INTERNALLY CONTROLLED COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER GA VR 232/714

Basic technical specifications:

- HV nominal voltage: 3 AC 22 kV (35 kV) 50 Hz
- LV nominal voltage: 3/PEN AC 420/242 V 50 Hz / TN-C,
- Frequency: 50 Hz
- Transformer nominal power: to 2x1 000 kVA
- HV bus-bars nominal current: regarding HV distributor´s type to 630 A
- LV bus-bars nominal current: to 1 500 A
- HV / LV distributor nominal insulation voltage: 24 kV / 1 000 V
- HV distributor short-time / dynamic current: 16 kA / 40 kA
- LV distributor short-time / dynamic current: do 30 kA / do 60 kA
- LV distributor cover: IP 20
- Whole station cover: IP 23D
- Temperature coefficient (Cover class): K 20
- Empty skeleton weight: cca 29 000 kg (in exposed aggregate concrete design)
- External dimensions: 7 140x2 320x3 550 mm (without roof overlap)
- Environment: 3.1.1. basic (within the kiosk-type TS rooms),
  4.1.1. ambient, ordinary (outside the TS rooms -)
- Exposure class: for internal components: XC1; for external components: XC4, XF1, XA1.
- Operating conditions: ambient temperature $-40°C \leq t \leq +40°C$
  altitude up to 1 000 m asl.

Note: If the transformer substation is used in different climate and operating conditions, the TS supplier is must be consulted.

Electrical current injury prevention: (STN EN 33 3201, STN EN 33 2000-4-41),

- in normal operation mode (of the live parts): in HV system by: 4.1.1 – out of reach placement
  4.1.1 – live parts insulation
  4.1.1 – barrier, cover
  in LV system by: 3.7.1. live parts insulation
  3.7.2. barriers or covers
  3.8.5. out of reach placement (position)

– in case of failure (of dead parts): in HV system by: 4.2.5. automatic feed disconnection with quick IT networks disconnections to be off (with low imped. neutral TR grounding)
4.2.9. bonding – uniform potential installation
in LV system by: 3.2. automatic feed disconnection
3.6.1. additional protection by residual current device (TS install.)

3.6.2. additional protection – additional protecting bonding

Station construction:

Internally controlled compact kiosk-type transformer substation is partially flush-mounted, with external dimensions of 7 140x2 320 mm, total height of 3 550 mm, clear height of the technological part 2 400 mm, clear height of the cable cellar 680 mm, ground sinking depth of 760 mm, over ground height of 2 790 mm (with flat roof). Station construction is self-supported and made of reinforced concrete Gräper LC25. Optionally, lightweight reinforced concrete Gräper LB25 may be used providing that the transformer substation meets requirements concerning structural rigidity while keeping lower weight and better thermal and acoustic insulation properties in comparison with kiosks made of basic concrete. The steel reinforcement is composed of steel bars and mats welded together into a single conductive structure and serves as a part of the bonding, grounding, or even lightning protection system. The installation of the station skeleton does not require any foundations, but only a well flushed and rammed out cut. The transformer substation is type-approved, conforming to the STN EN 62271-202 norm and meets the resistance tests against internal arcing fault of the German PEHLA directive.

Station construction forms a compact unit consisting of four monolithic parts: basement tank, sidewals, floor and a flat roof.

Basement tank and sidewalls: Made of waterproof and oil proof concrete (crack width is guaranteed up to 0,2 mm) as an oil catch tank. The construction resistance against strong chemical action of the liquids, soils and vapours conforms to the DIN (German Institute for Standardization) directive. The tank space is divided by a vertical oil-resistant separation wall into a compartment under the transformers and a compartment under the HV and LV distributors. The tank serves as a foundation for the non-freezing part of the station and allows station lifting by means of 4 anchor points (sealed chasing nuts) RD 36, placed in the shorter sides of the TS (see figures „B“, „D“). In order to join the external grounding two M12 points of HV/LV switchgear are led from the sidewalls of the station. The bell casting method was used to construct the tank and cable exchange label bodies, thus creating a monolithic unit which meets requirements for the impermeability of water and oil substances. All surfaces of the transformer substation touching the ground and cable feeder entry and exit seals may be painted by two layers of black penetrating insulation paint, if required by the customer. The inside of the tank can also be treated by waterproof and impermeable paint.

HV and LV cable entry holes are made on production in the lower part of the body (HV or LV distributor´s side). After cable installation, the entry holes are sealed by Hauff press fittings (HSI 150, HSI 90). The basement tank is fully divided by a separation wall to catch possible transformer´s oil leakage in order to protect the space under the HV and LV distributors from the leaking oil.

Sidewalls: Sidewalls are by default treated with white washable paint. The surface finish of the external walls can be on of the following options:
- concrete with bare filler (exposed aggregate concrete) with 8/12 granularity,
- raw concrete in final finish colour according to the RAL colour palette,
- plastered concrete with material (scraped finish), or material Rollputz (rolled on plaster), in final finish colour according to the RAL colour palette,
- stone facing (for example Dupa-Stone), facade bricks, wood or other material as required by customer.

Floor: cast from lightweight reinforced concrete Gräper LC25, 120 mm thickness, in the HV and LV distribution plant compartment, there are 2 feed openings into he cable cellar (floor space), with pressure balancing lid.

Roof: connected to the walls from inside at 4 points by screws and overlapping the wall contour by 9 cm. The roof can be lifted by 4 anchor points (sealed chasing nuts) RD 16, standardly corniced by 9 cm all around, thus providing additional protection of the joints between vertical walls and the roof . If the TS is built next to already existing construction or next to another building, the roof gutter can be partially or totally eliminated, or if required, the width of the roof gutter can be bigger than 9 cm. Drainage is ensured by means of inbuilt rain drains from plastic material, being placed under the attic (in stations with gutter) or on attic´s side (stations without gutter) connected with downpipes of 60/60 mm square section outside the station body. In order to increase the protection of the concrete surface against humidity, the upper roof is covered with additional hydrophobic coating, which fills capillary pores and acts against the hygroscopic properties of the concrete.

Surface treatment of the roof can be made of exposed aggregate concret, or fair-face concrete with rough surface and paint according to the RAL colour palette. The shape of the roof (flat, saddle, cradle) is optional as well.

Door: All metal parts including doors, frames, and ventilating parts are made by default of hot-dip galvanized 1,5 mm thick sheet steel, basic paint and two layers of the finish paint in RAL 7032 colour palette. The door is equipped with armour including external knob and internal handle with plastic lock cover and a pawl for fixing the door in open position at a 95° angle. For arrestment – the locking, bob weights and point-to-point bars are used within each door wing frame (four- point locking system Gräper). The lock is adapted for standard lock inserts. The outer side of the door is covered by warning plates in terms of the valid EN.

Optionally, the door and ventilating parts can be made of anodized aluminium and 2 lock inserts can be used for double lockout.

The access to the HV and LV switchgear of the substation is provided by a common single wing door without ventilating aperture and with internal dimensions WxH of 1 100x2 100 mm. On the HV/LV transformer´s side the door has a ventilating aperture and internal dimensions WxH of 1 250x2 100 mm. The door is equipped with an arresting pawl to fix the door in an open position and door wings are connected with the frame through a copper conductor with 16 mm^2 cross-section area.

Air ventilation: Air vents for the transformer space are located in the entrance door. There is an air vent with internal dimensions WxH of 1200x1000 mm in the wall opposite to the door. Optionally, there can be an air vent in the separating wall between the transformer and distributor chambers (or a slit in the full length of the separation wall), serving for the ventilation of the transformer chamber and thus heating the distributor space. Standard air vents are covered with Al-sheet flap strips, which are cast into the TS walls immediately below the roof in 80 cm distances and dimensions WxH 460x20 mm. The vents´ dimensions are designed to provide for a sufficient air ventilation and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper of the safety class comforming the DIN 40 050 V2A norm) and a net against foreign bodies and insects.

Grounding:

Composition of the TS internal grounding:
- **bonding bar** (BB) Cu 30x4 mm with M12 clips, located on the spreader insulator 1 kV, which is directly connected with all the technological components of the TS (vessel of the TR distributors tanks of the HV, LV, metal shield of the HV cables, branch bar PEN) and with individual mounted components (construction components – tank and roof reinforcement, frames, door, grate, conducting „U"- beams of the transformer, bearing structures of the distributors...) using the Cu conductor with S_{min} 30 mm^2. Each conductor of the grounding connected to the BB is labelled.
- **earth artery** is made of a FeZn strip conductorwith S_{min} 125 mm^2, being part of the TS steel reinforcement and it is cast directly in the external walls and kiosk´s beam, which serves as the connection of the common points of the grounding. Flexible parts are connected to the frame with copper (Cu) stripe or Cu grounding cable with min. cross-section area of 16 mm^2.
- **2 nodes of the grounding feeder** by Hauff HDE-M12/X to connect the external grounding (in general FeZn stripe 30x4 mm) to the bonding bar (from the internal part of the node by a connecting screw M12-St 37 Zn, from the external part of the node through **test clips** of the **SZ1, SZ2** grounding with screw M12). Grounding feeder nodes are generally lead out of the opposite sidewalls of the station space for HV and LV distributor.
The transformer substation in standard finish does not have external lightning protection system, as it is a ground object mostly located close to other higher objects. All the metal reinforcement built-in to the corresponding parts of the TS (roof, walls, false ceiling, basement tank) are welded into a single unit using Parts of the skeleton are welded together using conducting joints (e.g. Cu lines 35 mm^2) thus forming Faraday´s cage and after roof mountaing is mounted they are fully connected to the grounding. If customer wishes otherwise, it is possible to equip the transformer substation with external lightning rod with one collector and two wires connected to the common TS grounding via test clips in terms of the valid STN.

For each transformer station a common grounding system for HV and LV facilities must be constructed. Its design needs to take into account the operating conditions – fault current value of the distribution network in the given region, power transformer node operation mode and local soil conditions (STN EN 33 3201, STN EN 33 2000-5-54,)

Installation:

The internal installation of the station includes interior lighting of the TS, consisting of 3 oval incandescent 60 W lamps fitting with gate switch lighting in the distributor´s space of high and low voltage and 1 oval incandescent 60 W lamp fitting with gate switch lighting in the transfomer´s chamber supplemented by a one-phase socket of 230 V. Circuits feeding the lighting and socket installation are led out of the main LV distributor via installation breakers, or combined with residual current circuit breaker.

Further equipment – as specified by customer.

Internal space of the TS is horizontally divided by concrete floor into two compartments: cable cellar in the basement tank and technological space over the ground holding the transformers, HV and LV distributors. The over ground part of the TS is composed of two vertically divided chamber – common HV/LV switchgear chamber and transformer chamber.

Transformer:

Oil, hermetic or dry-type transformers up to the power of 1 000 kVA may be commonly used in the substation, placed on rails and vibration absorbers made by Gräper. In case of oil leakage the seat of the transformer is designed as an impermeable oil catch tank. If the transformer is equipped with bolster, it is fixed against side movement.Transformer insertion and removal can be performed through an entrance door or by crane if roof is removed. Max. dimensions of the TR (LxWxH) are cca 1 850x1 400x2 000 mm.

Transformer cooling is atmospheric. Air renewal is provided by air vents at the bottom of the door of the transformer substation (on the transformer´s side) and in the transformer chamber´s walls. Transformer´s protection against over current, or shortcut is provided on the HV side – by plugs or by switch with safety relay and on the LV side – by air breaker

High voltage distributor:

In transformer substation it is possible to use all the types of the commonly produced covered HV gas insulated distributors SF6 (for example GA, GA-C by Moeller, 8DJ10, 8DJ20 by Siemens, RM6 by Merlin Gerin,...), or or type-approved vacuum distributors up to the width of 7 fields including measurement on the HVside. Depending on type used, the nominal current of the distributors is up to 630 A, shortcut resistance (nominal short-time withstand current 1 s) to 20 kA, optionally up to 25 kA. It is possible to deliver the customers the HV distributor, or by Gräper company including the facility to decrease the pressure in arcing fault in HV distributor conforming to STN EN 62271-200 (PEHLA standards). Max. dimensions of the HV distributor (WxHxL) are ca 3 400x2 000x800 mm.

Low voltage distributor:

The panel version of the LV distributor is covered with IP 20. The feeder is equipped with air breaker depending on the transformer´s power, breakage bar switches are inserted (10 breakage bar switches to 400 A and construction width of 100 mm for one TR, or corresponding number of outlets with switches to 160 A and construction width of 50 mm), or breakers with max. attachable cables with cross-section area of 300 mm^2. Standard nominal current of the distributor is up to 1 500 A, shortcut resistance (short-time nominal withstand current 1 s) to 25 kA. Besides this, the distributor can include electricity consumption monitor, circuits for station lighting and service socket. The clips can be grounded on the main breaker´s feeder („ball pivots“) Ø 25 mm, which allow to protect the working place during the works on LV distributor via grounding tool (shorting set). Max. dimensions of one LV distributor (WxLxH) are ca: 1 000x2 000x500 mm.

Note: The number of LV outlets is limited by customer´s demands for additional LV distributor equipment such as monitors etc.

The distributors meet STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements.

The cable connections include HV distributor connection with transformer 24 kV by single-core cables 24-N2XSY 3x1x35 mm^2 and LV distributor connection with transformer 1 kV by cables 1-NYY-O 1x150 mm^2, resp. 1x240 mm^2.

Cable connections for high voltage are checked in each production phase. Filed tests of the TE fractional discharges in Gräper company´s own test-room can be carried out , following VDE 0434, VDE 0472

technical norms. According to the regulations the maximum allowed value for TE is ≤ 20pC. The real achieved value is ≤ 5 pC.

Transformer station construction specifications:

The station is constructed according to the norms and rules of STN EN, DIN, UVV etc., directly following the bellow given normative standards:

Cellular concrete	- DIN 4219
Reinforced concrete	- DIN 1045
VDE directives	- DIN 0141, 0101, 0100
Directive on the protection of underground waters	- GwSchV
Federal directive on waste disposal	- BimSchV
Electromagnetic radiation compliance	- BimSchV n.26

Individual structural components of the transformer substation are made of uninflammable materials, fire resistance of the station construction meets STN 73 0821 norms (fire resistance class required is F90, class documented is F120).

Delivery, assembly, ground cut for station placement:

The kiosk-type transformer station is delivered assembled and prepared for HV, LV cable connection and grounding. It is installed by crane into a prepared pit with compressed and flat surface according to the design project of the transformer substation´s producer – Gräper company (dimensions of the ground cut : 774x292 cm, cutting depth: min. 107 cm, compressed layer thickness: min. 20 cm).