

	STANDARD	Page 1 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

HYBRID MODULES

Revision	Data	List of modifications
00	28/11/2014	First emission
01	16/09/2016	The second emission
02	25/11/2016	2 - COMPONENTS LIST. Current Transformer. Code – 620 Typographic error - 6.1 - Common general ratings. Protection stage. 6.7.- Current transformer. Code.- 620
03	06/11/2019	2- COMPONENTS LIST. Circuit-breaker drive mechanism. Code – 263 removed 4.2.1- General service conditions; SPS Class, only class e (Very Heavy) 4.2.3- Seismic qualification level; _Codensa (AF5) 6.4.2- Bushing terminations; For 245 kV CBs the HV terminals shall be suitable to be interfaced with standardized e-distribuzione clamps (double cable). 6.7- Current transformer, New Code- 624. 6.8- Voltage transformers, New Code- 712. 8.1.1- General requirements, Selector switches positions, only 3 positions (Manual; Local; Remote) 8.1.2- Circuit-breakers drive mechanism, General requirements, manually the operating device energy, with a maximum effort below 200 N (EN 1005-3:2002+A1:2008) during the hole charge. ANNEX A – LOCAL COMPONENTS CODIFICATION ANNEX C – DIMENSIONAL DRAWINGS ANNEX D – ELECTRICAL SCHEMES
04	11/02/2020	Updated ANNEX D – ELECTRICAL SCHEMES Updated ANNEX A – LOCAL COMPONENTS CODIFICATION Updated 2- COMPONENT LIST
05	05/03/2020	Updated the name of the STANDARD for Hybrid Modules according GSGG001 Updated 2- COMPONENT LIST Updated ANNEX A – LOCAL COMPONENTS CODIFICATION
06	30/04/2020	Updated 2- COMPONENT LIST 8.4.3- RETELE ELECTRICI specific requirements Updated ANNEX A – LOCAL COMPONENTS CODIFICATION Updated for 72,5kV ANNEX C – DIMENSIONAL DRAWINGS
07	12/07/2024	Updating the company logo Updated ANNEX A – LOCAL COMPONENTS CODIFICATION
08	08/06/2026	2 – Component list, New code – Bushing SF6 Free class “e” Components with free SF6 solutions considered Updated ANNEX A – LOCAL COMPONENTS CODIFICATION

	STANDARD	Page 2 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

INDEX

1. SCOPE	3
2. COMPONENTS LIST	3
3. REFERENCE LAWS AND STANDARDS	7
4. SERVICE CONDITIONS.....	9
5. HYBRID MODULES COMPOSITION	10
6. TECHNICAL CHARACTERISTICS	11
7. CONSTRUCTION CHARACTERISTICS.....	17
8. FUNCTIONAL CHARACTERISTICS	22
9. TESTING.....	36
10. SUPPLY REQUIREMENTS	44
ANNEX A – LOCAL COMPONENTS CODIFICATION	47
ANNEX B – LAYOUT EXAMPLES	49
ANNEX C – DIMENSIONAL DRAWINGS	55
ANNEX D – ELECTRICAL SCHEMES	59
ANNEX E – SYNOPTIC EXAMPLES	92
ANNEX F – TENDER’S TECHNICAL DOCUMENTATION	95

	STANDARD	Page 3 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

1 SCOPE

Scope of this document is to provide technical requirements for the supply of Hybrid Modules with rated voltage from 72,5 kV to 245 kV to be used in Primary Substations of the Client.

Hybrid Modules are compact metal-enclosed switchgear assemblies, SF6 insulated (in alternative, nonfluorinated greenhouse gases and vacuum circuit-breakers are also acceptable), for outdoor or indoor installation in Primary Substations. The outgoing connections can be air type, cable type or bus-duct type.

Some requirements are applicable only to one or more companies, therefore, depending on the destination of the Hybrid Modules, the supplied equipment shall comply these specific requirements.

2 COMPONENTS LIST

The Hybrid Modules are composed by assembling the modular base components listed below (intended as terns of 3 elements, one for phase, obviously with the exception of support and Control Box). Each base component operates individually but interacting with the others components, even by mean of functional and safety interlocks.

Some typical typologies are provided in chapter 5.

If for manufacturer's design two or more base components are integrated in one component, it could be acceptable if compliant with the other requirements of this standard (in particular functional requirements).

Base component code	Base component description			
GSCH002/011	Lateral bay	With circuit-breaker	Air connection	72,5 kV
GSCH002/012				145 kV
GSCH002/013				170 kV
GSCH002/014				245 kV
GSCH002/021			Cable connection	72,5 kV
GSCH002/022				145 kV
GSCH002/023				170 kV
GSCH002/024				245 kV
GSCH002/031			Bus-duct connection	72,5 kV
GSCH002/032				145 kV
GSCH002/033				170 kV
GSCH002/034				245 kV
GSCH002/061		Without circuitbreaker	Air connection	72,5 kV
GSCH002/062				145-170 kV
GSCH002/063				245 kV
GSCH002/071			Cable connection	72,5 kV
GSCH002/072				145-170 kV
GSCH002/073				245 kV
GSCH002/081			Bus-duct connection	72,5 kV
GSCH002/082				145-170 kV

	STANDARD	Page 4 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

GSCH002/083				245 kV
GSCH002/111	Central bay	Without circuitbreaker	Air connection	72,5 kV
GSCH002/112				145-170 kV
GSCH002/113				245 kV
GSCH002/121			Cable connection	72,5 kV
GSCH002/122				145-170 kV
GSCH002/123				245 kV
GSCH002/131			Bus-duct connection	72,5 kV
GSCH002/132				145-170 kV
GSCH002/133				245 kV
GSCH002/211			Circuit-breaker drive mechanism	Single-pole
GSCH002/212	145-170 kV			
GSCH002/213	245 kV			
GSCH002/221	1°, 2°, 3° opening circuit	72,5 kV		
GSCH002/222		145-170 kV		
GSCH002/223		245 kV		
GSCH002/224	1°, 3° opening circuit	245 kV		
GSCH002/261	Three-pole	1°, 3° opening circuit		72,5 kV
GSCH002/262				145-170 kV
GSCH002/271				72,5 kV
GSCH002/272		1°, 2°, 3° opening circuit	145-170 kV	
GSCH002/281			1°, 2° opening circuit	72,5 kV
GSCH002/282		145-170 kV		
GSCH002/311	Disconnecter	72,5 kV		
GSCH002/312		145-170 kV		
GSCH002/313		245 kV		
GSCH002/321	Disconnecter with earthing switch	72,5 kV		
GSCH002/322		145-170 kV		
GSCH002/323		245 kV		
GSCH002/331	Disconnecter with ability of Bus-transfer current switching	72,5 kV		
GSCH002/332		145-170 kV		
GSCH002/333		245 kV		
GSCH002/411	Bushing SF6/air class “d”	72,5 kV		
GSCH002/412		145-170 kV		
GSCH002/413		245 kV		

	STANDARD	Page 5 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

GSCH002/421	Bushing SF6/air class “e”	72,5 kV
GSCH002/422		145-170 kV
GSCH002/423		245 kV
GSCH002/424	Bushing SF6 Free class “e”	72,5 kV
GSCH002/425		145-170 kV
GSCH002/426		245 kV
GSCH002/461	Cable connection upward exit	72,5 kV
GSCH002/462		145-170 kV
GSCH002/463		245 kV
GSCH002/464	Cable connection downward exit	72,5 kV
GSCH002/465		145-170 kV
GSCH002/466		245 kV
GSCH002/481	Equipments for direct connection between busduct and power transf.	72,5 kV
GSCH002/482		145-170 kV
GSCH002/483		245 kV
GSCH002/511	Bus-duct (1 linear meter x 3 poles)	72,5 kV
GSCH002/512		145-170 kV
GSCH002/513		245 kV
GSCH002/521	Bus-duct curve	72,5 kV
GSCH002/522		145-170 kV
GSCH002/523		245 kV
GSCH002/531		72,5 kV
GSCH002/532	Bus-duct expansion compensator	145-170 kV
GSCH002/533		245 kV
GSCH002/541	Bus-duct joint	72,5 kV
GSCH002/542		145-170 kV
GSCH002/543		245 kV
GSCH002/561	Partitioning with singlepole gas management (including relative equipments and control circuits)	72,5 kV
GSCH002/562		145-170 kV
GSCH002/563		245 kV
GSCH002/564	Partitioning with three- pole gas management (including relative equipments and control circuits)	72,5 kV
GSCH002/565		145-170 kV
GSCH002/566		245 kV
GSCH002/602	Current Transformer	

	STANDARD	Page 6 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

GSCH002/604				
GSCH002/605				
GSCH002/606				
GSCH002/607				
GSCH002/608				
GSCH002/612				
GSCH002/620				
GSCH002/621C				
GSCH002/622				
GSCH002/622C				
GSCH002/624				
GSCH002/700	EVDS - Electronic Voltage Detector System (capacitive dividers included)			
GSCH002/701	Voltage Transformer			
GSCH002/702				
GSCH002/703				
GSCH002/704				
GSCH002/705				
GSCH002/711				
GSCH002/712				
GSCH002/721				
GSCH002/722				
GSCH002/801	Support		Y1 type and Y2 type	72,5 kV
GSCH002/802				145-170 kV
GSCH002/803				245 kV
GSCH002/804			Single-bay type	72,5 kV
GSCH002/805				145-170 kV
GSCH002/806				245 kV
GSCH002/811		RETELE ELECTRICE	Y2 type	145 kV
GSCH002/812			Single-bay type	145 kV
GSCH002/901	Control Box		Y1 type	
GSCH002/902			Y2 type	
GSCH002/903			Single-bay type	
GSCH002/911		RETELE ELECTRICE	Y2 type	
GSCH002/912			Single-bay type	Line bay
GSCH002/913				Transformer bay

	STANDARD	Page 7 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

For components codification see annex A.

3 REFERENCE LAWS AND STANDARDS

3.1 Laws

3.1.1 All European countries

Commission Regulation (EC) 1494/2007 of 17 December 2007 (form of labels and additional labelling requirements as regards products and equipment containing certain fluorinated greenhouse gases).

3.2 Standards

The below listed reference documents shall be intended in the in-force edition at the contract date (amendments included).

3.2.1 Common standards

For Europe destinations the reference standard are the correspondent European standards (EN).

IEC 62271-205	High-voltage switchgear and controlgear - Part 205: Compact switchgear assemblies for rated voltages above 52 kV
IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 62271-203	High-voltage switchgear and controlgear - Part 203: Gas-insulated metal- enclosed switchgear for rated voltages above 52 kV
IEC 62271-100	High-voltage switchgear and controlgear – Part 100: Alternating current circuitbreakers
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: High-voltage alternating current disconnectors and earthing switches
IEC 62271-207	High-voltage switchgear and controlgear - Part 207: Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 62271-209	High-voltage switchgear and controlgear - Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable terminations

	STANDARD	Page 8 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

IEC 62271-211	High-voltage switchgear and controlgear – Part 211: Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment
IEC/TR 62271-301	High-voltage switchgear and controlgear – Part 301: Dimensional standardization of high-voltage terminals
IEC 62271-4	High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF6) and its mixtures
IEC 60073	Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators
IEC 60447	Basic and safety principles for man-machine interface, marking and identification - Actuating principles
IEC 61869-1	Instrument transformers – Part 1: General requirements
IEC 61869-2	Instrument transformers – Part 2: Additional Requirements for Current Transformers
IEC 61869-3	Instrument transformers – Part 3: Additional Requirements for Inductive Voltage Transformers
IEC 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
IEC/TS 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
IEC/TS 60815-3	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems
IEC 60137	Insulated bushings for alternating voltages above 1 000 V
IEC 60332-3-24	Tests on electric and optical fibre cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C
IEC 60529	Degree of protection provided by enclosures (IP Code)
IEC 60068-2-17	Environmental testing – Part 2: Tests – Test Q: Sealing
ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles- Specifications and test methods
ISO 4126	Safety devices for protection against excessive pressure
EN 1005-3:2002	Safety of machinery. Human physical performance Recommended force limits for machinery operation

	STANDARD	Page 9 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

3.2.2 Specific standards

3.2.2.1 RETELE ELECTRICE

Prescriptia Energetica PE 101/85 – Normativ pentru construcția instalațiilor electrice de conexiuni și transformare cu tensiuni peste 1 kV

NTE 011/12/00 - NORMĂ TEHNICĂ PENTRU PROIECTAREA SISTEMELOR DE CIRCUITE SECUNDARE ALE STAȚIILOR ELECTRICE

3.2.2.2 CEI 20-22/2 – Prove di incendio su cavi elettrici – Parte 2: Prova di non propagazione dell'incendio UNI 11144 – Bombole trasportabili per gas – Valvole per bombole per pressioni di esercizio 250 bar – Connessioni: forme e dimensioni

CLIENT operative note PVR001 (guarantee management)

CLIENT operative note PVR006 (bar code)

CLIENT STANDARD GST002 Power Transformers

4 SERVICE CONDITIONS

4.1 General service conditions

Unless otherwise specified, the reference service conditions are the outdoor normal service conditions of IEC 62271-1 (par. 2.1.2).

Minimum ambient air temperature (°C)	-25
SPS Class (IEC/TS 60815 series)	e (Very Heavy)
Ice coating (mm)	10

4.2 Specific service conditions

4.2.1 Romania² (RETELE ELECTRICE)

Minimum ambient air temperature (°C)	-30
Ice coating (mm)	22

4.2.2 Seismic qualification level

RETELE ELECTRICE	AF5 (IEC 62271-207)
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² In accordance with Prescriptia Energetica PE 101/85

	STANDARD	Page 10 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

5 HYBRID MODULES COMPOSITION

In the following the typical Hybrid Modules compositions are described (the figures shall be intended as terns of 3 elements, one for phase). Considering the modularity of Hybrid Module, different compositions could be required. See annex A for some layout examples.

For each Hybrid Module the Client company will provide the proper component list (using items in chapter 2) and the HV single-line diagram. It's up to the manufacturer to verify the coherence between the 2 documents and, if necessary, to ask for clarifications.

5.1 Y1 type

- n° 1 circuit-breaker with three-pole or single-pole mechanism
- n° 1 toroidal current transformer
- n° 3 SF6-air bushings (or cable connections or bus-duct connections)

Additionally, depending by the HV single-line diagram, the composition could include:

- up to n° 2 disconnectors (optionally with ability of Bus-transfer current switching), with motor-driven three-pole mechanism;
- up to n° 3 disconnector combined with earthing switch, with motor-driven three-pole mechanism
- up to n° 2 line voltage presence detectors

5.2 Y2 type

- n° 3 disconnectors combined with earthing switches, with motor-driven three-pole mechanism
- n° 2 circuit-breakers with three-pole or single-pole mechanism
- n° 2 toroidal current transformers
- n° 1 line voltage presence detector
- n° 3 SF6-air bushings (or cable connections or bus-duct connections)

5.3 Single-bay type

- n° 1 disconnector combined with earthing switch, with motor-driven three-pole mechanism
- n° 1 circuit-breaker with three-pole or single-pole mechanism
- n° 1 toroidal current transformer
- n° 2 SF6-air bushings (or cable connections or bus-duct connections)

Additionally, depending by the HV single-line diagram, the composition could include:

- n° 1 disconnector, with motor-driven three-pole mechanism
- n° 1 disconnector combined with earthing switch, with motor-driven three-pole mechanism

	STANDARD	Page 11 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

6 TECHNICAL CHARACTERISTICS

6.1 Common general ratings

Rated voltage Ur (kV)		72,5	145 / 170	245
Rated short-duration power-frequency withstand voltage Ud (kV rms):	Phase-to-earth, across open switching device and between phases	140	275	395
	Across the isolating distance	160	315	460
Rated lightning impulse withstand voltage Up (kVp):	Phase-to-earth, across open switching device and between phases	325	650	950
	Across the isolating distance	375	750	1050
Rated frequency fr (Hz)	RETELE ELETTRICE	50		
Rated normal current Ir (A)		2000		
Rated short time withstand current Ik (kA)		31,5	40/50 ³	
Degrees of protection provided by enclosures (IEC 60529)		IP 54 ⁴		
Rated supply voltage Ua (Vdc)	RETELE ELETTRICE	110~125		
D.C. maximum absorbed power, for each bay (W/bay)		2.000		
Under-voltage release (if requested) – d.c. maximum absorbed power (W/coil)		100		
Rated supply voltage for anti-condensation circuits (Vac)	RETELE ELETTRICE	230		
A.C. maximum absorbed power (VA)		600		
Protection stage (tab. 4 EN 62271-203)		2		
Auxiliary contact classes (Table 6 EN 62271-1)		1		

6.2 Circuit-breakers

In addition to paragraph 6.1 and to IEC 62271-100 requirements, the following further circuit-breakers ratings are required.

Rated voltage U_r (kV)	72,5	145	170	245
Rated short-circuit breaking current I_{sc} (kA)	31,5	40/50 ⁵		
First-pole-to-clear factor k_{pp}	1,5 (non-effectively earthed neutral system)			1,3
Rated operating sequence	O - 0,3 s - CO -1 min - CO ⁶			
Maximum break-time (ms)	60			
Circuit-breaker class	C2 – E1 – M2			
Rated line-charging breaking current I_l (A)	10	50	63	125

³ Only in particular cases a value of 50 kA (I_k) will be requested.

⁴ Applicable also to the Control Box and to the Operating Device Box(es).

⁵ Only in particular cases a value of 50 kA (I_{sc}) will be requested.

⁶ This requirement can be verified by mean of type tests performed with O - 0,3 s – CO -3 min – CO operating sequence and a declaration of the manufacturer about the CB compliance with O - 0,3 s – CO - 1 min – CO operating sequence.

	STANDARD	Page 12 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Rated cable-charging breaking current I_c (A)	125	160	250
Rated out-of-phase making and breaking current I_d (kA)	Clause 4.106 of IEC 62271-100		

6.3 Disconnectors and earthing switches

In addition to paragraph 6.1 and to IEC 62271-102 requirements, the following further disconnectors and earthing switches ratings are required.

Rated voltage Ur (kV)		72,5	145	170	245
Number of poles		3			
Opening (closing) time for motor operation (s)		≤15			
Disconnector mechanical endurance class Mr		M1			
Bus-transfer current switching by disconnectors (only if requested)	Rated bus-transfer current for disconnectors (A)	Clause B.4.106.1 of IEC 62271-102			
	Rated bus-transfer voltages for disconnectors (V)	Clause B.4.106.2 of IEC 62271-102 (referring to Air insulated disconnectors values)			
Earthing switches class		E0 – M1 – A			

6.4 SF6-air bushings

6.4.1 General requirements

The SF6-air bushings for the connections of Hybrid Modules terminations shall be compliant with IEC 60137, outdoor type, with internal SF6 insulation, composite type with glass fiber tube covered with silicone rubber. The color shall be light grey.

The complete Hybrid Module, bushing included, shall be designed to withstand static terminal load according to Table 14 of IEC 62271-100 (e.g. manufacturer shall demonstrate that stresses doesn't affect the proper CB and/or DS/ES functioning).

Bushings shall also be compliant with minimum values of cantilever withstand load provided by Table 1 of IEC 60137, Level I.

6.4.2 Bushing terminations

6.4.2.1 RETELE ELECTRICE

The bushing terminations shall be realized with corrosion resistant copper or aluminum alloy, in order to be interfaced with aluminum alloy clamps.

The final bushing terminations shall have $\varnothing 40 \pm 0,25 \times 80$ min (mm) (fig. 1 of IEC/TR 62271-301) dimensions.

For 245 kV CBs the HV terminals shall be suitable to be interfaced with standardized e-distribuzione clamps (double cable). Fig.1

	STANDARD	Page 13 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

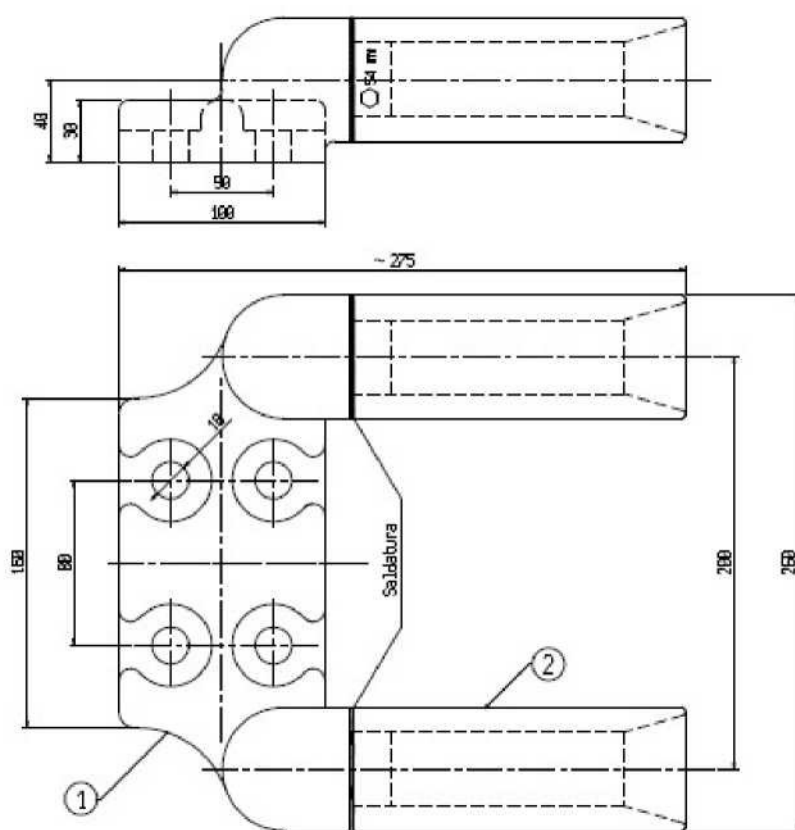


Fig. 1

6.5 Direct connections between bus-duct and power transformer with SF6/oil bushings

The direct connection between the bus-duct and the HV/MV power transformer can be requested in compliance with one of the following document:

- IEC 62271-211
- Client STANDARD GST002 Power Transformers - Local section Compatibility verification of the interfaces of the bus-duct with the substation in order to ensure the proper connection is a manufacturer responsibility.

6.6 Cable connections

IEC 62271-209 applies.

The cable connections can be requested with upward exit or downward exit (in upward case, the manufacturer shall ensure the on-site compatibility between cable supports and Hybrid Module).

Usually the cable connection enclosure shall be suitable for the dry-type cable-termination (see figure 5 of IEC62271-209); only if requested it shall be for fluid-filled cable terminations (see figure 3 of IEC 62271-209).

In case of “plug-in” dry-type cable-terminations, they will be provided by client in order to be mounted by the manufacturer; if the Hybrid Module transportation is possible with components fully assembled in a single unit, it's required the female cone factory preassembly.

	STANDARD	Page 14 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

6.7 Current transformers

In addition to IEC 61869-1 and IEC 61869-2 requirements, the following further toroidal current transformers requirements are prescribed.

Base component code (see par. 2)	GSCH002/604	GSCH002/602 605	GSCH002/606	GSCH002/607	GSCH002/608
Rated shorttime thermal current I_{th} (kA)	40				
Rated continuous thermal current I_{cth} (kA)	120% of I_{pr}				
Rated transformation ratio k_r (A/A)	200-400/1	400-800/1	1.600/1	200-400/1/1	400-8001.600/1/1
Core number	1	1	1	2	2
Accuracy class ⁷	5P30	5P30	5P30	5P30	5P30
Rated burden (VA)	15	15	15	15	15
Maximum secondary winding resistance (R_{ct}) at 75 °C (Ω)	5	5	5	5	5

⁷ the accuracy requirements refer to all specified transformation ratio

	STANDARD					Page 15 din 96
	HYBRID MODULES					GSCH002 Rev. 08 08/06/2026

Base component code (see par. 2)	GSCH002/ 612	GSCH002/ 620	GSCH002/ 621C	GSCH002/ 622	GSCH002/ 622C	GSCH002/ 624
Rated shorttime thermal current I_{th} (kA)	40					
Rated continuous thermal current I_{cth} (kA)	120% of I_{pr}					
Rated transformation ratio k_r (A/A)	400800/5/1/1	1.000 2.000/5/5/5	1.000 2.000/5/1/1	400800/5/5/5	400800/5/5/5	300-600- 1000/5/5/5/5/5
Core number	3	3	3	3	3	5
Accuracy class ⁸	0,2 – FS10	0,5 – 5P20	0,5 – 5P20	0,5 – 5P20	0,2s – FS10	0,2s – 2 $\geq$ FS $\leq$ 5
	5P30	5P20	5P20	5P20	5P20	0,2s – 2 $\geq$ FS $\leq$ 5
	5P30	5P20	5P20	5P20	5P20	5P20
	NA	NA	NA	NA	NA	5P20
	NA	NA	NA	NA	NA	5P20
Rated burden (VA)	15	30	30	30	30	30
Maximum secondary winding resistance (R_{ct}) at 75 °C (Ω)	5 (only for 1 A cores)	n.a.	n.a.	n.a.	n.a.	n.a.

6.8 Voltage transformers

In addition to IEC 61869-1 and IEC 61869-3 requirements, the following further inductive SF6 insulated voltage transformers requirements are prescribed (in alternative, free SF6 solutions may also be accepted).

⁸ the accuracy requirements refer to all specified transformation ratio

	STANDARD				Page 16 din 96
	HYBRID MODULES				GSCH002 Rev. 08 08/06/2026

Base component code	GSCH002/ 701	GSCH002/ 702	GSCH002/ 703	GSCH002/ 704	GSCH002/ 705
Highest voltage for equipment U_m (kV)	72,5	145	170	245	72,5
Rated Insulation levels	According to 6.1				
Rated transformation ratio k_r (kV/kV)	60: $\sqrt{3}$	132: $\sqrt{3}$	150: $\sqrt{3}$	220: $\sqrt{3}$	66: $\sqrt{3}$
	0,1: $\sqrt{3}$	0,1: $\sqrt{3}$	0,1: $\sqrt{3}$	0,1: $\sqrt{3}$	0,11: $\sqrt{3}$
Secondary windings	1	1	1	1	2
Rated voltage factor F_v	1,5 (rated time 30 s)				
Accuracy class	0,2 – 3P	0,2 – 3P	0,2 – 3P	0,2 – 3P	0,5 – 3P 0,5 – 3P
Rated burden (VA)	25	25	25	25	25

Base component code	GSCH002/ 711	GSCH002/ 712	GSCH002/ 721	GSCH002/ 722
Highest voltage for equipment U_m (kV)	145	145	145	145
Rated Insulation levels	According to 6.1			
Rated transformation ratio k_r (kV/kV)	120: $\sqrt{3}$	110	132: $\sqrt{3}$	110: $\sqrt{3}$
	0,1: $\sqrt{3}$	110: $\sqrt{3}$	0,11: $\sqrt{3}$	0,11: $\sqrt{3}$
Secondary windings	2	3	2	2
Rated voltage factor F_v	1,5 (rated time 30 s)			
Accuracy class	0,2	0,2	0,5 – 3P	0,5 – 3P
	0,2 – 3P	0,2 – 3P	0,5 – 3P	0,5 – 3P
	n.a.	0,2 – 3P	n.a.	n.a.
Rated burden (VA)	15	15	25	25

Referring to IEC 61869-1 table 8 “Arc fault duration and performance criteria”, it is requested:

- Protection stage: 2
- Internal arc fault protection: class II

	STANDARD	Page 17 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

7 CONSTRUCTION CHARACTERISTICS

7.1 General characteristics

The Hybrid Module shall be manufactured in accordance with IEC 62271-205.

According to par. 1.101 of IEC 62271-205, each switching device and its controlgear forming part of a compact switchgear assembly shall comply with the relevant individual standard. Being the Hybrid Module formed also by metal enclosed switchgear devices, the requirements of IEC 62271-203 are applicable.

The Hybrid Module consists of a single enclosure for each phase.

The normal use, control and maintenance operations shall be performed with total workers safety.

Components identifications shall be performed by plates located close to them.

All the written tests (labels, synoptic etc.) shall be in the local language of destination.

The SF6 solid decomposition products shall not influence the insulation and the equipment operation.

The over-voltages caused by breaking or making of capacitive current shall not compromise dielectric insulation of components enclosed in the enclosure.

Hybrid modules shall comply with dimensional constraints shown in annex C.

7.2 Enclosures and support structure

The enclosures shall be metallic and with the mechanical robustness necessary to ensure the correct operation of all internal mobile parts.

Any cover or detachable part of the equipment shouldn't be likely to be lost. All the detachable parts (including bolts) should be attached.

The enclosures shall be suitable for the vacuum treatment during gas filling processing, in factory or in field. Furthermore shall be able to absorb mechanical expansion due to normal service conditions.

The enclosures and support structure disposition shall ensure that:

- All equipment parts are easily accessible for normal check operations with the equipment in service. Manual operations shall be easily performed from the ground (maximum height 1.900 mm);
- It is possible to easily replace the complete pole elements without affect other poles;
- The maintenance or complete equipment/parts replacing are executable accessing with lifting vehicle (the manufacturer's maintenance manual shall indicate the procedure for carrying out this movement of the equipment).

The Hybrid Module enclosures shall be assembled on a metallic support structure suitable to be fixed on a foundation by means of chemical plugs or similar systems.

7.3 Dielectric mean

The dielectric mean for insulation and arc extinction is SF6, with a pressure over the atmospheric one.

The gas shall comply with EN 60376 standard. The manufacturer has to provide the necessary instructions for use and handling of SF6, in accordance with IEC 62271-4.

In alternative, non-fluorinated greenhouse gases and internal vacuum breaking unit are also acceptable.

7.4 Gas density control

The Hybrid Module is a closed pressure system. The relative leakage rate shall be $F_{rel} \leq 0,5\%$ per year. The value for the time between replenishments shall be at least 10 years (also valid for voltage transformers, if present).

	STANDARD	Page 18 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

It shall be possible to perform the SF6 replenishment with the equipment in service, avoiding the unwanted operation of the SF6 density control device.

Each pole and partition shall have a distinct SF6 circuit, with a device for the density control.

Solely the gas control circuit of the voltage transformers (when present) can be three-pole.

Each SF6 circuit shall provide a connection element (type DILO VK/BG-03/8 or equivalent⁹), with a nonreturn valve, both for SF6 control device and for gas filling/replenishment, provided by not losable protection screw taps (located not higher than 1.900 mm from the ground level).

The SF6 circuit piping shall be performed using stainless steel or painted copper, in order to reduce the stealing risk. Alternative solutions can be considered if the manufacturer proves their similar visible effect and equivalent technical and ageing characteristics.

The alarm threshold calibration has to take into account the leakage rate. The block threshold calibration shall be at least 0,02 MPa lower respect to the alarm threshold.

The SF6 density control device shall be:

- suitable to work in the provided temperature range;
- located in order to avoid the solar radiation influence on the external temperature measuring;
- Your indicator needle cannot be tampered with.
- insensitive to the vibration produced by the equipments operation;
- manufactured with stainless materials;
- realized in order to allow the functionality verification and the substitution with the poles under pressure;
- with the following scale(s) for a visible indication of gas density level:
 - The density meter should be colored and graduated.
 - There should be a nameplate with the relation between the SF6 pressure and ambient temperature

The SF6 density control device shall provide 2 operating levels independently adjustable (see details and specific requirements in 8.5):

- 1st minimum gas density level (“P1 gas”): alarm (replenishment necessary), with 2 contacts (1 contact in case of Single-bay type or voltage transformers);
- 2nd minimum gas density level (“P4 gas”): to get out of service (see 8.5 for details), with 2 contacts (1 contact in case of Single-bay type or voltage transformers).

The contacts operating tolerance shall be lower than $\pm 1,5\%$ (referred to the full scale) in the provided temperature range; the contacts of each minimum gas density level shall have a difference $\leq 0,005$ MPa between them.

7.5 Gas filling/replenishment device (Optional)

At request the manufacturer shall supply a device for the gas replenishment.

In case of SF6, the device shall be provided by female thread connection, W 21,7 x 1/14” (UNI 11144 – only for) on gas bottle side and DILO VK/BG-03/8 or equivalent on pole junction device side. The device will consist of:

- pressure regulator
- a safety valve (ISO 4126 compliant, calibrated at 8 bar rel);
- a pressure gauge 0÷1 MPa, 0,5 class, minim resolution ± 5 kPa, accompanied with a calibration certificate;
- flexible tube 5 meters long, DN $\geq$ 8.

7.6 Partitioning

7.6.1 Common requirements

Generally the partitioning of each pole should be unique. At request could be required to have other partitions: in this case the new partitions will be managed including in the electric scheme the additional functionalities of the interlocking, automatic openings and remote signaling.

⁹ In case of non-fluorinated green house gases, the Manufacturer will propose a suitable type different from the one used for SF6, in order to avoid mistakes.

	STANDARD	Page 19 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The partitions shall have adequate mechanical resistance to static and dynamic stresses and to vibrations due to both normal and short circuit operation. The partitions shall be designed for the maximum differential pressure in case of vacuum performed in one of the sections.

If the manufacturer consider necessary further partitions (i.e. V.T. presence), they will be subjected to client approval.

Partition examples are in annex B (represented in red color).

7.6.2 Specific requirements

7.7 Earthing

The manufacturer shall ensure the equi-potentiality between all parts forming the equipment.

On the base of each support there shall be 2 earthing points equipped with (AISI 316) M12 stainless steel bolts (included in the scope of supply) separated 50 mm vertically.



Support cannot be used as earthing path (even for CTs and VTs, that will also have an earthing path connection directly to the earthing points in the support base).

The manufacturer must ensure that the earthing at each of these points independently establishes that all parts of the equipment are equipotential. The equipment does not need additional grounding points to ensure an equipotential bonding of all components.

As for instrument transformers, the following secondary terminals shall be earthed:

	RETELE ELECTRICE
CTs	S1
VTs	n

7.8 Internal arc and overpressure safety devices

In order to provide a high protection to workers, the external effects of an internal arc (pressure increase of gas and possible burn-through of enclosure) must be limited.

Referring to item 5.102.2 of IEC 62271-203 and the performance criteria – Table 104 – it is requested protection stage 2: no fragmentation (burn-through is acceptable).

All enclosures (VT included, if any) shall be equipped with safety devices against the internal overpressures compliant with ISO 4126 (alternative solutions could be evaluated if the manufacturer proves their adequacy) and properly

	STANDARD	Page 20 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

calibrated over the maximum operating pressure, in order to avoid improper operations.

In case of overpressure safety valves operation, the expelled gas shall not run over people around the equipment and shall not damage Hybrid Module vital parts.

7.9 Current Transformers

The outdoor current transformers shall be manufactured in compliance to IEC 61869-1 and IEC 61869

2, toroidal type and suitable for exposed installation. They will be located close to the bushings (or to the cable or Bus-duct connections).

The secondary terminal box shall be located in order to be easily accessible.

Inside the Control Box shall be located a CT's terminal board, additional to the previous in the secondary terminal box, 6 mm² section. The terminal board inside the Control Box shall be short-circuitable on CT side and disconnectable on Control System side, with test sockets.

The connection cables between the secondary terminal boxes and the CT's terminal board shall be 2,5 mm² section if Isn =1 A or 4 mm² section if 5 A.

Manufacturer may omit the secondary terminal boxes: on this purpose the connections between the secondary windings and cables to CT's terminal board inside the Control Box shall be welded inside CTs. In this case the terminal board becomes the secondary terminals.

With reference to the annex C dimensional drawings, it is specified that the primary terminal "P1" shall be positioned toward the internal hybrid module side, as the "P2" is to SF6/air bushing or cable connection.

7.10 Voltage Transformers

The outdoor voltage transformers, suitable for exposed installation, shall be manufactured in compliance to IEC 61869-1 and IEC 61869-3 and partitioned respect to the hybrid modules enclosures.

7.11 Anti-condensation circuit

Inside all boxes a proper anti-condensation system shall be provided in order to prevent humidity damages and to ensure a proper air replacement.

The anti-condensation circuit shall be one for the overall equipment, supplied in a.c (see table in chapter 6 for the supply rated voltage) and protected with a magnetothermic automatic circuit-breaker. It shall be controlled by a humidistat; thermostat is admitted in addition if the manufacturer needs it to comply the minimum ambient temperature requirement. Both shall have fixed regulation (typical regulation values are 60% R.H. and + 5°C) and the contacts shall be connected in parallel.

The heating elements shall be connected in series in order to open the circuit in case of breaking of an element; a minimum current sensor shall detect and signal the anomaly (obviously not when circuit is OFF for environmental causes).

In parallel connection case, the manufacturer shall assure a correct fault detection and distance anomaly signaling in case of failure of an element, properly evaluating the tolerances of the supply voltage and of the components resistance.

The heating elements should be easily replaced without affecting any other component of the enclosure (even wiring) and with the equipment in service.

7.12 Protective treatments

All external surfaces shall have an effective and enduring anti-corrosion protection.

On request the enclosures shall be painted in light gray color (RAL 7035). Painting is anyway admitted even if not expressly requested.

The external visible part of partitions, if any, shall be in orange color (RAL 2004).

All iron parts (e.g. support, Control Box, Drive Mechanism Boxes, bolts etc.) shall be in non-corrosive material (AISI 316) or hot dip galvanized in compliance with ISO 1461. All processing shall be completed before the protective treatments.

Protective treatments alternative to the hot dip galvanization could be accepted if the manufacturer proves its adequacy. The metallic elements in contact shall be designed in order to avoid corrosion due to humidity galvanic effect.

7.13 Nameplate

	STANDARD	Page 21 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

7.13.1 Common requirements

The nameplates shall be in stainless steel. Alternative materials can be considered if the manufacturer proves the marking endurance respect to the ageing.

The nameplate must be in the language of the destination country.

5.10 of IEC 62271-205 applies. Moreover the nameplate, placed on the external side of the Control Box door, shall include:

- Art 5.10 Nameplates Applies 5.10 of IEC 62271-1 with the following addition: A common nameplate must be provided to identify the compact multi-function module. It must, as a minimum, specify the nominal characteristics listed in art. 4 of this Standard. The common plate must be clearly legible from the position of the local operating zone. For each individual appliance, a plate, in accordance with its own standard, is required when the nominal characteristics are not specified on the common plate.
- Art 4 Rated characteristics Article 4 of IEC 62271-1 applies in part with the following particularities: The rated characteristics of a compact multi-function module and its control equipment include the following:
 - (a) rated voltage (Ur);
 - (b) nominal insulation level;
 - (c) rated frequency (fr);
 - (d) rated thermal current (Ir) (for main circuits);
 - (e) rated short-time permissible current (Ik) (for main and ground circuits);
 - (f) Nominal permissible peak current (Ip) (for main and ground circuits);
 - (g) rated short circuit duration (tk); and, where applicable,
 - (h) the rated values of the equipment of the compact module, including its switching equipment (supply voltage and frequency) and its ancillary and control equipment.
- The rated characteristics of a compact multi-function module shall be assigned to ensure that the operation of the module within the limits of the assigned ratings does not expose any individual device to conditions exceeding its rated powers and ranges.
- reference to this STANDARD and revision
- composition type (Y1, Y2 or Single-bay);
- optional values, if any;
- the rated filling pressure value at 20°C (relative value).
- include number of SF6 kg and number of CO2 equivalent kgs.
- Include the sentence “Contains fluorinated greenhouse gases covered by the Kyoto Protocol” (in accordance with Commission Regulation (EC) 1494/2007 of 17 December 2007).
- Nameplate in the language of the destination country

7.13.2 specific requirements

According to PVR006/ PVR016 a bar code shall be assigned to each base component and to the overall assembly (containing references to the base components forming the assembly). Further details will be discussed during the conformity assessment process.

	STANDARD	Page 22 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

8 FUNCTIONAL CHARACTERISTICS

8.1 Drive mechanisms

8.1.1 General requirements

The equipment controls shall be realized in order to be managed by one or more selector switches for the operation type choice, with the following characteristics:

Companies	Selector switches positions	Names	Key
RETELE ELECTRICE	3	Manual Local Remote	Requested (extractable only in manual position) If the Hybrid Module have more than one, they have to be different

These selector switches shall be located inside the Control Box.

In particular the following switches are necessary:

- for Y1, single-bay and double bus-bar types: n° 1;
- for Y2 type: n° 2 (one for bay 1 and 2 and one for bay 3 – see annex B).

In “remote” position the electric remote controls are enabled and the electric local controls are disabled.

In “local” position the electric remote controls are disabled and the electric local controls are enabled.

In “manual” position all electric (local and remote) operations are disabled.

The switch operation shall not cause unwanted equipment operations.

The local operation of circuit-breakers (only three-pole operations, it shall not be possible to operate locally single-pole operations) and disconnectors/earthing switches shall be controlled by push-buttons located in the Control Box (see 8.2.1), with the following colors:

Operation	RETELE ELECTRICE (according with IEC 60073)
Closing	Black “I” on white background
Opening	White “O” on black background

The test lamp push button located in the Control Box should have the following color:

Push button	RETELE ELECTRICE (according with IEC 60073)
Test/reset lamp	White

Only one lamp test push button for the whole hybrid module.

	STANDARD	Page 23 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The main contact position of circuit-breaker and disconnector/earthing switch indicators have the following characteristics:

Position	RETELE ELECTRIC (according with IEC 60073)
Close	Black “I” on white background
Open	White “O” on black background

The location of the equipment's position indicator devices (open-closed) must guarantee that they are always visible to the operator at every instant of the operation.

Temporary block signalizations shall not be sent to the control system during normal operation.

As for D.C. supply it's specified that:

- the remote/local control supply of each bay shall be independent from the others;
- the motors supply is common for all circuit-breakers and disconnector of the equipment. All motors shall be equipped with protection magnetothermic automatic circuit-breaker.

8.1.2 Circuit-breakers drive mechanism

8.1.2.1 General requirements

The Circuit-breakers drive mechanism shall be spring type, three-pole or single-pole type, except for 245kV has to be single-pole type.

The drive energy storage shall be normally made by mean of d.c. electric motor (see table in chapter 6.1 for the supply rated voltage); when necessary it shall be possible to restore manually the operating device energy, with a maximum effort below 200 N (EN 1005-3:2002+A1:2008) during the hole charge. The equipment must have an indicator of the state of the spring (loaded/unloaded) and it has to be visible from the maneuver position. The manual device shall exclude the motor operation, The insertion of the crank handle in the case of manual loading must automatically suppress any power supply to the motorized equipment being maneuvered, or in alternative shall be designed excluding its possible movement in case of unexpected spring operation. Every hybrid module shall have only one handcrank for each type of CB mechanism. Plastic component is forbidden in the handcrank design.

All releases, both for closing and for opening, shall not work with a signal duration ≤ 3 ms.

The Circuit-breakers drive mechanism shall be able to perform the following cycles¹⁰:

- with motor working:
 - O - 0,3 s - CO - 1 min - CO with CB closed and opening and closing springs charged;
- with motor not working:
 - O - 0,3 s – CO with CB closed and opening and closing springs charged;
 - CO with CB open and closing springs charged;
 - O with CB closed and opening springs charged.

¹⁰ with the CB closed the opening springs shall be always charged.

	STANDARD	Page 24 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The single-pole CBs shall be equipped with a device for the signalization of poles not in the same position (closed or open). This is applicable also for three-pole CBs when they are electrically obtained by single-pole CBs, paralleling the releases coils.

8.1.2.2 Release drive circuits

Referring to the table in chapter 2, the release drive circuits typologies are:

- drive circuit of shunt closing release (always required);
- drive circuit of shunt opening release (1° and 2° circuit both independents);
- drive circuit of under-voltage release (3° circuit).

In the electric schemes in annex D both the control circuits for the different cases and the interlocks described in the paragraph 8.5 are shown.

It shall be possible to request the CB opening acting both on a single circuit at a time and concurrently on any combination of the different opening circuits.

In case during an operation an opposite operation request is received, the consent on the last operation shall be given only after the completion of on-going operation (in this case, only for singlepole CBs, the discrepancy between poles can exceeds the required limits)

The closing circuits shall be equipped with antipumping devices (1 for tripolar CBs and 3 for unipolar CBs) in order to inhibit further closing operations after the first one if an opening occurs during the initial closing request.

The main contacts position shall be assured stably and surely in the open and closed position. The CBs shall not operate in case of accidental auxiliary circuits supply interruption or in case of supply restore (excluding the drive circuit of under-voltage release).

It shall be possible to perform the CB closing and opening (when HV and d.c. supplies are off, i.e. due to a fault) by means of (safety located) hand operated levers or buttons.

8.1.2.2.a) RETELE ELECTRICE specific requirements

It shall be possible to manually lock/unlock the under-voltage release(s), both three-pole or single-pole type, by mean of a device provided of the “bloccato”/“sbloccato” indication (in local language). This device(s) shall be easily and safely accessible (shall not be necessary to open the part of the Operating Device Box where the operating devices are located) and shall be maneuverable from the ground level (maximum height 1.900 mm). It shall be possible to operate this device(s) with the CB in service and without causing an unwanted opening. In the functional scheme the locked under-voltage release signalization shall be provided.

Under-voltage releases consisting of energy storage systems (for example capacitors) are not admitted.

The CB closing consensus shall be interdict in case under-voltage release drive circuits are not supplied.

8.1.3 Disconnectors (DSs) and earthing switches (ESs) drive mechanism

The DSs and ESs operation shall be performed by three-pole motor-drive mechanisms with the possibility of emergency (for instance: absence of DC power supply) manual operation in case of need. It will consist of a gear motor (see table in paragraph 6.1 for the supply rated voltage) which will transmit its movement to the drive shaft of the disconnector. The same applies to earthing switch.

The motor drive system can be unique for DS and ES.

The drive mechanism shall operate on a highly reliable transmission system, in order to avoid any interruptions.

Every hybrid module shall have only one handcrank for each type of DS and ES mechanism. Plastic component is forbidden in the handcrank design.

Position indicating devices of disconnectors and earthing switches shall comply IEC 62271 -102, annex A.

The location of the equipment's position indicator devices (open-closed) must guarantee that they are always visible to the operator at every instant of the operation.

DS and ES shall be both equipped with the following circuits:

- n° 1 drive circuit of shunt closing release;
- n° 1 drive circuit of shunt opening release.

The ongoing operations shall be completed even in case of opposite operation request.

	STANDARD	Page 25 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The operation requests persistence after the operation conclusion shall not produce effects.

In case of a DS/ES operation is not completed, any previously received operation requests shall not remain stored. In case of motor supply outage during a DS/ES operation, the drive mechanism shall ensure:

- the keeping of the reached position, both during supply absence and at its restore;
- the execution after the supply restore of any requested closing or opening operation, independently from the operation type ongoing at supply outage instant;
- that in case of not completed operation the operation sequence shall be stopped and an anomaly remote signalization (Switch Not Maneuverable) shall be sent, by mean of a timed contact.

The operations shall not be carried out if the request signal duration is shorter than 3 ms.

The manual emergency operation shall be enabled by a Consensus Electromagnetic Device (CED¹¹):

- in case of 2 positions selector switch the hand-crank insertion is enabled only in “local” position, pressing a button¹² and in presence of all requested consensus conditions (see electric schemes);
- in case of 3 positions selector switch the hand-crank insertion is enabled only in “manual” position and in presence of all requested consensus conditions (see electric schemes).

The hand-crank for manual operation shall be withdrawable type; its insertion shall cause an anomaly remote signalization¹³ and shall disable the electric operations, both local and remote.

The insertion of the crank handle in the case of manual loading must automatically suppress any power supply to the motorized equipment being maneuvered.

The manual operation of DS and ES shall be compliant with IEC 60447.

The turns number for a complete manual operation shall not exceed 50.

All controls (remote, local and manual) shall be subject to the conditions described in paragraph 8.5 and represented in the electric scheme of annex D.

8.1.3.1 DS/ES mechanical locks and interlocks

DS combined with ES as a single unit shall have a mechanical interlocking device that prevent the closure of ES when DS is closed and prevent closure of DS when ES is closed (not applicable in case of DS/ES for which it's not physically possible to have these conditions).

Electrical interlocks are described in paragraph 8.5.

All mechanical locks and interlocks shall be designed to withstand, preventing damages and without need of maintenance:

- in case of motor-operation, to the strains produced by the motor starting torque;
- in case of manual-operation, to 3 times the maximum force required for manual operation (5.105 of 62271-102), or, if a strain limiting device is present, to 1,5 times its intervention rated value.

8.2 Control Box and Drive Mechanism Box

The requested cabinets are the followings:

- a cabinet for control and interface with the remote control system (hereinafter “Control Box”)
- cabinets for the CBs, DSs and ESs operating devices (hereinafter “Operating device Box”)

8.2.1 Control Box

All Hybrid Module auxiliary and control equipments shall be placed in the Control Box, located in correspondence of the central pole, on the side indicated in annex C; the Control Box can be fixed on the Hybrid Module support or on a specific independent support (in this case see annex C for maximum distance). In this box also the cables coming from CTs and, if any, VTs shall be connected to the respective terminal boards (see par. 7.9 and annex D). If the manufacturer proposes the control box separate from the module, the connection between the CB and the module

¹¹ “DEC – Dispositivo Elettromagnetico Consenso” for RETELE ELECTRICI.

¹² Different designs with the same functional results can be evaluated by RETELE ELECTRICI.

¹³ “SNM – Sezionatore Non Manovrabile” for RETELE ELECTRICI.

	STANDARD	Page 26 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

must be with heavy duty connection type (harting)

In case of interferences with some equipment parts (e.g. with VTs and HV cable connection) the box shall be located on the Hybrid Module side in correspondence with the LV cable shaft of the civil works (in this case some additional information should be provided by the user and the Control box position will be agreed).

The location of the control box should always consider pedestrian access to the equipment (projected and/or existing). Always prioritizing to facilitate the access and the operation of this.

In addition to the IP requirement of table al chapter 6.1, the box protection degree with open doors shall be minimum IP2X.

In addition to the dimensions shown in annex C, the box base height respect to the ground shall be ≥ 400 mm and all HMI (Human Machine Interface) elements (controls and signalizations) shall be at ≤ 1800 mm.

The box interior shall be accessible only from the front by mean of a door provided of handle and lock. The door (simple or double), hinged and provided of anti-wind system, shall be provided of a window in order to make visible from outside the synoptic and the signalization lamps. It shall be possible to open the door over 90° .

All accessories (hand cranks, document pocket etc.) shall be accommodated In the internal part of the box door.

All electric equipment components shall be:

- compliant with the respective IEC standards;
- equipped with an identification label indicating the codification used in the functional electric schemes;
- easily accessible for maintenance or substitution operations;
- of typologies for which interchangeable components are easily available in commerce (delivery time within 2 weeks) in the Hybrid Module destination country.

In particular, the extractible ones, plug-in connector included, shall be provided with proper anti-mistake coding.

The box internal wiring shall be made with conductors with adequate section ($\geq 1\text{mm}^2$), flexible type, compliant with IEC 60332-3-24 and insulated at $U_o/U = 450/750$ V.

The cable ends shall be provided by pre-insulated compression type terminals, suitable for the clamps where they have to be connected.

The connection cable from the Control Box to the equipments shall be of adequate section ($\geq 1,5\text{ mm}^2$), shielded, flexible, compliant with IEC 60332-3-24 and insulated at $U_o/U = 0,6/1$ kV.

Inside the Control Box an internal collector (in copper, section $\geq 60\text{ mm}^2$ and M5 regular interval threaded hole) shall be present for the earthing connection of all cable shields; the Manufacturer shall guarantee its effective connection to the Hybrid Module earthing system.

The entrance of cable coming from equipments and control system shall be from the Control Box bottom side, where a removable loophole (in aluminum, with useful dimension of 300×300 mm) shall be provided.

At about 200 mm below the Control Box shall be provided a removable horizontal crossbar, suitable for the anchorage of all the cables by mean of cable-fixers.

The Control Box shall include:

- selector switches;
- synoptic (see annex E) representing the HV electric scheme, with the equipments position (close or open), the partitioning (if any), the alarm/block signalization lamps and the lamps testing button; the synoptic shall also include control buttons for CBs, DS and ES;
- gas density signalization lamps (for each gas circuit, yellow color about 1st minimum gas density level; red color about 2nd minimum gas density level).
- magneto-thermic automatic circuit-breakers for the supplies protection (motors, lighting lamp, anti-condensation circuits – fuses are not admitted);
- interface terminal board for substation control system, including the CTs and VTs testing terminals (with correspondent automatic circuit-breakers, see par. 8.5);
- anti-condensation circuit;
- internal lighting lamp, with automatic switching in case of open door. The whole internal control box must be lightened to make easier the wiring works.

For each Hybrid Module the interface terminal boards composition depends on the HV switchgear typologies that form the whole assembly.

The interface terminal boards (and their modular terminals) shall be grouped, for every bay, switchgear by switchgear, according to principle electric schemes shown in annex D.

The terminals shall have section 4 mm^2 for control, signalization and anti-condensation circuits and section 10 mm^2

	STANDARD	Page 27 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

for the motors supply circuit.

The VTs (if any) terminals and protection circuit-breakers shall be located in the bottom part of the box, as close as possible to the cable entrance, in order to minimize the short circuit hazard.

Similarly also the CTs terminals shall be located in the bottom part of the box.

Two bridged terminals couples for the anti-condensation circuit and 2/3 (depending on the number of bays) bridged terminal couples for the motor supply circuit shall be provided.

The cable trunks close to the interface terminal boards shall be used for the control system wiring and cannot be used for the internal wiring.

The connections between the different equipment should be with the heavy duty connection type (harting). The protection degree has to be IP68.

The cable trunking systems for the internal wiring shall shave sufficient residual space ($\geq 10\%$ of used volume); the cables shall be anchored in some points in order to avoid their falling. The cable entry must have a cable gland.

The signalization lamps and the internal lighting lamps shall not be incandescent type (LED preferably). The lighting lamps shall be easily removable.

All provided electromechanical block keys (installed i.e. on transformer bay) shall be differently codified.

The earthing of a d.c. supply polarity is not admitted.

If diodes are used for the circuit separations or for the voltage return protection, they shall have reverse voltage ≥ 3 kV.

8.2.1.1 RETELE ELECTRICE specific requirements

In alternative to IEC 60332-3-24, cables compliant with CEI 20-22/2 and marked with CEI 20-22 II can be accepted.

8.2.2 Operating devices boxes

The drive mechanisms, the CB operation counters (four-digits, not-resettable, mechanical or in alternative electromechanical – in the latter case located in the Control Box), the auxiliary electric equipments, the auxiliary contacts and the terminal boards (or connectors) shall be located:

- in a single cabinet for disconnectors/earthing switches and three-pole CBs;
- in 3 cabinets for single-pole CBs.

During normal operation, with enclosures and doors closed, the main contact position indication (close/open) and, for CBs, the spring loading condition signalization shall be visible from ground level. In order to allow the verification, during maintenance activity, of the unchanged characteristics of the CB's no-load travel curve (see note in par. 10.2.2-9b), manufacturer shall provide the measuring points, properly machined.

In addition to the IP requirement of table at chapter 6, the box(es) protection degree with open doors or when using hand-crank (to charge CB's springs or manual operation on DS/ES) shall be minimum IP2X (unless the box can be opened only using tools).

All mechanical organs (included the motion transmission rods for three-pole CBs) shall be enclosed in metallic enclosures, IP2X, in order to prevent the access to parts in movement, unless they have slow motion (see par. 5.13.1 of IEC 62271-1) without cutting and crushing hazard.

The manufacturer shall provide the instruction for a safety access to mechanical organs.

8.3 Electronic Voltage Detector System EVDS

The EVDS detects the voltage presence in order to implement interlocks for preventing incorrect operation of disconnectors and earthing switches.

It is equipped with internal self-diagnostic.

The EVDS shall have a DC/failure auxiliary contact signalization.

If it is equipped with an ON/OFF button, in OFF position shall activate the DC/failure auxiliary contact signalization.

It's a low performance electronic device, not for measuring purpose, made by 2 parts.

	STANDARD	Page 28 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The first device part, self-supplied, is connected to a capacitive divider tern located on the Hybrid Module (on the line or busbar bay). It provides a digital information related to the presence or absence of the HV voltage; it pilots an optical fiber interface, one for each pole, making a galvanic separation.

In alternative, this first part can be made with 3 separate units, each connected to its capacitive divider and each with its optical fiber connection.

The fixing system of the FO for the EVDS must guarantee a correct connection of this element through time, in the same way this connection must be able to withstand the vibrations inherent to the equipment maneuvers and/or any type of internal or external movement.

The second device part includes relays and is supplied in d.c.; it receives and elaborates the optical fiber signals and it implements the requested interlocks.

The operation and hysteresis threshold shall provide that:

- the voltage absence signalization is guaranteed with $< 10\%$ of rated voltage;
- the voltage presence signalization is guaranteed with $> 45\%$ of rated voltage.

The EVDS is equipped with 2 electromechanical relays.

The first relay signals the voltage presence/absence and disables/enables the operations in accordance with the logic of the following table:

HV presence	EVDS supply presence	Voltage detector relay coil	Interlocks contact
YES	NO	Not-energized	Open
YES	YES	Not-energized	Open
NO	NO	Not-energized	Open
NO	YES	Energized	Close

The voltage absence signalization and its restoration shall not be instantaneous but delayed of about 1s.

The second relay is activated by the internal self-diagnostic.

This diagnostic relay, if not energized, provides:

- to remote signal the “HV presence anomaly”, by mean of wiring to the substation interface terminal board;
- to interact with the voltage presence/absence circuit, blocking operations for safety reason.

The diagnostic relay enables, if energized, the disconnectors or earth disconnectors operation in absence of HV.

Each EVDS shall be equipped with two leds for the following local state signalizations:

- red led on: voltage presence
- green led on: voltage absence

As for the first EVDS part:

- if three-phase type, it shall be located in the Control Box; the connections to the capacitive dividers shall be made using shielded cable; moreover, immediately close to each capacitive divider a restorable surge arrester shall be provided, in order to limit the residual voltage, in case of overvoltage, to 200 V;
- if single-phase type, the three devices shall be located immediately close to each capacitive divider. Three fiber optic cables, inserted in protective tubes, connect each device from capacitive divider to the second part.

The second EVDS part shall be located in the Control Box.

	STANDARD	Page 29 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The EVDS correct operation shall be guaranteed in the required temperature range.

The EVDS supply shall be protected with an automatic circuit-breaker, whose operation signalization shall be associated with the “HV presence anomaly” in the substation interface terminal board.

8.4 Electric schemes, controls and signalizations

8.4.1 General requirements

The electric schemes shall:

- a) be represented in the reference conventional conditions:
 - a.1) CB, DS and ES (if any) in open position;
 - a.2) CED not energized;
 - a.3) absence of a.c. and d.c. auxiliary supplies;
 - a.3) absence of HV;
 - a.4) gas absence;
 - a.5) closing springs discharged;
 - a.6) remote/local selector switch(es) in remote position;
 - a.7) in case of micro-switches with the state dependent on the opening/closing of the boxes/carters of operating devices, they shall be represented disabled (that is with boxes/carters open).
 - a.8) unlocked under-voltage release (when requested) for CB.
- b) report the following pressures values at 20°C (relative values):
 - b.1) rated filling pressure;
 - b.2) threshold setting pressure of the 1st minimum gas density level (alarm, replenishment necessary);
 - b.3) threshold setting pressure of the 2nd minimum gas density level (block or automatic opening with open position blocking).
- c) include the functional scheme, all information useful to identify each wire and cable, the equipments wiring schemes (auxiliary contacts, relays, gas density control devices etc.), the topographic schemes for interconnections between boxes, the topographic schemes about all the electric components in Control box/Operating device box(es), the anti-mistake coding.

Further details are in the specific requirements and in annex D, where the principle electric schemes of the different switchgears (and their functional typologies) are represented.

8.4.2 Romania specific requirements

The Annex D principle electric schemes (and their identifying code) are listed in the following tables, with the references to previous and RETELE ELECTRICICE technical specifications (the previous reference doesn't mean that the electric scheme is exactly the same – some modifications have been introduced).

	STANDARD	Page 30 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

8.4.3.1 Circuit-breakers

Code	Description
CB-S/1.2.	C.B. Single-pole operation - 1°, 2° opening circuit
CB-S/1.2.3.	C.B. Single-pole operation - 1°, 2°, 3° opening circuit
CB-T/1.3.	C.B. Three-pole operation - 1°, 3° opening circuit
CB-T/1.2.3.	C.B. Three-pole operation - 1°, 2°, 3° opening circuit
CB-T/1.2.	C.B. Three-pole operation - 1°, 2° opening circuit
245 CB-S/1.2.	245 kV C.B. Single-pole operation - 1°, 2° opening circuit

8.4.3.2 Disconnectors/Earthing switches

Code	Description
101	Line 1 Bay (Only “Y1” – EVDS)
102	Line 2 Bay (Only “Y1” – EVDS)
103	Customer Bay (Only “Y1”)
104	Busbar Bay (Only “Y1” – joined with Customer Bay)
201	Line Bay (External Voltage Transformers)
202	Line Bay (Integrated Gas insulated Inductive Voltage Transformers)
301	Busbar (or Line 2) Bay (EVDS)
302	Busbar (or Line 2) Bay (Integrated Gas insulated Inductive Voltage Transformers)
303	Busbar (or Line 2) Bay (EVDS and Partition)
401	Transformer Bay
402	Transformer Bay (Integrated Gas insulated Inductive Voltage Transformers)
DS electric scheme code	Description
501	Busbar Bay (Only “Single-bay” type)
502	Busbar Bay (Only “Single-bay” type - Partition)

	STANDARD	Page 31 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

8.4.3.3 Motors and anti-condensation power supplies

Code	Description
AM	Motors and anti-condensation terminal board power supplies

8.4.3.4 Current and Voltage Transformers for

Code	Description
CT/1	Current Transformers (type GSCH002/601 ÷ 606)
CT/2	Current Transformer (type GSCH002/607)
CT/3	Current Transformer (type GSCH002/608)
VT/1	Voltage Transformers (Inductive or Capacitor Voltage Transformers Version)
VT/2	Voltage Transformers (Gas insulated Inductive Voltage Transf. Version)

8.4.3.5 Current and Voltage Transformers for RETELE ELECTRICE See the electric diagrams from page 89 to page 97.

8.5 Controls, signalizations, interlock and automatic openings

8.5.1 Specific requirements

N/A

8.5.2 Romania specific requirements

8.5.2.1 Terminal Boards for interface with the control system

The equipment controls, the contacts related to their operating status and the possible anomalies shall be reported in the terminal boards for the interface with the substation control system, as shown in the principle electric diagrams listed in par. 8.4.3.

As required in par. 8.1.1, during normal operation temporary block signalizations shall not be sent to the control system.

Used abbreviations in electric diagrams and their meaning are listed in the following; for those related to the substation interlocks see the relevant section.

Italian is the language used in the terminal boards abbreviations; for the other languages the equivalent abbreviations as well as the synoptic will be agreed with the specific client.

Circuit-breakers

- drive circuit of shunt closing release control (CH-ABC)
- 1st drive circuit of shunt opening release control (1° AP-A; 1°AP-B; 1°AP-C or 1°AP-ABC)
- 2nd drive circuit of shunt opening release control (2° AP-ABC)
- 3rd drive circuit of under-voltage release control (3° AP-ABC)
- close position (ccX152 or 152NA)
- open position (caX152 or 152NC)
- remote/local selector switch in local (P) position (43SP-PROVA)
- 1st minimum gas density level (P1 GAS)
- 2nd minimum gas density level (P4 GAS)
- discharged springs (P4 MOLLE)
- intervention of motor protection device and/or auxiliary supply missing (42RT)
- motor maximum operation time (BX)
- anti-condensation circuit anomaly (AnR152)
- poles discrepancy - only single-pole CB (DP)
- locking of drive circuit of under-voltage release control – only if assembled (BL3°AP-ABC)

	STANDARD	Page 32 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Disconnectors – Earthing Switches

- drive circuit of shunt closing release control (DS: CH189"XY"; ES: CH189T"XY"; "XY" means the bay name i.e. L1, L2, TR, etc.)
- drive circuit of shunt opening release control (DS: AP189"XY"; ES: AP189T"XY"; "XY" means the bay name i.e. L1, L2, TR, etc.)
- close position (DS: ccX189"XY"; ES: ccX189T"XY")
- open position (DS: caX189"XY"; ES: caX189T"XY")
- intervention of motor protection device and/or auxiliary supply missing (DS: 42RT189"XY"; ES: 42RT189T"XY")
- motor maximum operation time (DS: BX189"XY; ES: 42RT189T"XY")
- not-maneuverable DS (DS: SNM189"XY"; ES: 42RT189T"XY")

Earthing Switches

Further specific control circuits, using signals from secondary terminals of on-site Inductive or Capacitive Voltage Transformers (see electric diagrams "VT/1" and "VT/2"), elaborate absence of voltage on HV line (and status ON/OFF of relative low voltage protection CBs) to enable the ES closing:

- voltage presence (27ON"XY")
- voltage absence (27OFF"XY")
- voltage presence anomaly (An PRES TENS"XY")

For this purpose the low voltage components shall have the following characteristics.

- 3P+N switch for protection of VT secondary circuits:
Ue = 400 V ac; In = 3A; Electromagnetic overcurrent relay - short-circuit current setting: 12 A ("type MA"); Icu ≥ 25 kA;
- K27A/L, K27B/L and K27ATL relays:
Rated voltage = 100 V AC.

Disconnectors – special cases – codes "101" and "102"

Similarly to the above "Earthing Switches" the specific voltage control circuits shall enable not only the ES closing but also the DS closing/opening, to guarantee operations without energy transit:

- voltage presence (27ON"XY")
- voltage absence (27OFF"XY")
- voltage presence anomaly (An PRES TENS"XY")

Voltage transformers – codes "VT/1" and "VT/2"

(more details in "Earthing Switches")

- Phase voltage (V"X"; "X" means the electrical phase i.e. 4, 8, 12; 0 is ground potential)
- Open position low voltage CB "ATV1" (ATV)
- Closed position low voltage CB "ATV1" (+ATV)
- 1st minimum gas density level – only SF6 VTs (P1 GAS)
- 2nd minimum gas density level – only SF6 VTs (P4 GAS)

8.5.2.2 Synoptic

The synoptic alarm/block signalization lamps (see par. 8.2.1) shall be those indicated in the previous paragraph.

Some signalizations, due to their nature, may be common to more switchgears, therefore they shall be grouped together.

For example, in the case of hybrid module Y2 type, having two remote/local selector switches ("Servizio/Prova"), one for Line-bay and Bus-bar, the other for Transformer bay, we have:

Line-bay and Bus-bar common signalizations

- remote/local selector switch in local (P) position (43SP/L-PROVA).
- 1st minimum gas density level (P1 GAS).

	STANDARD	Page 33 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

- 2nd minimum gas density level (P4 GAS).
- anti-condensation circuit anomaly (AnR)
- Lamps test button (PL) (only one but working also on lamps of the other bay)

Transformer-bay common signalizations

- remote/local selector switch in local (P) position (43SP/TR-PROVA).
- 1st minimum gas density level (P1 GAS).
- 2nd minimum gas density level (P4 GAS).
- anti-condensation circuit anomaly (AnR)

In annex E some synoptic drawing examples are shown; other cases will be assessed with the manufacturer.

Note: In case of single-pole CB, the synoptic shall have an additional signal lamp that is activated when the three mechanical locks of the under-voltage releases are - between them - in a not congruent position.

8.5.2.3 Interlocks

The hybrid modules shall be equipped with operation locks to ensure safety of both workers and switchgears, preventing wrong operations being performed either in electric (remote or local) or manual mode (only for DS/ESs, in local mode).

The required operation locks are:

- specific of the single switchgear (locks);
- between switchgears part of the same hybrid module (interlocks);
- between interfaced equipments (substation interlocks):
 - a. switchgears of different hybrid modules
 - b. stand-alone switchgears (CBs, DSs/ESs)
 - c. medium voltage switchboards

There are two types of substation interlocks:

- incoming (working on the hybrid module)
- outgoing (working on switchgears external to the hybrid module)

The differentiation is included in the abbreviations used for the same type of interlock (see in the principle electric diagrams, i.e. “INTBL. A – IN”; “INTBL. B – OUT”).

The main operating locks, divided for module type, are listed in the following.

8.5.2.3. a) Hybrid module Y1 type

“Linea 1” bay – code “101” (or “Linea 2” – code “102”)

- Disconnector 189L1 (or 189L2) closing lock for 2nd minimum gas density level (“P4 gas”);
- Interlock between CB 152, disconnector 189L1 and disconnector 189L2: impossibility of disconnector 189L1 (or 189L2) operation if CB 152 and disconnector 189L2 (or 189L1) are closed. The opening and closing operations of this disconnector are enabled, alternatively to the opening of CB 152 and disconnector 189L2 (or 189L1), by an external consensus (substation interlocks: “INTBL. A – IN”);
- Impossibility of disconnector 189L1 (or 189L2) operation in presence of HV on both lines L1 and L2. The closing and opening operations of this disconnector are enabled, alternatively to the HV absence on both lines L1 and L2, by an external consensus (substation interlocks: “BLOCCO 27”);
- Interlock between disconnector 189L1 (or 189L2) and his earthing switch 189TL1 (or 189TL2): impossibility to close the earthing switch if disconnector is closed and vice versa;
- Impossibility to close disconnector 189L1 (or 189L2) for external consensus absence (i.e. for presence of external earthing switch in closed position or for SF6 absence; substation interlocks: “INTBL. B – IN”);
- Impossibility to close earthing switch 189TL1 (or 189TL2) for external consensus absence (substation interlocks: “INTBL. C – IN”);

	STANDARD	Page 34 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

- Impossibility to close earthing switch 189TL1 (or 189TL2) for presence of HV on line L1 (or L2).

Circuit breaker bay

Circuit breaker bay shall be provided of the same locks as for Y2 type described in the following par. 8.5.2.3.b), differentiating their use whether as Line bay (see "Line 1" bay") or as Transformer bay (see "Transformer" bay").

Specifically, the:

- Closing lock of CB 152TR (or 152L) for disconnectors incomplete operation, shall be related to the three hybrid module disconnectors.

8.5.2.3. b) Hybrid module Y2 type¹⁴

"Linea 1" bay – code "201" and "202"

- CB 152L1 and disconnector 189L1 closing lock for 2nd minimum gas density level ("P4 gas");
- CB 152L1 closing lock for discharged springs;
- CB 152L1 closing lock for under-voltage release circuit not-supplied (if any) and, if singlepole type, with mechanical locks of the three under-voltage releases in a not congruent position (between them);
- CB 152L1 closing lock for incomplete operation of disconnectors 189L1 and 189Sb(L2);
- Impossibility to operate disconnector 189L1 when CB 152L1 is closed;
- Interlock between disconnector 189L1 and his earthing switch 189TL1: impossibility to close the earthing switch if disconnector is closed and vice versa;
- Impossibility to close earthing switch 189TL1 for presence of HV on line L1.

"Sbarra (Linea 2)" bay – code "301", "302" and "303"

- Disconnector 189SB1 closing lock for 2nd minimum gas density level ("P4 gas");
- Interlock between disconnector 189Sb(L2) and his earthing switch 189TSB(L2): impossibility to close the earthing switch if disconnector is closed and vice versa;
- Interlock between disconnector 189Sb(L2), CB 152 L1 and CB 152TR: impossibility to operate disconnector 189SB(L2) if these CBs are closed. The opening and closing operations of this disconnector are enabled, alternatively to the opening of CBs 152L1 and 152TR, by an external consensus (substation interlocks: "INTBL. A – IN");
- Impossibility to close disconnector 189SB(L2) for external consensus absence (i.e. for presence of external earthing switch in closed position or for SF6 absence; substation interlocks: "INTBL. B – IN");
- Impossibility to close earthing switch 189SB(L2) for external consensus absence (substation interlocks: "INTBL. C – IN");
- Impossibility to close earthing switch 189SB(L2) for presence of HV on busbar/Line2.

"Trasformatore" bay – code "401" and "402"

- CB 152TR and disconnector 189TR closing lock for 2nd minimum gas density level ("P4 gas");
- CB 152TR1 closing lock for discharged springs;
- CB 152TR1 closing lock for under-voltage release circuit not supplied;
- CB 152TR1 closing lock for disconnectors 189TR and 189Sb(L2) incomplete operation;
- Impossibility to operate disconnector 189TR when CB 152TR is closed;
- Interlock between disconnector 189TR and his earthing switch 189TTR: impossibility to close the earthing switch if disconnector is closed and vice versa;
- Interlock between disconnector 189TR and earthing switch 89TTTR on MV side of HV/MV transformer: impossibility to close the disconnector 189TR if earthing switch 89TTTR is closed and vice versa. This function shall be achieved by means of a device containing an electromagnet, which is energized, by means of a push-button, by a discordant auxiliary contact of the disconnector 189 TR

¹⁴ Note: in the following is described the case in which the two CBs of the Y2 type hybrid module are used in a Line bay and in a Transformer bay; but if both are used in Line bays the symbol "152TR" in sub-paragraph "Sbarra (Linea 2)" bay – code "301", "302" and "303"" becomes "152L2". The same applies in principle electric diagrams.

	STANDARD	Page 35 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

if the remote/local selector switch is in “Prova” position. The device shall allow the rotation and extraction of a key enabling the closing of the MV earthing switch 89TTR.

- Interlock between earthing switch 189TTR and CB MV 52TR: impossibility to close the earthing switch 189TTR if CB MV 52TR is closed and vice versa.

8.5.2.3 .c) Hybrid module Single-bay type

Circuit-breaker bay

Circuit breaker bay shall be equipped with the same locks as for Y2 type described in cap. 8.5.2.3.b), using according to the application locks of Line bay (see “Linea 1” bay, changing the “L1” part of the abbreviation in “L”) or locks of Transformer bay (see “Trasformatore” bay).

Specifically, the:

- CB 152L (or 152TR) closing lock for disconnectors incomplete operation, shall be related to all disconnectors of the hybrid module.

“Sbarra” bay – code “501” and “502”

- Disconnector 189SB closing lock for 2nd minimum gas density level (“P4 gas”);
- Interlock between CB 152L (or 152 TR) and disconnector 189 SB: impossibility to operate disconnector 189SB when CB is closed;
- Impossibility to close disconnector 189SB for external consensus absence (i.e. for presence of external earthing switch in closed position or for SF6 absence; substation interlocks: “INTBL. B – IN”).

8.5.2.4 Automatic openings

Following intervention for SF6 gas low-pressure (P4gas) due to a severe failure in a switchgear, the HV faulty part of the substation shall be isolated from the healthy part not subject to failure.

For this purpose commands for automatic opening shall be activated and simultaneously condition for the service restoring shall be prepared, even by means of specific substation automatisms.

If partitions are present the automatic opening logical operations shall work with the same criteria (see i.e. code “303” and “502”).

The automatic opening commands work both internally, in the faulty hybrid module, and simultaneously externally to the substation HV sections still healthy.

Consequently the automatic opening commands, similarly to the substation interlocks, can be both incoming and outgoing; in the principle electric diagrams of DS/ES they are abbreviated with “AP.AUT. – IN” and “AP.AUT. – OUT”, while in CBs ones the command (only incoming) is “AP.AUT.INTERBL”.

All the automatic openings are enabled only if remote/local selector switch is in “Servizio” position.

Generally in CBs case the automatic opening having internal origin work on 1st and 2nd drive circuits of shunt opening release control; in case of 152TR they work on 1st drive circuit of shunt opening release control and on 3rd drive circuit of under-voltage release control.

Circuit breaker, after the automatic opening, shall be blocked in open position.

Specifically, for 2nd minimum gas density level (“P4 gas”) intervention, the following operations shall occur, depending on the hybrid module type (see the principle electric diagrams; possible special cases will be assessed with the manufacturer):

Y1 type

CB opens and in line disconnectors an auxiliary contact (voltage-free) becomes available for an outgoing open command;

Y2 type

CBs and disconnector 189Sb(L2) open and in busbar disconnector an auxiliary contact (voltage-free) becomes available for an outgoing open command;

Single-bay type

CB open and in busbar disconnector 189SB (if present) an auxiliary contact (voltage-free) becomes available for an outgoing open command.

	STANDARD	Page 36 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

In case of failure in one of the SF6 insulated VT (if presents), the interventions for SF6 low pressure (P4 gas) in their specific partition work as follows:

Y1 type

- a) if the fault has occurred in a VT of "Line 1" (or "Line 2") bay the CB opens and, in case of external consensus (i.e. HV = off), the disconnector L1 (or L2) opens as well. The disconnector 189L1 (or 189L2), once open, intercepts the automatic opening command coming from the VT of "Line 1" (or "Line 2") bay in order to allow the CB closing.
- b) if the fault has occurred in a VT of the CB bay, the CB opens;

Y2 type

- a) if the fault has occurred in a VT of the CB bay, the CB opens;
- b) if the fault has occurred in a VT of SB(L2) bay, both CBs and the busbar disconnector open. The busbar disconnector, once open, intercepts the automatic opening command coming from the VTs in order to allow the CBs closing;

Single-bay type

CB and busbar 189SB disconnector (if any) open.

9 TESTING

9.1 General information

The applicable standard is IEC 62271-205, where is stated (par. 1.101) "If part of the compact switchgear assembly is formed by metal enclosed switchgear devices the requirements of IEC 62271-203 apply", consequently the IEC 62271-203 tests are also applicable with the clarifications stated in this chapter.

The tests to be performed on Hybrid Module are divided in:

- Type tests;
- Routine tests on factory;
- Commissioning tests.

9.2 Type tests

9.2.1 General

In principle type tests should be performed on a complete Hybrid Module manufactured in accordance with the present technical specification.

Type tests are be classified in:

- tests on the complete assembly
- tests on base components

9.2.2 Type tests on the complete assembly

(6.1 of IEC 62271-205)

The tests listed in the following paragraphs shall be performed on a complete Hybrid Module manufactured in accordance with the present technical specification (the layout shall be suggested by the manufacturer and approved by user).

The applicability of a type test performed on one of the provided layouts to an equipment with a different layout shall be demonstrated by the manufacturer (by mean of a technical report) and approved by the user.

9.2.2.1 Visual check and constructive characteristics check

The Hybrid Module, complete of all accessories and fully assembled in operation layout, shall be subject to a visual inspection in order to verify its functional, dimensional and constructive compliance with this STANDARD and with technical documentation listed in paragraph 10.2.2.

Visual inspection shall be repeated each time the required assembly includes at least one new base components

	STANDARD	Page 37 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

- never subject to this check.
- 9.2.2.2 Dielectric tests
(6.2 of IEC 62271-203)
- 9.2.2.3 Radio interference voltage (r.i.v.) test
(6.3 of IEC 62271-203)
Applicable only to SF6/air bushings.
- 9.2.2.4 Measurement of the resistance of circuits
(6.4 of IEC 62271-203)
The measure shall cover all Hybrid Module components, using all available access points.
- 9.2.2.5 Temperature-rise tests
(6.5 of IEC 62271-203)
- 9.2.2.6 Short-time withstand current and peak withstand current tests
(6.6 of IEC 62271-203)
- 9.2.2.7 Verification of the protection
(6.7 of IEC 62271-203)
- 9.2.2.8 Tightness test
(6.8 of IEC 62271-203)¹⁵
Test must be performed using test Qm, method 1 “Cumulative Test”, IEC 60068-2-17.
The initial gas concentration Co, with Hybrid Module filled at nominal density, shall be measured after at least 2 hours from pressurizing; the final concentration C1 shall be measured after more than 8 hours.
- 9.2.2.9 Electromagnetic compatibility tests (EMC)
(6.9 of IEC 62271-203)
- 9.2.2.10 Additional tests on auxiliary and control circuits
(6.10 of IEC 62271-203)
For this verification the manufacturer shall provide a paper copy of the Hybrid Module electric schemes.
The correct operation of all controls, interlocking, automatic openings and signalizations shall be also verified.
The absorption curves of closing and opening (shunt and under-voltage) releases, taking note of the maximum values, shall be registered in the following conditions:
- at rated voltage;
 - at 110% of the rated voltage;
 - at 70% of the rated voltage, for opening releases;
 - at 85% of the rated voltage, for closing release.
- The absorption curves of the CB and DS/ES motors (taking note of the maximum values, inrush excluded), of the springs charging times and of the DS/ES operating times, shall be registered in the following conditions:
- at rated voltage;
 - at 110% of the rated voltage;
 - at 85% of the rated voltage.
- The heating and/or anti-condensation circuit absorption shall be measured.
- 9.2.2.11 Verification of making and breaking capacities
(6.101 of IEC 62271-203)
According with this requirement the manufacturer shall demonstrate that associated components excluded from this test or changed respect to the tested one don't affect the making and breaking performances.

¹⁵ 6.102 quoted in this paragraph shall be intended as 9.2.2.12 of this document.

	STANDARD	Page 38 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

9.2.2.12 Mechanical and environmental tests

6.101 of IEC 62271-205 applies with the following additional information.

The static terminal load test (6.101.5 of IEC 62271-205) shall be performed considering the requirements in 6.4.1 of this document.

9.2.2.13 .a) Tests on Circuit-breakers

Mechanical and environmental tests

(IEC 62271-100 par. 6.101)

Humidity test is not required.

A new definition for operation with under-voltage release is added, similar to “opening time”, IEC 62271-100 par. 3.7.133 a):

“The opening time with under-voltage release is the time interval between the instant when the voltage drops suddenly to zero, the circuit-breaker being in the closed position, and the instant when the arcing contact are separated in all poles.”

In case of the under-voltage release is requested, its characteristics shall be verified in accordance with IEC 62271-1 (par. 5.8.4) at ambient temperature.

Moreover, for routine tests and commissioning tests purpose, the reference values and their tolerance at 110%, 100% and 70% of the rated voltage shall be provided.

9.2.2.12.b) Tests on disconnectors DS and earth switches ES

IEC 62271-102 (and Annex E) applies with following additional information

Operating and mechanical endurance test

(IEC 62271-102 par. 6.102)

Note: par. 6.102.3.2 applies also to measuring of resistance of earthing switch.

During test, referring par. 8.1.3.2 of this STANDARD, the DS/ES mechanical locks and interlocks operation shall be checked.

Operation under severe ice conditions

(IEC 62271-102 par. 6.103)

Note: par. 6.103.4.2 applies also to measuring of resistance of earthing switch.

This test is mandatory.

Operation at the temperature limits

(IEC 62271-102 par. 6.104)

This test is mandatory.

9.2.2.13

Proof tests for enclosures (6.103 of IEC 62271-203)

9.2.2.14

Pressure test on partitions (6.104 of IEC 62271-203)

9.2.2.15

Test under conditions of arcing due to an internal fault (6.105 of IEC 62271-203)

9.2.2.16

Insulator tests

(6.106 of IEC 62271-203)

9.2.2.17

Corrosion test on earthing connections (6.107 of IEC 62271-203)

9.2.2.18

Corrosion test on enclosures (6.108 of IEC 62271-203)

	STANDARD	Page 39 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

9.2.2.19 Protective treatments

Hot dip galvanized coatings on iron and steel components shall be verified in accordance with ISO 1461 by mean of magnetic flux equipments, performing at least 5 measures on each component, in uniform manner on the various surfaces, avoiding edges and angular parts.

The verification of other protective coatings shall be performed considering their characteristics: the manufacturer will indicate the minimum thickness allowed and the others characteristics.

9.2.2.20 Seismic verification

If requested, Hybrid Module (including the support) shall be compliant with seismic qualification, according with standards listed in 4.2.3.

9.2.3 Type tests on base components

The type tests listed in the following paragraphs can be performed on the single base component or on a different assembly equipped with the same component used for the Hybrid Modules.

The applicability of these type tests on the different Hybrid Modules layouts shall be demonstrated by the manufacturer (by mean of a technical report) and approved by the user.

9.2.3.1 Tests on Circuit-breakers

IEC 62271-100 applies with the following additional information

9.2.3.2 .a) X-radiation test procedure for vacuum interrupters

(6.11 of IEC 62271-203)

Only in case of vacuum CBs.

9.2.3.3 .b) Critical current tests

(IEC 62271-100 par. 6.107)

If applicable (see 6.107.1)

9.2.3.4 Tests on disconnectors DS and earth switches ES

IEC 62271-102 applies with the following additional information.

9.2.3.5 .a) Test to verify the proper functioning of the position indicating device

(IEC 62271-102 par. 6.105)

This test is mandatory.

9.2.3.6 .b) Bus-transfer current switching tests

(IEC 62271-102 par. 6.106)

This test is mandatory only for DS for which this characteristic is requested (see par. 6.3 of this document).

9.2.3.7 .c) Induced current switching test

(IEC 62271-102 par. 6.107)

This test is mandatory.

9.2.3.8 Tests on toroidal Current Transformers

(IEC 61869-2)

Manufacturer shall perform also the IEC 61869-2 par. 7.3.201 test; the CT technical documentation shall include the tolerance range for the secondary winding resistance.

9.2.3.9 Tests on Voltage Transformers

(IEC 61869-3)

Test under conditions of arcing due to an internal fault is required

Manufacturer shall perform also the IEC 61869-3 par. 7.4.6 and 7.4.7 tests.

9.2.3.10 Tests on SF6/air bushings, cable connections, transformer connections

	STANDARD	Page 40 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

SF6/air bushings, cable connections and transformer connections shall be tested in accordance with their respective IEC standards.

9.2.3.11 Tests on EVDS

Following checks shall be performed:

- verification of the intervention and hysteresis threshold;
- verification of interlocks with the line disconnectors and/or earth switches;
- verification of activation of self diagnostic function (internal fault presence signaling).

9.2.4 Specific requirements

9.2.4.1

Tests on enclosures, partitions, voltage transformer, SF6/air bushings, insulator, are included in the scope of D.M. 1/12/1980 and subsequent modification (D.M. 10/9/1981).

9.3 Routine tests in factory

(IEC 62271-203 par. 7)

The Routine tests (also called acceptance tests) shall be made in the manufacturer's factory on each Hybrid module supplied, to ensure the product compliance with:

- base components approved during the conformity assessment (homologation, certification etc.) process and on which the type tests have been performed;
- the approved technical documentation of the assembly specific layout to be supplied (layout drawing, electric schemes - both HV and low voltage, Control Box drawing etc.).

Test values/results shall be in compliance with rated values (and respective tolerances).

The manufacturer shall provide, for each Hybrid Module supplied, the report of all measures and tests carried out.

9.3.1 Dielectric test on the main circuit

(7.1 of 62271-203, partial discharge included)

Alternative methods for the partial discharge measurement can be proposed by the manufacturer and shall be approved by client.

9.3.2 Tests on auxiliary and control circuits

(IEC 62271-203 par. 7.2)

Functional tests (par. 7.2.2 of IEC 62271-1) shall be performed together with tests in par. 9.3.8, only at rated voltage.

Dielectric tests (par. 7.2.4 of IEC 62271-1) shall be performed applying 1 kV for 1 s.

Electronic devices, motors etc. can be excluded by dielectric test only if agreed during the conformity assessment (homologation, certification etc.) process.

EVDS shall be disconnected before dielectric test.

9.3.3 Measurement of the resistance of the main circuit

(IEC 62271-203 par. 7.3)

To be performed after mechanical operating tests.

The ambient temperature influence can be neglected.

The test shall be performed also on ES.

9.3.4 Tightness test

(IEC 62271-203 par. 7.4)

To be performed at least at 2nd minimum gas density level (block).

Manufacturer shall provide the results of tests on subassemblies. Sniffing device may be used to check the joint between subassemblies.

9.3.5 Design and visual checks

(IEC 62271-203 par. 7.5)

Following items shall be verified:

- switchgear compliance with approved documents;

	STANDARD	Page 41 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

- no visible defects;
- protective coatings (par. 9.2.2.19 of this document applies).

9.3.6 Pressure tests of enclosures

(IEC 62271-203 par. 7.101)

Manufacturer shall provide the results of internal tests.

9.3.6.1 Specific requirements

Manufacturer shall provide the “Certificazione di rispondenza” (see: D.M. 1/12/1980, Allegato A, Regola VSR.8.B.1, par. 5.2), including partitions, bushings and VTs (if any).

9.3.7 Mechanical operation tests

(IEC 62271-203 par. 7.102)

9.3.7.1 Tests on Circuit-Breakers

(IEC 62271-100 par.7.101)

The following items shall be recorded:

- at V_{max} , V_n , V_{min} , closing (C) and opening (O) times, time spread (on each release);
 - at V_{max} , V_n , V_{min} opening (O) times, time spread of under-voltage release coil (if present - see 9.2.2.12.a)) and it shall be verified its compliance with IEC 62271-1 par. 5.8.4;
- at V_n , close-open (CO) time and open-close-open (O-t-CO) cycle;
- at V_n , the operation time of one of each type (make and break) of auxiliary contacts, respect to the operation of main contacts on closing and on opening of CB;
- no-load travel curves.

The absorption curves of closing and opening (shunt and under-voltage) releases, taking note of the maximum values, shall be registered in the following conditions:

- at rated voltage;
- at 110% of the rated voltage;
- at 70% of the rated voltage, for opening releases;
- at 85% of the rated voltage, for closing release.

The spring recharging time of the motor after a closing operation and its absorption (maximum value, inrush excluded) shall be measured at rated voltage.

9.3.7.2 Tests on disconnectors DS and earth switches ES

(IEC 62271-102 par. 7-101)

The following items shall be verified:

- operation times and the drive motor absorption (inrush excluded) at V_{max} , V_n , V_{min} ;
- manual and electrical operation and its (mechanical and electrical) interlock devices;
- satisfactory operation of the auxiliary contacts and position indicating devices;
- mechanical locks.

9.3.8 Tests on auxiliary circuits, equipment and interlocks in the control mechanism

(IEC 62271-203 par. 7.103)

For this verification the manufacturer shall provide a paper copy of the Hybrid Module electric schemes.

Following items shall be verified:

	STANDARD	Page 42 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

- EVDS device (operation, interlocks with DS or ES, internal self-diagnostic) referring to its testing procedures;
- SF6 density control devices: the verification shall be performed at ambient temperature, in the real operating position, using nitrogen, with decreasing pressure values. SF6 can be used only in presence of recovery systems.
Test reports issued by the density control device manufacturer shall be provided (test position shall be evidenced too).
- correct operation of all controls, interlocking, automatic openings and signalizations, including galvanic separation between the power supplies of various circuits;
- heating and/or anti-condensation circuit absorption.

9.3.9 Pressure test on partitions

(IEC 62271-203 par. 7.104)

Manufacturer shall provide the results of testing on partitions.

9.3.10 Tests on Current Transformers

(IEC 61869-2 par. 7.1.2, Table 10: Routine tests including par. 7.3.201; Sample Test, par. 7.5.2 when applicable).

The tests of CTs shall be repeated sampling at least one unit for each tern.

It shall be verified also:

- the CTs compliance with approved documents;
- no visible defects;
- the presence of producer test reports of all CTs.

9.3.10.1 Specific requirements

The supplier shall inform for routine tests in the instrument transformers manufacturer factory. In case Client will not attend these tests they shall be repeated in the Hybrid Modules manufacturer factory according to the given criteria.

9.3.11 Tests on Voltage Transformers

(IEC 61869-3 par. 7.1.2, Table 10: Routine tests par. 7.3).

The tests of VTs shall be repeated sampling one unit for each tern.

It shall be verified also:

- the VTs compliance with approved documents;
- no visible defects;
- the presence of producer test reports of all VTs;
- SF6 density control devices: 9.3.8 applies.

9.3.11.1 Specific requirements

The supplier shall inform for routine tests in the instrument transformers manufacturer factory. In case Client will not attend these tests they shall be repeated in the Hybrid Modules manufacturer factory according to the given criteria.

9.3.12 Bushing tests

(IEC 60137 par.9.6)

Test reports issued by insulator manufacturer shall be provided.

9.4 Commissioning tests

(IEC 62271-203 par. 10)

The Commissioning tests (also called on-site acceptance tests) shall be performed in the client plant on each Hybrid Module supplied, after its installation.

	STANDARD	Page 43 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

The manufacturer, at the end of the on-site tests, shall deliver the report containing the results of the measures and tests performed on the Hybrid Module. These measures shall include check of transportation pressure, to be performed before installation.

This report, in paper and in electronic format (e.g. one or more “pdf” files) shall include also factory routine tests and all sub-components test reports.

IEC 62271-1 Par. 10.2.1 is applicable.

9.4.1 Dielectric test on the main circuit

(IEC 62271-203 par. 10.2.101.2 and C.3.2.3)

Dielectric test shall be performed on Hybrid Module, if disassembled in transport units and if stated in the approved technical documentation of the assembly specific layout to be supplied.

In alternative to test methods provided by par. 10.2.101.2.3 of IEC 62271-203, a test applying the grid rated voltage (see IEC - par. C.3.2.3) for 24 hours without energy transit can be performed.

9.4.2 Dielectric test on auxiliary circuits

(IEC 62271-203 par 10.2.101.3; IEC 62271-1 applies only par. 7.2.4)

Dielectric tests shall be performed applying 1 kV for 1 s.

EVDS shall be disconnected before dielectric test; others electronic devices, motors etc. can be excluded by dielectric test only if agreed during the conformity assessment (homologation, certification etc.) process.

9.4.3 Measurement of the resistance of the main circuit

(IEC 62271-203 par. 10.2.101.4)

To be performed after mechanical operating tests.

The ambient temperature influence can be neglected.

The test shall be performed also on ES.

9.4.4 Gas tightness test

(IEC 62271-203 par. 10.2.101.5)

To be performed at rated pressure.

The test shall be performed using test Qm, method 2 “Probing Test”, IEC 60068-2-17, after all the other tests, eight hours after the gas filling (for example one night is enough).

Fittings, gas density control devices and piping shall be checked. Manufacturer shall verify all on-site assembled connections between transport units.

The sensitivity of the sniffing device shall be at least 10^{-8} Pa x m³/s.

9.4.5 Checks and verifications

(IEC 62271-203 par. 10.2.101.6)

Following items shall be verified:

- assembly in accordance with the manufacturer’s drawings and instructions;
- control of damage absence;
- presence of accompanying required documentation and materials (see par. 10.3).

9.4.6 Mechanical operation tests

9.4.6.1 Tests on Circuit-Breakers

(IEC 62271-100 par. 10.2.102.2)

Before this tests at least 30 C-O no-load operations shall be performed.

The following items shall be recorded:

- a. at Vmax, Vn, Vmin, closing (C) and opening (O) times, time spread (on each release);
 - a1. at Vmax, Vn, Vmin opening (O) times, time spread on under-voltage release coil (if present see 9.2.2.12.a)) and it shall be verified its compliance with IEC 62271-1 par. 5.8.4;
- b. at Vn, close-open (CO) time and open-close-open (O-t-CO) cycle;
- c. at Vn, the operation time of one of each type (make and break) of auxiliary contacts, respect the operation

	STANDARD	Page 44 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

of main contacts on closing and on opening of CB.

The absorption curves of closing and opening (shunt and under-voltage) releases, taking note of the maximum values, shall be registered in the following conditions:

- at rated voltage;
- at 110% of the rated voltage;
- at 70% of the rated voltage, for opening releases;
- at 85% of the rated voltage, for closing release.

The spring recharging time of the motor after a closing operation and its absorption (maximum value, inrush excluded) shall be measured only at V_n .

9.4.6.2 Tests on disconnectors DS and earth switches ES (IEC 62271-102 par. 7.101)

The par. 9.3.7.2 of this document applies. The operation times and the drive motor absorption shall be performed only at rated voltage.

9.4.7 Tests on auxiliary circuits, equipment and interlocks in the control mechanism (IEC 62271-203 par. 7.103)

To be performed after dielectric test on auxiliary circuit.

The following items shall be verified:

- EVDS device (operation, interlocks with DS or ES, internal self-diagnostic) referring its testing procedures;
- all SF6 density control devices, including VT's ones - SF6 can be used only in presence of recovery systems; the verification shall be performed with the same modalities of the routine test (see 9.3.8), taking into account the ambient conditions (solar radiation, temperature) and comparing between them the intervention threshold pressure measured values;
- functional operations of whole circuit diagram (fault signals, switchgear automatic openings, interlocks etc. including from/to external ones);
- heating and/or anti-condensation circuit absorption.

9.4.8 Gas quality verifications

(IEC 62271-203 par. 10.2.101.7)

Manufacturer shall perform this verifications on Hybrid Module which have been object of vacuum treatment, i.e. in case of:

- on-field assembling and connections between transport units;
- enclosure opening, with gas recovery and new filling.

In this case the gas tightness checks shall be repeated.

10 SUPPLY REQUIREMENTS

10.1 Tender's technical documentation

For tender's technical evaluation the supplier shall provide the Annex F properly filled for each one of the possible rated voltages for the equipment (72,5 kV, 145-170 kV, 245 kV).

10.2 Conformity assessment

10.2.1 Conformity assessment process

The conformity assessment processes (homologation, certification etc.) are specified in the proper contractual documents.

10.2.2 Conformity assessment documentation

The "Conformity assessment documentation" consists in the project documentation that the supplier uses to manufacture Hybrid Modules and can be divided in:

- "Specific Assembly Type A documents" (public, not confidential, referred to a specific assembly);
- "General Type A documents" (public, not confidential, including common documents and base components type A documents);

	STANDARD	Page 45 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

c) “General Type B documents” (confidential, referred to each base components).

The documentation shall be collected separately for the client, for each composition type (see par. 5) and for each rated voltage U_r (72.5, 145-170, 245 kV).

10.2.2.1 Specific Assembly Type A documents

The Specific Assembly Type A documentation shall consist at least in:

- 1) Specific Assembly Type A documents list;
- 2) composition of the assembly, consisting in a list of the base components indicating:
 - base component code (see par. 2);
 - local codification (see Annex A);
 - base component description;
 - corresponding supplier’s model designation;
- 3) overall dimensions drawing (including the stresses transmitted to the foundations, the transport units, the partitions – if any – and their density control devices position); The height of all the manual operations must be included.
- 4) overall Hybrid Module pictures or 3D drawings;
- 5) HV single-line diagram;
- 6) electric diagram (see par. 8.4.1-c), low voltage components list included);
- 7) Control Box layout drawing;
- 8) reference resistance values.

10.2.2.2 General Type A documents

The General Type A documentation shall consist at least in:

- 1) General Type A documents list, sub-divided into common documents and into each base component documents;
- 2) Operating Device Box(es) layout drawings;
- 3) Electric diagram of individual devices (CB, DS, ES);
- 4) Interconnection cables path (typical);
- 5) Nameplate (typical);
- 6) Installation, use and maintenance handbook/manual;
- 7) Routine and commissioning tests:
 - a) test report form (two documents, one for factory tests and one for on-site tests);
 - b) reference values table (with tolerances)¹⁶;
 - c) EVDS device - testing procedures;
 - d) protective coatings description (typology, minimum thickness, reference standards);
- 8) documentation of safety device for protection against pole excessive pressure (ISO 4126, only if present);
- 9) list of documentation, materials and accessories supplied;
- 10) about gas:
 - a) gas circuit(s) drawing with density control device positions;
 - b) gas density control device characteristics and drawings;
 - c) pressure/temperature table for rated density level, 1st minimum gas density level and 2nd minimum gas density level;
- 11) main sub-components suppliers list, subdivided into the various types of base components;
- 12) List of materials used including packaging and relevant quantities (for disposal purposes and recycle);
- 13) only for , INAIL (ex ISPESL) Certification “Certificato di conformità del prototipo” - D.M.

¹⁶ specific detailed instructions to verify the CBs no-load travel curves during maintenance activity shall be included in the manual

	STANDARD	Page 46 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

01/12/1980.

10.2.2.3 General Type B documents

The General Type B documentation shall consist at least in:

- 1) General Type B documents list, sub-divided into each base component documents;
- 2) overall base component dimensions drawing;
- 3) nameplate and labels drawings (Operating Device Box(es), poles, coils, sequence operation plate, only for : manual lock/unlock of under-voltage release, etc.).

10.3 Packaging, transport, storage and installation/testing

Par. 10.1 and 10.2 of IEC 62271-203 apply.

The package shall be suitable to guarantee:

- the protection during transport (including by ship, if necessary);
- an elevation from the ground at least of 100 mm;
- the external storage for at least three months.

On external side of packaging, the following information shall be present:

- 1) manufacturer name;
- 2) manufacturing year/month;
- 3) manufacturer designation type;
- 4) manufacturer serial number;
- 5) reference to this STANDARD;
- 6) contract number;
- 7) destination substation;
- 8) total weight;
- 9) lifting information (showing the points and the correct method of lifting);
- 10) only for , the assembly bar code, in accordance with PVR006.

With each assembly the following items shall be supplied (items from 4) to 9) shall be in the local language of destination and shall be provided in paper form):

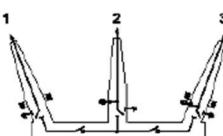
- 1) the support structure;
- 2) anchor bolts to the civil works (optional supply, they shall be provided only if expressly requested. In this case they shall be stainless or hot dip galvanized steel, chemical type);
- 3) springs hand-crank (and other tools according to the manufacturer design);
- 4) list of documentation, materials and accessories supplied (“packing list”);
- 5) overall dimensions drawing;
- 6) electric diagram;
- 7) installation, use and maintenance handbook/manual;
- 8) routine and commissioning tests:
 - a) routine (factory and commissioning) test reports;
 - b) reference values table (with tolerances);
- 9) about gas:
 - a) dielectric gas;
 - b) pressure/temperature table for rated density level, 1st minimum gas density level and 2nd minimum gas density level;
- 10) one digital support containing the whole type A documentation (pdf file format);
- 11) only for : Manufacturer shall provide the “Certificazione di rispondenza” (see: D.M. 1/12/1980, Allegato A, Regola VSR.8.B.1, par. 5.2), including partitions, bushings and VTs (if any).

Only for , items from 4) to 9) shall be also provided in electronic format together with the guarantee and barcode data requested by PVR001 and PVR006 (The file sending modalities will be discussed during the conformity assessment process).

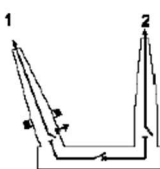
If on-site assembly is performed by the manufacturer, waste (including packaging) shall be disposed by him.

ANNEX A – LOCAL COMPONENTS CODIFICATION

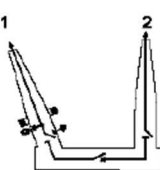
Hybrid Module: Configuration from base components				
Type Code	TS	Description	Units / Module	
	GSCH002 SubCode	Description		
GSCH002/1015	150019	HYBRID MODUL Y2 TYPE 145 kV AIR-AIR-AIR	Bay	Q.ty
	GSCH002/012	Lateral bay - With circuit-breaker - Air connection	1+3	2
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/282	Circuit-breaker drive mechanism - Three-pole (1°, 2° opening circuit) - 145-170 kV	1+3	2
	GSCH002/322	Disconnecter with earthing switch	1+2+3	3
	GSCH002/422	Bushing SF6/air class "e"	1+2+3	3
	GSCH002/607	Current transformer 145-170 kV - 200-400/1/1 (5P30/5P30)	3	1
	GSCH002/612	Current Transformer - 400-800/5/1/1A (0,2 – FS10/5P30/5P30)	1	1
	GSCH002/700	EVDS - Electronic Voltage Detector System (capacitive dividers included)	2+3	2
	GSCH002/811	Support Y2 Type	-	1
	GSCH002/911	Control Box – Y2 type	-	1



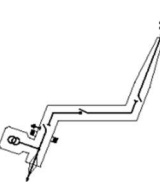
Type Code	GSCH002 SubCode	Description	Bay	Q.ty
GSCH002/1009	150020	HYBRID MODUL SINGLE BAY TYPE LINE 145 kV AIR-AIR		
	GSCH002/012	Lateral bay - With circuit-breaker - Air connection 145 Kv	1	1
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/282	Circuit-breaker drive mechanism - Three-pole (1°, 2° opening circuit) - 145-170 kV	1	1
	GSCH002/322	Disconnecter with earthing switch	1	1
	GSCH002/312	Disconnecter 145-170 kV	2	1
	GSCH002/422	Bushing SF6/air class "e"	1+2	2
	GSCH002/612	Current Transformer - 400-800/5/1/1A (0,2 – FS10/5P30/5P30)	1	1
	GSCH002/812	Support SB type	-	1
	GSCH002/912	Control Box – Single bay type used in Line bay	-	1



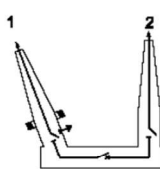
Type Code	GSCH002 SubCode	Description	Bay	Q.ty
GSCH002/1009	150021	HYBRID MODUL SINGLE BAY TYPE TRAF0 145 kV AIR-AIR		
	GSCH002/012	Lateral bay - With circuit-breaker - Air connection 145 kV	1	1
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/272	Circuit-breaker drive mechanism - Three-pole (1°, 2°, 3° opening circuit) - 145-170 kV	1	1
	GSCH002/322	Disconnecter with earthing switch	1	1
	GSCH002/312	Disconnecter 145-170 kV	2	1
	GSCH002/422	Bushing SF6/air class "e"	1+2	2
	GSCH002/607	Current transformer 145-170 kV - 200-400/1/1 (5P30/5P30)	1	1
	GSCH002/700	EVDS - Electronic Voltage Detector System (capacitive dividers included)	1	1
	GSCH002/812	Support SB type	-	1
	GSCH002/913	Control Box – Single bay type used in Transformer bay	-	1



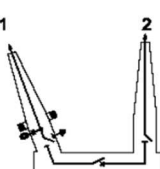
Type Code	GSCH002 SubCode	Description	Bay	Q.ty
GSCH002/1010	150022	HYBRID MODUL SINGLE BAY TYPE LINE 145 kV CABLE-AIR		
	GSCH002/022	Lateral bay - With circuit-breaker - Cable connection	1	1
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/282	Circuit-breaker drive mechanism - Three-pole (1°, 2° opening circuit) - 145-170 kV	1	1
	GSCH002/322	Disconnecter with earthing switch	1	1
	GSCH002/312	Disconnecter 145-170 kV	2	1
	GSCH002/465	Cable connection downward exit	1	1
	GSCH002/422	Bushing SF6/air class "e"	2	1
	GSCH002/612	Current Transformer - 400-800/5/1/1A (0,2 – FS10/5P30/5P30)	1	1
	GSCH002/711	Voltage transformer - 120/v3//0,1/v3	1	1
	GSCH002/812	Support SB type	-	1
	GSCH002/912	Control Box – Single bay type used in Line bay	-	1



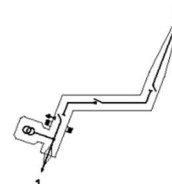
Type Code	GSCH002 SubCode	Description	Bay	Q.ty
GSCH002/1009	616151	HYBRID MODUL SF6 FREE SINGLE BAY TYPE LINE 145 kV AIR-AIR		
	GSCH002/012	Lateral bay - With circuit-breaker - Air connection 145 kV	1	1
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/282	Circuit-breaker drive mechanism - Three-pole (1°, 2° opening circuit) - 145-170 kV	1	1
	GSCH002/322	Disconnecter with earthing switch	1	1
	GSCH002/312	Disconnecter 145-170 kV	2	1
	GSCH002/425	Bushing SF6 Free class "e"	1+2	2
	GSCH002/612	Current Transformer - 400-800/5/1/1A (0,2 – FS10/5P30/5P30)	1	1
	GSCH002/812	Support SB type	-	1
	GSCH002/912	Control Box – Single bay type used in Line bay	-	1



Type Code	GSCH002 SubCode	Description	Bay	Q.ty
GSCH002/1009	616152	HYBRID MODUL SF6 FREE SINGLE BAY TYPE TRAF0 145 kV AIR-AIR		
	GSCH002/012	Lateral bay - With circuit-breaker - Air connection 145 Kv	1	1
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1
	GSCH002/272	Circuit-breaker drive mechanism - Three-pole (1°, 2°, 3° opening circuit) - 145-170 kV	1	1
	GSCH002/322	Disconnecter with earthing switch	1	1
	GSCH002/312	Disconnecter 145-170 kV	2	1
	GSCH002/425	Bushing SF6 Free class "e"	1+2	2
	GSCH002/607	Current transformer 145-170 kV - 200-400/1/1 (5P30/5P30)	1	1
	GSCH002/700	EVDS - Electronic Voltage Detector System (capacitive dividers included)	1	1
	GSCH002/812	Support SB type	-	1
	GSCH002/913	Control Box – Single bay type used in Transformer bay	-	1



Type Code	GSCH002 SubCode	Description	Bay	Q.ty	
GSCH002/1010	616153	HYBRID MODUL SF6 FREE SINGLE BAY TYPE LINE 145 kV CABLE-AIR			
	GSCH002/022	Lateral bay - With circuit-breaker - Cable connection	1	1	
	GSCH002/112	Central bay - Without circuit-breaker - Air connection	2	1	
	GSCH002/282	Circuit-breaker drive mechanism - Three-pole (1", 2" opening circuit) - 145-170 kV	1	1	
	GSCH002/322	Disconnecter with earthing switch	1	1	
	GSCH002/312	Disconnecter 145-170 kV	2	1	
	GSCH002/465	Cable connection downward exit	1	1	
	GSCH002/425	Bushing SF6 Free class "e"	2	1	
	GSCH002/612	Current Transformer - 400-800/5/1/1A (0,2 – FS10/5P30/5P30)	1	1	
	GSCH002/711	Voltage transformer - 120/v3//0,1/v3	1	1	
	GSCH002/812	Support SB type	-	1	
	GSCH002/912	Control Box – Single bay type used in Line bay	-	1	



145kV - Variation in the cost if the base configuration change with:

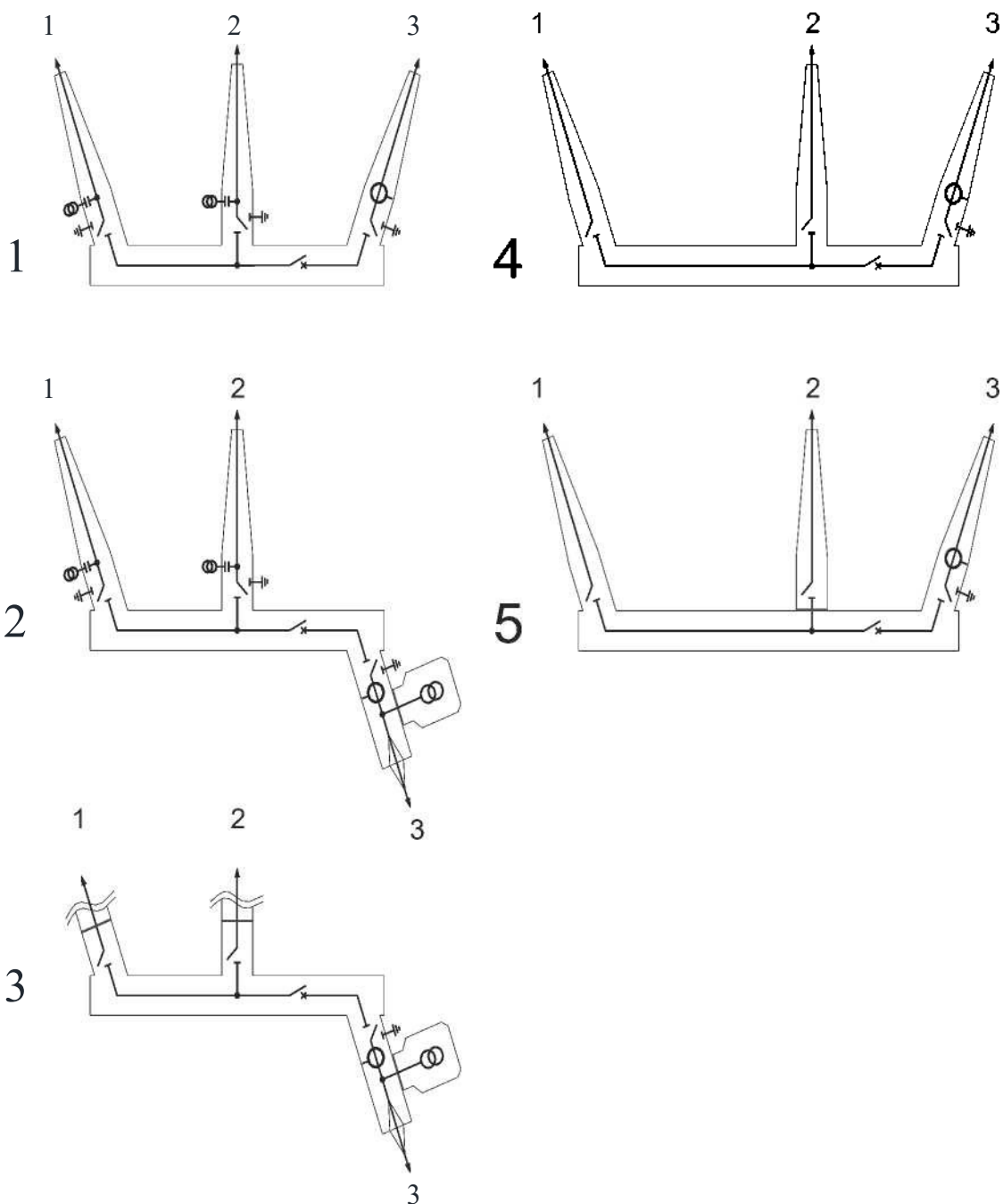
- 1 One bay connection change from air to cable
- 2 Include one EVDS
- 3 Circuit-breaker drive mechanism change from Single-pole to Three-pole.
- 4 Include the VT GSCH002/711
- 5 Include the CT GSCH002/607
- 6 Include the CT GSCH002/612

	STANDARD	Page 49 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

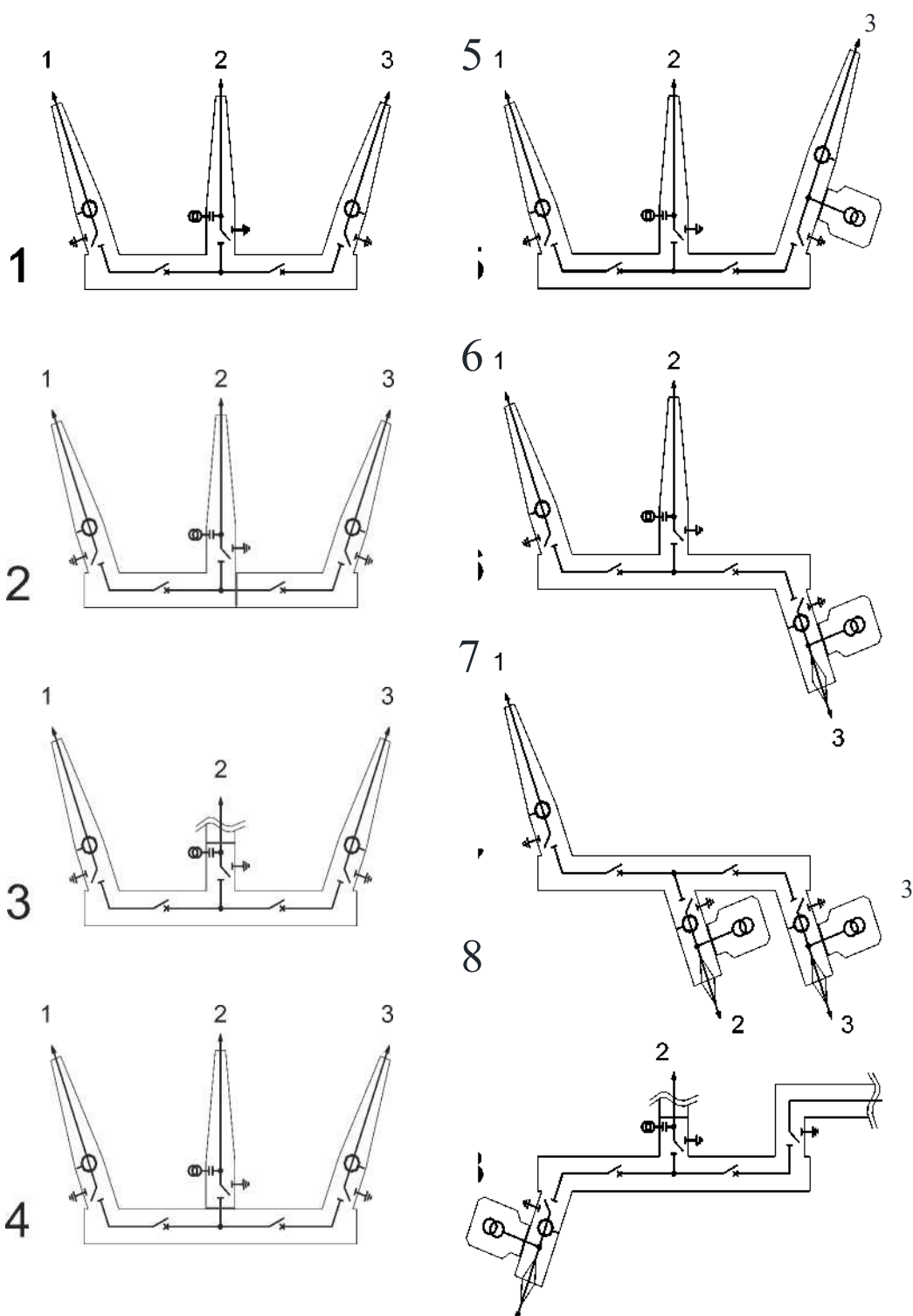
ANNEX B – LAYOUT EXAMPLES

B.1 – Examples of layout compositions with single line diagrams

Y1

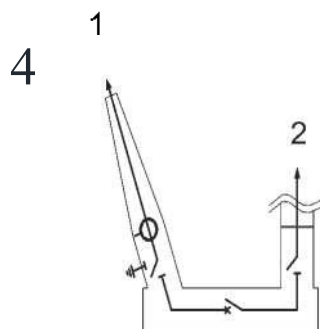
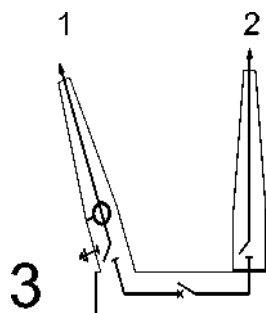
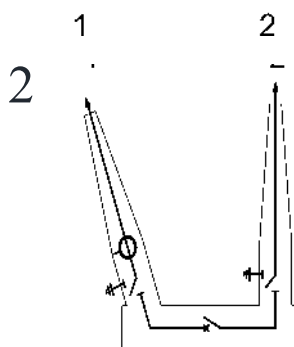
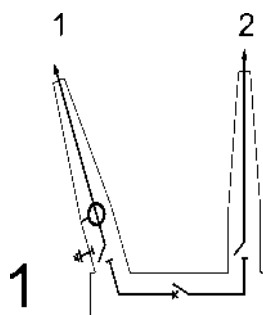


Y2



	STANDARD	Page 51 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Single bay



	STANDARD	Page 52 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

B.2 - Examples of composition lists using “Base component codes”

Y1 type – Annex B.1 fig. 4:

Base component description	BAY	Base component code GSCH002/...	Nr (terns)
Lateral bay - Without circuit-breaker - Air connection	1	062	1
Central bay - Without circuit-breaker - Air connection	2	112	1
Lateral bay - With circuit-breaker - Air connection	3	012	1
Circuit-breaker drive mechanism - Three-pole	3	282	1
Disconnecter with ability of Bus-transfer current switching	1	332	1
Disconnecter with ability of Bus-transfer current switching	2	332	1
Disconnecter with earthing switch	3	322	1
Bushing SF6/air class “e”	1	422	1
Bushing SF6/air class “e”	2	422	1
Bushing SF6/air class “e”	3	422	1
Current Transformer	3	622	1
Support	-	821	1
Control Box - Y1 type used in Line bay	-	921	1

Note (referring Annex B1 drawings):

- BAY 1: Lateral Bay
- BAY 2: Central Bay
- BAY 3: Lateral Bay

	STANDARD	Page 53 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Y2 type – Annex B.1 fig. 1:

Base component description	BAY	Base component code GSCH002/...	Nr (terns)
Lateral bay - With circuit-breaker - Air connection	1	013	1
Central bay - Without circuit-breaker - Air connection	2	112	1
Lateral bay - With circuit-breaker - Air connection	3	013	1
Circuit-breaker drive mechanism - Single-pole	1	212	1
Circuit-breaker drive mechanism - Three-pole	3	262	1
Disconnecter with earthing switch	1	322	1
Disconnecter with earthing switch	2	322	1
Disconnecter with earthing switch	3	322	1
EVDS - Electronic Voltage Detector System (capacitive dividers included)	2	700	1
Bushing SF6/air class “e”	1	422	1
Bushing SF6/air class “e”	2	422	1
Bushing SF6/air class “e”	3	422	1
Current Transformer	1	605	1
Current Transformer	3	604	1
Support	-	802	1
Control Box – Y2 type	-	902	1

Note (referring Annex B1 drawings):

- BAY 1: Lateral Bay
- BAY 2: Central Bay
- BAY 3: Lateral Bay

	STANDARD	Page 54 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Single bay type – Annex B.2 fig. 1:

Base component description	BAY	Base component code GSCH002/...	Nr (terns)
Lateral bay - With circuit-breaker - Air connection	1	012	1
Central bay - Without circuit-breaker - Air connection	2	112	1
Circuit-breaker drive mechanism - Three-pole	1	282	1
Disconnecter with earthing switch	1	322	1
Disconnecter	2	312	1
Bushing SF6/air class “e”	1	422	1
Bushing SF6/air class “e”	2	422	1
Current Transformer	1	622	1
Support	-	822	1
Control Box – Single bay type used in Line bay	-	924	1

Note (referring Annex B1 drawings):

- BAY 1: Lateral Bay
- BAY 2: Central Bay

	STANDARD	Page 55 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

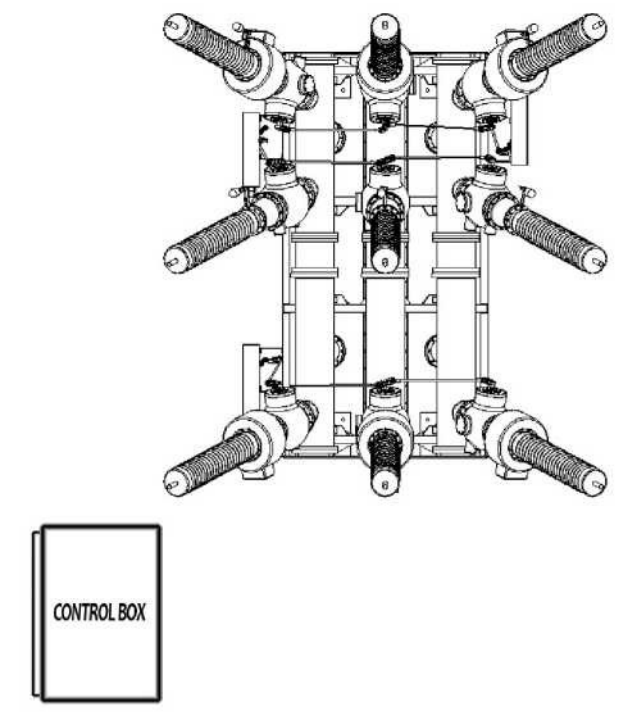
ANNEX C – DIMENSIONAL DRAWINGS

CONTROL BOX LOCATION

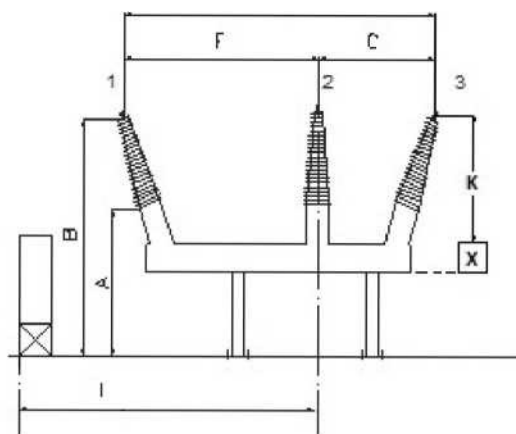
	BAY 1	BAY 2	BAY 3
Y1	LINE/TRAFO (*)	BUSBAR 1	BUSBAR 2
Y2	LINE	BUSBAR 1	TRAFO (*)
SB	LINE/TRAFO (*)	BUSBAR 1	-

(*) PHYSICAL POSITION CONTROL BOX

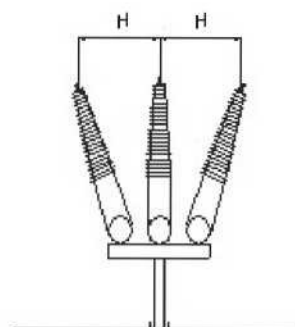
In case the control box is not attached to the equipment position should follow the figure below (in order to take out the hybrid module with a lift truck):



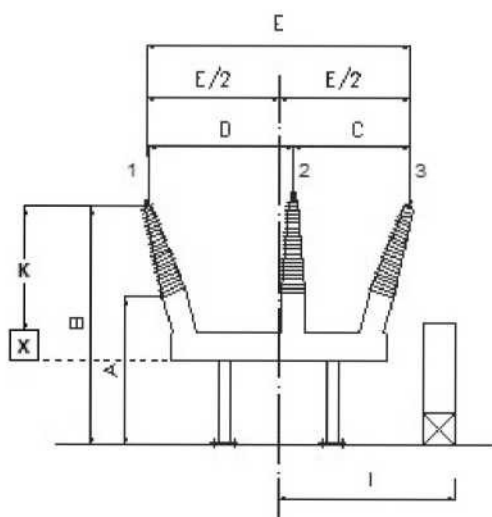
Y1



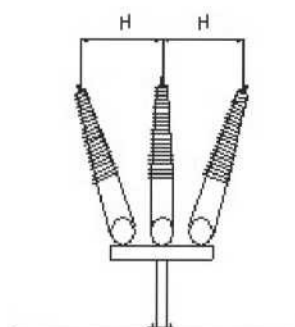
☒ Manual Operation

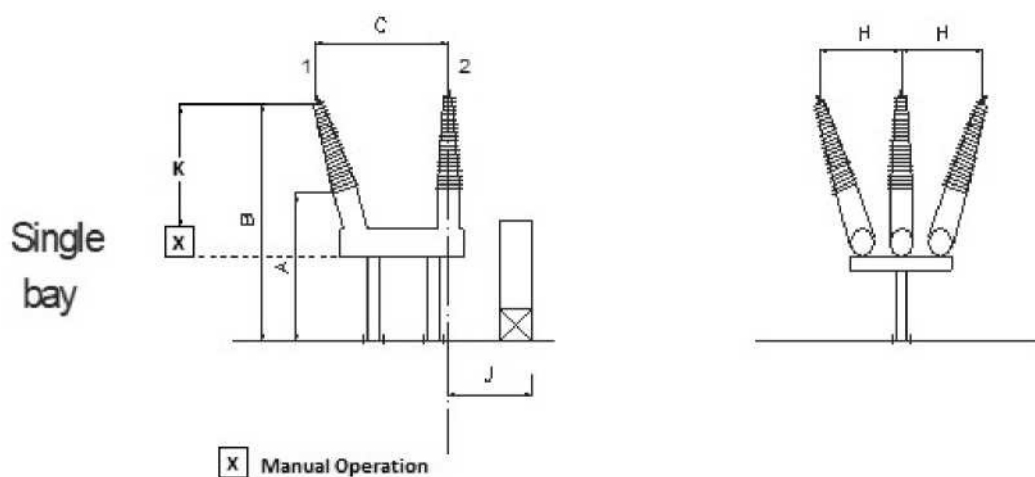


Y2



☒ Manual Operation





Ref. figure	A	B	C	D	E	F	G	H	I	J	K
Y1	$\geq 2250^{17}$	≤ 3800	≥ 890	n.a.	n.a.	≥ 890	≤ 3000	≤ 1400	≤ 2200	n.a.	> 1400
Y2				≥ 890	≤ 3000	n.a.	n.a.				
Single bay				n.a.	n.a.	n.a.	n.a.		n.a.	≤ 1300	

Table 1 – Dimensions for 72,5 kV Hybrid Modules (mm)

⁵⁷ In accordance with the Real Decreto 337/2014 has to be ≥ 2300 mm

	STANDARD								Page 58 din 96		
	HYBRID MODULES								GSCH002 Rev. 08 08/06/2026		

Ref. figure	A	B	C	D	E	F	G	H	I	J	K
Y1	$\geq 2250^{18}$	≥ 3800 ≤ 4700	≥ 1725	n.a.	n.a.	≥ 1725	≤ 5000	≥ 1300 ≤ 2200	≤ 3000	n.a.	> 2000
Y2				≥ 1725	≤ 5000	n.a.	n.a.				
Single bay				n.a.	n.a.	n.a.	n.a.		n.a.	≤ 1300	

Table 2 – Dimensions for 145 kV (and, only for , 170 kV) Hybrid Modules (mm)

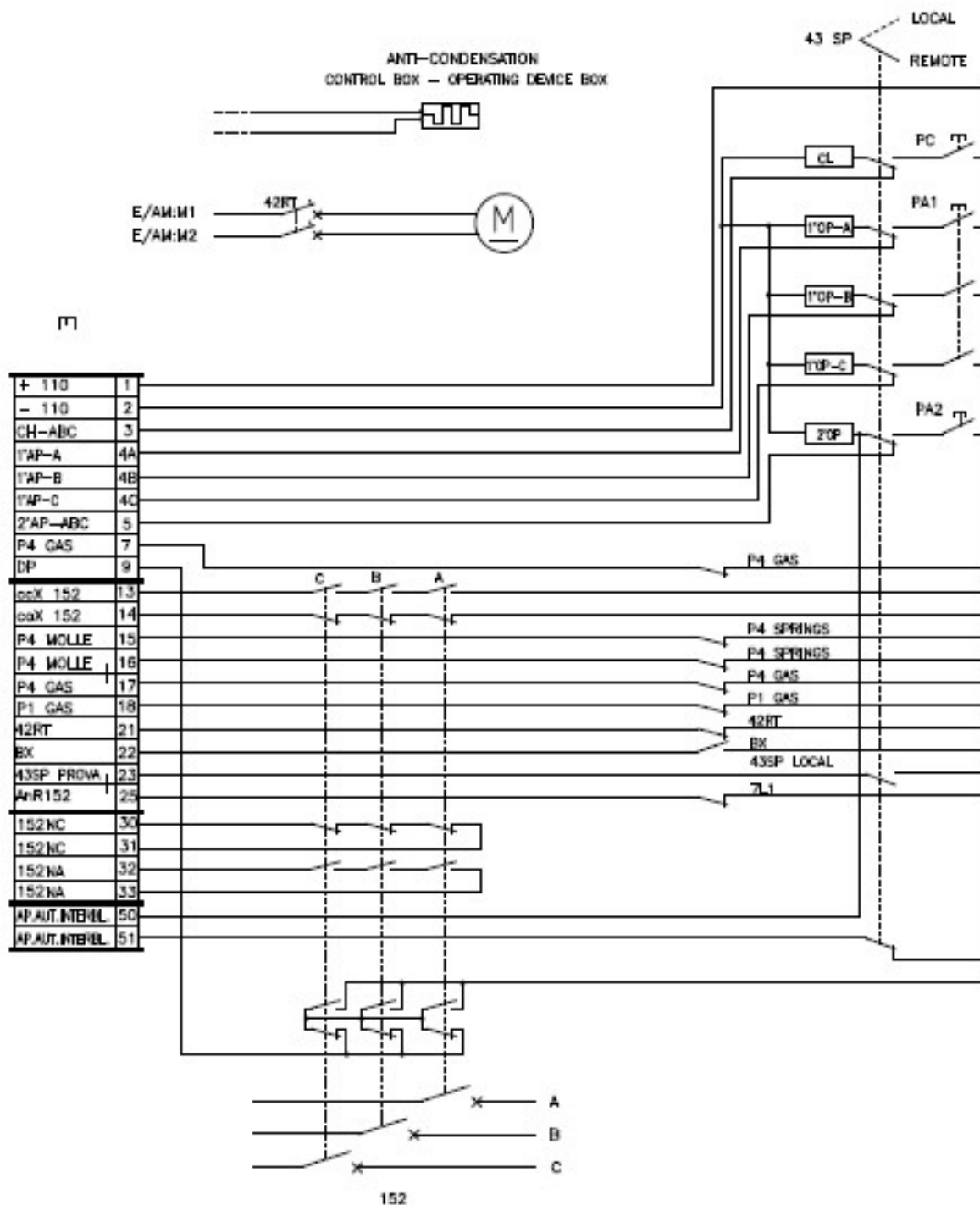
Ref. figure	A	B	C	D	E	F	G	H	I	J	K
Y1	$\geq 2250^{18}$	≤ 6000	≥ 2475	n.a.	n.a.	≥ 2475	≤ 6500	≤ 3200	≤ 3750	n.a.	> 3000
Y2				≥ 2475	≤ 6500	n.a.	n.a.				
Single bay				n.a.	n.a.	n.a.	n.a.		n.a.	≤ 1300	

Table 3 – Dimensions for 245 kV Hybrid Modules (mm)

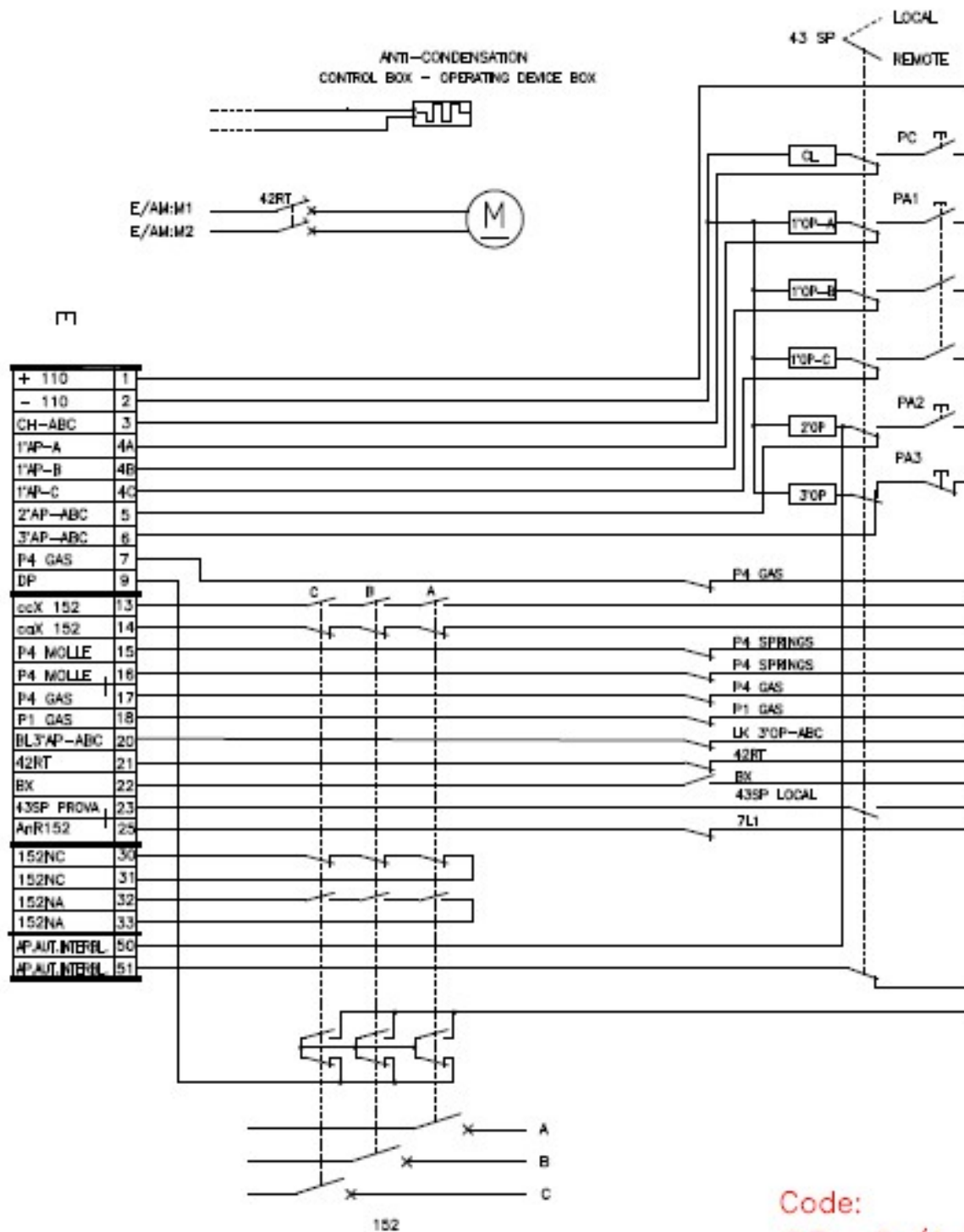
⁵⁸ In accordance with the Real Decreto 337/2014 has to be ≥ 2300 mm

ANNEX D – ELECTRICAL SCHEMES

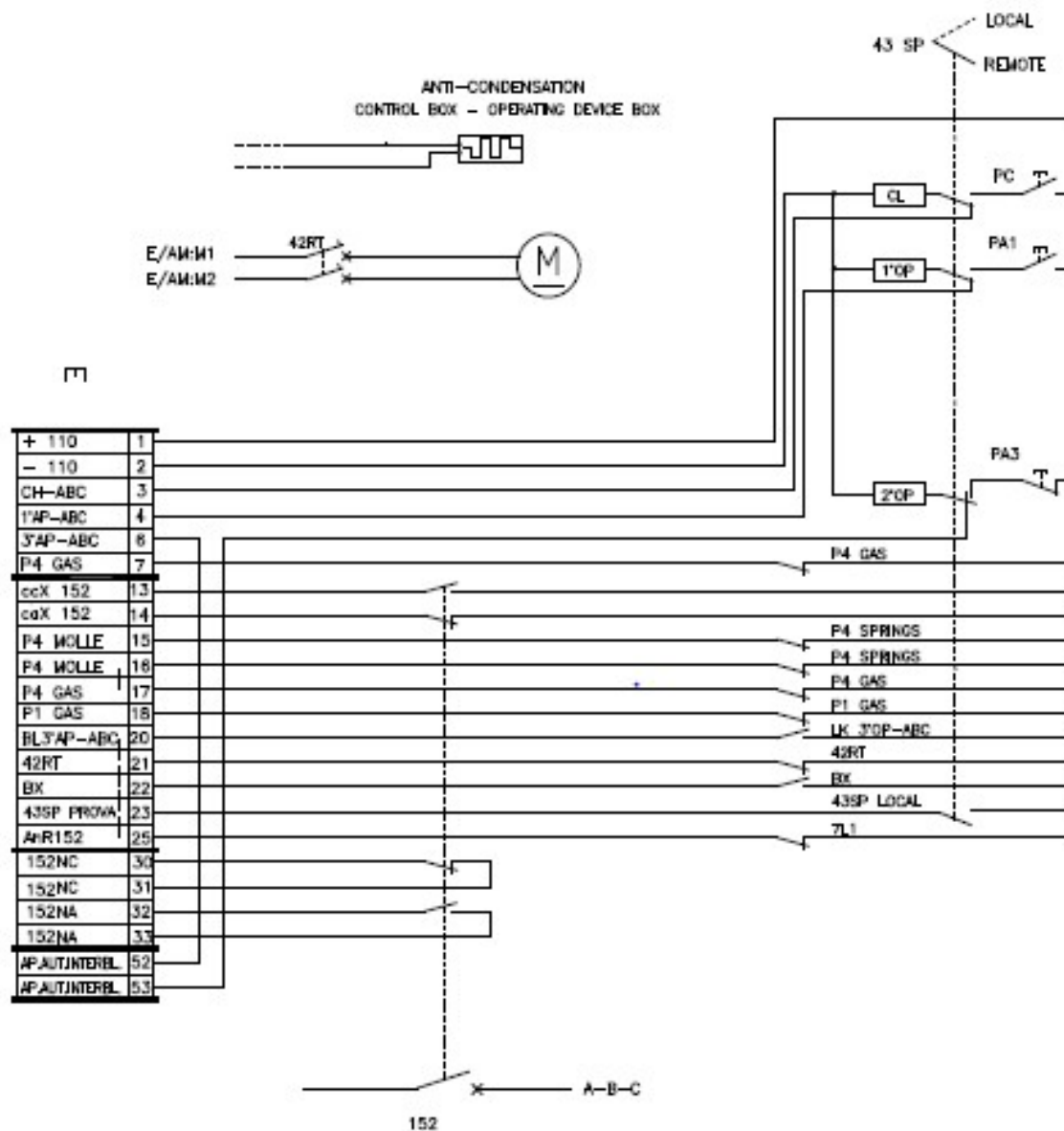
D.2 - ROMANIA ELECTRICAL DIAGRAMS



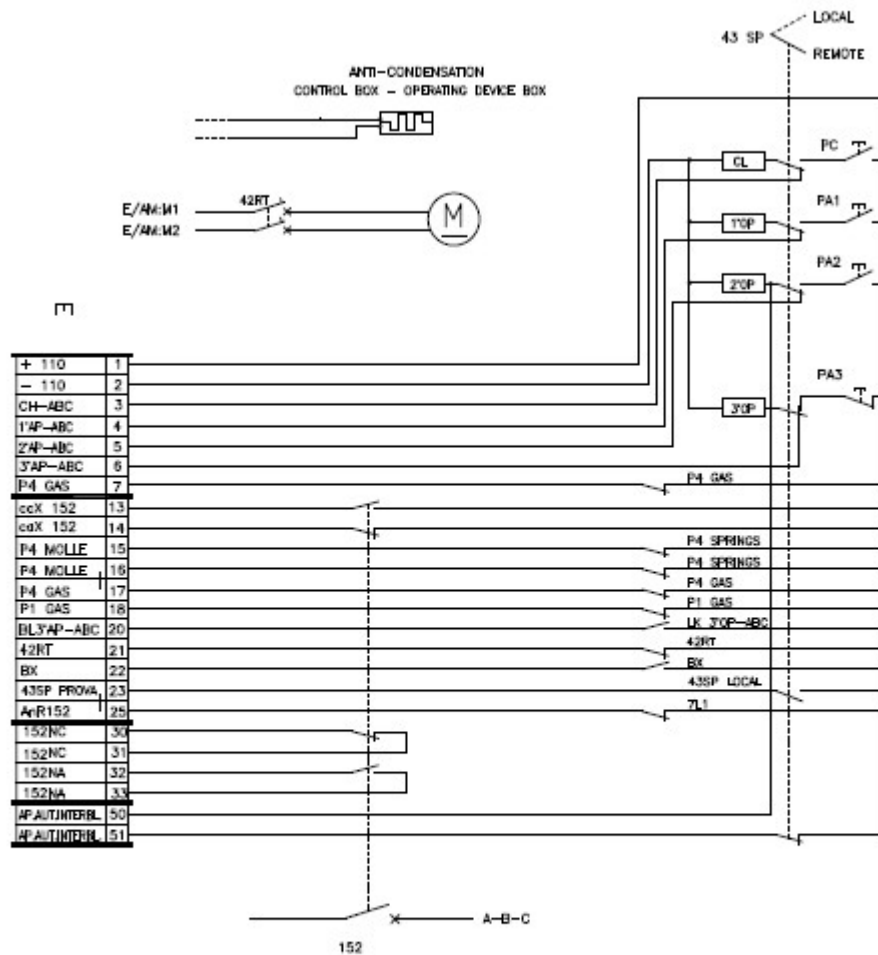
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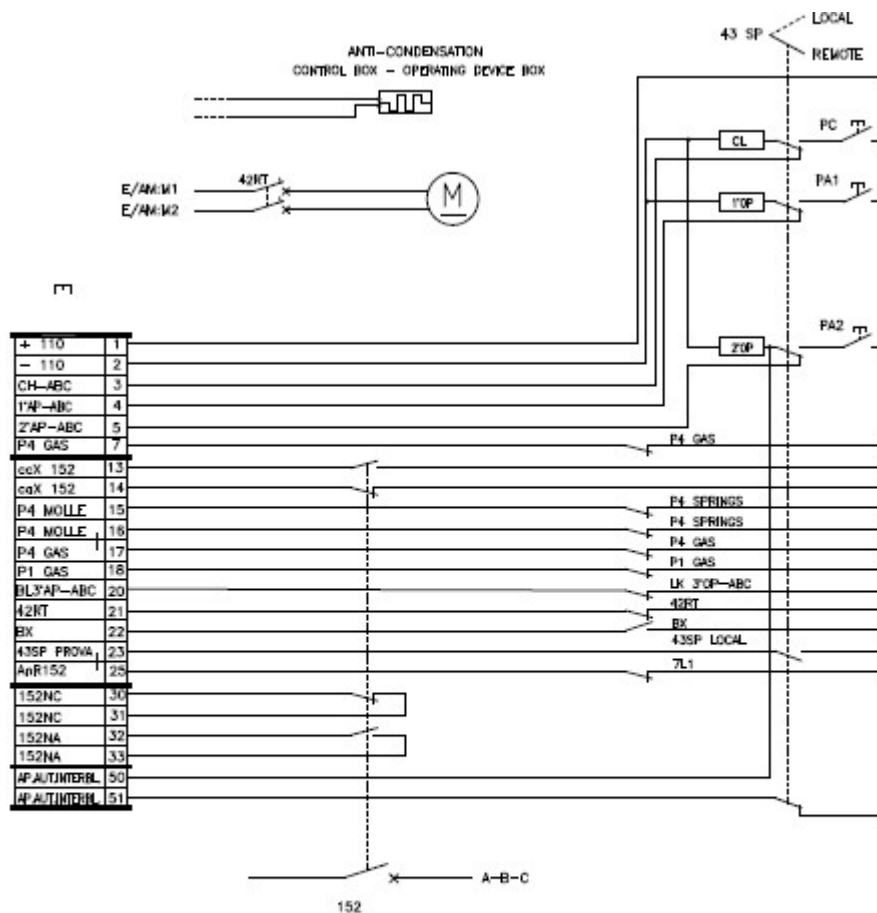
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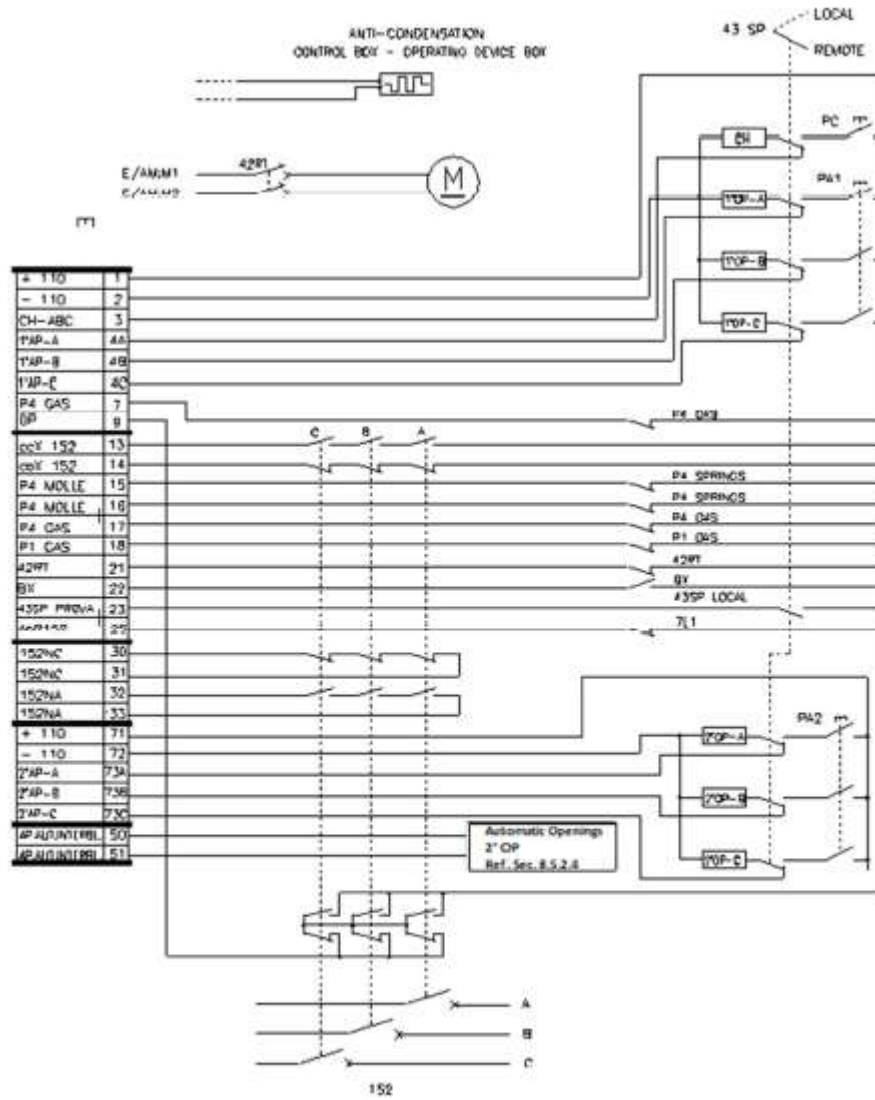
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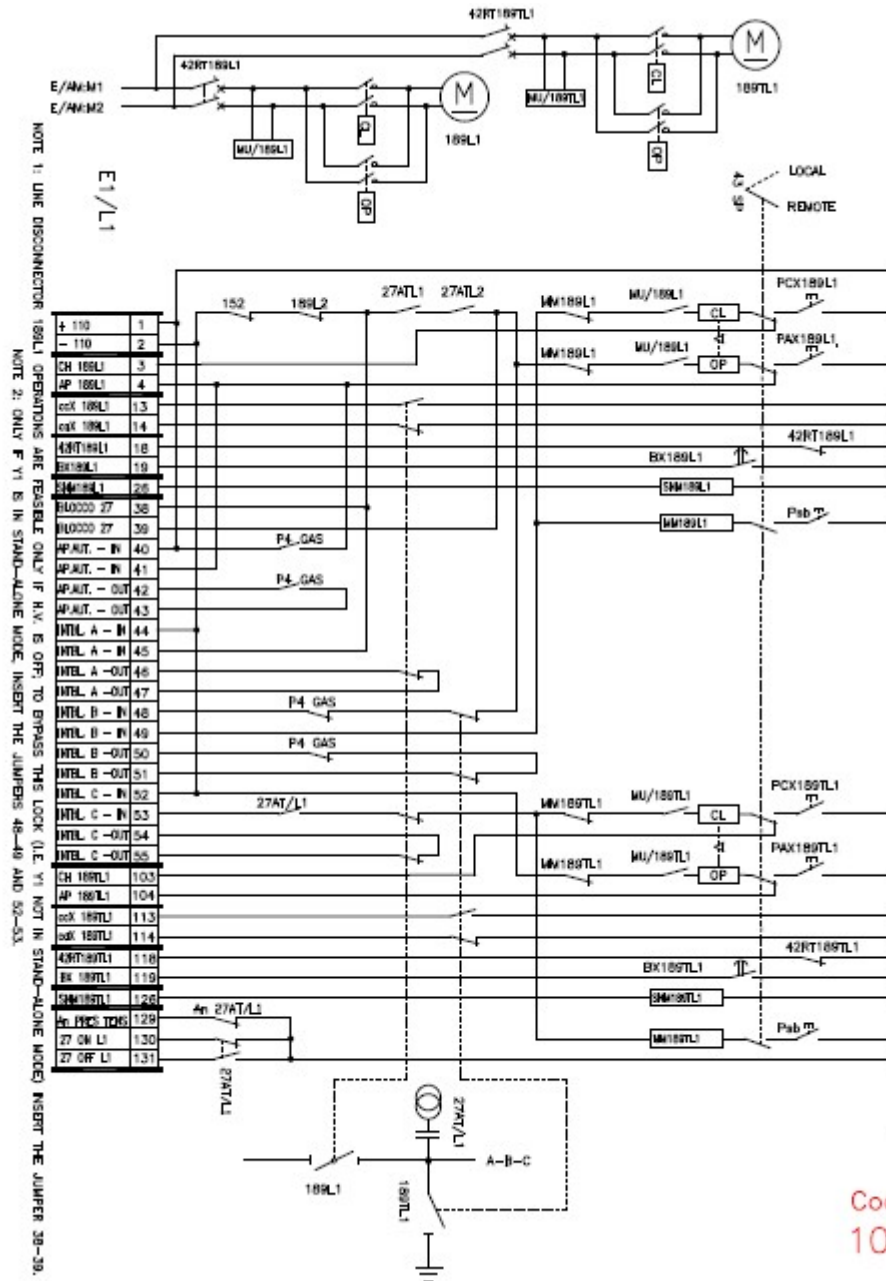
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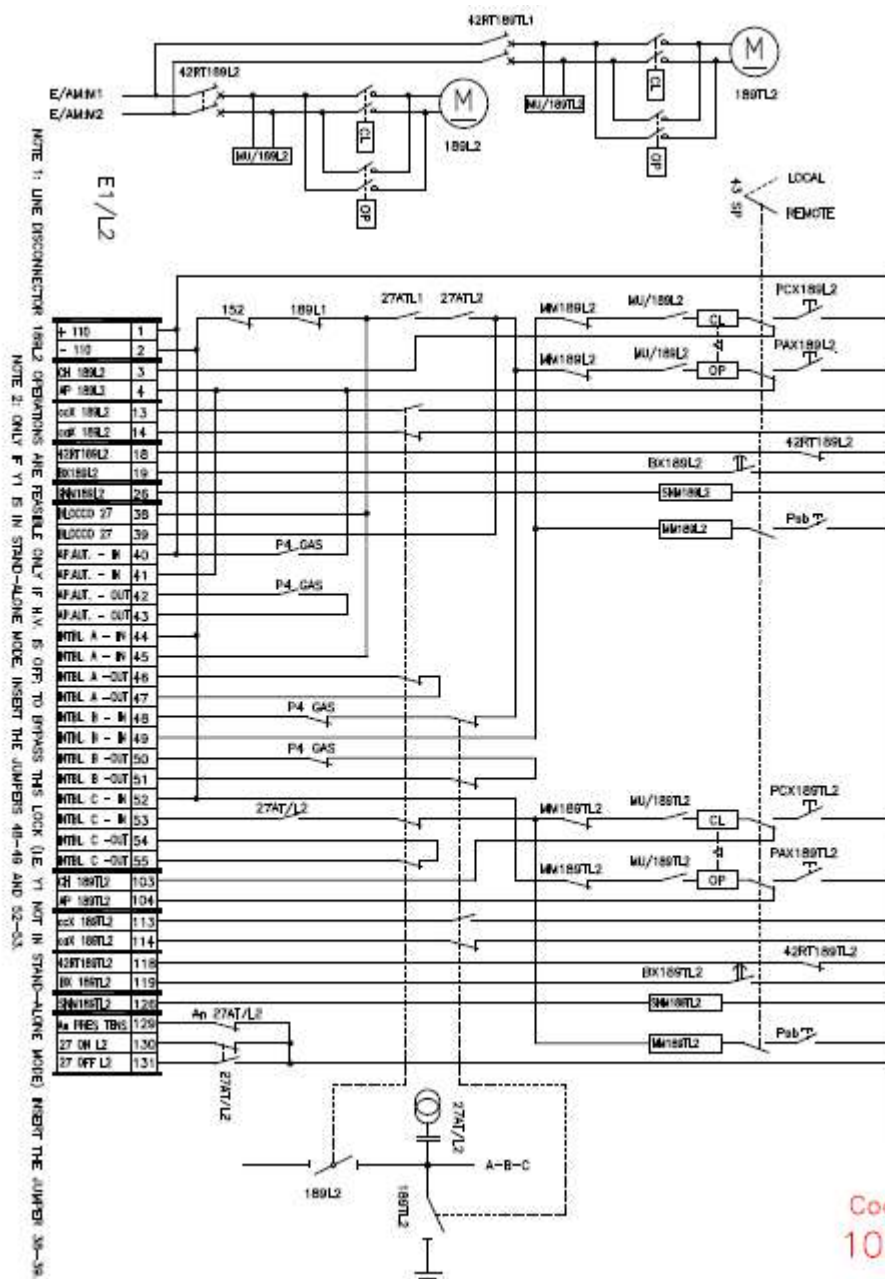
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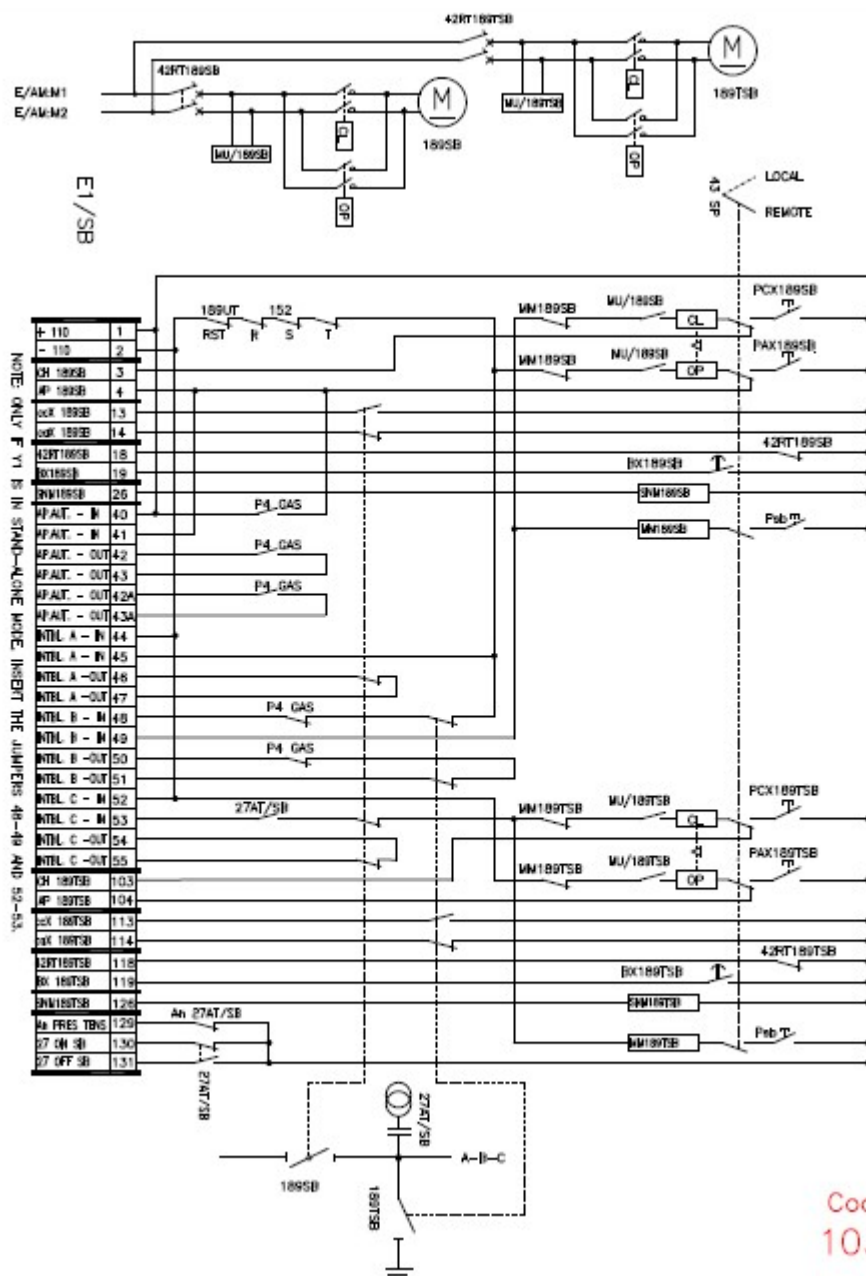


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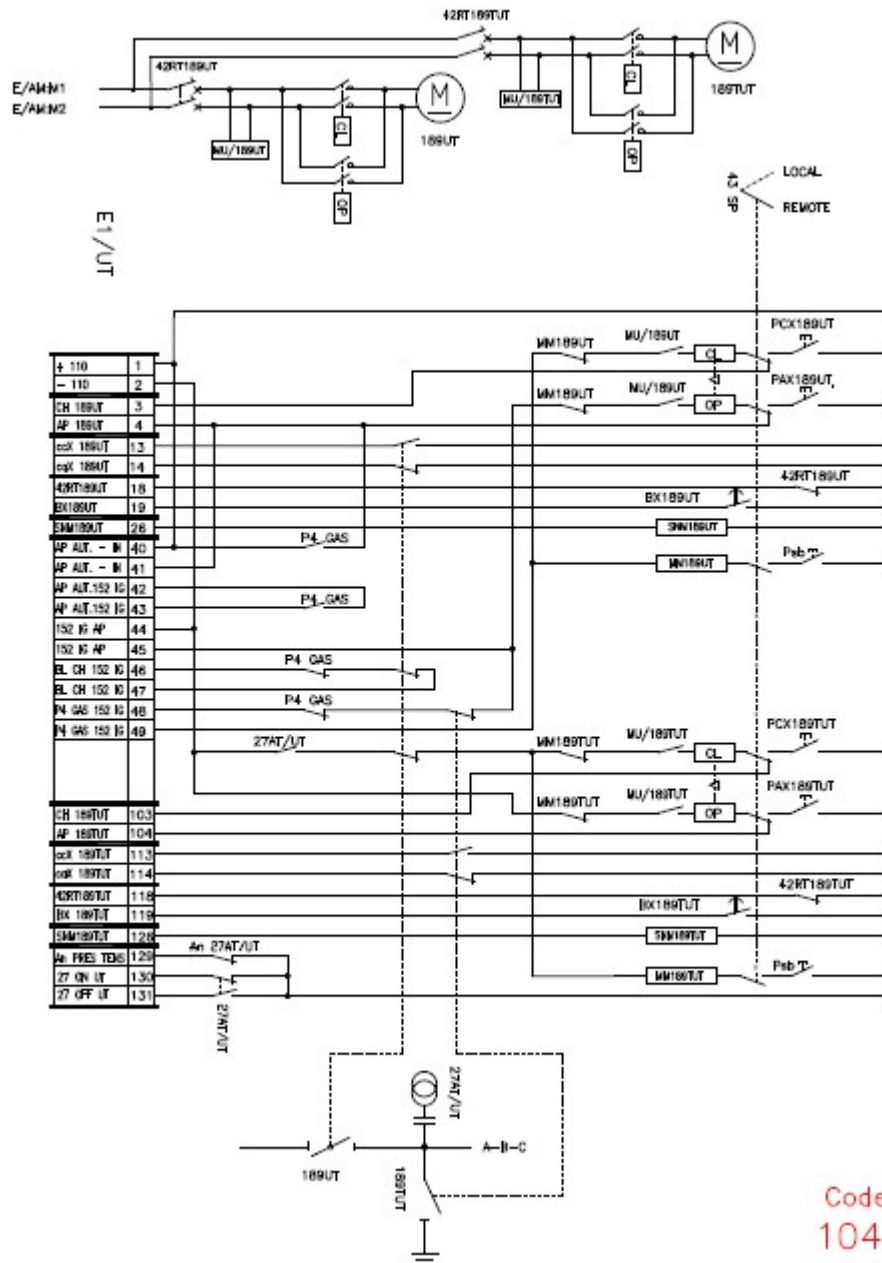


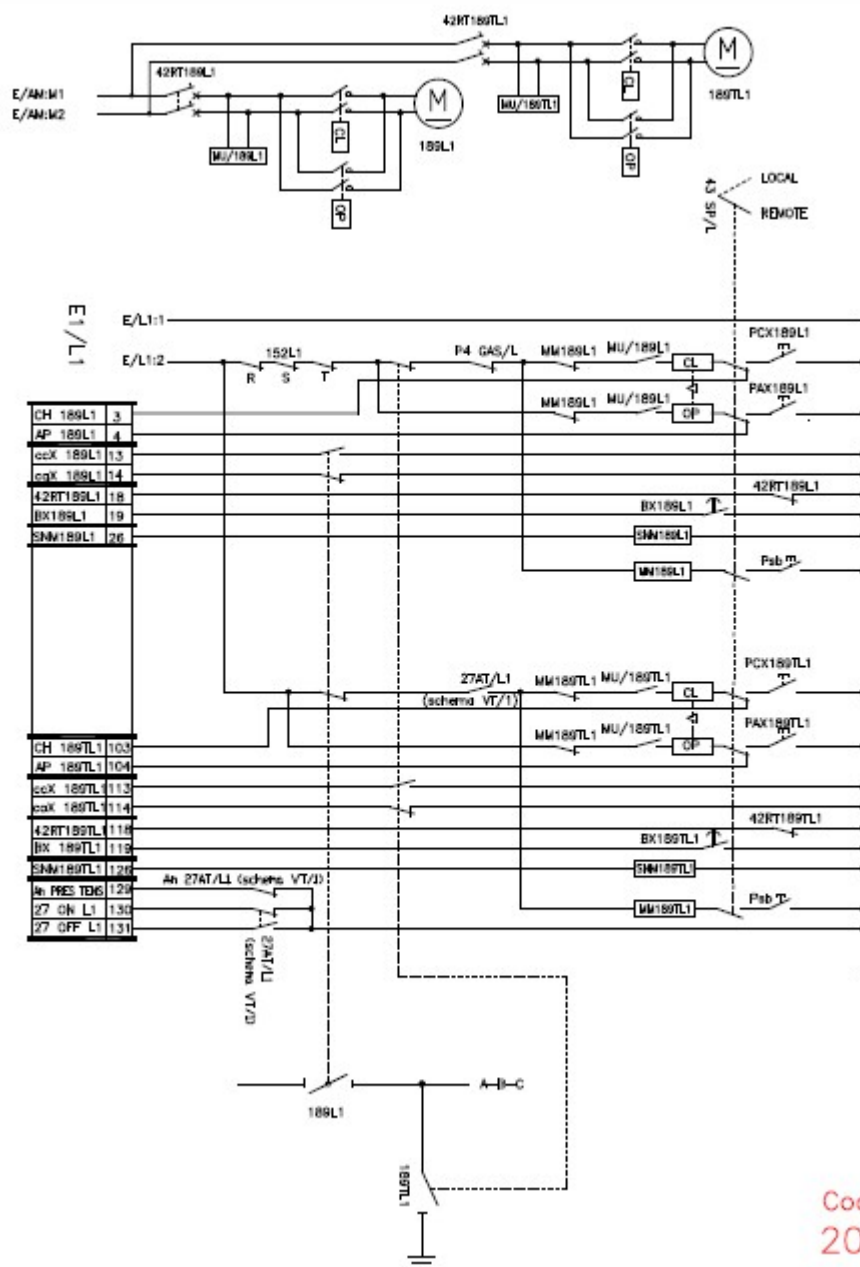
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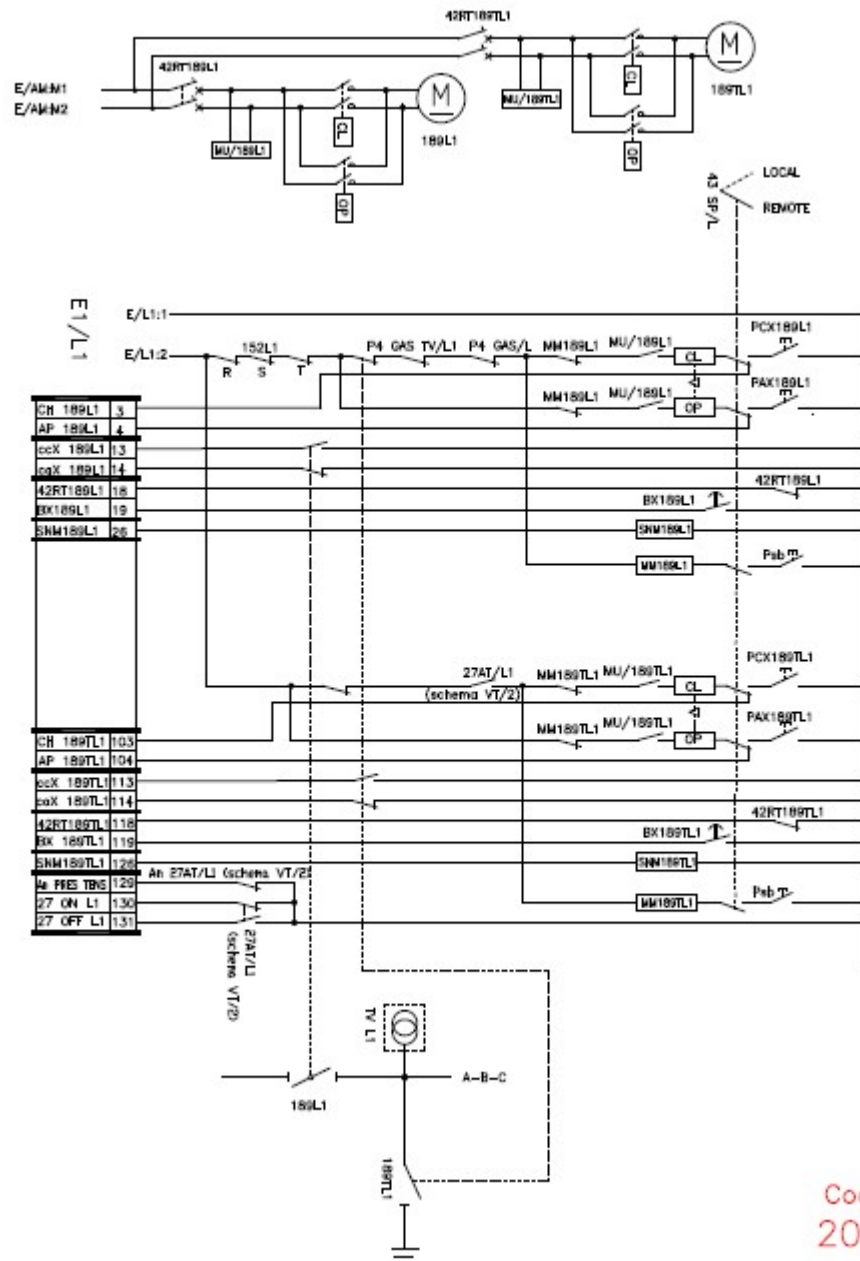


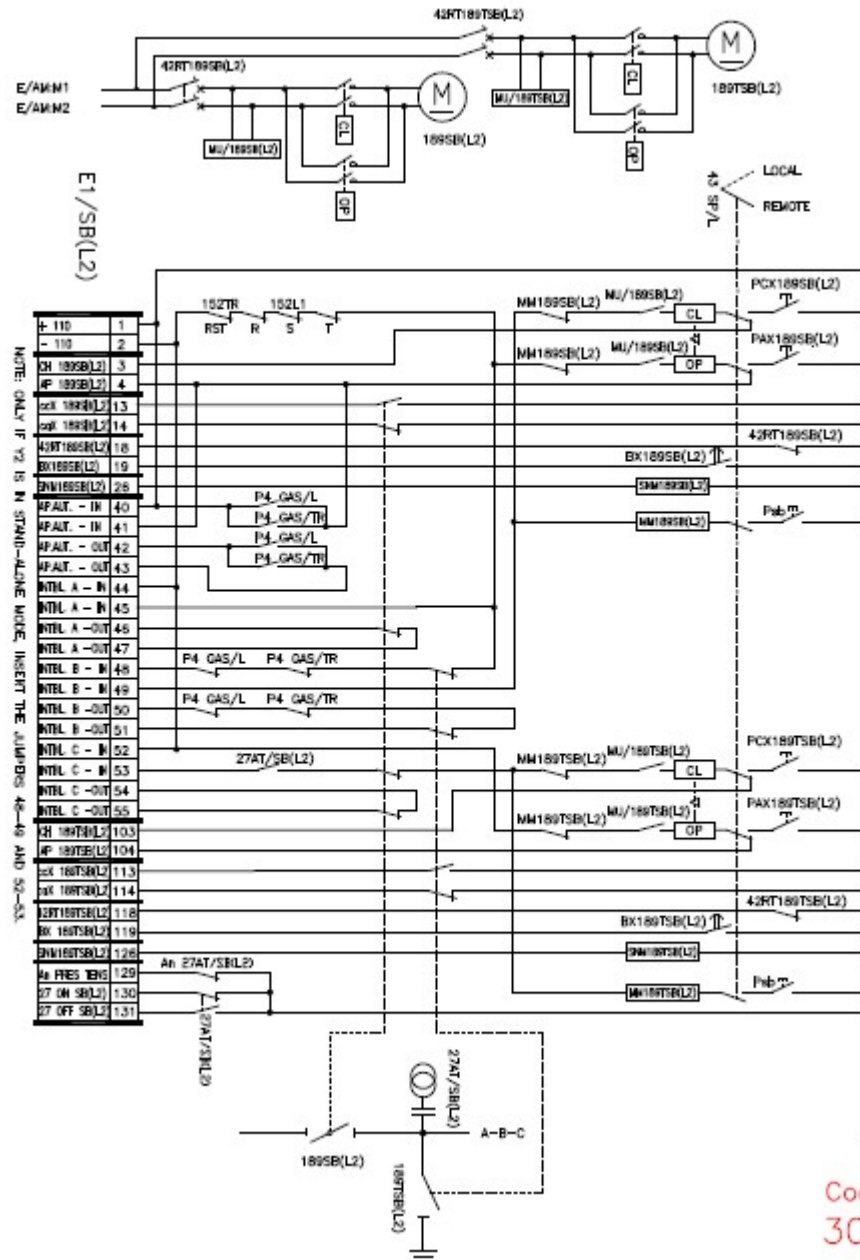
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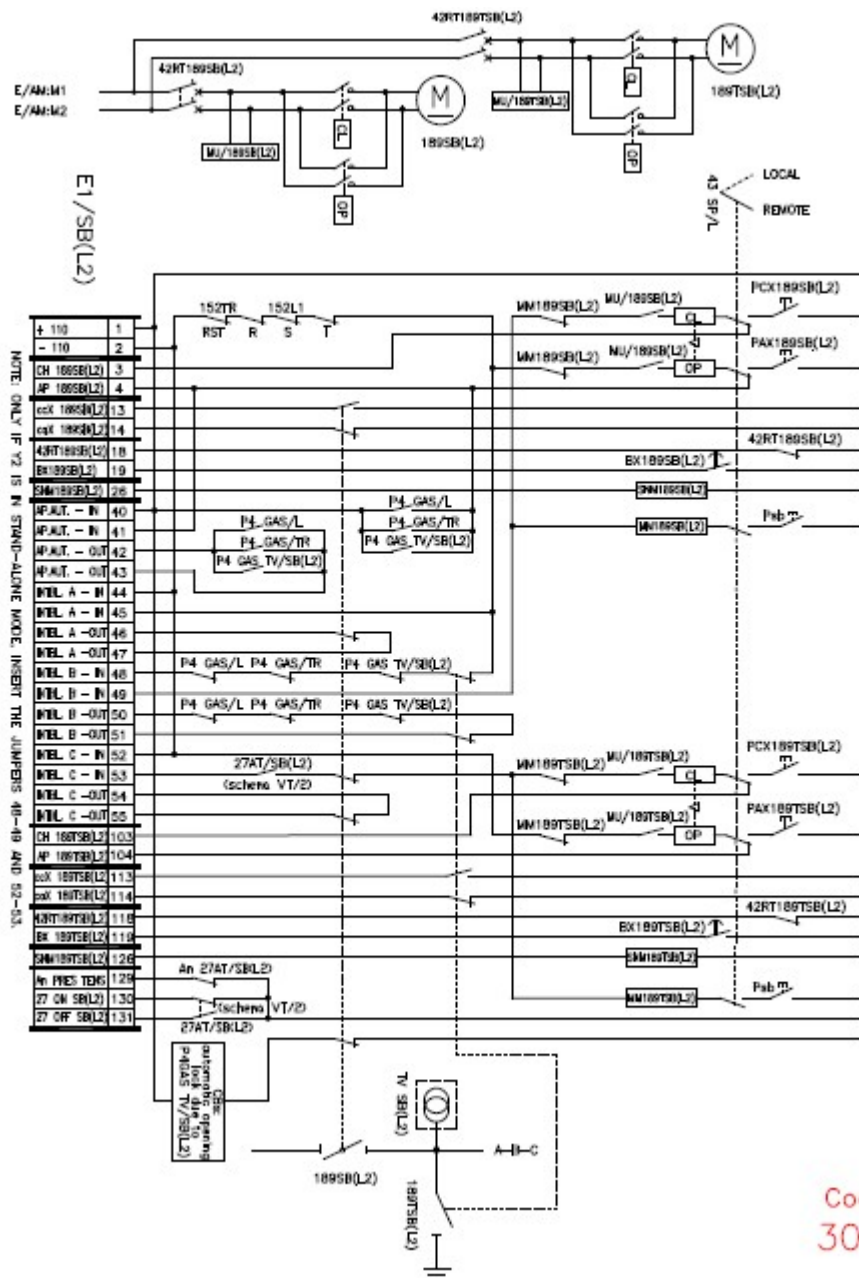


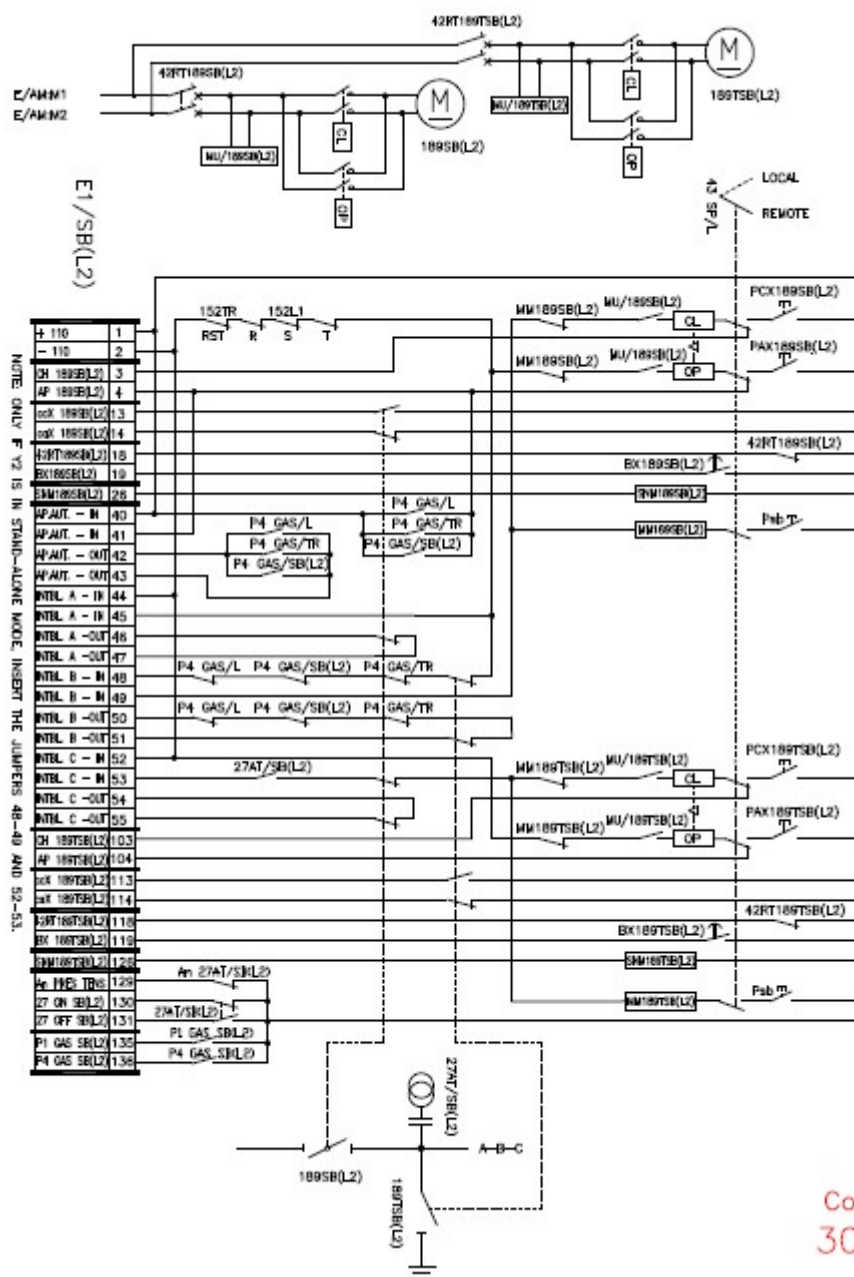
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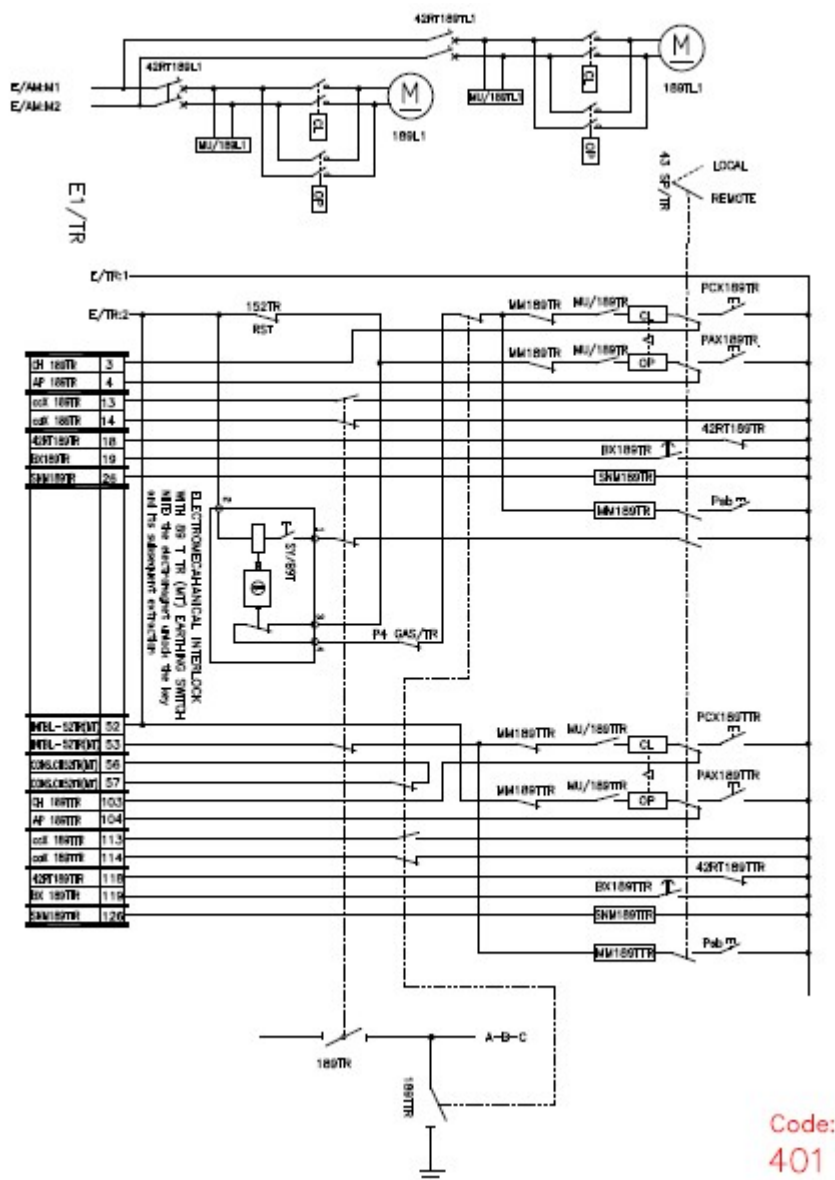


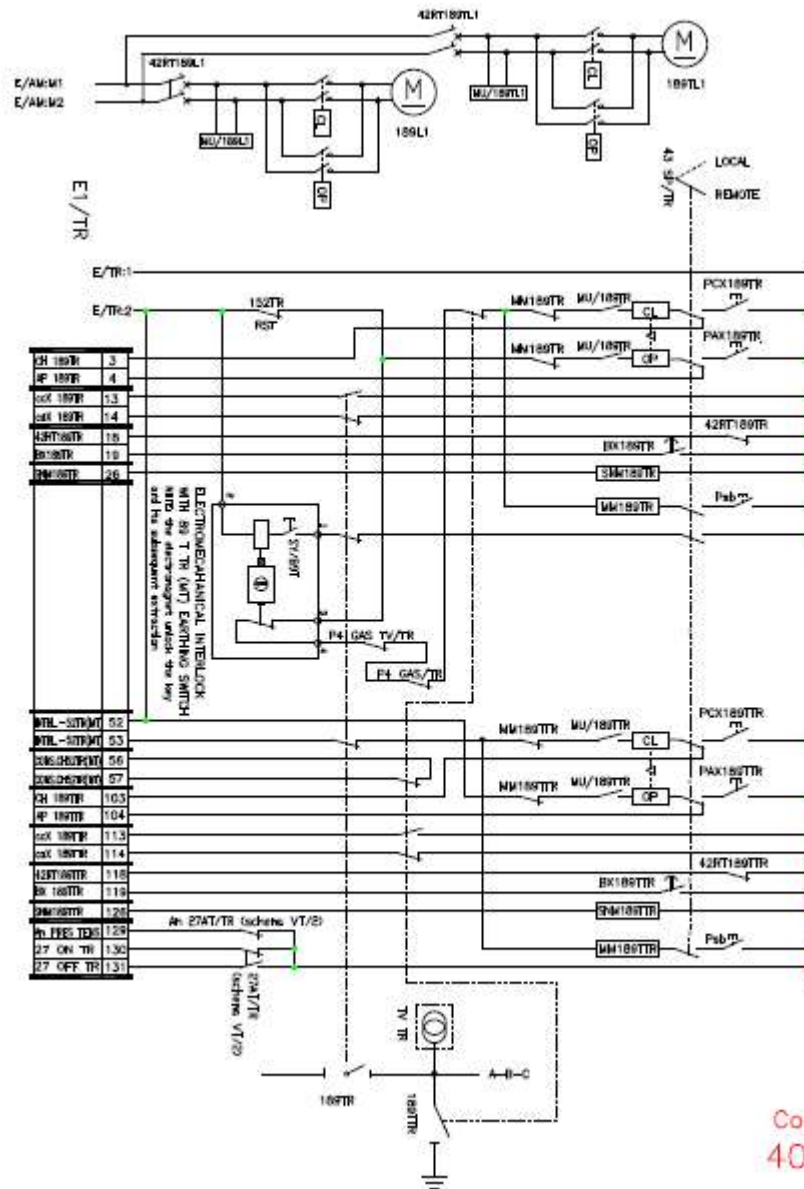


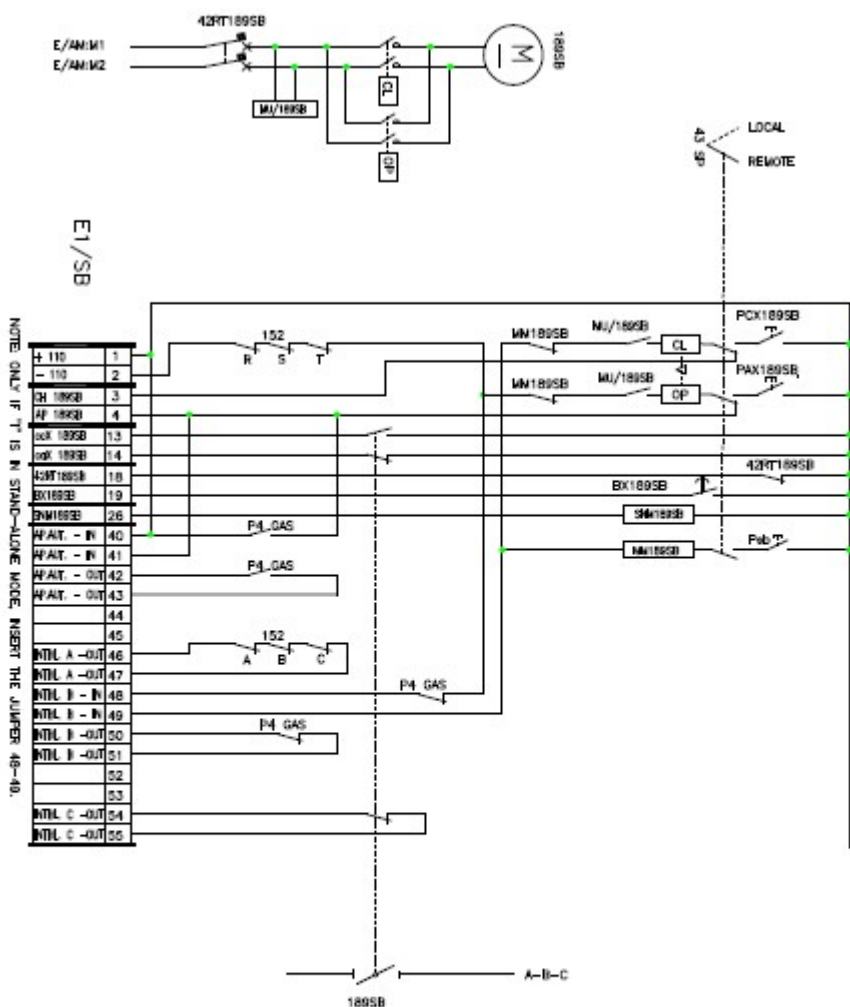
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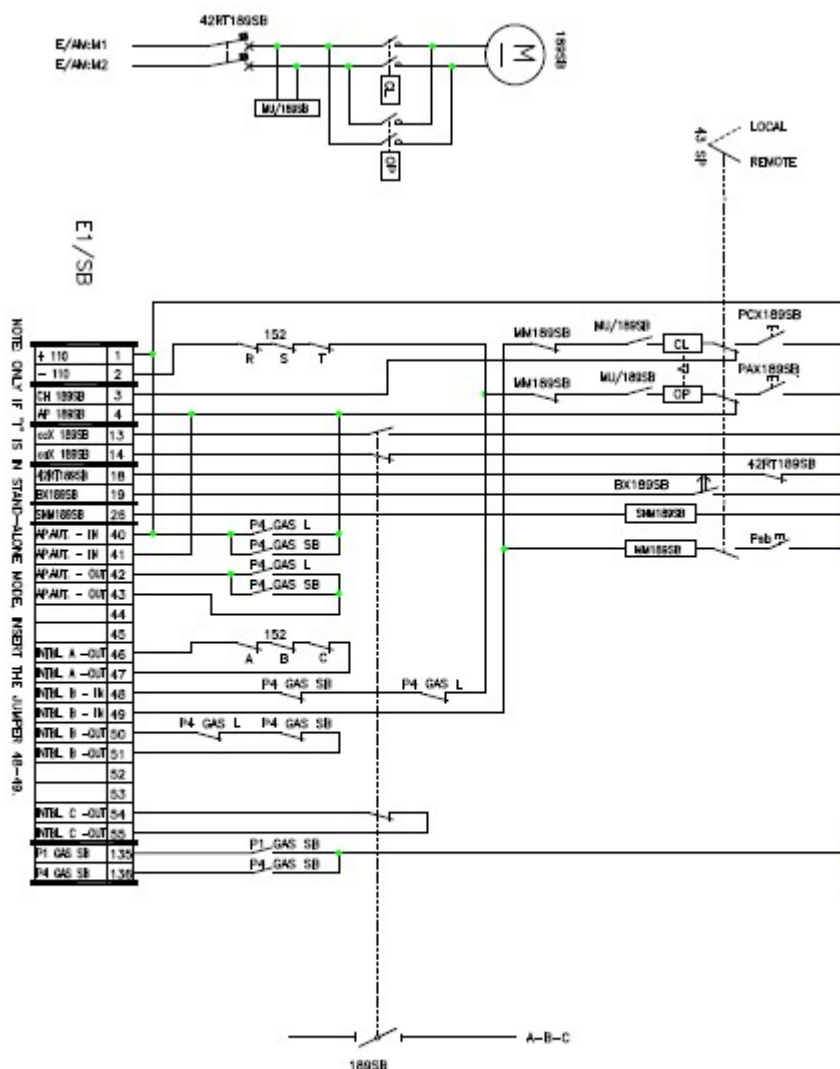








Code:
501



Code:
502

STANDARD

HYBRID MODULES



Code/Codice:
AM

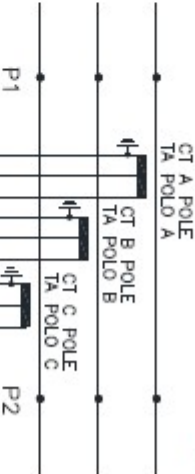
MOTORS (D.C.) AND
ANTI-CONDENSATION (A.C.)
POWER SUPPLIES

ALIMENTAZIONI MOTORI (C.C.)
E ANTICONDENSA (C.A.)

E/AM

ANTICOND.	R0
SUPPLY	R0
ANTICOND.	R4
SUPPLY	R4
+MOTORS	M1
+MOTORS	M1
+MOTORS	M1
-MOTORS	M2
-MOTORS	M2
-MOTORS	M2

SIDE: BUSBAR
LATO: SBARRA



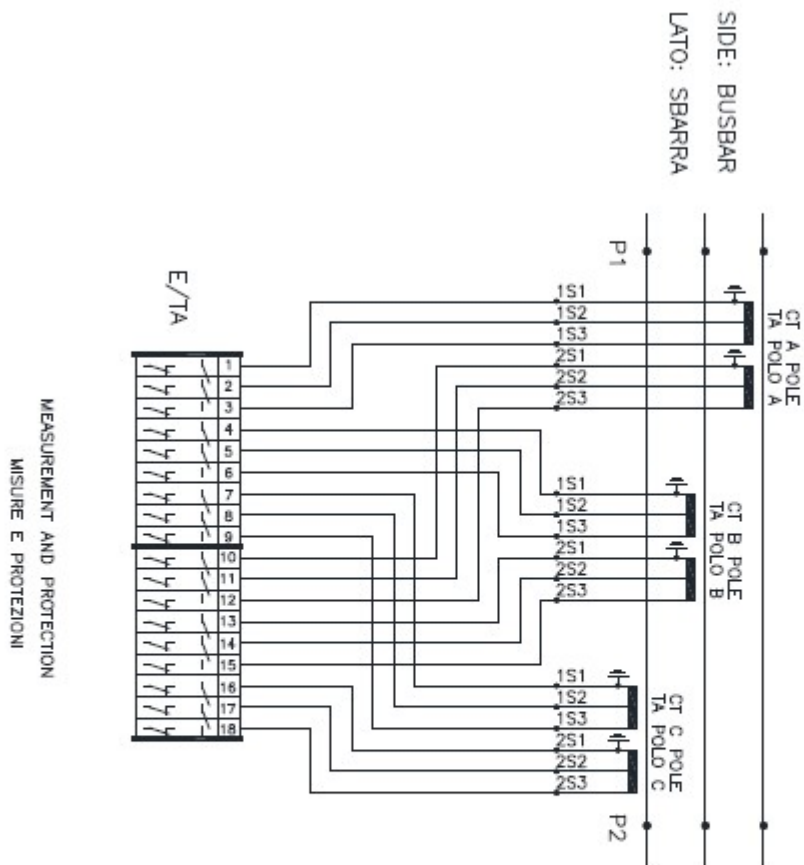
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E/TA

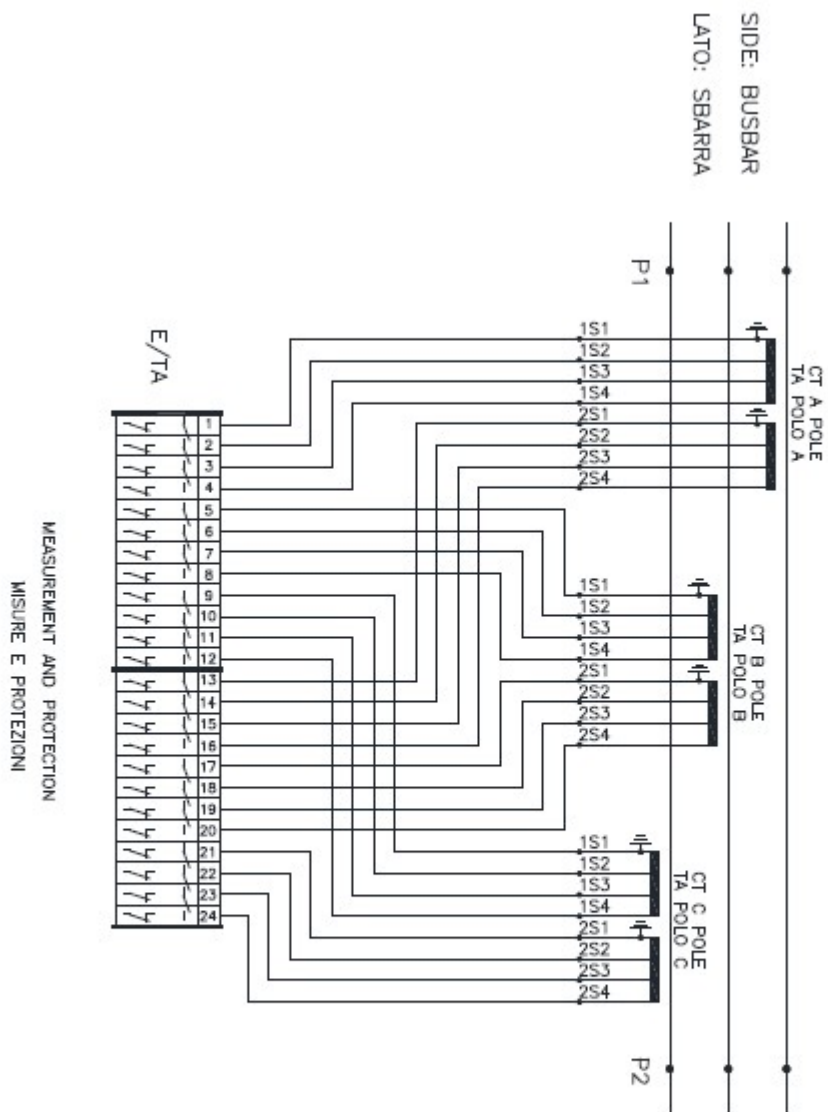
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MEASUREMENT AND PROTECTION
MISURE E PROTEZIONI

	STANDARD	Page 79 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026



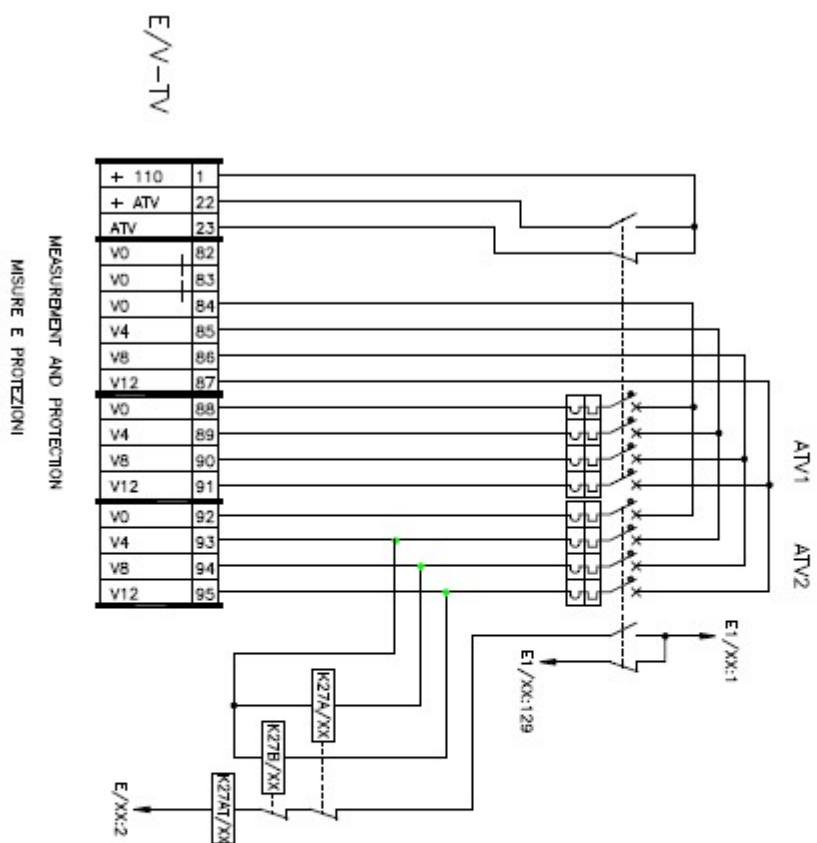
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Code/Codice:
CT/3

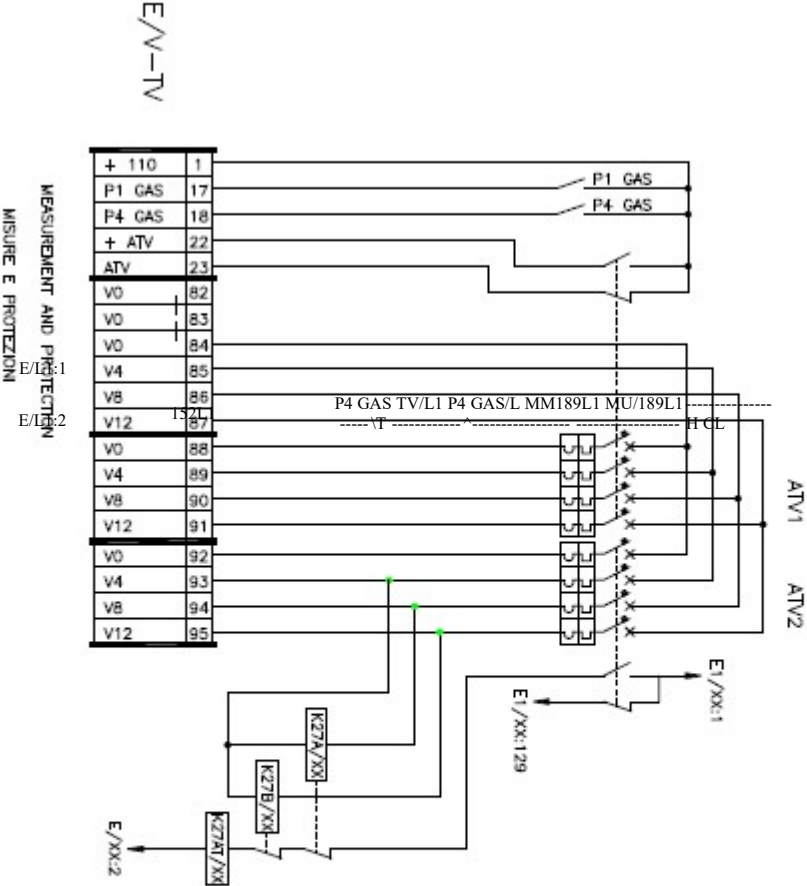
Inductive or Capacitor Voltage Transformers Version

Versione con TV – TVC tradizionali esterni

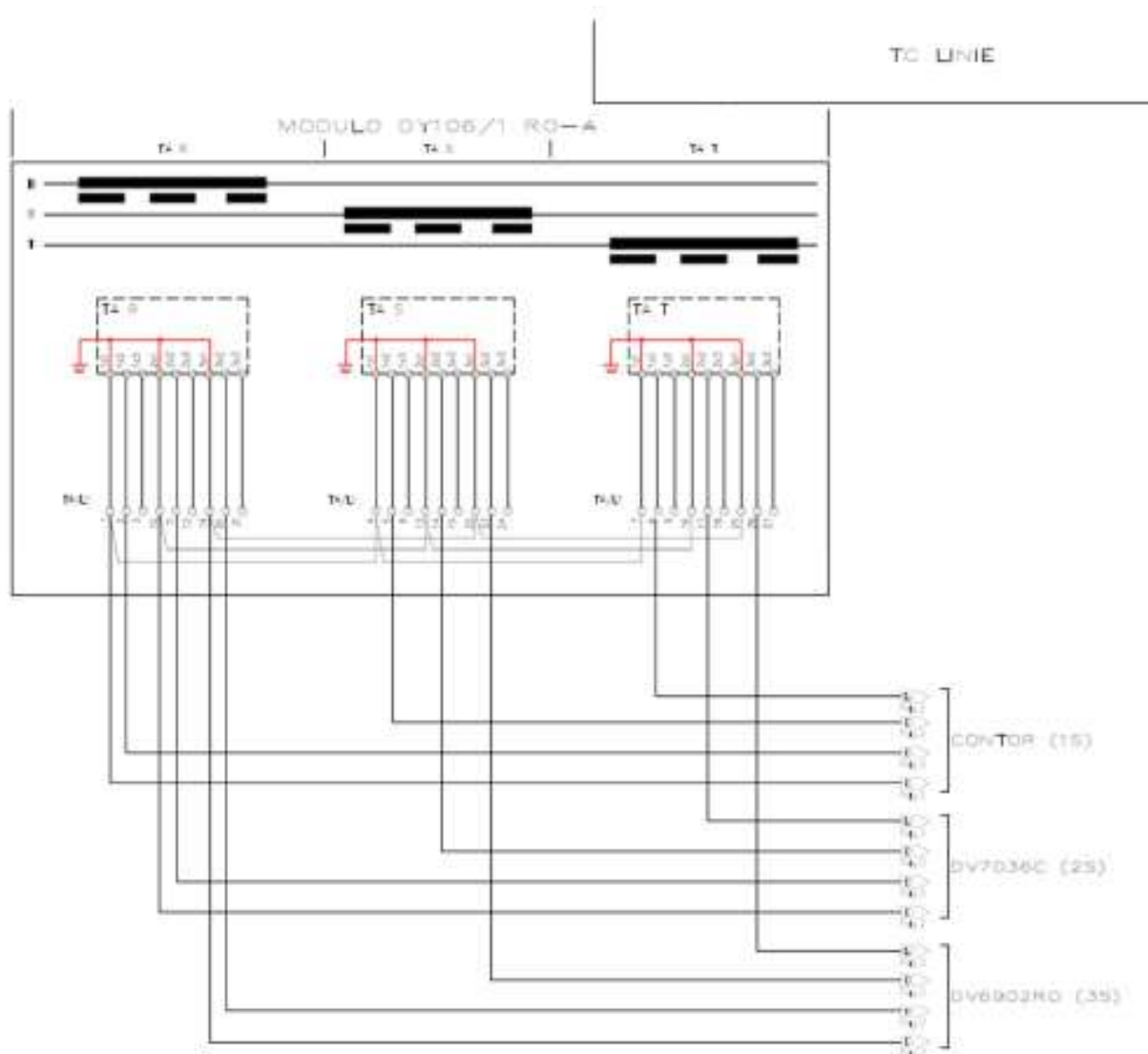


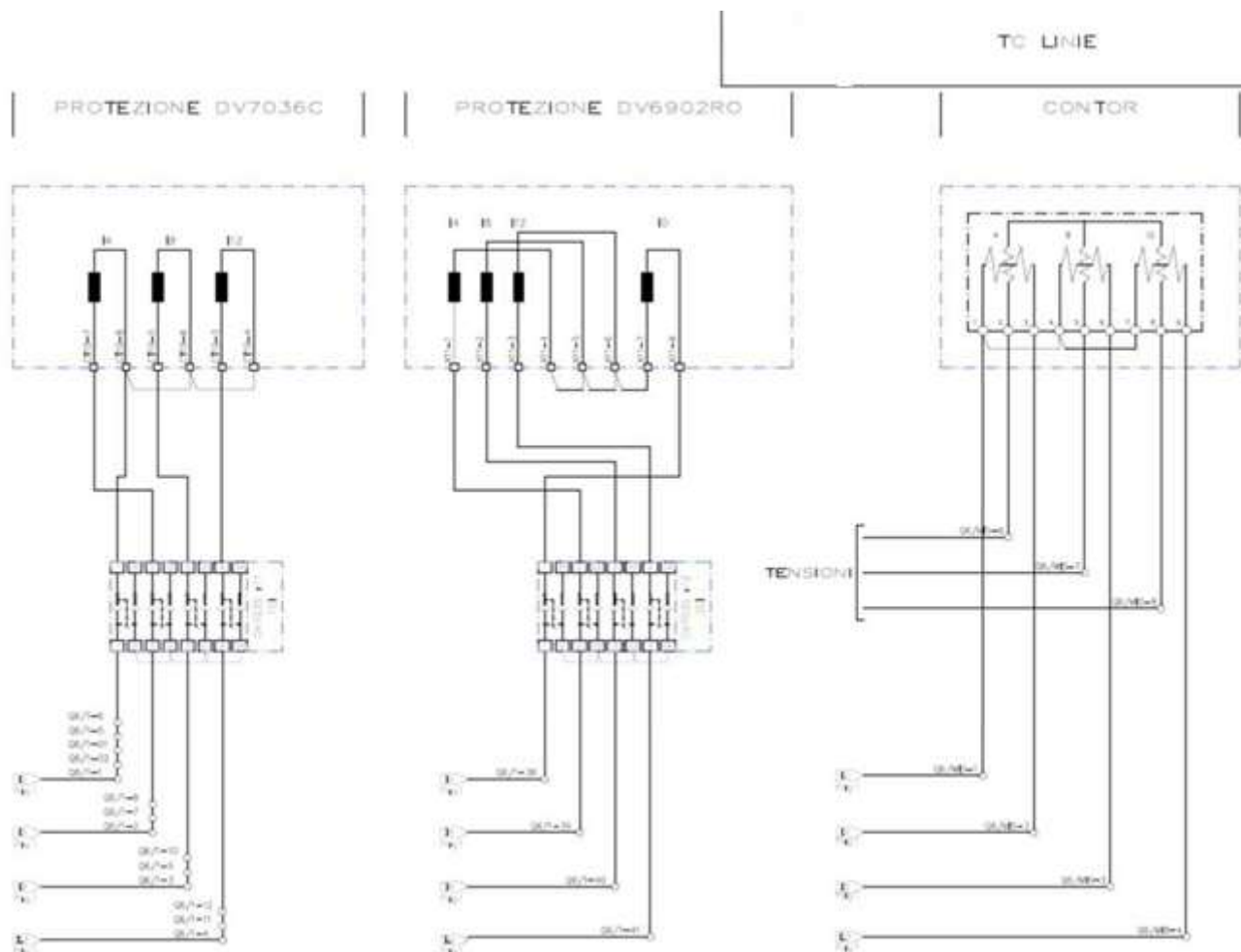
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VT/1

Gas insulated Inductive Voltage Transformers Version
Versione con TV in SF6 e relativa compartimentazione

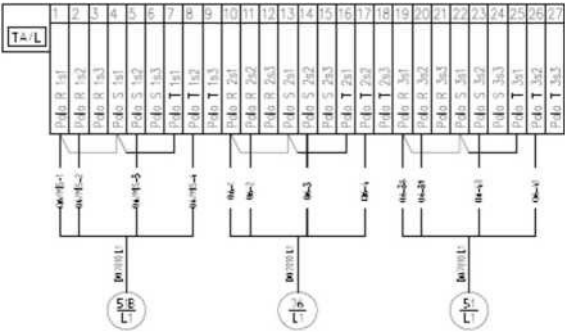


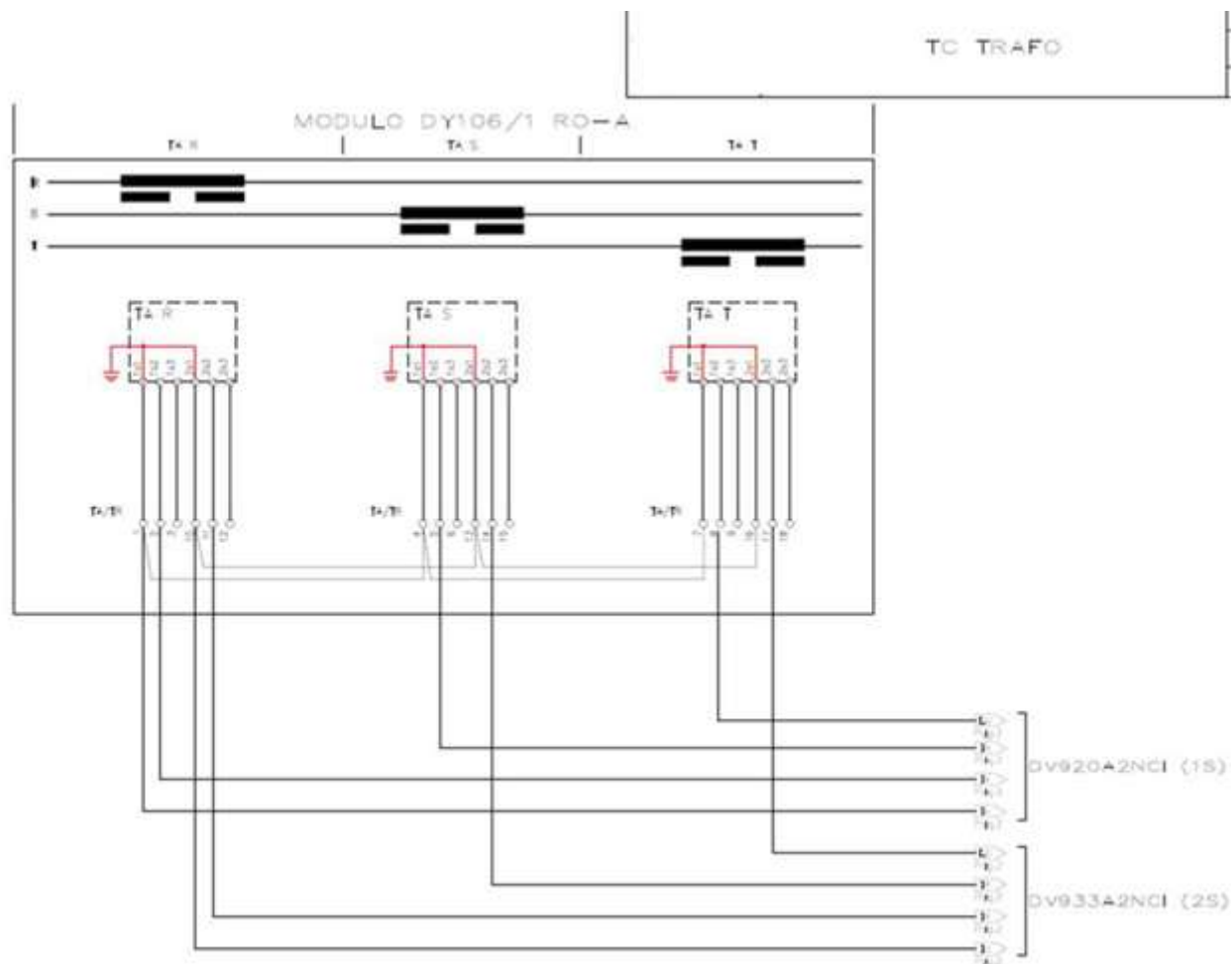
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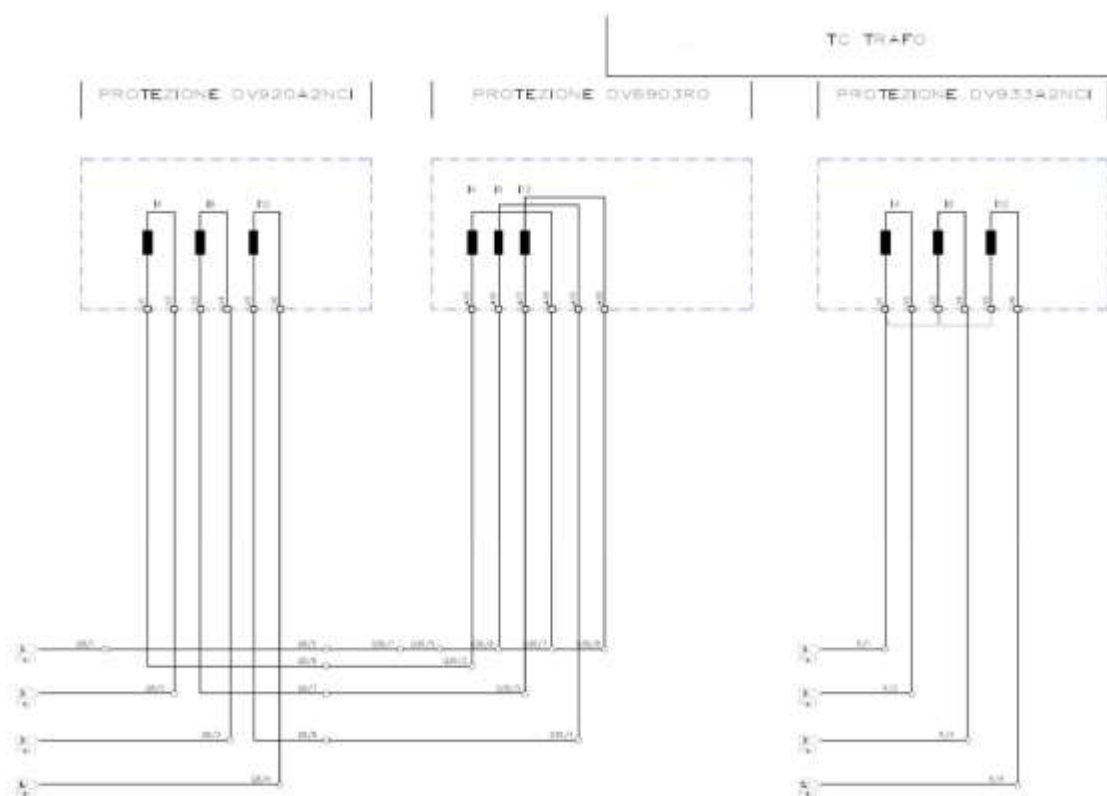




TC LINIE

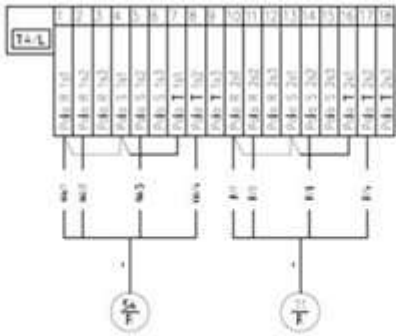




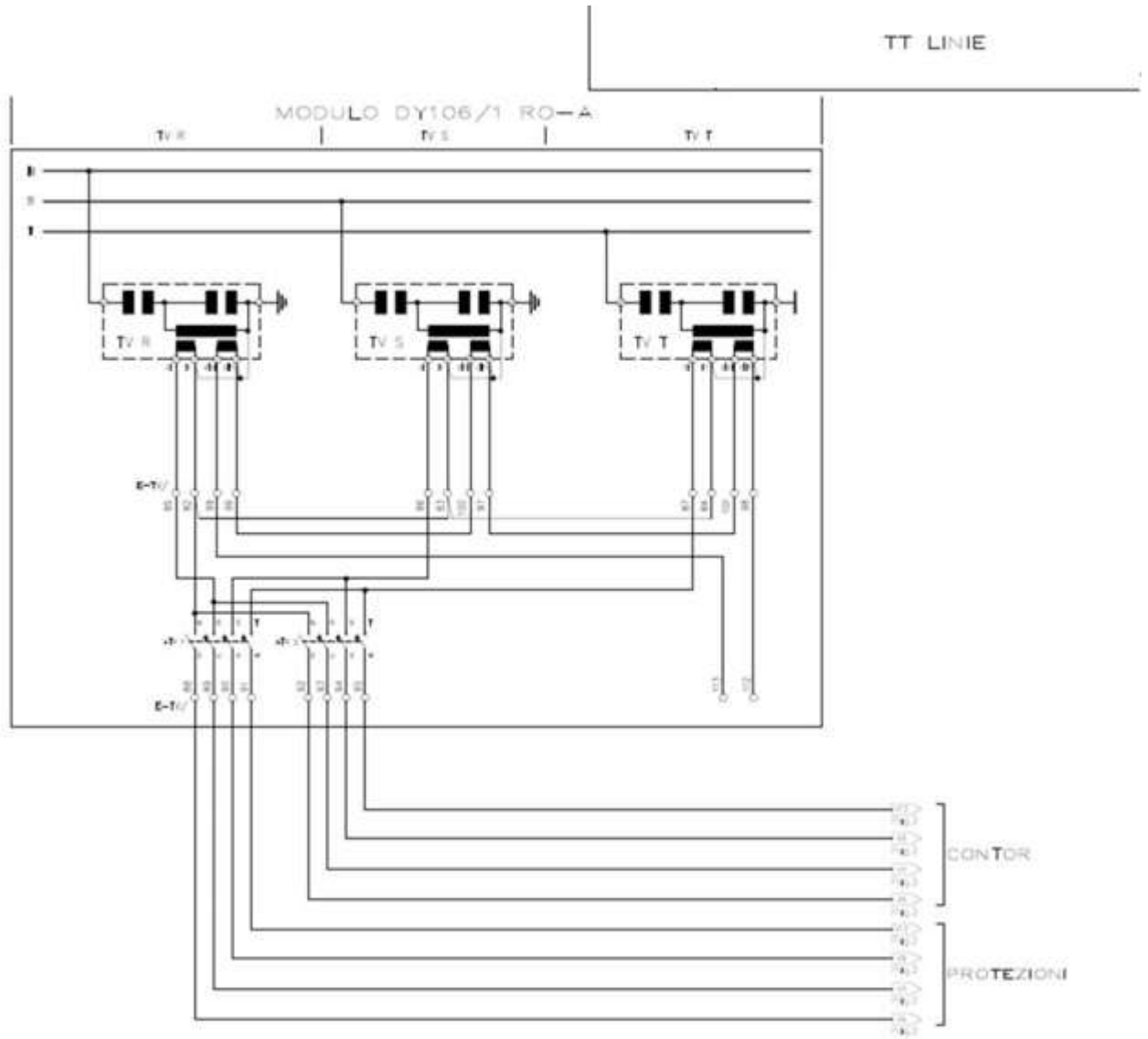


	STANDARD	Page 88 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

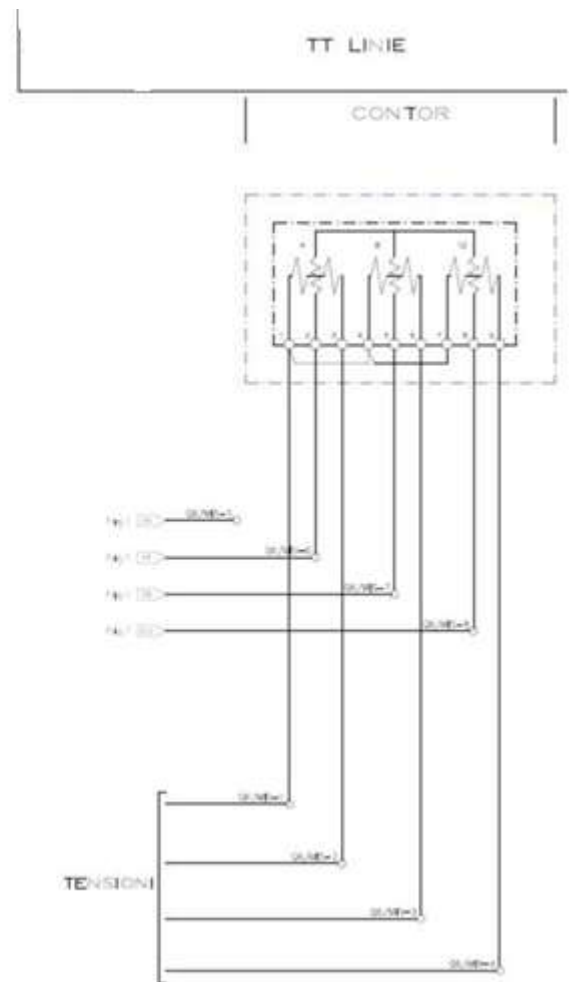
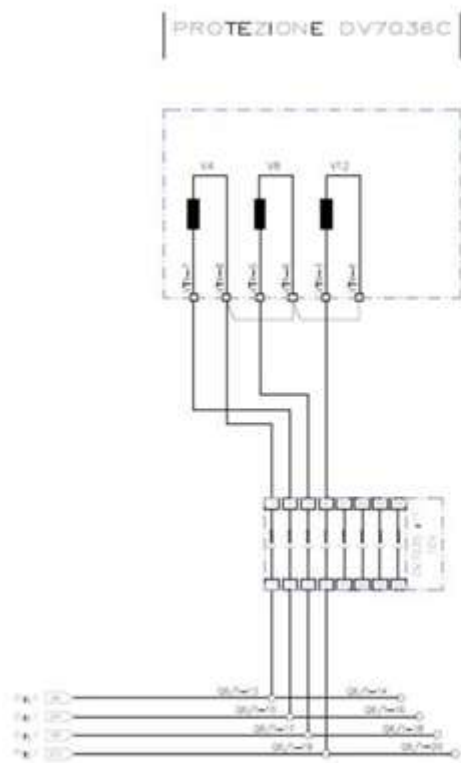
TO TRAFU



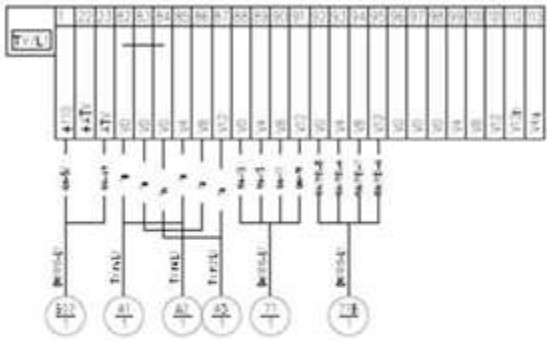
	STANDARD	Page 89 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026



	STANDARD	Page 90 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026



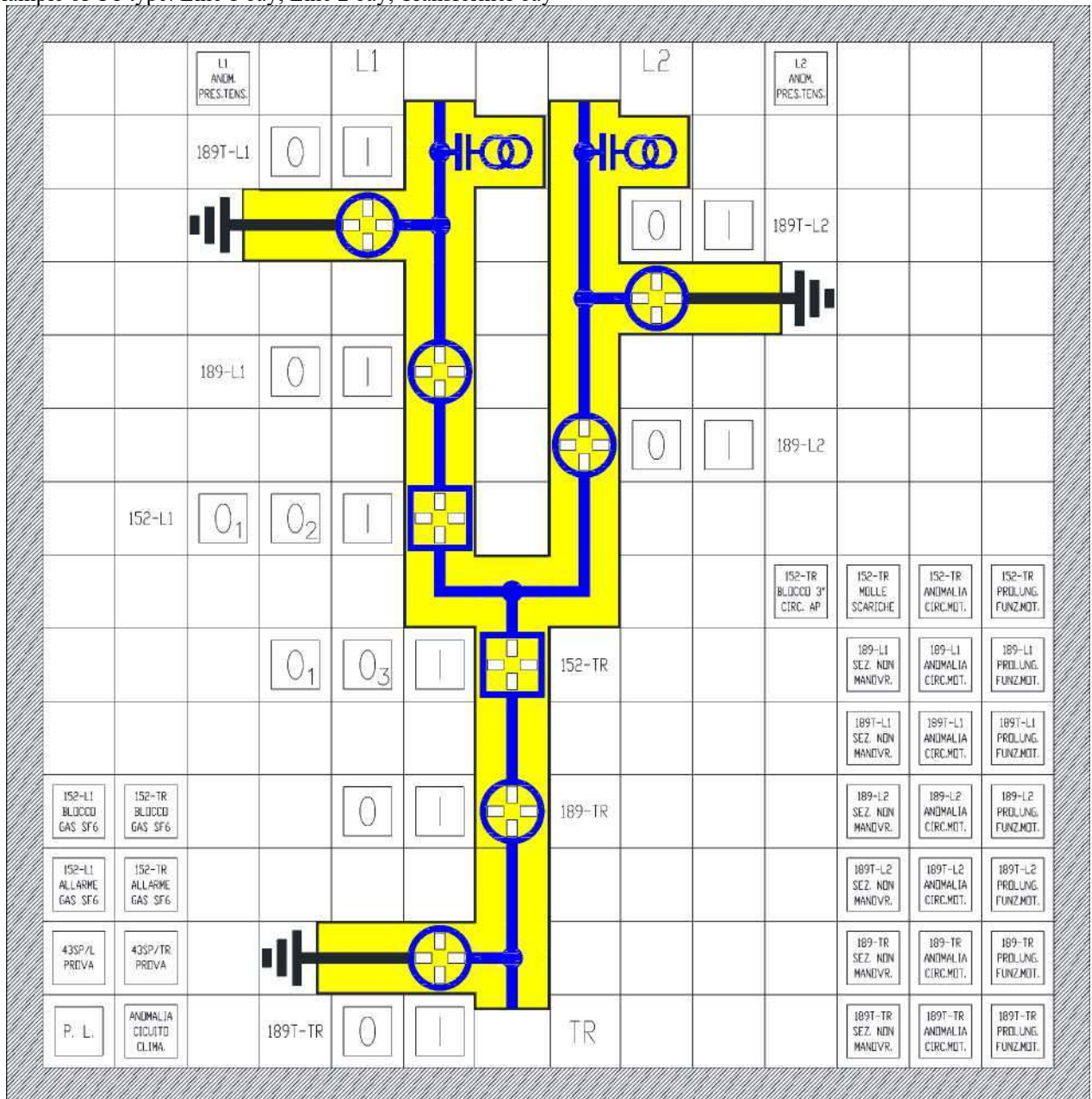
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	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026



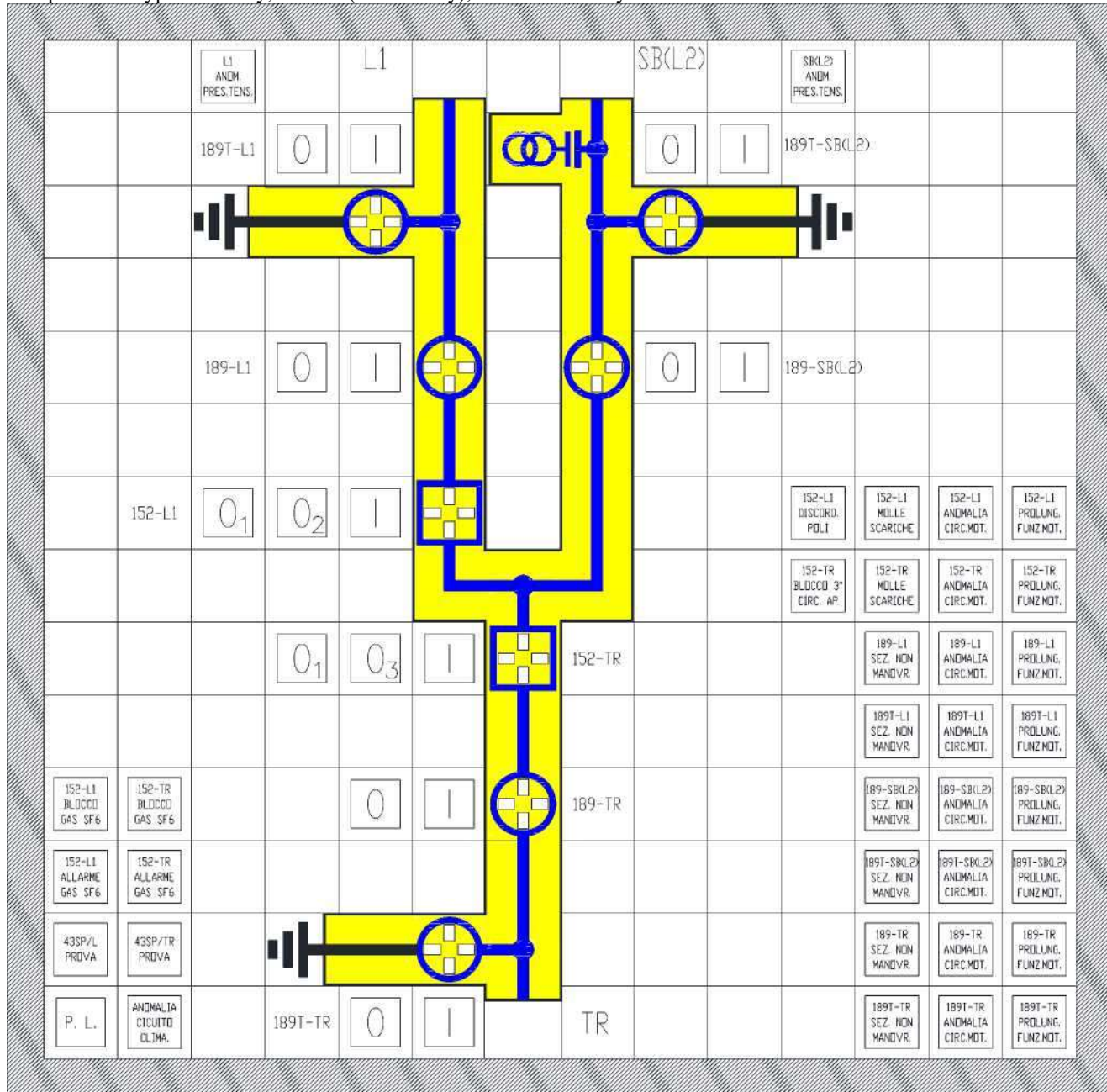
ANNEX E – SYNOPTIC EXAMPLES

E.2 – RETELE ELETTRICE SYNOPTIC EXAMPLES

Example of Y1 type: Line 1 bay, Line 2 bay, Transformer bay

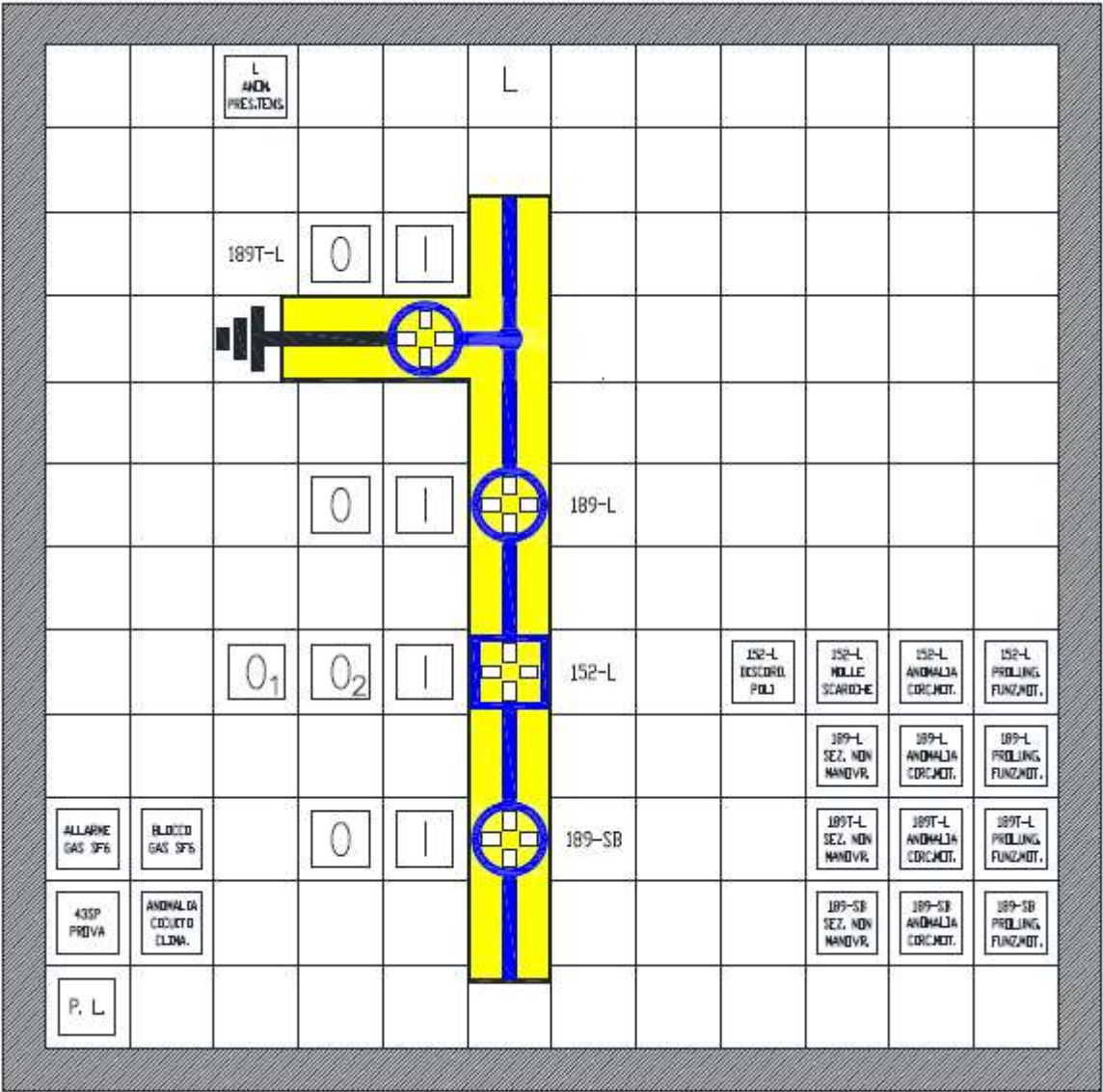


Example of Y2 type: Line bay, Busbar (or Line bay), Transformer bay



	STANDARD	Page 94 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Example of Single-bay type: Line bay, Busbar bay



	STANDARD	Page 95 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

ANNEX F – TENDER’S TECHNICAL DOCUMENTATION

STANDARD: GSCH002 – HYBRID MODULES		TENDER:	
SUPPLIER:		FACTORY:	
RATED VOLTAGE FOR EQUIPMENT U_r (kV):		SUPPLIER MODEL:	
TECHNICAL CHARACTERISTIC		STANDARD REQUIREMENT	SUPPLIER OFFER
<u>Service conditions</u>			
Service conditions		outdoor normal service conditions of IEC 62271-1	
Reference altitude (m)		≤ 1.000	
Minimum ambient air temperature ($^{\circ}\text{C}$)		- 30	
SPS Class (IEC/TS 60815 series)		d) or e)	
Ice coating (mm)		22	
Seismic qualification level		See table in 4.2.3	
<u>Common general ratings</u>			
Rated short-duration powerfrequency withstand voltage U_d (kV rms):	Phase-to-earth, across open switching device and between phases		
	Across the isolating distance		
Rated lightning impulse withstand voltage U_p (kVp):	Phase-to-earth, across open switching device and between phases		
	Across the isolating distance		
Rated frequency f_r (Hz)		50 and 60	
Rated normal current I_r (A)		2.000	
Rated short-time withstand current I_k (kA)			
Degrees of protection provided by enclosures (IEC 60529)		IP54	
Protection stage (tab. 104 EN 62271-203)		2	
Maximum SF6 leakage rate (% / year)		$\leq 0,5\%$	
HV Single-line diagram			To enclose a HV singleline diagram for each one of the detailed layout examples in Annex B.2
Dimensions		See Annex C	To enclose an overall equipment drawing for each one of the detailed layout examples in Annex B.2
<u>Circuit breakers</u>			
Rated short-circuit breaking current I_{sc} (kA)			
First-pole-to-clear factor k_{pp}			
Rated operating sequence		O - 0,3 s- CO -1 min - CO	

	STANDARD	Page 96 din 96
	HYBRID MODULES	GSCH002 Rev. 08 08/06/2026

Maximum break-time (ms)		60	
Circuit-breaker class		C2 – E1 – M2	
Rated line-charging breaking current I_l (A)			
Rated cable-charging breaking current I_c (A)			
Rated out-of-phase making and breaking current I_d (kA)		Clause 4.106 of IEC 62271-100	
<u>Disconnectors and earthing switches</u>			
Opening (closing) time for motor operation (s)		≤ 15	
Disconnector mechanical endurance class M_r		M1	
Bus-transfer current switching by disconnectors (only if requested)	Rated bus-transfer current for disconnectors (A)	Clause B.4.106.1 of IEC 62271-102	
	Rated bus-transfer voltages for disconnectors (V)	Clause B.4.106.1 of IEC 62271-102	
Earthing switches class		E0 – M1 – A	
<u>SF6-air Bushings</u>			
Insulators materials		Composite	
<u>Bus ducts</u>			To enclose an overall equipment drawing of a solution with bus-ducts
<u>Cable connections</u>			To enclose an overall equipment drawing of a solution with cable connections
<u>Current transformers</u>			
Rated short-time thermal current I_{th} (kA)		40	
Rated continuous thermal current I_{cth} (kA)		120% of I_{pr}	
Core number		1 or 2	
<u>Voltage transformers</u>			
Secondary windings		1, 2 or 3	
Rated voltage factor F_v		1,5 (rated time 30 s)	