KS... w series substations

Transformer substations in concrete enclosures operated from the inside

1000 kVA
800 kVA
630 kVA
800 kVA

ABB
1. Subject of the paper

The subject of the paper are transformer substations operated from the inside, housed in reinforced concrete enclosures:

- KS 22-30 w substation ................................ with transformer of up to 630 kVA
- KS 25-36 w substation ................................ with transformer of up to 630 kVA
- 2 KS 22-30 w substation .........................e.g.:  
  • separated medium-voltage and low-voltage compartments
  • with transformer of up to 800 kVA
- 2 KS 25-36 w substation .........................e.g.:  
  • two-transformer substation
  • with transformer of up to 1000 kVA

The substation is made as a complete, self-contained power device. It comprises a transformer, medium-voltage and low-voltage switchgear, a measurement circuit on the medium-voltage or low-voltage sides, cables and associated equipment; it’s a ready-to-use product to be placed directly in the desired location.

2. Application of the substation

The KS...w type transformer substations are designed to provide electrical power supply to public and industrial customers from medium-voltage networks of up 20 kV, and low-voltage networks of 400/230 V in TN-C systems.

3. Technical specifications

The substation, depending on the building type, is designed for the following equipment:

**Building KS 22-30 w**  (→ page 25)

medium-voltage switchgear: .................option: with SF₆ insulation - SafeRing or SafePlus  
  • up to 3 bays (24 kV)
  option: with air insulation - UniSwitch (compact)  
  • up to 3 bays (24 kV)
low-voltage switchboard type RNTw ...... 1250 A  6 (10)
transformer ........................................up to 630 kVA
**Building KS 25-36 w** (→ pages 27, 29)

medium-voltage switchgear: ............ option: with SF₆ insulation - SafeRing or SafePlus
  • up to 5 bays (24 kV)
  option: with air insulation - traditional
  • up to 4 (3) bays of 17.5 kV (24 kV)
  option: with air insulation - UniSwitch (compact)
  • up to 5 bays of 24 kV

low-voltage switchboard type RNTw ------- 1250 A
transformer...............................up to 630 kVA

**Buildings 2 KS 22-30 w** (→ pages 31-35)

**Buildings 2 KS 25-36 w**

medium-voltage switchgear: ............... the UniSwitch, SafePlus, and the traditional air insulated type switchgears, allow free choice of configuration of medium-voltage bays

transformer...............................up to 1000 kVA
up to 2 x 630 kVA

low-voltage RNTw type switchboard.... 1250 A
1600 A

**3.1. Substation building**

The **KS...w** substation buildings are made of concrete using permanent moulds (walls and base are made of B35 type concrete, roof is made of B45 type concrete – walls are 10 cm thick).

**Die-cast concrete building**
(deformations and cracking of the building in the construction, transportation and operation processes are eliminated)

Substation concrete components:
  building, base and roof

The supporting constructions as well as fixing and transporting fittings are metallically joined with building reinforcement.

All metal components of the building are hot-zinc-coated.

Substation doors and ventilation grates are made of aluminium sheets and sections, and are painted with polyester powder paints (→ fig. 07, page 42). The door frame of the transformer room is equipped with protection railing hooks; the ventilation grates are equipped with insect screens.

The building roof (→ page 16) is fitted with threaded transport sockets.

The installation of equipment inside the **KS...w** is made through the doors as standard (also possible through the roof).
The building cable base is also the building foundation. The base of the building has a separate, non-leaking oil pit, preventing the transformer oil from permeation into the soil and the ground water. The medium-voltage and low-voltage cables are passed into the building base through P70 type cable bushings (30 pcs. – 10 per each base wall) or HD cable bushings (→ fig. 06).

The substation building internal walls and roof are pained with white waterproof acrylic paints; the walls, base floor and substation building floor are mufti-layer painted with sealing paints. The external walls structural plaster finish and the roof are pained with sealing paints according to the RAL colour palette. The base trim and the roof are painted – from the outside – with sealing paints in the substation door colour (optionally, the base trim is finished with ceramic tiles). The standard substation external finish is shown in fig. 01.

The concrete moulding production stage allows for individual location of doors, division walls (or their removal), and special equipment holes.

The transport fittings are approved for permissible loads.

3.1.1. KS 22-30w substation building specifications (→ page 13):

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>External width at base</td>
<td>3000 mm</td>
</tr>
<tr>
<td>External width at roof</td>
<td>3150 mm</td>
</tr>
<tr>
<td>External length at base</td>
<td>2200 mm</td>
</tr>
<tr>
<td>External length at roof</td>
<td>2350 mm</td>
</tr>
<tr>
<td>Height above the ground</td>
<td>2700 mm</td>
</tr>
<tr>
<td>Base foundation depth</td>
<td>650 mm</td>
</tr>
<tr>
<td>Total height</td>
<td>3350 mm</td>
</tr>
<tr>
<td>Substation building weight</td>
<td>8000 kg</td>
</tr>
<tr>
<td>Substation building weight (equipped without transformer)</td>
<td>9500 kg</td>
</tr>
<tr>
<td>Substation building weight (equipped incl. transformer)</td>
<td>12000 kg</td>
</tr>
<tr>
<td>Base weight</td>
<td>3600 kg</td>
</tr>
<tr>
<td>Building area</td>
<td>6.6 m²</td>
</tr>
</tbody>
</table>

3.1.2. KS 25-36w substation building specifications (→ page 14):

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width building</td>
<td>3600 mm</td>
</tr>
<tr>
<td>Width roof</td>
<td>3750 mm</td>
</tr>
<tr>
<td>Length building</td>
<td>2500 mm</td>
</tr>
</tbody>
</table>
roof ........................................................................................................ 2650 mm
height above the ground ................................................................. 2700 mm
base foundation depth (including surface) ........................................ 700 mm
total height ......................................................................................... 3350 mm
substation building weight (without equipment) ............................... 10500 kg
substation building weight (equipped – without transformer) ......... 12000 kg
substation building weight (equipped – incl. transformer) ............... 14500 kg
base weight ......................................................................................... 4300 kg
building area ....................................................................................... 9 m²

3.1.3 Building supplementary data:

protection degree .................................................................................. IP 43
enclosure impact strength ...................................................................... 20 J
roof load strength .................................................................................. 2500 N/m²
enclosure class ....................................................................................... 10
fire resistance ......................................................................................... B
fire resistance of walls and ceilings ...................................................... 120 min
substation fire load (depending on the amount of oil in the transformer housing and size of the substation building) e.g.:
22-30 w substation with 630 kVA transformer ....................................... 2890 MJ/ m²
25-36 w substation with 630 kVA transformer ....................................... 2165 MJ/ m²

the minimum distance from other objects (depending on the type of the neighbouring buildings) 10 to 15 m *)

* distances can be reduced:
by 50% if the neighbouring building wall has a 60 min fire resistance, and there is only one door of at least 30 min fire resistance;
by further 25% if the neighbouring building is equipped with fixed, automatic fire extinguishing system.

The transformer substation can be located adjacent to a building, with a solid wall (no openings) towards the building, if the distance to the window and door openings is more than 1.1 m, and the horizontal and vertical distances from rooms with permanent presence of people is higher than 2.8 m.

3.2. Equipment arrangement

The KS...w permit installation of a cable cabinet operated from the outside (e.g. lighting cabinet, measurement circuit cabinets etc.)

The medium-voltage switchgear and low-voltage switchboards in the KS...w building are operated from common service corridor (common medium-voltage and low-voltage compartment), or from separate compartments of medium-voltage switchgear and low-voltage switchboards (separate compartments for the medium-voltage switchgear and low-voltage switchboards are constructed in modular – combined buildings).
The switchgear and switchboards can be accessed after opening service door, and the transformer can be accessed after opening the transformer room door (→ fig. 02+05). The division between the transformer and
the medium-voltage switchgear and low-voltage switchboards service corridor is made of supplementary substation equipment, i.e. RNTw switchgear, cable duct and mounting panels.

3.3. Substation technical specifications

The KS...w series transformer substations are type-tested at the Electrical Power Institute in Warsaw.

- transformer substations type: **KS 22-30 w** (up to 630 kVA) certificate no. 569
- transformer substations type: **KS 25-36 w** (up to 630 kVA) certificate no. 569
  atestation no. 021/2002
- transformer substations type: **KS 25-36 w** (up to 1000 kVA) certificate no. 596

Substations are tested for:

- general requirements regarding construction and functionality
- mechanical strength of the building against impacts and loads,
- ingress protection, heat build-up inside the station building,
- electric strength of insulation,
- main circuit and earthing connections fault current load,
- inspection and evaluation of internal arc fault effects.

**General substation data:**

- substation rated power ....................................................... 630 kVA (1000 kVA)
- rated frequency ............................................................... 50 Hz
- number of phases .............................................................. 3

**Medium-voltage side data:**

- rated voltage ................................................................. 17.5kV or 24 kV
- insulation rated level ........................................................ 125 kV / 50 kV
- busbar rated continuous current ....................................... 630 A (400 A)
  - line bay ................................................................. 630 A (400 A)
  - transformer bay ......................................................... 200 A
- peak withstanded rated current:
  - busbar ................................................................. 31.5 kA
  - line bay and earthing switch ....................................... 31.5 kA
- short-term withstanded rated current:
  - busbar ................................................................. 12.5 kA
  - line bay and earthing switch ....................................... 12.5 kA
- rated fault duration .......................................................... 1 sec.

**Low-voltage side data:**

- rated voltage ................................................................. 400 V
- insulation rated level ........................................................ 660 V
- busbar rated continuous current ....................................... 990 A (1440 A)
main switch disconnector (circuit breaker) ........................................ 1250 A (1600 A)
feeder bay .................................................................................. 400 A (630 A)
peak withstood rated current .................................................... 40 kA
short-term withstood rated current ............................................. 16 kA
rated fault duration ................................................................. 0.5 sec

Transformer data:

transformer type ................................................................. sealed, oil cooled
(transformer type sealed, oil cooled)
(transformer type either dry, resin type)
transformer power ............................................................... up to 630 kVA (1000 kVA)
upper-voltage connection ..................................................... connector-type
(transformer power up to 630 kVA)
(transformer power up to 1000 kVA)
(transformer connection connector-type)
(transformer connection terminal lug)
(transformer connection insulators)

3.3.1. Standards:

EN 61330 : Prefabricated transformer high-voltage/low-voltage stations
EN 60298 : 2000 – AC switchgears in metal enclosures for voltages above 1 kV.
IEC 439-1+AC : 1994 – Low-voltage switchgear and controlgear. Requirements for fully and partially tested sets.

3.4. Medium-voltage switchgears (→ page 17, and the : “UniSwitch” and “SafeRing and SafePlus” catalogues)

3.5. Low-voltage switchboards (→ pages 18-20)

3.6. Transformers (→ page 21, and the: “Distribution transformers” catalogue)

The transformer inside the building is standing movably on rails anchored to the station building floor (it’s possible to transport the substation with the transformer installed – assembled at the manufacturer’s facility).

3.7. Medium-voltage and low-voltage cable connections (→ page 22)

The transformer is connected with the medium-voltage switchgear using three single-phase cables 1 x 50 (70) mm², in cross-linked polyethylene insulation for up to 20 kV voltage (one per phase). The cables from the medium-voltage switchgear side, in SF₆ insulation, are terminated with elbow jack heads e.g. type EASW
20/250 (type of the head on the medium-voltage switchgear side is defined in the switchgear assembly and operation documentation).

The medium-voltage switchgear side, in air insulation – are terminated with indoor heads e.g. TI 24 type.
The cables for transformers fitted with connectors are terminated on the upper-voltage side with alternatively: elbow jack heads e.g. type EASW 20/250 or straight jack heads e.g. EASG 20/250.
For the transformers with insulators, the cables on the upper-voltage side are terminated with indoor heads e.g. TI 24 type. The type of the heads can be chosen depending on how the cables are connected at the upper-voltage side of the transformer.
The low-voltage cables of the RNTw switchboard are terminated with traditional KU 240 type cable terminals, and connected on the transformer side using e.g. PFISTERER type terminals or KU 240 type cable terminals. The transformer lower-voltage side terminals can be insulated with insulating covers.
The cables entering the building base through the P70 bushings are sealed from outside with thermo-shrink tubes.

3.8. Substation earthing (→ page 23)

The electric shock protection of the transformer substation is made with safety earthing. The low-voltage service earthing as well as the medium-voltage and low-voltage safety earthing are all connected to common earth.

Safety earthing:
The substation equipment and structures are connected to the earthing busbar with the 1 x 50 mm² cable in yellow and green insulation. The earthing busbar is connected through the measurement contact (1 → page 23) with external substation earthing (flat section 200mm²). The building reinforcement is used as a common, metallic connection of all the substation structure components.

RNTw switchboard service earthing:
The PEN terminal of the RNTw switchgear is connected through the measurement contact (3) with the substation external earthing.

Transformer service earthing:
The transformer neutral point is connected through the measurement contact (2) with the substation external earthing. The measurement contact (2) is connected to the transformer neutral point using the 1 x 50 mm² cable (1 x 120 mm² or tinned flat-section 25 x 4 mm² – acc. to the directives of Power Distribution Company) – with blue insulation.
To facilitate substation earthing installation, flat-section FeZn 50 x 4 segments are provided to connect the earthing points no. 1, 2, and 3 with the circumferential earthing.

4. Substation assembly and foundation (→ page 24)

The substation has been designed to be transportable to the construction site using traditional transportation means (weights of buildings are given in the substation building specifications → pages 6 and 7). A special lifting sling or a traverse is delivered with the substation for the setting up purposes (we can guarantee assistance in proper substation installation).
4.1. Substation foundation trench and installation of the substation (→ page 24)

The substation should be placed in a foundation trench filled with water draining sub-crust breakstone or gravel of $0 \div 16 \div 25$ mm granularity (→ page 24). In case of embankment grounds (unstable) a 15 cm thick concrete foundation slab should be made (B15 concrete with $\varnothing 12$ wire reinforcement in $15 \times 15$ cm mesh). The depth of the substation foundation trench can be obtained as the total depth of the trench plus surface thickness, as given in the infrastructure design. The trench depth – total of 650 mm, and substation height above ground level - 2550 mm.

5. Environmental protection

The KS...w substations do not create any ecological threat. Buildings, doors, and all associated structures are made of environmentally friendly materials. The building base contains a leak-proof oil pit that prevents the transformer oil permeation into soil, and ground waters through the building base.

6. Warranty

The manufacturer gives a limited warranty for transformer substations, equipped as ordered, for a period of minimum 24 months – excluding other vendors equipment, which is covered by a 12-month warranty. The manufacturer accepts no liability for damages and faults resulting from incorrect operation and usage, lack of maintenance or improperly performed engineering works. We guarantee assistance in choosing and commissioning of the substation, training of personnel, delivery of spares and consumables.
7. Documentation acceptance

During the preparation of the transformer substation documentation, apart from the legal and formal steps related to substation architecture and location, the following should be done:

- substation electrical diagram co-ordination and design, based on technical conditions issued by the relevant Power Distribution Company
- co-ordination of the type of electric power measurements needed with the Power Distribution Company, and design of the measuring circuit (if applicable)
- design of the external distribution networks
- design of the substation earthing, using natural earthings, based on soil resistivity measurements
- planning of the substation assembly procedure, with regard to transportation conditions

8. Ordering a substation

When ordering a substation, the following should be defined:
- type of building and roof
- operating voltage of the medium-voltage side
- type and number of bays in the medium-voltage switchgear
- configuration of the RNTw low-voltage switchboard
- additional equipment of the RNTw low-voltage switchboard
- transformer type, rated power, and voltages of the lower and upper voltage sides
- types of cables supplying power in the medium-voltage line bays
- transformer cable connections (connectors and insulators)
- substation exterior colour and contents of the warning labels (→ page 16)

9. Substation transportation and hand-over

We deliver the substation with our own transportation means, and provide lifting slings and traverses to unload and set-up the substation. Location preparation and the crane to unload the substation are provided by the client.

We guarantee assistance in setting-up of the station
KS 22-30 w substation building

General specifications
- building width: 3000 mm
- building length: 2200 mm
- building height above ground: 2700 mm
- building height inside: 2300 mm
- depth of building foundation: 650 mm
- protection degree: IP 43
- building weight without equipment: 8000 kg
- base weight: 3600 kg
- building area: 6.6 m²
- supplementary building dimensions: fig.s 02 and 03

Materials
- building and base: reinforced concrete (B35)
- roof: reinforced concrete (B45)
- joinery: aluminium (or aluzinc)

Joinery is painted with powder paints in the roof colour.

The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015)

The building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032)

Building wall thickness is 100 mm.

KS 22-30 w

Operated from the inside

Equipment installation through the door or after roof removal.

1. substation building
2. building base
3. building roof
4. service door
5. cable cabinet
6. ventilation grates
7. cable bushings
8. bushing between buildings
9. hatch
10. medium-voltage compartment
11. transformer room

630 kVA
KS 25-36 w substation building

General specifications
- building width: 3600 mm
- building length: 2500 mm
- building height above ground: 2700 mm
- building height inside: 2300 mm
- depth of building foundation: 650 mm
- protection degree: IP 43
- building weight without equipment: 10500 kg
- base weight: 4300 kg
- building area: 9 m²
- supplementary building dimensions: rys. nr 03, 04

Materials
- building and base: reinforced concrete (B35)
- roof: reinforced concrete (B45)
- joinery: aluminium (or aluzinc)

The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015)
The building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032)
Joinery is painted with powder paints in the roof colour

1. substation building
2. building base
3. building roof
4. service door
5. cable cabinet
6. ventilation grates
7. cable bushings
8. bushing between buildings
9. hatch
10. medium-voltage compartment
11. transformer room

* building wall thickness is 100 mm
The set of two buildings allow creation of two-transformer, multi-bay or other substations, as required.

Construction of such substation with typical buildings significantly facilitates the substation set-up and allows free choice of architecture.

Division of substation weights e.g. two-transformer substations, allows use of traditional transportation means (especially in difficult locations).

In case of embankment grounds (unstable) a concrete stabilising foundation slab should be made – reinforced concrete (B15 concrete with Ø12 mm wire reinforcement in 15 x 15 cm mesh).
Building roofs KS...w

Building roofs:
- KS 22-30 w
- KS 25-36 w
- 2 KS 22-30 w
- 2 KS 25-36 w

1. Flat, single slope, reinforced concrete, 2.5% pitch
2. Flat, double slope, reinforced concrete, 5% pitch
3. Flat, double slope, reinforced concrete, 5% pitch + steel envelope roof overstructure + roof tiles, 30° pitch
4. Flat, double slope, reinforced concrete, 5% pitch + steel double slope roof overstructure + roof tiles, 30° pitch

Outside operates substation roofs:
- Single or double slope reinforced concrete slab (B45), covered with sealing paints on outside
- The roof reinforced concrete slab is ready for additional steel roof envelope or double slope overstructure covered with ceramic tiles (option: sheet metal, shingle etc.)

1. Made for substations standing adjacent to buildings or for 2 KS...w substations.
2. Standard KS...w substation roof
3. Made for KS...w substations and 2 KS...w substations – on a reinforced concrete slab with a steel overstructure of an envelope roof with wooden laths for e.g. tiles.
4. Made for KS...w substations and 2 KS...w substations – on a reinforced concrete slab with a steel overstructure of a double slope roof with wooden laths for e.g. tiles. The sides are made of aluminium sections painted with powder paints.

Drainpipes in the KS...w and 2 KS...w buildings are made only on client’s request (roof gutters and drainpipes – material: aluminium or PVC)

External designations of the KS...w substations

- MV SWITCHGEAR
- LV SWITCHGEAR
- MV/LV TRANSFORMER
- Transformer room door
- Ground level
- Warning label with inscriptions: 1. DO NOT TOUCH 2. ELECTRICAL DEVICE 3. DANGER
- Company logo
- Substation type
- Substation number
- Medium-voltage switchgear service door
- Low-voltage switchboard service door
Medium—voltage switchgear
in SF₆ insulation

As standard, the substation is designed for SF₆ insulated switchgear, type:
SafeRing or SafePlus

The MV switchgear transformer bays are equipped with a circuit breaker or a fuse. In the switchgear equipped with the isolation switch (200 A), the transformer is protected by a combination of a high-power isolation switch, and high-voltage HH fuse links type CEF. The isolation switch rated current in the transformer bay is limited by the fuse link rated current (see table below).

Detailed information on switchgear design and operation is given in installation and operation documentation of the MV switchgears.

Note: the UniSwitch, SafePlus and traditional, air insulated switchgears allow free choice of configuration of medium-voltage side bays

Phase order

Each bay in the MV switchgear (SF₆) is standard equipped with neon lamp voltage indicators, and with test sockets for setting phase of the medium-voltage cables (in each phase).
Phasing devices are fitted on clients request.

<table>
<thead>
<tr>
<th>MV switchgears in SF₆ insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
</tr>
<tr>
<td>rated voltage</td>
</tr>
<tr>
<td>transformer bay:</td>
</tr>
<tr>
<td>- with fuse</td>
</tr>
<tr>
<td>- without fuse</td>
</tr>
<tr>
<td>number of bays</td>
</tr>
<tr>
<td>A (mm)</td>
</tr>
<tr>
<td>B (mm)</td>
</tr>
<tr>
<td>C (mm)</td>
</tr>
</tbody>
</table>

- application of different switchgear requires consultation

Table of fuse MV links selection in MV switchgear transformer bays

<table>
<thead>
<tr>
<th>upper voltage</th>
<th>transformer power</th>
<th>fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 kVA</td>
<td>10 A</td>
<td></td>
</tr>
<tr>
<td>160 kVA</td>
<td>16 A</td>
<td></td>
</tr>
<tr>
<td>250 kVA</td>
<td>25 A</td>
<td></td>
</tr>
<tr>
<td>400 kVA</td>
<td>25 A</td>
<td></td>
</tr>
<tr>
<td>630 kVA</td>
<td>40 A</td>
<td></td>
</tr>
<tr>
<td>1000 kVA</td>
<td>63 A</td>
<td></td>
</tr>
<tr>
<td>20 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 kVA</td>
<td>10 A</td>
<td></td>
</tr>
<tr>
<td>160 kVA</td>
<td>16 A</td>
<td></td>
</tr>
<tr>
<td>250 kVA</td>
<td>16 A</td>
<td></td>
</tr>
<tr>
<td>400 kVA</td>
<td>25 A</td>
<td></td>
</tr>
<tr>
<td>630 kVA</td>
<td>40 A</td>
<td></td>
</tr>
<tr>
<td>1000 kVA</td>
<td>50 A</td>
<td></td>
</tr>
</tbody>
</table>

Note: overcurrent CT settings (for the MV switchgear with circuit breaker) – acc. to directives given in the MV switchgear documentation.
RNTw switchboards

RNTw - for inside operated substations

- free-standing – supplied from above
- module design: 6, 10, 12 feeder bays gr. 2 (3)
- allows connection of RNTw to increase the number of feeder bays
- ready to add:
  - control/measurement system PK
  - measurement/counter system PR (current transformers)
  - transformer idle run compensation system

**RNT switchboard specifications:**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated continuous current</td>
<td>1250 A (1600 A)</td>
</tr>
<tr>
<td>Rated feeder current</td>
<td>160 / 400 / 630 A</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>230 / 400 V</td>
</tr>
<tr>
<td>Insulation rated voltage</td>
<td>660 V</td>
</tr>
<tr>
<td>1 second withstand rated current</td>
<td>16 kA</td>
</tr>
<tr>
<td>Peak rated current</td>
<td>40 kA</td>
</tr>
<tr>
<td>Ingress protection</td>
<td>IP 20</td>
</tr>
<tr>
<td>Standard colour</td>
<td>RAL 7032</td>
</tr>
</tbody>
</table>

**Example:**

- Portable earthing terminals
- Current transformers inspection window
- Internal load
- Compensation
- PV
- D01
- PEN
- RBL-2

**RNTw - 6**

**RNTw - 10**

**RNTw - 12**

**Rated continuous current:**

- RNTw - 6: 1250 A (1600 A)
- RNTw - 10: 160 / 400 / 630 A
- RNTw - 12: 230 / 400 V, 50 Hz

**RNTw switchboard design:**

- RNTw - 6: 670
- RNTw - 10: 1070
- RNTw - 12: 1270

**Additional equipment:**

- Control/measurement system PK
- Measurement/counter system PR (current transformers)
- Transformer idle run compensation system
Busbar busbars

1. Incomer: L1, L2, L3 - busbar Cu 60x10 (Cu 80 x 10)*
   PEN - busbar Cu 40x10 (Cu 60 x 10)*
   (the busbar bridge is standard fitted for busbar current transformers installation)

2. Feeder: L1, L2, L3 - busbar Cu 50x10 (Cu 80 x 10)*
   PEN - busbar Cu 40x10 (Cu 60 x 10)*
   *( ) execution for – 1600 A

Connections with the transformer

Example:
The RNTw switchboard busbar bridge (10 feeder bays) with SOCOMEC Sirco 1250 A (1600 A) insulating switch

RNTw incomer options:
- 1250 A OETL insulating switch
- 1250 A fuse insulating switch
- 1250 A circuit breaker
- without main circuit breaker

RNTw feeder options:
- SLBM gr. 2 (3) insulating switch
- XLBM gr. 2 (3) insulating switch

The RNTw switchboard with network-generator or automatic stand-by switching incomer supply, requires a customised design.
**PR, PK - measurements**

The RNT switchboards allow addition of the following measurement systems:
- PR – energy counter measurement
- PK – control measurement

**PR and PK systems measurement boards**

The TT type measurement boards are adapted to install directly on the wall or in measurement cabinets.
The TT-2 and TT-3 boards are fitted only with typical 3-phase counter boards.
The TP-2 and TP-3 boards are fitted additionally with the terminal strip, voltage protection, control lamps etc.

**Selection of current transformers for the measurement systems**

<table>
<thead>
<tr>
<th>Transformer power</th>
<th>Current transformer ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kVA</td>
<td>200 A / 5 A</td>
</tr>
<tr>
<td>160 kVA</td>
<td>300 A / 5 A</td>
</tr>
<tr>
<td>250 kVA</td>
<td>400 A / 5 A</td>
</tr>
<tr>
<td>400 kVA</td>
<td>600 A / 5 A</td>
</tr>
<tr>
<td>630 kVA</td>
<td>1000 A / 5 A</td>
</tr>
</tbody>
</table>

**Internal load and additional equipment**

All RNT switchboards are equipped with internal load system:
- service outlet, and station lighting circuit.
The RNT switchboards allow installation of a transformer idle run capacitor.

<table>
<thead>
<tr>
<th>Transformer power</th>
<th>Capacitor power *</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kVA</td>
<td>2 (2.5) kVar</td>
</tr>
<tr>
<td>160 kVA</td>
<td>2.5 (3) kVar</td>
</tr>
<tr>
<td>250 kVA</td>
<td>3 (5) kVar</td>
</tr>
<tr>
<td>400 kVA</td>
<td>5 (7.5) kVar</td>
</tr>
<tr>
<td>630 kVA</td>
<td>7.5 (10) kVar</td>
</tr>
</tbody>
</table>

* acc. to the transformer operation recommendations
The KS... type substation allow installation of dry type transformers:
- cast wil technology transformers
- RESIBLOC technology transformers

### Oil type

<table>
<thead>
<tr>
<th>manufacturer</th>
<th>ABB</th>
</tr>
</thead>
<tbody>
<tr>
<td>power (kVA)</td>
<td>160</td>
</tr>
<tr>
<td>A (mm)</td>
<td>950</td>
</tr>
<tr>
<td>B (mm)</td>
<td>780</td>
</tr>
<tr>
<td>C (mm)</td>
<td>1230</td>
</tr>
</tbody>
</table>

Transformer – medium voltage switchgear and low-voltage switchboard connection (see pages 10 and 22)
Medium-voltage and low-voltage cable connections

Transformer – medium-voltage switchgear connections

- single phase cables with 20 kV insulation:
  - up to 250 kVA: 35 mm²
  - from 400 to 630 kVA: 50 mm²
  - from 800 to 1250 kVA: 70 mm²

Transformer – low-voltage RNTz switchboard connections

- single phase cables with 1 kV insulation:
  - up to 250 kVA: 1 x 240 mm²
  - from 400 to 630 kVA: 2 x 240 mm²
  - from 800 to 1250 kVA: 4 x 185 (240) mm²

The medium-voltage switchgears in SF6 insulation allow connection of dry or oil cables.

Cable heads

<table>
<thead>
<tr>
<th>SF6 insulated switchgears</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>line bays – incomer cables</td>
<td>ASTS 20/630; AWKS 20/630</td>
<td>K400 TB; K400 LR</td>
<td>RICS</td>
</tr>
<tr>
<td>transformer bay – cables to the transformer</td>
<td>EASW 20/250</td>
<td>K 158 LR</td>
<td>RSES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air insulated switchgears</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>line bays – incomer cables</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
<tr>
<td>transformer bay – cables to the transformer</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformers</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>with traditional connectors (insulators)</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
<tr>
<td>with jack connectors</td>
<td>EASW 20/250; EASG 20/250</td>
<td>K 158 LR</td>
<td>RSES</td>
</tr>
</tbody>
</table>
Safety earthing:

- the substation equipment and structures and connected to the earthing busbar with a green and yellow insulated cable – 1 x 50 mm².
- the earthing busbar is connected through a test clamp 1 with external substation earthing (flat section 200 mm²).
- the building reinforcement is used as additional, common metallic connection for all substation structure components.

RNTw switchboard service earthing:

- the PEN terminal of the RNTw switchboard is connected through the test clamp 3 with external substation earthing.

Transformer service earthing:

- the transformer neutral point is connected through the test clamp 2 with external substation earthing.
- the connection of the test terminal with the transformer neutral point is made with the 1 x 50 mm² cable (1 x 120 mm² or 25 x 4 mm² tinned flat section – according to Electric Power Distribution Company) – with blue insulation.
- to facilitate creation of substation earthing, flat-section FeZn 50 x 4 mm segments are included to connect the earthing points number 1, 2, and 3 with the circumferential earthing.
Substation installation and placement

**Substation placement**
(with equipment)

- 19 T crane (25 T in case of difficulties)
- Traverse
- Breakstone or reinforced concrete slab

**KS 22-30 w**

- 3000 (2 KS 22-30 w)
- 2200 (2 KS 22-30 w)
- 2700 (2 KS 22-30 w)
- 2500 (2 KS 22-30 w)
- 2800 (2 KS 22-30 w)
- 4200 (2 KS 22-30 w)
- 650 (2 KS 22-30 w)
- 300 (2 KS 22-30 w)

**KS 25-36 w**

- 3600 (2 KS 25-36 w)
- 2500 (2 KS 25-36 w)
- 3600 (2 KS 25-36 w)
- 2500 (2 KS 25-36 w)
- 5300 (2 KS 25-36 w)
- 5300 (2 KS 25-36 w)

**2 KS 22-30 w**

- 4900 (2 KS 22-30 w)
- 5300 (2 KS 22-30 w)
- 5000 (2 KS 22-30 w)

**2 KS 25-36 w**

- 4900 (2 KS 25-36 w)
- 5300 (2 KS 25-36 w)
- 5000 (2 KS 25-36 w)

---

In case of embankment grounds (unstable) a concrete stabilising foundation slab should be made – reinforced concrete
(B15 concrete with Ø12 mm wire reinforcement in 15 x 15 cm mesh).
Transformer substation
KS 22-30 w

Substation equipment options - standard

- substation building: KS 22-30 w
- MV switchgear:
  - option: SF$_2$ insulation – SafeRing or SafePlus
  - up to 3 bays (24 kV)
  - option: air insulation – UniSwitch (compact)
    - up to 3 bays (24 kV)
- LV switchboard: RNTw - 6, 10 bay
- transformer: max. 630 kVA

**Equipment placement**

1. concrete building
2. building with cable cabinet
3. medium-voltage switchgear
4. MV/LV transformer
5. low-voltage switchboard
6. PR energy counter measurement
7. additional LV cable cabinet for installation of e.g.:
   - individual LV switchboards
   - board for street lighting
   - PR energy counter measurement
   - capacitor set
8. service door 1050 x 2000 mm
9. transformer room door 1050 x 2000 mm
10. ventilation grates
11. MV cable duct
12. base hatch

![fig. 8.1](image-url)
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.

fig. 8.2
Transformer substation

KS 25-36 w

Substation equipment options - standard

- Substation building: KS 25-36 w (e.g. with cable cabinet)
- rozdzielnica SN: option: SF6 insulation – SafeRing or SafePlus
  - option: air insulation (traditional)
  - option: air insulation – UniSwitch (compact)
- LV switchboard: RNTw - 6 (10) (12)
- transformer: max. 630 kVA

Equipment placement

1. concrete building
2. medium-voltage switchgear – SF6
3. medium-voltage switchgear – air insulated
4. medium-voltage switchgear - air insulated (compact)
5. MV/LV transformer
6. low-voltage switchboard: RNTw
7. PR energy counter measurement
8. additional LV cable cabinet for installation of e.g.:
   - individual LV switchboards
   - street lighting cabinet
   - PR energy counter measurement
9. service door 1050 x 2000 mm
10. transformer room door 1050 x 2000 mm
11. ventilation grates
12. MV cable duct
13. base hatch
14. capacitor set

fig. 9.1
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.

fig. 9.2
Transformer substation

KS 25-36 w

Substation equipment options: with medium-voltage side measurement

substation building
KS 25-36 w (e.g. with cable cabinet)

MV switchgear:
Option: air insulation (traditional)
• 1 line bay 17.5 kV (24 kV) +
• measurement bay +
• 1 transformer bay
Option: air insulation – UniSwitch (compact)
• 2 line bays 17.5 kV (24 kV) +
• measurement bay +
• 1 transformer bay
Option: SF6 insulation – SafeRing or SafePlus
• 2 line bays 17.5 kV (24 kV) +
• measurement bay +
• 1 transformer bay

LV switchboard
RNTw - 6 (10) (12)
max. 630 kVA

Equipment placement
1 concrete building
2 building with cable cabinet (6)
3 medium-voltage switchgear – SF6
4 medium-voltage switchgear – air insulated
5 medium-voltage switchgear - air insulated (compact)
6 Energy measurement cubicles
7 MV/LV transformer
8 low-voltage switchboard: RNTw
9 PR energy counter measurement
10 additional LV cable cabinet for installation of e.g.:
   - individual LV switchboards
   - street lighting cabinet
   - PR energy counter measurement
11 service door 1050 x 2000 mm
12 transformer room door 1050 x 2000 mm
13 ventilation grates
14 MV cable duct
15 base hatch
16 capacitor set

fig. 10.1
The UniSwitch, SafePlus and traditional switchgear allow free choice of configuration of bays and measurement systems on the medium-voltage side.

The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.

Fig. 10.2
## Transformer substation

### 2KS 22-30 w

Substation equipment options: with medium-voltage side measurement – separate medium-voltage and low-voltage compartments

| Equipment Placement |  
|---------------------|--------------------------------------------------|
| 1                   | concrete building                                |
| 2                   | medium-voltage switchgear – SF6                  |
| 3                   | medium-voltage switchgear – air insulated        |
| 4                   | medium-voltage switchgear - air insulated (compact) |
| 5                   | Measurement cubicle                              |
| 6                   | MV/LV transformer                                |
| 7                   | low-voltage switchboard: RNTw                    |
| 8                   | PR energy counter measurement                    |
| 9                   | additional LV cable cabinet for installation of e.g.:
|                      | - individual LV switchboards                     |
|                      | - street lighting cabinet                        |
|                      | - PR energy counter measurement                   |
| 10                  | service door 1050 x 2000 mm                      |
| 11                  | transformer room door 1050 x 2000 mm             |
| 12                  | ventilation grates                               |
| 13                  | MV cable duct                                    |
| 14                  | base hatch                                       |
| 15                  | capacitor set                                    |

| Substation Building | 2 KS 22-30 w |

<table>
<thead>
<tr>
<th>17.5 kV MV switchgear</th>
<th>Option: air insulation (traditional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g.</td>
<td>2 line bays +</td>
</tr>
<tr>
<td></td>
<td>• measurement bay +</td>
</tr>
<tr>
<td></td>
<td>• 1 transformer bay</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>24 kV MV switchgear</th>
<th>Option: air insulation – UniSwitch (compact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g.</td>
<td>2 line bays</td>
</tr>
<tr>
<td></td>
<td>• measurement bay +</td>
</tr>
<tr>
<td></td>
<td>• 1 transformer bay</td>
</tr>
</tbody>
</table>

| LV switchboard/transformer | RNTw - 6 (10) (12) max. 630 kVA |

**fig. 11.1**
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.

KS... w substation electrical diagram – example

Note: The UniSwitch, SafePlus and traditional switchgear allow free choice of configuration of bays and measurement systems on the medium-voltage side.
Transformer substation

2KS 25-36 w

Substation equipment options: two-transformer substation

substation buildings 2 x KS 25-36 w

MV switchgear e.g. 9 line bays (375 mm), 24 kV - UniSwitch+
2 x 4 bays SF6 SafeRing
any SafePlus configuration
5 MV bays, 24 kV – air insulated (traditional) switchgear

LV switchboard e.g. 2 x RNTw – 6 (10) (12)

transformer e.g. 2 x max. 630 kVA

Equipment placement

1 concrete building
2 medium-voltage switchgear
3 MV/LV transformer
4 low-voltage switchboard: RNTw
5 bus section
6 PR energy counter measurement
7 bolts securing the two KS 25-36 w buildings together
8 service door 1050 x 2000 mm
9 transformer room door 1050 x 2000 mm
10 ventilation grates
11 capacitor set
12 transformer room division
13 base hatch

fig. 12.1
Note: The UniSwitch, SafePlus and traditional switchgear allow free choice of configuration of bays and measurement systems on the medium-voltage side.

...the medium-voltage and low-voltage switchgear and switchboard can be equipped with mechanical locks.

The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.
Transformer substation

2KS 25-36 w

Substation equipment options: 1000 KVA transformer – separate medium-voltage and low-voltage (power distribution company and clients) compartments

substation buildings 2 x 25-36 w

MV switchgear
e.g. 9 line bays (375 mm), 24 kV - UniSwitch+
2 x 4 bays SF6 SafeRing
any SafePlus configuration
5 MV bays, 24 kV – air insulated (traditional) switchgear

LV switchboard
RNTw - 6 (10) (12)

transformer
1000 kVA

Equipment placement

1 concrete building
2 medium-voltage switchgear
3 MV/LV transformer
4 low-voltage switchboard: RNTw – 1600 A
5 PR energy counter measurement
6 service door 1050 x 2100 mm
7 transformer room door 1200 x 2100 mm
8 ventilation grates
9 capacitor set
10 base hatch

fig. 13
KS 25-36 w Substation Exterior

Exterior 2-3

Exterior 1-2

Exterior 1-4

Exterior 3-4

WALLS sand colour
METAL PARTS grey or brown colour
TRIM grey or brown colour
ROOF grey or brown colour

TRIM grey or brown colour
WALLS sand colour
METAL PARTS grey or brown colour
ROOF grey or brown colour
KS 22-30 w substation equipment placement

fig. 02

1. fig. 3-bay SafeRing medium-voltage switchgear
2. Additional low-voltage equipment support
3. MV/LV transformer, max 630 kV/ A, dimensions max. 1600 x 1030 mm
4. Transformer moving rails
5. Test connection
6. Transformer mounting sites
7. Cable base hatch
8. Earthing busbar
9. Test connection
10. Earthing busbar
11. Earthing busbar
12. Earthing busbar
13. Medium-voltage switchgear
14. 2-way selector
KS 22-30 w substation equipment placement

fig. 03
Cable bushings

Fig. 06

Version 1

P50 cable bushing

Thermo-shrink tube

XPLE insulated cable

Version 2

P70 cable bushing

Thermo-shrink tube

Insulated cable

Version 3

HD125 (150) cable bushing

Thermo-shrink tube

XPLE insulated or paper-oil insulated cable
KS...w substations joinery

fig. 0.7

Technical specifications:
1. Material – aluminium or aluzinc sheet
2. Finish coating – polyester powder paint
3. Protection – IP43

Insect screen

KS...w substation ventilation grate

KS...w substation service door