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**C2/113**  
**Homologation procedure**  
**for HV switchgear**  
**according to the technical prescription C2/112**

**Part 4**  
**Specific design and construction requirements for HV switchgear,**  
**intended for use in a Client installation to be connected to**  
**the public HV distribution grid of a Belgian DSO**

**Edition 2 - DPC (10.2023)**

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29

30	Table of contents	
31	<b>1 OBJECT AND SCOPE</b>	<b>5</b>
32	<b>2 GENERAL</b>	<b>5</b>
33	<b>3 REFERENCES</b>	<b>5</b>
34	<b>4 MAN-MACHINE INTERFACE</b>	<b>6</b>
35	4.1 General	6
36	4.2 Basic rules	6
37	4.3 Composition	6
38	4.4 Lines	6
39	4.4.1 General	6
40	4.4.2 Representation of the main circuit	7
41	4.4.3 Representation of the main earthing circuit of the FU	9
42	4.5 Symbols	9
43	4.5.1 General	9
44	4.5.2 Symbols for components of the synoptic diagram	9
45	4.5.3 Symbols for switching devices	10
46	4.6 Indicators	11
47	4.6.1 Generalities	11
48	4.6.2 Location of the indicator	11
49	4.6.3 Colour and display	11
50	4.6.4 Position indicators	12
51	4.6.5 Status indicators of components	13
52	4.7 Control zones and control buttons	14
53	4.7.1 General	14
54	4.7.2 Control zone	14
55	4.7.3 Content of the control zone	14
56	4.7.4 Control buttons	14
57	4.7.5 Motorised/automatic control	14
58	4.8 Information (other indicators)	14
59	4.8.1 Name plate	14
60	4.8.2 Holder for feeder identification	15
61	4.8.3 Service voltage range for the Voltage Detection and Indicating System (VDIS)	15
62	4.8.4 Fault Current Indicator (FCI)	15
63	<b>5 VOLTAGE DETECTION AND INDICATING SYSTEM (VDIS)</b>	<b>16</b>
64	<b>6 SPECIFIC REQUIREMENTS FOR A HV BILLING METERING FUNCTION</b>	<b>17</b>
65	6.1 General	17
66	6.2 Design and construction	17
67	6.2.1 General aspects	17
68	6.2.2 CT mounting and wiring of secondary CT circuits	18
69	6.2.3 VT mounting and wiring of secondary VT circuits	19
70	6.2.4 Nameplates and markings	19
71	6.2.5 Schematic diagrams	20
72	<b>7 PRACTICAL REQUIREMENTS FOR CABLE CONNECTIONS</b>	<b>21</b>
73	7.1 General	21
74	7.2 HV switchgear of category AA1x/AA20	21
75	7.3 HV switchgear of category AA3x	22
76	<b>8 ACCESSIBILITY TO COMPARTMENTS, LSC CATEGORY &amp; INTERLOCKS</b>	<b>25</b>
77	8.1 Accessibility to compartments	25
78	8.2 LSC category	25
79	8.3 Interlocks	25
80	8.3.1 Scope	25
81	8.3.2 General principles	25
82	8.3.3 Criteria	26
83	8.4 Locking facilities	26
84	8.4.1 Definition	26

85	8.4.2	Scope .....	26
86	8.4.3	Criteria .....	26
87	<b>9</b>	<b>MISCELLANEOUS AND ADDITIONAL REQUIREMENTS .....</b>	<b>27</b>
88	<b>9.1</b>	<b>Arc suppression device .....</b>	<b>27</b>
89	<b>9.2</b>	<b>Indicating system for the dielectric withstand ability of the insulating gas for switchgear with gas insulated switching devices .....</b>	<b>27</b>
90			
91	<b>9.3</b>	<b>Earthing arrangements .....</b>	<b>27</b>
92	<b>9.4</b>	<b>Raising base frames .....</b>	<b>28</b>
93	9.4.1	Raising base frame type AA1x-R and AA20-R .....	28
94	9.4.2	Energy absorbing base frames type AA15-A .....	28
95	9.4.3	Raising base frame type AA3x-R .....	28
96	<b>9.5</b>	<b>Features for installation of a Fault Current Indicator (FCI) .....</b>	<b>28</b>
97	<b>9.6</b>	<b>LV terminal block for protective current transformers (CTs) .....</b>	<b>28</b>
98	<b>10</b>	<b>OPERATING MECHANISM FUNCTIONALITIES OF SWITCHING DEVICES .....</b>	<b>29</b>
99	<b>10.1</b>	<b>Scope .....</b>	<b>29</b>
100	<b>10.2</b>	<b>Generalities .....</b>	<b>29</b>
101	<b>10.3</b>	<b>FU KKNx .....</b>	<b>29</b>
102	10.3.1	Principle of operation of the switching devices .....	29
103	10.3.2	Versions .....	29
104	10.3.3	Functionalities of switch-disconnector provided with a motor operation .....	29
105	<b>10.4</b>	<b>FU TxTx .....</b>	<b>29</b>
106	10.4.1	Principle of operation of the switching devices .....	29
107	10.4.2	Versions .....	30
108	<b>10.5</b>	<b>FU DKNx .....</b>	<b>30</b>
109	10.5.1	Principle of operation of the switching devices .....	30
110	10.5.2	Versions .....	30
111	10.5.3	Functionalities of the circuit-breaker .....	30
112	<b>10.6</b>	<b>FU DxTx .....</b>	<b>30</b>
113	10.6.1	Principle of operation of the switching devices .....	30
114	10.6.2	Versions .....	31
115	<b>11</b>	<b>INSTALLATION AND OPERATING INSTRUCTIONS .....</b>	<b>32</b>
116	<b>11.1</b>	<b>General .....</b>	<b>32</b>
117	<b>11.2</b>	<b>Installation .....</b>	<b>32</b>
118	<b>11.3</b>	<b>Operating instructions .....</b>	<b>32</b>
119	11.3.1	The essential requirements for dead working .....	32
120	11.3.2	Operating instructions .....	32
121			

## 122 1 Object and scope

123 This document defines the specific design and construction requirements for the functional units (FUs) of HV  
124 metal enclosed switchgear according to EN 62271-200, indented to be used in a Client installation to be  
125 connected to the public HV distribution grid of a Belgian Distribution System Operator (DSO).

## 126 2 General

127 The requirements described in this document deal with the following functional units (FUs):

- 128 • FU K intended to be connected to the distribution loop (KKNx)
- 129 • FU D or T for the general protection<sup>1</sup> (DxTx and TxTx)
- 130 • FU D for DSO feeder (DKNx)
- 131 • FUs R, K, T, DxTx and P, installed downstream the general protection and the HV billing metering
- 132 • FU M for HV billing metering (Mxxx)

133 The following chapters mention whether the requirements apply to all FUs or FUs in particular:

- 134 • Chapter 4 applies to all FUs used in substations accessible for operators of the DSO
- 135 • Chapter 5, 7, 8 and 10 lists the specific FUs for which the requirements apply
- 136 • Chapter 6 applies to the HV billing metering function
- 137 • Chapter 11 applies to all possible variants of FUs for which the homologation has been requested

138 This document shall be read in conjunction with Synergrid documents C2/112, C2/113-7 and C2/119.

## 139 3 References

140 The standards listed in Table 1 below are referenced in the present document.

NBN EN 62271-200 Ed.3 (2021) + Amd.1 (2024) <sup>2</sup>	High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
NBN EN 62271-1 Ed.2 (2017) + Amd.1 (2021)	High-voltage switchgear and controlgear - Part 1: Common specifications
NBN EN 62271-102 Ed.2 (2018) + Amd.1 (2022)	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
NBN EN 62271-213 Ed.1 (2021)	High-voltage switchgear and controlgear - Part 213: Voltage detecting and indicating system
NBN EN 61869-2 Ed.1 (2012)	Instrument transformers - Part 2: Additional requirements for current transformers
NBN EN 61869-3 Ed.1 (2011)	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
NBN EN 60073 Ed.6 (2002)	Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators
NBN EN 50110-1 Ed. (2023)	Operation of electrical installations
NBN EN 50181 Ed.2 (2010)	Plug-in bushings above 1 kV up to 36 kV and from 250 A to 1,25 kA for equipment other than liquid filled transformers
NBN HD 620 S3 (2023)	Distribution cables with extruded insulation for rated voltages from 3,6/6 (7,2) kV up to and including 20,8/36 (42) kV
DIN 6796 (2009-08)	Conical spring washers for bolted connections
IEC 60417 Ed.1 (2002)	Graphical symbols for use on equipment
ISO 7010: 2020 (Cor. 2020-08)	Graphical symbols - Safety colours and safety signs - Registered safety signs

141 **Table 1:** normative references

<sup>1</sup> Also refers to the protection of the unique distribution transformer in a Client installation

<sup>2</sup> Amendment 1 to be published, presently in CDV stage

## 142 **4 Man-machine interface**

### 143 **4.1 General**

144 The man-machine interface shall give a clear idea of:

- 145 • the way to operate the switchgear
- 146 • the status of the switching devices and other components of the FUs (e.g. circuit breaker springs
- 147 charged/discharged, HV fuse blown)
- 148 • ratings of the switchgear

149 for the operator who is in front of the switchgear.

150 It consists of:

- 151 • Control interfaces of switching devices
- 152 • Synoptic
  - 153 ○ HV single line diagram
  - 154 ○ Position/status indicators
- 155 • Rating plates

156 The man-machine interface is applicable to all functional units (FU) used in substations accessible for the  
157 operators of the DSO.

158 The man-machine interface should not require any text or guideline. If for any reason text or guideline  
159 appears on or in a switchgear, it shall at least be shown in Dutch and French.

### 160 **4.2 Basic rules**

161 The man-machine interface comprises:

- 162 • control areas including the interfaces for manual operation of the switching devices
- 163 • a single line diagram with integrated mechanical position indicators of the switching devices,  
164 connecting or interrupting the electrical circuit(s) in which the corresponding switching device is  
165 located. The position indicator of the (switch)disconnecter and earthing switch shall be reliable  
166 according to IEC 62271-102.

167 Its presentation shall be simple and logical. This ensures a clear, quick and reliable interpretation whilst  
168 standing in front of the FU. In order to achieve this requirement, the following basic rules must be set:

- 169 • The function of all operating interfaces is clearly indicated
- 170 • All operating interfaces are clearly linked to the corresponding position indicators showing the  
171 effect of operation
- 172 • Only the use of fully mechanical position/status indicators is allowed
- 173 • Unambiguous symbols shall be used
  - 174 ○ E.g. direction of rotation, lines, indications, ...
- 175 • Any line, text, symbol, ... which degrades the readability shall be omitted
- 176 • Lines and texts must be clearly visible by the operator, standing in front of the switchgear
- 177 • The use of colours and symbols shall be in accordance with the Belgian grid conventions explained  
178 in this document
- 179 • The man-machine interface is located at the front side on the FU
- 180 • The materials and fixation used ensure reliability of the man-machine interface during the entire  
181 lifetime of the switchgear.

### 182 **4.3 Composition**

183 A man-machine interface consists of lines, symbols that represent certain devices in the functional unit,  
184 position indicators for the switches, control elements integrated in colored area's and information regarding  
185 the FU.

### 186 **4.4 Lines**

#### 187 **4.4.1 General**

188 A synoptic diagram comprises generally 2 types of lines:

- 189 • lines representing the electrical circuits (single line diagram) : continuous lines
- 190 • lines representing a link between components, or between the control interface and position  
191 indicator if not adjacent to each other : thin dotted lines

#### 192 **4.4.1.1 Colour of the lines**

193 The colours of the lines used in the single line diagram are black over white background or white over black  
194 background. The colours red, yellow/green, yellow and/or green are forbidden.

195 4.4.1.2 *Background colour and contrast with the lines*

196 The lines themselves shall be clearly distinguishable.

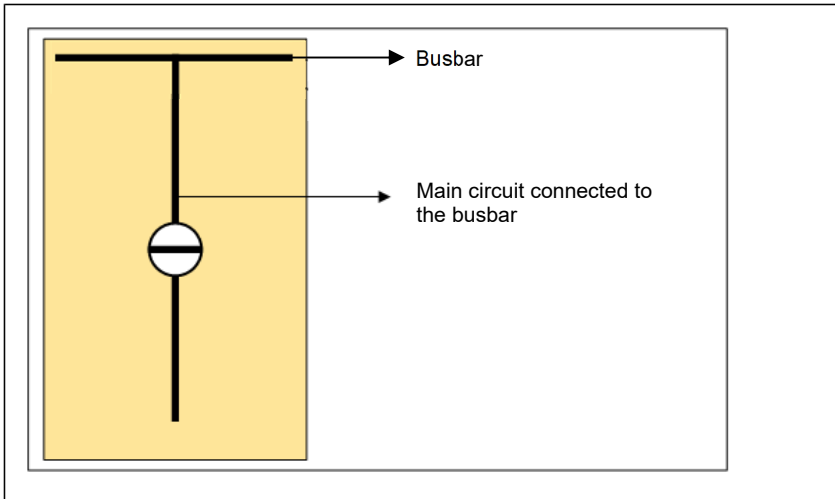
197 4.4.1.3 *Separation between FU*

198 The interruption of the busbar between adjacent FUs shall avoid any confusion.

199 4.4.2 *Representation of the main circuit*

200 The main circuit is represented by a continuous line representing its path.

201 Figure 1 shows an example of the main circuit of one FU



202

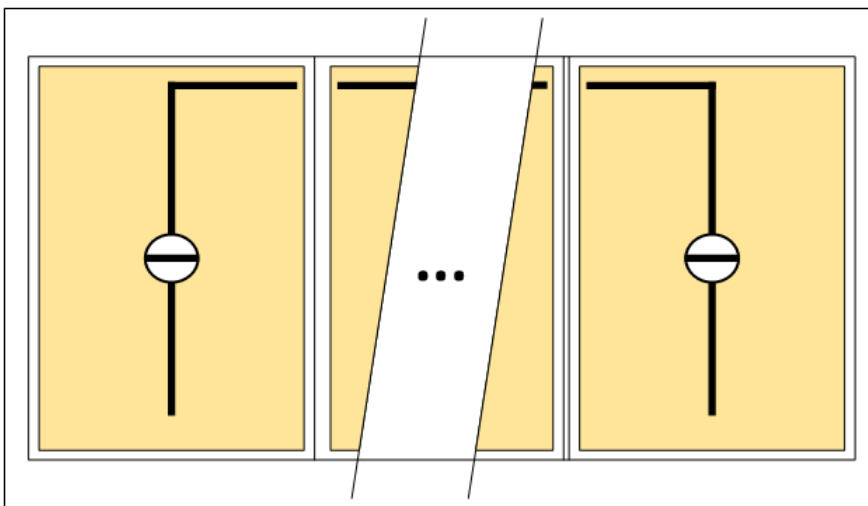
203 **Figure 1**

204

205 Any interruption in the main busbar or main circuit shall be as small as possible. It shall not exceed 50 mm

206 (see Figures 2 and 3 below) and shall not cause any confusion.

207 Figure 2 shows an example of a non-extensible switchgear

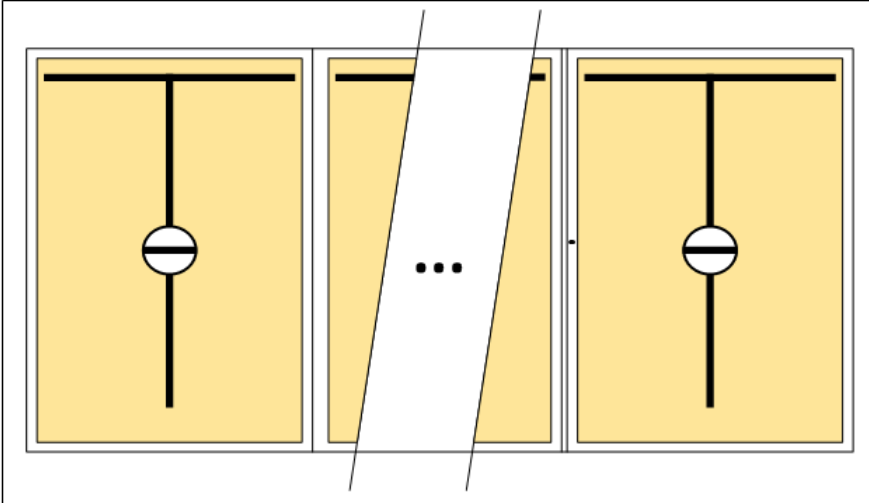


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209 **Figure 2**

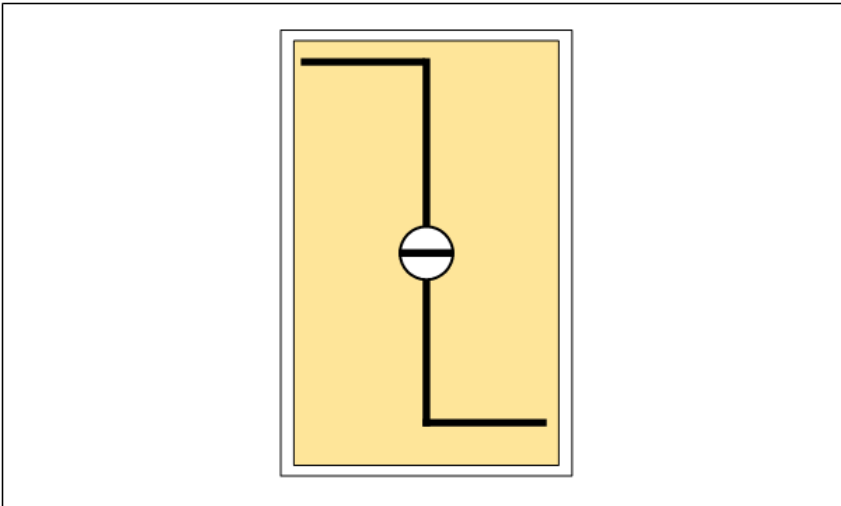
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211 Figure 3 shows an example of an extensible switchgear



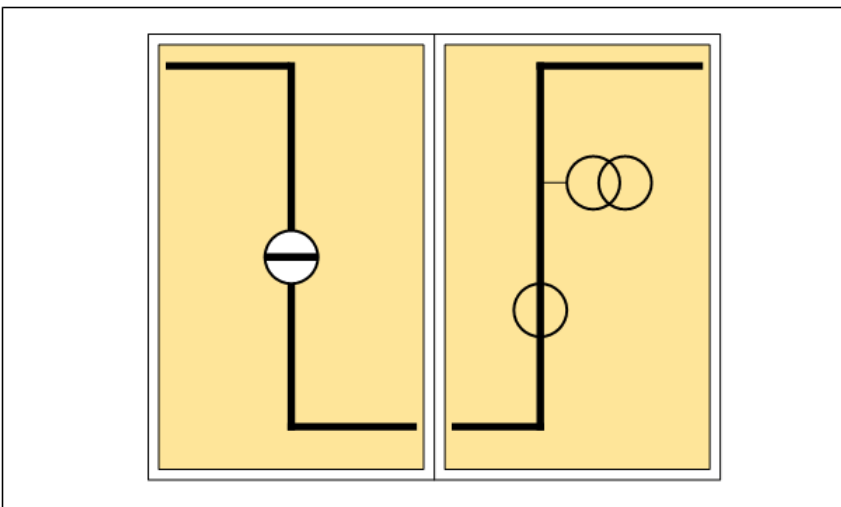
212  
213 **Figure 3**

214  
215 Figure 4 shows an example of the integration of a position indicator in the main circuit.



216  
217 **Figure 4**

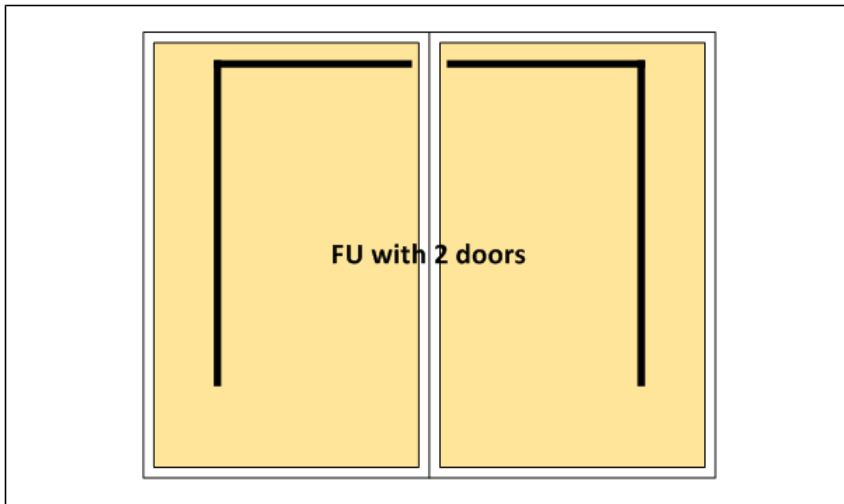
218  
219 Figure 5 shows an example of the integration of the symbols of the metering CT and VT of a billing  
220 metering FU M



221  
222 **Figure 5**  
223



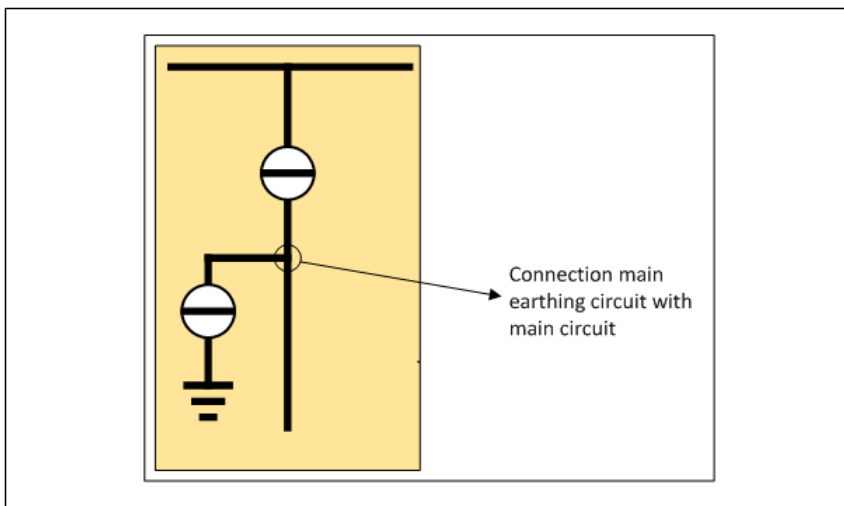
224 Figure 6 shows an example of one FU with 2 doors.



225  
226 **Figure 6**

227 **4.4.3 Representation of the main earthing circuit of the FU**

228 Figure 7 shows the representation of the earthing circuit.





229  
230 **Figure 7**

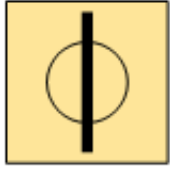
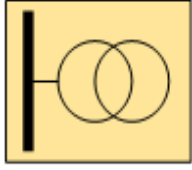
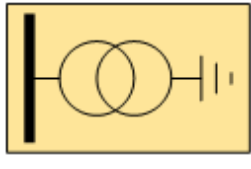
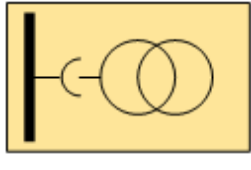
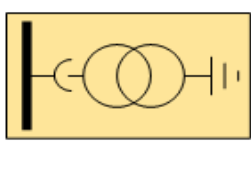
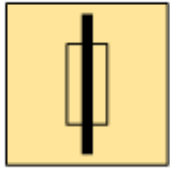
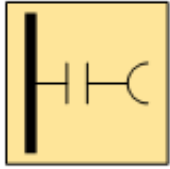

231 **4.5 Symbols**

232 **4.5.1 General**

234 The symbols of the components in or connected to the electrical circuits and the symbols of the switching devices are represented on the synoptic diagram. They have the same colour as the lines indicating the main circuit.

237 **4.5.2 Symbols for components of the synoptic diagram**

Terminal	If a FU can be connected with a HV cable, this feature is represented on the synoptic diagram. A cable connection is represented by an equilateral triangle, fully coloured and pointing downwards connected to the end point below the main circuit in derivation.	
Earthing	If a connection with the earth is displayed, withstanding the same short circuit current as the main circuit, the typical grounding symbol no. 5017 according to IEC 60417 in thick lines is used.	

Current transformer	The current transformer (CT) is represented by a single circle which represents the primary coil. The line of the main circuit runs through this circle. Remark: Only CT's with a metering winding are represented on metering panels. CT's with only a protection winding used together with circuit breakers are never represented.	
Voltage transformer (fixed)	The voltage transformer (VT) is represented by two circles that intersect each other. A thin line runs from the main circuit to the first circle, representing the primary coil. If the voltage transformer is connected between a phase and the earth, an earth symbol no 5017 according to IEC 60417 is connected to the second circle.	
Voltage transformers (pluggable)		
		
		
Fuse	The fuse is represented by a rectangle. Its outlines can be thinner than that of the synoptic main circuit. Remark: the centre of the fuse symbol can be used to indicate if one of the fuses is blown.	
VDIS (voltage detecting and indicating system)	The voltage indicators are represented by the symbol of a capacitor linked to the main circuit on one side and to a plug represented by a half circle on the other side. The symbol to be used is symbol no 5017 according to IEC 60417. It is located where the capacitive divider is connected to the main circuit in the single line diagram	
Arc mitigation system	The arc mitigation device is represented by the symbol in the right column. This symbol shall be visible on the front on a non-removable part of the enclosure.	
HV cable test plug	The high voltage cable test plugs are represented by the symbol in the right column	

238

**Table 2**

239


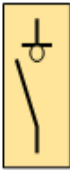


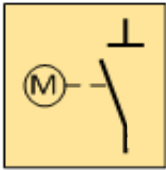
**4.5.3 Symbols for switching devices**

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242

Symbols for switching devices according to the standard IEC 60617 shall be printed in the control zone of the switching device in black on a white background. If the position indicator of a switching device is far from its control zone, the symbol shall be repeated next to the position indicator.

Switches	disconnector	
	switch-disconnector Remark: Only switching devices where the clearance between open contacts is designed to meet the functional requirements specified for disconnectors are allowed.	
	earthing switch	
	circuit breaker	
Motorisation	The symbol for the motorisation of a switch is an encircled letter M. This symbol is placed next to the symbol for the switch and is connected with it by a dashed line. The symbol of the switch is random in this example	

243 **Table 3**

244 **4.6 Indicators**

245 **4.6.1 Generalities**

246 The paragraphs hereafter describe 3 types of indicators:

- 247 • position indicators of the switching devices
- 248 • state indicators of components:
- 249 • status indicator to check dielectric withstand ability of the insulating medium in the gas-filled
- 250 compartment

251 **4.6.2 Location of the indicator**

252 The position indicators of the switching devices shall be integrated in the HV single line diagram. They shall  
 253 connect or interrupt the HV single line diagram representing the circuit, depending on the position of the  
 254 switching device as shown in Figures 1 to 5 and Figure 7.

255 **4.6.3 Colour and display**

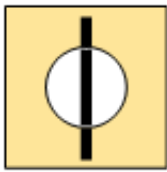
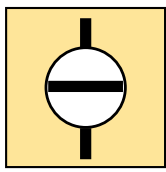
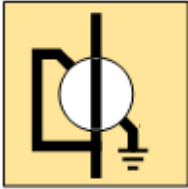
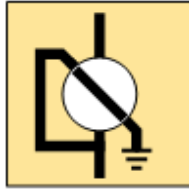
256 A similar colour shall be used as for the HV single line diagram.

257 The position indicator of a circuit-breaker shall be represented with a horizontal line for the open position and  
 258 a vertical line for the closed position. Hence, the single line crossing the position indicator of the circuit-  
 259 breaker shall be vertical. It is allowed to have a "O" instead of a horizontal line and a "I" instead of a vertical  
 260 line for the indication of the open respectively closed position of the circuit-breaker.

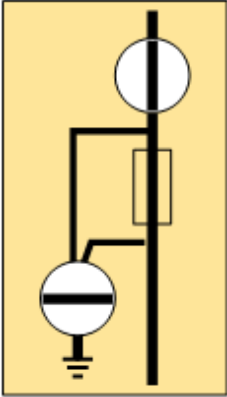
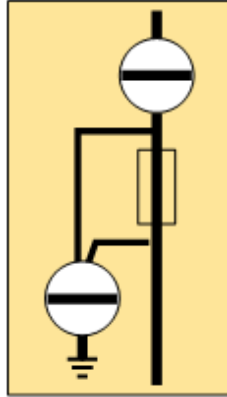
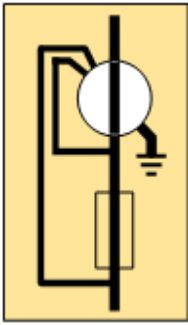
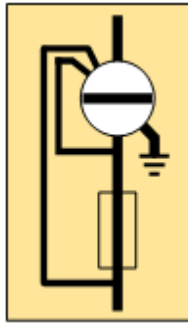
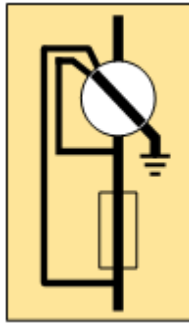
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262 4.6.4 Position indicators

263 The Tables 4 and 5 below show possible examples of position indicators

2 position switch for a disconnecter, a switch-disconnector and an earthing switch			
	Closed position	Open position	
3 position switch for a disconnecter or a switch-disconnector combined with an earthing switch			
	Closed position	Open position	Earthed position

264 **Table 4**

2 position switch for a switch-fuse combination with fuses and 2 earthing switches with one common position indicator			
	Closed position	Open position	Earthed position
3 position switch for switch-fuse combination with fuses and earthing switch and 1 supplementary earthing switch, integrated in one common position indicator			
	Closed position	Open position	Earthed position

265 **Table 5**

266 Table 6 shows the possibilities of position indication for a circuit breaker functional unit.

267

position indicator of the circuit breaker with a line	<ul style="list-style-type: none"> <li>• open position “-” (transverse line)</li> <li>• closed position “I” (in line)</li> </ul>	
position indicator of the circuit breaker with I & O	<ul style="list-style-type: none"> <li>• open position “O”</li> <li>• closed position “I”</li> </ul>	Colours: Red & Green can never be used on a position indicator

268 **Table 6**

269 A symbol "M" is placed near the position indicator of the motorised switching device (according to the  
 270 standard IEC 60617). A dashed line connects the symbol "M" to this indicator (see also last figure in Table  
 271 2 of the motorisation symbol).  
 272 If the motorisation is used to pre-accumulate latched energy as a preparatory action, the symbol "M" shall  
 273 not be used.

274 **4.6.5 Status indicators of components**

275 Basic rules:

- 276 • Circuit-breakers with fast auto-reclosing (DKNx) shall be equipped with a status indicator of the  
 277 energy storage in the spring (charged or discharged). This indicator shall be mechanical.
- 278 • FUs with arc mitigation system shall be equipped with a status indicator of this arc mitigation system.  
 279 This indicator can be either integrated in the pressure indicator, or mechanical. In any case, the  
 280 status of an activated arc suppression system can only be reset by a manual action.
- 281 • Switchgear/FUs with gas-filled compartment shall be equipped with a status indicator to check the  
 282 dielectric withstand ability of the insulating medium in the gas-filled compartment.

283 **4.6.5.1 Status indicator of the energy storage in a spring**

284 The spring status indicator shall consist of symbols corresponding to both possible charged and discharged  
 285 status. It shall be combined with a legend explaining both possible statuses.

286 Table 7 shows possible ways to display the status of the spring

	Spring discharged	Spring charged
Only one of the symbols is visible while the other is hidden		
both positions are displayed and an arrow indicates the status		

287 **Table 7**

288

289 **4.6.5.2 Status indicator of an arc mitigation system**

290 This indicator may not be integrated in the single line diagram. It shall be placed on a neutral place on the  
 291 man-machine interface, e.g. on the manometer, avoiding any confusion with the indicators needed for the  
 292 normal operations.

293 The arc mitigation system symbol shown in table 1 shall be placed next to the status indicator of this  
 294 system.

295 If needed for reasons of clarity, the status indicator of the arc mitigation system shall be combined with a  
 296 legend explaining all possible statuses.

297

298 **4.6.5.3 Status indicator to check the dielectric withstand ability of the insulating medium in the gas-filled  
 299 compartment**

300 The dielectric withstand ability of the insulating gas can be checked in service. The control device shall not  
 301 be influenced by ambient conditions (e.g. temperature).

302 The indicator is mandatory for FUs/switchgear with a gas-filled compartment. It shall be analogue and will  
 303 allow a local visual check without the need of any auxiliary supply.

304 This status indicator shall be combined with a legend explaining all possible statuses.

305 **4.7 Control zones and control buttons**

306 **4.7.1 General**

307 This section explains all the details concerning the control zones of the FU. The operating interfaces are  
308 located in well-defined control zones to aid the operator selecting the required controls.

309 **4.7.2 Control zone**

310 The operating interfaces shall be integrated in coloured control zones:



- 311 • red for:
  - 312 ○ disconnectors,
  - 313 ○ switch-disconnectors,
  - 314 ○ switch-fuse combination
  - 315 ○ circuit-breakers,
- 316 • yellow/green shaded for earthing-switches

317 **Note:** the interface to charge a spring and pre-accumulate energy that shall be latched is not considered as  
318 an operating interface and does not need to be integrated in a control zone. The same philosophy applies  
319 for all other switches that need more than one action to complete an operation.

320 **4.7.3 Content of the control zone**

321 A control zone includes:

- 322 • A small pad with the symbol of the controlled switching device as represented in Table 3 in black  
323 over white background.
- 324 • Pictograms O (open) and I (close) according to IEC 60417 (n°5007 & 5008) as visualized in table 7  
325 and in case of rotating action, arrows indicating the senses of rotation around the operating axis for  
326 the closing and opening operations.

closing		pictogram conforming to IEC 60417 (no. 5007)
opening		pictogram conforming to IEC 60417 (no. 5008)

327 **Table 8**

328 **4.7.4 Control buttons**

329 If two separate control buttons (mechanical activations) are used to open and close the switch, they both  
330 may be located in one single control zone. The pictograms "O" and "I" may be integrated onto the control  
331 buttons. The colour of the buttons and their pictograms are according to the standard NBN EN 60073 §  
332 5.2.1.4:

- 333 • the control button for the opening/disconnecting action has a black background with a white "O";
- 334 • the control button for the closing/connection action has a white background with a black "I".

335 It is also permitted to use the green (I) and red (O) colours.

336 In case of one unique button to trip/open a switch-fuse combination or a circuit-breaker of FU DxTx used as  
337 general protection, this button must be red, with the required contrast, according to the standard NBN EN  
338 60073, Table 9.

339 In any case, within a FU, one colour scheme shall be applied to avoid any possible confusion.

340 **4.7.5 Motorised/automatic control**

341 A local electrical operation of the motorisation is not allowed for FUs KKNx  
342

343 **4.8 Information (other indicators)**

344 **4.8.1 Name plate**

345 For modular cubicles, a name plate is applied for each cubicle. For RMUs, one name plate containing the  
346 general information may be provided per unit (block). Additionally, and per function, a name plate for the  
347 specific data of that function must be provided. The nameplate should contain all the information which  
348 must be specified according to the standard (in accordance with clause 5.10 of the standard NBN EN  
349 62271-200). The name plate must be incorporated in the man-machine interface.

350 In addition to this data, the name plate also states:

- 351 • The "AAxx" category according to the prescription C2/113-7
- 352 • The code according to C2/119 for every FU

- 353       • The Synergid homologation reference (see C2/113-0)  
354       • The applicable cable test voltage  $U_{c.t.}$  (d.c.)

355   4.8.2 Holder for feeder identification

356   The man-machine interface shall be fitted with an identification holder for every FU KKNx and DKNx.  
357   This holder shall have a transparent cover with minimum dimensions of HxL = 40x150 mm.  
358   This holder shall be located at the top of the FU or in an area near to the full triangle that represent the cables  
359   connection point.  
360   They shall be mounted on (a) cover(s) on the FU(s) that cannot be dismantled without tools to minimise the  
361   risk of being interchanged.

362   4.8.3 Service voltage range for the Voltage Detection and Indicating System (VDIS)

363   The service voltage range shall be indicated next to the VDIS interface.

364   4.8.4 Fault Current Indicator (FCI)

365   The FCI will be part of the man-machine interface. The cutout for the FCI shall therefore be placed on the  
366   front side of the switchgear.

367   The additional requirements for incorporating the FCI are described in §9.4 of this document.

368   The type of FCI used by the different DSOs is indicated in the DSO specific requirements, document C2/113-  
369   5.

## 370 **5 Voltage Detection and Indicating System (VDIS)**

371 Only integrated, capacitive VDIS according NBN EN 62271-213 are accepted.

372 The VDIS is mandatory for FU KKNx connected to the loop and FU DKNx.

373 The VDIS should be mounted horizontally and placed at the front, readable by the operator in front of the  
374 switchgear.

375 The VDS shall be mounted on a non-removable front cover in case it is flush-mounted.

376 The type of VDIS used by the different DSOs is indicated in the DSO specific requirements C2/113-5.

377 The same type of VDIS shall be used for the FU KKNx connected to the loop and FU DKNx in one same  
378 installation.



## 379 **6 Specific requirements for a HV billing metering function**

### 380 **6.1 General**

381 This chapter describes the specific requirements for a HV billing metering function with code Mxx according  
382 C2/119 intended to be used in a Client installation to be connected to the public HV distribution grid of a  
383 Belgian DSO.

384 The billing metering function and its current and voltage transformers shall also comply with the requirements  
385 specified in the Synergrid technical specification C2/113-3.

386 The billing metering function shall comprise 3 current transformers (CTs) and 3 voltage transformers (VTs).  
387 The VTs shall be connected between phase and earth. The billing metering FU shall be fully equipped by its  
388 manufacturer. This includes the mounting as well as the primary and secondary connections of the CTs and  
389 VTs.

390 The VTs shall be connected downstream of the CTs so that the burden of the VTs is included in the kWh  
391 measurement. The CTs and VTs connection scheme shall comply with the 3-Wattmeter method.

392 A HV billing metering FU shall not include HV switching device(s).

393 It is not allowed to install a protection against short-circuits through HV fuses on the primary side of VTs.

394 CTs and VTs with double primary and/or secondary windings are in principle not accepted, except if otherwise  
395 specified in the DSO specific requirements C2/113-5.

396 The billing metering function may be equipped with a second set of VTs if necessary. The second set of VTs  
397 shall only be used for voltage metering or for the connection of a network decoupling relay. The billing  
398 metering function with 2 sets of VTs shall also be subject to homologation.

399 Splitting up of the secondary VT circuit is in principle not accepted, except if otherwise specified in the  
400 complementary prescription C2/113-5 of some DSO's.

401 The manufacturer shall indicate with which types of CTs and VTs the functional unit is homologated.  
402 He shall deliver the CTs and VTs. They shall be installed in advance by the manufacturer.

403 The internal LV wiring and their connection up on the LV terminals is done by the manufacturer. The  
404 manufacturer bears the responsibility for the correct LV wiring of the instrument transformers. The LV wiring  
405 shall be checked according subclause 7.10.5 of NBN EN 62271-1 and this check shall be reported in a routine  
406 test report.

### 407 **6.2 Design and construction**

#### 408 **6.2.1 General aspects**

409 The billing metering function shall comprise at least two (2) compartments:

- 410 • an ambient air insulated HV metering compartment
- 411 • a LV compartment

412 The HV metering compartment shall have one (or more) front door(s) or (a) removable front cover(s). This  
413 compartment shall have tool based access, regardless of the aforementioned design.

414 The LV compartment shall have a front door or a removable front cover.

415 The sole possible access to the HV and LV compartments shall be through their front door(s) or cover(s).

416 The front door(s) or cover(s) of both the HV and the LV compartments shall be independently fitted with a  
417 padlock facility. Provision of a sealable bolt instead of a padlock facility is not acceptable.

418 It shall not be possible to remove parts of the enclosure from the outside for both LV and HV compartments  
419 without opening the respective front door(s) or front cover(s) of this (these) compartment(s).

420 The HV metering compartment comprises :

- 421 • 3 CTs and 3 VTs
- 422 • The primary connexions to adjacent (up- and downstream) installed functional units
- 423 • A bottom plate equipped with cable sealings for cable entrance and cable clamps in case the billing  
424 metering function is connected by means of incoming and/or outgoing MV power cables
- 425 • One spherical earthing point with diameter 20mm on each phase, installed downstream of the VTs  
426 in such a way that a removable earthing (20kA-1s) can be connected to this earthing point

427 The CTs and VTs shall in any circumstances be accessible.

428 A fourth spherical earthing point (with diameter 20mm), connected to the earthing circuit, shall be placed in  
429 principle on the outside of the enclosure. In case the fourth spherical point is placed inside the HV metering  
430 compartment, closing of the door(s) or placement of the front cover(s) shall be prevented as long as the  
431 removable earthing is connected to the metering function. It is acceptable to equip a HV metering function of  
432 category AA10 with three spherical earthing points that are connected to the earthing circuit instead of one  
433 single (fourth) spherical earthing point.

434 The LV compartment comprises:

- 435 • A LV terminal block for the secondary CT circuits
- 436 • A 4-pole fuse-switch for the secondary VT circuits.
- 437 • 2 cable glands/grommets allowing LV cables outlet out of the metering FU; routing through the LV  
438 compartments of the adjacent FUs or through the HV compartment of the metering function is not  
439 allowed.

440 The LV terminal block for the secondary CT circuits shall be non-interruptible and equipped with:

- 441 • Short-circuit facility for which both short-circuited and opened position shall be clearly visible
- 442 • A test plug of 4 mm diameter on each phase and neutral terminal

443 The 4-pole fuse-switch for the secondary VT circuits shall be equipped with:

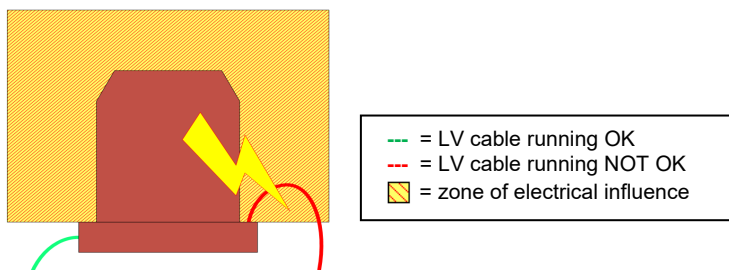
- 444 • Either a LV fuse with rating 0,5 A or a cylindrical link (conductor) for each phase, depending on the  
445 DSO specific requirements mentioned in document C2/113-5
- 446 • A switchable neutral containing a cylindrical link (conductor)

447 The LV wiring from the secondary terminals of the CTs and VTs to the LV compartment shall be done by  
448 means of 2 separate uninterrupted<sup>3</sup> cables type LIYY or LiHH:

- 449 • LIYY or LiHH 6 x 2,5mm<sup>2</sup> for the secondary CT circuits, directly connected to the LV terminal block
- 450 • LIYY or LiHH 4 x 2,5mm<sup>2</sup> for the secondary VT circuits, directly connected to the 4 pole fuse-switch

451 The LV wiring from the secondary terminals of the CTs and VTs to the LV compartment shall ensure double  
452 insulation. It shall be mechanically protected in the HV metering compartment.

453 The LV cables must be connected and routed in such a way that they are running outside the zone of  
454 electrical influence of the CTs and VTs and that they do not hinder the intervention when the HV compartment  
455 is opened.  
456



457 **Figure 8:** zone of electrical influence of CTs and VTs  
458

459 In order to ensure proof against fraud on the LV wiring of the CTs and VTs:

- 460 • If present, the busbar connections between the HV metering compartment in the metering FU and  
461 the adjacent HV compartments in the metering FU or in the adjacent FUs shall run through busbar  
462 bushings in IP2X segregation plates.
- 463 • If present, the cables connections between the HV metering compartment in the metering FU and  
464 the adjacent HV compartments in the metering FU or in the adjacent FUs or the cellar shall pass  
465 through IP2X partitions

#### 466 6.2.2 CT mounting and wiring of secondary CT circuits

467 The CTs are mounted on an earthed base plate which is part of the metering function.

468 The visual earthing of the metallic base plate of the CTs shall be done by connecting the base plate to the  
469 main earthing bar through a green-yellow wire or a bare copper conductor with yellow/green marking. The  
470 minimum cross section of this conductor shall be 6mm<sup>2</sup>.

471 The secondary terminal "s2" shall be visually earthed. Hence, the use of an earthing screw on the "s2"  
472 terminal is not acceptable. The earthing shall be done by means of a green-yellow wire or a bare copper  
473 conductor with yellow/green marking which shall be connected to the earthing terminal of the metallic base

<sup>3</sup> The use of connectors is not allowed

474 plate (chassis) of the CT or directly to the earth collector: see Figures 9 and 10 in §6.2.5. The cross section  
475 shall be 2,5mm<sup>2</sup> if the earthing conductor is mechanically protected or 4mm<sup>2</sup> if this conductor is not  
476 mechanically protected.

477 The colour code of the wiring from the secondary terminals of the CT to the LV terminal block in the LV  
478 compartment is according the standardized colour scheme of a 6 cores LIYY or LiHH cable:

- 479 • Phase L1: Brown / Brown-Black
- 480 • Phase L2: Grey / Grey-Black
- 481 • Phase L3: Red / Red-Black

482 The coloured LV wires of the LIYY or LiHH cable shall be connected to the secondary terminals of the CTs  
483 according to the schematic diagram in Figures 9 and 10 in §6.2.5. For the CTs, the unicolor wires are  
484 connected to the terminal “s1” and the two-tones wires are connected to the terminal “s2”.

485 Each core of the 6 cores LIYY or LiHH cable shall have a cross section of 2,5mm<sup>2</sup>.

486 Mounting and wiring of the CTs shall be such that primary and secondary connections can be easily checked,  
487 i.e. the connections shall be accessible and readable.

#### 488 6.2.3 VT mounting and wiring of secondary VT circuits

489 The VTs are mounted on an earthed base plate part of the metering function.

490 The visual earthing of the metallic base plate of the VTs shall be done by connecting the base plate to the  
491 main earthing bar through a green-yellow wire or a bare copper conductor with yellow/green marking. The  
492 minimum cross section of this conductor shall be 6mm<sup>2</sup>.

493 The terminals “n” and “N” shall be visually earthed. Hence, the use of an earthing screw for terminals “n” and  
494 “N” is not acceptable. The earthing shall be done by means of a green-yellow wire or a bare copper conductor  
495 with yellow/green marking which shall be connected to the earthing terminal of the metallic base plate of the  
496 VT or directly to the earth collector: see Figures 9 and 10 in §6.2.5. The cross section shall be 2,5mm<sup>2</sup> if the  
497 earthing conductor is mechanically protected or 4mm<sup>2</sup> if this conductor is not mechanically protected.

498 The colour code of the wiring from the secondary terminals of the VT to the LV terminal block in the LV  
499 compartment is according the standardized colour scheme of a 4 cores LIYY or LiHH cable:

- 500 • Phase L1: Brown
- 501 • Phase L2: Grey
- 502 • Phase L3: Red
- 503 • Neutral “n”: Blue

504 The coloured LV wires of the LIYY or LiHH cable shall be connected to the secondary terminals of the VTs  
505 according to the schematic diagram represented in Figures 9 and 10 in §6.2.5.

506 Each core of the 4 cores LIYY or LiHH cable shall have a cross section of 2,5mm<sup>2</sup>.

507 The wiring of the secondary star-point of the VTs, i.e. interconnecting the “n”- terminal of the 3 VTs, shall be  
508 done by means of a blue coloured wire with cross section 2,5mm<sup>2</sup>.

509 Mounting and wiring of the VTs shall be such that primary and secondary connections can be easily checked,  
510 i.e. the connections shall be accessible and readable.

#### 511 6.2.4 Nameplates and markings

512 The nameplate of the metering function shall contain the information specified in subclause 6.11 of NBN EN  
513 62271-200. In addition, the following data shall be mentioned on the name plate:

- 514 - Synergrid category AAxx according to C2/113-7
- 515 - Internal arc classification IAC (if assigned):
  - 516 ○ Arc fault current and duration IA, tA for category AA3x
  - 517 ○ Single-phase-to-earth arc fault current and duration IAe, tAe for category AA10
- 518 - Code Mxx according to C2/119

519 The nameplate of the CT shall contain the information specified in subclause 6.13.202 of NBN EN 61869-2.

520 The nameplate of the VT shall contain the information specified in subclause 6.13.302 of NBN EN 61869-3.

521 A second nameplate (duplicate) of the VTs and CTs shall be placed on a location accessible by the DSO,  
522 preferably on the outside of the front door (or cover) of the LV compartment or HV metering compartment. It  
523 shall be possible for the DSO to check the nameplate on the CTs and VTs with the duplicate during  
524 commissioning.

525 For billing metering functions with code MKK, a connection diagram illustrating the physical layout of the  
526 connections at the primary terminals of the CTs and VTs in the HV metering compartment shall be

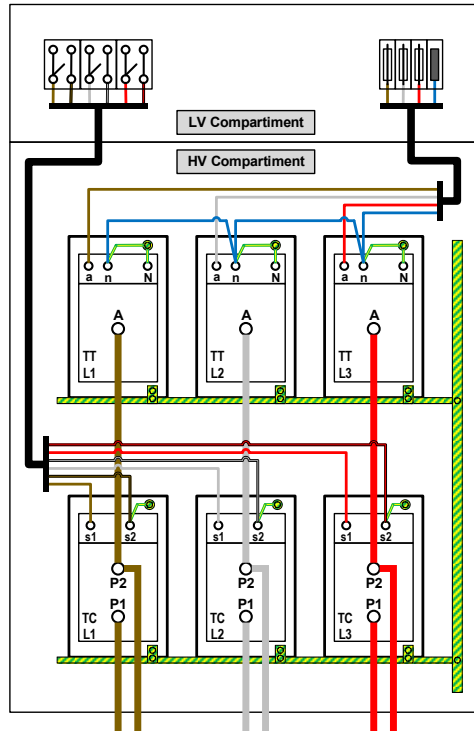
527 represented on an adhesive label or plasticised paper, stuck in a visible place at the inside of the HV metering  
 528 compartment front door or cover.

529 The wiring diagrams of the complete secondary CTs and VTs circuits shall be present in the LV compartment.

530 A phase indication L1 – L2 – L3 shall be present in the HV metering compartment.

531 **6.2.5 Schematic diagrams**

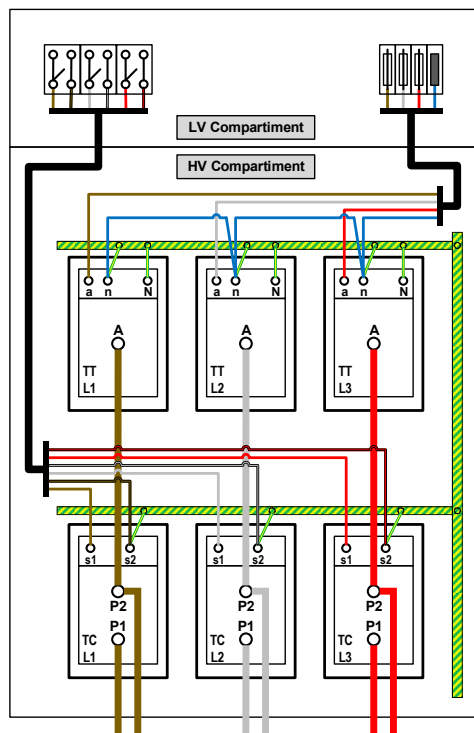
532 The schematic diagrams are illustrated in Figures 9 and 10 below.



**Figure 9:**

533 terminals “n” and “N” (VTs) & “s2” (CTs) connected to the earthing terminal of VTs resp. CTs metallic base plate

533  
 534  
 535  
 536



**Figure 10:**

537 terminals “n” and “N” (VTs) & “s2” (CTs) directly connected to the earthing collector

537  
 538  
 539

## 540 7 Practical requirements for cable connections

### 541 7.1 General

542 This chapter describes the practical requirements in relation to the connection of cables in the cable  
543 compartment of FU KKNx and FU DKNx. A difference is made between HV switchgear of categories  
544 AA1x/AA20 and switchgear categories of AA3x.

545 The following requirements apply in general for all HV switchgear regardless the assigned AAxx category(-  
546 ies):

- 547 • All cables connected to functional units are single-phase high voltage cables.
- 548 • The HV cables for connection to a distribution grid range from 150 mm<sup>2</sup> to 240 mm<sup>2</sup>. All HV cables  
549 are in accordance with NBN HD 620. If connection with 400 mm<sup>2</sup> is necessary, the requirements are  
550 indicated in the DSO specific requirements C2/113-5.

### 551 7.2 HV switchgear of category AA1x/AA20

552 The interface for cable connection shall be outer cone type C in accordance with NBN EN 50181, size C1  
553 cones (I<sub>r</sub> = 630A).

554 They shall be horizontal and frontally arranged.

555 For FU KKNx, the minimum required height for the connectors in the cable compartment is 305 mm,  
556 measured between the centre of the outer cone and the top of the cable fixation clamp as shown on the right  
557 in Figure 12 below.

558 For FU DKNx, the minimum required height for the connectors in the cable compartment is 375 mm,  
559 measured between the centre of the outer cone and the top of the current transformers (CTs) if mounted  
560 around the cables above the cable clamps as shown in Figure 13 below.

561 For FU KKNx, the height of the interface for the cable connection measured between floor of the switchgear  
562 and the centre of the outer cone, shall be at least 800 mm. If this height is < 800 mm, the switchgear  
563 manufacturer shall provide an appropriate raising base frame to reach this height between the floor of the  
564 switchgear room and the centre of the outer cone after installation.

565 The cable compartment of FUs KKNx and DKNx shall contain:

- 566 • cable fixation clamps covering the aforementioned range of the cables.

567 The cable clamps are positioned inside the functional unit, and are part of the switchgear.

568 The cable clamps shall be accessible from the opened cable compartment and can be mounted  
569 easily on the connected cables, using the prescribed tools.

- 570 • An earthing circuit with at least one earthing M8 connection point per phase for the connection of the  
571 cable shield and/or the earthing wire of the HV-connector.

572 The connection points shall be positioned as such that they are accessible from the opened cable  
573 compartment with the cables mounted.

- 574 • For FU KKNx, the space to mount the current sensors of fault current indicators (FCI) which shall be:
  - 575 ○ present on every phase.
  - 576 ○ either on the bushings or on the cables.

577 If current sensors are mounted on the cable, these can be either mounted above or below  
578 the cable clamps. In any case, they shall always be mounted above the bottom plate of the  
579 switchgear, if present.

- 580 • When mounted above the cable clamps, the required space mentioned above shall  
581 be 355 mm as shown on the left in Figure 12 below.

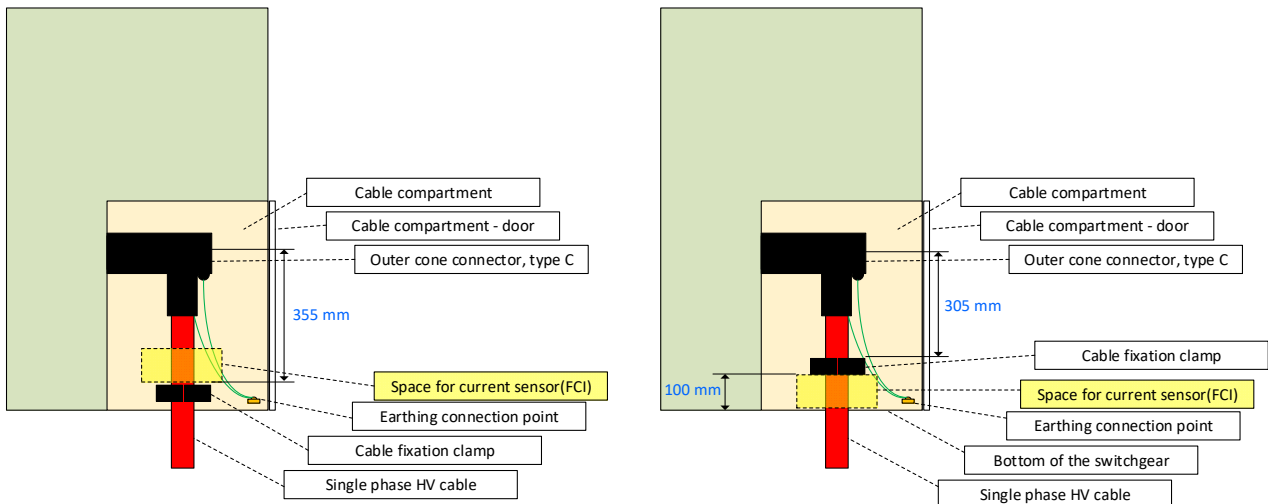
- 582 • When mounted between the cable clamp and the bottom, the required space  
583 between the bottom and the lowest point of the cable clamp is 100 mm. In this case,  
584 the material of the cable clamp shall be insulating.

585 The current sensors shall be easily mountable with opened/removed cable compartment  
586 door/cover, with the other cables and sensors already mounted.

587 • For FU DKNx, the space to mount the current transformers (CTs) of the overcurrent protection  
588 relay.

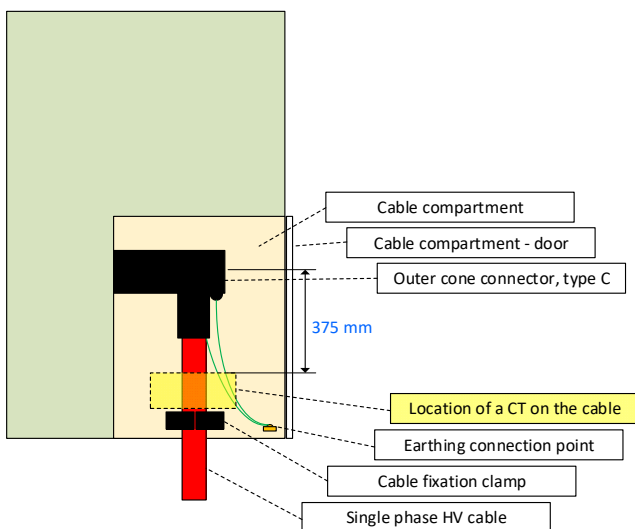
589 If the cable compartment is fitted with bottom plates, then it shall fulfil the following requirements:

- 590 • It shall consist of different removable parts allowing efficient connection of the cables.  
591 • These bottom plates shall seal the cable compartment after mounting the cables.  
592 • The holes for the cables entries in the bottom plate shall be aligned with the vertical part of the elbow  
593 connectors and contain as many cable entries as there are cable clamps. All unused cable entries  
594 (spares) shall be closed.



595

596 **Figure 12:** arrangements of the cable compartment for FU KKNx of categories AA1x/AA20



597

598 **Figure 13:** arrangements of the cable compartment for FU DKNx of categories AA1x/AA20

### 599 **7.3 HV switchgear of category AA3x**

600 All cables are terminated with cable terminations with cable lug, using fixed bolt or stud size M12, minimum  
601 length 35 mm. They shall be delivered with a conical spring washer according to DIN 6796, plain washers  
602 and a nut.

603 Only one cable lug shall be mounted per connection flag. The connection area on the terminal flag shall  
604 cover the entire connection area of the cable lug, without compromising the isolating distance of the cable  
605 termination.

606 The arrangement of the cables connection flags and the available space around them shall allow the  
607 connection of the HV cables by one person.

608 The FUs KKNx intended to be connected to the distribution loop shall have a minimum width of 500 mm.

609 The minimum required space for these cable terminations in the cable compartment is 355 mm, measured  
610 between the centre of the hole in the connection surface and the top of the cable fixation clamp as shown on  
611 the right in Figure 14 below.

612 The cable compartment of FUs KKNx and DKNx shall contain:

- 613 • cable fixation clamps, covering the aforementioned range of the cables.

614 The cable clamps are positioned inside the functional unit, and are part of the switchgear.

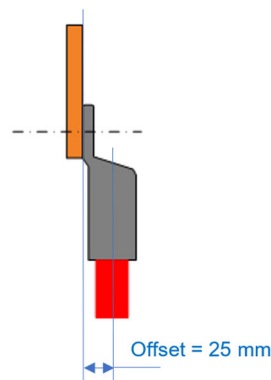
615 The cable clamps shall be accessible from the opened cable compartment and mounted easily on  
616 the connected cables, using the prescribed tools.

- 617 • A bottom plate, consisting of different removable parts enabling efficient connection of the cables.

618 These bottom plates shall seal the cable compartment after mounting the cables.

619 The bottom plate shall contain as many cable entries as there are cable clamps. All unused cable  
620 entries (spares) shall be closed.

621 The bottom plates and the cable fixation clamps are designed in order to allow easy connection of  
622 HV cables with cross-section varying from 150 mm<sup>2</sup> to 400 mm<sup>2</sup> equipped with cable connection  
623 lug with an offset equal to 25 mm as shown in Figure 13 below.



624

625 **Figure 13:** cable connection lug with an offset equal to 25 mm

- 626 • An earthing circuit with at least one earthing M8 connection point per phase for the connection of  
627 the cable shield.

628 The connection points shall be positioned as such that they are accessible from the opened cable  
629 compartment with the cables mounted and no extension of the cable screen or earthing wire is  
630 necessary.

- 631 • A connection point on each phase (e.g. a temporary spherical bolt or a threaded stud) for  
632 connecting the cable testing equipment.

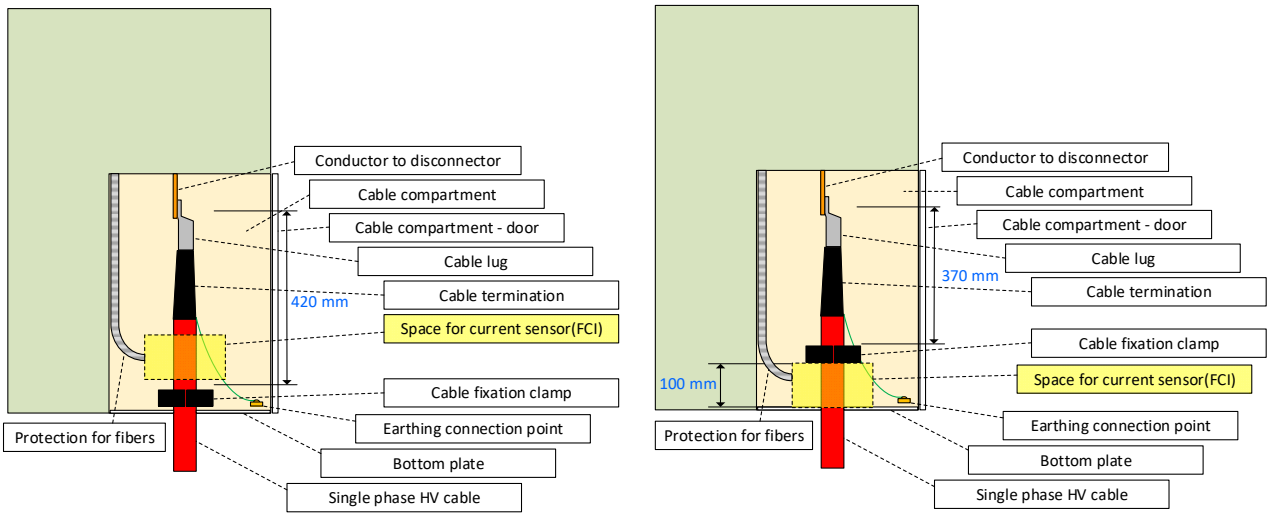
- 633 • For FU KxN, the space to mount the current sensors of fault current indicators (FCI) shall be:

- 634 ○ present on every phase.
- 635 ○ on the cables below the cable termination

636 The current sensor can be either mounted above or below the cable clamps but always  
637 above the bottom plate of the switchgear:

- 638 ■ When mounted above the cable clamps, the required space mentioned above shall  
639 be 405 mm as shown on the left in Figure 14 below.
- 640 ■ When mounted between the cable clamp and the bottom plate, the required space  
641 between the bottom plate and the lowest point of the cable clamp is 100 mm. In this  
642 case, the material of the cable clamp shall be insulating.

643 The current sensors shall be easily mountable from the opened cable compartment door,  
644 with the other cables and sensors already mounted.




645  
646 **Figure 14** : arrangements of the cable compartment for FU KKNx of category AA3x



## 647 8 Accessibility to compartments, LSC category & interlocks

### 648 8.1 Accessibility to compartments

649 Every non-interlocked door, cover or partition, removable from its accessible side, and giving access to  
650 hazardous HV live parts, shall be fitted with the symbol ISO 7010 code W012. 

651 The following accessibility requirements apply to FUs KKNx intended to be connected to the loop, to DKNx  
652 and to FUs M:

- 654 • FUs KKNx & DKNx:
  - 655 • Cables compartment : interlock-based access
  - 656 • Test plug compartment (if present): interlock-based access
  - 657 • Other HV compartments  
658 (busbar – (switch)-disconnecter – circuit-breaker - other than cables compartment)
    - 659 ○ sealed for life : inaccessible
    - 660 ○ ambient air insulated : tool-based access
  - 661 • Low voltage compartment:
    - 662 ○ DKNx : door with handle (without key lock)
- 663 • FU M:
  - 664 • HV metering compartment and LV compartment :
    - 665 ○ Front side : padlockable
    - 666 ○ Other side : not dismantlable from outside

### 667 8.2 LSC category

668 The following minimum loss of service continuity (LSC) categories are required for every FU in function of  
669 the type of FU :

- 670 • FUs KKNx, DKNx, DKTx, TKTx :LSC2
- 671 • FU M : LSC1

### 672 8.3 Interlocks

#### 673 8.3.1 Scope

674 The following interlock requirements apply to:

- 675 • FUs KKNx intended to be connected to the loop and DKNx
- 676 • FUs DxTx and TKTx used as general protection
- 677 • FUs DKTx and TKTx used as dedicated feeder protection.

#### 678 8.3.2 General principles

679 The switching devices and the doors/covers of interlock-accessible compartments in the same functional  
680 unit shall be automatically interlocked in order to avoid any operation endangering:

- 681 • the safety of DSO's personal
- 682 • the service continuity.

683 Interlocks shall prevent:

- 684 • to operate a switching device in unsafe condition(s) of the switchgear
- 685 • to remotely operate a switching device in abnormal condition(s) of the switchgear (e.g. pressure  
686 below  $p_{me}$ , operation of arc suppressor, ...)
- 687 • to operate a disconnecter under load
- 688 • to perform manual and motorized operation simultaneously that lead to harmful consequences
- 689 • to earth a part of a main circuit as long as it is not disconnected
- 690 • to connect an earthed part of the main circuit to the busbar
- 691 • to reconnect an accessible main circuit to the busbar.
- 692 • to open/remove or reclose/reset the interlocked door/cover of a high voltage interlock-accessible  
693 compartment if not all HV circuits to which this door/cover provides access are earthed.

694 For FUs type KKNx to be connected to the loop and DKNx, the design shall allow to reopen the earthing-  
695 switch when the door/cover of the cables or test-plug compartment is open/removed. If a special action is to  
696 be carried out, this must be clearly and explicitly indicated in the vicinity of the intervention point.

697 For FUs DxNx and DxTx used as general protection in which the circuit-breaker is part of the earthing of  
698 the circuit downstream this FU.

699 For FU type DKN8, an interlock shall prevent to close and open the earthing switch when the circuit breaker  
700 is closed.

### 701 8.3.3 Criteria

#### 702 In general:

- 703 • the interlocks may not be disabled by the use of both hands of one operator nor by the use of an  
704 accessory for normal operating activities<sup>4</sup>.
- 705 • An attempt to operate a switching-device blocked by an interlock cannot change the status of the  
706 switching-device; to allow its operation, the locking condition must disappear and a new attempt of  
707 operation must be made.
- 708 • An interlock must remain effective until the completion of the operation that releases it.

#### 709 Interlocks of manual operations:

711 The interlocks of the manual operations shall be mechanical, i.e. they shall not use electrical components  
712 and shall be operational independent of any external energy source.  
713 Key interlocks are not allowed.

714 Electrical interlocks of manual operations (blocking magnets) are not allowed, except for interlocks of manual  
715 operations in one FU depending on conditions in another FU.

716 Electrical interlocks shall lock in absence of auxiliary supply. Blocking magnets shall not be permanently  
717 supplied.

#### 718 Interlocks of electrical operations:

720 The interlocks of electrical operations (remote-controlled operations or local electrical operations) shall be  
721 realized with hardware electrical contacts and wiring.

## 722 8.4 Locking facilities

### 723 8.4.1 Definition

724 Locking facility is a device that disables an operation by placing a padlock or a multi-lock on the operating  
725 interface.

### 726 8.4.2 Scope

- 727 • The HV switching device of every FU ensuring the isolating distance in open position shall be  
728 padlockable in this position. Therefore, both the interface for the manual closing operation and the  
729 motor switch (where present) in disabled position shall be fitted with a locking facility.
- 730 • In addition:
  - 731 ○ The switch-disconnectors of the FUs KKNx connected to the loop shall be padlockable in  
732 the closed and open positions. Therefore, the interface(s) for both manual closing and  
733 opening operations and the motor switch (where present) in both enabled and disabled  
734 positions shall be fitted with a locking facility.
  - 735 ○ The earthing-switch of the FUs KKNx connected to the loop shall be padlockable in both the  
736 open and closed positions.
  - 737 ○ The earthing-switch of the FU DKNx shall be padlockable in the closed position. In case of  
738 a FU DKNx for which the CB is part of the earthing circuit, the CB shall be padlockable in its  
739 closed position.
  - 740 ○ The access to the HV and LV compartments of a billing metering functional unit (FU M) shall  
741 be fitted with a locking facility.

### 742 8.4.3 Criteria

743 The shape, the section and the arrangement of the hole to host the locking device shall allow both:

- 744 • the introduction of a padlock with a handle with a diameter of 8 mm and a radius of curvature of 16  
745 mm
- 746 • the introduction of a multi-lock with an external radius of curvature of 40 mm

---

<sup>4</sup> normal operations include: switching operations, HV fuse replacement, cable testing, phase comparison

## 747 **9 Miscellaneous and additional requirements**

### 748 **9.1 Arc suppression device**

749 If the arc suppressor is a specific device different than the earthing-switch of the FU:

- 750 • it shall be armed in factory by the switchgear manufacturer before delivery
- 751 • it shall not be possible to rearm it

752 If the arc suppressor is the earthing-switch of the FU, it shall be ready to operate as soon as the earthing  
753 switch is opened.

### 754 **9.2 Indicating system for the dielectric withstand ability of the insulating gas for** 755 **switchgear with gas insulated switching devices**

756 Each gas insulated compartment shall be fitted with an appropriate indicator to check the ability of the  
757 insulating gas to ensure the dielectric withstand.

758 This device shall not be influenced by the ambient conditions.

759 This requirement applies to all FUs.

760 For each motorized switch-disconnector, the contact(s) of the indicator will change position in case of loss of  
761 the dielectric withstand ability of the insulating gas:

- 762 • Normally open (NO) contact(s) for locking the electrical opening and closing operations
- 763 • There shall be one normally closed (NC) contact signaling the loss of the dielectric withstand ability  
764 of the insulating gas
- 765 • In case the indicator is not able to drive more than one contact, this contact shall comply to point 1.  
766 The use of a relay for duplication of this contact is allowed. This relay shall always have at least 2  
767 changeover contacts respecting the functionality of the 1<sup>st</sup> and 2<sup>nd</sup> bullet above.

#### 768 NOTE:

- 769 ▪ Normally open (NO) contact: a contact that shall be open in its normal (non-actuated) position and this  
770 normal position shall correspond to "loss of the dielectric withstand ability of the insulating gas"
- 771 ▪ Normally closed (NC) contact: a contact that shall be closed in its normal (non-actuated) position and  
772 this normal position shall correspond to "loss of the dielectric withstand ability of the insulating gas"

773 The indicator shall be analogue. The local visual check shall be possible without the need of an auxiliary  
774 voltage supply. The indicator shall be replaceable without the need to de-energize the busbar.

### 775 **9.3 Earthing arrangements**

776 Each HV switchgear assembly is provided with a general earthing conductor. This earthing conductor may  
777 be composed of the metal enclosure of the several FUs connected to each other or of an uninsulated copper  
778 bar. The earthing conductor must be able to withstand a permissible short-time current of 2 kA for 1 sec  
779 without degradation of its functionality. The earthing conductor (copper bar or enclosure) features a hole for  
780 a 12 mm diameter bolt to be connected with the earthing system of the HV-installation. The connection point  
781 is indicated with the symbol 5019 of IEC 60417 typically for earthing indication.

782 This main earthing conductor ensures for each FU the connection to (non-exhaustive list):

- 783 • the metal enclosure (if a copper conductor is used)
- 784 • the star point of the earthing switch
- 785 • the screen of the HV cables and the equipotential wire of the conductive outer surface of the  
786 screened HV cable terminals
- 787 • the LV earthing connection terminals of the capacitive voltage dividers
- 788 • the conductive housing of the fault current detectors if applicable
- 789 • the earthing terminal of the instrument transformers if applicable
- 790 • one terminal for each secondary winding of the CT's if applicable
- 791 • the N terminal of the VT's between phase and earth if applicable
- 792 • the n terminal(s) of the VT's between phase and earth if applicable
- 793 • the main earthing terminal in the LV compartment
- 794 • all exposed conductive parts of LV auxiliaries

795  
796 It is assumed that the bolt connections between fixed panels, the bolted connections for covers and the  
797 hinges of doors ensure a sufficient electrical continuity between these metal enclosures. Metallic parts of the  
798 enclosures shall be designed to carry 30 A DC with a voltage drop of maximum 3 V to the earthing point  
799 provided.

800 The N terminal of VT's as well as his corresponding n terminal(s) and one of the secondary terminals of a  
801 CT are connected with the main earthing conductor by an as short as possible yellow/green marked copper  
802 conductor with adequate diameter<sup>5</sup>.

## 803 **9.4 Raising base frames**

### 804 **9.4.1 Raising base frame type AA1x-R and AA20-R**

805 Raising baseframes associated to AA1x or AA20 switchgear shall be used:

- 806 • to improve the ergonomics for the execution of the cable plugs in case the height of the cable  
807 connection in the FU KKNx with reference to the floor of the switchgear is less than 800 mm in order  
808 to reach this minimum height of 800 mm
- 809 • or to allow respecting the 600 mm bending radius of the HV cables in case the height of the cable  
810 cellar is not sufficient.

811 The maximum height for raising base frames type AA1x-R and AA20-R is limited to 600 mm.

812 Raising base frames type AA15-R can be assembled together with energy absorbing base-frames type  
813 AA15-A.

### 814 **9.4.2 Energy absorbing base frames type AA15-A**

815 If applicable, a range of energy absorbing base frames AA15-A shall be available and cover all dimensions  
816 corresponding to the possible blocs of FUs within a switchgear family.

### 817 **9.4.3 Raising base frame type AA3x-R**

818 Raising baseframes associated to AA3x switchgear shall be used:

- 819 • to improve the ergonomics for the execution of the cable terminals in case the height of the cable  
820 connection in the FU KKNx with reference to the floor of the switchgear is less than 800 mm ~~mm~~  
821 in order to reach this minimum height of 800 mm
- 822 • or to allow respecting the 675 mm bending radius of the HV cables in case the height of the cable  
823 cellar is not sufficient.

824 The maximum height for raising base frames type AA3x-R is limited to 675 mm.

## 825 **9.5 Features for installation of a Fault Current Indicator (FCI)**

826 All FUs KxNx shall comprise the following features to install Fault Current Indicators (FCI):

- 827 • A tube  $\varnothing \geq 20$  mm with a pull-wire between the cables compartment and the position of the FCI, to  
828 guide the cables between the current sensors and the FCI
- 829 • A cutout width (W) x height (H) =  $92^{+0.8/-0}$  mm x  $45^{+0.6/-0}$  mm on the front side to mount the FCI

830 Upon delivery, this cut-out shall be masked with a removable part in plastic or metal. Around the cut-  
831 out a minimal space of 4 mm must be free of any accessory. A free volume having the width and  
832 height of the cut-out and also a depth of 125 mm must be reserved behind the cut-out in order to  
833 introduce and embed the FCI and its connection wires.

## 834 **9.6 LV terminal block for protective current transformers (CTs)**

835 Circuit-breaker functions with coding Dx~~xx~~ shall be equipped with a LV terminal block for wiring the secondary  
836 circuits of the protective CTs.

837 This terminal block shall comprise non-interruptible terminals unless the terminals are interrupted following  
838 their short-circuiting. The short-circuiting shall be on the side where the wiring of the protective CTs is  
839 connected.

---

<sup>5</sup> For diameters, see chapter 3 - "Specific requirements for a HV billing metering function"

## 840 **10 Operating mechanism functionalities of switching devices**

### 841 **10.1 Scope**

842 The following requirements apply to

- 843 • FUs KKNx intended to be connected to the loop and DKNx
- 844 • FUs DxTx and TxTx used as general protection

### 845 **10.2 Generalities**

846 Only spring-type mechanisms are allowed for stored energy mechanisms.

847 The required operating levers/handles shall be provided upon the delivery of HV installation. A collection  
848 system for these operating levers/handles shall be included with the delivery.

### 849 **10.3 FU KKNx**

#### 850 *10.3.1 Principle of operation of the switching devices*

851 Switch-disconnector :

- 852 • The mechanism shall be designed to provide stored energy independent unlatched closing and  
853 opening operations.  
854 Stored and latched closing and opening operations are not allowed.

855 Earthing switch :

- 856 • The mechanism shall be designed to provide
    - 857 ○ For the closing operation : stored energy independent unlatched closing operation
    - 858 ○ For the opening operation : either dependent or stored energy independent
- 859 Stored and latched closing and opening operations are not allowed.

#### 860 *10.3.2 Versions*

861 Switch-disconnector :

- 862 • A motorized version for both the closing and the opening operations shall be available
- 863 • Motorization shall not impair manual closing and opening operations.

864 Earthing switch :

- 865 • Only manual version for both the closing and the opening operations is allowed.

#### 866 *10.3.3 Functionalities of switch-disconnector provided with a motor operation*

867 Priority to opening : in case of 2 simultaneous commands for closing and opening,

- 868 • if the switch-disconnector is initially closed it shall open and stay open
- 869 • if the switch-disconnector is initially opened it shall stay open without closing

870

871 Anti-pumping: If a closing command is given and maintained, followed by an opening command,  
872 the switch-disconnector shall close and then open but shall not reclose. To allow a second closing, the  
873 maintained closing command must be released and a new command must be sent.

874

875 Behaviour in case of loss of auxiliary power during operation:

876 If the auxiliary power disappears during a closing or opening operation, this operation cannot go on when the  
877 auxiliary power supply reappears. A new command is necessary to pursue the operation.

878

879 The power supply of the electrical control and motor circuits of the switch-disconnector shall be interruptible  
880 from the front panel of the LV compartment of the FU. The motor switch ensuring this functionality shall be  
881 padlockable in both disabled and enabled positions.

### 882 **10.4 FU TxTx**

#### 883 *10.4.1 Principle of operation of the switching devices*

884 Switch-disconnector (of switch-fuse combination) :

- 885 • The mechanism shall be designed to provide stored and latched energy opening operation
- 886 • The energy for opening shall be stored and latched before or during the closing operation

887

888 10.4.2 Versions

889 Switch-fuse combination :

- 890 • The mechanism shall be designed to enable the energy release for the opening by :
  - 891 ○ fuse-striker
  - 892 ○ shunt release (associated with the transformer protection device)
  - 893 ○ time-delayed under-voltage release

894 **10.5 FU DKNx**

895 10.5.1 Principle of operation of the switching devices

896 Circuit-breaker :

- 897 • The mechanism shall be designed to provide stored and latched energy closing and opening operations
- 898
- 899 • The spring storing the energy for 1 CO cycle shall be automatically recharged after a closing operation, allowing the fast auto-reclosing sequence O-0.3s-CO-15s-CO
- 900

901 Disconnecter :

- 902 • Stored and latched closing and opening operations are not allowed.

903 Earthing switch :

- 904 • The mechanism shall be designed to provide
  - 905 ○ For the closing operation : stored energy independent
  - 906 ○ For the opening operation : either dependent or stored energy independent
- 907 Stored and latched closing and opening operations are not allowed.

908 10.5.2 Versions

909 Circuit-breaker :

- 910 • Manual opening and closing operating interfaces shall be present
- 911 • Shunt releases for opening and closing operations shall be present
- 912 • A motorized version for spring charging operation shall be available
- 913 • Motorization shall not impair manual spring charging operation.

914 Disconnecter :

- 915 • Only manual version for both the closing and the opening operations is allowed.

916 Earthing switch :

- 917 • Only manual version for both the closing and the opening operations is allowed.

918 10.5.3 Functionalities of the circuit-breaker

919 Priority to opening : in case of 2 simultaneous commands (as well mechanical as electrical) for closing and opening,

- 921 • if the circuit-breaker is initially closed it shall open and stay open
- 922 • if the circuit-breaker is initially opened it shall stay open

923 Anti-pumping: If a closing command is given and maintained, followed by an opening command, the circuit-breaker shall close and then open but shall not reclose at the end of the spring charging. To allow a second closing, the maintained closing command must be released and a new closing command must be sent.

927 The control circuits shall react on opening and closing impulses of 20 ms and more

930 The power supply of the electrical control and motor circuits of the circuit-breaker, except the tripping circuit controlled by the protection relay, shall be interruptible from the front panel of the LV compartment of the FU. The motor switch ensuring this functionality shall be padlockable in both disabled and enabled positions.

933 **10.6 FU DxTx**

934 10.6.1 Principle of operation of the switching devices

935 Circuit-breaker:

- 936 • The mechanism shall be designed to provide stored and latched energy opening operation
- 937 • The energy for opening shall be stored and latched before or during the closing operation

938

939 10.6.2 Versions

940 Circuit-breaker:

- 941 • The mechanism shall be designed to enable the energy release for the opening by :
  - 942 ○ Low-energy release (associated with a CT-powered protection relay)
  - 943 ○ shunt release (associated with the transformer protection device)
  - 944 ○ time-delayed under-voltage release

# 945 11 Installation and operating instructions

## 946 11.1 General

947 The installation and operation manuals shall cover the range of all possible variants of FUs for which the  
948 homologation has been requested.

949 The installation and operating instructions shall be available both in Dutch and French languages.

## 950 11.2 Installation

951 The manufacturer shall indicate all his requirements to install the switchgear in order to guarantee both the  
952 safety and the performances required by the Synergrid prescriptions C2/113-3, in the installation instruction,  
953 amongst others :

- 954 • the dimensions, position of the fixation points, and position of the HV cables output for the different  
955 FUs and baseframes
- 956 • the distances to be respected between the switchgear and the walls and ceiling of the switching room  
957 regarding the internal arc withstand
- 958 • the openings to be provided in the floor slab with regard to :
  - 959 ○ the connection of the HV cables,
  - 960 ○ the fixation of the switchgear to the ground
  - 961 ○ the evacuation of hot gases in case of internal arc in the different compartments
- 962 • the openings to be provided in the walls of the switching room with regard to the hot gases evacuation  
963 out of the room for switchgear categories AA13 & AA33
- 964 • the method to install the FUs :
  - 965 ○ handling of the FUs and the baseframes
  - 966 ○ fixation to the ground
  - 967 ○ fixation between FUs/blocs of FUs
  - 968 ○ placement of baseframes and of FUs over baseframes
  - 969 ○ mounting or extension of the busbar
  - 970 ○ mounting of gas deflectors
  - 971 ○ mounting of gas evacuation channel including the end element with the pressure relief
- 972 • the method to connect the HV cables in the different types of FUs
- 973 • the method to earth the switchgear
- 974 • the method to install the Fault Current Indicators (FCI) in the FU KKNx connected to the loop

## 975 11.3 Operating instructions

### 976 11.3.1 The essential requirements for dead working

977 The standard EN 50110-1 mentions in § 6.2 the five (5) essential requirements<sup>6</sup> that must be obtained to  
978 ensure safe dead working. The Belgian General Regulation for Electrical Installations (AREI/RGIE) also  
979 mentions these five rules expanded with two administrative requirements that will not be included in these  
980 panels. The 5 and 2 accompanying requirements are:

- 981 • Preparations of the activities
- 982 • Complete disconnection (rule no. 1)
- 983 • Securing against re-connection (rule no. 2)
- 984 • Verifying the dead installation (rule no. 3)
- 985 • Earthing and Short-circuiting (rule no. 4)
- 986 • Providing protection against adjacent live part (rule no. 5)
- 987 • Releasing the installation

### 988 11.3.2 Operating instructions

989 The manufacturer shall provide the operating instructions as a quick user guide in order to guarantee both  
990 the safety and the performances required by the Synergrid prescriptions.

991 The quick user guide shall comprise the following operating instructions, based on the Belgian version of the  
992 synoptic diagrams:

- 993 • operating instructions to safely put a FU out of service
- 994 • operating instructions to safely put a FU back into service
- 995 • normal operating procedures to proceed to:
  - 996 ○ a HV cable test on FU KKNx connected to the loop and DKNx when equipped with an  
997 interface for cable testing

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<sup>6</sup> F: 5 Règles d'Or ; NL: Vitale 5



998                   ○ HV fuses replacement on FU TKTx

999   The form of the quick user guide shall meet the following requirements:

- 1000       • the operating instructions shall be illustrated with photos or drawings, possibly with text in the User's
- 1001       language (F, NL or both F and NL) with mention of a revision date
- 1002       • the format (size) can be according the manufacturer standard, provided readability is not
- 1003       compromised
- 1004       • the physical support shall be durable in time (e.g. plasticised pages)

1005   The manufacturer shall put available the quick user guide for each Client installation, including a system that

1006   allows the quick user guide to be kept in its provided place. The provided place may be part of the collection

1007   system for the operating levers/handles, mentioned in §10.2 of this document.