuit-breaker auxiliary contacts
S33M/1...3 = Limit contacts for spring-loading motor
S43 = Switch for setting remote/local control
S51 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed only after pressing the reset pushbutton, or after energizing the coil for electrical reset (if available)

S75E/1.4 = Contacts for electrical signalling of circuit-breaker in disconnected position (only with withdrawable circuit-breakers)
S75I/1..5 = Contacts for electrical signalling of circuit-breaker in connected position (only with withdrawable circuit-breakers)
S75T/1..4 = Contacts for electrical signalling of circuit-breaker in test isolated position (only with withdrawable circuit-breakers)
SC = Pushbutton or contact for closing the circuit-breaker
SO = Pushbutton or contact for opening the circuit-breaker
SO1 = Pushbutton or contact for opening the circuit-breaker with delayed trip
SO2 = Pushbutton or contact for opening the circuit-breaker with instantaneous trip
SR = Pushbutton or contact for electrical circuit-breaker reset
TI/L1 = Current transformer located on phase L1
TI/L2 = Current transformer located on phase L2
TI/L3 = Current transformer located on phase L3
TO = Homopolar toroidal current transformer (see note W)
Vaux = Auxiliary power supply voltage (see note F)
UI/L1 = Current sensor (Rogowski coil) located on phase L1
UI/L2 = Current sensor (Rogowski coil) located on phase L2
UI/L3 = Current sensor (Rogowski coil) located on phase L3
UI/N = Current sensor (Rogowski coil) located on neutral
UI/0 = Current sensor (Rogowski coil) located on the conductor connecting to earth the star point of the MV/LV transformer (see note G)
W1 = Serial interface with control system (external bus): EIA RS485 interface (see note E)
W2 = Serial interface with the accessories of PR121/P, PR122/P and PR123/P releases (internal bus)
X = Delivery connector for auxiliary circuits of withdrawable version circuit-breaker
X1...X7 = Connectors for the accessories of the circuit-breaker
XF = Delivery terminal box for the position contacts of the withdrawable circuit-breaker (located on the fixed part of the circuit-breaker)
XK1 = Connector for power circuits of PR121/P, PR122/P and PR123/P releases
XK2 - XK3 = Connectors for auxiliary circuits of PR121/P, PR122/P and PR123/P releases
XK4 = Connector to signal open/close
XK5 = PR120/V module connector
XO = Connector for YO1
XV = Delivery terminal box for the auxiliary circuits of the fixed circuit-breaker
YC = Shunt closing release
YO = Shunt opening release
YO1 = Trip coil
YO2 = Second shunt opening release (see note Q)
YR = Coil to electrically reset the circuit-breaker
YU = Undervoltage release (see notes B and Q)

Figures Description

Fig. 1 = Motor circuit to load the closing springs.
Fig. 2 = Circuit of shunt closing release.
Fig. 4 = Shunt opening release.
Fig. 6 = Instantaneous undervoltage release (see notes B and Q).
Fig. 7 = Undervoltage release with electronic time-delay device, outside the circuit-breaker (see notes B and Q)
Fig. 8 = Second shunt opening release (see note Q).
Fig.11 = Contact for electrical signalling of springs loaded.
Fig.12 = Contact for electrical signalling of undervoltage release energized (see notes B and S).
Fig.13 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed only after pressing the reset pushbutton.
Fig.14 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release and electrical reset coil. The circuit-breaker may be closed only after pressing the reset pushbutton or energizing the coil.
Fig.21 = First set of circuit-breaker auxiliary contacts.
Fig.22 = Second set of circuit-breaker auxiliary contacts (not available for PR122/P and PR123/P releases)(see note V)
Fig.23 = Third set of supplementary auxiliary contacts outside the circuit-breaker.
Fig.31 = First set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig.32 = Second set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig.41 = Auxiliary circuits of PR121/P release (see note F).
Fig.42 = Auxiliary circuits of PR122/P and PR123/P releases (see notes F, M and V).
Fig.43 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases internally connected to the three-pole and four-pole circuit-breaker (optional for the release PR122/P) (see note U).
Fig.44 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases externally connected to the circuit-breaker (optional for the release PR122/P) (see note O, U and X).
Fig.45 = Circuits of the communication module PR120/D-M of the PR122/P and PR123/P releases (optional) (see note E).
Fig.46 = Circuits of the indicator module PR120/K of the PR122/P and PR123/P releases - connection 1 (optional) (see note V).

Fig.47 = Circuits of the indicator module PR120/K of the PR122/P and PR123/P releases - connection 2 (optional) (see note V).
Fig.48 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases connected inside the three-pole circuit-breaker with outside neutral conductor (optional for the release PR122/P)(see note U).
Fig.61 = SACE SOR TEST UNIT Test/monitoring Unit (see note R)
Fig.62 = Circuits of the signalling unit PR021/K (outside the circuit-breaker).

Incompatibilities

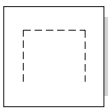
The circuits indicated in the following figures cannot be supplied simultaneously on the same circuit-breaker:
6 - 7 - 8
13 - 14
22 - 46 - 47
43 - 44 - 48

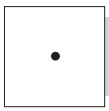
Notes

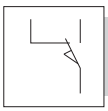
A) The circuit-breaker is only fitted with the accessories specified in the ABB SACE order acknowledgement. Consult this catalogue for information on how to make out an order.
B) The undervoltage release is supplied for operation using a power supply branched on the supply side of the circuit-breaker or from an independent source. The circuit-breaker can only close when the release is energized (there is a mechanical lock on closing).
If the same power supply is used for the closing and undervoltage releases and the circuit-breaker is required to close automatically when the auxiliary power supply comes back on, a 30 ms delay must be introduced between the undervoltage release accept signal and the energizing of the closing release. This may be achieved using an external circuit comprising a permanent make contact, the contact shown in fig. 12 and a time-delay relay.
E) For connecting the EIA RS485 serial line, see “Technical Application Book – volume 9” communication via BUS with the ABB switches.
F) The auxiliary voltage Vaux allows actuation of all operations of the PR121/P, PR122/P and PR123/P releases.
Having requested a Vaux insulated from earth, one must use “galvanically separated converters” in compliance with IEC 60950 (UL 1950) or equivalent standards that ensure a common mode current or leakage current (see IEC 478/1, CEI 22/3) not greater than 3.5 mA, IEC 60364-41 and CEI 64-8.
G) Earth fault protection is available with the PR122/P and PR123/P releases by means of a current sensor located on the conductor connecting to earth the star center of the MV/LV transformer.
The connections between terminals 1 and 2 (or 3) of current transformer UI/O and poles T7 and T8 of the X (or XV) connector must be made with a two-pole shielded and stranded cable (type BELDEN 3105A/3105B) no more than 15m long. The shield must be earthed on the circuit-breaker side and current sensor side.
N) With releases PR122/P and PR123/P, the connections to the zone selectivity inputs and outputs must be made with a two-pole shielded and stranded cable (type BELDEN 3105A/3105B), no more than 300m long. The shield must be earthed on the selectivity input side.
O) Systems with a rated voltage greater than 690V require the use of an insulation voltage transformer to connect to the busbars (connect according to the diagrams on the sheet provided with the kit 1SDH000460R0508).
P) With releases PR122/P and PR123/P with communication module PR120/D-M, the coils YO and YC are controlled directly from contacts K51/YO and K51/YC with maximum voltages of 110-120 VDC and 240-250 VAC.
Q) The second shunt opening release may be installed as an alternative to the undervoltage release.
R) The SACE SOR TEST UNIT + opening release (YO) is guaranteed to operate starting at 75% of the Vaux of the opening release itself.
While the YO power supply contact is closing (short-circuit on terminals 4 and 5), the SACE SOR TEST UNIT is unable to detect the opening coil status.
Consequently:
- For continuously powered opening coil, the TEST FAILED and ALARM signals will be activated
- If the coil opening command is of the pulsing type, the TEST FAILED signal may appear at the same time. In this case, the TEST FAILED signal is actually an alarm signal only if it remains lit for more than 20s.

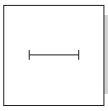
S) Also available in the version with normally-closed contact
U) The measuring module PR120/V is always supplied with relay PR123/P.
V) If fig. 22 is present (second set of auxiliary contacts) simultaneously as relay PR122/P (or PR123/P), the contacts for the zone selectivity in fig. 42 (K51/SZin, K51/SZout, K51/GZin and K51/GZout) are not wired. In addition, the indicator module PR120/K in figures 46 and 47 cannot be supplied.
W) For the connections between TO toroidal transformer and poles of CB X (or XV) connector, use a shielded 4-pole cable with paired braided wires (BELDEN 9696 paired type), length not exceeding 10m. The shielding will be grounded on CB side.
X) T3 and T4 poles of X (or XV) connector are used to measure voltage when U>690V. In this case, they must be connected to the secondary winding of the TU voltage transformer (see fig. 44). Ask ABB SACE for applications of the residual current protection with voltages higher than 690V.
Y) The shielding of the connection cable will be grounded on CB side only. The connection must be made with a two-pole shielded and stranded cable (type BELDEN 3105A) no more than 15m long.
Z) Short-circuit T5 and T6 if the external neutral current sensor (UI/N)is not connected.

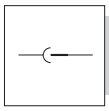
Circuit diagram symbols (IEC 60617 and CEI 3-14 ... 3-26 Standards)

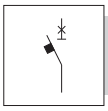

Shield
(may be drawn
in any shape)

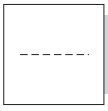

Terminal

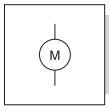

Change-over position contact with momentary circuit breaking (limit contact)


Time delay

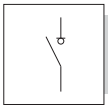

Plug and socket
(male and female)

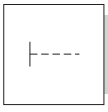

Power isolator with automatic breaking action

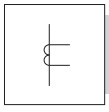

Mechanical or electrical connection

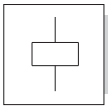


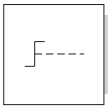
Motor
(general symbol)

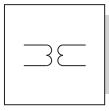

Switch-disconnector

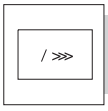

Manual mechanical control (general case)

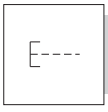

Current transformer

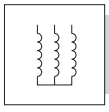

Control coil
(general symbol)

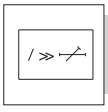

Rotating control

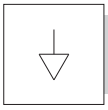

Voltage transformer

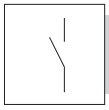

Instantaneous overcurrent relay

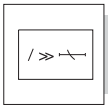

Pushbutton control

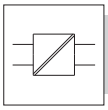

Winding of three-phase transformer, Star connection

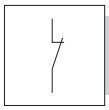

Overcurrent relay with adjustable short time-delay trip

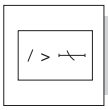

Equipotentiality

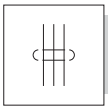

Make contact

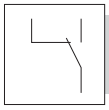

Overcurrent relay with inverse short time-delay tripa
tempo breve inverso


Galvanically separated converter


Break contact with automatic circuit breaking

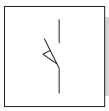

Overcurrent relay with inverse long time-delay trip

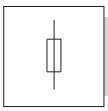

Shielded cable conductors (i.e., 3 conductors shown)

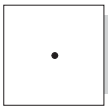

Change-over contact

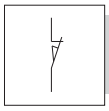

Earth fault overcurrent relay with inverse short time delay

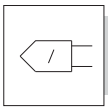

Conductors or stranded cables (i.e., 3 conductors shown)


Make position contact (limit contact)


Fuse (general symbol)

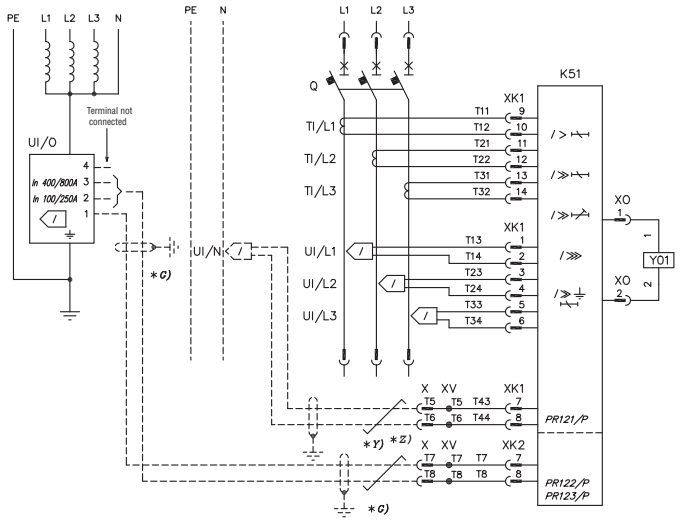

Connection of conductors


Break position contact (limit contact)

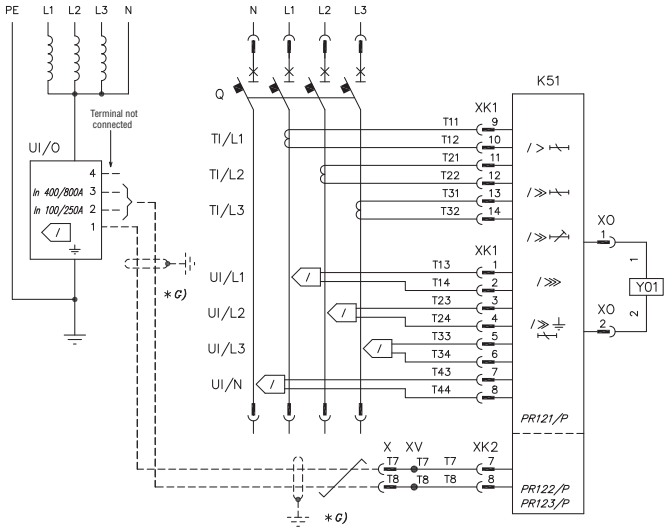

Current sensor

Circuit diagram - Operating status

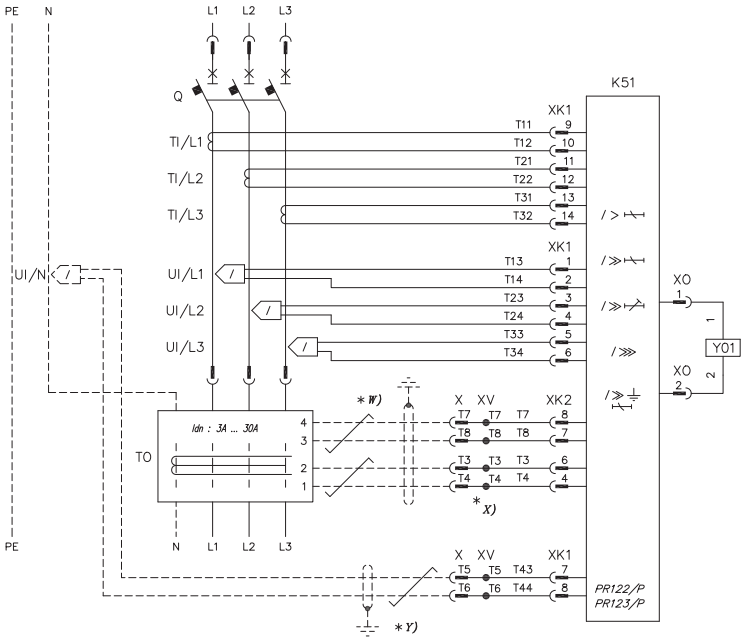
Three-pole circuit-breaker with PR121/P, PR122/P or PR123/P electronic release



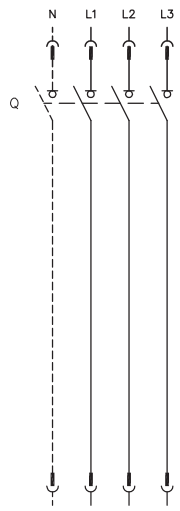
Four-pole circuit-breaker with PR121/P, PR122/P or PR123/P electronic release



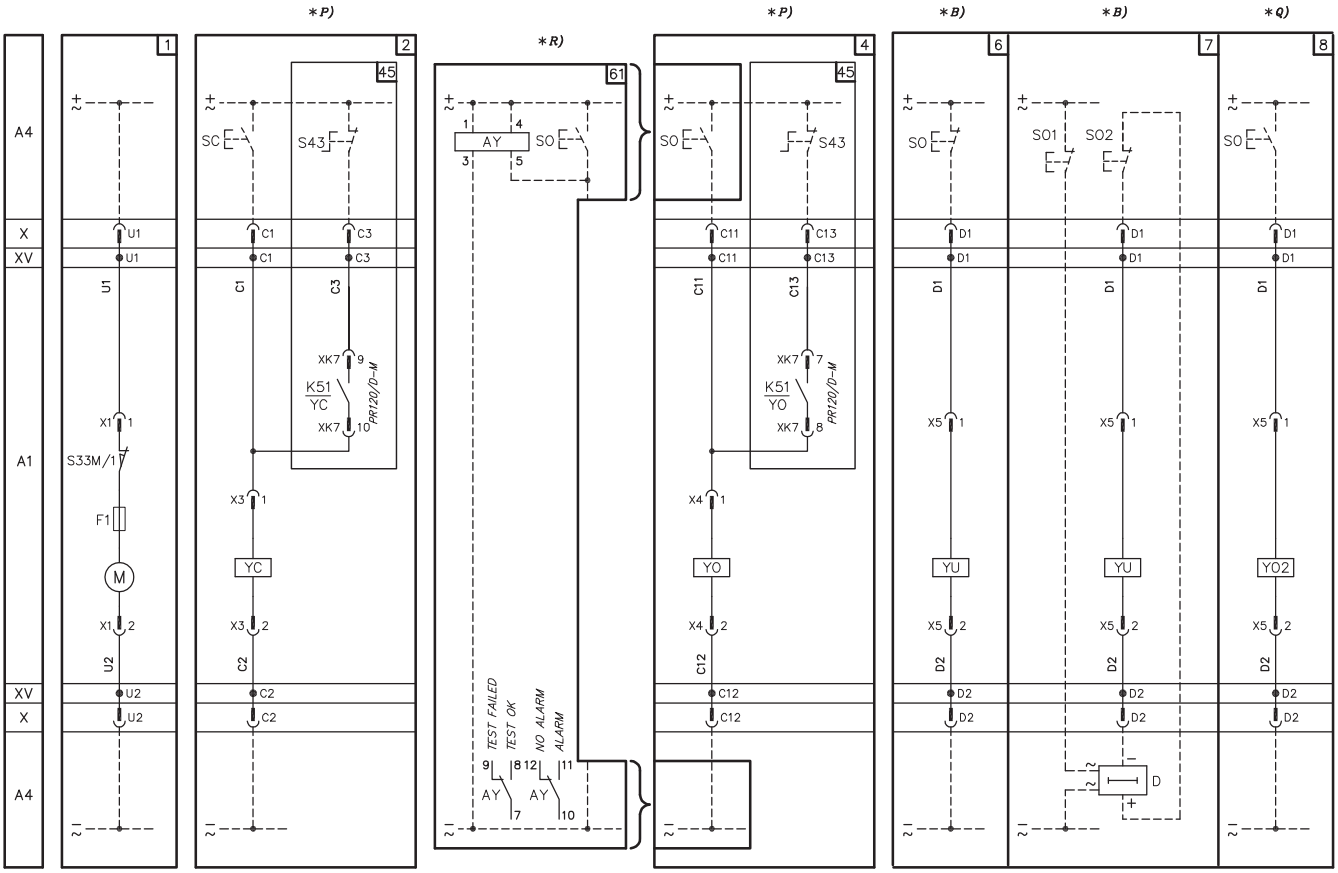
Three-pole circuit-breaker with PR122/P or PR123/P electronic release, residual current protection and U<=690V.



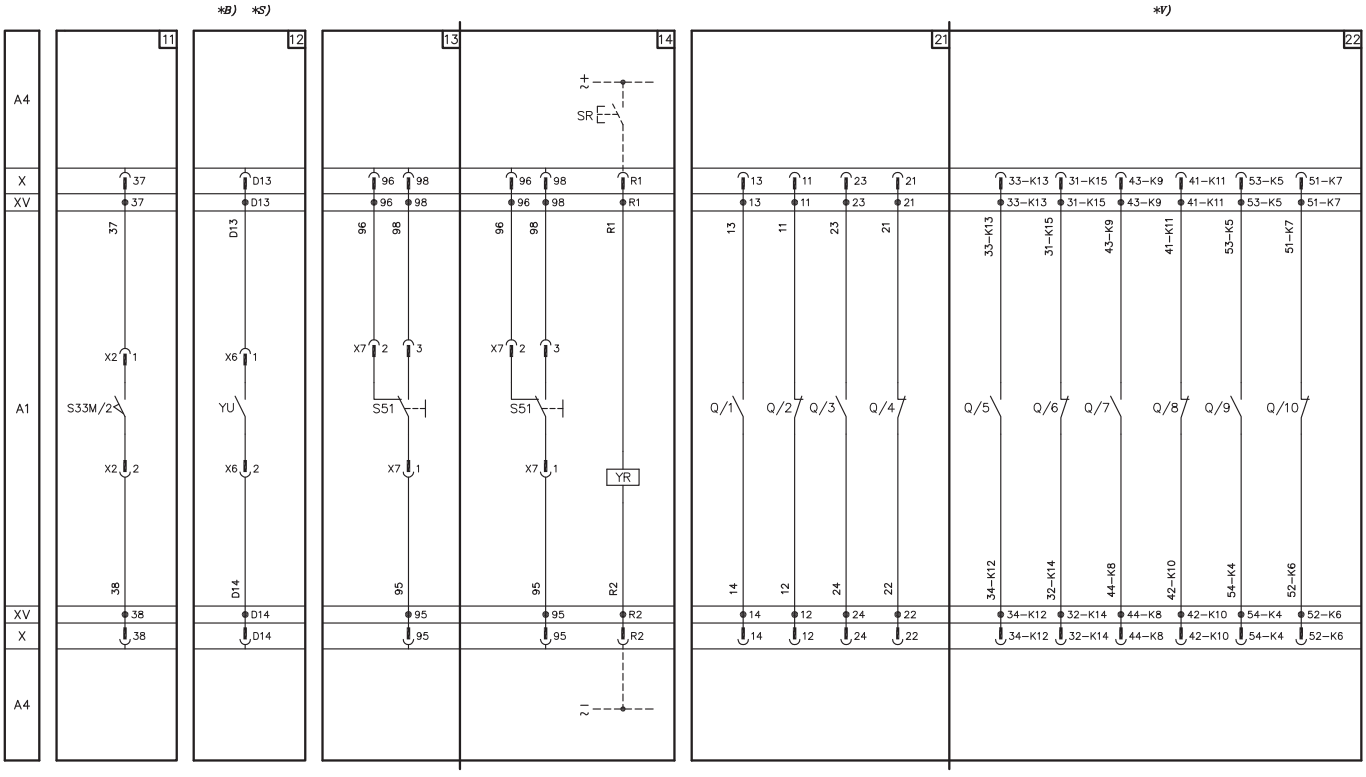
Three-or four-pole switch-disconnector



Motor operating mechanism, opening, closing and undervoltage releases

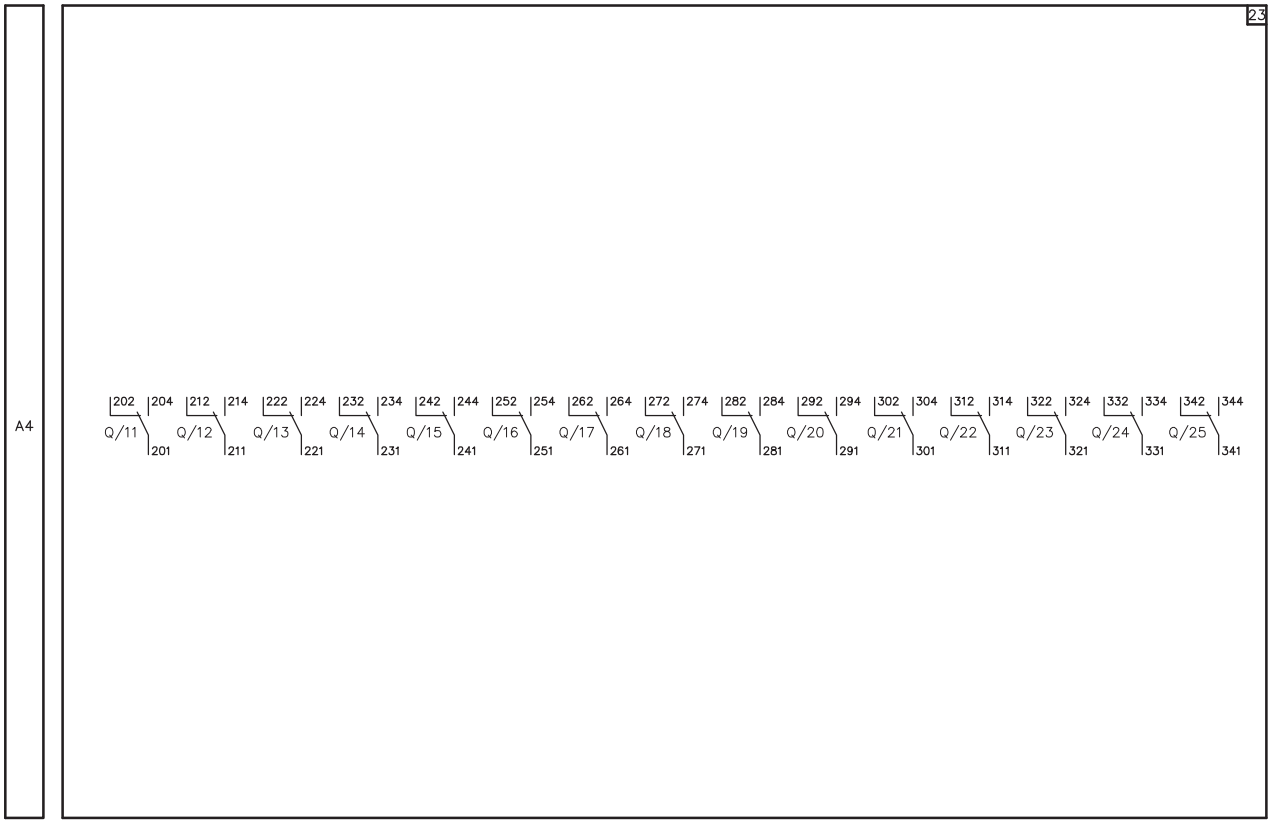


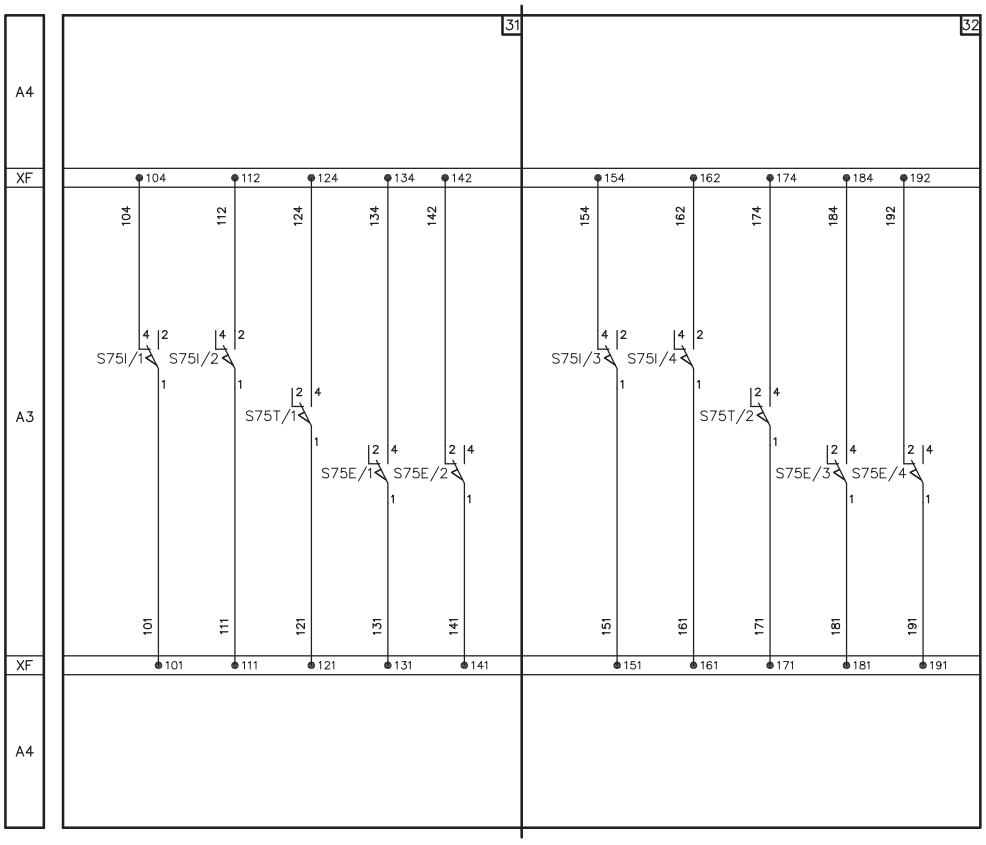
Signalling contacts



Model	L6555			Apparatus	Emax	Scale
				Doc. no.	1SDH000460R0002	Page No 68/74

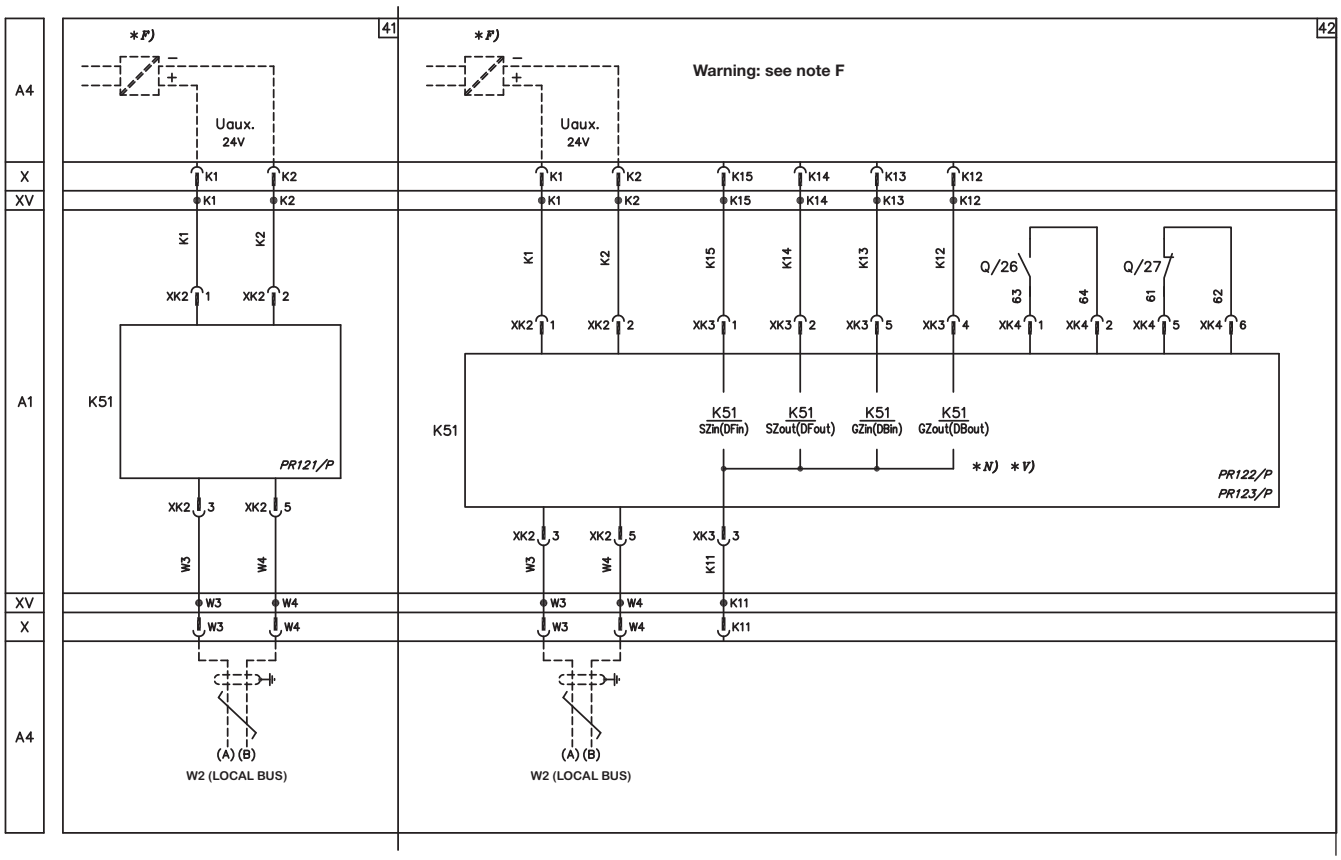
Signalling contacts



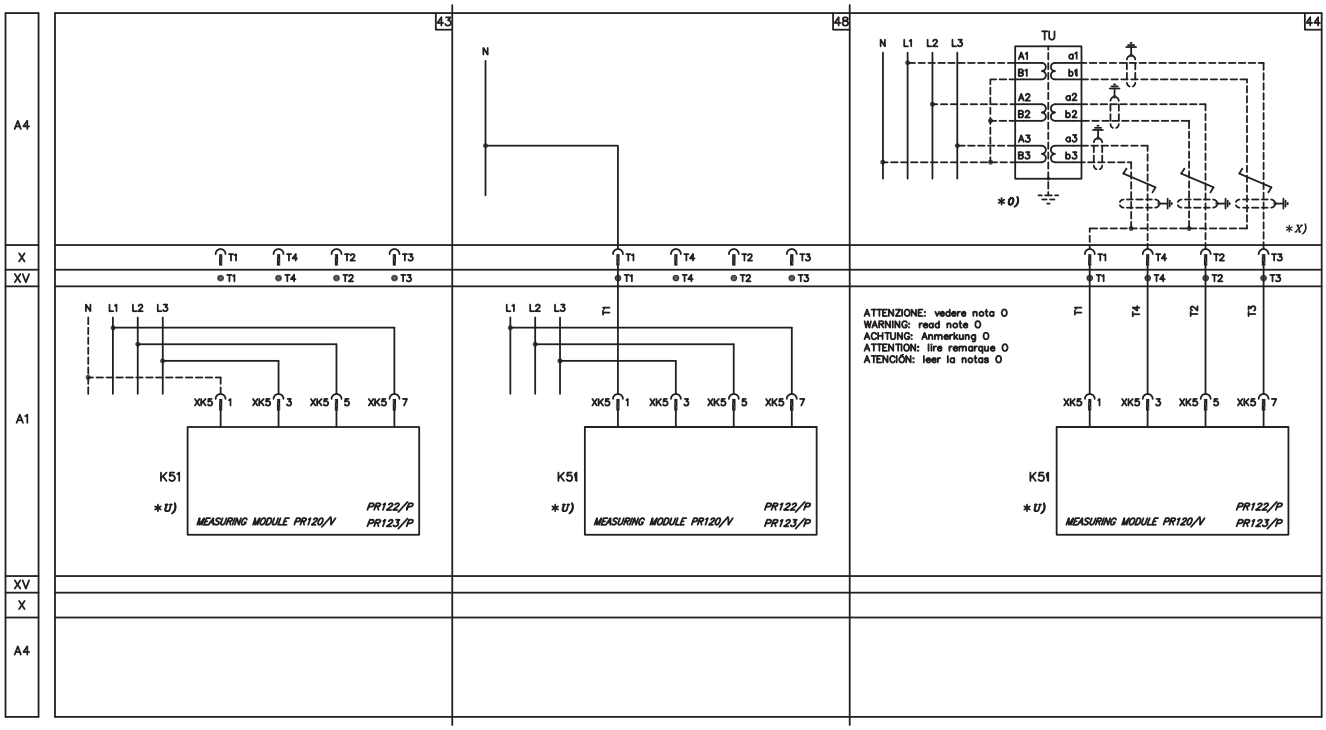


Model	L6555			Apparatus	Emax	Scale
				Doc. No	1SDH000460R0002	Page No 69/74

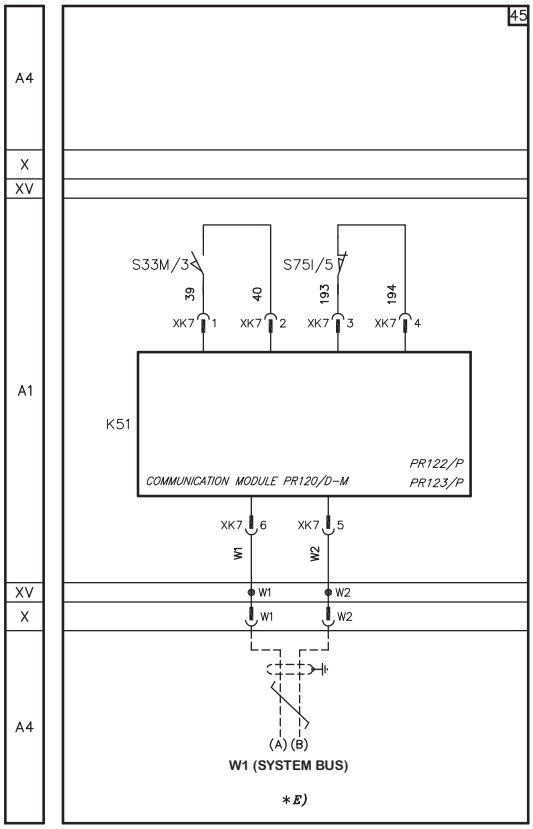
Auxiliary circuits of the PR121, PR122 and PR123 releases



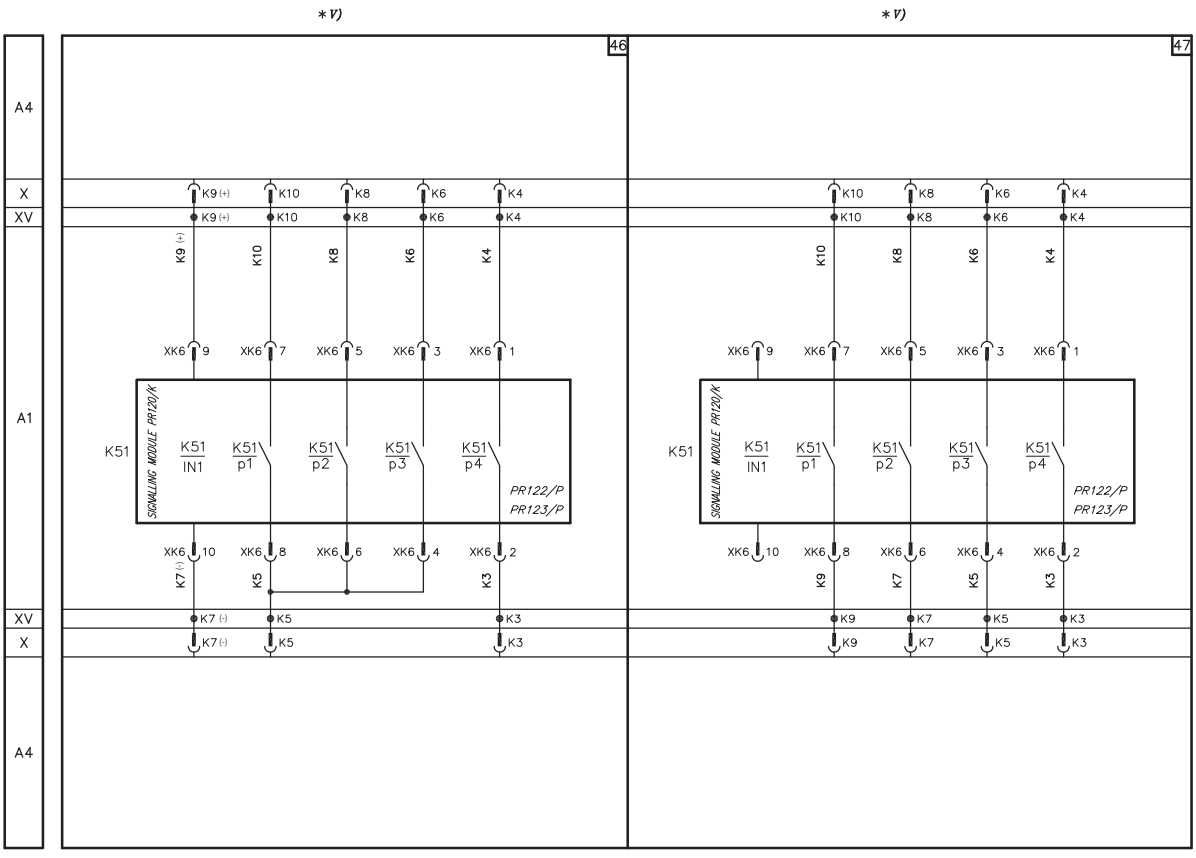
PR120/V measuring module



PR120/D-M communication module

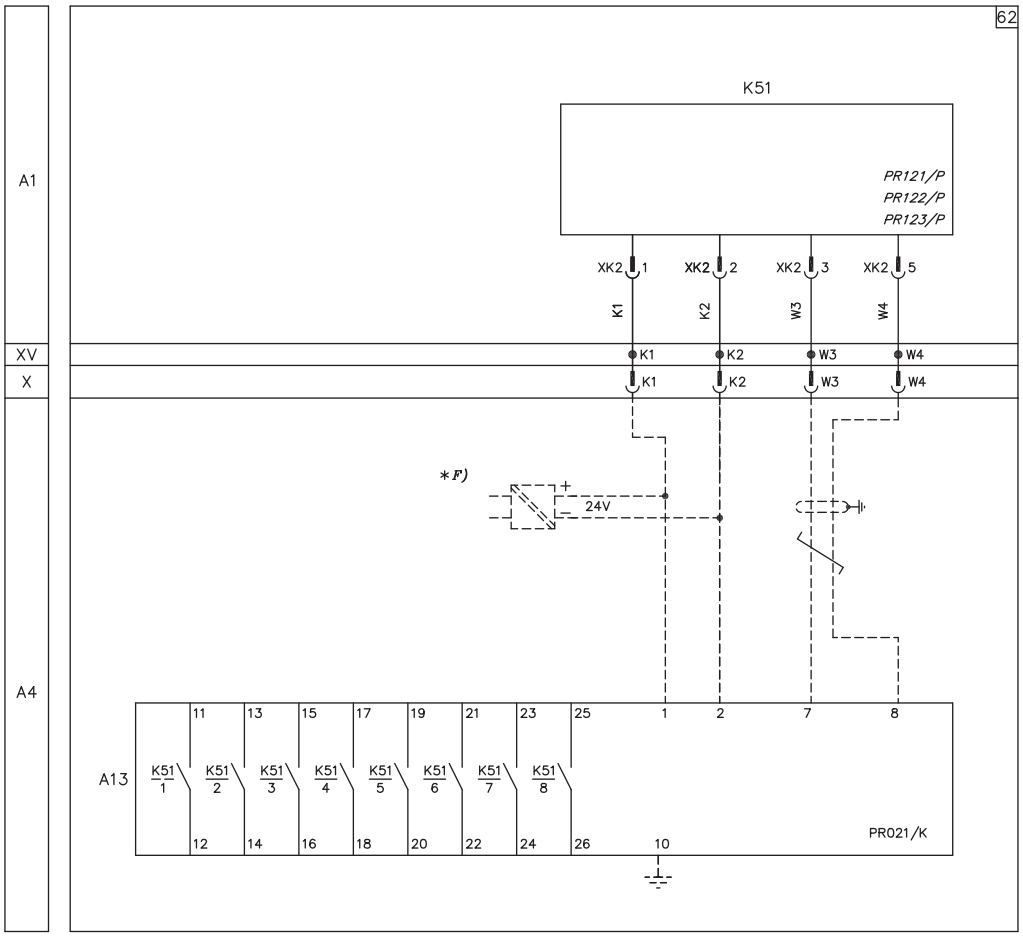


PR120/K signalling module



Model	L6555			Apparatus	Emax	Scale
				Doc. No	1SDH000460R0002	Page No 71/74

PR021/K signalling unit



Model	L6555			Apparatus	Emax	Scale
				Doc. no.	1SDH000460R0002	Page No 72/74

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Due to possible developments of standards as well as of materials, the characteristics and dimensions specified in the present catalogue may only be considered binding after confirmation by ABB SACE.

1SDH000460R0002 L6555

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http://www.abb.com

Appendix E

Dehydrating Breather

ABB/Comem SDB-14C (39 pages)

INSTRUCTION MANUAL

Self-Dehydrating Breather Type “SDB”

CONTENTS

1. SAFETY

1.1 Safety instructions

Make sure that any personnel installing and operating the “self-dehydrating air breather”:

- Are technically qualified and competent
- Fully comply with these assembling instructions

Improper operations or misuse could cause danger to:

- Life and limb
- To the equipment and other assets of the operator
- To the proper function of the equipment

Safety instructions in this manual are shown in three different forms to emphasize important information.

WARNING

This information indicates particular danger to life and health. Disregarding such a warning can lead to serious or fatal injury.

CAUTION

This information indicates particular danger to equipment and/or other property of the user. Serious or fatal injury cannot be excluded.

NOTE

This note gives important and specific information concerning the equipment.

1.2 Specified applications

The dehydrating breather is used for oil-insulated transformer and on-load tap-changer to dry the air which is suctioned in by the oil conservator during the thermal contraction of the oil mass.

It is important to observe the limit values indicated on the nameplate and in the operating instruction before commissioning the device.

1.3 Safety notes on the equipment operation

Electrical installation is subject to the relevant national safety rules.
It is mandatory to connect the grounding cable.

CAUTION

During the regeneration phase, the surface temperature increases. Touching the surface is dangerous.

CAUTION

Installation, electrical connection and fitting the device may only be performed by qualified personnel and only in accordance with this instruction manual.
It is the responsibility of the user to ensure that the device is used for specified application only.
For safety reasons, please avoid any unauthorized and improper usage.

WARNING

All relevant fire protection regulations must be strictly followed.

2. SELF DEHYDRATING BREATHER TYPE “SDB”

2.1 Drawing

2.1.1 SDB-10C

The following are the external dimensions for the self-dehydrating air breather type SDB-10C:

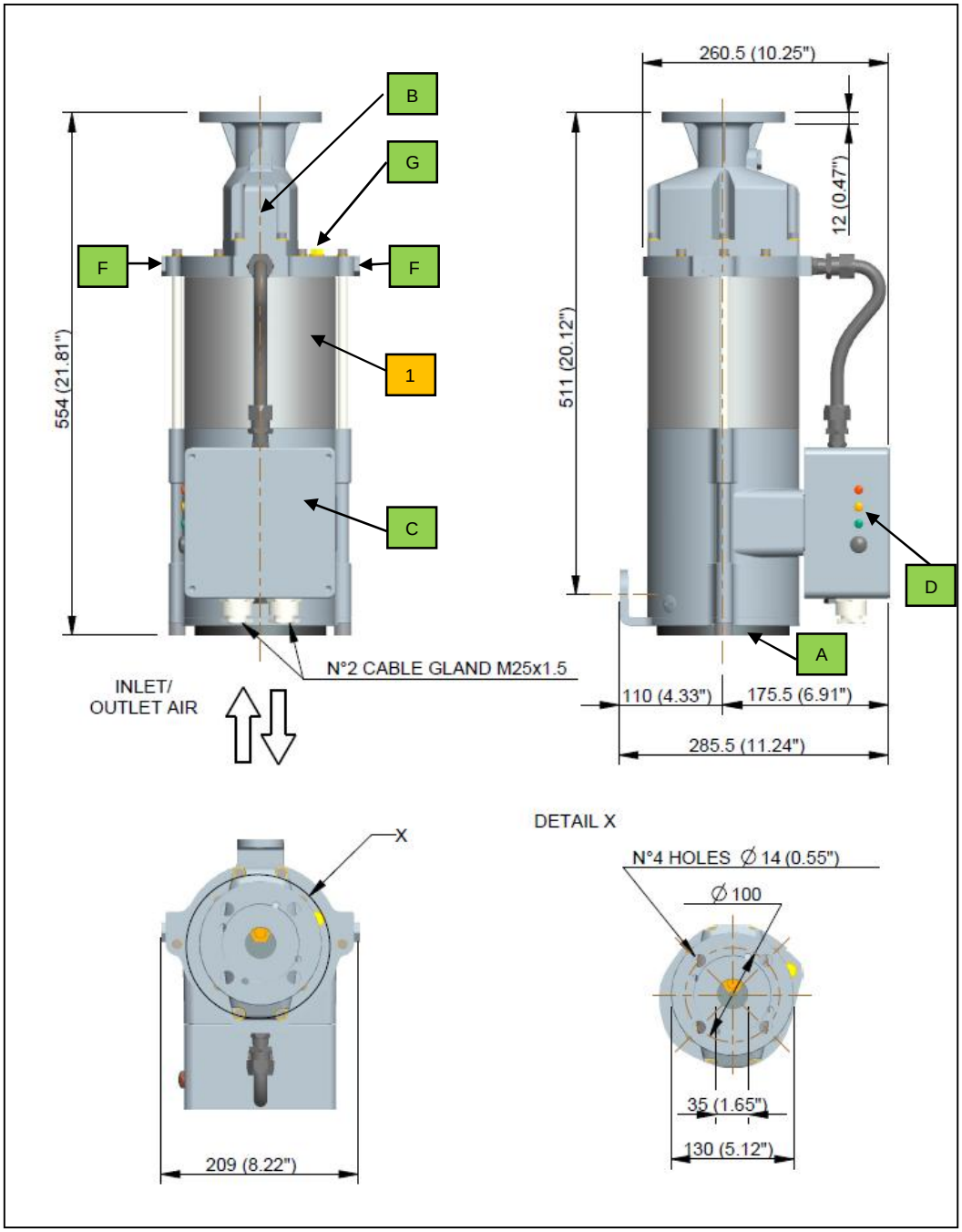


Fig. 1

2.1.2 SDB-10

The following are the external dimensions for the self-dehydrating air breather type SDB-10:

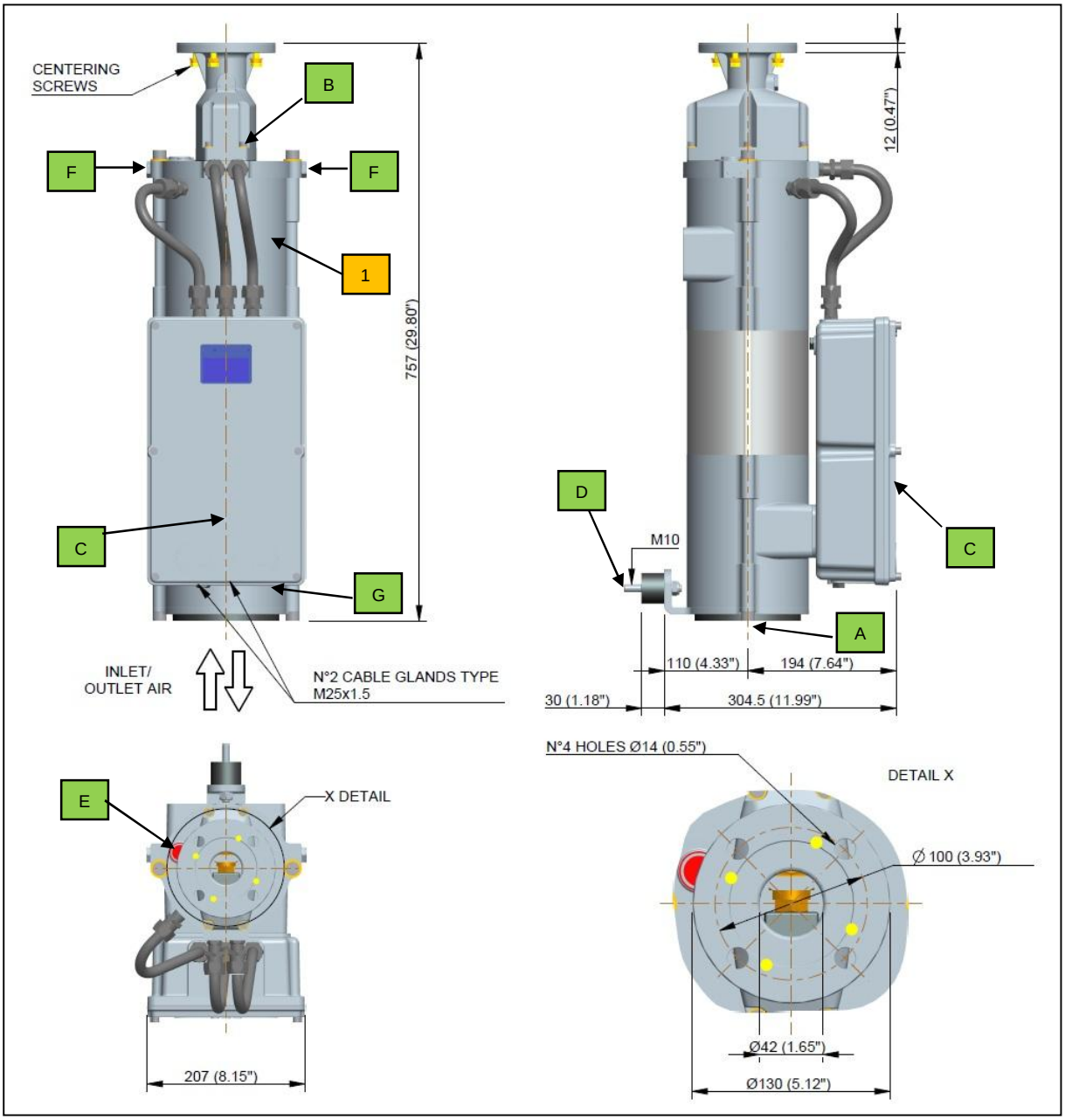


Fig. 2

2.1.3 SDB-12C/14C

The following are the external dimensions for the self-dehydrating air breather type SDB-12C/14C:

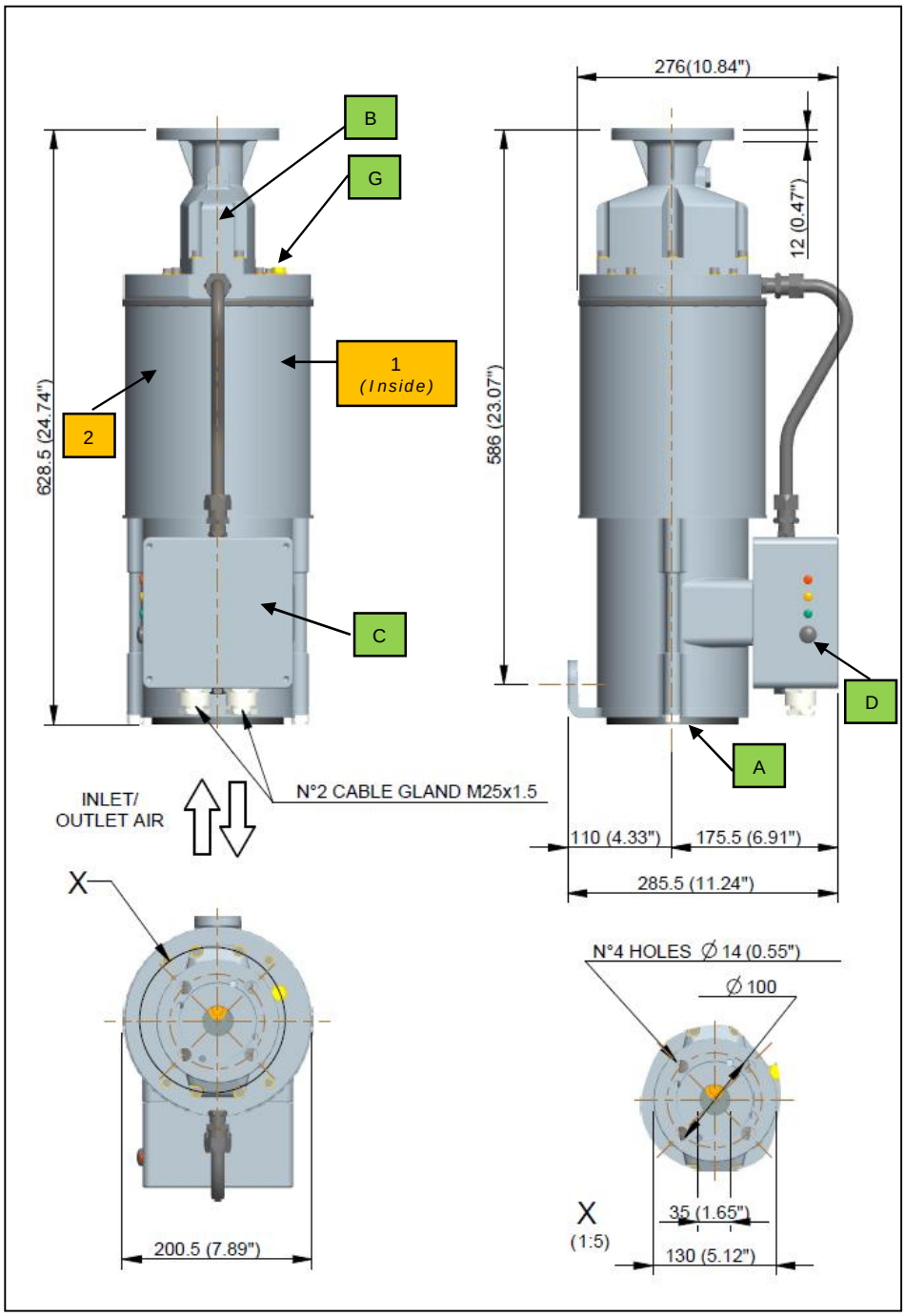


Fig. 3

2.1.4 SDB-15

The following are the external dimensions for the self-dehydrating air breather type SDB-15:

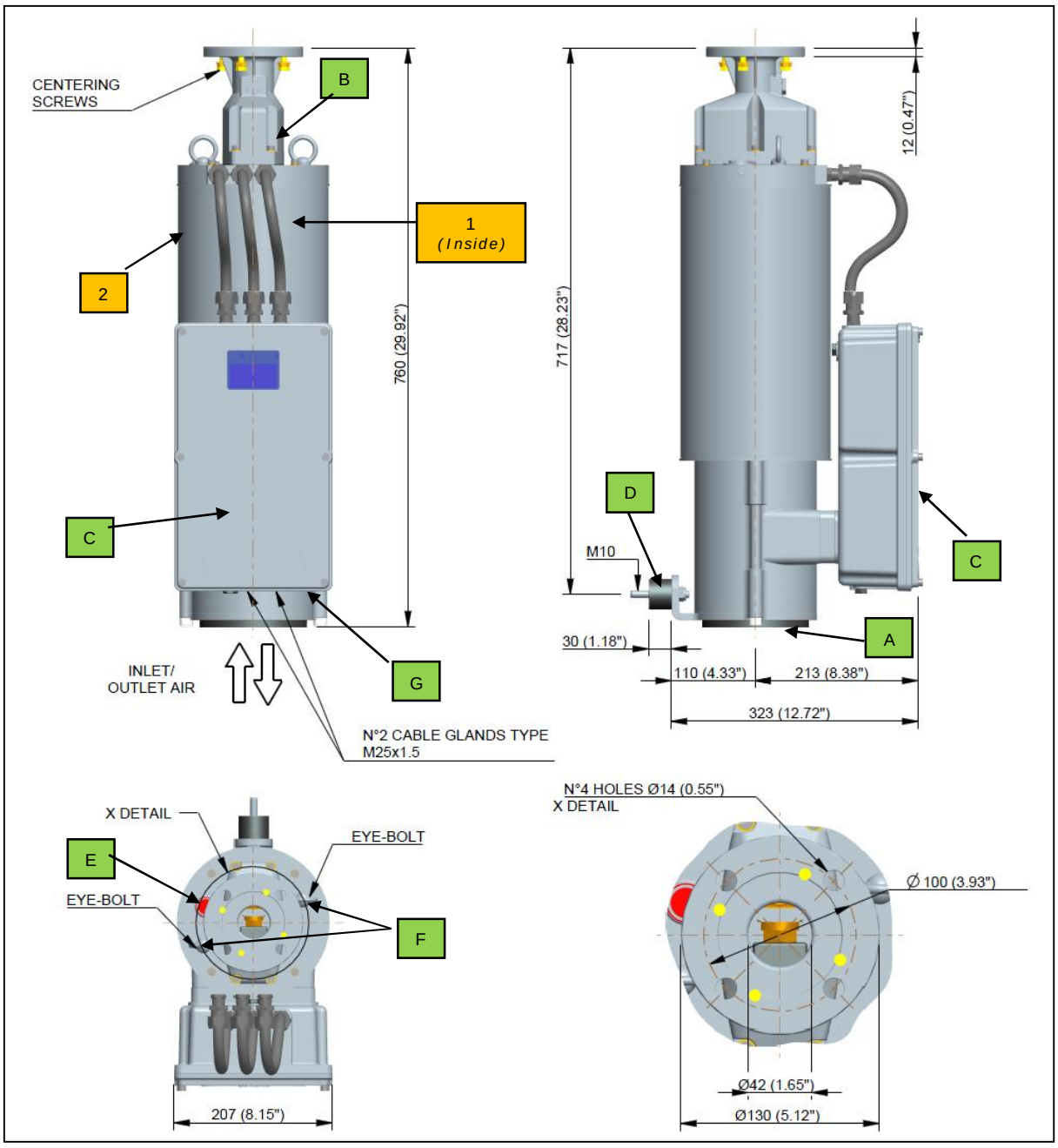


Fig. 4

2.1.5 SDB-30

The following are the external dimensions for the self-dehydrating air breather type SDB-30:

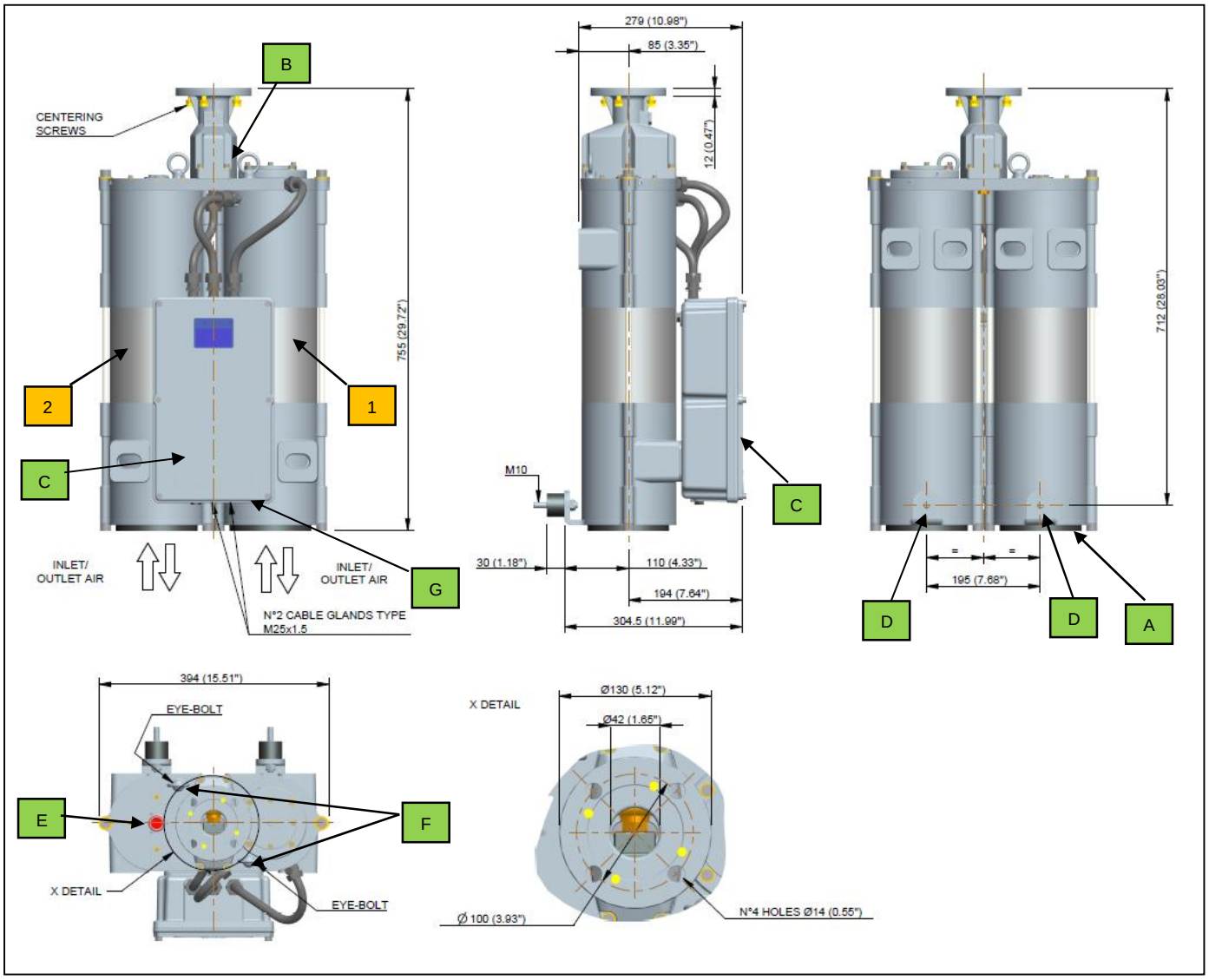


Fig. 5

2.2 Operating principle

2.2.1 SDB-10C

The self-dehydrating air breather works in accordance with the following principles.
During the normal operation the oil conservator intakes air that passes through the metallic filter (Fig.1/A). The metallic filter stops dust, sand and other particles from the contaminating air. The air then passes through the salt tank 1 (Fig.1/1). The salt tank is filled with silica gel that absorbs the moisture. The dehydrated air goes through piping to the oil conservator.

After a pre-determinate time (settable) a solenoid valve (upper part – fig.1/B) blocks the passage of air through salt tank 1 and deviates through the main self-dehydrating breather (Fig.6 --- SDB-14C, SDB-15 or SDB-30) by the pipe connected on one of the two plug (Fig.1/F). At the same time, a heating system inside tank 1 is activated. The water vapor leaving the silica gel is expelled outward by a fan that also dissipates the heat. Inside the salt, a probe controls the temperature of the heating element.
After the salt regeneration in tank 1 (timed regeneration), the solenoid valve is de-energized.

No maintenance is required for replacement and regeneration of the desiccant.

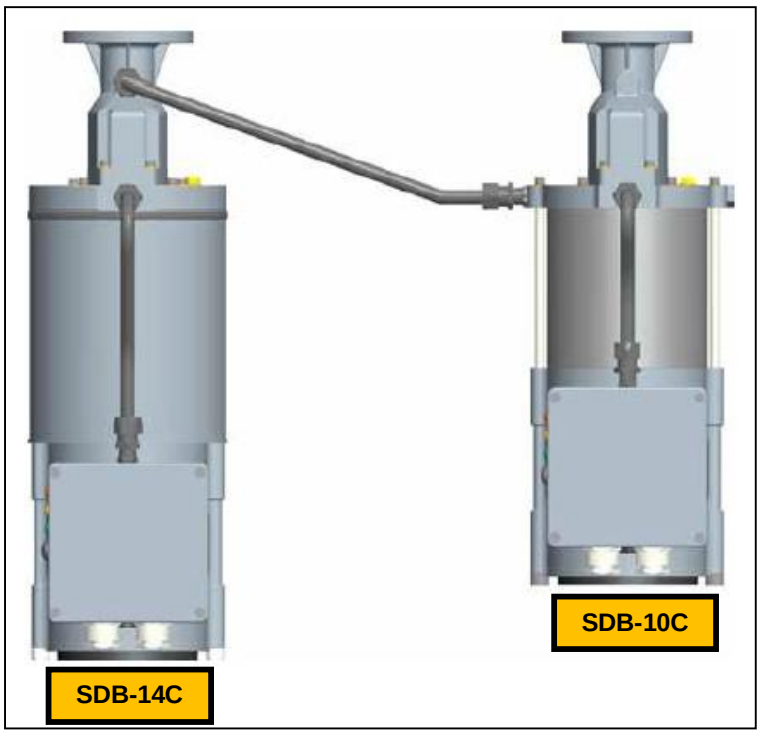


Fig. 6

2.2.2 SDB-12C & SDB-14C

The self-dehydrating air breather works in accordance with the following principles.
During the normal operation the oil conservator intakes air that passes through the metallic filter (Fig.3/A). The metallic filter stops dust, sand and other particles from the contaminating air. The air then passes through the salt tank 1 (Fig.3/1). The salt tank is filled with silica gel that absorbs the moisture. The dehydrated air goes through piping to the oil conservator.

After a pre-determinate time (settable) a solenoid valve (upper part – fig.3/B) blocks the passage of air through salt tank 1 and deviates through the “plenum chamber” 2 (Fig.3/2). At the same time, a heating system inside tank 1 is activated. The water vapor leaving the silica gel is expelled outward by a fan that also dissipates the heat.
Inside the salt, a probe controls the temperature of the heating element.
After the salt regeneration in tank 1 (timed regeneration), the solenoid valve is de-energized and the airflow through tank 2 is inhibited. The salt in this tank (2) is also dehydrated, regeneration of the salt in tank 2 follows automatically.

No maintenance is required for replacement and regeneration of the desiccant.

2.2.3 SDB-10

The self-dehydrating air breather works in accordance with the following principles.
During the normal operation the oil conservator intakes air that passes through the metallic filter (Fig.2/A). The metallic filter stops dust, sand and other particles from the contaminating air. The air then passes through the salt tank 1 (Fig.2/1). The salt tank is filled with silica gel that absorbs the moisture. The dehydrated air goes through piping to the oil conservator.

When the silica gel absorbs the moisture in the air, the weight of the salt increases and is constantly monitored by a weighing cell. When the weight increases and exceeds the pre-set value a solenoid valve (upper part – fig.2/B) blocks the passage of air through salt tank 1 and deviates through the main self-dehydrating breather (Fig.7 --- SDB-15 or SDB-30) by the pipe connected on one of the two plug (Fig.2/F). At the same time, a heating system inside tank 1 is activated. The water vapor leaving the silica gel is expelled outward by a fan that also dissipates the heat.
Inside the salt, a probe controls the temperature of the heating element.
During the functioning of the device, the weighing cell temperature is monitored by a temperature sensor mounted in the upper part.
After the salt regeneration in tank 1 (timed regeneration), the solenoid valve is de-energized.
No maintenance is required for replacement and regeneration of the desiccant.

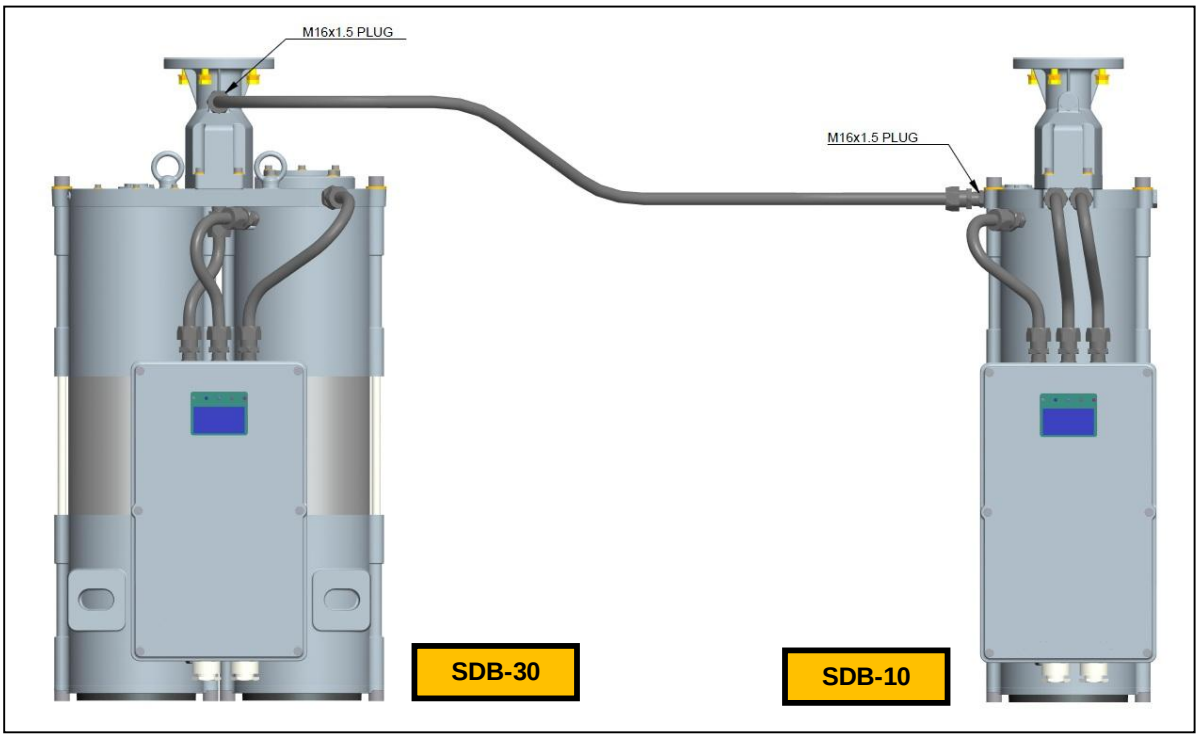


Fig. 7

2.2.4 SDB-15 & SDB-30

The self-dehydrating air breather works in accordance with the following principles.
During the normal operation the oil conservator intakes air that passes through the metallic filter (Fig.4-5/A). The metallic filter stops dust, sand and other particles from the contaminating air. The air then passes through the salt tank 1 (Fig.4-5/1). The salt tank is filled with silica gel that absorbs the moisture. The dehydrated air goes through piping to the oil conservator.

When the silica gel absorbs the moisture in the air, the weight of the salt increases and is constantly monitored by a weighing cell. When the weight increases and exceeds the pre-set value a solenoid valve (upper part – fig.4-5/B) blocks the passage of air through salt tank 1 and deviates through the “plenum chamber” 2 (Fig.4-5/2). At the same time, a heating system inside tank 1 is activated. The water vapor leaving the silica gel is expelled outward by a fan that also dissipates the heat.
Inside the salt, a probe controls the temperature of the heating element.
During the functioning of the device, the weighing cell temperature is monitored by a temperature sensor mounted in the upper part.
After the salt regeneration in tank 1 (timed regeneration), the solenoid valve is de-energized and the airflow through tank 2 is inhibited.
The salt in this tank (2) is also dehydrated, regeneration of the salt in tank 2 follows automatically.

No maintenance is required for replacement and regeneration of the desiccant.

2.3 System control

All the data coming from the instruments (heating elements, probes, fans, weighing cell and solenoid valve) are sent to an electronic control circuit.
For SDB-10/15/30, to avoid calibration problems of the weighing cell that can stop the device, a time control is also present which starts the backing process at a predetermined time.
The control unit and the terminals for the electrical connections are located in the terminal box (Fig.1-2-3-4-5/C).

2.4 Self-monitoring function

The self-dehydrating air breather has a self-monitoring function. When the device has got a failure, this is detected by contacts that can be set in accordance to customer demand on the following configuration:

STANDARD CONFIGURATION		SPECIAL CONFIGURATION	
Malfunction	What is detected	Malfunction	What is detected
POWER FAILURE	• Failure of the power supply • Failure of the electronic circuit	POWER FAILURE	• Failure of the power supply • Failure of the electronic circuit • Failure of the heating element • Failure of the weighing cell (SDB-10/15/30)
SYSTEM FAILURE	• Failure of the heating element • Failure of the weighing cell (SDB-10/15/30)		

Table 1

2.5 Outputs

		STANDARD CONFIGURATION	SPECIAL CONFIGURATION
STANDARD	RELAY	1 x change over contact: POWER FAILURE (terminals 22-24-21) 1 x change over contact: SYSTEM FAILURE (terminals 12-14-11)	1 x NC contact: POWER FAILURE (terminals 22-21) 1 x change over contact: HEATER ON (terminals 12-14-11)
	USB type B (SDB-10/15/30)	interface to download relevant device data	interface to download relevant device data
	RS-232 (SDB-10/15/30)	interface to set the main technical features of the circuit control	interface to set the main technical features of the circuit control
OPTIONS	ANALOG OUTPUT	4-20 mA (terminals 41-44) (Minimum / Maximum resistance: 100 / 470 Ohm)	4-20 mA (terminals 41-44) (Minimum / Maximum resistance: 100 / 470 Ohm)
	DIGITAL OUTPUT RS-485	Digital Signal (terminals 3-4))	Digital Signal (terminals 3-4))

Table 2

2.6 Status indicators

2.6.1 SDB-10C/12C/14C

Three LEDs which indicate the status of the device are installed outside the terminal box and observable by the external side (Fig.1/D and Fig.3/D).

Green LED (pulsating):	Power voltage ON
Yellow LED (pulsating):	Regenerating tank ON
Red LED (Fig.5/E):	Alarm

The display inside the box (Fig.8/A) shows information about the time between 2 regeneration process.

To set this time is necessary to push the button (Fig. 8/B) for 5 seconds until the number start to blink, after that, pushing the button is possible to increase the number of day (1 days steps, minimum value 1 days and maximum value 50 days)

After 5 second where the button is not pushed, the condition pass to idle.

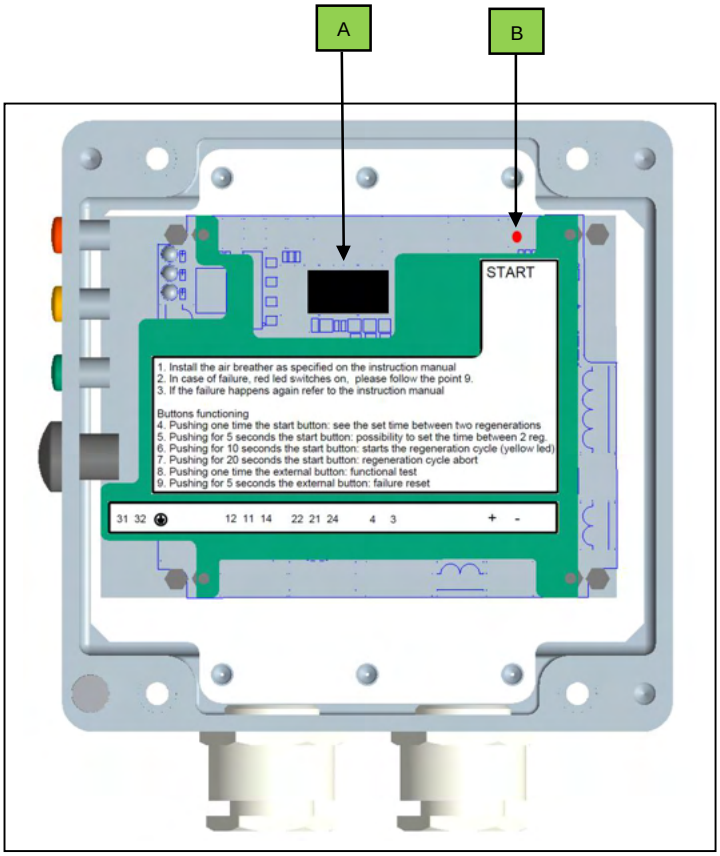


Fig. 8

NOTE

The time between 2 regenerations cycles could be set in accordance with the table in appendix A4 (as default it is fixed at 15 days)

2.6.2 SDB-10/15/30

Five LEDs which indicate the status of the device are installed inside the terminal box and observable through the glass.

Green LED (Fig.9/A):	Power voltage ON
Yellow LED (Fig.9/B):	Regenerating tank 1
Yellow LED (Fig.9/C):	Regenerating tank 2
Blue LED (Fig. 9/D):	ON: tank 2 in operation (for SDB-10: SDB-15/30 connected in operation) OFF: tank 1 in operation
Red LED (Fig.9/E):	Alarm

The display (Fig.9/F) shows information that is normally displayed as:

State (Fig.10/B):

- IDLE: normal functioning
- WARM UP CYL: heating tank 1 or 2
- DRYING CYL: maintenance at high temperatures in the tank (1 or 2) during the regeneration phase
- COOL DOWN CYL: after the dehydrating phase

Salt Saturation (Fig.10/A): Salt condition:

- 0%: completely dry
- 100%: saturation condition

Alarm warning: an alarm warning is displayed on the screen when a failure occurs (see chapter 5.3). The warnings are:

- WARNING: FAN 1 FAIL and FAN 2 FAIL (only for SDB-030)
- HEATER 1 FALL
- HEATER 2 FALL
- TANK 1 NOT DRYED
- SALTS REPLACEMENT

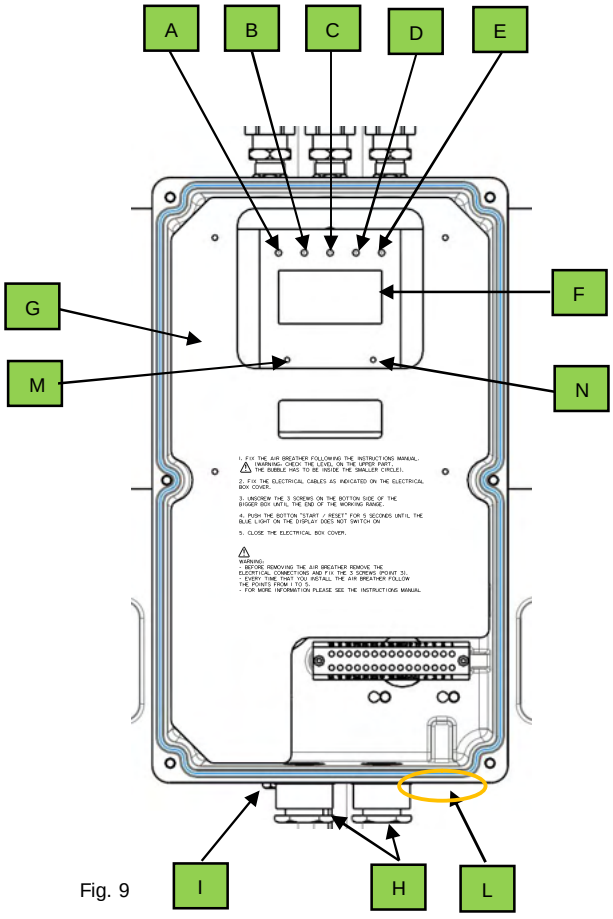


Fig. 9

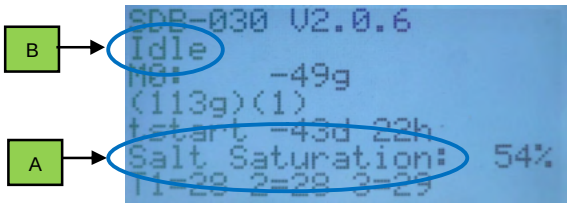


Fig. 10

2.7 Technical features

Standard connection flange	DN40 flange in accordance with standard UNI EN 1092-1:2003					
Material	All the external part are resistant to transformer oils, salt fog and UV rays **					
Color	RAL 9002 **					
Ambient temperature	-40 to 80°C / -40 to 176°F ***					
Degree of protection	IP45 in accordance with EN60529 (except terminal box which is IP65)					
Vibration damping	Optional anti-vibration supports can be anchored to the transformer (Fig.3/D,4/D)					
Functional test	Available (Push and hold the stand-by button for 10 seconds (see chapter 5.2)					
	SDB-10C	SDB-10	SDB-12C	SDB-14C	SDB-15	SDB-30
Weight	12Kg/26.5lb	22Kg/48.5lb	18Kg/39.6lb	18Kg/39.6lb	28Kg/61.7lb	37Kg/81.6lb
Salt weight (main tank)	2.0Kg/4.4lb	2.0Kg/4.4lb	2.0Kg/4.4lb	2.0Kg/4.4lb	2.5Kg/5.5lb	3.0Kg/6.6lb
Maximum oil volume	45 m^3, 40 tons oil, 12,000 gals				90 m^3, 80 tons oil, 24,000 gals	
Power Panel						
Degree of protection of terminal board	IP 65 according to EN 60259					
Ventilation valve	To prevent the formation of condensation (Fig.6/I, 9/I)					
Cable gland	Two M25x1.5 (Fig.6/H, 9/H)					
Wires	4 mm^2, AWG 24-10 flexible cables with or without terminals (screws are used to fasten the cables to the terminal board on the terminal box). For digital/analog output advised 4x1mm^2 (4x0.00155"^{2})/ 2x1mm^2 (2x0.0155"^{2}) shielded twisted pair cable.					
Power Supply						
Supply voltage	115/230 VAC/DC ±10% 50/60 Hz					
Current consumption	Max 100 mA					
Current consumption (during regeneration process)	3.0 A					
Heating element insulation	2.0 kV 50/60 Hz, 1 min, power terminals – ground – ground					
Braking capacity (relays on the electronic card)	Voltage		Current		Braking capacity	
	230V AC		2A		500 VA	cosø >0,5
	30/110/220V DC		10/03/0,12 A			L/R<40 ms
Analog output (optional)	**(See chapter 2.5)**					
Signal output	4-20 mA SDB-15/30: proportional to silica gel saturation level (0% - 4mA …… 100% - 20mA) SDB-10C/12C/14C: proportional to tank 1 temperature					
Max distance for analogical output	Max 30 m / 98 ft (for different demands contact COMEM)					
Digital output (optional)	**(See chapter 2.5)**					
Digital output	Serial RS485 (for more information contact COMEM assistance dept.)					
Distance for digital output	Max 30 m / 98 ft (for different demands contact COMEM)					
Signal contacts	**(See chapter 2.5)**					
Dielectric strength of contacts (short duration power frequency withstand voltage 1 min)	Between contacts and ground: 2kV					
	Between contacts in open position: 1kV					

** *For critical environmental conditions please contact Comem*
*** *Below -20°C/-4°F the inscriptions on the display disappear until the temperature reaches over -20°C/-4°F again.*

Table 3

2.8 Test

Description:	Relevant Standard:	Description:	Relevant Standard:
Fast transient/burs immunity test	IEC 61 000-4-4	Voltage fluctuations and flicker	EN 61000-3-3
Conducted disturbances	IEC 61 000-4-6	Protection grade (IP 65 for terminal box)	CEI EN 60259
Electrostatic discharge	IEC 61 000-4-2	Protection grade (IP 45 for completely device)	CEI EN 60259
Supply variation	IEC 61 000-4-11	Low temperature	IEC 60068-2-1
Surge immunity test	IEC 61 000-4-5	Dry heat	IEC 60068-2-2
Magnetic field immunity test	IEC 61 000-4-3	Damp heat, cyclic	IEC 60068-2-30
Immunity test	IEC 61 000-6-2	Damp heat, constant	IEC 60068-2-78
Emission standard	IEC 61 000-6-4 (EN 55022)	Oscillation test , shock test	IEC 60068-2-27
Power-frequency magnetic field	EN61000-4-8	Stationary vibration, sinusoidal (cl.4M4)	EN 60721-3-4
Harmonic current emission	EN 61000-3-2	Seismic vibration (class 0, level II)	EN 60068-3-3

Table 3

2.9 Applications

	SDB type	Power consumption*	Silicagel**
Tap Changers	SDB-10C/10	350W	2 kg
	SDB-12C	350W	2 kg
Network transformer <40MVA	SDB-14C	350W	2 kg
Network transformer >40MVA <200MVA	SDB-15	600 W	2.5 Kg
Network transformer >200MVA	SDB-30	600 W	3 kg
Shunt reactors >40Mvar <200Mvar	SDB-15	600W	2.5 Kg
Shunt reactors >200Mvar	SDB-30	600 W	3 kg
HVDC transformers	SDB-30	600 W	3 kg
Furnace transformers	SDB-30	600 W	3 kg
GSU transformers	2xSDB-30	1200W	6 kg

** during the heating procedure*
*** main tank*

Table 4

NOTE

For each application, in case of the quantity of oil exceed the max value for each breather, Comem advice to put 2 SDB in parallel.

3. Installation

CAUTION

The operating and installation requirements described in this manual must be strictly followed. If not, the device can be damaged or a malfunction may occur.

The unit must be mounted level and upright.

The unit and piping must be installed so the oil is not able to enter the breather.

Do not install in an enclosed cabinet; proper ventilation is required.

3.1 SDB-10C

First step: Remove the tape from the entry/exit air zones. Fix the upper flange (Fig.11/A) on the flange of the pipe from the conservator (Fig.11/B) with four M12 screws (Fig.11/C).

CAUTION

Put the plane gasket between the two flanges.

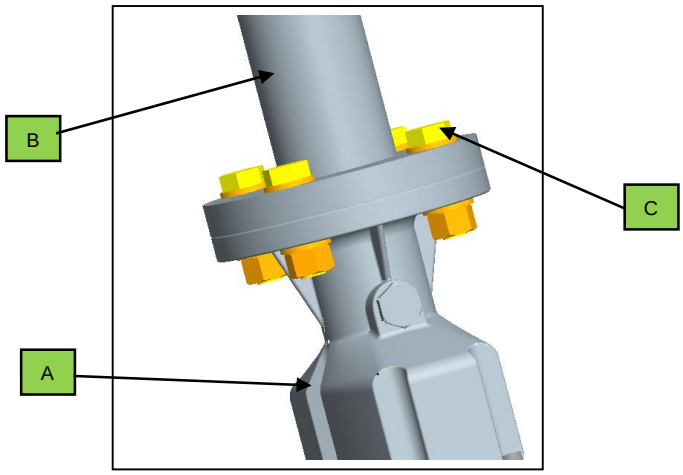


Fig. 11

Second step: unscrew plug on the SDB-10. Depending on the position of the main air breather (SDB-14C/15 or SDB-30) unscrew the right plug (Fig.12/A) or left plug (Fig.12/B).
Unscrew the plug on the main air breather (Fig.13/A).

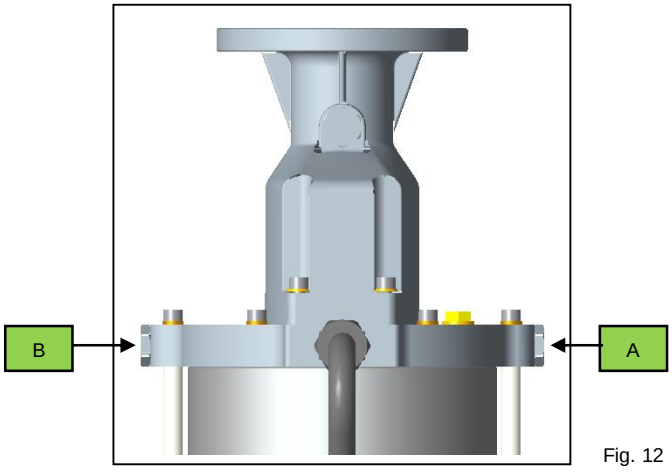


Fig. 12

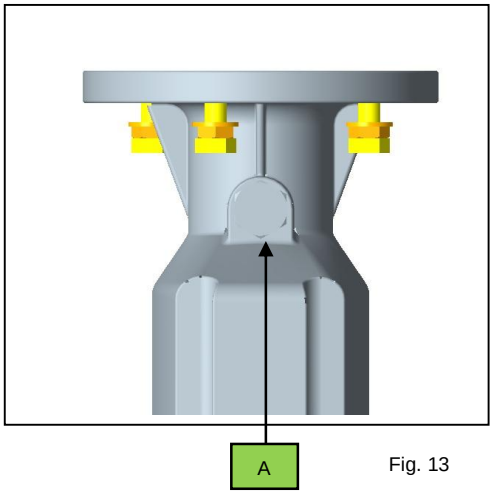


Fig. 13

Connect a pipe between the two plugs (Fig.14). The plug thread is M16x1.5 (For detail see the Appendix A5)

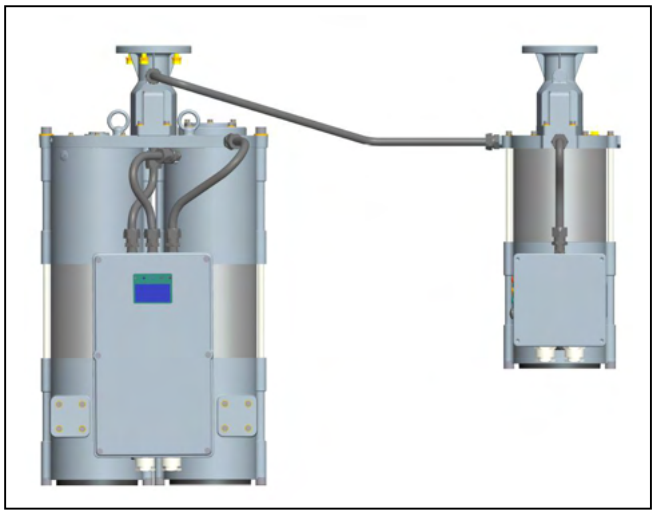


Fig. 14

WARNING

Between the plug and the housing must be positioned an OR gasket to avoid any leakage.
The system (pipe and plug) must be assembled to guarantee the sealing.

NOTE

According to the transformer design, COMEM can supply the plugs and the pipe.

3.2 SDB-10

First step: Remove the tape from the entry/exit air zones. Fix the upper flange (Fig.15/A) on the flange of the pipe from the conservator (Fig.15/B) with four M12 screws (Fig.15/C).

CAUTION

Put the plane gasket between the two flanges.

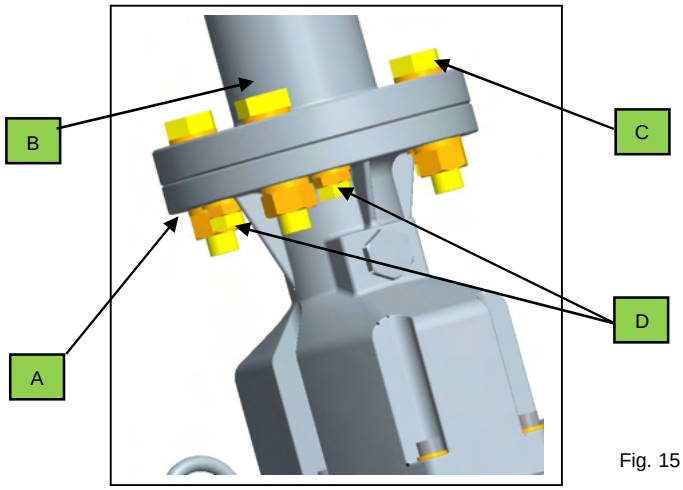


Fig. 15

Second step: Check the upper level (Fig.2/E), the internal bubble must be inside the smallest black ring.
Readjust the four special screws (Fig.15/D) to find the right position following the scheme:

- Move the vertical axis to the right (black arrow – Fig.17) and unscrew the screws 1-2-3 and fix the M12 screw until the end of the working range (Fig.17).

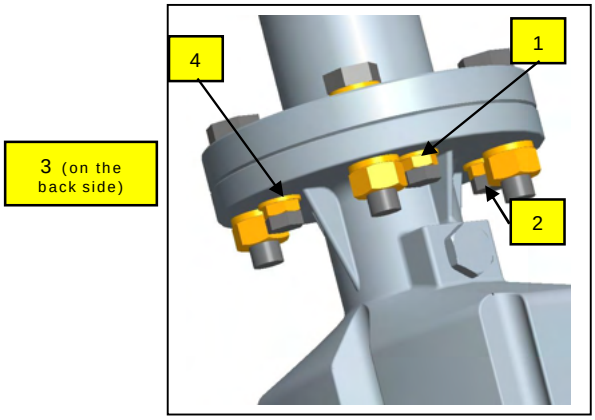


Fig. 16

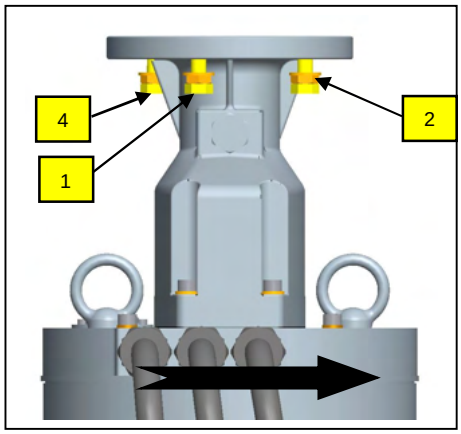


Fig. 17

- Move the vertical axis to the left (black arrow – Fig.16) and unscrew the screws 1-4-3 and fix the M12 screw until the end of the working range.

- Move the vertical axis toward (white arrow – Fig.19) and unscrew the screws 1-2-4 and fix the M12 screw until the end of the working range

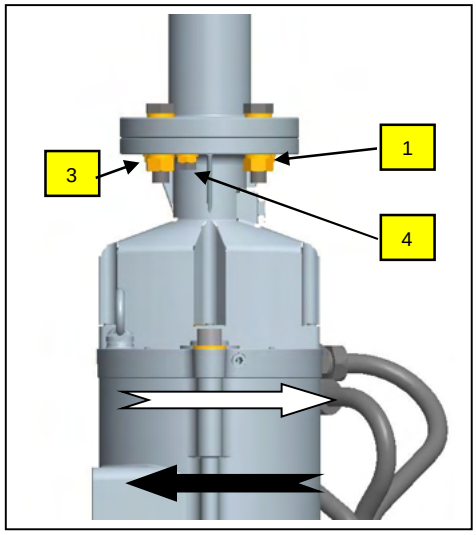


Fig. 19

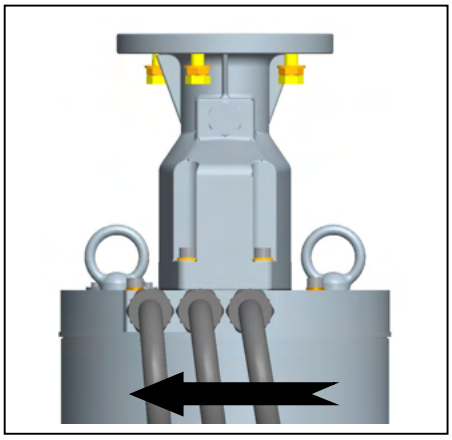


Fig. 18

- Move the vertical axis back (black arrow – Fig.19) and unscrew the special screws 4-2-3 and fix the M12 screw until the end of the working range.

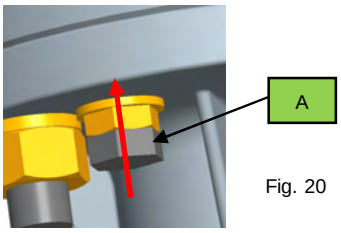


Fig. 20

At the end verify the upper level (Fig.2/E). If the internal bubble is inside the smallest black ring fix the four nuts against the flange (Fig.20/A) to avoid to unscrewing of the screws and to miss the correct position of the air dehydrating breather.

Third step: unscrew the bottom screw in the lower part of the device (Fig.21/A) until the end of the screws working range.

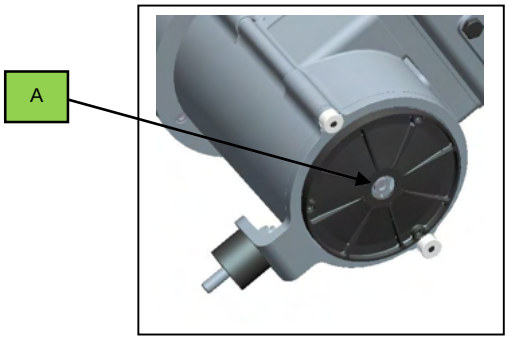


Fig. 21

Fig. 22

NOTE

The transformer manufacturer can choose whether to apply the anti-vibration kit which is supplied with the SDB depending on the sturdiness of the support (Fig.22/A).

For the electrical connections COMEM advise to use armed cables.

Fourth step: unscrew plug on the SDB-10. Depending on the position of the main air breather (SDB-15 or SDB-30) unscrew the right plug (Fig.23/A) or left plug (Fig.23/B).
Unscrew the plug on the main air breather (Fig.24/A).

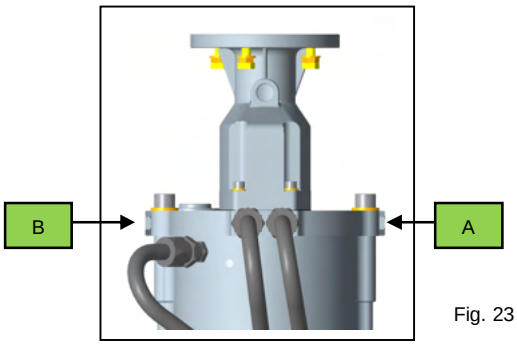


Fig. 23

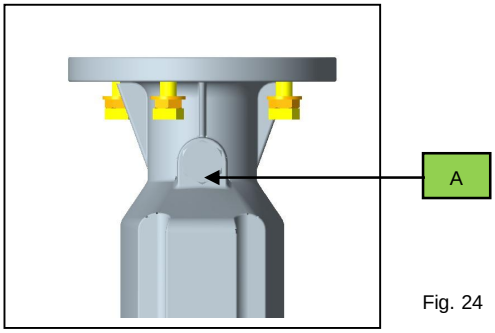


Fig. 24

Connect a pipe between the two plugs (Fig.25). The plug thread is M16x1.5 (For detail see the Appendix A5).

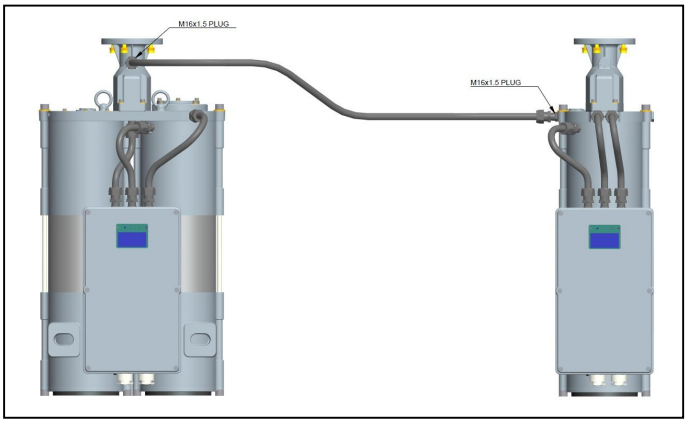


Fig. 25

WARNING

Between the plug and the housing must be positioned an OR gasket to avoid any leakage.
The system (pipe and plug) must be assembled to guarantee the sealing.

NOTE

According to the transformer design, COMEM can supply the plugs and the pipe.

3.3 SDB-12C/14C

First step: Remove the tape from the entry/exit air zones. Fix the upper flange (Fig.26/A) on the flange of the pipe from the conservator (Fig.26/B) with four M12 screws (Fig.26/C).

CAUTION

Put the plane gasket between the two flanges.

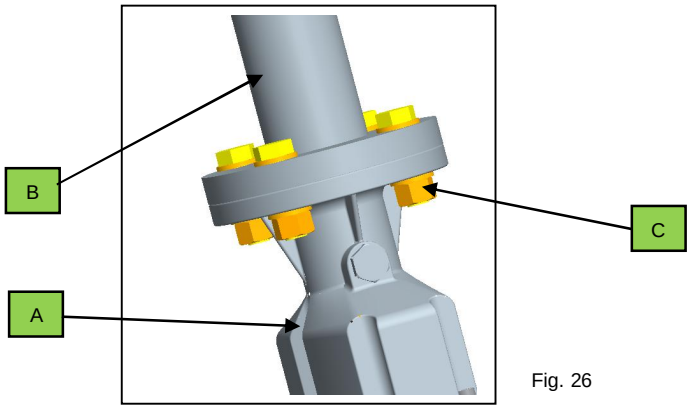


Fig. 26

3.4 SDB-15/30

First step: Remove the tape from the entry/exit air zones. Fix the upper flange (Fig.27/A) on the flange of the pipe from the conservator (Fig.27/B) with four M12 screws (Fig.27/C).

CAUTION

Put the plane gasket between the two flanges.

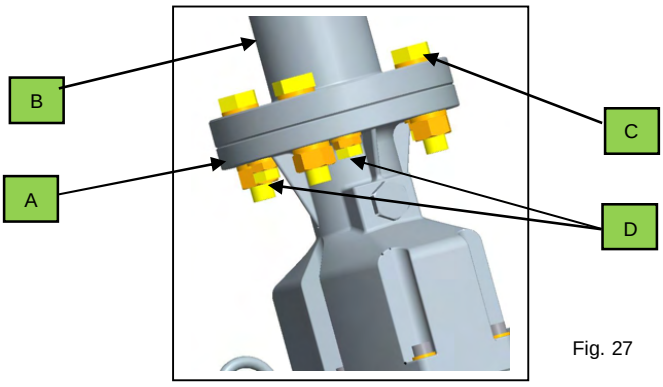


Fig. 27

Second step: Check the upper level (Fig.4/E – 5/E), the internal bubble must be inside the smallest black ring.
Readjust the four special screws (Fig.27/D) to find the right position following the scheme:

- Move the vertical axis to the right (black arrow – Fig.29) and unscrew the screws 1-2-3 and fix the M12 screw until the end of the working range (Fig.29).

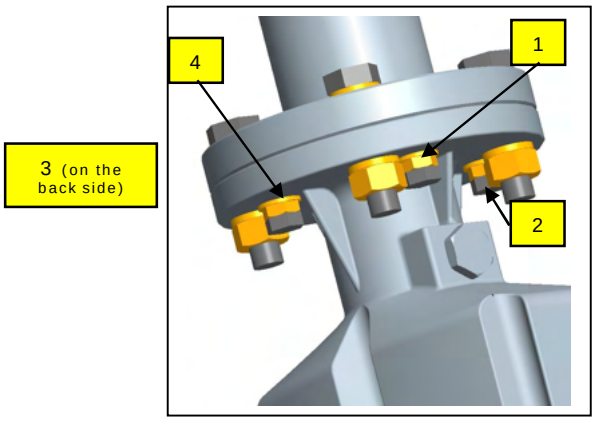


Fig. 28

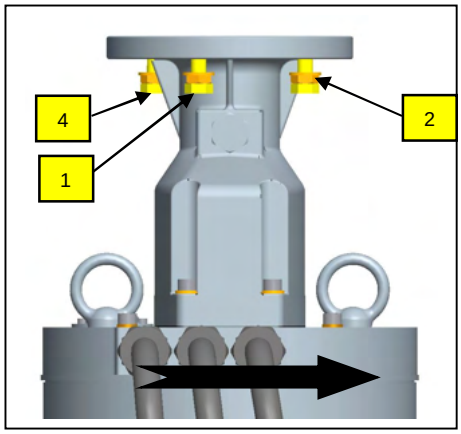


Fig. 29

- Move the vertical axis to the left (black arrow – Fig.30) and unscrew the screws 1-4-3 and fix the M12 screw until the end of the working range.

- Move the vertical axis toward (white arrow – Fig.31) and unscrew the screws 1-2-4 and fix the M12 screw until the end of the working range

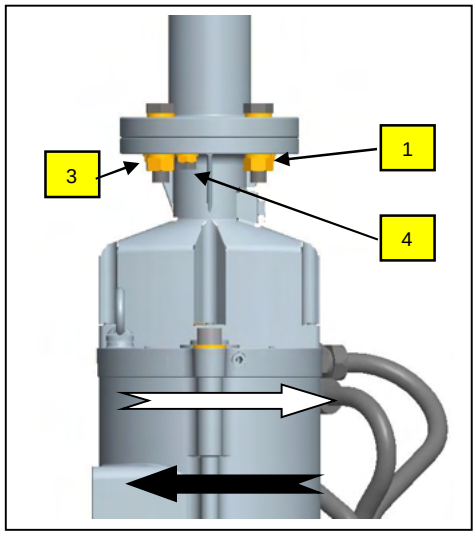


Fig. 31

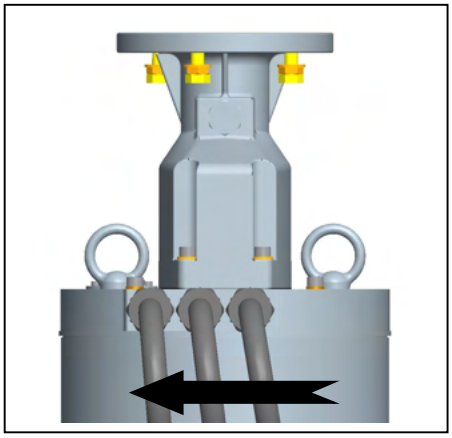


Fig. 30

- Move the vertical axis back (black arrow – Fig.31) and unscrew the special screws 4-2-3 and fix the M12 screw until the end of the working range.

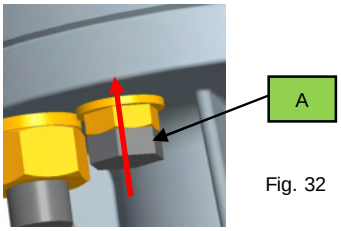


Fig. 32

At the end verify the upper level (Fig.4/E, 5/E). If the internal bubble is inside the smallest black ring fix the four nuts against the flange (Fig.32/A) to avoid to unscrewing of the screws and to miss the correct position of the air dehydrating breather.

Third step: unscrew the bottom screw in the lower part of the device (Fig.33/A) until the end of the screws working range.

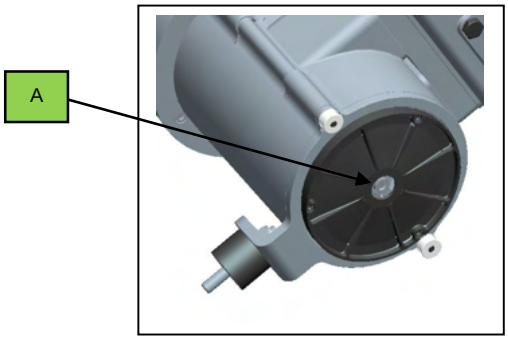


Fig. 33

NOTE

The transformer manufacturer can choose whether to apply the anti-vibration kit which is supplied with the SDB depending on the sturdiness of the support (Fig.34/A).

For the electrical connections COMEM advise to use armed cables.

Fig.34

4. Connection

CAUTION

Electrical connections should only be performed by qualified and skilled personnel trained in the applicable health and safety regulations of the relevant country.

WARNING

Dangerous electrical voltages!
It is imperative to deactivate the power supply during wiring of the device.

CAUTION

During the terminal box assembly, use caution not to damage the OR gasket. If this occurs it must be substituted.

To wire the dehydrating breather, open the terminal box (Fig.1-2-3-4-5/C). An external ground screw is positioned under the electrical box (Fig. 2-4-5/G) for SDB-10/15/30 and on the upper flange (Fig. 1-3/G) for SDB-10C/12C/14C.

4.1 Power voltage

First, connect protective ground externally (Fig.1-2-3-4-5/G).
Connect the power voltage (as written on the label on the terminal box cover) to terminals 31- 32.
For the SDB-10C/12C/14C remove the fast plug-in pulling the wire (Fig.35/A), connect the supply voltage wires in accordance to the label electrical scheme (Fig.36) and connect again the plug-in (Fig.37).

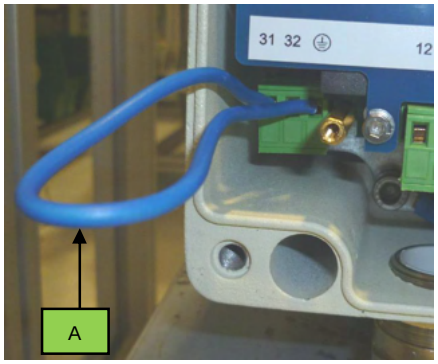


Fig.35

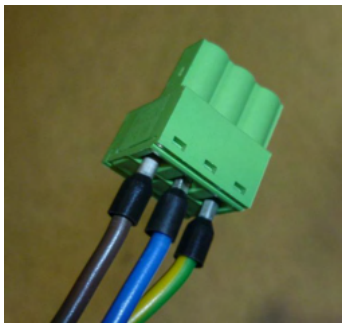


Fig.36

Fig.37

Fig.3

4.2 Relay

4.2.1 Standard Configuration

There are 2 contact failures (See chapter 2.5):

- 1 x change over contact: POWER FAILURE (terminal 22-24-21)
  NO contact: terminals 24-21
  NC contact: terminals 21-22

  After supply voltage:
  NC contact: terminals 24-21
  NO contact: terminals 21-22

- 1 x change over contact: SYSTEM FAILURE (terminal 12-14-11)
  NO contact: terminals 14-11
  NC contact: terminals 11-12

4.2.2 Special Configuration

There is one-contact failures (See chapter 2.5):

- 1 x NC contact: POWER FAILURE (terminal 22-21)
  NC contact: terminals 21-22

  After supply voltage:
  NO contact: terminals 21-22

- 1 x change over contact: HEATER ON (terminal 12-14-11)
  NO contact: terminals 14-11
  NC contact: terminals 11-12

CAUTION

The alarm relays (contact failure) will not trip the transformer.

4.3 Analog Output (optional)

Terminals for analog output 4-20 mA: 41-44

4.4 Digital Output (optional)

Digital output RS485: terminals 3-4

CAUTION

Close the free cable gland with a plug or gasket if both cable glands are not used.

5. Operation and maintenance

5.1 Operation

- **SDB-10/15/30 (MANDATORY):** after the installation and connection, the device has to be calibrated. After the connection of the power supply, the device goes in stand-by for one hour. During this time, the weight is not measured.
  To insure that the salt is not damaged during transport, one complete cycle has to be performed.

  The operator has to push the START/RESET button (Fig.9/M) on the terminal box for approximately five seconds until the blue light (Fig.9/D) switches on. The entire regeneration cycle takes about twenty hours.

- **SDB-10C/12C/14C:** set the time (days) between two-regeneration processes in accordance to appendix A4 (default value: 15 days).
  In case of necessity, it is possible to force a regeneration cycle pushing for 10 seconds the START internal button(Fig.8/B).

5.2 Regeneration cycle sequence:

SDB-10C	SDB-12C/14C	SDB-10	SDB-15/30
- Warm Up cyl1 - dehydrate cyl1 - cooling cyl1	- Warm Up cyl1 - dehydrate cyl1 - cooling cyl1 - warm up cyl2 - dehydrate cyl2 - cooling cyl2	- Warm Up cyl1 - dehydrate cyl1 - cooling cyl1 - calibration	- Warm Up cyl1 - dehydrate cyl1 - cooling cyl1 - warm up cyl2 - dehydrate cyl2 - cooling cyl2 - calibration

Table 5

CAUTION

The total regeneration phase takes about 20 hours.
In order to stop the regeneration cycle, push and hold both button (START/ RESET) (Fig.9/M – 8/B) for 20 seconds (for the SDB-10/15/30 the correct calibration of the load cell is not guaranteed if this is performed).

NOTE

Comem advices to disconnect the SDB during the electrical transformer routine test

5.3 Maintenance

During regular maintenance on the transformer, we recommend performing the following checks on the dehydrating breather:

- Check the exterior condition of the device (especially the filter air Fig.1-2-3-4-5/A)
- Check the LED indication
- Check the display indication (SDB-10/15/30)
- Check the failure contact
- Check the upper level (Fig.2-4-5/E, SDB-10/15/30), the internal bubble must be inside the smallest black ring
- It is possible, to perform a functional test pushing
  - SDB-10/15/30: 10 seconds the stand-by button (Fig.7/N)
  - SDB-10C/12C/14: external button (Fig.1-3/D)

CAUTION

SDB-10/15/30: if the device is not level, proceed as explained in section 3.2/3.4 (first step) and after, if the condition of the device is on IDLE, start the regeneration cycle as explained in section 5.1.

NOTE

If the fitting is not powered for more than 3 days, the clock will re-start at the next powering from the date and hour of the end of the last regeneration cycle.

NOTE

It is not possible to do the functional test if the regeneration process is activated.

5.3 Fault monitoring

The device has a self-monitoring function to detect internal faults, which are displayed by LEDs and failure contacts. Adding information can be done by the display on the SDB-10/15/30.
The following table lists the individual faults.

FAULT	LED Indication	ERROR-RELAY (STANDARD CONFIGURATION)	ERROR-RELAY (SPECIAL CONFIGURATION)	DISPLAY Indication (SDB-10/15/30)	NOTE
Failure of the supply voltage	All LED's off	POWER FAILURE: terminal 22-24-21	POWER FAILURE: terminal 22-24-21	None	Check if the supply voltage is connected correctly
Electronic control defective	Red: ON	POWER FAILURE: terminal 22-24-21	POWER FAILURE: terminal 22-24-21	None	Try to switch off and switch on the power supply. If the error remains please contact COMEM.
Heater 1 defective	Red: ON Blue: ON	SYSTEM FAILURE: terminal 12-14-11	POWER FAILURE: terminal 22-24-21	HEATER 1 FALL	Push the RESET(1) button in the terminal box. If the error remains the dehydrating breather should be replaced. Please contact COMEM.
Heater 2 defective	Red: ON Blue: OFF	SYSTEM FAILURE: terminal 12-14-11	POWER FAILURE: terminal 22-24-21	HEATER 2 FALL	Push the RESET(1) button in the terminal box. If the error remains the dehydrating breather continues to work because the main tank (1) is not damage. During the regeneration, for a short time, the salt in the tank 2 will not be regenerated and will continue to work. In this condition, the device may work for a long time. Please contact COMEM to replace it.
FAN 1 Defective	NOT indicated	-	-	WARNING: FAN1 FAIL	The device goes on to work correctly. The regeneration cycle will be longer than before.
FAN 2 Defective **(SDB-15/30)**	NOT indicated	-		WARNING: FAN2 FAIL	The device goes on to work correctly. The regeneration cycle will be longer than before.
WEIGHING CELL defect **(SDB-10/15/30)**	Red: ON Blue: ON	SYSTEM FAILURE: terminal 12-14-11	POWER FAILURE: terminal 22-24-21	TANK 1 NOT DRIED	Push RESET(1) button. If error remains it means that the weighing cell is damaged. Control of the weight is no longer possible, but the device works because of the backup time control. If the error remains the dehydrating breather should be replaced. Please contact COMEM.
SALT REPLACEMENT	Red: ON	SYSTEM FAILURE: terminal 12-14-11	POWER FAILURE: terminal 22-24-21	SALT REPLACEMENT	After a fixed number of regeneration cycles, COMEM advises to verify the device condition (contact COMEM for further details). Push the reset button to eliminate the error.
LOAD CELL outside range **(SDB-10/15/30)**	Red: ON	SYSTEM FAILURE: terminal 12-14-11	POWER FAILURE: terminal 22-24-21	LOAD > 10 Kg	Push RESET(1) button. If error remains it means that the weighing cell is damaged. Control of the weight is no longer possible, but the device works because of the backup time control. If the error remains the dehydrating breather should be replaced. Please contact COMEM.

Table 6

(1)RESET:
- SDB 10/15/30: push the both button (Start/Reset (M) – Stand by (N)) for 20 seconds
- SDB 010/012/015: push the external button for 5 seconds

5.4 Movement, transport and storage

Move the SDB-15/30 using the eyebolts in the upper part (Fig.4-5/F). The SDB-10/10C/12C/14C can be handled without any tools.
Handle the device with care.
When you remove the device from the transformer (for example during shipping operation), please follow the procedure:

- Switch off the supply voltage
- Remove the supply wire from the terminal box
- Turn the screw on the bottom side (Fig.21-33) with the maximum torque of 2 Nm (1.5 lbft) **(only for SDB-10/15/30)**

CAUTION

During the transformer transport, COMEM advises to disassemble the air breather and to place it inside the original box.

Not to paint the device. In this case any guarantees concerning the corrosion resistance decline.

Only mild soap and water should be used to clean the electrical box cover. Solvents must not be used for any reason as they will degrade the performance of the paint. Use of solvents on the unit will immediately void the warranty.

When you install the device please follow section 3, 4 and 5.

The SDB must be stored in the original packing and in a dry place with temperature in the range -10÷40°C (14÷104 °F).
Upon receiving the device, please check:

- The outer surface of the packaging to ensure that it is intact
- That there are no breakages

If damages are found, please contact Comem and provide the information from the shipping list and the serial number of the Self-dehydrating breather.

APPENDIX A: OPTIONS

A1: Flange DIN 45962 connection

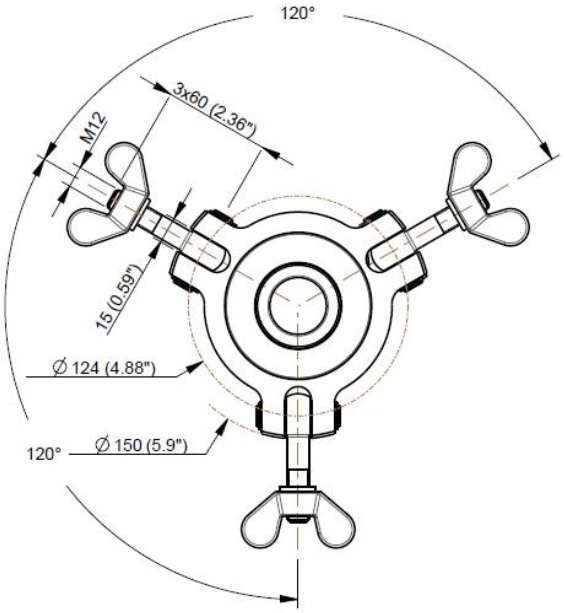


Fig.38

CAUTION

The minimum thickness flange has to be 15 mm

The rotation range shall be completely covered adjusting the position of SDB and fixing the locknut

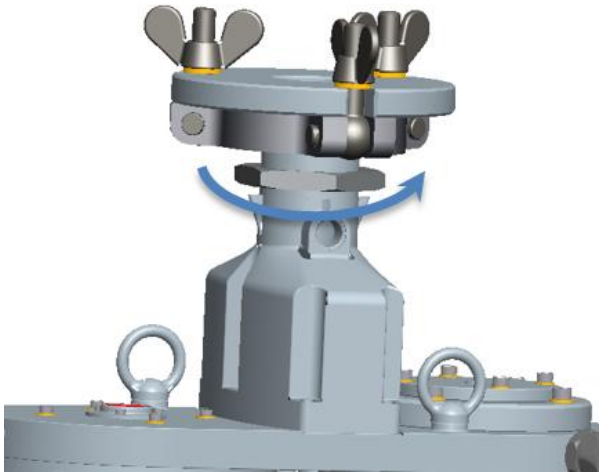


Fig.39

A2: Overpressure valve (kit 5CONE29800)

To avoid an overpressure in the conservator pipe in case of high discharge flow (advised for high quantity of oil (>80 tonn)). Comem suggests to assembly the overpressure valve kit (Fig. 40) with the following features:

- Mono directional flow
- Gasket material: NBR (-40°C)
- External material: AISI 303
- Open pressure: 0.15-0.35 bar

Fig.40

NOTE

The kit will has to be requested by the customer during the order phase and it will assembled on the SDB directly by Comem worker

A3: MODBUS register

A3.1 SDB-10C/12C/14C

	Register address	Operation	Notes
			Operation for controlling
	1	W	Start Cycle
	2	W	Abort Cycle
	3	W	Test Cycle
	4	W	Standby Off
	5	W	Reset Cycle
	6	W	Reset Log
	7	W	Self Test
			Operation for monitoring
	30101	R	Hour
	30102	R	Minute
	30103	R	Second
	30104	R	Day
	30105	R	Month
	30106	R	Year
	30107	R	T1
	30108	R	T2
	30109	R	Cycle status
	30110	E	EV status
	30111	R	N. of cycles
	30112	R	N. of available events (log)
	30113	R	Days to next cycle
	30114	R	Anti-Condensation Header State
			Data logging
EVENTO - 1	34001	R	Timestamp
	34002	R	
	34003	R	Cycle #
	34004	R	LogType
	34005	R	T1
	34006	R	T2
	…	…	…
EVENTO - 480	36881	R	Timestamp
	36882	R	
	36883	R	Cycle #
	36884	R	LogType
	36885	R	T1
	36886	R	T2

Table 7

A3.2 SDB-10/15/30

	Register address	Operation	Notes
			Operation for controlling
	0x1	W	Start Cycle
	0x2	W	Abort Cycle
	0x3	W	Test Cycle
	0x4	W	Standby Off
	0x5	W	Reset Cycle
	0x6	W	Reset Log
			Operation for monitoring
	0x2000	R	Salts Percentage
	0x2001	R	Temperature T1
	0x2002	R	Events number
	0x3000	R	Hours
	0x3001	R	Minutes
	0x3002	R	Seconds
	0x3003	R	Day
	0x3004	R	Month
			Data logging
EVENTO - 1	0x2100	R	Day Hour
	0x2101	R	
	0x2102	R	Cycles number
	0x2103	R	Event type
	0x2104	R	Salts weight
	0x2105	R	Temperature T1
	0x2106	R	Temperature T2
	0x2107	R	Temperature T3
	…	…	…
EVENTO - 480	0x2100	R	Day Hour
	0x2101	R	
	0x2102	R	Cycles number
	0x2103	R	Event type
	0x2104	R	Salts weight
	0x2105	R	Temperature T1
	0x2106	R	Temperature T2
	0x2107	R	Temperature T3

Table 8

A3.3 MODBUS address

When are installed two or more units, it is necessary to differentiate the MODBUS address changing the dip-switches position

The available SDB address are

- SDB-10/15/30: 1(default) to 16

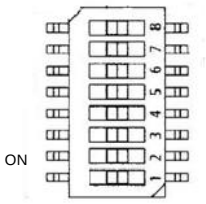


Fig.41

8	7	6	5	4	3	2	1	ADDRESS
ON	ON	ON	OFF	ON	ON	ON	ON	16
ON	ON	ON	ON	OFF	OFF	OFF	OFF	15
ON	ON	ON	ON	OFF	OFF	OFF	ON	14
ON	ON	ON	ON	OFF	OFF	ON	OFF	13
ON	ON	ON	ON	OFF	OFF	ON	ON	12
ON	ON	ON	ON	OFF	ON	OFF	OFF	11
ON	ON	ON	ON	OFF	ON	OFF	ON	10
ON	ON	ON	ON	OFF	ON	ON	OFF	9
ON	ON	ON	ON	OFF	ON	ON	ON	8
ON	ON	ON	ON	ON	OFF	OFF	OFF	7
ON	ON	ON	ON	ON	OFF	OFF	ON	6
ON	ON	ON	ON	ON	OFF	ON	OFF	5
ON	ON	ON	ON	ON	OFF	ON	ON	4
ON	ON	ON	ON	ON	ON	OFF	OFF	3
ON	ON	ON	ON	ON	ON	OFF	ON	2
ON	ON	ON	ON	ON	ON	ON	ON	1

Table 9

- SDB-10C/12C/14C: 160 – 175 (default)

Fig.42

4	3	2	1	ADDRESS
OFF	OFF	OFF	OFF	175
OFF	OFF	OFF	ON	174
OFF	OFF	ON	OFF	173
OFF	OFF	ON	ON	172
OFF	ON	OFF	OFF	171
OFF	ON	OFF	ON	170
OFF	ON	ON	OFF	169
OFF	ON	ON	ON	168
ON	OFF	OFF	OFF	167
ON	OFF	OFF	ON	166
ON	OFF	ON	OFF	165
ON	OFF	ON	ON	164
ON	ON	OFF	OFF	163
ON	ON	OFF	ON	162
ON	ON	ON	OFF	161
ON	ON	ON	ON	160

Table 10

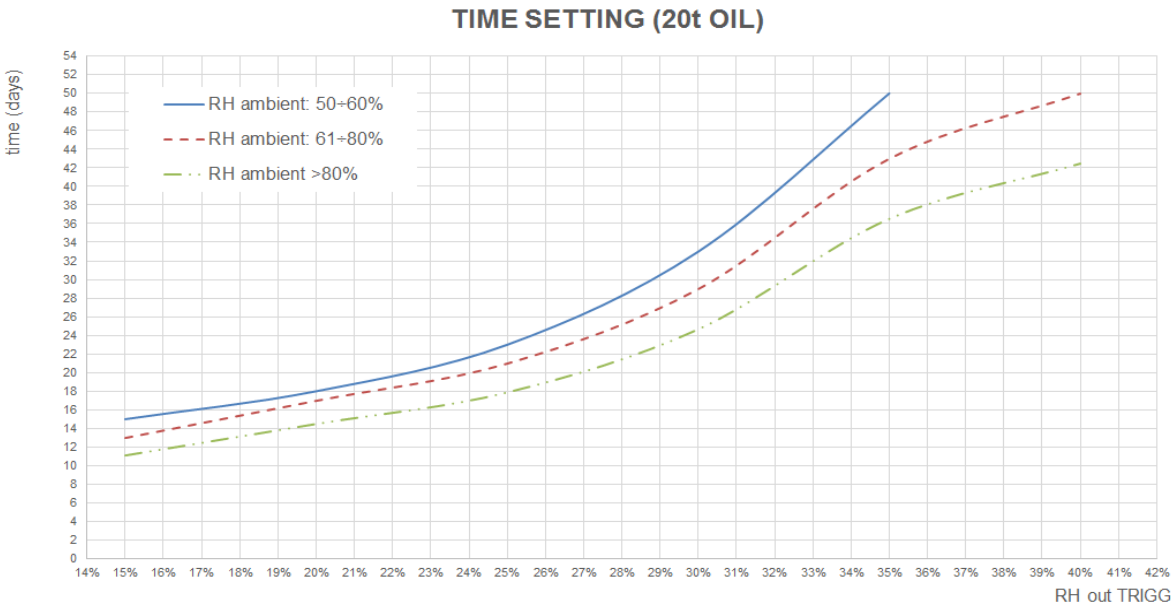
A4: SET TIME BETWEEN TWO REGENERATION PROCESSES (SDB-10C/12C/14C)

There is the possibility to set the time between two regeneration processes:

1. Pushing for 5 seconds the button (Fig.8/B) till the number on the display (Fig.8/A) starts to blink.
2. Pushing again the button until the selected time is reached (max selected time is 50 days).

The indicative time is showed in the graph 1 considering

- An average value (yearly) of the ambient humidity (%).
- An average value of the oil density.
- A temperature difference of 40 °C .
- A specific oil quantity (in the example 20 tons).
- An output relative humidity trigger (%)



Graph 1

Notes:

- As default, the pre-set time between two regeneration processes is 15 days for SDB-10C/12C and 20 days for SDB-14C.
- For any further information or specific cases, please contact COMEM.

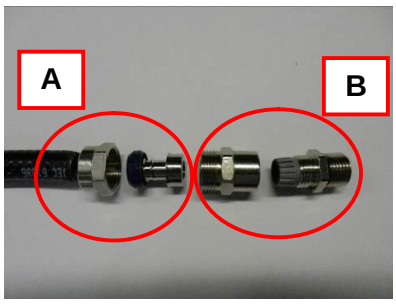
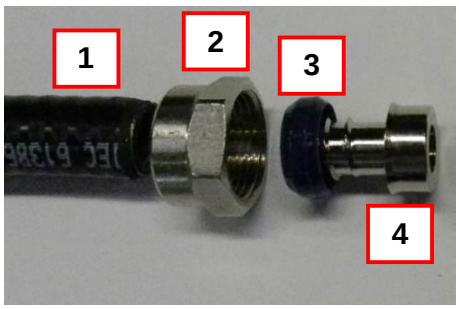
A5: SDB-10/10C Connection

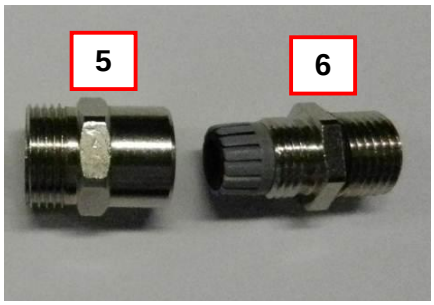
A5.1 Components

KIT: 5COE464103 composes by:

a) N°2 x 5COE464101: plug
b) 5COE459900: connection tube

A5.2 Operation instructions

Phase	Actions	Figures	Notes
1	Connect the “connection tube” pre-assembled with the plug to the main air dehumidifier (SDB-14C, SDB-15, SDB-30)		On the thread, apply some sealing glue (e.g. Loctite 542) to optimize yhe sealing. 
2	Cut the opposite side of the tube at the suitable length (according to installation layout)		After cutting, ensure there are no burrs.
3	The cable gland assembly has to be prepared		A: components to assembly on the tube B: components to assembly on SDB-010
3a	Components identification (A)		1: tube 2: connection washer 3: Internal gasket 4: Fixing screw

Phase	Action to do	Pictures	Notes
3b	Components identification (B)		5: connection spacer 6: plug
4	Pipe preparation: Insert the connection washer (2) on the tube (1)		
4a	Insert the internal gasket (3) on the tube (1)		
4b	Screw the fixing screw (4) in the tube (1)		The tube has to enter completely inside the fixing screw. Ensure no burrs are present.

Phase	Action to do	Pictures	Notes
5	Unscrew the SDB-10/10C plug		
5a	Screw the plug (6 – Phase 3b) in the hole		On the thread, apply some sealing glue (e.g. Loctite 542) to optimize the sealing 
5b	Screw the connector spacer (5) on the plug (6)		On the thread, apply some sealing glue (e.g. Loctite 542) to optimize the sealing. 
6	Connect the tube (phase 4b) to the SDB-010 (phase 5b)		On the thread, apply some sealing glue (e.g. Loctite 542) to optimize the sealing. 

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Appendix F

Liquid Temperature Gauge

Qualitrol AKM345 (6 pages)

OTIWTI™

Remote mount thermometers (AKM)

The next generation thermometer from the global leader

- Six switch capability, sequentially independent, with adjustable hysteresis
- Reduce failure costs with reliable AKM bellows operation
- Widest range of inputs and outputs including double gradient onboard
- Simple to work on with the new smart design case
- Further reduce your costs with the high switching capability no extra components for fan bank control and alarm trip

Product Summary

Description Capillary based, mechanical, remote indicating thermometer where electrical power is not required for indication. Configurations for oil temperature measurement and winding temperature simulation. Features up to 6 flexible switches for alarm, trip, and cooling system functions and can be equipped with various electronic outputs for SCADA and remote monitoring applications.

Application For oil (liquid) or simulated winding temperature indication with integrated features for control or alarm functions. Designed for use where the point of measurement (the well or pocket) is not easily viewed by personnel requiring separate or remote indication.

QUALITROL®
Defining Reliability

OTIWTI™ Remote mount thermometers (AKM)

The next generation thermometer from the global leader	• Over 75 years of experience designing mechanical temperature measurement devices for transformers • Over 250,000 capillary type thermometers in service worldwide in all environmental conditions • Improved connection ease with a greater number cable glands; 3xM25 style and 2xM20 style • Improved switching flexibility with up to 6 fully configurable switches • New and improved swing out case design allows for easy cable connection, switch configuration and testing without removal of the cover
Accomplish the most demanding control and alarm configurations	• Up to 6 fully independent switches flexible enough for most control and alarm schemes • Each switch can be specified by switch type, hysteresis range, and set point, without limitation of sequential set points • Standard switch rated for up to 15 Amps AC and up to 10 Amp DC, switches also available for higher VDC (magnetic blow out, M.B.O.), and switches for milliamp loads-- see technical specifications for more information • Various analog outputs also available (mA, Pt 100, and Cu 10) -- see technical specifications for more information • Each switch can be specified with adjustable hysteresis (5 to 25°C)
Reduce costs with reliable AKM bellows operation	• Non-pressured bellows system better resists leakage when compared to bourdon tube (pressurized) style capillary thermometers • Integrated heating element in bellows for winding temperature indication eliminates extra cost and complexity of accessories to simulate the winding • AKM bellows system provides a 260° dial deflection (angle the pointer travels from minimum to maximum) making it easier to interpret temperature reading from a distance
Minimize installation complexity with all-in-one design	• Single enclosure design minimizes need for additional accessories such as matching units and heated wells commonly used by other mechanical temperature solutions • New hinged cover enables easy access to switch settings and connections during installation while shielding device from elements. Features all captive screws and can be completely removed, if necessary • Same installation footprint and mounting options as the previous generation AKM 345 • Improved wiring installation with addition of 2 cable glands (for a total of 5) and an increase in size to 3xM25 and 2xM20 versus the previous generation
Simplify operations by using one family of thermometer for all environmental conditions	• Wide range of options allow for standard use of one thermometer series across a wide array of applications and operating conditions • Extreme temperature survivability with polar executions for use down to -60°C • Enclosures with IP55 or IP65 rating with numerous mounting configurations available • The most flexible switching capabilities available for implementation of any control and alarm configuration

New improved AKM OTIWTI™

AKM BELLOWS TECHNOLOGY
System provides a 260° dial deflection (angle the pointer travels from minimum to maximum) making it easier to interpret temperature reading from a distance

AKM BELLOWS TECHNOLOGY
Non-pressured bellows system better resists leakage when compared to bourdon tube (pressurized) style capillary thermometers

AKM BELLOWS TECHNOLOGY
Integrated heating element in AKM bellows for winding temperature indication eliminates extra cost and complexity of accessories to simulate the winding

ONE FAMILY OF THERMOMETER FOR ALL ENVIRONMENTAL CONDITIONS
Enclosures with IP55 or IP65 rating with numerous mounting configurations available including extreme temperatures down to -60°C

NEW CASE DESIGN
Swing out case design allows for easy terminal block connection, switch configuration and testing without removal of the cover

NEW 6 SWITCH CAPABILITY
Up to 6 fully independent switches flexible enough for most control and alarm schemes

IMPROVED WIRING INSTALLATION
Improved wiring installation with addition of 2 cable glands (for a total of 5) and an increase in size to 3xM25 and 2xM20 versus the previous generation

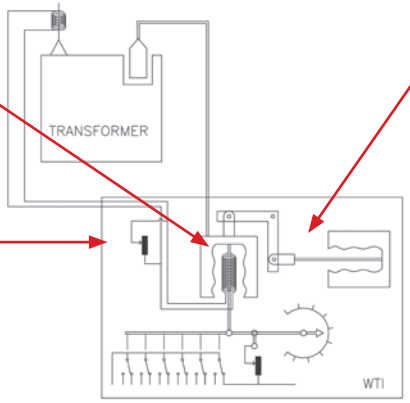
ELECTRONIC OUTPUTS (USER UPGRADE KITS AVAILABLE)
Various analog outputs available (mA, Pt 100, and Cu 10) -- user upgrade possible via rear access panel by trained personnel.

AKM345 DOUBLE GRADIENT OPTION
The Double Gradient option allows for setting two separate winding simulations in the same Winding Temperature Indicating Thermometer.

Winding system

Integrated heating element in AKM Measurement bellows simplifies winding temperature indication by eliminating the complexity of accessories to simulate the winding

Single enclosure design minimizes need for additional accessories such as matching units and heated wells commonly used by other mechanical temperature solutions



AKM Compensation bellow automatically compensates for ambient temperature

Options and accessories

Pockets/wells

- Pockets and wells available to fit all bulb types including IEC and ANSI standards

46950
46949
44595-1

Remote indicators

- Digital and analog indicators available for remote display of temperature measurement
- For use with 4-20 mA output option

47875 47877 47877-1

Power supply

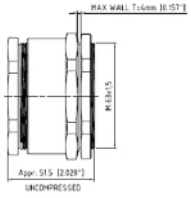
- For use with remote indicators and remote electronic outputs when 24 VDC is not available
- Universal Power Supply 85-264 VAC, 90-250 VDC
- Tolerance +10% or -15%
- DIN rail mounting

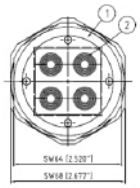
48510 48515

Pass through capillary gland

- For environmental isolation when capillary needs to pass through an enclosure

RG 63/4





Electronic output user upgrade kit

- Add electronic output capability to units previously purchased without output
- Upgrade possible through back access panel by trained personnel only

47675

Don't see what you need?
QUALITROL regularly creates models with special customer requirements.
Contact your local sales representative or QUALITROL Application Engineer to review your special requirements.

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OTIWTI™ Remote mount thermometers (AKM)

TECHNICAL SPECIFICATIONS

Materials	Housing	Die-cast aluminum, polyester powder coat finish
	Capillary	Copper or copper/nickel with stainless steel jacket
	Lens	UV stabilized polycarbonate (standard), glass optional
Functional specification	Indication accuracy	±1.5% full-scale
	Standard measurement range	0 to 150°C (32°F to 302°F)
	Bulb types	Standard: 14mm diameter x 156mm length Available: for wells per DIN 42554, ASA C57.12.00
	Winding thermal image	Internal winding simulation: TD50 5 Amp/TD50 (up to 2.2A CT Max) or TD76 (up to 2.65A CT max) External winding simulation: (AKM 44678) up to 2A CT or (AKM 44674) up to 1.2A CT max, matching unit (AKM 44677) for up to 5A CT max
	Mounting styles	Stainless steel anti-vibration mount (standard), elastomeric seismic mount optional
	Cover	Swing up cover design, fully detachable, with all captive hardware
	Cable glands	3 x M25, 2 x M20
Output parameters	Number of switches	2 to 6 switches (independently specified types)
	Switch types	VAC, VDC, M.B.O. (magnetic blow out, high DC)
	Switching differential (hysteresis)	10° to 14°C for most dial ranges, optional adjustable differential from 5° to 25°C
	Switching accuracy	± 3% full-scale
	Optional remote outputs	Current loops: 0 to 1 or 4 to 20mA
		Voltage: 1-5V, etc...
		Resistive: Pt 100 or Cu 10 ohm
Environmental	Protection class	IP55 (standard), IP65 optional
	Dielectric isolation (hi pot)	2500 VAC at 50Hz, 60 seconds, all terminals to ground
	Surge withstand capability	IEEE C37.90.1 (TD111 output board only)
	Operating temperature	-40°C to 70°C (-40°F to 158°F), polar execution available -60°C to 50°C (-76°F to 122°F)
	Storage temperature	-50°C to 80°C (-58°F to 176°F)
	Humidity	95% non-condensing relative humidity @ 95°C (203°F)
	Vibration	50Hz/60Hz @ 0.1mm inch displacement, 3-axes
	Shock	10 G's half-sine, in three orthogonal planes

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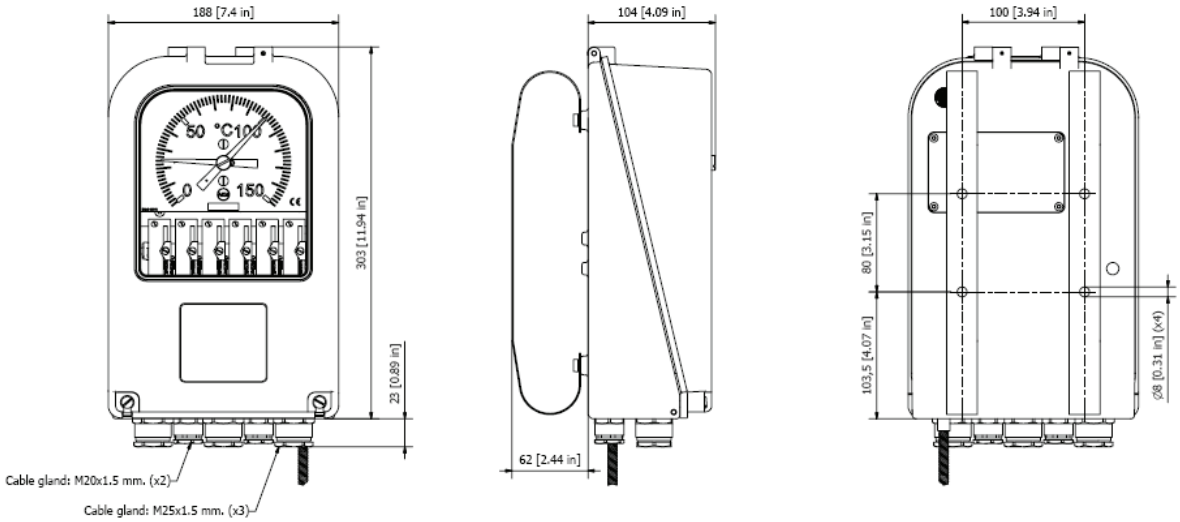
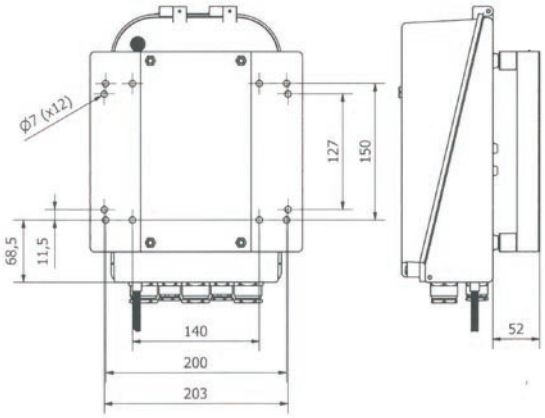
OTIWTI™ - Mounting styles and dimensions

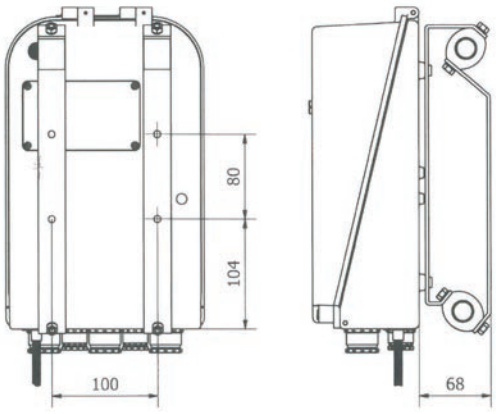
Standard mounting



Universal mounting



Siesmic mounting



QUALITROL® Field Services

To further improve reliability, QUALITROL provides comprehensive education and on-site commissioning services, maintenance contracts and technical support to all customers worldwide. Emergency response is available on all products and services.

About QUALITROL®

QUALITROL Company LLC manufactures substation and transformer monitoring and protection devices used by electric utilities and manufacturing companies. It is the global leader in sales and installations of transformer asset protection equipment, fault recorders and faul locators. Established in 1945, QUALITROL Company produces thousands of different types of products on demand, each customized to customers' unique requirements.

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SECTION 13

Appendix G

Liquid Level Gauge

Qualitrol LLG042 (4 pages)

QUALITROL® 032/045 & AKM 44712

Large oil level indicators

Better transformer protection with accurate oil level monitoring and alarm and limit functions

- **Rugged design and corrosion resistant materials provide long, trouble free life**
- **Many options provide customized solutions for your application**

Product Summary

Description **Provides continuous indication of the liquid level inside of a transformer's main tank, conservator tank or load tap changer compartment. Models available with gear driven or lever driven float mechanisms. Gear driven mechanism provides amplified pointer movement relative to corresponding float travel. Lever driven gauges offers slimmer profile for tight spaces within a transformer. Integrated switches allow for limit and alarm control functions.**

Application **For monitoring of the liquid level inside a transformer's conservator and/or main tank, load tap changer compartment, or other vessels where liquid level is critical.**

QUALITROL®
Defining Reliability

Better transformer protection with accurate oil level monitoring and alarm and limit functions

- Low level and high level alarm control is made possible with up to 3 integrated switches for 032, 042 and 045 models and up to 4 switches for 44712 and 34725 models
- Gear driven mechanism provides amplified pointer movement relative to the corresponding float movement for enhanced clarity of visual display
- Models with analog output (0-1 mA or 4-20 mA) allow for continuous remote monitoring of oil level

Rugged design and corrosion resistant materials provide long, trouble free life

- Die-cast aluminum housing is coated with a thermosetting powder coat finish
- Stainless steel and corrosion resistant parts protect gauge against harsh environmental conditions
- Optional UV resistant polycarbonate lens resists yellowing with age
- 045 models are designed for hazerdous locations and are UL listed for class 1 div 2

Many options provide customized solutions for your application

- Switching can be supplied for various liquid levels
- Both industry-standard and custom engineered dial markings are available
- A wide variety of electrical connections are available including quick connects, Military style, ANSI, conduit-ready and terminal box styles

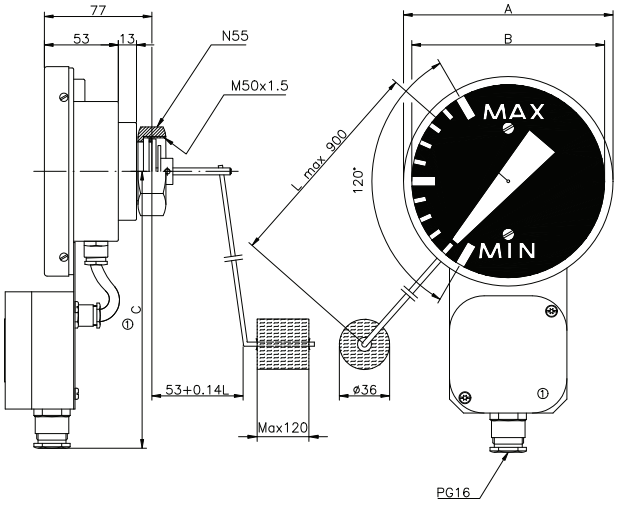
032/042/045 TECHNICAL SPECIFICATIONS

Mechanical	Mounting	Flange mount, various sizes available
	Float mechanism	Gear (042 and 045 series) or lever (032 series)
Dimensions	Dial diameter	5.5” (140mm)
Materials	Case	Die cast aluminum
	Bezel	Stainless steel
	Flange	Aluminum (standard), brass
	Float rod	Brass, copper coated steel or aluminium
	Float	Nitrophyl, steel, cork, homogenous acrylate plastic
	Lens	UV stabilized polycarbonate (standard), glass or tempered glass
Electrical	Connection type	Terminal box or permamently attached (standard), quick connectors, sealed-weatherproof connectors
	Number of switches	Up to 3
	Switch rating (AC)	10A @ 125, 250, 480 VAC
	Switch rating (DC)	1/2A @ 125 VDC, resistive
		1/4A @ 250 VDC, resistive
	Switch type	SPDT
	Dielectric strength	1,500 VAC for 60 seconds
Scada output	Output signal	4 - 20 mA (optional 0-1 mA on 039 series)
	Supply voltage	24 VDC nominal (120 or 240 VAC on 039 series)
	Max load	600Ω

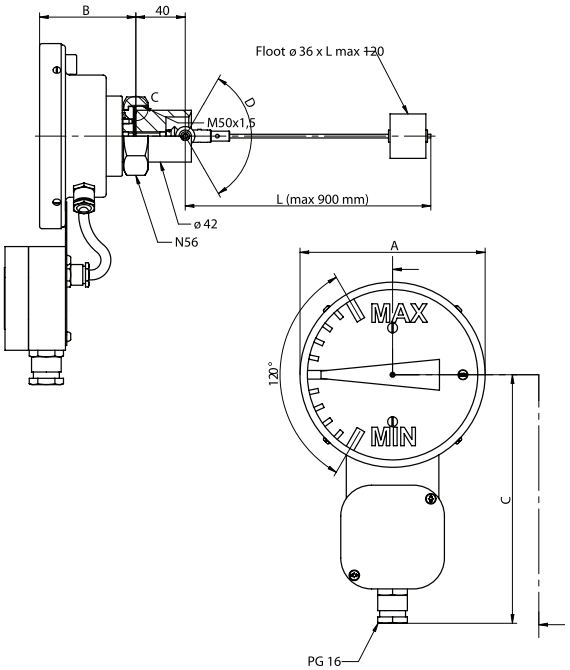
44712/34725 TECHNICAL SPECIFICATIONS

Mechanical	Mounting	M50 thread mount
	Float mechanism	Gear (34725) or lever (44712)
Dimensions	Dial diameter	5.9” (150 mm) or 9.8” (250 mm)
Materials	Case	Die cast aluminum, stainless steel
	Bezel	Stainless steel
	Flange	Aluminum (standard), brass
	Float rod	Brass, copper coated steel or aluminium
	Float	Nitrophyl, steel, cork, homogenous acrylate plastic
	Lens	UV stabilized polycarbonate (standard), glass or tempered glass
Electrical	Connection type	Terminal box (standard) or permamently attached, quick connects, sealed-weatherproof connectors
	Number of switches	4
	Switch rating (AC)	5A @ 250 VAC
	Switch rating (DC)	0.30A @ 125 VDC, resistive
	Switch type	SPST or SPDT
	Dielectric strength	2,000 VAC for 60 seconds
Scada output	Output signal	4 - 20 mA
	Supply voltage	24 VDC nominal
	Max load	600Ω

44712 Series



34725 Series



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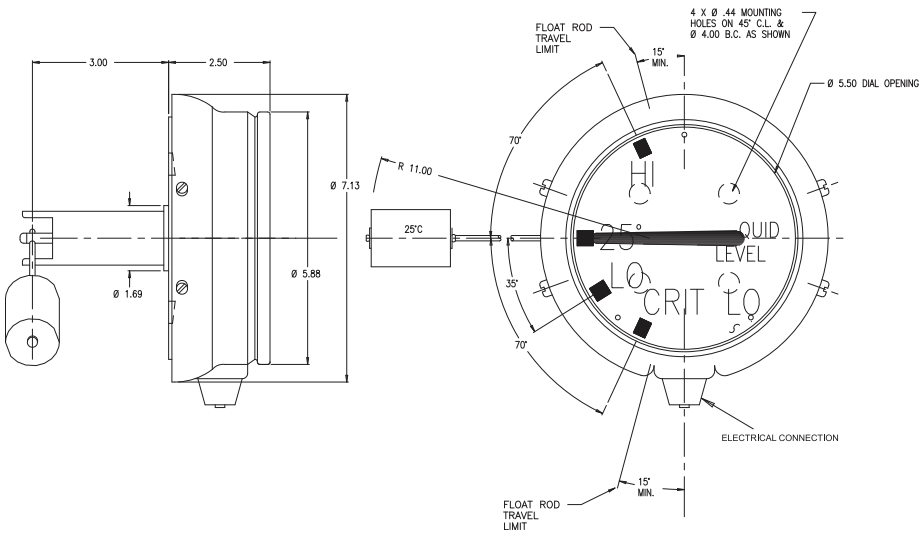
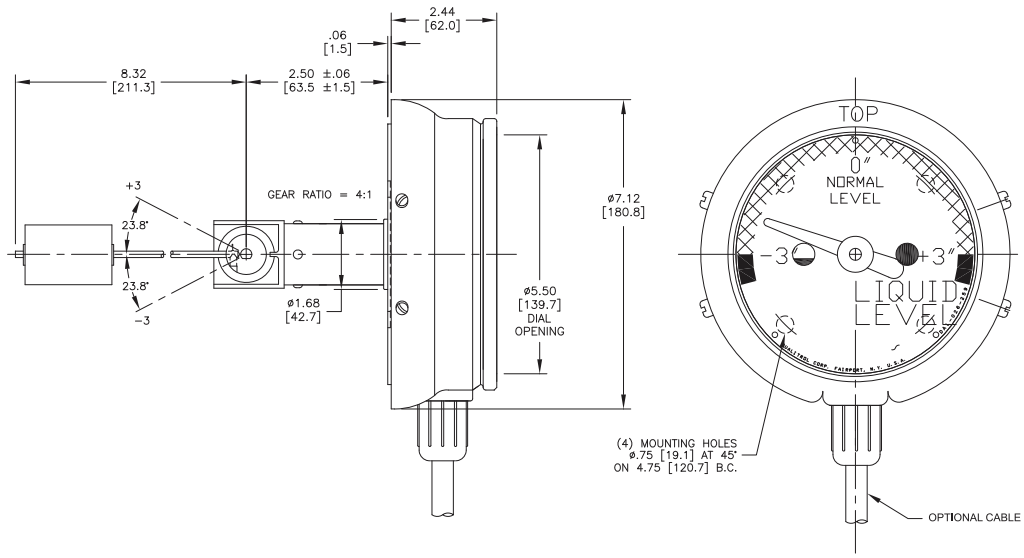
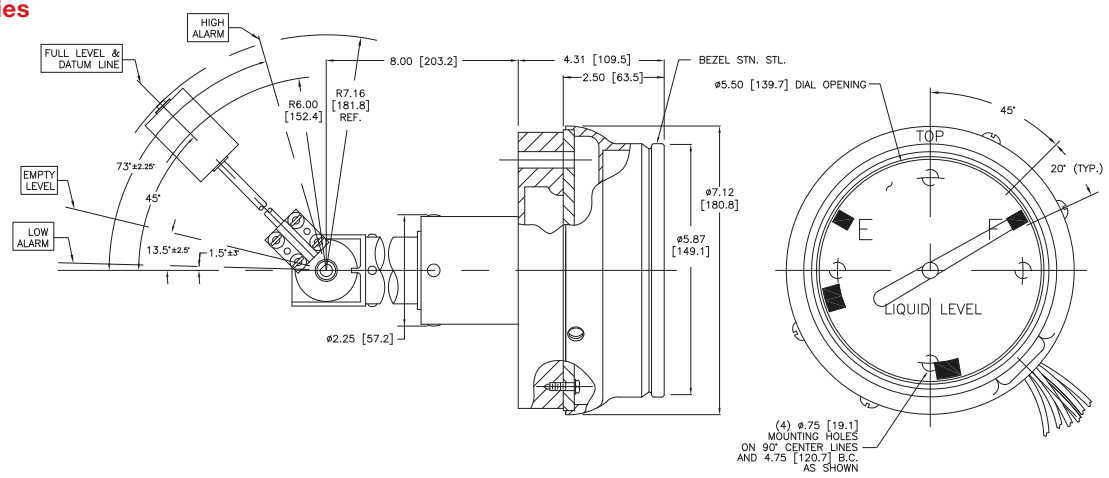
032 Series



042 Series



045 Series



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SECTION 14

Appendix H

Paint Specification

704-80180 C5M (VH) (20 pages)

IST POWER LTD

PAINT APPLICATION AND PREPARATION PROCEDURE FOR

LIQUID FILLED TRANSFORMERS FOR C5M (VH) PROTECTION (>25 years)

Quality Process Instruction

Quick Guide

a) **All sharp edges and corners must be removed; welds dressed smooth, all welding spatter should be removed.**
b) **All areas are to be thoroughly cleaned of any contamination before metal spraying or painting.**
c) **The manufacturers paint datasheets form part of this specification and must be adhered to.**

d) **Paint records must be taken.**

Circulation/storage
REFER TO "ISSUED DOCUMENT REGISTER" HELD BY QUALITY MANAGER

Ref: 704-60180 Issue: 4	Author: Peter Jones Approved for Issue: Peter Jones Date: 30/3/20	Change Ref: G312

Safety

1. Review and adhere to all instructions contained in the company HSE Policies ref.GHI-001 & 002 (see company notice boards).
2. Review and adhere to all paint safety data sheet instructions referenced in this instruction (copies in COSHH folders)
3. PPE required: Full face respiratory mask, gloves, coveralls and safety footwear. Ensure no loose items of clothing or accessories.
4. Maintain a clean & tidy work area – remove potential trip hazards
5. Near Miss and HSE concerns must be reported by the "ARF" system, or directly to the Health & Safety Representative/Manager

Background

The transformers being supplied will probably be installed in a marine, coastal or severely polluted environment. The painting/corrosion protection is therefore to be to a minimum of C5M (VH) to EN ISO 12944.

Summary of corrosion protection system

The corrosion protection of the steel components of the transformers will be as follows:

Interior

- Blast clean
- 2 pack Epoxy paint

Exterior

- Blast clean
- Zinc Spray
- 2 pack Epoxy Primer
- 2 pack Epoxy MIO
- 2 pack Acrylic Polyurethane Finish

The manufacturers paint datasheets form part of this specification.

During the painting process the manufacturer guidelines for mixing, spraying, curing/drying & over coating are to be followed.

Pre-blast clean inspection

All sharp edges and corners must be removed; welds dressed smooth, all welding spatter should be removed.

All welds are to be dressed smooth in accordance with the 'good' standard of ISO 12944-3. All welds must be inspected for undercuts/irregularities and made good where necessary.

Exterior

Blast clean

The exterior of the transformer tanks and conservators to be grit blasted to SA 3 of ISO 8501-1. Particular attention is to be made in hard to reach areas.

Mask stainless steel earth pads before blasting.

All areas are to be thoroughly cleaned of any contamination before metal spraying.

Zinc spraying is to take place as quickly as possible after grit blasting

Zinc spray

The exterior of the tank is to be zinc sprayed in accordance with ISO 2063. Thickness of the zinc coating must not be less than 100 µm.

Exterior Painting

A stripe coat is required on all edges, welds and hard to reach areas for all layers of paint.

Primer/Sealer

Paint Manufacturer: International
Paint Type: Two component epoxy primer
Paint Description: Intergard 269
No of coats: One
Coat thickness: 20 µm (thinned to reach this thickness) (minimum DFT)
Colour: Red
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
10°C	40 min	16 hours	16 hours
15°C	35 min	12 hours	12 hours
25°C	30 min	8 hours	8 hours
40°C	15 min	1 hour	4 hours

Intermediate coat

Paint Manufacturer: International
Paint Type: Two component, epoxy micaceous iron oxide
Paint Description: Intercure 384
No of coats: One
Coat thickness: 150 µm (minimum DFT)
Colour: Silver grey
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
5°C	4 hours	14 hours	7 hours
15°C	2.5 hours	8 hours	4 hours
25°C	2.5 hours	3.5 hours	3.5 hours
40°C	45 min	1.5 hours	1 hour

Finish coat

Paint Manufacturer: International
Paint Type: Two component acrylic polyurethane
Paint Description: Interthane 990
No of coats: One
Coat thickness: 50 µm (minimum DFT)
Colour: Refer to tank fabrication drawing for Final Colour
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
5°C	5 hours	24 hours	24 hours
15°C	150 min	10 hours	10 hours
25°C	90 min	6 hours	6 hours
40°C	60 min	3 hours	3 hours

Note: Minimum external dry film thickness is 320 microns including zinc spray coating.

Interior

Blast Clean

The interior of the transformer tanks and conservators it to be grit blast to SA 2 ½ of IS 8501-1. All surplus grit and residue must be removed before painting.

Painting is to be carried out within four hours of grit blasting.

Interior Painting

All of the transformer interior should be painted with Valspar 39,0009-50.

Interior paint

Paint Manufacturer: Valspar
Paint Type: Two component epoxy primer
Paint Description: Valspar
No of coats: One
Coat thickness: 40 µm (minimum DFT)
Colour: White

Temperature	Touch Dry	Hard Dry	Minimum
20°C		6 hours	6 hours

Paint Repair Procedure

If the paint coating is damaged in any way, repairs must be done to the following procedure.

Using hand or mechanical means, rub down the affected area so that all paint coats are feathered towards the damaged area.

Clean down and thoroughly degrease.

Each coat of paint is to overlap the previous coat. Minimum film thicknesses are to be maintained.

All coats of paint are to be applied by brush.

Primer/Sealer

Paint Manufacturer: International
Paint Type: Two component zinc rich epoxy primer
Paint Description: Interzinc 52
No of coats: One
Coat thickness: 60 µm (minimum DFT)
Colour: Grey
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
5°C	2 hours	10 hours	8 hours
15°C	90 min	6 hours	4 hours
25°C	75 min	4 hours	3 hours
40°C	45 min	2 hours	2 hours

Intermediate coat

Paint Manufacturer: International
Paint Type: Two component, epoxy micaceous iron oxide
Paint Description: Intercure 384
No of coats: One
Coat thickness: 200 µm (minimum DFT)
Colour: Silver grey
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
5°C	4 hours	14 hours	7 hours
15°C	2.5 hours	8 hours	4 hours
25°C	2.5 hours	3.5 hours	3.5 hours
40°C	45 mins	1.5 hours	1 hour

Finish coat

Paint Manufacturer: International
Paint Type: Two component acrylic polyurethane
Paint Description: Interthane 990
No of coats: One
Coat thickness: 60 µm (minimum DFT)
Colour: Refer to tank fabrication drawing for Final Colour
Drying Time:

Temperature	Touch Dry	Hard Dry	Minimum
5°C	5 hours	24 hours	24 hours
15°C	150 min	10 hours	10 hours
25°C	90 min	6 hours	6 hours
40°C	60 min	3 hours	3 hours

Paint process stages for the tank

Item	Process Description	Standard	Hold Point (I = IST) A = ABB
1	Visual inspection of structure	ISO 8501-3	
2	Visual inspection – Oil / Grease removal	SSPC-SP1	
3	Grit Blast standard	ISO 8501-1 Sa 3	
4	Surface profile	ISO 8503-5	
5	Environmental Conditions	Product Data	
6	Apply coat 1		
7	Apply coat 2		
8	Apply coat 3		
9	Total Thickness DFT		IST to witness
12	Visual appearance		
13	Adhesion Test on Test plate		
14	Approval of completed treatment		
15	Approval of Inspection documents		IST to review

Intercure® 384

Epoxy

PRODUCT DESCRIPTION

A two component, high solids, low VOC epoxy micaceous iron oxide intermediate coating offering excellent barrier protection, low temperature cure and rapid overcoating properties.

Pigmented with micaceous iron oxide to comply with the requirements of BS5493:1977

INTENDED USES

As a high build intermediate to provide excellent barrier protection as part of a high performance system in aggressive environments including offshore structures, bridges, chemical and petrochemical plants and power stations.

The incorporation of plate-like micaceous iron oxide pigment both increases the barrier effect and improves long term overcoating properties of the system making this material ideally suitable for application in the fabrication shop, prior to shipping, with final overcoating at site.

The rapid curing and overcoating properties of Intercure 384 provide production flexibility, making this product suitable for use both in new construction and on site as a maintenance coating.

PRACTICAL INFORMATION FOR INTERCURE 384

Colour	Silver Grey MIO
Gloss Level	Matt
Volume Solids	72%
Typical Thickness	125-175 microns (5-7 mils) dry equivalent to 174-243 microns (7-9.7 mils) wet
Theoretical Coverage	5.80 m²/litre at 125 microns d.f.t and stated volume solids 231 sq.ft/US gallon at 5 mils d.f.t and stated volume solids
Practical Coverage	Allow appropriate loss factors
Method of Application	Airless Spray, Air Spray, Brush, Roller

Drying Time

			Overcoating Interval with recommended topcoats	
Temperature	**Touch Dry**	**Hard Dry**	*Minimum*	*Maximum*
5°C (41°F)	4 hours	14 hours	7 hours	Extended[1]
15°C (59°F)	2.5 hours	8 hours	4 hours	Extended[1]
25°C (77°F)	2.5 hours	3.5 hours	3.5 hours	Extended[1]
40°C (104°F)	45 minutes	1.5 hours	1 hour	Extended[1]

[1] See International Protective Coatings Definitions and Abbreviations

REGULATORY DATA

Flash Point (Typical)	Part A 37°C (99°F); Part B 27°C (81°F); Mixed 33°C (91°F)	
Product Weight	1.79 kg/l (14.9 lb/gal)	
VOC	169 g/kg	EU Solvent Emissions Directive (Council Directive 1999/13/EC)

See Product Characteristics section for further details

Intercure® 384

Epoxy

SURFACE PREPARATION

All surfaces to be coated should be clean, dry and free from contamination. Prior to paint application all surfaces should be assessed and treated in accordance with ISO 8504:2000.

Oil or grease should be removed in accordance with SSPC-SP1 solvent cleaning.

Abrasive Blast Cleaning

Abrasive blast clean to Sa2½ (ISO 8501-1:2007) or SSPC-SP6. If oxidation has occurred between blasting and application of Intercure 384, the surface should be reblasted to the specified visual standard.

Surface defects revealed by the blast cleaning process should be ground, filled, or treated in the appropriate manner.

Shop Primed Steel

Weld seams and damaged areas should be blast cleaned to Sa2½ (ISO 8501-1:2007) or SSPC-SP6.

If the shop primer shows extensive or widely scattered breakdown overall sweep blasting may be necessary.

Metallic Zinc Primed Surfaces

Ensure that the surface of the primer is clean, dry and free from contamination and zinc salts before application of Intercure 384. Ensure zinc primers are fully cured before overcoating.

APPLICATION

Mixing

Material is supplied in two containers as a unit. Always mix a complete unit in the proportions supplied. Once the unit has been mixed it must be used within the working pot life specified.

(1) Agitate Base (Part A) with a power agitator.
(2) Combine entire contents of Curing Agent (Part B) with Base (Part A) and mix thoroughly with power agitator.

Mix Ratio

3.00 part(s) : 1.00 part(s) by volume

Working Pot Life

5°C (41°F)	15°C (59°F)	25°C (77°F)	40°C (104°F)
90 minutes	90 minutes	60 minutes	30 minutes

Airless Spray	Recommended	Tip Range 0.38-0.58 mm (15-23 thou) Total output fluid pressure at spray tip not less than 176 kg/cm² (2503 p.s.i.)	
Air Spray (Pressure Pot)	Recommended (5% thinning required)	Gun Air Cap Fluid Tip	DeVilbiss MBC or JGA 704 or 765 E
Brush	Suitable - small areas only	Typically 75 microns (3.0 mils) can be achieved	
Roller	Suitable - small areas only	Typically 75 microns (3.0 mils) can be achieved	
Thinner	International GTA220	Do not thin more than allowed by local environmental legislation	
Cleaner	International GTA822		

Work Stoppages

Do not allow material to remain in hoses, gun or spray equipment. Thoroughly flush all equipment with International GTA822. Once units of paint have been mixed they should not be resealed and it is advised that after prolonged stoppages work recommences with freshly mixed units.

Clean Up

Clean all equipment immediately after use with International GTA822. It is good working practice to periodically flush out spray equipment during the course of the working day. Frequency of cleaning will depend upon amount sprayed, temperature and elapsed time, including any delays.

All surplus materials and empty containers should be disposed of in accordance with appropriate regional regulations/legislation.

PRODUCT CHARACTERISTICS

Intercure 384 is capable of curing at temperatures below 0°C (32°F). However, this product should not be applied at temperatures below 0°C (32°F) where there is a possibility of ice formation on the substrate.

This product must only be thinned using recommended International GTA220 thinners. The use of alternative thinners, particularly those containing ketones, can severely inhibit the curing mechanism of the coating.

Surface temperature must always be a minimum of 3°C (5°F) above dew point.

Over-application of Intercure 384 will extend both the minimum overcoating periods and handling times, and may be detrimental to long term overcoating properties.

Absolute measured adhesion of topcoats to aged Intercure 384 is less than that to fresh material, however, it is adequate for the specified end use.

This product is frequently used as a 'travel coat' prior to final overcoating on site. To ensure best extended overcoating properties ensure over-application does not occur and that the surface is fully cleaned of any contamination which may be present in the surface texture due to the coarse nature of the micaceous iron oxide pigmentation.

In common with all epoxies Intercure 384 will chalk and discolour on exterior exposure. However, these phenomena are not detrimental to anti-corrosive performance.

As with all products with high micaceous iron oxide levels, only relatively dark colours can be formulated, consequently with some colours of thin film finishes two coats may be needed to give good coverage.

Intercure 384 is not designed for continuous water immersion.

This product has the following specification approvals:
- BS5493:1977 KUID & KF1F
- UK Department of Transport Item No.112

Note: VOC values are typical and are provided for guidance purpose only. These may be subject to variation depending on factors such as differences in colour and normal manufacturing tolerances.

SYSTEMS COMPATIBILITY

Please consult International Protective Coatings for specific information regarding application to prefabrication primers.

The following primers are recommended for Intercure 384:

Intercure 200HS	Interzinc 12 - mist coat may be required
Intercure 324	Interzinc 22 - mist coat may be required
Intercure 202	Interzinc 42
Intergard 251	Interzinc 52
Intergard 269	Interzinc 135
	Interzinc 315

The following topcoats are recommended for Intercure 384:

Interfine 629HS
Intergard 740
Interthane 990

For other suitable topcoats/intermediates, consult International Protective Coatings.

ADDITIONAL INFORMATION

Further information regarding industry standards, terms and abbreviations used in this data sheet can be found in the following documents available at www.international-pc.com:

- Definitions & Abbreviations
- Surface Preparation
- Paint Application
- Theoretical & Practical Coverage

Individual copies of these information sections are available upon request.

SAFETY PRECAUTIONS

This product is intended for use only by professional applicators in industrial situations in accordance with the advice given on this sheet, the Material Safety Data Sheet and the container(s), and should not be used without reference to the Material Safety Data Sheet (MSDS) which International Protective Coatings has provided to its customers.

All work involving the application and use of this product should be performed in compliance with all relevant national, Health, Safety & Environmental standards and regulations.

In the event welding or flame cutting is performed on metal coated with this product, dust and fumes will be emitted which will require the use of appropriate personal protective equipment and adequate local exhaust ventilation.

If in doubt regarding the suitability of use of this product, consult International Protective Coatings for further advice.

PACK SIZE	Unit Size	Part A		Part B	
		Vol	Pack	Vol	Pack
	20 litre	15 litre	20 litre	5 litre	5 litre
	For availability of other pack sizes, contact International Protective Coatings.				
SHIPPING WEIGHT (TYPICAL)	Unit Size	Part A		Part B	
	20 litre	32.8 kg		5.36 kg	
STORAGE	Shelf Life	12 months minimum at 25°C (77°F). Subject to re-inspection thereafter. Store in dry, shaded conditions away from sources of heat and ignition.			

Important Note

Issue date: 12/12/2014

www.international-pc.com

Intergard® 269
Epoxy

PRODUCT DESCRIPTION

A quick drying two component epoxy primer.

Suitable for overcoating after prolonged periods of weathering.

INTENDED USES

As a blast holding primer suitable for use in immersed and exposed conditions and overcoatable with a wide range of high performance systems.

For use at both new construction and maintenance.

Also for use as a tie coat on zinc silicate to prevent zinc salt formation on weathering and pinholing of subsequent high build topcoats.

PRACTICAL INFORMATION FOR INTERGARD 269

Colour	Red (See Product Characteristics section for further details)
Gloss Level	Matt
Volume Solids	47%
Typical Thickness	40 microns (1.6 mils) dry equivalent to 85 microns (3.4 mils) wet
Theoretical Coverage	11.80 m²/litre at 40 microns d.f.t and stated volume solids 471 sq.ft/US gallon at 1.6 mils d.f.t and stated volume solids
Practical Coverage	Allow appropriate loss factors
Method of Application	Airless Spray, Air Spray, Brush, Roller

Drying Time

			Overcoating Interval with recommended topcoats	
Temperature	**Touch Dry**	**Hard Dry**	*Minimum*	*Maximum*
10°C (50°F)	40 minutes	16 hours	16 hours	Extended[1]
15°C (59°F)	35 minutes	12 hours	12 hours	Extended[1]
25°C (77°F)	30 minutes	8 hours	8 hours	Extended[1]
40°C (104°F)	15 minutes	1 hour	4 hours	Extended[1]

[1] Maximum overcoating intervals are shorter when using polysiloxane topcoats. Consult International Protective Coatings for further details.

REGULATORY DATA

Flash Point	Part A 26°C (79°F); Part B 25°C (77°F); Mixed 26°C (79°F)	
Product Weight	1.53 kg/l (12.8 lb/gal)	
VOC	3.75 lb/gal (450 g/lt)	EPA Method 24
	293 g/kg	EU Solvent Emissions Directive (Council Directive 1999/13/EC)

See Product Characteristics section for further details

SURFACE PREPARATION

All surfaces to be coated should be clean, dry and free from contamination. Prior to paint application all surfaces should be assessed and treated in accordance with ISO 8504:2000.

Oil or grease should be removed in accordance with SSPC-SP1 solvent cleaning.

Abrasive Blast Cleaning

For immersion service, Intergard 269 must be applied to surfaces blast cleaned to Sa2½ (ISO 8501-1:2007) or SSPC-SP10. However, for atmospheric exposure Intergard 269 may be applied to surfaces prepared to a minimum of Sa2½ (ISO 8501-1:2007) or SSPC-SP6.

Surface defects revealed by the blast cleaning process should be ground, filled, or treated in the appropriate manner.

Ultra High Pressure Hydroblasting / (non-immersed service only)

May be applied to surfaces prepared to Sa2 (ISO 8501-1:2007) or SSPC-SP6 which have flash rusted to no worse than Grade HB2M (refer to International Hydroblasting Standards). Further information is available from International Protective Coatings.

Tie Coat Applications (see Product Characteristics)

In the case of zinc primers, where necessary, remove weld spatter, smooth weld seams and sharp edges and blast clean welds and damaged primer to Sa2½ (ISO 8501-1:2007) or SSPC-SP6. The shop primer or other primer surface should be dry and free of all contamination (oil, grease, salt etc) and overcoated with Intergard 269 within the overcoating intervals specified for the primer (consult the relevant product data sheet).

Ensure that the zinc primer has fully cured and is clean, dry and free from zinc salts prior to overcoating.

APPLICATION

Mixing

Material is supplied in two containers as a unit. Always mix a complete unit in the proportions supplied. Once the unit has been mixed it must be used within the working pot life specified.

(1) Agitate Base (Part A) with a power agitator.
(2) Combine entire contents of Curing Agent (Part B) with Base (Part A) and mix thoroughly with power agitator.

Mix Ratio

4 part(s) : 1 part(s) by volume

Working Pot Life

10°C (50°F)	15°C (59°F)	25°C (77°F)	40°C (104°F)
17 hours	12 hours	8 hours	3 hours

Airless Spray	Recommended	Tip Range 0.38-0.53 mm (15-21 thou) Total output fluid pressure at spray tip not less than 141 kg/cm² (2005 p.s.i.)
Air Spray (Pressure Pot)	Recommended	Gun DeVilbiss MBC or JGA Air Cap 704 or 765 Fluid Tip E
Brush	Suitable - small areas only	Typically 25-30 microns (1.0-1.2 mils) can be achieved
Roller	Suitable - small areas only	Typically 25-30 microns (1.0-1.2 mils) can be achieved
Thinner	International GTA220 (or International GTA415)	Do not thin

Cleaner

International GTA822 or International GTA415

Work Stoppages

Do not allow material to remain in hoses, gun or spray equipment. Thoroughly flush all equipment with International GTA822. Once units of paint have been mixed they should not be resealed and it is advised that after prolonged stoppages work recommences with freshly mixed units.

Clean Up

Clean all equipment immediately after use with International GTA822. It is good working practice to periodically flush out spray equipment during the course of the working day. Frequency of cleaning will depend upon amount sprayed, temperature and elapsed time, including any delays.

All surplus materials and empty containers should be disposed of in accordance with appropriate regional regulations/legislation.

PRODUCT CHARACTERISTICS

Use as a Holding Primer

Intergard 269 is suitable for use as a blast holding primer for steelwork intended for exposure in both immersed and atmospheric exposure conditions. Apply Intergard 269 at the recommended thickness as over-application will result in a glossy surface which may not be suitable for overcoating after ageing.

When coating steel in high ambient temperatures thinning with International thinners may be necessary to prevent dry spray and control film thickness.

This product will not cure adequately below 5°C (41°F). For maximum performance ambient curing temperatures should be above 10°C (50°F).

Intergard 269 is also suitable for application to degreased and abraded stainless steel and galvanised steel. Abrasion can be carried out by light blasting using a non-ferrous abrasive or by carborondum disking on small areas.

Use as a Tie Coat

To ensure good penetration of zinc silicate coatings Intergard 269 should be thinned by 15-25% with International thinners. Intergard 269 should be allowed to cure before topcoating with high builds otherwise the effectiveness in preventing pinholing is reduced.

Excessive film thickness may lead to splitting of the film when overcoated with high build systems.

For application at temperatures below 10°C (50°F) alternative tie coats are available. For information contact International Protective Coatings.

When used in a marine environment the schemes and overcoating intervals utilised may differ.

Intergard 269 is globally available in Red; alternative shades may be available upon request. Consult International Protective Coatings for further details.

Note: VOC values quoted are based on maximum possible for the product taking into account variations due to colour differences and normal manufacturing tolerances.

Low molecular weight reactive additives, which will form part of the film during normal ambient cure conditions, will also affect VOC values determined using EPA Method 24.

SYSTEMS COMPATIBILITY

Intergard 269 is suitable for use over the following primers:

Interzinc 22
Interzinc 52

The following topcoats/intermediates are recommended for Intergard 269:

Intercure 200HS	Intergard 740
Intercure 420	Interseal 670HS
Interfine 629HS	Interthane 870
Interfine 878	Interthane 990
Interfine 979	Interzone 505
Intergard 251	Interzone 954
Intergard 345	Interzone 1000
Intergard 475HS	

For details of other systems, consult International Protective Coatings.

ADDITIONAL INFORMATION

Further information regarding industry standards, terms and abbreviations used in this data sheet can be found in the following documents available at www.international-pc.com:

- Definitions & Abbreviations
- Surface Preparation
- Paint Application
- Theoretical & Practical Coverage

Individual copies of these information sections are available upon request.

SAFETY PRECAUTIONS

This product is intended for use only by professional applicators in industrial situations in accordance with the advice given on this sheet, the Material Safety Data Sheet and the container(s), and should not be used without reference to the Material Safety Data Sheet (MSDS) which International Protective Coatings has provided to its customers.

All work involving the application and use of this product should be performed in compliance with all relevant national, Health, Safety & Environmental standards and regulations.

In the event welding or flame cutting is performed on metal coated with this product, dust and fumes will be emitted which will require the use of appropriate personal protective equipment and adequate local exhaust ventilation.

If in doubt regarding the suitability of use of this product, consult International Protective Coatings for further advice.

PACK SIZE	Unit Size	Part A		Part B	
		Vol	Pack	Vol	Pack
	20 litre	16 litre	20 litre	4 litre	5 litre
	5 US gal	4 US gal	5 US gal	1 US gal	1 US gal

For availability of other pack sizes, contact International Protective Coatings.

SHIPPING WEIGHT	Unit Size	Part A	Part B
	20 litre	28.9 kg	4.1 kg
	5 US gal	59.7 lb	8.4 lb

STORAGE		
	Shelf Life	12 months minimum at 25°C (77°F). Subject to re-inspection thereafter. Store in dry, shaded conditions away from sources of heat and ignition.

Important Note

Issue date: 05/10/2009

www.international-pc.com

Interthane® 990

Polyurethane

PRODUCT DESCRIPTION

A two component acrylic polyurethane finish giving excellent durability and long term recoatability.

INTENDED USES

Suitable for use in both new construction and as a maintenance finish which can be used in a wide variety of environments including offshore structures, chemical and petrochemical plants, bridges, pulp and paper mills, and in the power industry.

PRACTICAL INFORMATION FOR INTERTHANE 990

Colour	Wide range via the Chromascan system
Gloss Level	High Gloss
Volume Solids	57% ± 3% (depends on colour)
Typical Thickness	50-75 microns (2-3 mils) dry equivalent to 88-132 microns (3.5-5.3 mils) wet
Theoretical Coverage	11.40 m²/litre at 50 microns d.f.t and stated volume solids 457 sq.ft/US gallon at 2 mils d.f.t and stated volume solids
Practical Coverage	Allow appropriate loss factors
Method of Application	Airless Spray, Air Spray, Brush, Roller

Drying Time

			Overcoating Interval with recommended topcoats	
Temperature	**Touch Dry**	**Hard Dry**	*Minimum*	*Maximum*
5°C (41°F)	5 hours	24 hours	24 hours	Extended[1]
15°C (59°F)	150 minutes	10 hours	10 hours	Extended[1]
25°C (77°F)	90 minutes	6 hours	6 hours	Extended[1]
40°C (104°F)	60 minutes	3 hours	3 hours	Extended[1]

[1] See International Protective Coatings Definitions and Abbreviations

REGULATORY DATA

Flash Point	Part A 34°C (93°F); Part B 49°C (120°F); Mixed 35°C (95°F)	
Product Weight	1.21 kg/l (10.1 lb/gal)	
VOC	3.50 lb/gal (420 g/lt) 341 g/kg	EPA Method 24 EU Solvent Emissions Directive (Council Directive 1999/13/EC)

See Product Characteristics section for further details

SURFACE PREPARATION

All surfaces to be coated should be clean, dry and free from contamination. Prior to paint application all surfaces should be assessed and treated in accordance with ISO 8504:2000.

Primed Surfaces

Interthane 990 should always be applied over a recommended anti-corrosive coating scheme. The primer surface should be dry and free from all contamination and Interthane 990 must be applied within the overcoating intervals specified (consult the relevant product data sheet).

Areas of breakdown, damage etc., should be prepared to the specified standard (e.g. Sa2½ (ISO 8501-1:2007) or SSPC-SP6, Abrasive Blasting, or SSPC-SP11, Power Tool Cleaning) and patch primed prior to the application of Interthane 990.

APPLICATION

Mixing

Material is supplied in two containers as a unit. Always mix a complete unit in the proportions supplied. Once the unit has been mixed it must be used within the working pot life specified.

(1) Agitate Base (Part A) with a power agitator.
(2) Combine entire contents of Curing Agent (Part B) with Base (Part A) and mix thoroughly with power agitator

Mix Ratio

6 part(s): 1part(s) by volume

Working Pot Life

5°C (41°F)	15°C (59°F)	25°C (77°F)	40°C (104°F)
12 hours	4 hours	2 hours	45 minutes

Airless Spray	Recommended	Tip Range 0.33-0.45 mm (13-18 thou) Total output fluid pressure at spray tip not less than 155 kg/cm² (2204 p.s.i.)	
Air Spray (Pressure Pot)	Recommended	Gun Air Cap Fluid Tip	DeVilbiss MBC or JGA 704 or 765 E
Air Spray (Conventional)	Suitable	Use suitable proprietary equipment	
Brush	Suitable	Typically 40-50 microns (1.6-2.0 mils) can be achieved	
Roller	Suitable	Typically 40-50 microns (1.6-2.0 mils) can be achieved	
Thinner	International GTA713 (or International GTA733 or GTA056)	Do not thin more than allowed by local environmental legislation.	

Cleaner

International GTA713 (or International GTA733 or GTA056)

Work Stoppages

Do not allow material to remain in hoses, gun or spray equipment. Thoroughly flush all equipment with International GTA713. Once units of paint have been mixed they should not be resealed and it is advised that after prolonged stoppages work recommences with freshly mixed units.

Clean Up

Clean all equipment immediately after use with International GTA713. It is good working practice to periodically flush out spray equipment during the course of the working day. Frequency of cleaning will depend upon amount sprayed, temperature and elapsed time, including any delays.

All surplus materials and empty containers should be disposed of in accordance with appropriate regional regulations/legislation.

PRODUCT CHARACTERISTICS

Interthane 990 is available in a range of metallic finishes - please consult the separate Interthane 990 Metallic Working Procedures document for further information.

Level of sheen and surface finish are dependent on application method. Avoid using a mixture of application methods whenever possible.

Best results in terms of gloss and appearance will always be obtained by conventional air spray application.

For brush and roller application, and in some colours, two or more coats of Interthane 990 may be required to give uniform coverage, especially when applying Interthane 990 over dark undercoats, and when using certain lead free bright colours such as yellows and oranges. Best practice is to use a colour compatible intermediate or anticorrosive coating under the Interthane 990.

When overcoating after weathering or ageing, ensure the coating is fully cleaned to remove all surface contamination such as oil, grease, salt crystals and traffic fumes, before application of a further coat of Interthane 990.

Absolute measured adhesion of topcoats to aged Interthane 990 is less than that to fresh material, however, it is adequate for the specified end use.

This product must only be thinned using the recommended International thinners. The use of alternative thinners, particularly those containing alcohols, can severely inhibit the curing mechanism of the coating.

Surface temperature must always be a minimum of 3°C (5°F) above dew point.

When applying Interthane 990 in confined spaces ensure adequate ventilation.

Condensation occurring during or immediately after application may result in a matt finish and an inferior film.

Premature exposure to ponding water will cause colour change, especially in dark colours and at low temperatures.

This product is not recommended for use in immersion conditions. When severe chemical or solvent splashing is likely to occur contact International Protective Coatings for information regarding suitability.

A modified version of Interthane 990 is available for use within the Korean marketplace in order to provide improved workability.

Note: VOC values quoted are based on maximum possible for the product taking into account variations due to colour differences and normal manufacturing tolerances.

Low molecular weight reactive additives, which will form part of the film during normal ambient cure conditions, will also affect VOC values determined using EPA Method 24.

SYSTEMS COMPATIBILITY

The following primers/intermediates are recommended for Interthane 990:

Intercure 200	Interseal 670HS
Intercure 200HS	Interzinc 315
Intercure 420	Interzinc 52
Intergard 251	Interzinc 52HS
Intergard 269	Interzone 505
Intergard 345	Interzone 954
Intergard 475HS	Interzone 1000

Interthane 990 is designed only to be topcoated with itself.

For other suitable primers/intermediates consult International Protective Coatings.

ADDITIONAL INFORMATION

Further information regarding industry standards, terms and abbreviations used in this data sheet can be found in the following documents available at www.international-pc.com:

- Definitions & Abbreviations
- Surface Preparation
- Paint Application
- Theoretical & Practical Coverage
- Interthane 990 Metallic Finish Working Procedures

Individual copies of these information sections are available upon request.

SAFETY PRECAUTIONS

This product is intended for use only by professional applicators in industrial situations in accordance with the advice given on this sheet, the Material Safety Data Sheet and the container(s), and should not be used without reference to the Material Safety Data Sheet (MSDS) which International Protective Coatings has provided to its customers.

All work involving the application and use of this product should be performed in compliance with all relevant national, Health, Safety & Environmental standards and regulations.

In the event welding or flame cutting is performed on metal coated with this product, dust and fumes will be emitted which will require the use of appropriate personal protective equipment and adequate local exhaust ventilation.

If in doubt regarding the suitability of use of this product, consult International Protective Coatings for further advice.

Warning: Contains isocyanate. Wear air-fed hood for spray application.

PACK SIZE	Unit Size	Part A		Part B	
		Vol	Pack	Vol	Pack
	20 litre	17.14 litre	20 litre	2.86 litre	3.7 litre
	5 US gal	4.29 US gal	5 US gal	0.71 US gal	1 US gal

For availability of other pack sizes, contact International Protective Coatings.

SHIPPING WEIGHT	Unit Size	Part A	Part B
	20 litre	23.1 kg	3.5 kg
	5 US gal	47.6 lb	7.1 lb

STORAGE	Shelf Life	24 months (Part A) & 12 months (Part B) minimum at 25°C (77°F) Subject to re-inspection thereafter. Store in dry, shaded conditions away from sources of heat and ignition.

Important Note

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Valspar Industries GmbH

Informacja techniczna

EP-farba do gruntowania
Nr art. 39,0009-50
Nr art. 588.33.99 utwardzacz

Ausgabe 06/04 Rev. 2
390009-50 Sch

Charakterystyka: Dwuskładnikowa farba epoksydowa, zawierająca rozcieńczalnik organiczny, schnąca na powietrzu i w suszarce. Nie zawiera chromu i ołowiu..

Zastosowanie: Farba gruntująca dla konstrukcji żelaznych i stalowych, dla odpowiedzialnych systemów antykorozyjnych oraz jako warstwa gruntująca dla powierzchni ocynkowanych takich jak: kadzie transformatorów, pokrywy, konserwatory i radiatory.
Farba EP Art. nr. 39,009 – 50 została dopuszczona przez Firmy ABB i ALSTOM do malowania powierzchni wewnętrznych transformatorów.

Dane techniczne:

Wszystkie dane dotyczą farby zmieszanej z utwardzaczem (art. nr. 588.33.99) w stosunku wagowym 5:1. Dane określone zostały dla warunków znormalizowanych, 20°C i 65% wilgotności względnej.

Nr art.			**39,0009-50**
Kolor			biały
Stosunek mieszania, wagowy			5:1
		Prüfnormen nach DIN	
Gęstość	(g/cm^3)	53217	1,45
Zawartość części stałych	(%)	53216	ca. 68
Objętość części stałych	(cm^3 / kg)	53219	ca. 330
Objętość części stałych	(%)	53219	ca. 48
Wydajność teoretyczna przy 40 µm	(m^2 / kg)	55945	ca. 8,5
Lepkość		53219	strukturalna
Czas schnięcia przy 20 °C i 40 µm grubości warstwy suchej:			
Stopień 1		53150	po 20 minutach
Stopień 4		53150	po 5 godzinach
Stopień 6		53150	po 6 godzinach
Do zestawów z farbami **„Valspar“:**			EP, EPW, PUR, ACN
Osągalna grubość powłoki:	polewanie		40 µm
	natrysk		80 µm
Odporność na temp. -suche powietrze			do 150 °C
Max. czas magazynowania			12
Rozcieńczalnik specjalny : Art. nr.			39.0410

Wskazówki dotyczące przygotowania:

Powierzchni: Najlepiej metodą strumienio-ścierną wg. DIN 55928 część 4, stopień czystości Sa 2,5 - 3. Należy zachować uśrednioną wysokość nierówności R_z , zgodnie z normą DIN 4768 część 1 lub DIN ISO 8503 część 1. Im większa jest wysokość nierówności, tym grubsza musi być warstwa powłoki malarskiej, tak aby osiągnąć tzw. „wystarczające pokrycie wierzchołków nierówności powierzchni". Trwałość ochrona warstwy malarskiej zależy w znacznej mierze od dokładności przygotowania podłoża przed malowaniem.

Farby: w razie potrzeby należy używać rozcieńczalnika art.-nr. 39.0410:

Nakładanie pędzlem	Bez rozcieńczania. Tylko w wyjątkowych przypadkach
Natrysk metodą powietrzną	Ustawić odpowiednią lepkość farby przez dodanie 10- 20 % rozcieńczalnika. Dysza 1,5 - 1,8 mm / ciśnienie powietrza 4-5 bar
Natrysk Airless	Lepkość dostawcza. Rozcieńczać tylko w wyjątkowych przypadkach. Dysza 0,43-0,55 mm / kąt natrysku 40° (w zależności od wielkości obiektu), ciśnienie natrysku 150-200 bar.
Natrysk Airmix, Air-Coat	Lepkość dostawcza, ewentualnie ustawić odpowiednią lepkość farby przez dodanie 3 – 10 % rozcieńczalnika, dysza 0,28 - 0,45 mm / kąt natrysku 20 - 65° (w zależności od wielkości obiektu), ciśnienie natrysku 50 - 100 bar; ciśnienie powietrza wspomagającego 1-4 bar.
Czas przydatności zmieszanych składników przy 20 °C	około 12 godzin, w zbiorniku do polewania max. 8 godzin!
Temperatura pracy	min +5 °C!
Temp.obiektu / wilg.wzgl.	min +3 °C powyżej punktu rosy / max. 85 %!

Uwagi: Minimalny czas konieczny do nałożenia farby nawierzchniowej na bazie PUR lub ACN wynosi:
16 godz przy 20 ^{0}C temp. obiektu 2 godz. przy 40 ^{0}C temp. obiektu, 1 godz. przy 60 ^{0}C temp. obiektu.
Nałożenie farby nawierzchniowej EP, przy temp. obiektu 20 ^{0}C, możliwe jest najwcześniej :
-przy grubości warstwy suchej 40µm po 4 godz, -przy grubości warstwy suchej 80µm po 8 godz.
Przy temperaturach +5,+10 ^{0}C należy stosować "szybki" utwardzacz Art.nr. 39,0809
Grubość powłoki suchej przy malowaniu wnętrza transformatora nie może przekraczać 80 m

Przykładowy zestaw warstw malarskich:
Farbą EP można kilkakrotnie przemalowywać powierzchnię gruntowaną.

np.:	farba do gruntowania EP biała	nr art. 39,0009-50	
	farba międzywarstwowa EP	nr art. 39,0075 -50	
	farba nawierzchniowa ACN	nr art. 41, 7633	lub
	farba do gruntowania EP biała	nr art. 39,0009-50	
	farba międzywarstwowa EP z miką	nr art. 39,0915-F	
	farba nawierzchniowa ACN	nr art. 41,7633	

Do malowania nawierzchniowego można stosować wszystkie farby - wymienione w pozycji na stronie pierwszej - Do zestawów z farbami **„Valspar"-**
Dane techn. dot. farby międzywarstwowej i nawierzchniowej zawarte są w odrębnych informacjach.

Dane bezpieczeństwa:	**farba bazowa: 39,0009-50**	**utwardzacz:588.33.99**
Temperatura zapłonu	24°C	24 °C
Klasa zagrożenia wg VbF	nie dotyczy	A II
Przepisy transportowe wg ADR/RID	patrz nadruk na opakowaniu lub „Karta danych bezpieczeństwa"	
Znakowanie wg EWG 88/379	patrz nadruk na opakowaniu lub „Karta danych bezpieczeństwa"	

Środki bezpieczeństwa: Przy stosowaniu produktu należy zachować wszelkie środki ostrożności obowiązujące w odniesieniu do materiałów malarskich, wynikające z „Karty danych bezpieczeństwa". Są to np.: „Przepisy dot. zapo-biegania nieszczęśliwym wypadkom" VBG 23, Branżowego Stowarzyszenia Przemysłu Chemicznego.

Niniejsza publikacja unieważnia wszystkie wcześniejsze wersje Informacji Technicznej dot. w/w farby.

UWAGA:
Pisemne lub ustne zalecenia techniczno-aplikacyjne dot. naszych produktów, przekazywane jako pomoc naszym Klientom, nie są zobowiązujące i nie stanowią podstawy do jakichkolwiek dodatkowych roszczeń z tytułu zawarcia umowy kupna. Zalecenia te opracowane zostały zgodnie z naszymi doświadczeniami i zgodnie z aktualnym stanem wiedzy naukowej i praktycznej. Nie zwalniają one Kupującego od samodzielnej kontroli przydatności naszego produktu do przewidzianego zastosowania. Ponadto obowiązują nasze ogólne warunki dostaw i płatności.

SECTION 15

Appendix I

Test Certificates (tba pages)

iST POWER

IST POWER LTD

64/66 Percy Road, Leicester, LE2 8FN (reg'd office) Tel: +44 (0)116 283 3321

Longley Lane, Sharston Industrial Estate, Wythenshawe, Manchester, M22 4RU Tel: +44 (0)161 428 9507

Email:- sales@istpower.com Web: www.istpower.com

TRANSFORMER TEST CERTIFICATE

CUSTOMER : Linxon UK LTD **ELECTRICAL SPEC :** 0105500

RATING kVA : 850 3 **PHASE** 50 **Hz** **SERIAL No :** 102287/26-01

	PRIMARY	SECONDARY
RATED VOLTS :	66000	420
RATED AMPS :	7.44	1168

TEMPERATURE CLASS : A **COOLING :** KNAN **VECTOR GROUP :** ZNyn1

REFERENCE TEMP. °C : 75

THIS TRANSFORMER HAS BEEN TESTED IN ACCORDANCE WITH SPECIFICATION

BS EN 60076 : 2011

AND HAS SATISFACTORILY PASSED THE FOLLOWING TESTS

VOLTAGE RATIO AT NO LOAD : AS RATED VOLTS

WINDING RESISTANCE AT 20 DEGREES C :

	PRIMARY	SECONDARY
	Ohms	milli Ohms
A - B	11.81	2.38
B - C	11.79	2.43
C - A	11.75	2.70

TEST RESULTS

SHORT CIRCUIT IMPEDANCE :	**%**	4.93
LOAD LOSS :	**Watts**	9325
NO LOAD LOSS :	**Watts**	3705
NO LOAD CURRENT :	**%**	0.49
ZERO SEQUENCE IMPEDANCE :	**Ohms per ph.**	46.02

INDUCED OVERVOLTS : 200% AT 100Hz FOR 60 Seconds

SEPARATE SOURCE VOLTS PRIMARY : 140kV AT 50Hz FOR 60 Seconds

SEPARATE SOURCE VOLTS SECONDARY : 3kV AT 50Hz FOR 60 Seconds

INSULATION RESISTANCE PRIMARY TO SEC AND EARTH : 1.75 G Ohms

INSULATION RESISTANCE SECONDARY TO EARTH : 677 M Ohms

REMARKS :

TESTED : Mark Jackson **APPROVED :** Elizabeth MacKenzie

WITNESSED : _____ **DATE :** 26/08/2021

iST POWER

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Email:- sales@istpower.com Web: www.istpower.com

CERTIFICATE OF CONFORMANCE

CUSTOMER : Linxon UK LTD

IST ELECTRICAL SPEC : 0105500

SPECIFICATION : BS EN 60076 : 2011

SERIAL No : 102287/26-01

CUSTOMER PART No : **ISSUE :**
(If Applicable)

The goods identified by the above unique serial number have been tested and inspected to the above specification and have been proved to conform in all respects with your order.

APPROVED : Mark Jackson TEST ENGINEER

DATE : 26/08/2021

iST POWER

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TRANSFORMER TEST CERTIFICATE

CUSTOMER : Linxon UK Ltd **ELECTRICAL SPEC :** 0105500

RATING kVA : 850 3 **PHASE** 50 **Hz** **SERIAL No :** 102287/27-01

	PRIMARY	SECONDARY
RATED VOLTS :	66000	420
RATED AMPS :	7.44	1168

TEMPERATURE CLASS : A **COOLING :** KNAN **VECTOR GROUP :** ZNyn1

REFERENCE TEMP. °C : 75

THIS TRANSFORMER HAS BEEN TESTED IN ACCORDANCE WITH SPECIFICATION

BS EN 60076 : 2011

AND HAS SATISFACTORILY PASSED THE FOLLOWING TESTS

VOLTAGE RATIO AT NO LOAD : AS RATED VOLTS

WINDING RESISTANCE AT 20 DEGREES C :

	PRIMARY Ohms	SECONDARY milli Ohms
A - B	11.68	2.40
B - C	11.74	2.43
C - A	11.64	2.45

TEST RESULTS

SHORT CIRCUIT IMPEDANCE :	**%**	4.95
LOAD LOSS :	**Watts**	9291
NO LOAD LOSS :	**Watts**	3613
NO LOAD CURRENT :	**%**	0.48
ZERO SEQUENCE IMPEDANCE :	**Ohms per ph.**	46.39

INDUCED OVERVOLTS : 200% AT 100Hz Included as Partial Discharge Test

SEPARATE SOURCE VOLTS PRIMARY : 140kV AT 50Hz FOR 60 Seconds

SEPARATE SOURCE VOLTS SECONDARY : 3kV AT 50Hz FOR 60 Seconds

INSULATION RESISTANCE PRIMARY TO SEC AND EARTH : 2 G Ohms

INSULATION RESISTANCE SECONDARY TO EARTH : 850 M Ohms

REMARKS : Insulation Resistance Tested at 2.5kV

TESTED : Mark Jackson **APPROVED :** Elizabeth MacKenzie

WITNESSED : _____ **DATE :** 31/08/2021

iST POWER

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Email:- sales@istpower.com Web: www.istpower.com

CERTIFICATE OF CONFORMANCE

CUSTOMER : Linxon UK Ltd

IST ELECTRICAL SPEC : 0105500

SPECIFICATION : BS EN 60076 : 2011

SERIAL No : 102287/27-01

CUSTOMER PART No : **ISSUE :**
(If Applicable)

The goods identified by the above unique serial number have been tested and inspected to the above specification and have been proved to conform in all respects with your order.

APPROVED : Mark Jackson TEST ENGINEER

DATE : 31/08/2021

iST POWER

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Email:- sales@istpower.com Web: www.istpower.com

TRANSFORMER TEST CERTIFICATE

CUSTOMER : Linxon UK Ltd **ELECTRICAL SPEC :** 0105500

RATING kVA : 850 3 **PHASE** 50 **Hz** **SERIAL No :** 102287/28-01

	PRIMARY	SECONDARY
RATED VOLTS :	66000	420
RATED AMPS :	7.44	1168

TEMPERATURE CLASS : A **COOLING :** KNAN **VECTOR GROUP :** ZNyn1

REFERENCE TEMP. °C : 75

THIS TRANSFORMER HAS BEEN TESTED IN ACCORDANCE WITH SPECIFICATION

BS EN 60076 : 2011

AND HAS SATISFACTORILY PASSED THE FOLLOWING TESTS

VOLTAGE RATIO AT NO LOAD : AS RATED VOLTS

WINDING RESISTANCE AT 20 DEGREES C :

	PRIMARY Ohms	SECONDARY milli Ohms
A - B	11.89	2.39
B - C	11.85	2.43
C - A	11.84	2.44

TEST RESULTS

SHORT CIRCUIT IMPEDANCE :	**%**	4.91
LOAD LOSS :	**Watts**	9388
NO LOAD LOSS :	**Watts**	3696
NO LOAD CURRENT :	**%**	0.50
ZERO SEQUENCE IMPEDANCE :	**Ohms per ph.**	46.84

INDUCED OVERVOLTS : 200% AT 100Hz Included as Partial Discharge Test

SEPARATE SOURCE VOLTS PRIMARY : 140kV AT 50Hz FOR 60 Seconds

SEPARATE SOURCE VOLTS SECONDARY : 3kV AT 50Hz FOR 60 Seconds

INSULATION RESISTANCE PRIMARY TO SEC AND EARTH : 2.3 G Ohms

INSULATION RESISTANCE SECONDARY TO EARTH : 1.142 G Ohms

REMARKS : Insulation Resistance Tested at 2.5kV

TESTED : Mark Jackson **APPROVED :** Elizabeth MacKenzie

WITNESSED : David Poulton **DATE :** 13/09/2021

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Email:- sales@istpower.com Web: www.istpower.com

CERTIFICATE OF CONFORMANCE

CUSTOMER : Linxon UK Ltd

IST ELECTRICAL SPEC : 0105500

SPECIFICATION : BS EN 60076 : 2011

SERIAL No : 102287/28-01

CUSTOMER PART No : **ISSUE :**
(If Applicable)

The goods identified by the above unique serial number have been tested and inspected to the above specification and have been proved to conform in all respects with your order.

APPROVED : Mark Jackson TEST ENGINEER

DATE : 13/09/2021

SECTION 16

Appendix J

Site Acceptance Test Plan (2 pages)

iST POWER

IST POWER LTD

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Longley Lane, Sharston Industrial Estate, Wythenshawe, Manchester, M22 4RU Tel: +44 (0)161 428 9507

Email:- sales@istpower.com Web: www.istpower.com

Site Acceptance Test Plan

CUSTOMER : Linxon

SERIAL NUMBER : 102287/26-01, 102287/27-01, 102287/28-01

ELECTRICAL SPEC : 0105392

DESCRIPTION : 850 kVA Earthing Auxiliary Transformer

VOLTAGE : 66000 / 420 V

DATE:

TESTS	Purpose	SPECIFICATION
Measurement of Winding Resistance	Check for uniformity across phases and consistency with factory results allowing for temperature.	BS EN 60076 – 1 (11.2)
Measurement of Voltage Ratio and Vector Group	To prove vector group ZNyn1 and integrity of transformer.	BS EN 60076 – 1 (11.3)
Measurement of Insulation Resistance for comparison with factory results	No breakdown of Voltage at 2.5kV for 60s Core – Tank Wdgs – Tank	BS EN 60076 1 – (11.12)
Frequency Response Analysis	To compare with factory sweeps for discrepancies.	BS EN 60076 – 18
Check of Auxiliary Wiring and Marshalling box	500V applied >1MΩ • Function of devices • Tidiness of Marshalling box • Integrity of looms and terminal connections • Point to point continuity from devices to Marshalling box. • Electronic breather function • CT knee points, ratio and polarity • OTI "boil up" test to 120^{0}C to check alarm and trip	BS EN 60076 – 3 (9)
Oil Samples and DGA	Tested offsite by approved partner.	BS EN 60422

Installation Checks	(✓)
Correctly positioned on site.	
Visual inspection satisfactory (no visible signs of damage etc)	
No damaged paintwork	
Earthing connections satisfactory	
No oil leaks	
Transformer oil level satisfactory	
All bushing and oil filled chambers oil levels correct	
Dehydrating breather correctly fitted and cap removed (if applicable)	
Breather silica gel clear (if applicable)	
Pressure relief device checked (diaphragm intact and associated ducting satisf.) (if applicable)	
Oil and wiring temperature gauge checked (if applicable)	
HV / LV bushings satisfactory	
All insulators undamaged and clean	
All protective covers and shield fitted	
All rating, diagram, identification, valve location, plates, etc, fitted and satisfactory	

All cabling and wiring visually satisfactory	
Kiosk and cubicle heaters operating satisfactory (if applicable)	
Fuses and Isolator Switch operating satisfactory (if applicable)	
All compartments clean and tidy	
All valves in correct operational position	
All blanking plates satisfactory	
Anti vibration pads satisfactory and evenly compressed	

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POWER