

OPERATING - INSTRUCTION

Three-phase-synchronous generator
with
cylindrical rotor

„Fenestrelle“

Type:	HTM 110 D10
Serial no.:	526406 08001-002
Customer:	Energie S.p.A
Customers order no.:	FEN 05.05.2007
Our order / project:	126595 / K.D11-07029

Issue no.:	01
Date:	08.10.2008

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1 Safety instructions

This operating instruction contains important warning instructions and safety instructions. The user has to pay attention to this.

This motor is assigned only for a certain use which is described in the instructions. Besides you find the most important assumptions and safety measures for use and running the machine to guarantee a running without complaining.

We don't take the guarantee and responsibility for use outside the described purpose and without attention to the necessary assumptions and safety measures.

Only specialists are allowed to transport, set up, connect, put into operation, service and operate motors and generators. The specialist has to know the valid safety regulations and erection standards.

All work has to be controlled by responsible specialists.

The specialists have to be authorised for their work.

Specialists are people who

- are well skilled and have the experience
- know the valid standards, instructions, regulations and accident prevention instructions
- know the functioning and operating conditions of the electrical machines
- know and may avoid dangers

Non-qualified people and wrong use can lead to dangers for

- body and live
- the machine and further property of the user
- the efficient work of the machine

It's only allowed to operate a machine with the delivered accessories and material from ELIN EBG Motoren GmbH



The danger warnings characterised in this manual have to be considered especially.



Warning of dangerous electrical voltage.

Protection equipment



Insulated tools, isolating protective clothing, protection device, seat belts, devices and other aids must be received in perfect condition. The isolating protective clothing must be examined before each use by the user for obvious damage.

Damage to isolating protective clothing may be eliminated only by technically suitable workshops. Gloves may not be repaired however. Isolating gloves and shoes must be examined in certain time intervals also electrically for their protective effect.

Carrying of wrist-watches, rings and bracelets with the work is forbidden.

First aid measures by accidents with electrical current



By accidents with electrical current you should take the following measures:

- ◆ Interruption of circuit by switching off, by pulling the plug, by taking the safety device out.
- ◆ If these measures are not immediately possible, casualty must be pulled away from the electric circuit by using non conductive articles.
- ◆ Call a doctor!
- ◆ **Emergency call:**

Rescue guidance center Phone:

- ◆ Accomplish first aid measures up to the arrival of the doctor.
 - immediate placing in rest position
 - control of respiration and pulse
 - when respiratory arrest then breath donation
 - when cycle stop then heart-lung-revival
 - when unconsciousness and existing respiration then side storage
 - germ-free coverage of the fire wounds

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2 General description

Design

The synchronous machines are designed with external armature alternator. The three phase winding is placed in the stator. The rotor, constructed as drum-type rotor, carries the exciter winding and the damper winding. The exciting current comes from the brushes and collecting rings. The exciter unit consists of main exciter machine, rotating rectifier with voltage protection. The mounting of this unit is in overhung position. (Outside of bearings)

[See sectional drawing](#)

Standards and construction specifications

The construction of machines conforms to the regulations according to standards listed on data sheets.

Area of application

Only according to specification of your order. ([Data sheet](#))

Explanation of the abbreviations used in the text

DE.....Drive end (not the fan side)

NDE....Non - drive end (fan side)

Condensation outlet

There are outlet holes at the lowest point at the casing to allow condensation to be dispersed.

2.1 Constructional design of stator

Stator

The stator housing is of single section welded steel construction providing solid support for the core and the winding. Large openings ensure a good accessibility for inspection and maintenance. On DE the planetary gearing is connected to the flange. It is possible to change the bearing shell without disassembly of gear.

Stator core

The core consists of 0,5 mm thick laminations of high-grade alloy steel with both sides insulated. The core is assembled in several stacks separated by rigid steel spacers to provide radial cooling ducts. The core assembly is clamped under high pressure by end ring plates connected by welding through strong steel rods at the back of laminations.

Stator winding

The stator winding is of the fractional pitch, double layer type with form wound coils. A sealed class F VACUTAPE insulation's system is used. The temperature rise is according to class B.

System VACUTAPE

The insulation consists of tapes which are wound half-tapped. The tape is made of mica on carrier materials. In order to prevent any discharges the windings are provided with a corona protection varnish over the zone of slots. The insulated coils are located firmly in the open slots of the stator core using appropriate packing material and are held in place by means of slot wedges. Strong retaining rings on brackets supported and absorbent connection pieces between the coils and adequate designed bandages are provided.

The finished wound stator core is tested with special respect to correct wiring and voltage stress. After having successfully withstood these tests the complete core is impregnated under vacuum with epoxy-resin. Final polymerisation is done in a forced-air circulation oven. The so produced windings have a high mechanical and thermal strength and are hardly sensitive against humidity and aggressive gases and vapours.

After impregnation and polymerisation a quality control by loss-factor measurement is performed.

Space heater

To prevent condensation and moisture, the machines are equipped with a space heater.

For ratings and connections see data sheet, connection diagram and outline drawing.

[See connection diagram](#)

2.2 Constructional design of rotor

Shaft

The shaft, a welded spider type shaft construction of forged and rolled steel, annealed free of tension, is carefully machined and tested.

Rotor core

The rotor core consists of 1 mm thick laminations of high strength sheet-steel which are insulated on both sides. The core is sub-divided into individual sections in axial direction, and these are spaced by means of steel spacers. The ducts that are thus formed allow the axially flowing cooling air to radiate outwards, which means rapid dispersal of the heat due to energy losses created in the rotor.

The exact compression of the rotor core is held by heavy end plates, connected to the shaft by proper means. The rotor core is shrink fitted on the shaft and secured by means of round keys.

Excitation winding of rotor

The insulated coils of the excitation winding are inserted in half open slots of the rotor laminations and held by slot-wedges. The winding connections are brazed.

The coil ends are placed on proper supports and held firmly by means of high strength steel rings. The connection between the excitation winding and the exciter leads through a hole of the shaft. The concluding resin impregnation gives the rotor winding the high mechanical and thermal strength. Temperature rise according to insulation class B.

Damper winding of rotor

The bare damper bars are inserted stiffly into the half-open slots of the rotor core and are fixed in the middle of the core. Thin metal liners are used to provide good mechanical and electrical contact. The damper rings (end plates) are connected to the damper bars by brazing.

2.3 Bearing supports

Bearing brackets

The bearing brackets, made of thick rolled metal sheets, support the components of the bearing mountings. The exciter side bearing bracket has large openings to allow the maintenance of the bearing. The exciter is mounted on the bearing bracket.

2.4 Bearing arrangement

Sleeve bearings

Construction

The bearing housing, flange-mounting type, supports the bearing shell. The split housing and split shell are connected together by means of pins and bolts. The bearing shells have a spherical seat to provide self alignment and to avoid stress concentrations.

The bearing, drive end side, is designed as floating bearing and equipped with two axial thrust bearings, suitable for small loads in both directions. ([see appendix / sleeve bearings](#))

The shell is prevented from radial distortion by means of a cylindrical pin and a corresponding keyway.

The shells are lined with high-grade bearing metal and carefully machined to obtain exact clearances. The shaft journals are polished. The bearings are sealed off by split sealing rings. A pressure equalising sealing chamber prevents oil entering to generator. Machines with great drop of pressure have an additional pressurised sealing chamber.

The sleeve bearings are equipped without oil ring. Large motors have one bearing housing insulated from the bracket to eliminate circulating currents.

([See Data sheet](#))

Bearing temperature

According standards VDE 0530, § 16 and ÖVE-M10 may the bearing temperature rise 50 K over an ambient temperature of 40 °C. Normally, the bearing operating temperature should not exceed 80°C.

Higher operating temperatures may result in accelerated deterioration of the oil and more frequent changes may be necessary.

Bearing temperatures are monitored by the use of bearing thermometers. Equipment according to order. [See data sheet](#).

Bearing lubrication - circulating oil

Sleeve bearings with circulating oil lubrication have to be connected to a suitable oil supply system. Pay attention to feed the bearings with pure dynamo oil within a temperature range of +40 °C to 50 °C. The required quantity and quality of oil and the essential oil pressure in front of the bearing are stated on the outline drawing and in the [data sheet](#).

The calculation of the essential oil is based on a normal 8 K flow-heating. ([See Data sheet](#))

The cooling oil is lead directly to the shell. A flow control valve in front of the bearing serves as an exact dosing device for the oil through-put. The oil drainage pipe must be of sufficient size and diameter as well as gradient to allow a free reflux of the oil.

2.5 Cooling

March through -ventilation, closed cooling cycle

The machine is internal ventilated on both sides. The cooling cycle is closed. The cooling air moves through the cooling ducts of rotor forced by a fan which is placed on DE and NDE of rotor. Special air guides are responsible for effective cooling of stator and rotor.

The type of cooling and values of air-water heat-exchanger according to data sheet. ([Data sheet](#))

The direction of air stream an arrangement of heat exchanger is shown in drawing. ([Outline drawing](#))

2.6 High voltage terminal box and current leads

High voltage terminal box, Y-connection terminal box including current transformers

The stator terminal box is made of welded steel sheets. It consists of the bottom part which is screwed to the stator and the removable cover.

In order to prohibit breaking of the terminal box in case of a short circuit fault between terminal bars, there is a predetermined breaking point on the bottom side of the terminal box. This predetermined breaking point protect the service staff and devices against exploding parts.

The ends of the stator winding are brought out to the terminal box (U1, V1, W1) through gland seal screw connections. These bushings are fixed to a terminal plate which is separated from the bottom part of the terminal box. The voltage transformers also leads to this connection point.

In a separate terminal box the Y-Connectors are connected with the current transformers. The second end of connectors are coupled by a copper bar to Y-Connection point.

The secondary connections of current and voltage transformers are wired to an auxiliary terminal box which is lateral installed.

The mains cables are carried through gland seal screw connections to the terminal box.

This gland seal screw connections have to move on cables before connecting to main terminals.

The placement of terminal boxes ([Outline drawing](#)) and numbers and size of cable entrance is shown on drawing. The terminal connections are according [connection diagram](#), [Data sheet](#))

Auxiliary terminal boxes

The Synchronous Generator is equipped with auxiliary terminal boxes. The position, arrangement and connecting dimensions are to be obtained from the confirmed [outline drawing](#).

The connections for measuring and control devices and also the space heater are made inside the auxiliary terminal boxes ([Connection diagram](#)).

Design

The required number of terminals are placed inside split aluminium diecasted housings. Each terminal is marked with a destination plate.

The destinations comply with the connection diagram provided in each terminal box.

The cable entry is done via stuffing boxes.

Exciter terminal box

The exciter terminals are placed in a terminal box. The position, arrangement and connecting dimensions are to be obtained from the confirmed [outline drawing](#). The connection is shown in the [connection diagram](#).

Design

The required number of terminals are placed inside split aluminium diecasted housings. Each terminal is marked with a destination plate.

The destinations comply with the connection diagram provided in each terminal box. The cable entry is done via stuffing boxes.

2.7 Vibration behaviour

Quality of balancing

The rotors are dynamically balanced at rated speed. The quality of balancing complies with class "G 2,5" according to DIN ISO 1940 standard.

Intensity of vibration

The vibration can be evaluated by using the amount of vibration at the bearing housing measured as the effective vibration speed. These machines conform with the guidelines according to EN 60034-14, Table1 (Step "R").

2.8 Excitation system

General

The excitation system is composed of brushless exciter, synchronous exciter with salient poles and rotating armature, rotating rectifier bridge with varistor voltage protection and Permanent magnet generator (PMG).

The PMG supplies the power to automatic voltage regulator ([Thyne 3](#)). The electronic regulator provides excitation to brushless field winding.

The energy generated by the synchronous exciter is transferred to the rectifier - bridge and from here to the rotor of the main generator, without the use of slip - rings and brushes. Optionally for measurement- purposes it is possible to connect slip rings as well.

Non-linear resistances are connected across the rotor field winding to provide path for the negative sequence currents. The synchronous exciter armature and the rectifier - bridge are mounted on separate shaft connected to the main generator rotor.

Stator

The stator core lamination is made of good magnetic characteristic steel sheets, punched according to a salient profile, locked and pressed by means of tie rods and core pressing plates. The excitation coils are anchored on the poles. The excitation winding consists of enameled wires wound up in coils. The pole coils so obtained are taped several times with mica paper. The coils are fixed to the poles by pole shoe and special adhesive. The coils are connected in series and the two ends are connected to external terminal box. On the pole shoes there are one or two special windings: one for diode failure monitoring and an other for indirect diode current measurement.

Rotor

The rotor core consists of low iron losses silicon steel laminations with high mechanical characteristics. F class type insulating varnish is applied on both sides of the silicon steel sheets. The semi - closed slots are punched on the core outside provided for the rotor winding. The rotor winding is a three phase, two layer concentrated winding. Phase connection 2//D. Conductors are composed of enameled elementary wires of class F insulation. Ground insulation consists in a slot lining made with class F materials. Insulation cylinders internally support the end windings protected with glass cloth. The assembled rotor is impregnated under the vacuum with polyester resin.

Rotating rectifier bridge

The rotating rectifier is of the three- phase type with single diode per arm. The supporting structure of the rectifier- bridge is a welded steel structure. Diode in each phase of this bridge are built up on aluminium alloy heat sinks, which are separated from each other and assembled on the insulated disk.

The output current is fed directly from the rectifiers to the field winding of the main generator via connection inside the shaft.

Ventilation

Exciter is connected to the main ventilation circuit of the generator via air duct. In order to provide sufficient air flow rate there is a radial type fan in the exciter. Air flow cools down the rectifier bridge, stator and rotor windings.

2.9 Electronic voltage regulator

The regulation of the energizing current need is taken place via a digital regulator [Thyne 3](#). The [Thyne 3](#) regulator is equipped with all necessary signals and protection tools. The exact description of the [Thyne 3](#) regulator you can find in the appendix. The connections to the terminal boxes you can find in the [connection diagrams](#).

2.10 Auxiliary equipment and protective devices

2.10.1 Slot thermometer

For measuring the winding temperature Pt 100 (100 Ohm at 0 °C RTD's; PT-Calibration see [appendix](#)) are installed in each phase of the winding between the upper and lower coil in the slot. The numbers of winding temperature sensors is given in [Data sheet](#). Connections are made to an auxiliary terminal box.

2.10.2 Iron thermometer

To control the stator core temperature there are mounted resistance thermometers PT100 in the stator back. Connections are made to an auxiliary terminal box.

2.10.3 Bearing thermometer

To control the bearing temperature each bearing is equipped with a double probe resistance temperature detector Pt 100. (100 Ohm at 0 °C RTD's). Connections are made to an auxiliary terminal box.

Additional to the standard equipment a pointer thermometer on each bearing is installed. Furthermore a double resistance thermometer for supervision of the oil temperature is installed in each oil sump.

2.10.4 Cooling air monitoring

On one side of stator and winding there is a double resistance temperature detector mounted, which observes the inlet air temperature on one side and the outlet air temperature on the other side.

Additional to the standard equipment a pointer thermometer for supervision of the air in- and outlet is installed.

2.10.5 Bearing vibration monitoring

For supervision of bearing vibrations detectors are mounted in x-direction. For detectors in y-direction a whole is provided.

2.10.6 Space heater

To prevent condensation and moisture inside the generator a stand-by heater is used. The standby heater is placed on each side on the centre section of stator core. Connections are made to an auxiliary terminal box. Technical data of space heaters is given on [data sheet](#).

2.10.7 Rotor – Earth brush

Between the bearing and the sealing of the gear on DE – side is a rotor – earth brush installed. In a double brush holder there are 2 silver – graphite brushes installed. These brushes are only for one direction of rotation installed.

3 Technical data

3.1 Data sheet

TP-synchron-generator

Type: HTM 110 E10

3.2 Operating conditions

Erection: indoor

Height over sea level: < 1100m

Ambient temperature min, max: 0 / +40 °C

Driving machine: Pelton turbine

Coupling: fastened via clamping set

Axial Bearing clearance: $\pm 0,25$ mm

Duty: S1

3.3 Electrical data

Standards: EN 60034

WS-Exciter: WP 50, brushless with rotating diodes

Insulation class: "F"

Temperature rise: Stator and rotor "B / B"

Apparent Power: 11.000 kVA

Rated output: 8.800 kW

Rated terminal voltage: 6.000 V +/- 5 %

Rated current: 1.059 A

Frequency: 50 Hz

Connection: star (insulated)

Rated speed: 600 1/min

Overspeed: max. 1080 1/min % (max. 5 min)

Power factor: 0,80

Efficiency:

- with tolerance acc. to IEC
- incl. losses in the exciter, incl. losses in the bearings

Load	:	100	75	50	25	(%) Sn
cos phi = 0,8	:	97,29	97,29	96,96	ca. 95,38	(%)
cos phi = 0,9	:	97,71	97,69	97,39	ca. 95,95	(%)
cos phi = 1,0	:	98,15	98,15	97,88	ca. 96,59	(%)

Unbalanced load (I₂/I_N) 10 % (permanent)

Unbalanced load (I₂/I_N) 2 x t 15 sec.

Excitation voltage at no load: acc. Test report

Excitation voltage at nominal load: acc. Test report

Excitation current at no load: acc. Test report

Excitation current at nominal load: acc. Test report

Rotor

Cylindrical rotor

Voltage at no load: acc. Test report

Voltage at nominal load: acc. Test report

Current at no load: acc. Test report

Current at nominal load: acc. Test report

Generator HTV-110 D10

Rated Power	P [kW]	8800
Apparent Power	S [kVA]	11000
Rated voltage	U [kV] Tol. +/-5% Y-conn.	6
Rated current	I [A]	1059
Rated frequency	f [Hz]	50
Rated speed	n [rpm]	600
Overspeed (for max.2 min)	no [rpm]	1200
Powerfactor	cos (phi)	0,8
Moment of Inertia	J [kgm ²]	2600
Sudden short-circuit current	p.u.	13,7
Sustained short-circuit current (p-fact = 0,8)	p.u.	1,71
<i>Time Constants at 20°C</i>		
No-Load Direct-axis Transient	Tdo' [s]	3,735
No-Load Direct-axis Sub-Transient	Tdo'' [s]	0,029
Short-circuit Direct-axis Transient	Td' [s]	0,547
Short-circuit Direct-axis Sub-Transient	Td'' [s]	0,023
Short circuit armature	Ta [s]	0,135
<i>Reactances</i>		
Direct-axis subtransient reactance	Xd''unsaturated [p.u.]	0,207
	Xd''saturated [p.u.]	0,186
Direct-axis transient reactance	Xd'unsaturated [p.u.]	0,263
	Xd'saturated [p.u.]	0,237
Direct-axis synchronous reactance	Xd unsaturated [p.u.]	1,799
	Xd saturated [p.u.]	1,583
Quadrature-axis subtransient reactance	Xq'' unsat [p.u.]	0,251
Quadrature-axis transient reactance	Xq' unsat [p.u.]	1,799
Quadrature-axis synchronous reactance	Xq unsat [p.u.]	1,799
Potier's Reactance	Xp [p.u.]	0,180
Zero-sequence Reactance	Xo [p.u.]	0,095
Negativ Sequence Reactance	X2 [p.u.]	0,229
Stator stray reactance	X1sigma [p.u.]	0,153
Rotor stray reactance	X2sigma [p.u.]	0,119
Stator winding resistance	R1 [Ohm] at 20°C	0,0122
Rotor winding resistance	R2 [Ohm] at 20°C	0,9310
Short circuit current		
Sudden short circuit current (peak)	i [^] [A]	14500
Subtransient short circuit current	Ik'' [A]	5700
Sustained short circuit current	Ik [A]	1810

3.4 Mechanical data

Standards:	EN 60034
Direction of rotation generator:	left hand side (view on DE)
Type of construction:	IM 7211 (B3) (shaft ends cylindrical)
Type of enclosure:	IP 44 (exciter: IP 23)
Corrosion protection:	K2 acc. to DIN 50019, DIN 50014
Final painting:	RAL 2002
Cooling:	IC 81 W
Air gap:	9 mm
Moment of inertia (Generator):	2600 kgm ²
Mass:	46800 kg
Balancing:	G2,5 acc. to DIN ISO 1940 with half key
Smoothness of running:	Grade A acc. to EN60034-14 at rigid mounting
- (v_{eff} = max. 2,8 mm/s) at overspeed it can be more	

Cooler (both side vented)

Quantity:	1 cooler
Cooling water quantity:	ca. 52 m ³ /h
Cooling water quality:	30 % Glycol
Water – inlet temperature:	15 – 30 °C
Water – temperature rise:	max. 5 K

Sleeve bearings with forced oil lubrication

Pillow block bearings

Fixed bearing:	DE (insul.)
Flouting bearing:	NDE (insul.)
Type DE:	EGZLK 35-400 isol., abnormal
Type NDE:	EGZLQ 35-400 isol., abnormal
Oil quantity	AS 35 l/min – BS 20 l/min
Oil pressure:	0,5 bar
Oil quality:	ISO VG 46 (Panolin)

3.5 Terminal box connections

Main terminal box (1x)

Winding terminals:	U1 V1 W1 U2 V2 W2
Kind of prodection:	IP 44
Location:	on the left hand side (view on DE)
Number of clamps:	3
Cable entrance:	from bottom
Cable entrance size:	9 x M63x1,5 (Ø 30-40 mm)

Auxiliary terminal box(es)

Kind of prodection:	IP 54
Location:	see utline drawing
No. of cables:	3 per phase
No. of cable glands:	9
Cable outhter diameter:	32,5 mm

3.6 Temperature control – auxiliary equipment

Stator winding: 6 pcs. PT100
 Stator core: 3 pcs. Fe- PT100

Bearings: 1 pcs. double - PT100 on each bearing
 1 pcs. double - PT100 in the bearing sump each bearing

Cold Air: 1 pcs. double - PT100
 Warm Air: 1 pcs. double - PT100

All PT100 in 4-wire execution from connection claps (without monitoring equipment)

Space heater: 400 V, 50 Hz

1 pointer thermometer each bearing (without contacts)
 1 pointer thermometer for warm air (without contacts)



Guide values for adjustment of tripping values

Measuring points	Permissible operation temperature	Adjustment T=operating temperature	
		Warning	Disconn.
Stator winding Temp. rise acc. to Ins. Cl. F	max. 120 °C	T+10K	T+15K
FE-Thermometer	max. 105 °C	T+ 10K	T+15K
Sleeve bearing	max. 85°C	T+5K	T+10K
Cold air after cooler	max. 45°C	T+10K	T+15K
Warm air before cooler (forced air cooling from two sides)	max. 75°C	T+10K	T+15K
Ambient temperature	40°C		

3.7 Exciter (526413)

Type:	WP 60
Rated output:	100 kW
Rated voltage:	ca. 347 V
Rated current:	ca. 288 A
Rated speed:	600 (1200) 1/min
Frequency:	120 Hz
Rated load of exciter field:	ca. 2200 W
Field winding resistance:	11,54 Ohm (at 120 °C) 16,07 Ohm (at 120 °C)
Rectifier connection:	Three phase – bridge connection
Rectifier unit:	Rotating rectifier
Diode:	6x Avalanche DA 807-880-26

4 Transportation and storage

4.1 Transportation

The generators are delivered completely mounted. The cooler housing and the cover of the terminal box will get disassembled because of better handling and transportation. The openings are covered with plates. Fastening bolts and taper pins are included in the packaging. In principle all the supporting shims required to align the equipment properly are included in the supply. The packing is done as ordered.



Before lifting of the motor with the help of lifting bolts, the cooler housing must be disassembled

Dimensions and weights

The dimensions and weights can be inferred from the [data sheet](#) and the [outline drawing](#).

Rust protection

All bare surfaces which are susceptible to rust will be given a protective coating before being packed. The storage surfaces of the sleeve bearings are covered with rust-protection oil. This oil has not to get removed when filling the bearing with normal oil.

Transport safeguard

For the protection of the bearings, the machine is equipped with a transport protection device. Corresponding instruction plates are placed on the machine.



Before operation the safeguard device must be loosened!

Package disposal

The package must be disposed by the local waste industry law.

4.2 Storage

The machines should be stored in a dry, vibration-free and well ventilated room.

For a storage more than six months the following points should be accomplished:

Bearing shells DE and NDE has to be disassembled and HGW-strips has to be inserted between rotor- and stator coil.

Disassembling of the outer and inner sealing rings. Coating of the bearing shell, bearing head and the bearing carrier of the shaft with special oil from the manufacturer.

Coating of the shaft end, the patches of the bearing head as well as the foot surfaces with a corrosion protection agent e.g. "Tectyl 506"

Switching on the space heater* and lock the cable entries, or: weld the engine into plastics under bringing in of "Silicagel".

Remove all preservation measures before start-up again!

If a very rapid availability (up to six months) of the machine should be demanded due to the management, we recommend to accomplish the following points:

1. Storing of the machine in a dry, vibrationless room.
2. Coat the shaft end and the foot surfaces with a corrosion protection agent e.g. "Tectyl 506".
3. The sleeve bearings has to be coatet with STP- oil during the storage time.
Before start up the machine has to be filled with oil.
4. Locking of the cable entries and switching on the space heater*.

*only for machines equipped with space heaters.

Before start up the isolation resistance of the windings has to be measured and possible moist windings has to be dried. ([see chapter 5.3](#))

5 Assembling and operation

5.1 Installation and alignment

Trained personnel and precise tools are needed for exact installation and alignment. The alignment of the generator occurs with screwed on foundation plates and shaded plates by means of levelling spindle.

The axis middle will get complied with a tolerance shown on the dimension drawing. Shaded plates with a thickness of total 11 mm allow an exactly height – adjustment. The foundation plates are to cast with shrinkage-free potting compound. After curing of the potting-compound there is an exactly control or correction of the machine alignment necessary.

The bearing on DE - side is a locating bearing. Therefore a setting of the magnetic middle is not necessary.

The alignment and coupling from the gear mechanism to the turbine has to be done by means of the instructions of the manufacturer of gear mechanism and turbine.



The ND lateral bearing transport locks are to be removed before assembly.

Bearing oil supply connection

The sleeve bearings with circulating oil lubrication have to be connected together with the gear mechanism to a common oil supply system. Pay attention , that only a clean dynamo oil in a temperature range of +40 °C up to max. 50 °C is used for the lubrication of the bearings. The required quantity , quality and pressure are shown on the lubrication plates and on outline drawing. See also data sheet.

The oil will be supplied direct to the bearing shell. The volume can be regulated by mean of a valve. For data of the gear mechanism oil see instructions of the manufacturer.

The bearings are designed without lubrication rings. In case of fail function of the oil supply the bearings will be damaged in a very short time.

A second oil supply is required.

Mounting of the cooler housing

The cooler housing has to be fastened from down by the lateral stator boxes with 8 screws.



The 3 transport – cover plates on the stator must be disassembled before mounting the cooler housing.

Cooling water supply

The air-coolers must be connected to a cooling water supply. For Cooling water data see [Datasheet](#).

To avoid large amounts of moisture condense, the cooling water temperature should not fall below 15°C. (air humidity in the middle range).

5.2 Electrical connections



Not to loose the IP – type of protection, you must duly close the terminal box after the connection.

Line connection

The line connection must be as per the connection diagram fitted to the inside of the terminal box.



If the direction of rotation of the generator is "right" (view from DE), the direction of rotation of the gear mechanism – entry is "left".

Connection of instrument lines, current and voltage, space heater

The connection must be as per the connection diagram fitted to the inside of the terminal box.

Earthing connection

An earthing terminal is located on the machine casing labelled with an earthing symbol and suitable for earthing conductor or strip for the earth connection.

Another earthing terminal is placed inside the terminal box for earthing of the cables.



At the end of mounting or after maintenance work, where the potencial reconciliation was interrupted, the earthing resistance [acc. to 5.3 and 6.5](#) is to test and to log.

Earthing conductors should have a cross-section as follows:

Main-short circuit power	Minimum cross-section of Cu-conductor at a nominal voltage			
	6	kV	10	kV
< 200 MVA	70	mm ²	70	mm ²
>200-250 MVA	95	mm ²	70	mm ²
>250-350 MVA	150	mm ²	95	mm ²
>350-500 MVA	185	mm ²	150	mm ²
>500-800 MVA	---	---	185	mm ²

5.3 Start up of machine

Checking of insulation resistance

The machine is equipped with windings being insensitive against humidity. Nevertheless humidity will condense under unfavourable climatic conditions on the surface of the windings, the parts surrounding the windings, and on the supports and connections to the terminals.

By this fact, it is important to measure the insulation resistance towards earth before first start up and after extended outage.

If the winding is connected in star or in delta it is sufficient to determine the insulation resistance of one phase towards earth. The insulation resistance depends on the temperature of the winding. For justification of the insulation condition it is essential to measure the insulation resistance R (in M) during 1 minute by means of DC-voltage. A measuring voltage of 1000 V is preferable. In doing so the temperature of the winding has to be approximately determined.

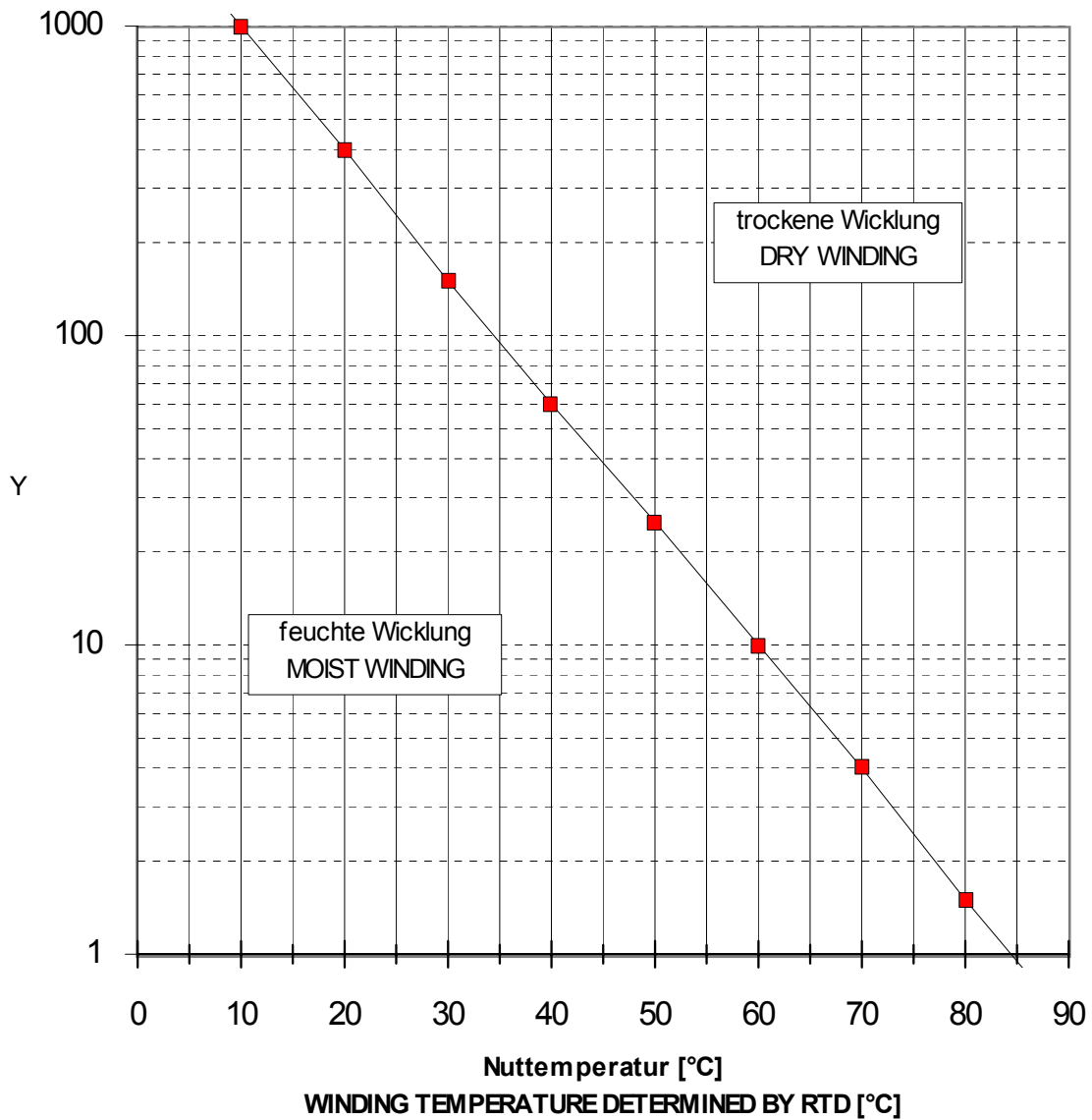
In order to obtain an evaluation hardly depending on the size of the motor the capacity C (μF) towards earth has to be determined, too, or taken from the test certificate.

The measurement of the capacity may be done by means of a capacitance measuring bridge or can be taken from a measurement of current voltage using 230 V AC. The product of insulation resistance and capacity is to be listed in the enclosed diagram over the determined winding temperature. Depending on the location of the point within the ranges "DRY WINDING" or "MOIST WINDING" the motor is ready for starting-up or has to be dried out by proper means until the condition for starting-up is achieved.

The drying out should be done with warm air taking care of the possibility of air exchange. Any method of drying that involves heating the winding must be checked and controlled so that the winding temperature in the stator and rotor does not exceed 60 °C. The manufacturer is always at your disposal if you need additional information's in special cases.

Diagram see next page!

INSULATION TIME CONSTANT



Y => Isolationszeitkonstante T / INSULATION TIME CONSTANT T

$$T = R \text{ [M}\Omega\text{]} \times C \text{ [}\mu\text{F}\text{]}$$

Operation of heat exchanger

Before each start-up of the machine, the cooling water supply is to be started and the function to be controlled. For cooling water data see [data sheet](#).

During first operation the quantity of cooling water must be set, taking care of the winding temperature not to exceed the allowable temperature.

See description of the supplier of the heat exchanger in the [appendix](#).

Starting-up sleeve bearing circulating oil lubrication

Before every starting-up the oil supply system has to be switched on and checked for proper operation.



The oil flow, the oil pressure and oil level in the bearing has to be checked. During the first operating hours the rotation of the lubrication ring must be checked.

In case of fail function of the oil supply the bearings will be damaged in a very short time.

Start-up of the control devices and voltage regulator

Functional test of the calibration of the external measurements will be done during the start-up.

The parameters of the voltage regulator are also programmed during the start-up.

(see manual of the supplier of the voltage regulator.)

Checklist for First startup

The machine is surely installed:

Screws fixed fast?

Machine mounting pads pined?

After longer storage or stop:

Insulation resistances of the windings of ok?

Examine the electrical connections:

Correct connection?

Perfect condition of the terminals?

Terminal distances ok?

Mechanical firmness given?

Electrical conductivity?

Protection device:

Everything ok?

None manipulates?

Function control?

Transport safeguard devices:

Are all from the generator shaft removed?

Transport – cover plates:

Are all transport - cover plates under the cooler housing removed?

Examine the free movement:

Correct adjustment?

Lock the covers and cover plates:

Are all again properly locked?

Examine the direction of rotation:

The machine turns into the correct direction?

Oil supply:

Flow rate, oil level and temperature ok?

Abnormal behavior:

Vibrations?

Noise?

Temperatures?

Cooling:

Sufficient cooling ensures?

Cooling water flow rate and temperature ok?

Bearing:

Lubrication ok?

Rotation of lubrication rings?

Machine is ready for use!

The first start up was accomplished by:

[Confirmation to manufacturer](#)

Name:

Date:

Company:

Signature:

.....

.....

6 Service, Maintenance

General



Before starting any work on the machine, make sure to ascertain that it has been shut down and protected against any restart!

The type of operations management and the circumspection exercised in maintenance are of a general significance for the useful life of the machine.

One of the most important factors is to keep all cooling air pathways clean. Therefore, it is necessary to clean the machine at regular intervals to be determined at the plant and to be adapted to the ambient conditions.

In addition, the machine must be inspected at regular intervals for its balance quality, any abnormal operating noise, and other alterations, and their causes must be found and remedied. The frequency of such checks shall be adapted to the operating conditions. In normal operating conditions, we recommend to carry out a machine revision after no more than **two years** in operation.

6.1 Maintenance of bearings

Sleeve bearings forced feed lubrication

If the initial operating instructions are observed, the maintenance of the sleeve bearings is restricted to periodic temperature checks, oil level checks and observance of the oil change intervals. (According to company RENK you must change the oil every **20.000 operating hours**). The inspection hole in the casing should be used to check the proper turning of the lubricating oil ring (**every month**).

During the first days and weeks of operation or after a change of the bearing shell, the bearings have to be watched carefully, particularly the oil level, oil flow and bearing temperature should be checked regularly.

Oil changes have to be made if necessary. Use only high grade non-foaming oils. More precisely oil-specifications you will get from the gear manufacturer.



If for whatever reason the bearing temperature rises more than 80°C, the equipment must be switched off and the reason for this abnormal rise in temperature ascertained.

If the lining of the bearing shell is very worn it should be renewed or replaced by a new bearing shell. See also description of the bearing manufacturer. ([Appendix](#))

6.2 Maintenance of windings

Cleaning

Dust and dirt are the biggest enemies of all mechanical equipment, particularly of stator windings. Depending on the amount of dirt, they should be cleaned when checked. Increased winding temperatures are usually the result of a dirty winding, or dirt in the cooling air ducts or in the heat exchanger itself. In order to ensure that no damage is done to the insulation, no tools with sharp edges may be used for cleaning the winding.

Windings covered with loose dust should be blown out thoroughly using dry compressed air or cleaned by means of a vacuum cleaner. Wipe down sticky dirt and dust with a dry cloth, and this applies to oily patches too. Where the dirt is stubborn, moisten a clean cloth using Eskanol and then wring it well, so that the solvent only attacks the dirt on the surface. Wipe down treated area with a dry cloth and remove all solvent traces.

If layers of paint are attacked despite careful cleaning, they should be repainted where deficient using an insulating paint which resists oil and which dries naturally.

The paints used must be compatible with those used by the manufacturers. Please consult us if is any doubt.



After removing the penetrated liquid the insulation resistance of the windings has to be tested ([see 5.3](#)) and logged.

6.3 Maintenance of cooler – disassembly

Maintenance

For maintenance of cooler see description of the manufacturer. See [data sheet](#) and [appendix](#).

Maintenance overview

maintenance work	period of time
cooling water analysis	1 year
water flow measuring, inlet – outlet temperature control	1 month
inside cleaning	1 year
corrosion control	1 year
sealings, valves inspection	3 months

The specifications in the maintenance plan are recommended minimum entries and do not apply after longer downtimes. They have to be adapted to the ambient operating conditions and do not give a operating warranty at compliance.
A detailed description of the cooler is to find in the appendix.

Dismantling

The cooler is fixed at the machine via an air -direction changing box. See [outline drawing](#). The fixing has to be done on both sides with a pressure-frame.
If it is necessary to change the cooler, the water connections and the pressure frame have to be disassembled. Afterwards the cooler can be slided out on one side.

6.4 Maintenance of rotor – earth brushes

The rotor – earth brushes must be checked **every 6 months** and changed if necessary.



After changing the earthing brushes, the transitions resistance of the brushes has to be tested.



The brushes can be used only for one direction of rotation! See direction of rotation arrow on the brushes!

6.5 Maintenance schedule

Maintenance work	Maintenance rate
General machine revision:	2 years
Oil change:	20.000 Operating hours
Cooling water analysis:	1 year
Water flow measuring, inlet – outlet temperature control:	1 month
Inside cleaning of cooler:	1 year
Corrosion control of cooler:	1 year
Sealings, valves inspection:	3 months

7 Disassembling

7.1 Disassembling of the generator

- 1) Disassembling of the gear mechanism
- 2) Removing of bearing oil
- 3) Disassembling of oil pipes
- 4) Removing of the covers beside on the stator boxes
- 5) Disassembling of the cooler housing
- 6) Dismantling of the upper parts of the bearing heads on DE and NDE
- 7) Disassembling of the sealing rings on the inside of the bearingshell on DE and NDE.
- 8) Disassembling of exciter ([see disassembling of exciter](#))
- 9) Drawing off of the exciter-exhauster
- 10) Disassembling of the swimming seal between NDE – bearing and exciterexhauster
- 11) Hanging up of the rotor with the device on the place where the sealing rings are located. Do not increase more than **0,3 mm**! See drawing: [Rotor lifting mechanism](#)



The rotor must not get layed down in the stator core !

- 12) Dismantling of the bearing shells (see [appendix](#))
- 13) Disassembling of the devided mechanism sealing-ring and the mechanism cover-shield.
- 14) Disassembling of the air-channel below the NDE – bearing
- 15) Unscrew and laying down of the bearing head lower parts on DE and NDE
- 16) Pull out of the rotor with dismantling device (see drawing: [Rotor disassembly device](#))



**The rotor must not get layed down in the stator core!
The rotor-winding-bandages can damage the stator winding.**



Also if the rotor will get layed down on the base, it should not get placed on the winding-headbandages.

7.2 Disassembly and assembly of exciter

(Exciter, PMG, rectifier)

Stator

- 1) Remove cover and mount PMG lifting device
- 2) Disconnect PMG stator winding outgoing cables.
- 3) 0,8 mm thick press-span shall be inserted in the air gap of the PMG around the periphery. Remove PMG stator by lifting.
- 4) Unscrew housing fixing screws. During removal of housing, PMG cables shall be drawn through cable duct of the housing.
- 5) Now main exciter stator with poles is accessible for mounting.

Rotor

- 1) Remove cover plate
- 2) Unscrew 5 pcs. of PMG rotor fixing M12 screws. Remove PMG rotor with the help of 5 pcs. of M12x170 bolt shanks without heating. In case of assembly the rotor hub can be heated up to 80 °C absolute temperature. Avoid direct heating of poles.
- 3) Remove inter-connecting pieces between diodes and rings. Remove M10 bolts fixing rings and cable connections.
- 4) Unscrew 4 pcs. of M10 x 60 bolts fixing ring assembly. Unscrew varistor cable connections on the rings. Remove ring assembly.
- 5) Now rectifier assembly rectifier outlet fixing M12 nuts are visible. Unscrew nuts. Unscrew (only 2 pcs. out of the four pieces) M6 hexagon-socket head screws fixing varistor to the hub. Unscrew M10 bolts at the bottom of the heat sink fixing winding ends.
- 6) Remove loose rectifier assembly. Remove M10 bolts of winding connections and cable connections.
- 7) Unscrew M16 bolts fixing rectifier hub. Remove shear pin. Remove rectifier hub.
- 8) Now main hub fixing screws are accessible. Remove main hub fixing hexagonsocket head screws (4 pcs.)
- 9) Remove rotor by using the detaching device (See drawing: [Push on and pull off device](#)).

The assembly of motor is done in the reverse order to the sequence of disassembly. Check tightening torque.

7.3 Trouble shooting

Diode replacement

- 1) Disassemble exciter as described before.
- 2) Disconnect diode connections. Check diodes piece by piece. Faulty diodes shall be replaced.
- 3) Assembly shall be made in opposite order of disassembly.
Tightening torque for diodes thread 3/4"-16 UNF-2A : 50 Nm
Tightening torque for diodes-nuts thread 3/8"-24 UNF-2A : 12 Nm

Varistor replacement

- 1) Disassemble exciter as described before.
- 2) Disconnect varistor connecting cables and check the varistors piece by piece.
- 3) If replacement is needed unscrew M6 hexagon-socket head screws. Varistor can be picked up and replaced.
- 4) Assembly shall be made in opposite of disassembly.

8. Warranty / Failure

In case of any warranty claims, the "General Terms of Delivery of the Austrian Electric and Electronic Industry" shall apply for goods supplied within Austria.

For supplies to foreign countries, our "General Terms of Delivery" shall apply. They are essentially based on the recommendations of the "United Nations Economic Commission for Europe".



We want to emphasize that we will not assume any liability in case of non-observance of this Installation, Operating and Maintenance Instruction.

We also can not take on the liability resp. guarantee for damages on the machine which has been caused by independent works resp. not under the supervision of experts of our company.

Not to lose the right to guarantee, please inform in any way our department „Services“

ELIN EBG Motoren GmbH

Dep. Services

Elingasse 3

8160 Weiz

Austria

Phone: (+43/3172) 90 606 – 2463-0

Fax: (+43/3172) 90 5850

E-mail : serviceemg@elinebgmotoren.at

Failure



If there occurs any failures you must switch off the machine and please contact our service-department (address see above). In the appendix you have some failure reports which you can send us by fax. So we can treat your failure diagnosis faster.

Electronic failure report

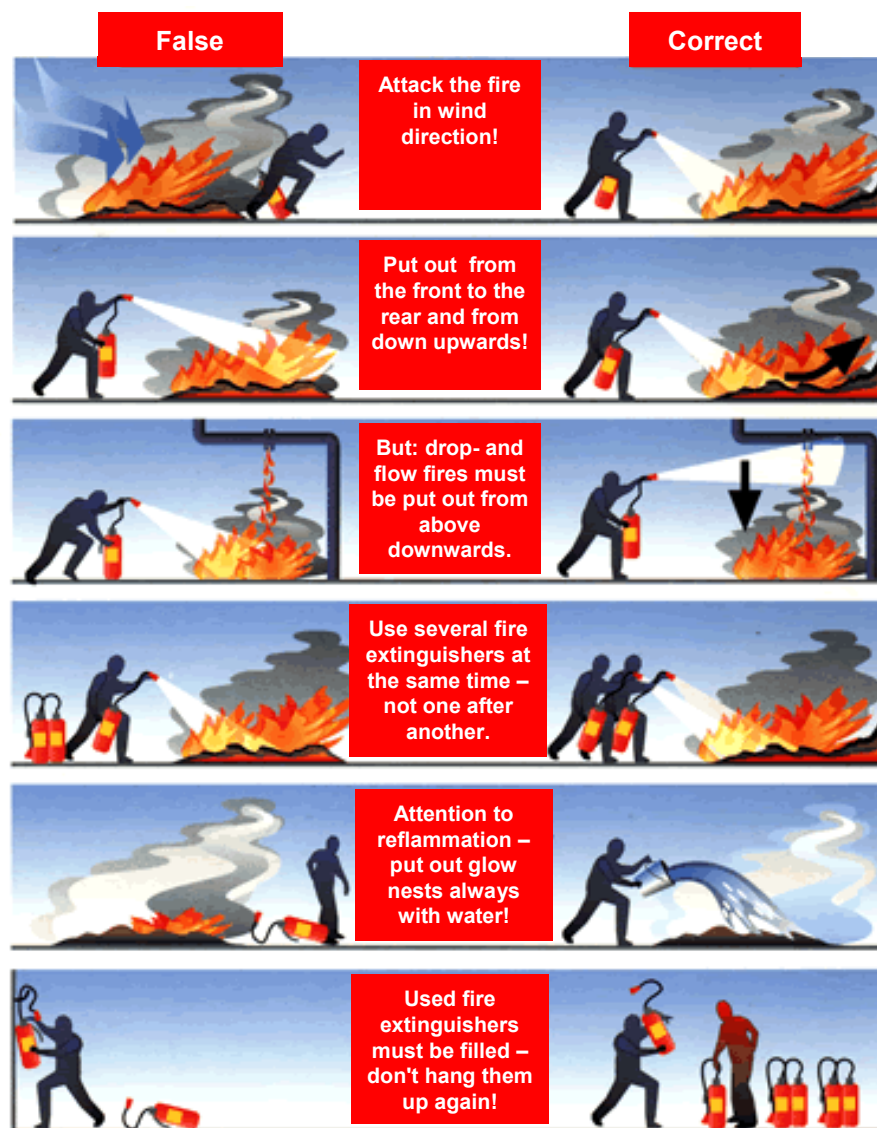
We Keep the World in Motion	Issue no:	01	Page:	36 to 43
	Date:	08.10.2008	Filename:	BTHB_526406_E_01

9. Emergency data

Fire fighting



- 1) Switch off the machine immediately
- 2) Secure against restarting
- 3) Contact the fire department and refer to electrical fire
- 4) Fight fire with suitable extinction agent (e.g. CO₂ - Fire extinguisher)



First aid measures by accidents with electrical current



By accidents with electrical current you should take the following measures:

- ◆ Interruption of circuit by switching off, by pulling the plug, by taking the safety device out.
- ◆ If these measures are not immediately possible, casualty must be pulled away from the electric circuit by using non conductive articles.
- ◆ Call a doctor!
- ◆ **Emergency call:**
Rescue guidance center Phone:
- ◆ Accomplish first aid measures up to the arrival of the doctor.
 - immediate placing in rest position
 - control of respiration and pulse
 - when respiratory arrest then breath donation
 - when cycle stop then heart-lung-revival
 - when unconsciousness and existing respiration then side storage
 - germ-free coverage of the fire wounds

10. Spare Parts

10.1 Spare parts inventory

A list of the parts subjected to wear is attached to the specification. This list shows those parts which are usually required. There is a precise distinction between parts subjected to normal wear and tear, which can therefore be regarded as "required" spare parts, and parts that might become faulty and are therefore merely "recommended" spare parts.

10.2 Order procedure

Ordering address:

ELIN EBG Motoren GmbH

Dep. Services

Elingasse 3
8160 Weiz
Austria

Phone: (+43/3172) 90 606 – 2463-0

Fax: (+43/3172) 90 5850

E-mail : serviceemg@elinebgmotoren.at

Necessary data for a perfect order processing:

Machine data:

Type: HTM 110 D10
Serial no...: 526406 08001

Data of spare parts: (e.g.: Bearing thermometer DE)

Stock no. : 24467
Spare part : 2* PT100, G1/2, EL=380
Quantity : 1 piece

Spare part list

Spare part which are recommended by manufacturer:

○ Spare parts inventory necessary

✱ Spare parts inventory recommended

Spare part		Pcs.	Type-Drawing No.	Stock-No.
Sleeve bearing shell DE	○	1	E-ZLK 35-400 AXTH	24000
Sleeve bearing shell NDE	○	1	E-ZLQ 35-400	24001
Seal ring for Sleeve bearing DE / NDE	✱	3	Renk Typ 20, D=425	25028
Seal ring for Sleeve bearing DE	✱	1	Renk Typ 20, D=450	25029
Oil ring for Sleeve bearing DE / NDE	✱	1	Renk size 35-2	25030
Bearing thermometer DE / NDE	✱	2	2* PT100, G1/2, EL=380	24467
Air thermometer	✱	1	2* PT100, G3/4, EL=150	5132220
Rotor – earthing brush	✱	4	2510 G5/AG51	979253
Brush holder	✱	1	2510-20	967692
Space heater	✱	1	400V, 1500 W	24706
Diode	○	6	Avalanche DA 807-880-26	24337
Holding clamp	○	6	Avalanche MCS 351	24497
Set brake pads (2x)	✱	2	Twiflex Typ 20	20660

List of revisions

Date of issue	Issue	Modified page	Kind of modification	created / checked
08.10.2008	01	-	First edition	gh / hg

Use confirmation

I confirm that I read the operating manual attentively and I will keep the aforementioned regulations and references.

The operating manual read by:

..... Signature	..... Date
..... Signature	..... Date
..... Signature	..... Date
..... Signature	..... Date
..... Signature	..... Date

ELIN EBG Motoren GmbH

Elingasse 3
8160 Weiz
Austria

Phone: (+43/3172) 90 606 – 0
Fax: (+43/3172) 90 606 – 499
E-mail: dokucenteremg@elinebgmotoren.at
Internet: www.elinebgmotoren.at

Appendix

Drawings of the machine

see [Drawing list](#)

Descriptions of machine components

see [Equipment parts list](#)

EC-Declaration of Conformity

[Form](#) 2 pages

Failure report

[Form](#) QC4-EMG02-002E 1 page

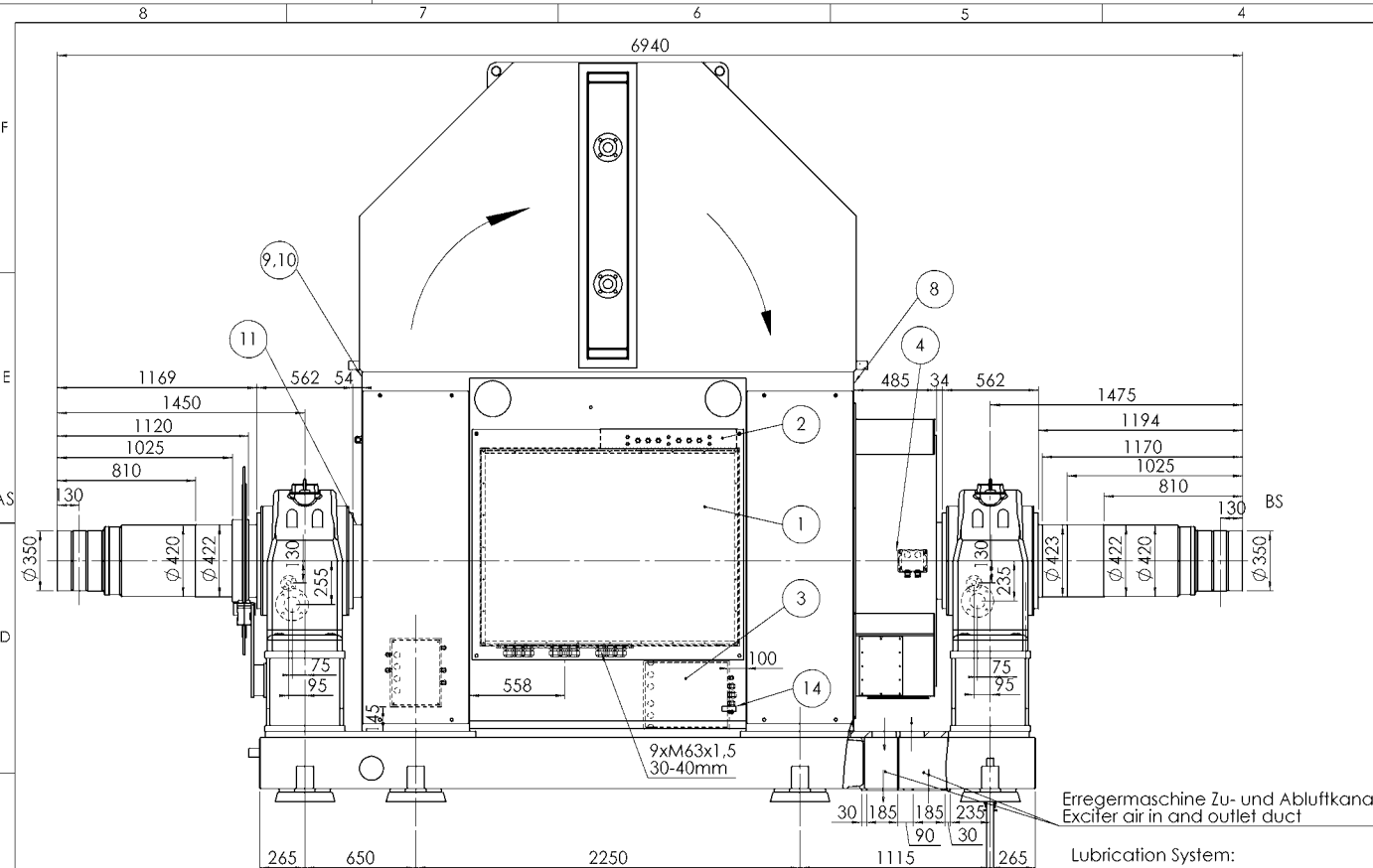
Tables

[PT - Calibration](#) no Dg.no. 1 page

Drawing list 526406

08.10.2008

Pos.	Drawing-No.	Description
10	5894151	Outline drawing machine
20	5894358	Sectional drawing machine
30	526406	Sectional drawing shaft end-turbine
40	5894357	Main terminal box
50	5894482	Terminal box PT100
60	5894624	Terminal box space heater
70	5894621	Terminal box vibration sensors
80	5894626	Terminal box speed sensors
90	5894481	Terminal box transformer
100	5894155	Connection diagram stator
110	5894157	Connection diagram PT100
120	5894156	Connection diagram rotor
130	5894625	Connection diagram space heater
140	5894158	Connection diagram vibration-, and speed sensors
150	5894472	Winding schema
160	L526406	Rating plate 526406 08001
170	L526406	Rating plate 526406 08002



Erregermaschine Zu- und Abluftkanal
Exciter air in and outlet duct

Lubrication System:

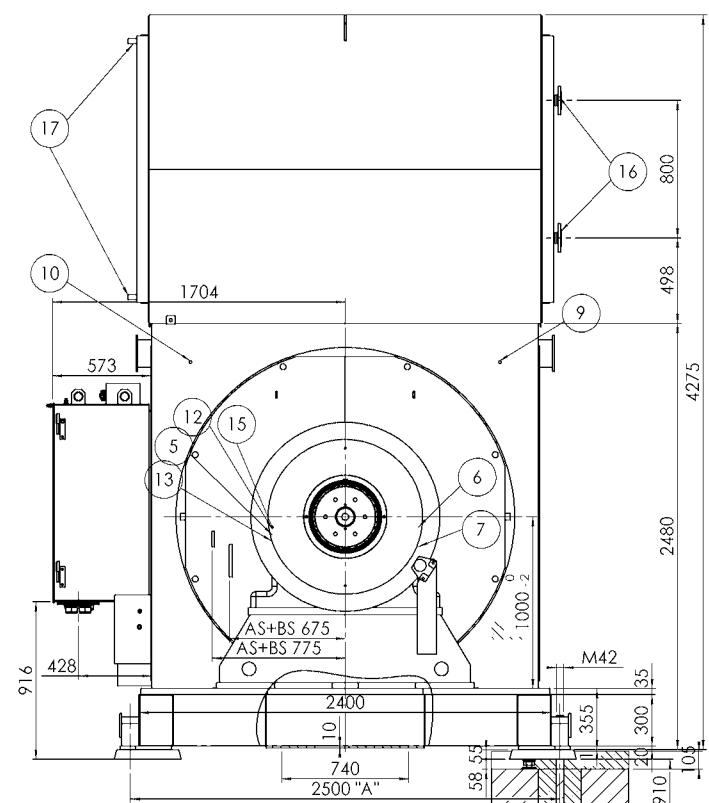
Oilpressure: 0,5 bar
Oilquantity: AS min 35l/min
BS min 20l/min
Oilquality: ISO VG 46 Panolin Turwada

Jacking Oilsystem:

Startpressure: AS 77 bar
BS 74 bar
Holdingpressure: AS 46 bar
BS 44 bar
Oilquantity: AS and BS ca 1-2 l/min

Brake:
Oilpressure for the brake: 30 bar

Wärmetauscher: Heat exchanger:
Type: 2256/1600/32-Vsv-s119-32T143
max. Cooler capacity 270kW
Cooling water quantity (30% Glykol) 52 m³/h
max Water inlet temp. 30°C
min Water inlet temp. 15°C



Gesamtmasse: 46800 kg
Generator mass:


Massenträgheitsmoment ohne Turbine: 2600 kgm²
Mass moment of inertia without turbine:

Dyn. Fundamentbelastung im Abstand "A"
Dyn. Foundation load at distance "A"

Bei Nennmoment: ± 56 kN
At Rated torque:

Bei Kurzschlussmoment: ± 551 kN
At Short-circuit torque:

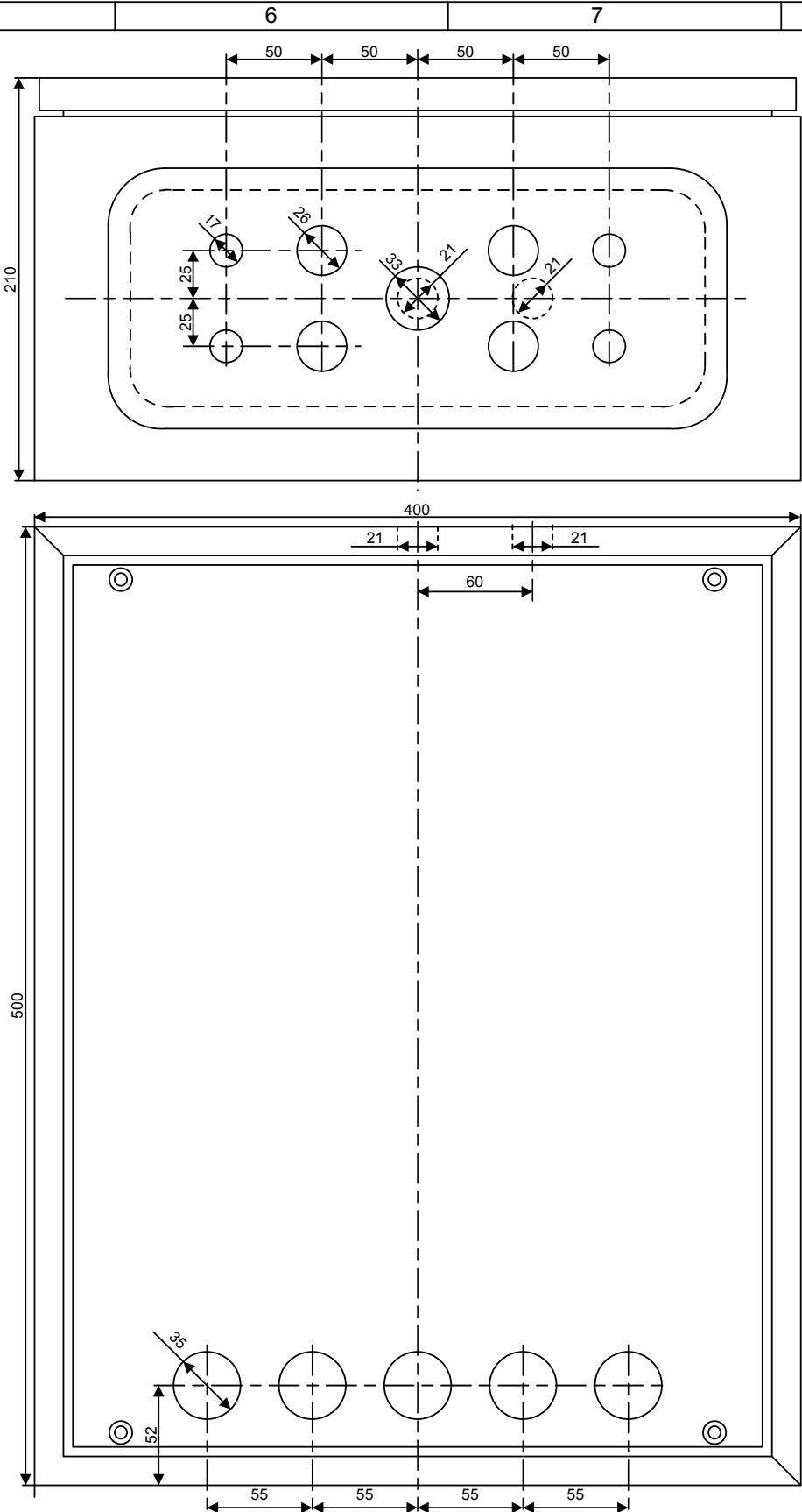
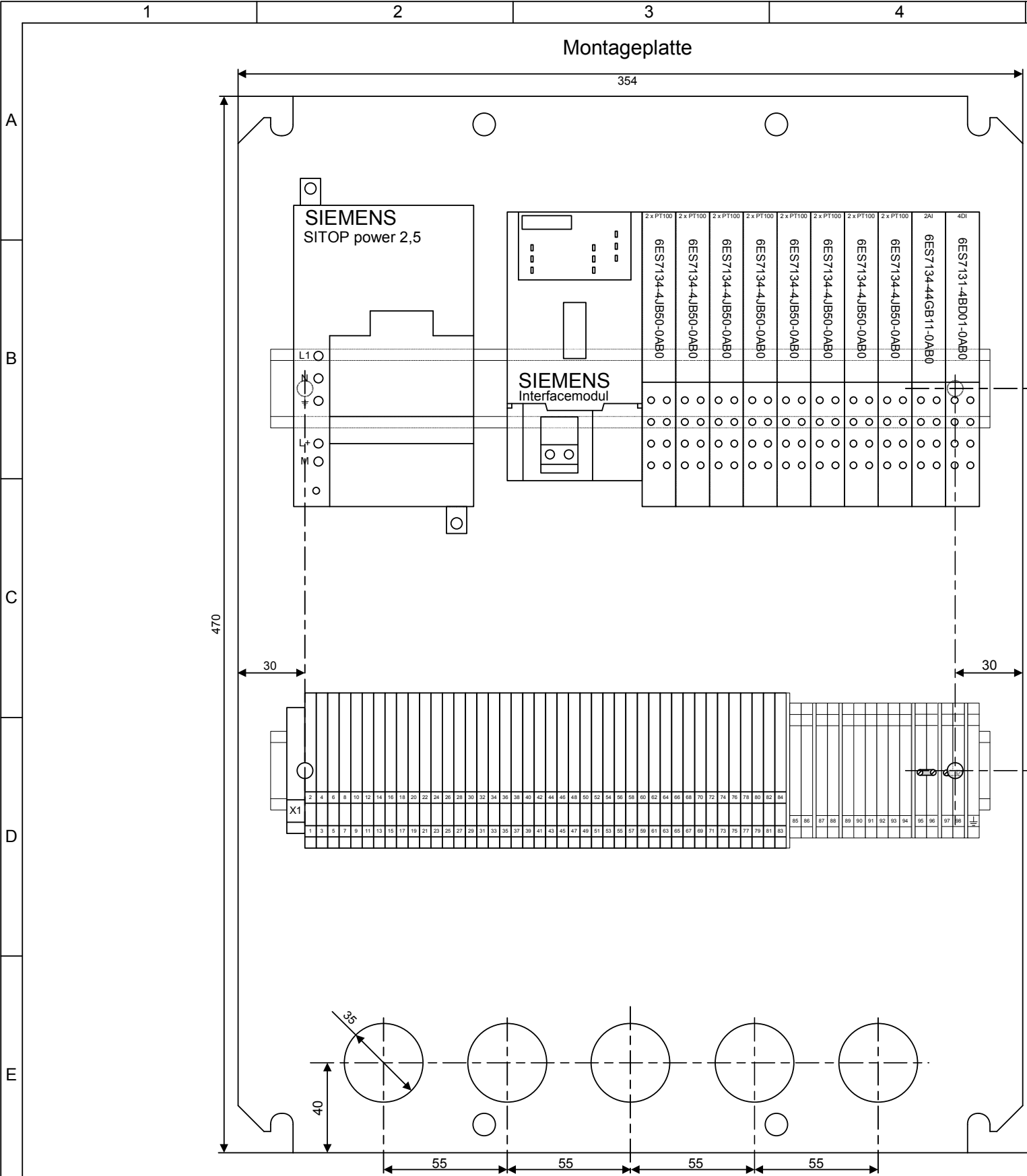
Zusätzliche Kräfte durch Strahldruck bei Nennlast:
Extra forces by jetpressure at nominalload:
Horizontal: 190 kN
Vertikal: 100 kN

Vermerk:		100-KN		Massenträgheit: - kgm²	
Getr. Stückliste PARTS LIST SEPERATE		Y N	Masse: - kg		
Maßstab SCALE 1:22	Anlage / Plant :	Fenestrelle		Mat.Nr.	526406
	Kunde / PURCH.	Energie S.p.A		Projekt Nr.	-
	Type	HTV110		Klassen Nr.	- BG
	Bearb./DES	10.7.2008	Schiffer	 ELIN EBG Motoren GmbH	
Gepr./CHECK					
		Massbild HTM110D010 + WP60 11000 kVA, 6000 V, IM7215		5894151	
				BL/SHT 1 von/OF 1	
Änd. / REV.		1			
Ähn./SIM. TO		5892131			
Ers. / UST.FOR					
Ers.d. / REPLBY					
EDV Nr. 5894151_Massbild		Mappe Nr. -			

- ① Klemmenkasten mit Strom-u. Spg.-Wandler
Terminal box with current a. voltage transf.
- ② Klemmenk. für Wandler-Sekundärklemmen
Terminal box for transformer sec. - terminals
- ③ Hilfsklemmenk. für Thermometer u. Standhgz.
Terminal box for thermometer and space heater
- ④ Erregerklemmenkasten
Exciter terminal box
- ⑤ Lagerthermometer Pt 100
Bearing thermometer Pt 100
- ⑥ Lager Zeigerthermometer
Bearing Dialthermometer
- ⑦ Lagersumpftermometer Pt100
Bearing Oilthermometer Pt100
- ⑧ Zuluftthermometer Pt 100
Air inlet thermometer Pt100
- ⑨ Abluftthermometer Pt 100
Air outlet thermometer Pt100
- ⑩ Abluft Zeigerthermometer
Air outlet Dialthermometer
- ⑪ Rotorerdungsbürste
Rotor earthbrush
- ⑫ Ölzulauf AS + BS G3/4 DN20 DIN 2573
Oil inlet AS + BS
- ⑬ Öl Ablauf AS + BS DN80 DIN2573
Oil outlet AS + BS
- ⑭ Erdungsanschluß
Earth terminal
- ⑮ Anschluss Hochdruckentlastung G1/4
Jacking Oilconnection
- ⑯ Kühlwasseranschlüsse DN100, PN16, 2633
Cooling water flange
- ⑰ Entlüftung mit Sicherheitsventil 6 bar
Ventilation with safety valve
- ⑱ Entleerung
Drain
- ⑲ Schwingungsmessung
Vibration measurement

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1	Kühlerhöhe geändert	11.07.2008	SCHIFFE	X
Ä	Änderung	Datum	Name	App.



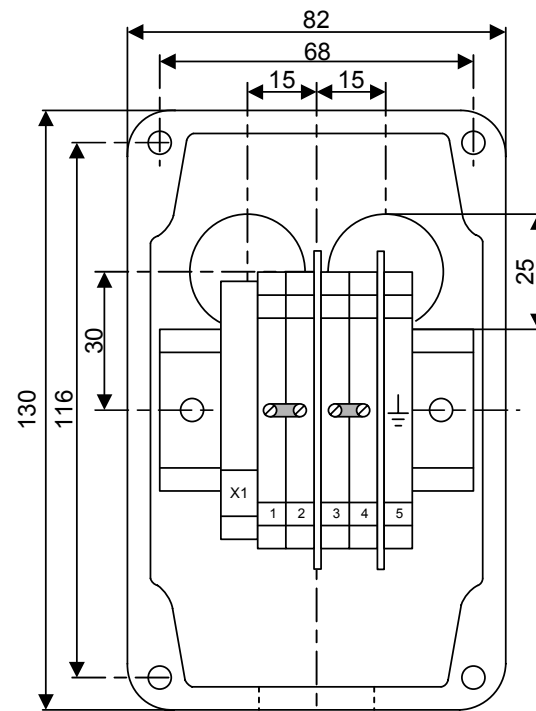
DRILLED HOLE	SCREWED GLAND (M)	CABLE DIAMETERS
17 mm	M16	6 - 12 mm
21 mm	M20	8 - 13 mm
26 mm	M25	9 - 19 mm
33 mm	M32	17 - 27 mm

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Ä	Änderung Revision	Datum Date	Name

Anlage Plant	Fenetsrelle	Kunde Purch.	Energie S.p.A
Typ Type	HTV110 D10	Mat. Nr. Mat. no.	526406
Bearbeiter Des	Mitterberger	Datum Date	29.05.2008
Geprüft Check	Fetz	Datum Date	29.05.2008
Klemmenkasten JB03 Hilfseinrichtungen Terminal box JB03 for auxiliary device		5894482	
		Blatt Sheet	1
		von of	1
Änd./ Rev.			
Ers. f. Ubst. for	-		
Ahn. Z. Sim. to	-		
		A3	



SCREWED GLAND (M)	CABLE DIAMETERS
M16	6 - 12 mm
M20	8 - 13 mm
M25	9 - 19 mm
M32	17 - 27 mm

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Bearbeiter Des	Mitterberger	Datum Date	30.05.2008
Geprüft Check	Fetz	Datum Date	30.05.2008



Allgemeintoleranzen
GENERAL TOL.
ISO 2768 - mH
OENORM M 1365 - m

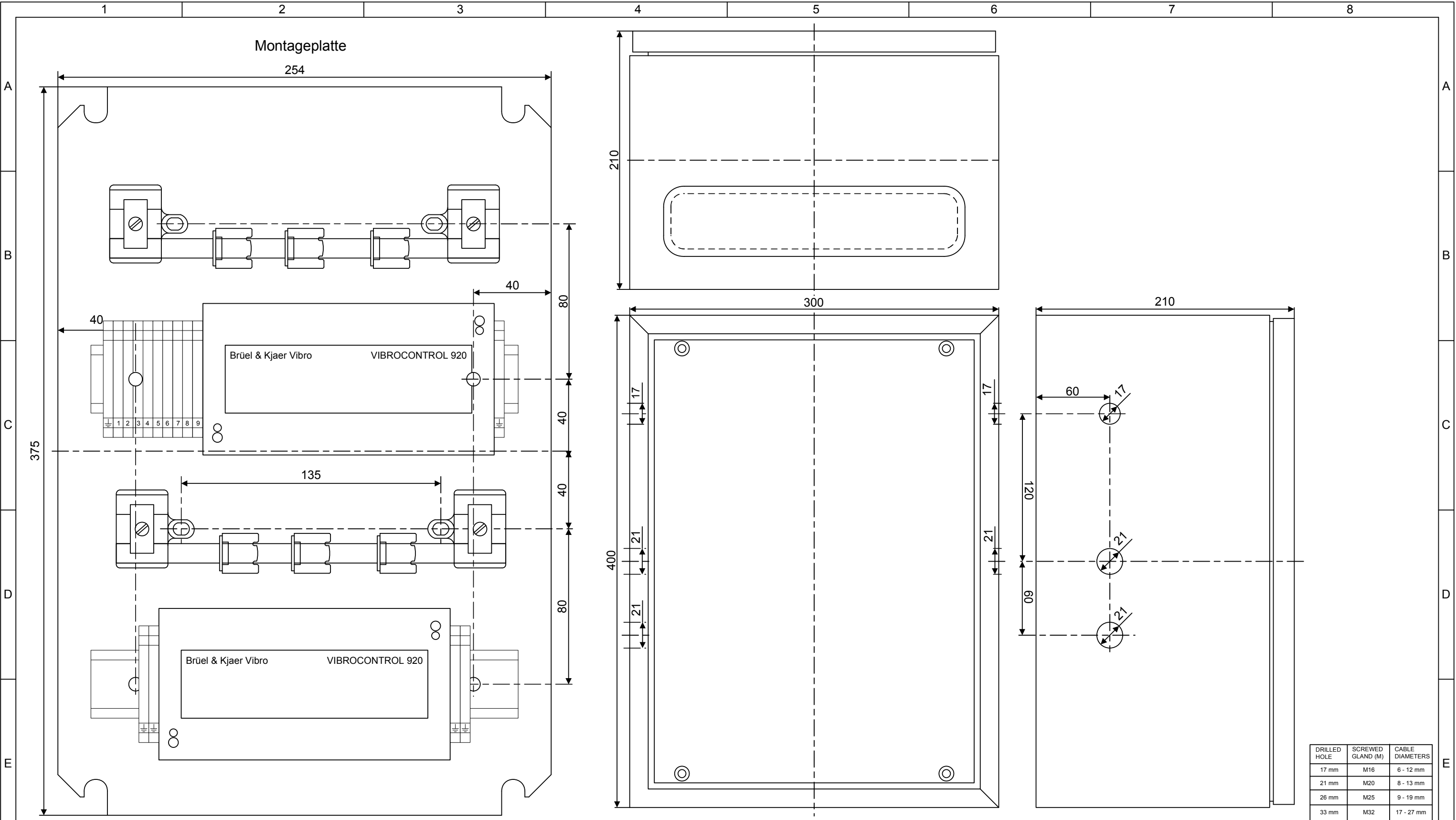
				Anlage Plant	Fenestrelle
				Kunde Purch.	Energie S.p.A
				Typ Type	HTV110 D10
Ä	Änderung Revision	Datum Date	Name Name	Mat. Nr. Mat. no.	526406

Generatorklemmenkasten
Heizung
Terminal box heater

5894624

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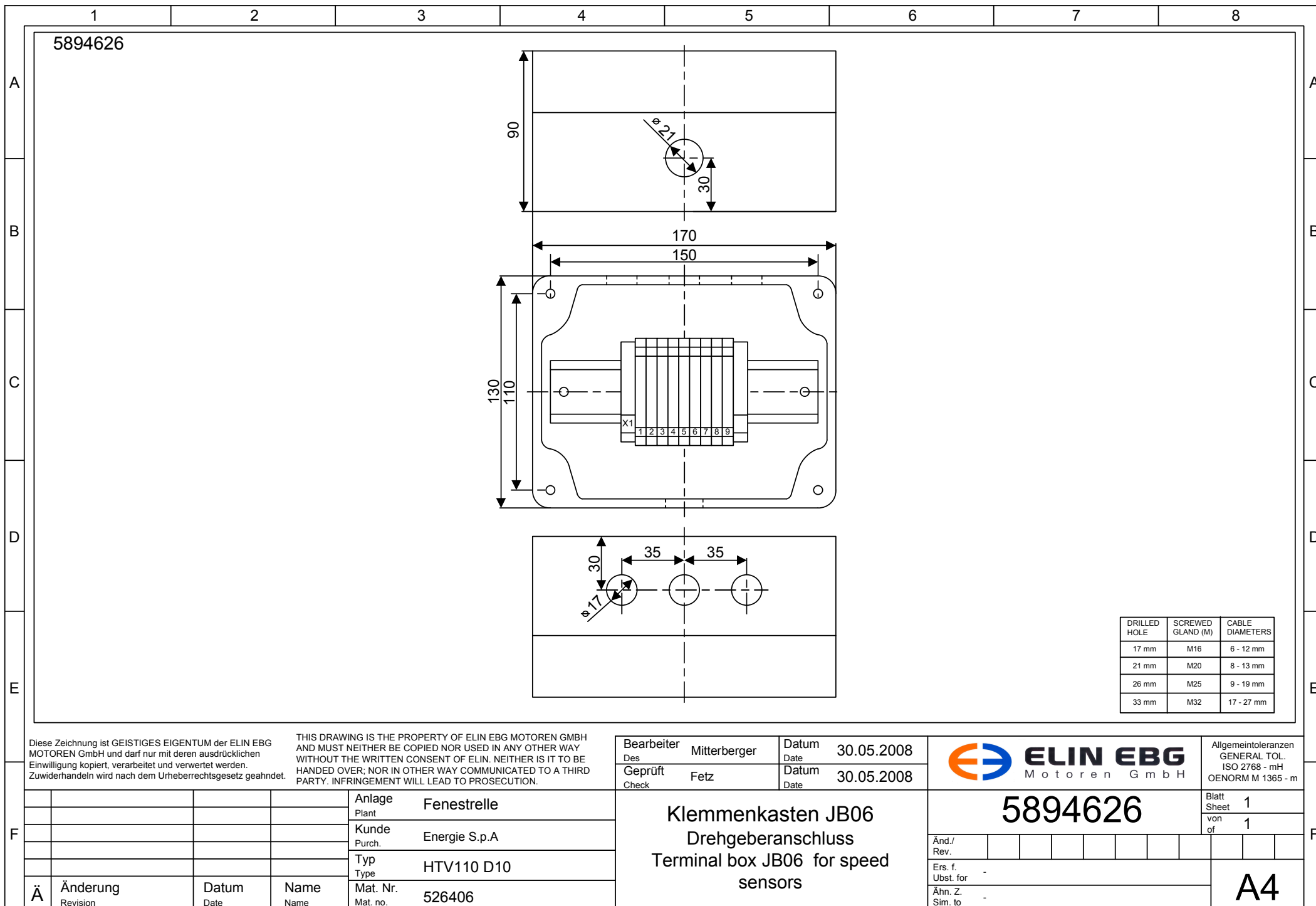


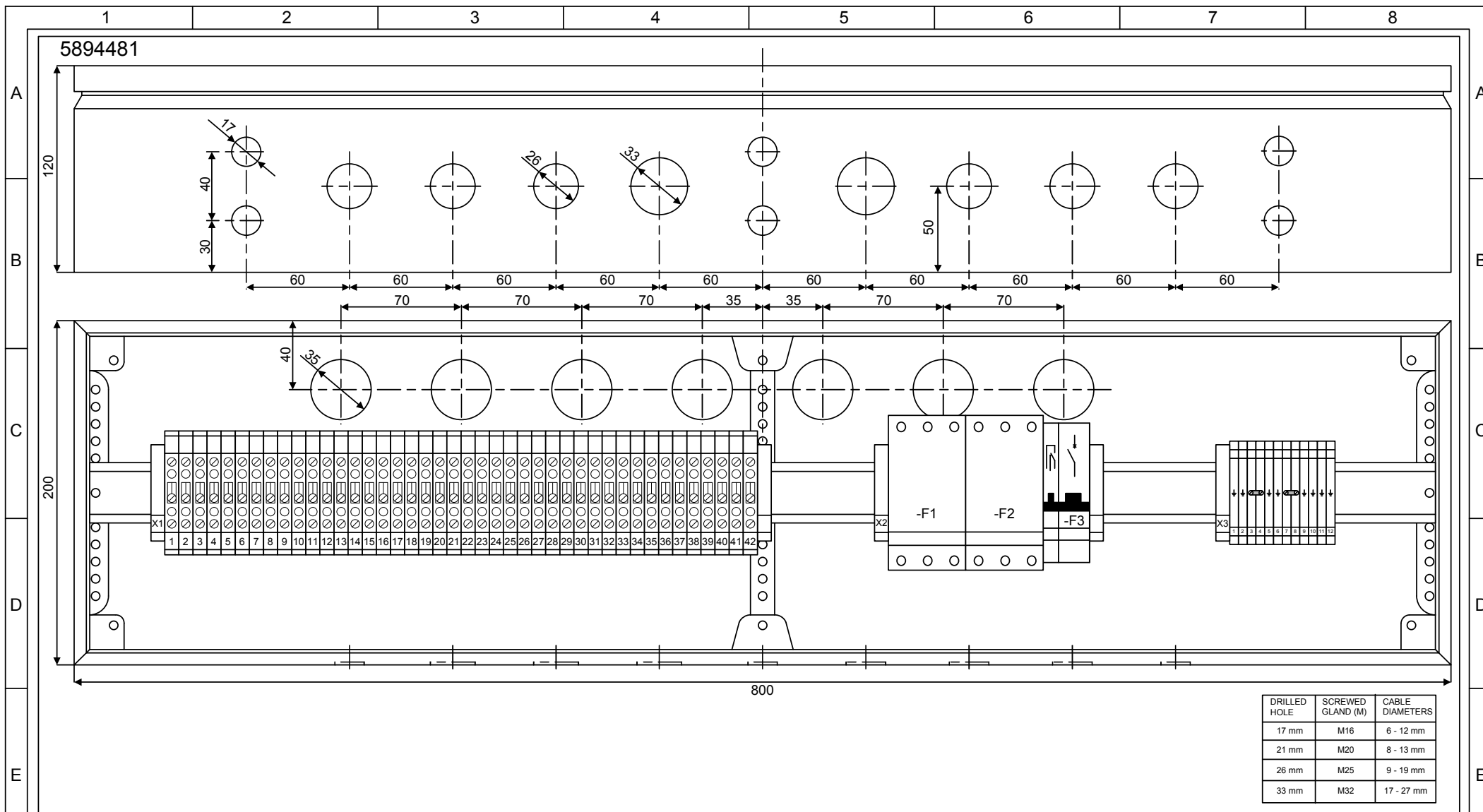
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1	Klemmen für Drehgeber ergänzt	30.05.2008	Mitterberger
Ä	Änderung Revision	Datum Date	Name Name

Anlage Plant	Fenestrelle	Kunde Purch.	Energie S.p.A
Typ Type	HTV110 D10	Mat. Nr. Mat. no.	526406
Bearbeiter Des	Mitterberger	Datum Date	30.05.2008
Geprüft Check	Fetz	Datum Date	30.05.2008
Klemmenkasten JB05 Schwingungsmessung Terminal box JB05 for vibration measurement		5894621	
		Blatt Sheet von of	1 1
Änd./ Rev.	1		
Ers. f. Ubst. for	-		
Ähn. Z. Sim. to	-		
		A3	





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Bearbeiter	Mitterberger	Datum	29.05.2008
Des		Date	
Geprüft	Fetz	Datum	29.05.2008
Check		Date	

ELIN EBG
Motoren GmbH

Allgemeintoleranzen
GENERAL TOL.
ISO 2768 - mH
OENORM M 1365 - m

Klemmenkasten JB02
Wandlerbeschaltung
Terminal box JB02 for transformers

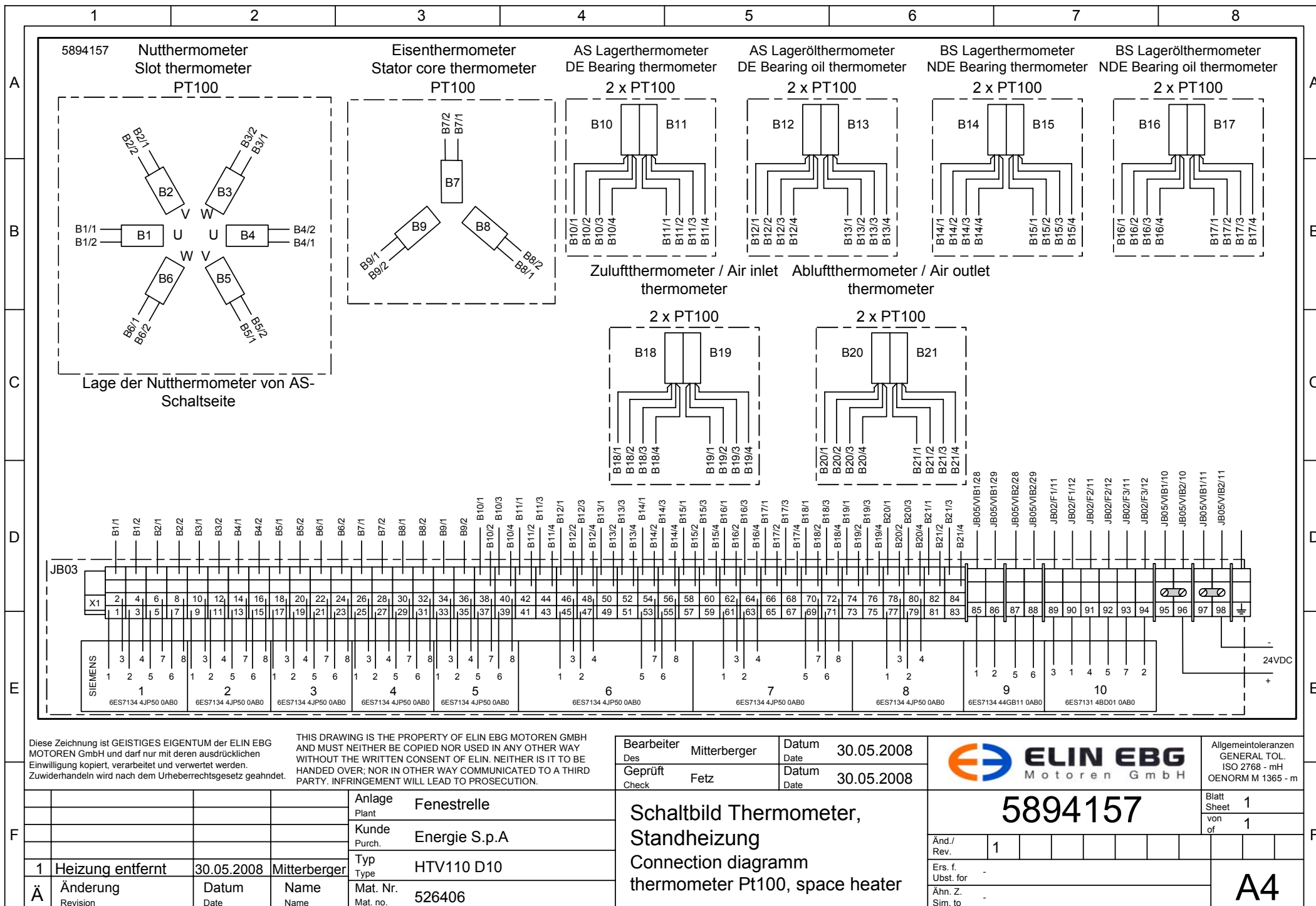
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von 1

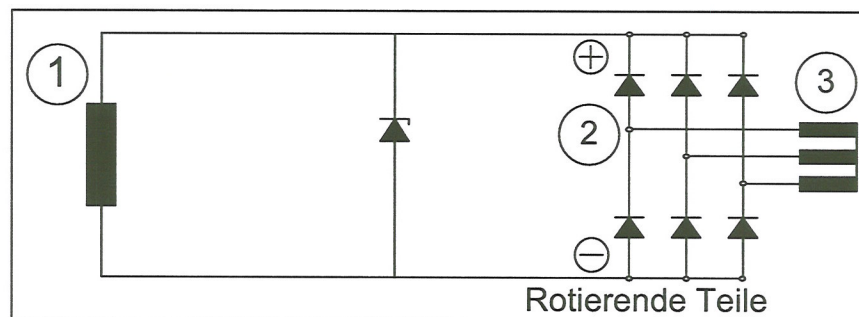
Änd./ Rev.									
Ers. f. Ubst. for	-								
Ähn. Z. Sim. to	-								

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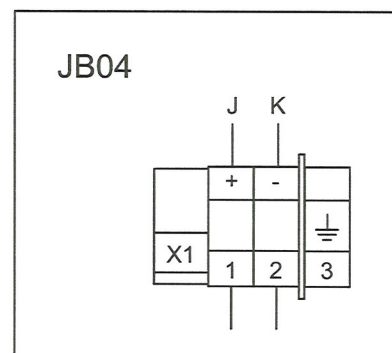
Ä	Änderung	Datum	Name	Anlage	Fenestrelle
	Revision	Date	Name	Kunde	Energie S.p.A
				Typ	HTV110 D10
				Mat. Nr.	526406
				Mat. no.	



5894156



- 1 Läuferwicklung Generator
rotor winding generator
- 2 Dioden mit Varistoren
rotating rectifier and varistors
- 3 Läuferwicklung Erregermasch.
rotor winding exciter
- 4 Ständerwicklung Erregermaschine
stator winding exciter



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Bearbeiter Des	Mitterberger	Datum Date	29.05.2008
Geprüft Check	Fetz	Datum Date	29.05.2008

ELIN EBG
Motoren GmbH

Allgemeintoleranzen
GENERAL TOL.
ISO 2768 - mH
OENORM M 1365 - m

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Schaltbild
Erregermaschine

Änd./ Rev.									
Ers. f. Ubst. for	-								
Ähn. Z. Sim. to	-								

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Anlage Plant	Fenestrelle
Kunde Purch.	Energie S.p.A
Typ Type	HTV110 D10
Ä Revision	Datum Date
Name Name	Mat. Nr. Mat. no.
	526406

Rechtslauf





U1
V1
W1
U2
V2
W2

ZWEISCHICHT-SPULEN Wicklung

SCHALTUNG: Y, 10-FACH PARALLEL
NUTENZAHL: 120
POLZAHL (2P): 10
4 NUTEN JE POL UND PHASE
NUTSCHRITT: 1 - 11
SPULENGRUPPENFOLGE: 444/444/
TECHN. DATEN NR.: 18196

BS - Schaltseite

Gefr. Stückliste PARTS LIST SEPERATE		<table><tr><td>Y</td></tr><tr><td>N</td></tr></table>	Y	N	Masse: -	kg	Massenträgheit: -	kgm²							
Y															
N															
Maßstab SCALE 1:1	Anlage / Plant : -		Mat.Nr. 526406		Oberfläche SURFACE Re V acc. DIN ISO 1302										
	Kunde / PURCH. -		Projekt Nr. -												
	type HTM-110D10		Klassen Nr. - BG												
	Bearb./DES 19.04.2008 Podmaniczki Gepr./CHECK 21.04.2008 Felz		 ELIN EBG Motoren GmbH		Allgemeintoleranzen GENERAL TOL. ISO 2768 - mH OENORM M 1365 - m										
Staenderwickelschema					5894472										
-					BL/SHT 1										
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-					Änd. / REV. <table><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>										
-					Ähnl.Z/SIMILTO - <table><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>										
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EDV Nr. 5894472 Staenderwickelschema		Masse Nr. -		Ers.d. / REPL.FOR <table><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>											
															



CE



Exciter	Type WP60A		
Ser.No. 23848 08001	Year of fabr. 2008		
100 kW	347 V	288 A	S1
600 1/min	IP 23	I.Cl. F	
Self - Excitator	167 V	11,2 A	
Mass Stator	660 kg		

Sleeve bearing
Forced oil lubrication

Quality of oil:	ISO VG 46
Quantity of oil l/min:	35
Oil pressure bar:	0,5
Oilquantity l/min:	1
Startpressure bar:	~100

Sleeve bearing
Forced oil lubrication

Quality of oil:	ISO VG 46
Quantity of oil l/min:	20
Oil pressure bar:	0,5
Oilquantity l/min:	1
Startpressure bar:	~100

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<p>Allgemeintoleranzen GENERAL TOL. ISO 2768 - mH OENORM M 1365 - m</p>	
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CE



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Equipment parts list 526406

08.10.2008

Pos.	Pce.	Material-no.	Equipment	Manufacturer or supplier / Type
10	1	24285	Cooler	GEA 11-2256/1600/32
20	1	23984	Sleeve bearing DE	RENK EGZLK 35-400 insul. abn.
30	1	23987	Sleeve bearing NDE	RENK EGZLQ 35-400 insul. abn.
40	1	24549	Current transformer	ZELISKO SGS 10/1K/GR1
50	6	23914	Current transformer	ZELISKO SGS 10/3K/GR2
60	3	24550	Voltage transformer	ZELISKO EGG 20
70	1	24827	Voltage regulator	Thyne 3
80	2	24467	Bearing thermometer DE / NDE	Sensotec 2*PT100, EL=380
90	2	24874	Pointer thermometer	JUMO TYP 608225 G1/2
100	1	24875	Pointer thermometer	JUMO TYP 608225 G3/4
110	6	21953	Slot thermometer	EPHY-MESS 1xPT100 2x6x150
120	3	946402	FE-Thermometer	PT100 50X10X2
130	3	5132220	Air thermometer	EPHY-MESS 2*PT100, EL = 150
140	2	24879	Space heater	Jambor 690V 1500W
150	1	15304	Absortion resistor	GWK 150
160	2	24744	Supervision electronic	VIBROCONTROL 920
170	2	24745	Vibration speed sensor	VS-069
180	1	13898	Safety valve	SM 152-1/2 AB 8 BAR
190	2	5132787	Throttle valve	RENK PARKER G3/4"

Betriebs- und Wartungsanleitung
Operation and Maintenance Instruction

GEA Kreislaukühler
GEA Circuit Cooler

für Elektromotoren und Generatoren
for Electric Motors and Generators

Deutsch/English

11 49 0156 01
Ausgabe/Edition: 3.0
Version 2.2000
Vöge EE

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1. Allgemein

Der Kreislaufkühler ist ein Rippenrohr-Wärmeaustauscher. Er hat die Aufgabe, die von der Umluft im Elektromotor oder Generator aufgenommene Wärme an das Kühlwasser zu übertragen. Das Kühlwasser fließt durch die Rohre. Um die Rippen strömt die Luft.

2. Konstruktionsbeschreibung

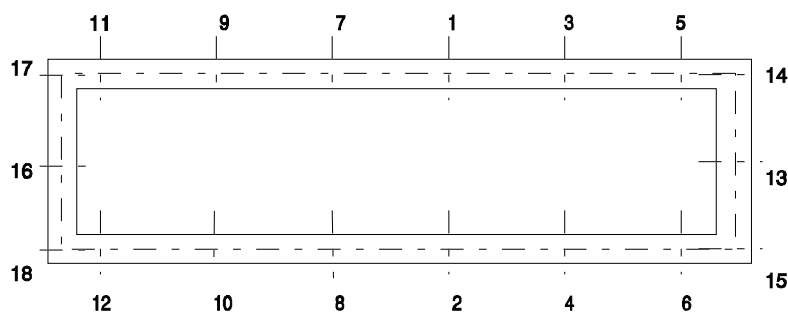
Der Kühler besteht, je nach Anforderung an die Kühlleistung, aus einem oder auch mehreren einzelnen Bündeln. Die Anordnung des Kühlers im Gesamtsystem ist anlagenabhängig und wird mit dem Hersteller der elektrischen Maschine abgestimmt. In der Regel wird der Kühler so angeordnet, daß die Luft im geschlossenen Kreislauf durch die Maschine und den Kühler geführt wird. Der Lufttransport erfolgt entweder durch Eigenbelüftung der Maschine oder durch Fremdbelüftung.

Je nach Anlagenkonzeption ist der Kühler in die elektrische Maschine eingeschoben oder in einen Luftkanal eingebaut.

Zwischen den beiden Rohrböden liegt das Rippenrohrbündel. Die Rohrhälse der Rohre sind wasserdicht in die Rohrböden eingewalzt.

Zur Wasserführung dienen Stutzen- und Umlenkwasserkammer. Die Kammern sind mit Flachdichtungen auf den Rohrböden verschraubt. Die Trennsteg für die Wasserwege werden durch Profildichtungen abgedichtet.

Die Verschraubung der Kammern erfolgt mit Kopf- oder Stiftschrauben und Muttern. Die Gewindeabmessung ist M12, in einzelnen Fällen M16. Die Vorspannung ist gleichmäßig in drei Stufen, jeweils von der Mitte der beiden Längsseiten entsprechend nachfolgendem Schema aufzubringen.



Die Gewinde sind mit Öl zu schmieren, andere Gleitmittel sind nicht zulässig.

Bei einer Elastomerdichtung aus EPDM (Gummiqualität) sind die 3 Stufen des Anzugdrehmoments:

Gewinde/thread	M12	- 25	- 50	- 73	Nm
Gewinde/thread	M16	- 40	- 80	- 115	Nm

1. General

The circuit cooler is a compact heat exchanger. The cooler transmits the thermal heat from the circuit air of the electric motor or generator to the cooling water. The cooling water flows through the tubes. The air flows around the fins.

2. Design Description

The cooler consists in accordance with the thermal requirements out of one or more single bundles. The design of the cooler arrangement is adapt together with the electric engine builder to the layout of the plant. Normally the air flows in a closed circuit through the engine and the cooler. The air is blown by a fan of the engine itself or by an additional fan.

In accordance to the plant draft the cooler is fitted to the engine as a slide in bundle or fitted into the air housing.

The fin tube bundle is arranged between the both tube sheets. The ends of the tubes are water tight rolled in into the tube sheets.

The headers are bolted to the tube sheets by insertion of gaskets. The separating baffles are sealed by a profile seal.

The headers are bolted with bolts or studs and nuts M12 in some cases with M16. The torque has to be given in three steps, each from the middle of both longitudinal sides of the headers, according following scheme.

The threads have to be oiled. Other lubricant are not allowed.

In case of a elastomer gasket out of EPDM (rubber quality) the three steps of the torque are:

Bei einer Dichtung aus gebundenem Aramidfasermaterial (Asbestersatz) sind die 3 Stufen:

In case of a aramidfibre gasket (asbestos substitute) the three steps are:

Gewinde/thread	M12	- 25	- 50	- 73	Nm
-----------------------	------------	-------------	-------------	-------------	-----------

Gewinde/thread	M16	- 60	- 120	- 180	Nm
-----------------------	------------	-------------	--------------	--------------	-----------

Die Seitenwände zwischen den Rohrböden dienen der Luftführung. Bei längeren Kühlern sind die Seitenwände untereinander mit Trageisen verbunden. Die Trageisen dienen gleichzeitig zur Schwingungsabstützung des Rippenrohrbündels.

The side walls between the tube sheets guiding the circuit air. In case of longer coolers the side walls are connected with support beams. The support beams additional support the tube stake against vibration.

Die Wasserräume der Kühlerbündel können über Verschraubungen entlüftet und entwässert werden.

The bundles can be drained or vented by plugs.

Der Wasseranschluß hat gemäß dem entsprechenden Kühler-Montageplan / Einbauzeichnung zu erfolgen.

The water pipes have to be connected according to the cooler mounting plan or installation plan.

3. Lagerung, Ein- und Ausbau des Kühlers

3. Storage, Installation and Removing of Cooler Bundles

3.1 Lagerung

3.1 Storage

Die Lagerung der Kühler hat vor dem Einbau in einer gut belüfteten, trockenen Halle zu erfolgen. Sie sind gegen Verschmutzung abzudecken und vor mechanischer Beschädigung zu schützen.

The coolers have to be stored in a dry and vented hall. They have to be protected against dirt and mechanical damages.

Der Innenraum der Kühlerbündel ist vor dem Versand entwässert und die Wasseranschlußflansche sind mit Kunststoffkappen verschlossen worden. Das Rippenfeld ist mit einer Schutzplatte abgedeckt.

The inside of the cooler bundles is drained before dispatch. The water flanges are closed with plastic caps and the fin bay is covered with a protection plate.

3.2 Einbau des Kühlers

3.2 Installation of Cooler Bundles

Vor dem ersten Einbau des Kühlers sind die Schutzplatten vom Rippenfeld zu entfernen.

Before first installation the protection plates from the fin bay have to be removed. On the side walls are 4 lifting lugs with holes Ø 14 mm to mount Ø 12 shackles. In case of vertical fin tube arrangement lifting lugs are on the headers.

An den Seitenwänden der Bündel sind 4 Transporteisen mit Loch Ø14 mm angebracht, in die zum Transport Schäkel Ø12 angebracht werden können. Bei einer Einbaulage mit stehenden Rohren sind an den Kammern Transportösen vorgesehen.

The air connections have to be sealed with new gaskets provided at site against the outside air.

Die luftseitigen Anschlüsse sind mit bauseitig beizustellenden neuen Dichtungen gegen die Außenluft abzudichten.

The water connections have to be fitted to the water piping with new gaskets provided at site. All connections must be free of tensions.

Die wasserseitigen Anschlüsse sind mit bauseitig beizustellenden neuen Dichtungen mit dem Wasserleitungssystem zu verbinden. Alle Anschlüsse haben spannungsarm zu erfolgen, Verspannungen sind nicht zulässig.

3.3 Ausbau des Kühlers

3.3 Removing of Cooler Bundles

Vor dem Ausbau des Kühlers ist er wasserseitig zu entleeren. Der Ausbau der Bündel erfolgt in umgekehrter Reihenfolge wie der Einbau. Der Kühler ist an einem geeigneten Platz abzulegen. Das Rippenfeld ist vor Beschädigungen und Verschmutzungen zu schützen. Bei längerer Lagerzeit sind auch die Wasseranschlüsse zu verschließen.

Before removing the cooler has to be drained. Removing the cooler is carried out vice versa as the mounting. The cooler has to be deposit at a suitable place. The fin bay has to be protected against damages and dirt. For long term storage the water connections have also be closed.

4. Inbetriebnahme

4.1 Dichtprobe

Nach dem Anschluß der Wasserleitungen wird vor der eigentlichen Inbetriebnahme eine Wasserdruckprobe mit sauberem Wasser (Trinkwasserqualität) empfohlen. Wird der Kühler nicht unmittelbar danach in Betrieb genommen, ist der Kühler zu entleeren (siehe Betriebsstillstand Artikel 5).

Nach längeren Lagerzeiten und auch nach längeren Stillstandszeiten sind die Kammerschrauben generell mit dem vorgeschriebenen Drehmoment zu überprüfen, bei Bedarf nachzuziehen und auf Dichtigkeit zu überprüfen. Sollten die Bündel im Bereich der Dichtung dann undicht sein, sind die Dichtungen auszuwechseln (siehe Konstruktionsbeschreibung Artikel 2).

4.2 Entlüftung

Die Entlüftung der Wasserräume erfolgt über die Entlüftungsschrauben an der Stutzenkammer. An diesem Anschluß kann auch eine Dauerentlüftung zum Wasseraustritt angeschlossen werden.

4.3 Offener Kühlkreislauf

4.3.1 Kühlwassermengenstrom

Der Mengenstrom ist entsprechend den Auslegungsdaten einzustellen.

Häufige Schwankungen der Wassergeschwindigkeit sind nachteilig für eine natürliche Schutzschichtausbildung gegenüber Korrosion. Bei offenen Kühlkreisläufen (Durchlaufkühlung, Kühlturmwasser) kann eine zu geringe Wassergeschwindigkeit zu gefährlichen Schmutzablagerungen führen, eine zu hohe Geschwindigkeit zu Erosion. Bei offenen Kühlkreisläufen darf die Mindestgeschwindigkeit nicht über einen längeren Zeitraum eingestellt werden.

Folgende Grenzggeschwindigkeiten sind einzuhalten

4. Commissioning

4.1 Pressure Test

After the water pipes have been connected GEA, however, recommend to check the tightness prior to the commissioning. Clean water (drinking water quality) has to be used for the pressure test. If the commissioning didn't start immediate after the pressure test the cooler has to be drained (see item 5 Standstill).

After prolonged storage or extended standstill the header screws have to be checked with the recommended torque and shall be tightened with the recommended torque if necessary. After that the cooler has to be pressure tested. In case of leakage's the gaskets have to be changed (see item 2).

4.2 Venting

For cooler venting use the venting plug at the nozzle header. For continuously venting a venting pipe can be installed.

4.3 Open Cooling Circuit

4.3.1 Cooling Water Flow

The flow rate of cooling water has to be in accordance with the layout values of the cooler.

Frequent fluctuations of the water velocity impend the formation of a natural protective film against corrosion. In case of open cooling circuits too low water velocity encourages dangerous dirt deposits and too high velocity causes erosion. In case of open cooling water circuits never operate at min. velocity for a prolonged period.

The following water velocities have to be observed:

Material	DIN Material Nr./No.	vergleichbar comparable ASTM-Nr./No.	zulässige Grenzggeschwindigkeit m/s admissible Cooling Water Velocity m/s	
			min	max
CuNi10Fe1Mn	2.0872	B-111 C70600	1,5	2,5
CuNi30Mn1Fe	2.0882	B-111 C71500	1,5	3,0
CuZn28Sn1	2.0470	B-111.C44300	1,0	2,0
CuZn20Al	2.0460	B-111.C68700	1,0	2,2
Edelstahl Stainless Steel	1.4571	A-249 TP316Ti	1,5	3,0
Titan/Titanium Grad 1	3,7025	B-338 Gr. 1	1,0	4,0

4.3.2 Schutzschicht

Die chemische Beständigkeit von Kupferlegierungen, Edelstahl und Titan gegen Kühlwasser beruht auf Ihrer Fähigkeit zur Bildung schwerlöslicher natürlicher Schutzschichten.

Neue Kühlrohre, insbesondere Kupfernickelrohre, deren Schutzschicht noch nicht voll entwickelt ist, dürfen anfänglich nicht mit verschmutztem Wasser in Verbindung gebracht werden, da der sofort entstehende Schmutzfilm den Aufbau einer Schutzschicht stört.

Zur Wasserdruckprobe der Bündel darf deshalb nur sauberes Wasser (Trinkwasserqualität) verwendet werden.

Titan ist ein Werkstoff mit höchster Korrosionsbeständigkeit, die Anforderungen an die Kühlwasserqualität sind sehr gering. Bei der Druckprobe ist Wasser in Trinkwasserqualität nicht erforderlich.

4.4 Geschlossener Kühlkreislauf

4.4.1 Kühlwassermengenstrom

Der Mengenstrom ist entsprechend den Auslegungsdaten einzustellen.

Es muß sichergestellt sein, daß das Kreislaufwasser sauber ist und keine Ablagerungen in den Rohren erfolgen (Trinkwasserqualität).

Folgende maximale Geschwindigkeiten sind einzuhalten:

4.3.2 Protective Film

Material	DIN Material Nr./No.	vergleichbar comparable ASTM-Nr./No.	zulässige Grenzgeschwindigkeit m/s admissible Cooling Water Velocity m/s min max
Cu	2.0090	UNS-C12200	2,0
CuNi10Fe1Mn	2.0872	B-111 C70600	2,5

4.4.2 Schutzschicht

Die chemische Beständigkeit von Kupfer und Kupfernickellegierungen gegen Kühlwasser beruht auf Ihrer Fähigkeit zur Bildung schwerlöslicher natürlicher Schutzschichten.

Neue Kühlrohre deren Schutzschicht noch nicht voll entwickelt ist, dürfen nicht mit verschmutztem Wasser in Verbindung gebracht werden, da der sofort entstehende Schmutzfilm den Aufbau einer Schutzschicht stört.

Auch zur nachträglichen Wasserdruckprobe der Bündel darf deshalb nur sauberes Wasser verwendet werden.

4.3.2 Protective Film

The good chemical resistance of copper alloys, stainless steel and titanium against corrosion is due to their ability to form a natural protection coat which is difficult to dissolve .

New cooling tubes, especially copper alloy tubes, of which the protection coat has not yet fully developed shall not come into contact with contaminated water. The immediately forming dirt deposit will disturb the formation of a protective coat.

Water pressure test have to be done therefore only with clean water.

Titanium is a material with highest corrosion resistance. The recommendations to the cooling water quality are very low. Water in drinking water quality is therefor not necessary for the pressure test.

4.4 Closed Water Circuit

4.4.1 Cooling Water Flow

The flow rate of cooling water has to be in accordance with the layout values of the cooler.

It must be guaranteed that the circuit water is clean and no deposits in the tubes can occur (drinking water quality).

The following water velocities have to be observed:

4.4.2 Protective Film

The good chemical resistance of copper and copper nickel alloy against corrosion is due to their ability to form a natural protection coat which is difficult to dissolve .

New cooling tubes of which the protection coat has not yet fully developed shall not come into contact with contaminated water. The immediately forming dirt deposit will disturb the formation of a protective coat.

Water pressure test have to be done therefore only with clean water.

5. Betriebsstillstand

5.1 Betriebsstillstand bei offenem Kühlkreislauf

Wird der Kühler für mehr als 3 Tage aus dem Betrieb genommen, ist er grundsätzlich auf der Wasserseite zu entleeren.

Ein Stillstand ist besonders für wasserberührte Rohre aus Kupferlegierungen schädlich, wenn sich die Schutzschicht noch nicht voll ausgebildet hat oder aber die Gefahr ihrer Zerstörung durch Korrosion unter Ablagerungen besteht.

Nach Möglichkeit soll der Betrieb während der ersten 2 Monate nicht durch Stillstände unterbrochen werden. Fällt die Kühlwasserversorgung aus und wird der Betrieb innerhalb von 3 Tagen wieder aufgenommen, kann der Kühler mit Kühlwasser gefüllt stehenbleiben. Es muß aber sichergestellt sein, daß die Rohre frei von Ablagerungen sind.

Im Fall von Ablagerungen muß das Kühlwasser abgelassen, die Rohre gereinigt, mit sauberem Wasser gespült und anschließend getrocknet werden. Empfohlen wird das Durchblasen mit warmer vorgetrockneter Luft. Der Kühler muß ausreichend belüftet werden. Wird See-, Brack- oder salzreiches Wasser (Richtwert: Chloridgehalt ≥ 500 mg/l) als Kühlwasser eingesetzt, muß mit sauberem Wasser (Trinkwasserqualität) gespült werden.

Bei Stillständen von mehr als 3 Tagen innerhalb der Einfahrphase von 2 Monaten und später bei Stillständen von 2 Wochen und mehr, ist das gleiche Reinigungsverfahren anzuwenden.

Für kurze Betriebsunterbrechungen ist das Fahren niedriger Kühlwassermengen (Schleichströmung) günstiger als absoluter Kühlwasser-Stillstand.

5.2 Betriebsstillstand bei geschlossenem Kühlkreislauf

Für geschlossene Kühlkreisläufe ist Kreislaufwasser in Trinkwasserqualität vorgeschrieben (siehe Artikel 4.4). Unter diesen Voraussetzungen ist ein Entleeren der Wasserseite nicht erforderlich.

5.3 Betriebsstillstand bei Frostgefahr

Falls Stillstände im Winter auftreten und Einfriergefahr besteht, sind die Bündel auch bei kurzen Betriebsunterbrechungen zu entleeren.

6. Wartung und Reinigung

Die Luftseite unterliegt unter normalen Betriebsverhältnissen keiner Verschmutzung.

Bei geschlossenem Kühlkreislauf und der geforderten guten Wasserqualität ist auch die Wasserseite wartungsfrei. Ist durch mangelhafte Sorgfalt eine Verschmutzung des Kreislaufwassers entstanden, ist eine umgehende wasserseitige Reinigung erforderlich und das Wasser ist auszutauschen.

5. Standstill

5.1 Standstill in Case of Open Cooling Water Circuit

In case of standstills of more than 3 days the water side has to be drained.

A standstill is especially dangerous for copper alloy tubes in case of not complete build up protective coat or the risk of getting disturbed by corrosion under deposits.

The cooler operation should not be interrupted during the first 2 months after commissioning if possible. However, if there is a failure in cooling water supply and operation is resumed within three days time, the cooler can be left undrained. It must be guaranteed that the tubes are free of deposits.

In case of deposits the cooler must be drained, the tubes have to be cleaned, flushed with clean water and dried. A blow through with warm predried air through the pipes is recommended. The cooler has to be sufficient vented. If sea water, brackish or saline water (reference value chloride content ≥ 500 mg/l) is used as cooling water for flushing clean water (drinking water quality) has to be used.

In case of standstills for more than 3 days during the start-up period of 2 months and later on during standstills for more than 2 weeks the same cleaning procedure has to be used.

In case of short standstills operating with low water velocity is to be preferred to water standstill.

5.2 Standstill in Case of Closed Cooling Circuit

Drinking water quality is prescribed for closed cooling water circuits (see item 4.3). Under this conditions no draining in case of standstill is necessary.

5.3 Standstill at Freezing Conditions

The cooler has to be drained in case of wintertime standstills, when a frost injury to the cooler must be feared, also during short standstill periods.

6. Maintenance and Cleaning

Under normal conditions the air side is free of fouling.

In case of closed water circuit the water side of the cooler is generally free of maintenance good water quality assumed. If by poor care a contamination of the circuit water has happened a immediate cleaning of the water side is necessary and the water must be exchanged

Bei offenem Kühlkreislauf sind die Wartungsintervalle auf der Wasserseite von der eingesetzten Wasserqualität abhängig. GEA empfiehlt die erste Kontrolle nach einem viertel Jahr.

Je nach Befund kann der Zeitraum ausgedehnt werden. Es ist jedoch auch bei einem offenen Kühlkreis durchaus möglich, daß auf eine Wartung verzichtet werden kann. Bei extrem schlechter Wasserqualität, kann unter Umständen auch ein kürzeres Kontrollintervall erforderlich werden. Bei Kühlturmwasser ist eventuell die Wasserbehandlung des Kühlturms zu überprüfen. Bei Durchlaufwasser ist eventuell eine Wasserbehandlung sinnvoll.

Zur Wartung sind die Bündel zuerst über die Wasserleitungen und die Entleerungsschrauben zu entwässern und dann beide Kammern zu demontieren.

6.1 Mechanische Reinigung der Rohre

Zeigen sich bei der Wartung Ablagerungen auf der Rohrinseite, muß gereinigt werden.

Jedes Rohr muß noch in feuchtem Zustand mit der Reinigungsbürste gereinigt werden.
Nach Abschluß der Reinigung müssen die abgelösten Ablagerungen herausgespült werden.

Nach der Reinigung sind die Kammern mit neuen Dichtungen wieder zu montieren (Montage siehe Konstruktionsbeschreibung Artikel 2).

6.2 Chemische Reinigung der Rohre

Wenn die mechanische Reinigung erfolglos ist (z.B. Kesselsteinablagerungen), ist eine chemische Reinigung der Rohrinseite durch eine fachkundige Firma erforderlich.

Insbesondere ist darauf zu achten, daß der Reinigungsvorgang nur so kurz wie nötig erfolgt und keine Reinigungsmittelrückstände im Kühlsystem verbleiben.

Der erneute Aufbau der Schutzschicht gemäß Artikel 4.3.2 oder 4.4.2 muß beachtet werden.

7. Reparatur bei Wasserleckage

Ursache einer Wasserleckage kann ein durchkorrodiertes Rohr oder eine undichte Einwalzstelle sein. Um das schadhafte Rohr ausfindig zu machen, ist es zweckmäßig, das Bündel auszubauen und auf geeignete Auflageböcke abzulegen.

Das ausgebaute Bündel ist mit Wasser wieder aufzufüllen und unter Wasserdruck zu setzen. Aus dem abtropfenden Wasser kann der Bereich der Leckage abgeschätzt werden. Zur genaueren Identifizierung einer Korrosionsleckage kann es erforderlich werden, die Rohre einzeln aus dem fraglichen Bereich abzudrücken. Dazu sind die Kammern zu demontieren. (siehe Konstruktionsbeschreibung Artikel 2).

The cleaning intervals of the water side in case of open cooling water circuits depends on the quality of the cooling water is used. GEA recommend the first control after three months time.

The control intervals could be extended in accordance with the finding . It may be that even in case of an open cooling water circuit maintenance might not be necessary. In case of extremely bad water quality it may be necessary to shorten the control intervals. In case of cooling tower water, the water treatment has to be checked. It may be useful to treat also passage water.

For maintenance the bundles have to be drained through the water pipes and the draining plugs and the headers have to be dismantled.

6.1 Mechanical Cleaning of the Tubes

In case that deposits at the tube inside are found during the maintenance the tubes have to be cleaned.

All tubes have to be brushed with the cleaning brush in wet state. After brushing the detached deposits have to be rinsed.

After that the headers have to be mounted together with new gaskets (mounting see design description item 2).

6.2 Chemical Cleaning of the Tubes

Chemical cleaning is required if mechanical cleaning is not successful (for instance in case of boiler scale). The chemical cleaning should be done by a competent company.

Especially it has to be taken care of a cleaning procedure as short as possible and that no cleaning residue is left in the cooling system.

It must be payed attention to format the protective coat new. See item 4.3.2 or 4.4.2.

7. Repair of Water Leakage's

Cause of a water leakage may be a corroded tube or a leaking rolled in tube end. To find out the leaking tube it is helpful to remove the bundle and to deposit it on suitable benches.

The removed bundle has to be filled up with water and should be put under water pressure. The area of the leaking can be estimated by the dripping water. To find out the real leaking tube it could be necessary to do an individual pressure test of single tubes of the identified area. Therefore the headers have to be dismantled (see design description item 2).

Im Bedarfsfall, insbesondere bei einer undichten Einwalzstelle, empfiehlt es sich zur Lokalisierung der Leckage, wasserseitig Druckluft von max. 0,5 bar Überdruck aufzubringen und das Bündel in ein Wasserbecken mit sauberem Trinkwasser abzutauchen. Das Restwasser muß nach erfolgter Druckprobe mit Druckluft aus dem Rippenpaket ausgeblasen werden.

Eine undichte Einwalzstelle ist nachzuwalzen. Ein durchkorrodiertes Rohr ist beidseitig mit konischen Verschußstopfen abzudichten. Der Werkstoff der Stopfen soll gleich dem Rohrbodenwerkstoff sein. Der Kegel des Stopfens ist 1 : 25.

Die Verschußstopfen sind mit leichten Hammerschlägen einzutreiben. Die Kammern werden mit neuen Dichtungen wieder montiert und das Bündel einer Wasserdruckprobe unterzogen. Zeigen sich keine weiteren Leckagen, Beobachtungszeit > 15 min, kann das Bündel wieder montiert und in Betrieb genommen werden.

In case of need, especially of a leaking rolled in tube end, it is recommended to find out the leaking tube by floating the bundle in a tank filled up with clean water (drinking water quality). The water side has to put under air over pressure of 0,5 bar. The remained water in the coil has to be blown out with compressed air after the check.

A leaking tube end has to be rolled again. The defective tube must be plugged with a conical plug. The material of the plug should be identical to the tube sheet material. The cone of the plug is 1 : 25.

The plugs should be driven with a hammer into the leaking tube on both sides. The header must be mounted with new gaskets and the bundle has to be pressure tested again over a period of in minimum of 15 minutes. After that the bundle could be mounted and commissioned again.

Flansch, flange
DN 100 PN16
DIN 2633

800

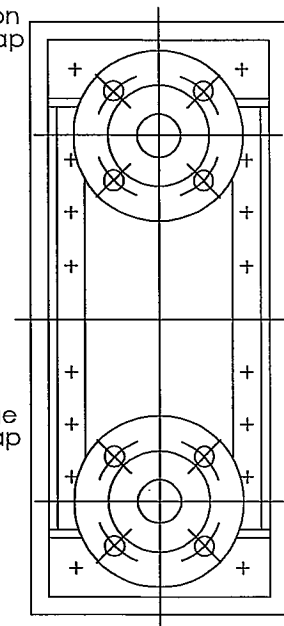
Entlüftung, ventilation
Verschlußklappe, cap

Entleerung, drainage
Verschlußklappe, cap

$L = 2.280 +3/-0$

69

1.695



GEA-Ref.: 20020771
zu Maschine: HTM110D10

Material-Nr.: 526406

Projekt: Fenestrelle

Prüfüberdruck 9 bar, testpressure

Oberfläche		Maßstab	Position	Menge
		08VK2077100		
Bearb.	Datum	Rippenrohr-Wärmetauscher fin tube heatexchanger		
Gepr.	Name			
Norm				
Kühlsystem/ cooling system:				Blatt
				Bl
EDV Nr.				

2.467

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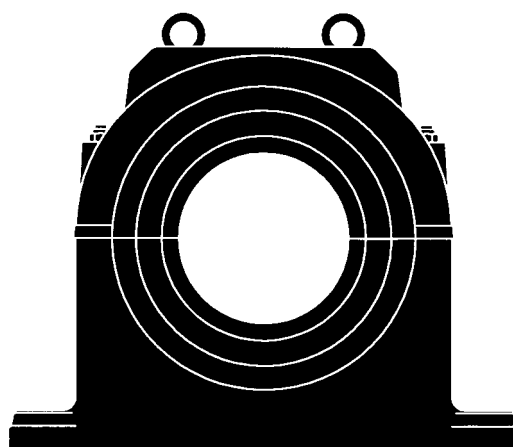
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Slide Bearings TYPE EG, ER

Size 35 - 112

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Bearing Coding

Installation and Maintenance

①	②	③	④	⑤	⑥
Type	Housing	Heat Dissipation	Shape of Bore and Type of Lubrication	Thrust part	Size - Diameter
E	R - finned pedestal bearing (size 35 - 45) G - smooth pedestal bearing	N - natural cooling	C - plain cylindrical bore without oil ring	Q - without thrust part (non locating bearing)	35 300≤D≤450
		Z - lubrication by oil circulation with external oil cooling	L - plain cylindrical bore with loose oil rings	B - plain sliding surfaces (locating bearing)	45 375≤D≤560
		X - lubrication by oil circulation with external oil cooling for high oil throughput	Y - two-lobe bore (lemon shape) without oil ring	K - taper land faces for both senses of rotation (locating bearing)	56 475≤D≤710
		U - circulating pump and natural cooling			71 600≤D≤900
		T - circulating pump and water cooling (finned cooler in oil sump)			90 750≤D≤1000
		W - water cooling (finned cooler in oil sump)		A - elastically supported circular tilting pads (locating bearing)	112 950≤D≤1250
				E - taper land faces for one sense of rotation (locating bearing)	

Example for bearing coding:

①	②	③	④	⑤	⑥
E	G	Z	L	A	35-355

Type E slide bearing with smooth foot-mounted housing, lubrication by oil circulation with external oil cooling, plain cylindrical bore with loose oil ring, locating bearing with elastically supported circular tilting pads, size 35, diameter 355.

Shaft seals

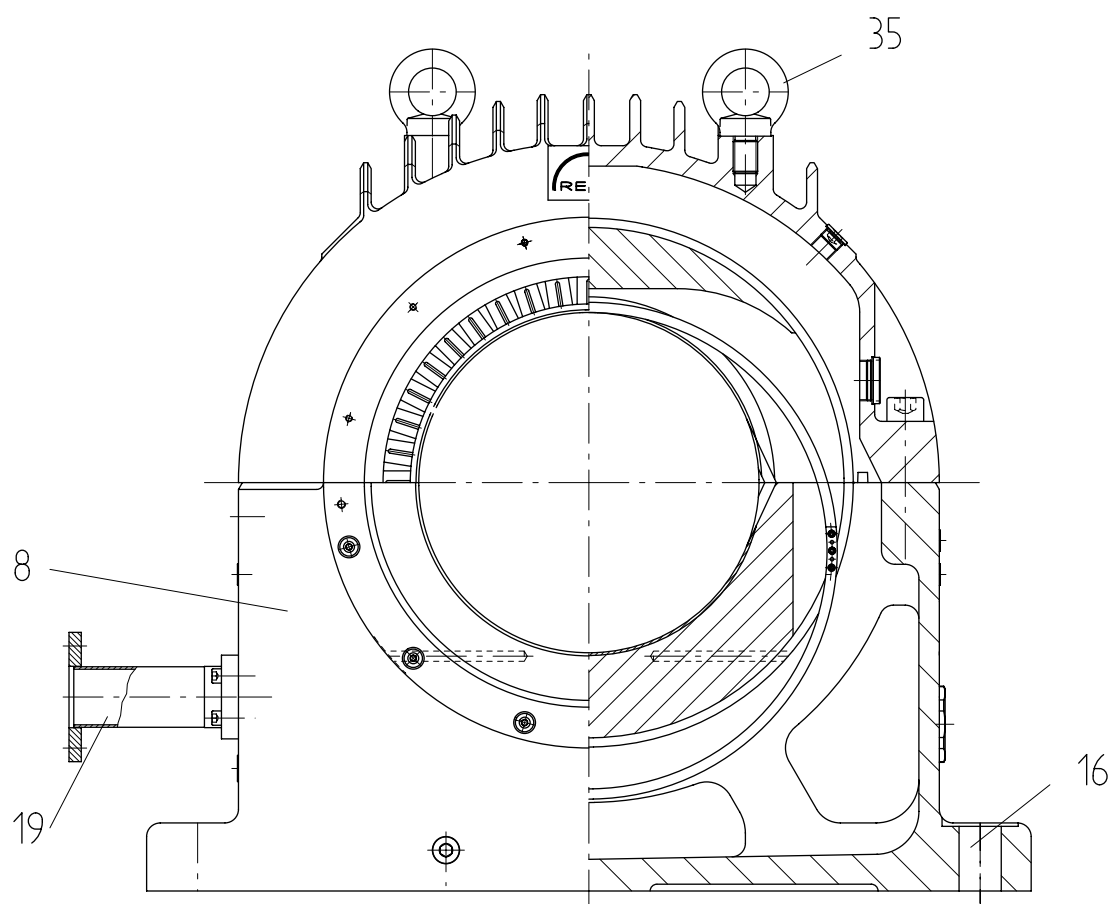
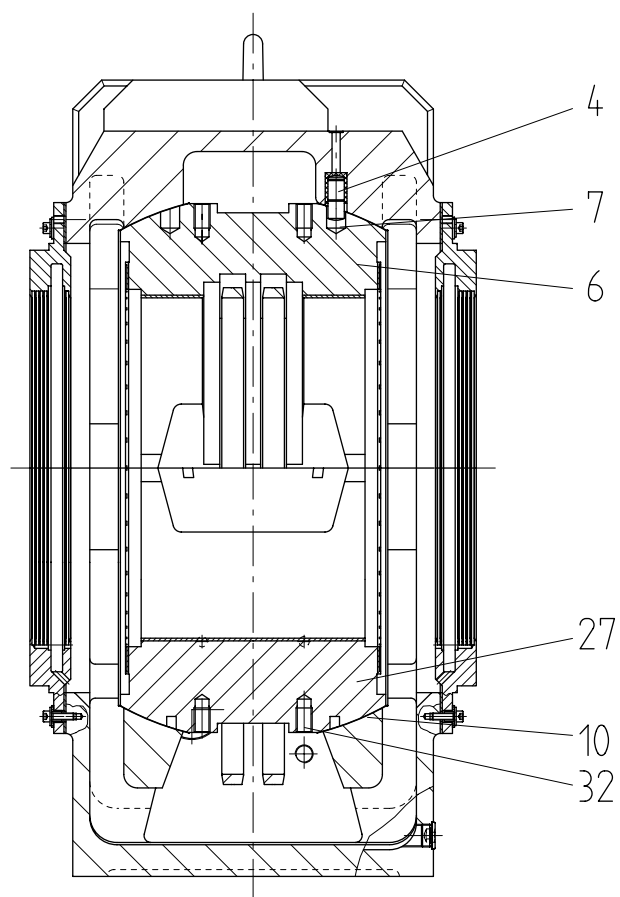
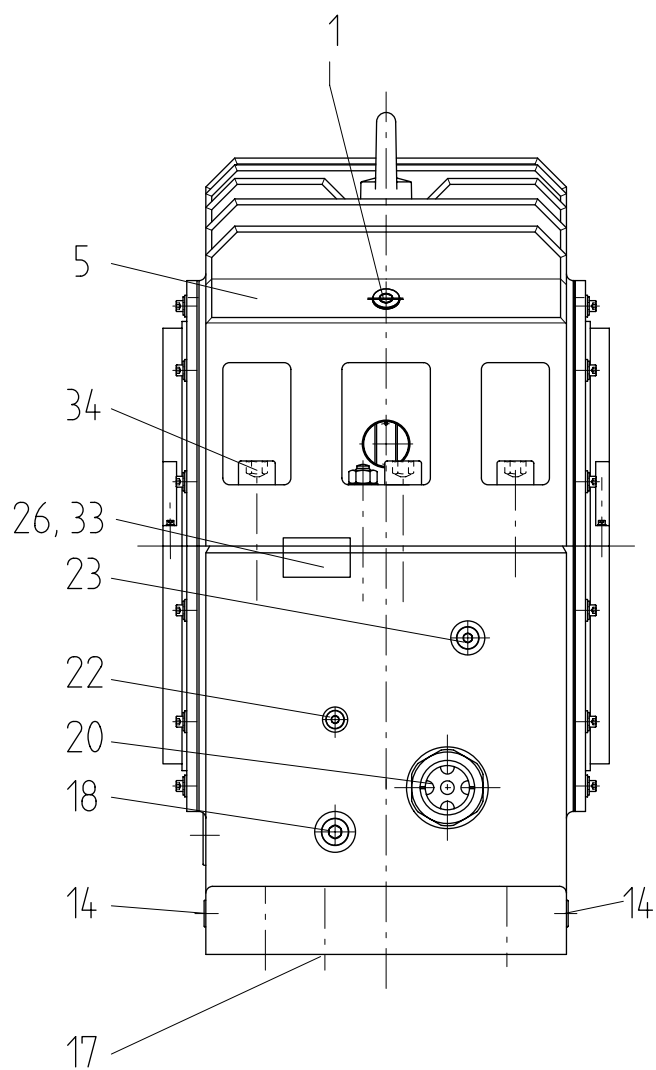
Type 20 - rigid labyrinth seal (IP 44)

Type 22 - rigid labyrinth seal (IP 55)

General Drawing

Slide Bearing type EG, ER

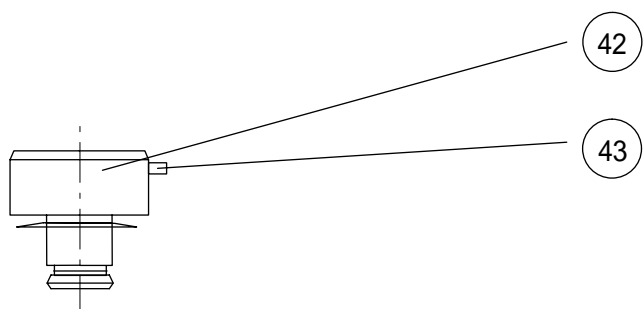
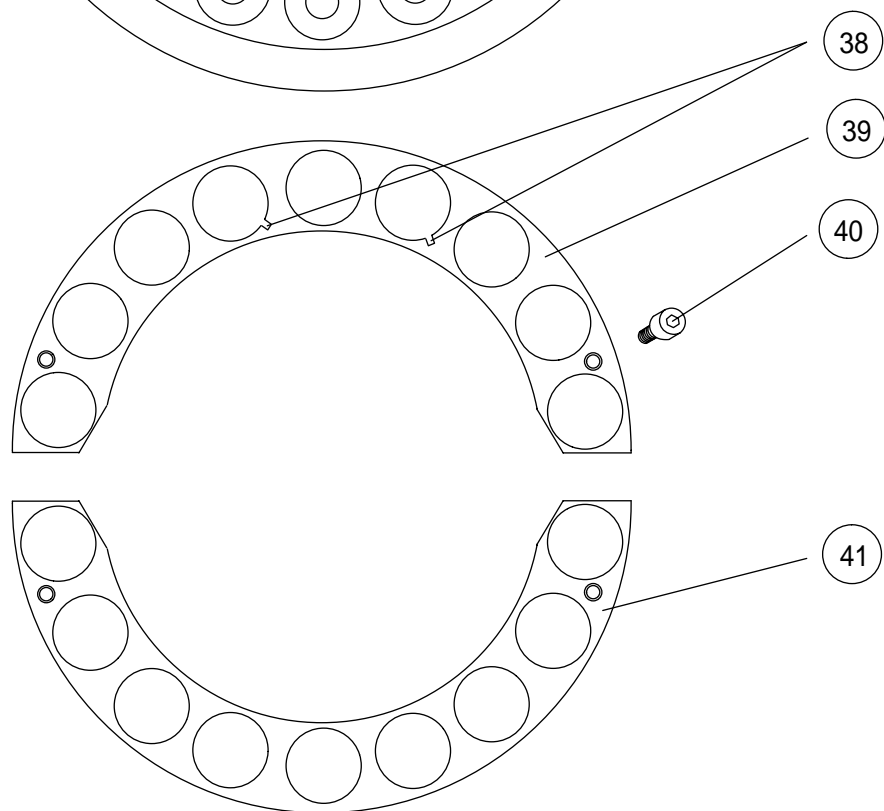
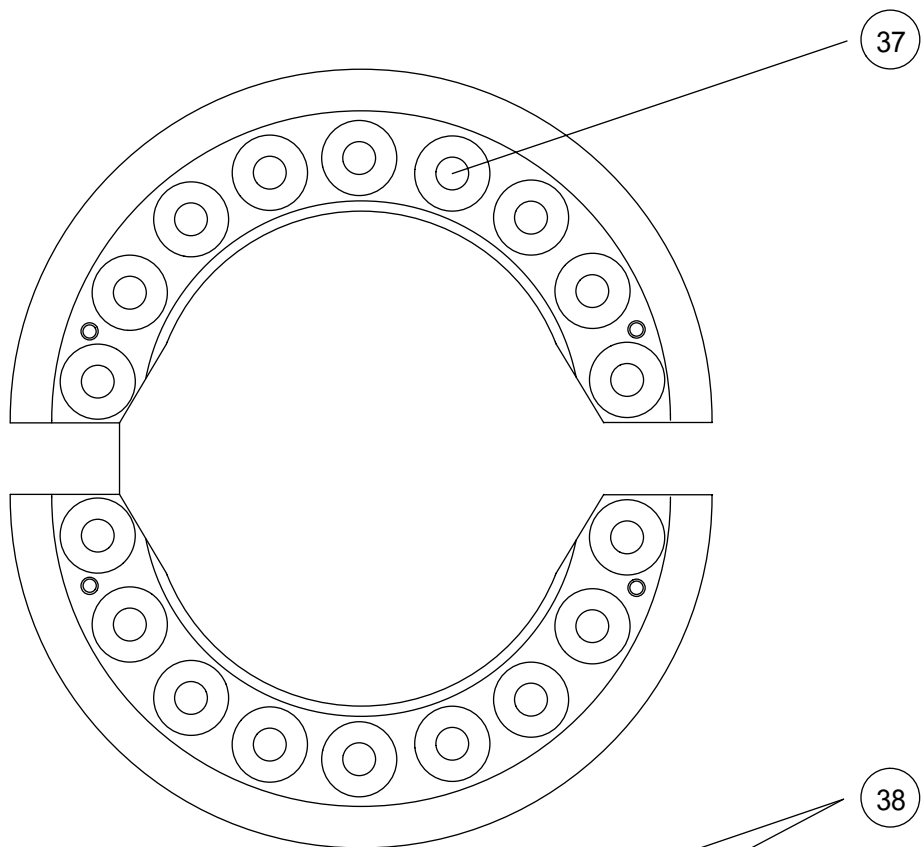
35 - 112



- 1 Oil filling hole
- 2
- 3
- 4 Positioning pin
- 5 Housing - top half
- 6 Shell - top half
- 7 Positioning pin hole
- 8 Housing - bottom half
- 9
- 10 Spherical surface
- 11 Cooling water in-or outlet (Type E.T..)
- 12 Cooling water out-or inlet (Type E.T..)
- 13 Cooler (Type E.T..)
- 14 Hexagon head plug (Oil drain plug)
- 15 Foot plate (Type ER...)
- 16 Foot plate holes
- 17 Dowel pin hole
- 18 Connection hole for oil sump temperature measurement
- 19 Oil outlet pipe with special pipe nut and lead seal
- 20 Oil sight glass
- 21 Screw plug
- 22 Connection hole for journal bearing temperature measurement
- 23 Oil inlet connection hole
- 24 Screw plug
- 25 Connection hole for thrust part supply (optional)
- 26 Engraved number
- 27 Shell - bottom part
- 28 Engraved number
- 29
- 30 Engraved number
- 31
- 32 Tapped hole (shell - top and bottom halves)
- 33 Engraved number
- 34 Screw (split line of the housing)
- 35 Eye bolt
- 36 Connection hole for thrust part temperature measurement (optional)

General Drawing

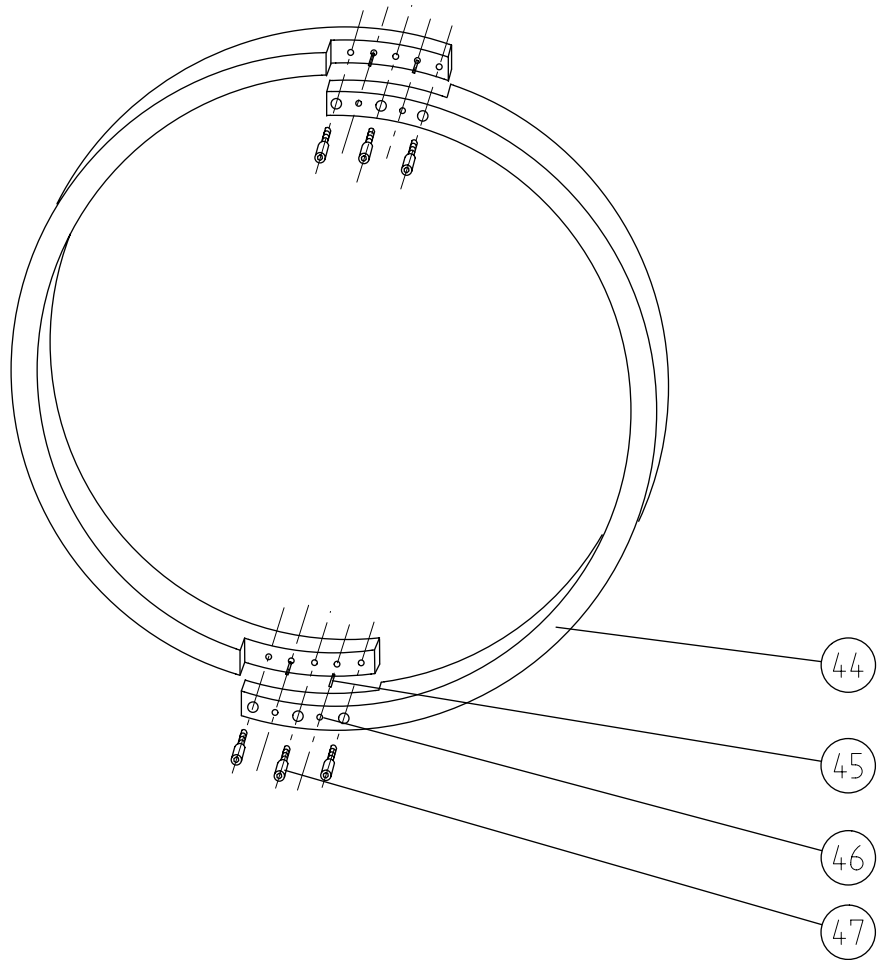
Thrust Part with RD-Thrust Pads



- 37 Thrust pad hole
- 38 Location groove
- 39 Shroud ring top half
- 40 Screw
- 41 Shroud ring bottom half
- 42 RD-thrust pad
- 43 Anti - Rotation pin

General Drawing

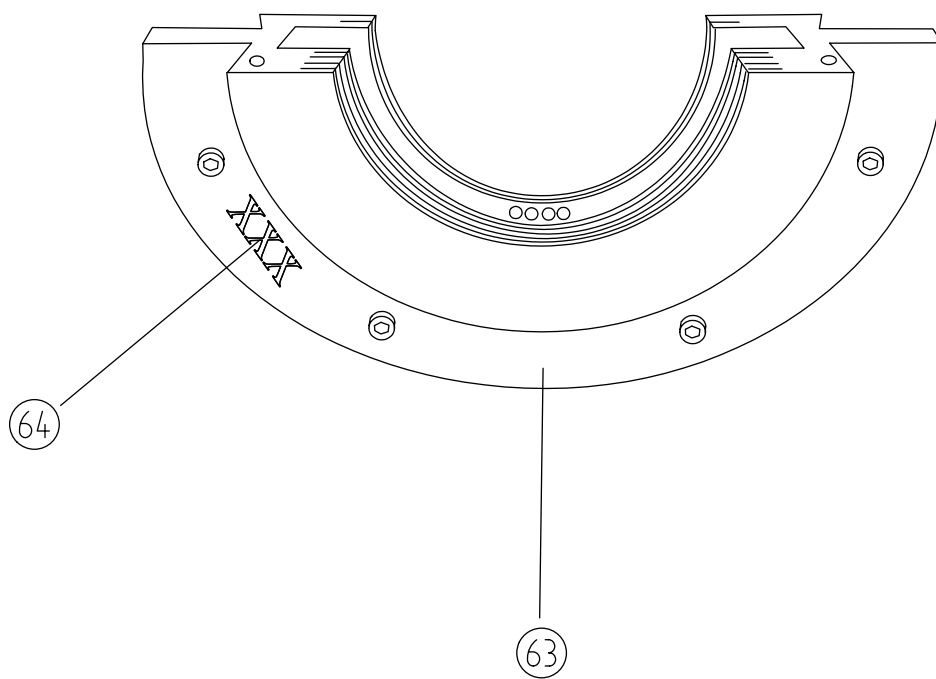
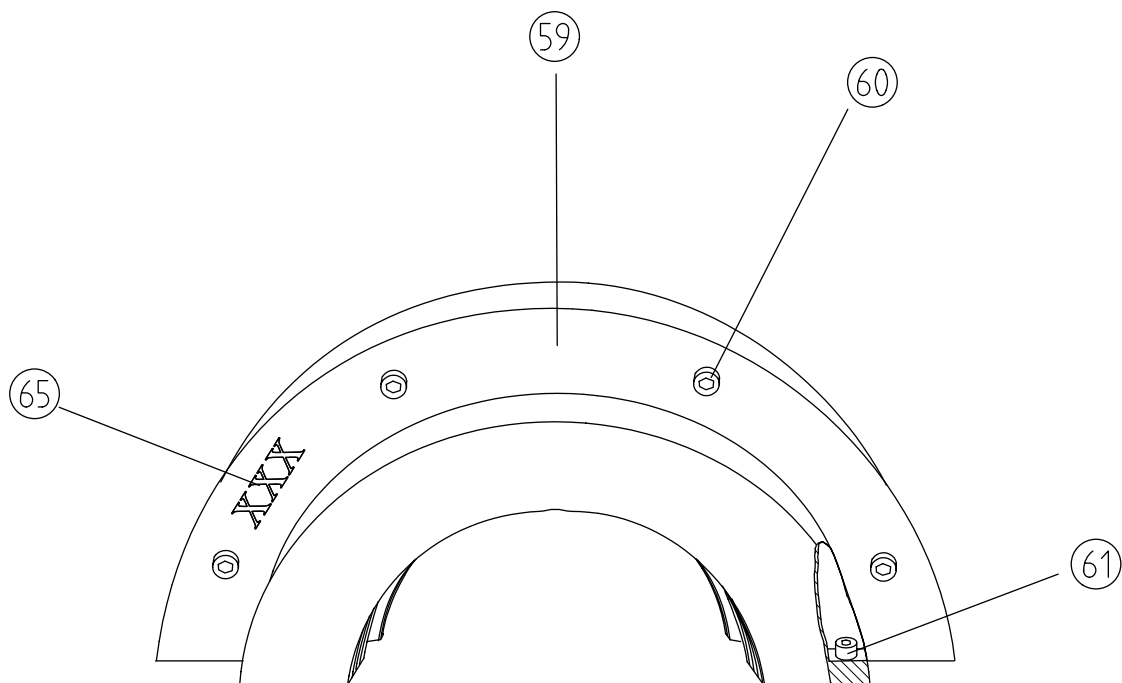
Loose Oil Ring



- 44 Loose oil ring
- 45 Dowel pin
- 46 Hole
- 47 Screw

General drawing

Rigid Labyrinth Seal



59	Rigid labyrinth seal - top half
60	Scew
61	Screw (split line)
63	Rigid labyrinth seal - bottom part
64	Engraved number
65	Engraved number
66	Taper sleeves

1 Considerations for Use

The instructions for installation and maintenance are addressed to qualified technical personnel (fitters, mechanic installers, mechanical engineers).

Read these instructions carefully before starting assembly.

Slide bearings of type EG and ER are almost universally used in the engineering industry. Therefore it is not possible to provide detailed information on all possible types and range of applications for these bearing types. For instance, the position of the connection points for supply and monitoring equipment is determined by the place of application (in the following called " installation "). Please keep ready the guidelines with the technical documentation before starting installation and maintenance of the slide bearings.

Additional technical documentation with detailed information is supplied in case of special design bearings. Please contact RENK Export or Domestic Department for supplementary information on bearings. Please indicate the bearing coding and the full reference number, too.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:



Danger!

Warning of dangers for personnel.
Example: Warning of injury

Attention!

Warning of damage for the bearing or installation.

Useful recommendations and additional information are framed.

E...Q

This is how chapters, instructions or recommendations are marked when referring to a single type or size of a bearing.

Example: Slide bearing type E without thrust pads (non-locating bearing)

- Instruction follows.
- Beginning of an enumeration.
- () This is how the different parts of a bearing as described in the general drawings(numbers) are marked in the text.
- Use the enclosed check-list before starting assembly or operation. Copies available on request.
- The check list provides the experienced mechanical fitters for RENK bearings with the necessary instructions for installation and operation.

2 **Safety Instructions**



Danger!

The installation and maintenance of the slide bearings should be carried out by:

- persons nominated by the safety representative
- persons correspondingly trained and instructed
- persons with knowledge on appropriate standards, regulations and accident prevention rules
- persons with knowledge on first-aid measures and local rescue centers.



Warning of injury!

Before starting work on the bearing:

- Switch off the installation.
- Make sure the installation is not in operation.

Never lift or transport machines, etc. by the bearing eye bolts. These are only intended for assembly and dismantling of the bearing !



Warning of injury!

Do not grab such heavy bearing parts as the housing during assembly or dismantling works. This could result in bruising or injury to hands !

Attention!

All parts of a slide bearing consisting of top and bottom part such as the housing, shells, shaft seals are marked by engraved numbers. Fit together only the parts with the same number.

Attention!

In case • the admissible bearing temperature exceeds 15 K

- inadmissible vibrations occur
- unusual noises or odours are noticed
- monitoring equipment triggers alarm

shut down the installation and inform the maintenance personnel in charge.

Attention!

Do not operate the bearing below the transition speed values indicated in the bearing calculation, thus avoiding inadmissible operating conditions, which could lead to damage of the bearing.

Attention!

Please observe our leaflet Technical Information No. 85 which refers to various sealing compounds for extended technical applications.

3 Preparatory Works

3.1 Tools and equipment

– Following tools and equipment are necessary:

- Allan key set
- Wrenching key set
- Open-jawed spanner set
- Feeler gauges (up 0,05 mm)
- Caliper gauge
- Emery paper, plain scraper
- Oil rubber
- Lifting equipment
- Permanent sealing compound
- Clean cloth
- Oil with the viscosity indicated (see bearing type plate)
- Detergents
- Liquid screw locking compound (e.g. LOCTITE 242)
- Liquid sealing compound and Teflon-tape

3.2 Use of lifting equipment



Warning of injury!

Before transport or lifting check if the eye bolts are tight ! Insecure eye bolts could result in bearing becoming loose.

Before moving the bearing by the eye bolts make sure that the split line screws are tightened, otherwise the bottom half of the bearing could become detached.

Make sure that the eye bolts are not exposed to bending stress, otherwise the bolts could break.

Follow exactly the instructions for the use of lifting equipment.

- Use lifting equipment for assembly or transport of the bearing items:
- Following steps are to be observed before using the lifting equipment:

Whole bearing unit

- Check if the screws are tight (34):

Bearing size	35	45	56	71	90	112
Torque value [Nm] $\mu_{\text{tot}} = 0,1$ (lightly oiled)	1150	2010	3230	4890	4890	4890

- Check if the eye bolts (35) are tight.
- Connect the lifting equipment to the eye bolts (35).

Top half of the housing

- Check if the eye bolts (35) are tight.
- Connect the lifting devices to the eye bolts (35).

Bottom half of the housing

- Screw two eye bolts (35) with suitable threads tight into the cross-placed opposite tapped holes.

Bearing size	35	45	56	71	90	112
Tapped hole	M 30	M 36	M 42	M 48	M 48	M 48

- Connect the lifting equipment to the eye bolts (35).

Shells

- Screw two eye bolts or screw hooks with suitable threads tight into the tapped holes (32):

Bearing size	35	45	56	71	90	112
Tapped hole	M 16	M 20	M 30	M 30	M 36	M 42

- Connect the lifting equipment to the eye bolts or to the screw hooks.

3.3 Dismantling of the bearing

Attention

Make sure that the work place and the parts to be assembled are clean. Contamination and damages to the bearing, especially of the working surfaces, have a negative influence on the operating quality and could lead to premature fatigue.

3.3.1 Dismantling of the Rigid labyrinth seal (type 20 and 22)

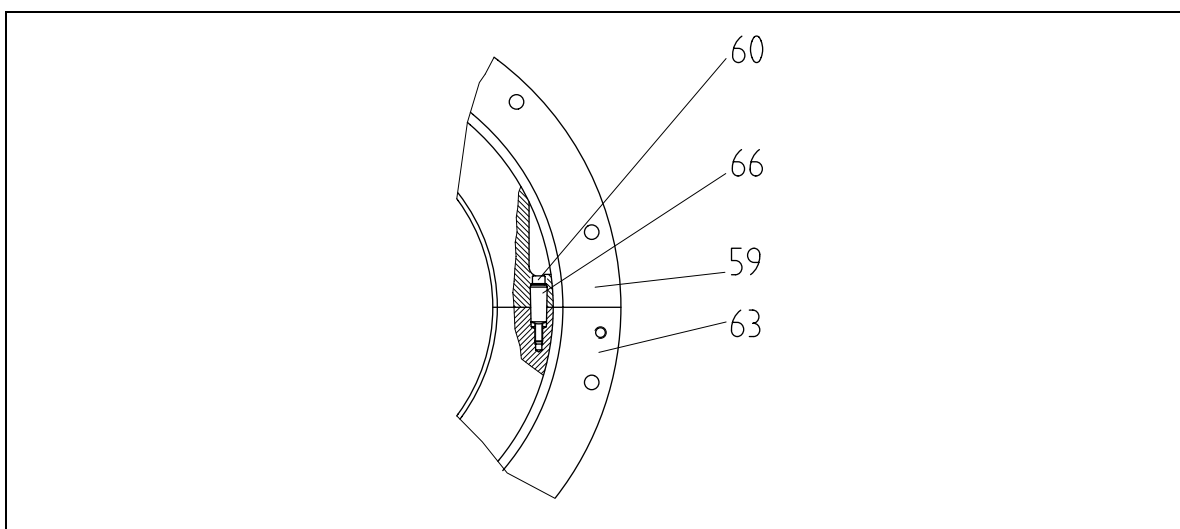


Illustration 1: Dismantling of the rigid labyrinth seal

- Loosen all screws (60) of the top half (59).
- Take out the screws (61).
- After removing the screws (61) pull out in upward direction the taper sleeves (66) from the split line bores. You can separate both halves of the rigid labyrinth seal only after removing the taper sleeves (66). The taper sleeves (66) are provided with M 10 threads in which you can screw counter nuts or any other suitable pulling tool.
- Screw an eye bolt M12 or a screw hook into the threaded hole on the top half (59).
- Connect the lifting equipment to the eye bolts or to the screw hooks.
- Remove the screws (60) of the top half (59).
- Take away the top half carefully, in axial direction, from the housing.
- Loosen the screws of the bottom half (63).
- Screw two eye bolts M12 or screw hooks into the threaded holes of the bottom half (63).
- Further on proceed as in the case of the top half.
- Remove the gasket from the flange surface.
- Damaged gaskets must be renewed.

3.3.2 Dismantling of the housing

- Unscrew the screws (34) or the nuts respectively and lift the top half of the housing (5).
- Take out both top (6) and bottom (27) halves of the shell from the bottom half (8) of the housing.

Attention!

Do not damage the thrust and radial working surfaces!

Attention!

In the case of insulated housings (white plastic insulating foil) avoid any jamming of the top half of the shell when you lift it up
Jamming could lead to damage of the insulating foil in the bottom half of the housing.

- Remove the taper pins (30) by using suitable tools and unscrew both screws (31).
- Separate top and bottom half of the shell (6), (27) without using any tools or other devices.

E.T..
E.W..

The cooler (13) is already assembled and does not have to be removed for cleaning purposes.

3.4 Cleaning of the bearing

Attention!

Use only non-aggressive detergents, such as for instance:

- VALVOLINE 150.
- Alkaline cleaning compounds (pH-value 6 to 9, short reaction time).



Warning of injury!

Please observe the instructions for the use of the detergents.

Attention!

Never use cleaning wool or fibrous cloth. Residues of such materials left in the bearing could lead to excessive temperatures.

- Clean the following parts thoroughly, to remove all residues of preservation :
 - inside the top half of the housing (5)
 - inside the bottom half of the housing (8)
 - all plain parts of the top and bottom half of the housing (5), (8)
 - top half of the shell (6)
 - bottom half of the shell (27)
 - sealing surfaces of the seal carrier
 - loose oil rings (44).

E..L.
size
35-71

3.5 Check-up

- Please check if there is any visible damage. Check the split line and the working surfaces in particular.

E..L.
size
35-71

The loose oil rings (44) should show absolutely no burrs or have no shoulders.

Insulated
Bearings
size
35-71

- Check the insulating layer of the spherical seatings (10).
- If necessary, change the damaged parts.

Attention!

The insulating layer of the spherical surface can be repaired ones with special tools and insulating material.

E...A

3.6 Assembly of the RD-thrust pads

- Clean top (39) and bottom (41) halves of the shroud ring and all RD-thrust pads (42). Proceed as described under chapter 3.4 (Cleaning of the bearing).

Bearing size	Diameter	Number of RD-thrust pads per bearing [Pieces]
35	300	16
	315	18
	335	18
	355	20
	375	24
	400	24
45	375	16
	400	18
	425	18
	450	20
	475	26
	500	26
56	475	16
	500	18
	530	18
	560	22
	600	24
	630	30
71	600	18
	630	18
	670	24
	710	24
90	750	18
	800	20
	850	22
	900	24
112	950	20
	1000	22
	1050	22
	1120	26

- Check if the parts show any visible damage.
- Carry out the assembly of both thrust parts of the top (6) and bottom (27) half of the shell according to the following instructions:
- An RD-thrust pad on both sides of the top half of the shell has a bore for the insertion of a thermo sensor (thrust part temperature measurement).

To mount the RD-thrust pad into the correct position proceed as follows:

- Find the position of the location hole (38) on the top half of the shroud ring (39). Insert the RD-thrust pad (42) with the anti-rotation pin (43) into the corresponding thrust pad location hole (37).
- Insert all other RD-thrust pads (42) into the corresponding thrust pad holes (37) of the top and bottom half of the shell (6), (27).

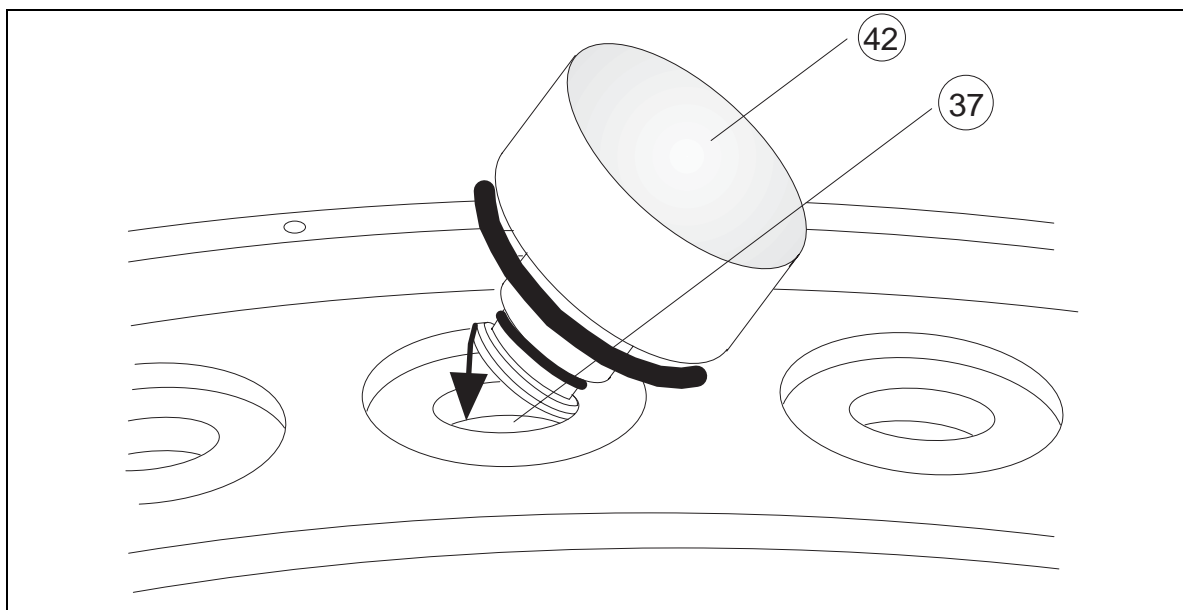


Illustration 2: Assembly of the RD-thrust pads

- Place the top half of the shroud ring (39) into the the top half of the shell (6) by inserting the anti-rotation pin (43) into the location hole (38). Match the split line of the top half of the shell (6) with the split line of the top half of the shroud ring (39) in true alignment.

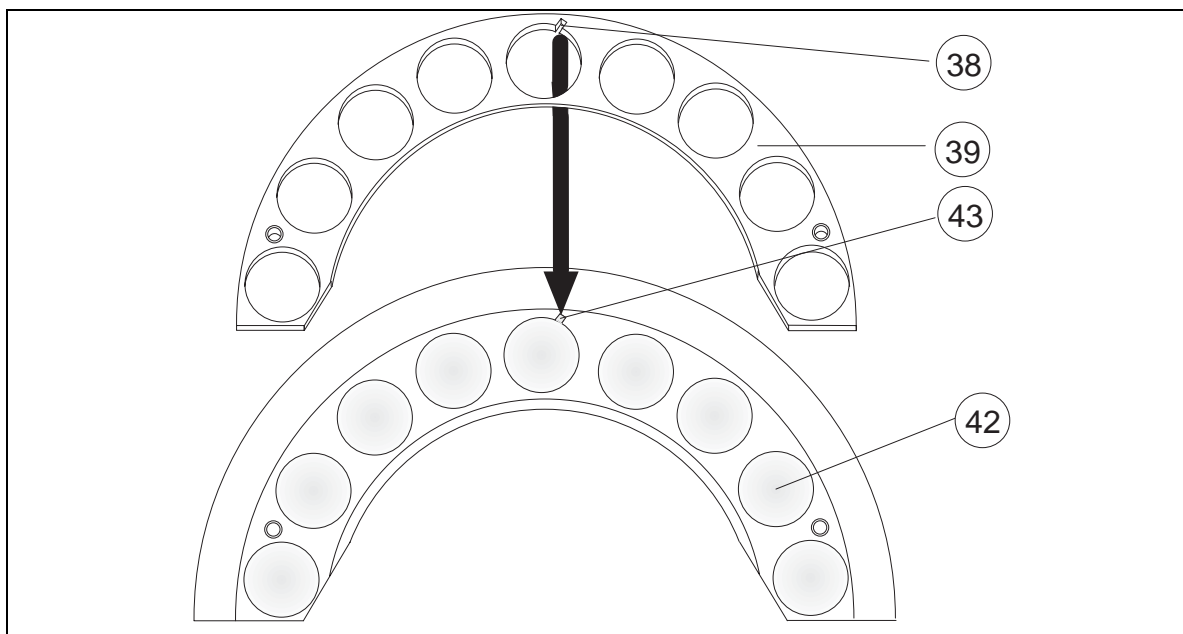


Illustration 3: Assembly of the shroud ring

Installation and Maintenance

- Tighten the screws (40) by using the following torque values:

Bearing size	35	45	56	71
Tapped hole	M 10	M 10	M 10	M 12
Torque [Nm]	40	40	40	69

- Place the bottom half of the shroud ring (41) into the bottom half of the shell (27). Match the corresponding split lines in true alignment. Tighten the screws (40) with the same torque value as valid for the top half of the shell (6).
- Check the mobility of all RD-thrust pads (42).
If the RD-thrust pads jam, realign the top (39) and bottom half (41) of the shroud ring.

Attention!

Insufficient mobility of the RD-thrust pads will cause damage of the bearing.

Both top and bottom halves of the shells are prepared for assembly.

4 Assembly of the Bearing

Attention!

Remove all impurities or other objects such as screws, nuts, etc. from inside the bearing. If left inside they could lead to damage to the bearing. Cover up the opened bearing during breaks.

Attention!

Carry out all assembly operations without making use of force.

Attention!

Use a liquid screw locking compound (e.g. LOCTITE 242) for all housing, split line and flange screws.

4.1 Assembly of the bottom half of the bearing on foundations

Attention!

Make sure that all bearings installed on a shaft line are opened. To open them untighten the screws or the nuts of the split line of the housing.

Attention!

Do not let the lifting device touch the working surfaces of the shaft.

- Lift the shaft high enough to get sufficient room for assembly. Make sure the shaft does not move.
- Adjust the bottom half of the housing on the foundation on site. (see also the Technical Documentation for the Installation).

Insulated
bearings

Chapter 7.1 provides information on the assembly of pedestal insulation of the bearings.

E.T..
E.W..
size
35-45

When adjusting the bearing please observe the position of the water in- and outlets (11) (12).

- Make sure that the bottom half of the housing (8) lies on the foot plate (15). This is the only way to avoid deflexion of the bearing.

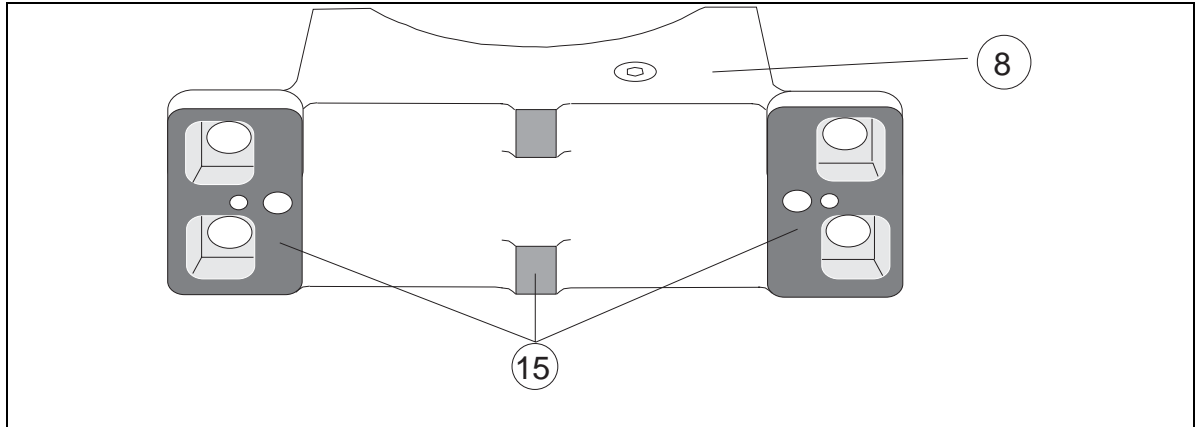


Illustration 4: Foot plates of ER/EG bearing

- Twist suitable foot screws loose into the holes (16) (about 4 turns) to fix the bottom half of the bearing safely into its place. For bearings with high thrust or radial loads use 8.8 quality screws..

Bearing size	35	45	56	71	90	112
Bore for foot screws (16) [mm]	55	62	62	70	70	80
Suitable foot screw thread	M 42	M 48	M 48	M 64	M 64	M 72

4.2 Fitting in the bottom half of the shell

E...E

Attention!

Mounting the bottom half of the shell (not marked with an arrow) correctly will ease the assembly of the top half shell (marked with an arrow) (see chapter 4.4).

- Apply some lubricant to the spherical seating (10) in the bottom half of the housing (8) and on the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).
- Place the bottom half of the shell (27) on the working surface of the shaft. Turn the bottom half of the shell (27) into the bottom half of the housing (8) with the split line surfaces of both halves in true alignment.

If the shell does not turn in easily, readjust the bottom half of the housing.

E...B,
E...K
E...E
E...A

Attention !

These operations should be carried out most carefully. The thrust parts of the bottom shell should not be damaged.

- Lower down the shaft till it sits on the bottom half of the shell (27).

4.3 Installation of the loose oil rings

- Open both split lines of the loose oil rings (44) by untightening and taking out the screws (47). Separate both halves of the loose oil rings (44) carefully without using any tools or other devices.

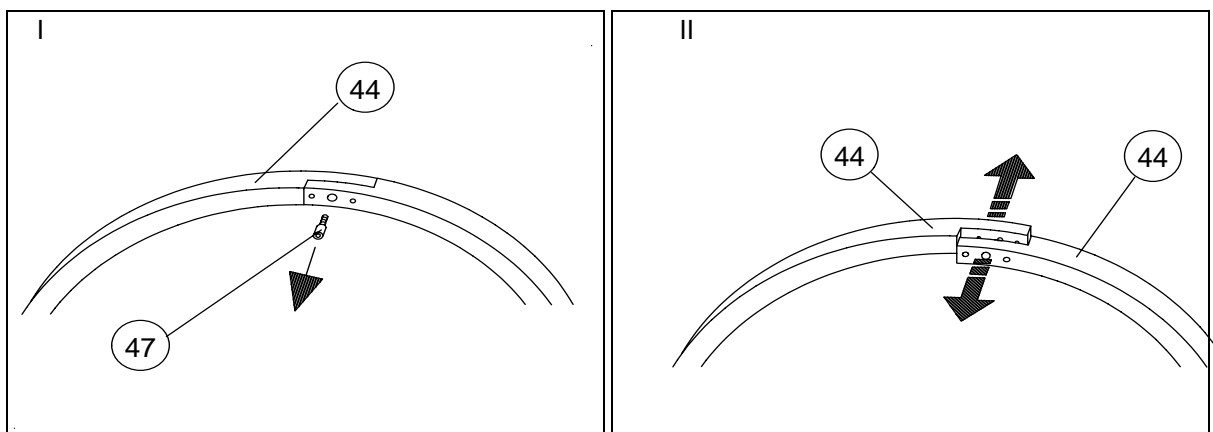


Illustration 5: Opening of the loose oil rings

- Place both halves of the loose oil rings into the shell groove encircling the shaft. Press the positioning pin (45) of each split line into the corresponding hole (46).
- Adjust both halves of the loose oil rings till the split lines match each other.

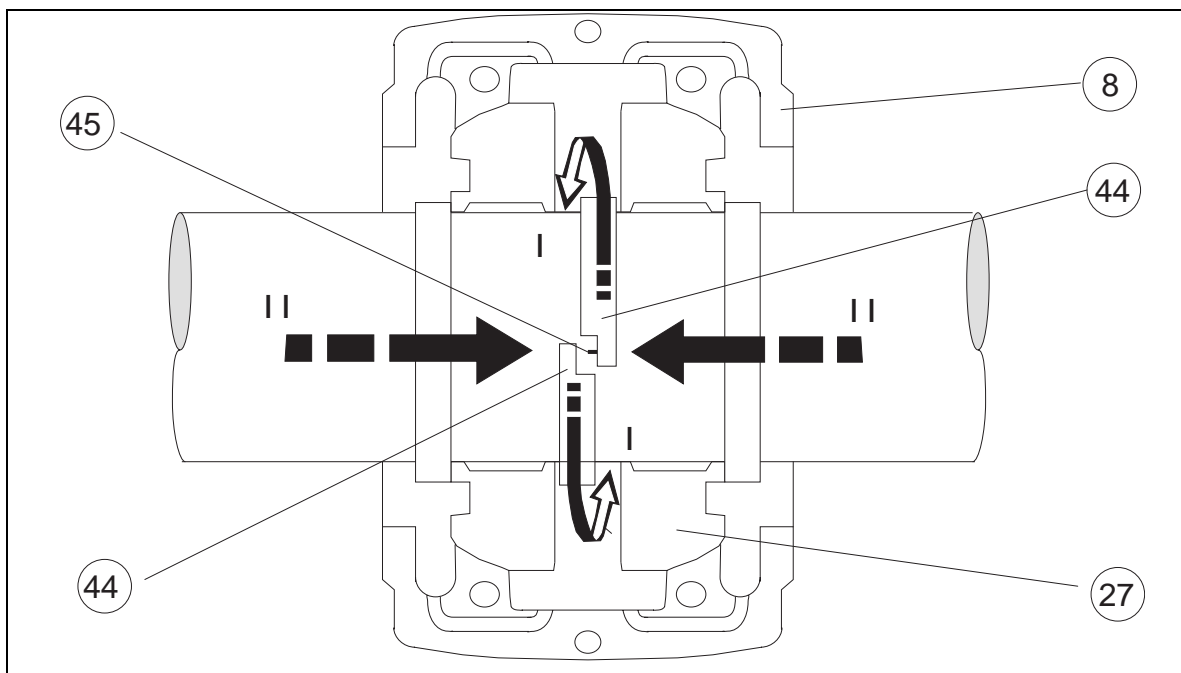


Illustration 6: Installation of the loose oil rings

- Tighten the screws (47) by using the following torque values:

Bearing size	35	45	56	71
Torque [Nm]	4,9	8,0	8,0	8,0

4.4 Fitting in the top half of the shell

- Apply some lubricant on the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).
- Check if the engraved number (28) on the bottom half of the shell corresponds with the engraved number (30) on the top half of the shell.
- Place the top half of the shell (6) on the shaft; both engraved numbers (28),(30) should be on one side.

Attention!

An incorrectly placed shell could jam the shaft thus leading to the damage of both shaft and bearing.

E...B,
E...K,
E...E,
E...A

Attention!

Place the top half of the shell carefully on the shaft. The thrust parts of the top half of the shell should not be damaged.

insulated
bearings

In the case of bearings arranged for insulation monitoring, connect the black cable for insulation monitoring to the shell.

According to the bearing type, there are two possibilities of connection.

1. The black cable is provided with a cable connector.

- Plug the cable with the cable connector into the counterpart available on the top of the shell.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

2. The black cable is provided with an eyelet.

- Fasten the cable with the eyelet to the split line of the shell, by using one of the shell joint bolts.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

- Assemble both halves of the shell by carefully inserting the taper pins.
- Tighten up the screw (31) by using the following torque values:

Bearing size	35	45	56	71	90	112
Torque [Nm] $\mu_{tot} = 0,1$ (lightly oiled)	170	330	1150	1150	2010	3230

- Check the split line of the shell by using a feeler gauge. The split line gap should be less than 0,05 mm. If the split line is greater than this, dismantle both top (6) and bottom (27) halves of the shell. Rework the split line surfaces of the top (6) and bottom (27) half of the shell with an oil rubber.

- Check the mobility of the loose oil rings (44).

A guide bush in the bottom half of the shell secures the function of the loose oil rings.

- Check the mobility of the loose oil rings (44) in the guide bush.

E..L.
size 35-
45
marine
bearings
size 35-
45

E...E

Shells with taper land faces suitable only for one direction of rotation are marked with an arrow on the top half shell, which indicates the sense of rotation of the shaft.

The arrow indicates the allowed direction of shaft rotation after completion of the bearing assembly.

- Before mounting the top half of the housing check that the proposed direction of rotation of the shaft corresponds to the direction indicated by the arrow on the top half of the shell.
- If the directions match, continue the assembly of the bearing.
- If the directions do not match, the shell must be disassembled, re-aligned and mounted again.

Attention!

A wrongly placed shell, without observance of the direction of rotation of the shaft, impairs the operational safety of the bearing.

4.5 Assembly of the top half of the housing

- Check the true alignment of the split lines of the shell (6), (27) and bottom (8) half of the housing.

E..C.
E..L.
E..Y.

The positioning pin (4) in the top half of the housing fits in the corresponding positioning pin hole (7) in the shell.

- Check if the engraved numbers (26) and (33) on the top and bottom halves of the housing correspond.
- Clean the split line surfaces of the top and bottom halves of the housing (5) (8).
- Apply Curil®T over the whole surface of the split line of the bottom half (8) of the housing.

Please observe the instructions for the use of sealing compound.

- Lower the top half of the housing (5) vertically on the bottom half of the housing (8). The engraved numbers should be on the same side of the bearing. Lower the top half of the housing (5) till the split line of the housing is not visible any more.
- Gently hit the bottom half of the housing (8) with a nylon hammer, thus ensuring the alignment of the spherical seating.
- Insert the four screws (34). Tighten them crosswise by using the following torque values:

Bearing size	35	45	56	71	90	112
Torque value [Nm] $\mu_{\text{tot}} = 0,1$ (lightly oiled)	1150	2010	3230	4890	4890	4890

insulated
bearings

Insulation monitoring

In the case of electric insulated bearings provided with insulation monitoring, the cable coming out of the housing must be connected in a professional manner.

According to the type supplied, please follow the assembly instructions given below.

- a) The cable is very short and provided with a further cable connector at the end of it.
This cable is ready for connection to the housing.
The bottom half of the housing is provided with the counterpart.
- Plug the cable connector into the counterpart.

Attention!

This connection bypasses the electrical insulation of the bearing.

In the case of electric machines, make sure at least one bearing is electrically insulated.

To check the electrical insulation, interrupt the connection cable - housing. Check the electrical resistance with a suitable measuring instrument. Make sure that both bearings and the coupling are electrically insulated.

- b) The cable has a free end. In this case the customer has to make the connection.

Attention!

If only one bearing is insulated, the end of the cable must not be earthed.

Any further connection depends on the customer's requirements related to the insulation monitoring and can not therefore be described here.

4.6 Alignment of the bearing

Attention !

If both a non-locating and a locating bearing are to be mounted on a shaft line, both bearings must be adjusted in turn. Start with adjustment of the locating bearing.

- Measure the distances (a,b,c,d) between shaft and lateral bores of the housing on both sides of the bearing.
The measured values a and c must not differ by more than 0,4 mm on each side.

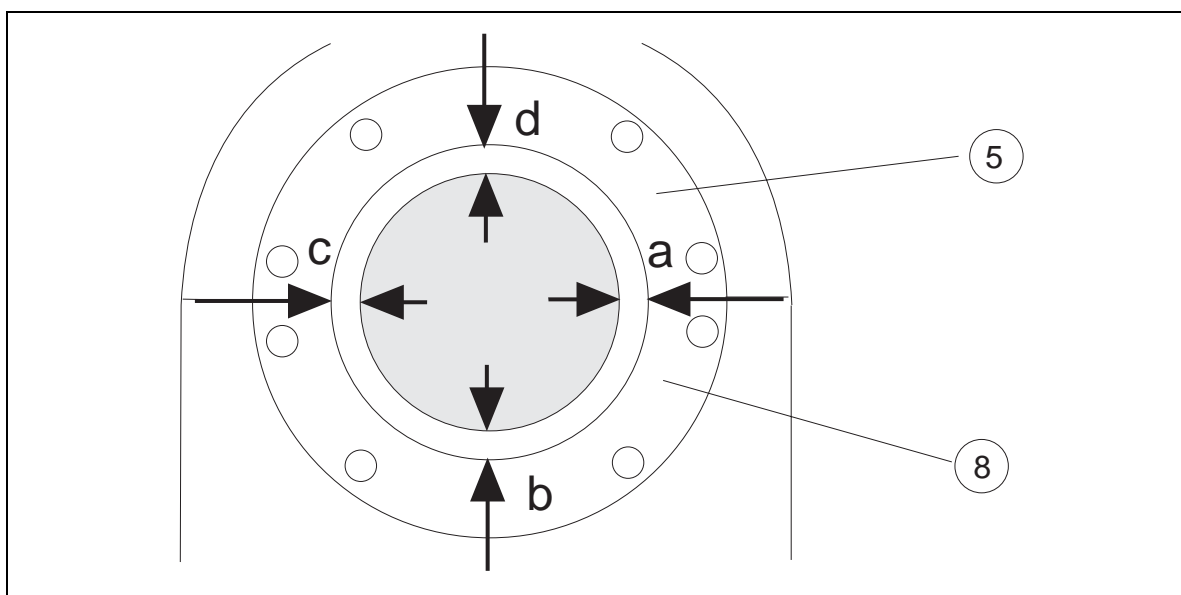


Illustration 7: Alignment of the bearing

In case of large clearances and disadvantageous tolerances the measured values b and d can differ by more than 0,4 mm on one side. If so the values b and d must be compared separately for both sides of the bearing. However, even in such a case the deviation of the measured value b on each side must not exceed 0,4 mm. The same is valid for value d.

- To do so always loose the screws of the split line of both bearings.
- Use lining plates for the height adjustment of the bottom half of the housing (8).
- After every measurement tighten up the split line screws again.

After adjustment of both bearings,

- tighten up the plate screws or the nuts respectively with the necessary torque.
The necessary torque values are depending on
 - the used plate screws
 - the material of the housing and the anchoring in the foundation
(see also the Technical Documentation of the Installation).
- Check the alignment.
- Drill both holes for the positioning pin holes (17) and insert the positioning pins.

5 Assembly of rigid labyrinth seal (Type 20, 22)

- Check if the engraved numbers (64) and (65) on the bottom half (63) and top half (59) of the rigid labyrinth seal correspond.
- Clean
 - the flange surfaces of the top half (59) and bottom half (63) of the rigid labyrinth seal
 - the split line surfaces of the top half (59) and bottom half (63) of the rigid labyrinth seal
 - the flange surfaces of the housing.
- Apply a uniform layer of sealing compound on the split lines of the bottom half (63) of the rigid labyrinth seal.
- Before assembling the rigid labyrinth seal place a new gasket into the flange surface of the housing. Make sure the nut edge is upwards.
- Place the top half (59) of the rigid labyrinth seal on the shaft and press slightly the bottom half (63) of the rigid labyrinth seal from below against it. Lightly push the rigid labyrinth seal completely into the housing.
- Tighten the screws (61) with the taper sleeves (66) to the rated torque: 10 Nm
- Place in parallel alignment the split line of the rigid labyrinth seal and the split line of the housing. Press the rigid labyrinth seal slightly from below against the shaft. Adjust the rigid labyrinth seal in such a way that the clearance "f" between the shaft and the rigid labyrinth seal at both split lines has the same figure.

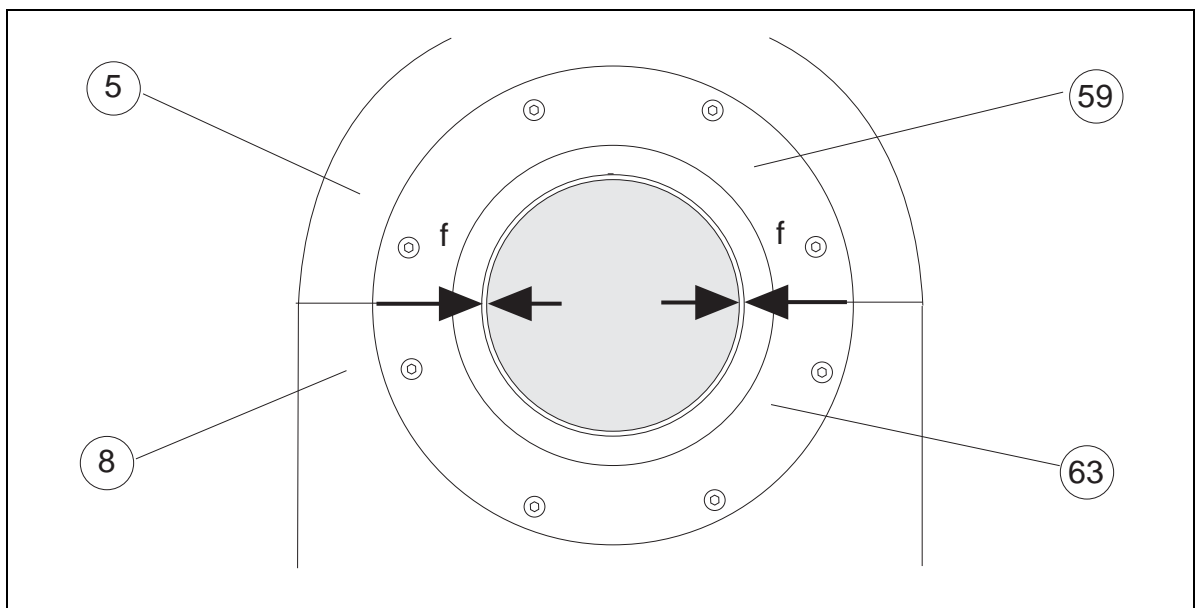


Illustration 8: Alignment of the rigid labyrinth seal

- Tighten the screws (60) by using the following torque values:

Bearing size	35 - 56	71 - 112
Torque [Nm]	40	69

6 Instructions for Assembly of Peripheral Equipment

E..L.
size 35-
45

Attention!

In case of loose oil rings lubrication, attention has to be paid regarding to the free movement of the loose oil rings if oil sump thermometers, heating cartridges, refrigerating devices and similar equipments are additionally monted.

6.1 Assembly of the oil supply equipment

The oil supply equipment together with the pressure, temperature and flow measuring instruments are usually provided by the user. The oil quantity and viscosity necessary for the operation of the bearing are indicated in the bearing calculations. This manual contains only indications on the connection points with the bearing. The connection bores for the oil inlets are on both lateral sides of the bearing, bolted with screw plugs. Remove only those plugs where pipes will be connected.

Connection conditions

	Pipelines	Flow speed	Indications
Inlet	Precision steel pipe DIN 2391 Steel pipe DIN 2448	about 1,5 m/s	Place the throttle valve in the inlet pipeline directly in front of the bearing
Outlet	Steel pipe DIN 2448	max. 0,15 m/s	<ul style="list-style-type: none"> 15° inclination if 15° inclination is not possible enlarge correspondingly the cross sections of the pipeline directly behind the bearing. <p>Too low inclination or / and too small cross-section lead to oil back pressure in the bearing. Leakage or overflowing are the consequences.</p>

- Before starting assembly pickle all pipes which
 - have been welded
 - have been bent hot
 - are contaminated and rusty inside.



Warning of injury!

Please observe the instructions for the use of the pickle. Wear rubber gloves, rubber apron, rubber boots and safety glasses.

Rinsing of the oil circuit

- Rinse the whole oil circuit to remove all impurities. The bearing must not be connected to the oil circuit during rinsing operations. The rinsing should be done before connecting the oil supply to the bearing or the bearing should be disconnected from the oil circuit. If this is not possible, dismantle the top half of the housing and remove the shells.

To avoid damage to the fittings:

- Remove all measuring terminal and switching fittings.
- Close all connections (see also the Technical Documentation of the Installation).
- Fill up the oil supply installation with lubricant. Use the type with the viscosity indicated on the bearing type plate.
- Start operating the oil supply installation. Collect the first charge of high contaminated oil separately. Continue rinsing till the lubricant contains no impurities any more.
- Drain off the oil supply installation completely. Clean the oil tank and the filters.

Warning of environmental pollution!

Please observe the instructions for the use of the lubricant. The manufacturer could provide information on waste oil disposal.

- Assemble all fittings.

Oil inlet

- Connect the inlet pipe at the connection hole (23) for the oil inlet. Seal with Teflon tape or liquid sealing compound.
Depending on the bearing size, the connection hole has the following threads:

Bearing size	35	45	56	71	90	112
Connection hole / Oil inlet (23)	G 3/4"	G 3/4"	G 1"	G 1"	G 1"	G 1"

If the bearing calculation specifies a separate supply source for the thrust parts:

- connect the inlet pipes at the connection hole of the thrust part supply (25) on the lateral side of the bearing. Seal with Teflon tape or liquid sealing compound.

Oil outlet

E.Z.,
E.X..

- Screw the oil outlet (19) tight into the housing. Connect the oil outlet pipe to the flange.

E.U.,
E.T..

- Connect the outlet pipe at the oil sump temperature measurement connection hole (18) and seal with Teflon tape or liquid sealing compound.
Depending on the bearing size, the connection holes (18) for the oil sump temperature measurement have the following threads:

Bearing size	35	45	56	71
Connecting hole for oil sump temperature measurement (18)	G 1"	G 1"	G 1"	G 1"

6.2 Temperature measurement

- Fix suitable feeler gauges:
 - into one of the connection holes (22) for temperature measurements of the journal parts
 - into one of the connection holes (18) for temperature measurements of the oil sump
 - into one of the connection holes (optional) (36) for temperature measurement of the thrust parts.

Proceed as follows:

- Take out the screw plugs (24) from the connection holes.
- Place the thermo sensor into the bore by using Teflon tape or sealing compound.
- Connect the thermo sensor at the temperature monitoring equipment of the installation (see the Technical Documentation of the Installation for connecting and adjustment).

E.T..
E.W..

6.3 Water supply

Following requirements should be observed before connecting the cooler (13):

- water velocity of maximum 1,5 m/s in the cooling water inlet
- water pressure of maximum 5 bar
- adjusting tap on inlet
- outlet of cooling water under no pressure.

The direction of the cooling water passage in the cooler (13) is arbitrary.

7 Bearing Insulation

7.1 Pedestal insulation

The electrical insulation is attained by the insulated assembly of the foot screws.

- Insert all foot screws equipped with insulating sleeves and discs into the holes (16).
- Insulate the positioning pins too before inserting them into the positioning pin hole (17).

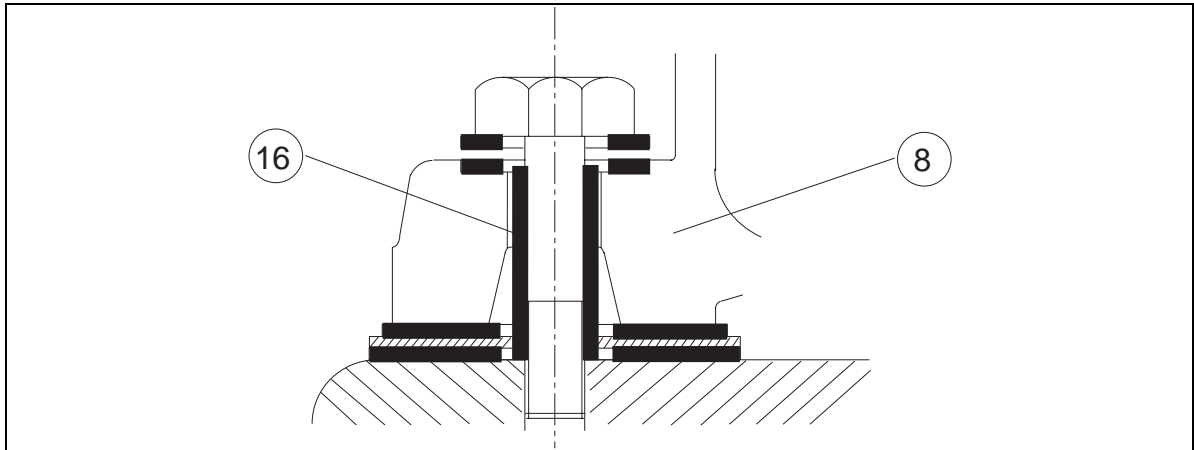


Illustration 9: Insulated foot-mounted bearing

Attention!

It is not allowed to bypass the foot insulation. Such bearing connections as thermo sensor or pipes should be insulated.

**Size
35-45**

7.2 Bearings with insulated spherical seatings

These bearings are delivered insulated. The electrical insulation is guaranteed by:

- plastic coating of the spherical seatings (10)
- shaft seals out of non-conducting materials
- insulated positioning pin (4)
- insulated screwed connections for thermometers.

It is not necessary to insulate the pipelines.

- Mark the insulated bearing with the delivered plate "Insulated shells". Mount the plate at a visible place by using two grooved drive studs.

8 Operation

8.1 Fill up lubrication oil

Attention!

Make sure that no impurities get into the bearing.

- Tighten all screw plugs (24) in the connection holes (14), (18), (21), (22), (23), (25), (36) with the necessary torque values:

Screw plug threads	G 3/8	G 1/2	G 3/4	G 1	G 1 1/4	G 1 1/2	G 2	G 2 1/2
Torque [Nm] for plugs with moulded on plastic seal	30	40	60	110	160	230	320	500
Torque [Nm] for plugs with elastic seal	34	60	85	130	240	300	330	410

- Retighten the connection holes for oil inlet and outlet, and for the thrust parts (if existing). The necessary torque values depend on the screw connections used.

In case thermo sensor or/and oil sump thermometer are used:

- Check if they are tight (according the manufacturer's instructions).
- Fill up the oil supply installation with lubricant. Use a lubricant with the viscosity indicated for the bearing operation.
- Start operating the oil supply installation in order to fill the bearing with lubricant.

E.Z..
E.X..

E.N..
E.W..
E.T..

- Use a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filling hole (1) up to the middle point of the oil sight glass (20).

The oil level limits are as follows:

minimum oil level: **bottom of the oil sight glass**

maximum oil level: **top of the oil sight glass**

Attention!

- Not enough lubricant leads to temperature rises and thus to damages to the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant could brake the oil rings considerably, thus leading to damages to the bearing.

8.2 Trial run

- Before the trial run, check the following:
 - the way the oil supply system works (see also the Technical Documentation of the Installation). The lubricant quantity at the bearing oil inlet must correspond to the values indicated in the EDP-calculations.
 - if the temperature monitoring equipment works
 - if the water cooling installation works.

E.T..
E.W..

Attention!

Not enough lubricant leads to

- temperature rises and thus damage of the bearing.

Too much lubricant leads to

- leakages.

The bearing is ready for operation.

- Supervise the bearing during the trial run (5-10 operating hours).
Pay special attention to:
 - the way the oil supply installation works(necessary lubricant quantity, lubricant temperature, lubricant pressure before entering the bearing)
 - bearing temperature
 - sliding noises of the shaft seals
 - tightness
 - occurrence of inadmissible vibrations.

Attention!

If the bearing temperature exceeds the calculated value by more than 15 K (see Bearing calculation) stop the installation immediately. Carry out an inspection of the bearing.

9 Maintenance and Inspection

9.1 Maintenance Schedule

Maintenance work	Deadline
Exterior cleaning of the bearing	every 100-1000 hours
Oil change	Bearing in reversing operation every 5000 operating hours. Bearing in continuous operation every 8.000 operating hours (please observe also the indications for the use of the lubricating oil).
Bearing inspection	During prevention maintenance work for the installation. Immediately if: <ul style="list-style-type: none"> • the bearing temperature exceeds 15 K over the indicated value (see the EDP-calculations) • unusual operating noises occur • unusual changes of the lubricating oil become visible • increased oil level in the case of bearing type E.W.... or E.T...

9.2 Oil Change

Risk of pollution!

Please observe the instructions for the use of the lubricating oil. The manufacturer can provide information on waste oil disposal.

- Shut down the installation and secure it against unintended operation.
- Take all necessary measures to collect the whole quantity of the lubricating oil.
- Let off the lubricating oil in still warm condition. Impurities and residues will thus be scavenged.
- Unscrew the hexagon head plug (14). Let off the lubricating oil and collect it.

Attention!

In case the lubricating oil contains unusual residues or is visibly changed, eliminate the causes. If necessary, carry out an inspection.

- Tighten the hexagon head plug (14) by using the following torque values:

Bearing size	35 - 112
Torque [Nm]	110

- Remove the screw plugs (21) from the oil filling hole (1).

Attention!

Make sure that no impurities get into the bearing.

E.NL..
size 35-
45

- Use a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filling hole (1) up to the middle point of the oil sight glass (20).

The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass

maximum oil level: top of the oil sight glass

Attention!

- Not enough lubricant leads to temperature rises and thus to damages to the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant could brake the oil rings considerably, thus leading to damages to the bearing.

- Tighten the screw plug (21) into the oil filling hole (1) by using the following torque values:

Bearing size	35 -112
Torque [Nm]	110

9.3 Cleaning and Checking of the Bearing

Attention!

Use only non-aggressive detergents such as for instance

- VALVOLINE 150
- Alkaline cleaning compounds (pH-value 6 to 9, short reaction time).



Warning of injury!

Please observe the instructions for the use of the detergents.

Attention!

Never use cleaning wool or cloth. Residues of such materials left in the bearing could lead to excessive temperatures.

– Clean the following parts thoroughly:

- top half of the housing (5)
- bottom half of the housing (8)
- top half of the shell (6)
- bottom half of the shell (27)
- sealing surfaces of the seal carrier
- loose oil rings (44).

E..L.

E..W..
E.T..

– Check the condition of the cooler (13).

In case the cooler (13) is incrustated with oil sludge:

- Dismantle the cooler. Remove the incrustation by using for instance a wire brush.
- Install the cooler (13) by placing it in angular adjustment into the bearing.

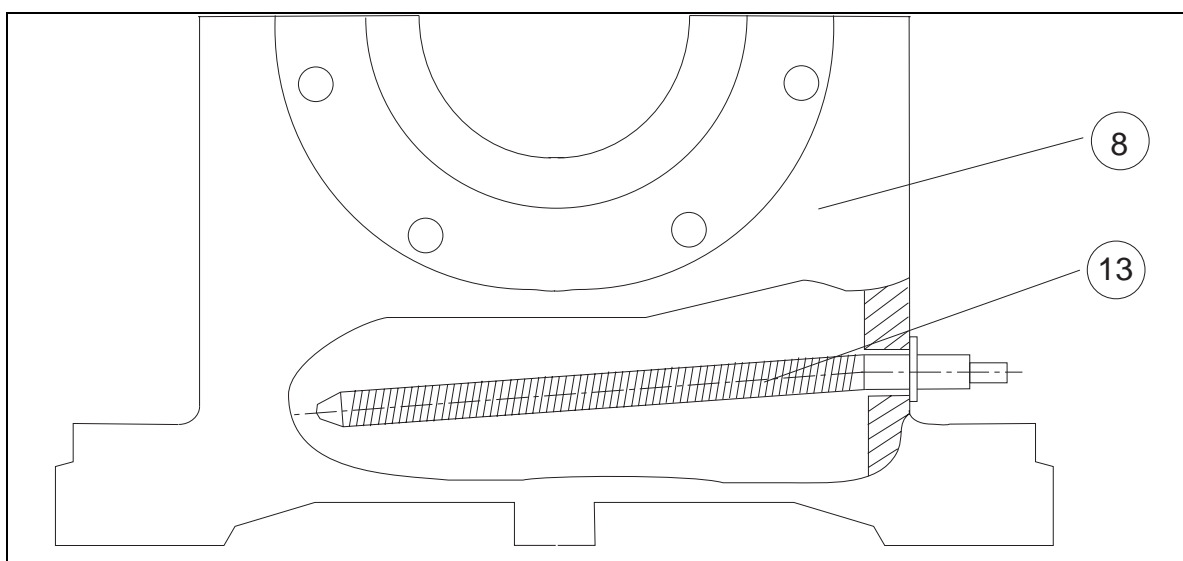


Illustration 9: Assembly position of the cooler

Installation and Maintenance

- Carry out a visual check of the wear condition of all bearing parts. The following graph provides information on the parts that must be replaced in case of wear. The right evaluation of the wear condition, especially of the working surfaces of the shell, implies a lot of experience. If in doubt, replace the worn part with new ones.

Bearing part	Wear condition	Maintenance proceedings
Shell	Scoring	Bearing temperature before inspection: <ul style="list-style-type: none"> • not increased - no new shells • increased - new shells
	White metal lining damaged	New shell
	Bow wave ridges	New shells
Shaft seal	Baffles broken or damaged	New shaft seal
Loose oil ring	Geometrical form (roundness, flatness) visibly changed	New loose oil ring

insulated
bearings
size
35-45

- Check the insulating layer of the spherical seating (10) of the top half (5) and bottom half (8) of the housing. In case of damage contact the RENK-sales agency in charge.

E...A

- Check the mobility of all RD-thrust pads (42).

9.4 Starting Operation after Inspection

- Fit the thermo sensors for temperature measurement of the journal part in the connection holes (22).
- Retighten all screw plugs in the connection holes (14), (18), (19), (22), (32) by using the following torque values:

Screw plug threads	G 3/8	G 1/2	G 3/4	G 1	G 1 1/4	G 1 1/2	G 2	G 2 1/2
Torque [Nm] for plugs with moulded on plastic seal	30	40	60	110	160	230	320	500
Torque [Nm] for plugs with elastic seal	34	60	85	130	240	300	330	410

- Retighten the connection holes for oil inlet and outlet and the bores for the thrust part oil supply. The torque depends on the threaded joints used.
- Retighten the foot bolts to the rated torque. The torque depends on:
 - the foot bolts used
 - the material the housing and the foundation are made of (see also the Technical Documentation of the Installation).
- Carry out a visual check of the assembled bearing.
- Fill up the oil supply system with lubricant. Use the same type of lubricant as indicated on the type plate.
- Start operating the oil supply system in order to fill up the bearing with lubricant.
- Check
 - the way the oil supply system works (see also the Technical Documentation of the Installation). The lubricant quantity at the bearing oil inlet must correspond to the values indicated in the EDP-calculations.
 - if the temperature monitoring equipment works.

Attention!

Make sure that no impurities get into the bearing.

E.Z..
E.X..

- Use a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filling hole (1) up to the middle point of the oil sight glass (20).

The oil level limits are as follows:

minimum oil level: **bottom of the oil sight glass**

maximum oil level: **top of the oil sight glass**

E.N..
E.W..

Attention!

- Not enough lubricant leads to temperature rises and thus to damages to the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant could brake the oil rings considerably, thus leading to damages to the bearing.

- Tighten the screw plug into the oil filling hole (1) by using the following torque values:

Bearing size	35 - 71
Torque [Nm]	110

**E.W..
E..T**

- Check if the temperature monitoring equipment works.
- Start operating the cooling water supply system and check its functioning.

The bearing is ready for operation.

- Supervise the bearing during the trial run (5-10 operating hours).
Pay special attention to:
 - the way the oil supply installation works(necessary lubricant quantity, lubricant temperature, lubricant pressure before entering the bearing)
 - bearing temperature
 - sliding noises of the shaft seals
 - tightness
 - occurrence of inadmissible vibrations.

Attention!

If the bearing temperature exceeds the calculated value of 15 K (see the EDP-bearing calculations) stop the installation immediately. Carry out an inspection of the bearing and find out the causes.

10 Corrosion Protection for Longer Standstill Periods

If you want to protect the bearing mounted on an installation against corrosion proceed as follows:

- Dismantle the bearing (see Chapter 3.3).
- Clean the bearing (see Chapter 9.3).
- Paint or spray the top half (6), and the bottom half (27) of the shell and the shaft with Tectyl 511.
- Assemble the bearing (see Chapter 4).
- Close all connection holes with screw plugs.
- Seal the gaps between
 - shaft seal and housing
 - shaft seal and shaftby using a self-adhesive, permanent tape.
- Spray some anti-corrosive such as Tectyl 511 or VALVOLINE into the bearing.
- Put a bag of dessicant (silicate gel) inside. The dessicant absorbs the humidity and prevents the formation of condensation water inside the bearing.

In case the standstill period is **longer than 1/2 year**:

- Repeat the preservation procedures.
- Put a new bag of dessicant into the bearing.

In case the standstill period **lasts more years**:

- Dismantle the shells.
- Preserve and store the bearing parts.

11 Transport Protection

In case of a machine equipped with slide bearing type EG/ER:

- Carry out the corrosion protection as described in Chapter 10 and apply enough lubricant on the working surfaces of the bearing.
- Pull the rotor against the sub-frame by using timbers placed across the shaft and press firmly into the bearing.

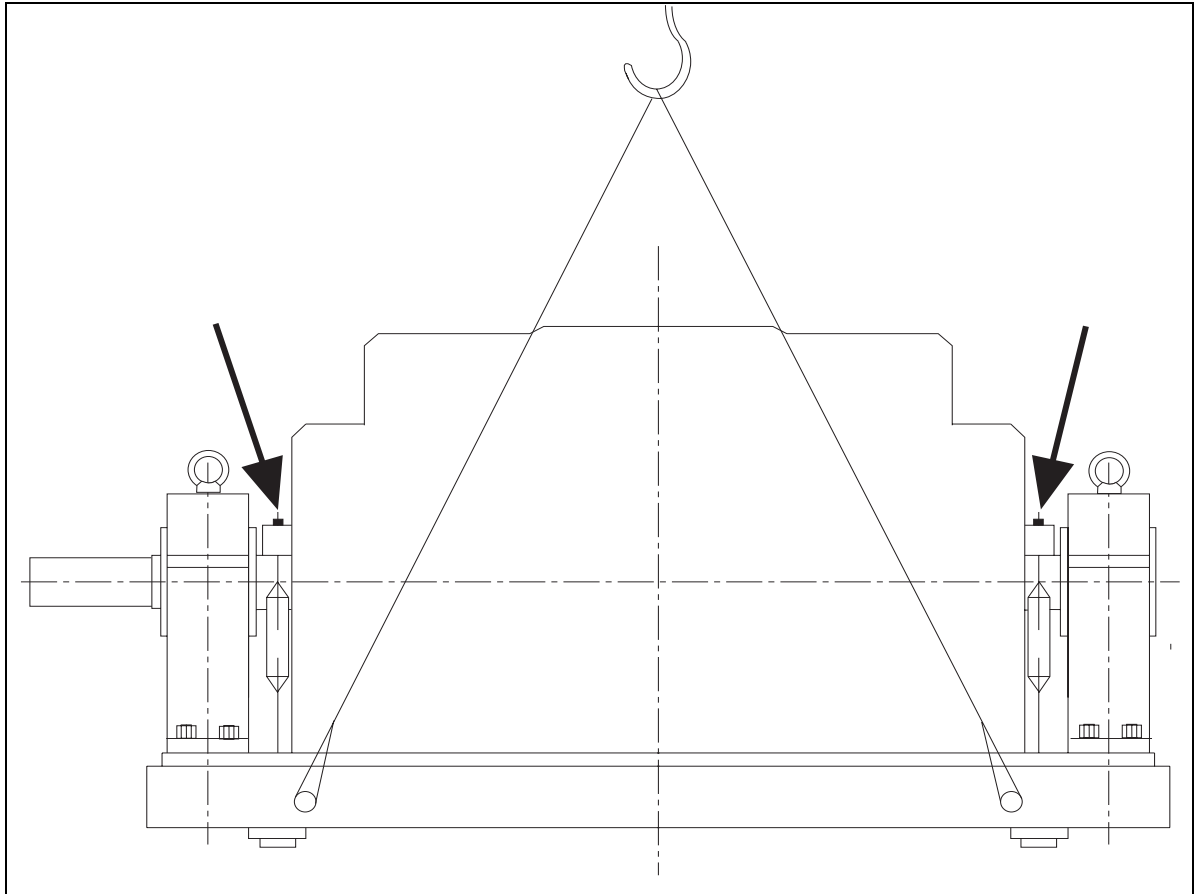


Illustration 10: Transport protection

12 **Glossary**

Rigid labyrinth seal The rigid labyrinth seal (type 20, 22) is used with slide bearings type E with high oil throughput. It corresponds to the protective system IP44, IP55 and is made of an aluminium alloy.

The rigid labyrinth seal is built of two halves, flanged at the housing. The labyrinths that wipe out the lubricant are arranged into two groups. The first two labyrinths, installed inside, keep back most of the lubricant. Five further labyrinths protect the bearing from outside. They prevent the lubricant overflow and the ingress of impurities. The overflow lubricant is collected into a chamber between the both groups of labyrinths. Through the return bores the lubricant flows back into the bearing.

Spherical seating The spherical seating is a special feature enabling the alignment of the shell in the housing. The shell is seated on two spherical seatings. The advantages of the spherical seating are:

- easy at assembly
- good heat transfer from the shell to the housing
- suitable for such applications with high thrust or journal loads.

**ZELISKO****Elektrotechnik und Elektronik**

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Tel.: +43 (0)2236-409 Fax: +43 (0)2236 409-299 od. 322 E-Mail: info@zelisko.com, Internet: <http://www.zelisko.com>**SGS 10/Gr.1****SGS 10/Gr.2****SGS 20/Gr.1****SGS 30**

Stützer-Stromwandler (Schmale Bauform)

Die Stromwandler der Typenreihe SGS sind wartungsfreie Gießharzwandler für Nennspannungen bis 36 kV, entsprechend den Vorschriften IEC 44-1 (früher IEC185), VDE 0414 oder ÖVE-P20-1/1994.

- Nennströme bis 2500 A
- Primär umschaltbar bis 2x600 A
- Kurzschlussströme bis 50 kA eff / 1sec (120 kA Spitze)
- Klassengenauigkeiten bis 0.2S
- Frequenz 50 Hz oder 60 Hz
- Bis zu 3 Mess- und/oder Schutzkerne.
- Die Sekundärklemmen sind in einem plombierbaren Klemmenkasten (Schutzgrad IP53) angeordnet. Die Wandler sind somit eichfähig und für Verrechnungszwecke geeignet.
- Konkret realisierbare Kernleistungen und Kurzschlussströme sind von Kernanzahl, Klassengenauigkeit, Nennstrom und Überstromziffer abhängig. Für die genaue Auslegung Ihres Wandlers steht Ihnen unser zuständiger Vertreter oder unser Werk gerne zur Verfügung.

Auf Anfrage bieten wir Ihnen auch gerne Sonderauslegungen nach anderen Vorschriften oder mit Nicht-Standard Daten an.

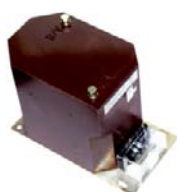
Support Current Transformers (Small Design)

The SGS types current transformer are maintenance free cast resin indoors current transformers for rated voltages up to 36 kV according to IEC 44-1 (former IEC185) VDE 0414 or ÖVE-P20-1/1994 standards.

- Rated primary currents up to 2500 A
- Primary changeable up to 2x600 A
- Rated short-time thermal currents up to 50 kA rms / 1 sec (120 kA peak)
- Accuracy classes up to 0.2S
- Frequency 50 or 60 Hz
- Up to 3 measurement and/or protection cores
- The secondary terminals are arranged in a waterproof sealable box (type of protection IP53) which allows official calibrating and thus usage for account metering.
- The current transformer with particular values of rated power and short-time thermal current are determined by the respective values of accuracy class, rated primary current and instrument security factor. Please contact our representative or our factory directly for a detailed current transformer definition.

Upon request we are glad to offer transformers manufactured according to other standards or with non-standard technical specs.

Wandler Typ	Max Nennspannung	Prüfwechselspannung	Prüfstoßspannung	Höhe	Breite	Länge	Gewicht
Current transformer Type	Max. rated primary voltage	Rated AC test voltage	Rated impulse test voltage	Height	Width	Length	Weight
	KV rms	KV rms	KV	mm	mm	mm	Kg
SGS10/Gr.1	12	28	75	220	148	325	20
SGS10/Gr.2	12	28	75	220	148	455	30
SGS20/Gr.1	24	50	125	280	175	330	28
SGS20/Gr.2	24	50	125	280	175	457	42
SGS20/B	24	50	125	280	208	330	34
SGS30/Gr.0	36	70	170	350	208	330	40
SGS30/Gr.1	36	70	170	390	250	385	53

**ZGS 20****EGS 10****EGS 30****ZGS 10****ZGS 30**

Spannungswandler

Die Spannungswandler der Typenreihen EGS(G) (eipolig isoliert) und ZGS(G) (zweipolig isoliert) sind wartungsfreie Gießharzwandler für Innenraum und für Nennspannungen bis 36 kV, entsprechend den Vorschriften IEC 60044-2 (früher IEC 186, IEC 44-2), VDE 0414 oder ÖVE-P20-2/1994.

- Die Sekundärklemmen sind in einem dichten, plombierbaren Klemmenkasten (Schutzgrad IP53) angeordnet. Die Wandler sind somit eichfähig und für Verrechnungszwecke geeignet.
- Sekundär Spannung 100/ $\sqrt{3}$ V oder 110/ $\sqrt{3}$ V bei EGS(G) und 100 V oder 110 V bei ZGS(G) Wandler
- Einpolig Wandler, auf Wunsch mit Erdschlusswicklung 100 / 3 oder 110 / 3 V
- EGS10(20) /S Spannungswandler mit Sicherung
- Spannungsfaktor 1,9xUn 8h bei EGS(G) und 1,2xUn dauernd bei ZGS(G) Wandler
- Frequenz 50 Hz oder 60 Hz

Voltage transformers

Voltage transformers series EGS(G) (earthed) and ZGS(G) (unearthed) are maintenance free cast resin transformers for indoor installation and for rated voltages up to 36 kV according to the IEC 60044-2 (former IEC 186, IEC 44-2) standard.

- The secondary terminals cover are arranged in a waterproof sealable (degree of protection IP53) box which allows official calibrating and thus usage for settlement purposes
- Rated secondary voltages 100/ $\sqrt{3}$ V or 110/ $\sqrt{3}$ V for EGS(G) and 100 V or 110V for ZGS(G) transformers
- On request the EGS(G) transformers can content a residual voltage winding with 100 / 3 V or 110 / 3 V
- EGS10(20) /S voltage transformers with fuse
- Rated voltage factor 1,9xUn 8h for EGS(G) and 1,2xUn continuous for ZGS(G) transformers
- Frequency 50 or 60 Hz

Wan. Typ	Max. Nennspannung	Prüfwechselspannung	Prüfstoßspannung	Grenzleistung Meßwickl	Grenzleistung Hilfswickl	Max Leistung Kl. 0,2	Max Leistung Kl. 0,5	Max Leistung Kl.1	Ge-wicht
VT Type	Max. rated primary voltage	Rated AC test voltage	Rated impulse test voltage	Limiting output meas. Wdg.	Limiting output aux. Wdg.	Max output at class 0,2	Max output at class 0,5	Max output at class 1	Weight
	KV rms	KV rms	KV	VA	VA	VA	VA	VA	Kg
EGS 10	12	28	75	400	200	30	90	180	14
EGS 10/S	12	28	75	400	200	30	90	180	18
EGS 20	24	50	125	600	350	30	90	180	26
EGS 20/S	24	50	125	600	350	30	90	180	31
EGG 20	(24)	(50)	(125)	(600)	(350)	(50)	(120)	(200)	(47)
EGS 30	36	70	170	800	500	50	120	200	61
ZGS 10	12	28	75	400	-	30	50	180	14
ZGS 20	24	50	125	600	-	30	50	180	26
ZGG 20	24	50	125	600	-	50	120	200	46
ZGS 30	36	70	170	800	-	50	120	200	60

THYNE3

Compact Excitation System

Operation- and Service Instructions



Revision: 4
Author: 30.01.2002 Dr. Riss
Checked: 30.01.2002 Klanacsky
Approved: 30.01.2002 Reitinger
Registered: 30.01.2002 Hantsch
First Edition: 06.04.1999 Dr. Riss, Stephanides

CAUTION

Installing, commissioning and operating of this product may be performed by thoroughly trained and specialized personnel *

only. We explicitly will not take any responsibility for any damage on our products caused by improper installation, configuration and handling. Internal modifications must solely be carried out by specialized personnel authorized by VA TECH SAT GmbH & Co / Department PE.

* **Definition:** Specialized personnel, when authorized and properly instructed, may perform following tasks.

- Installing, mounting, commissioning and operating of the apparatus and the system when familiar with,
- Switching operations according to the relevant Safety Standards for medium and high voltage switchgear, i.e. plant energizing and de-energizing, preventive isolation, safety earthing and securing, when instructed,
- Maintenance and application of safety gear according to Standard Rules and Regulations,
- First Aid after extensive training.

CAUTION

Insulation resistance- and high voltage tests must never be applied and may only be carried out on the power circuits. Improper use of such tests could damage the system's solid state components.

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APPENDIX

THYNE3 - BLOCK DIAGRAM

Dwg.No.: 3-529 140

THYNE3 - CONNECTION TERMINALS

Dwg.No.: 3-529 144

THYNE3 - INTERFACE DIAGRAM DRAFT

Dwg.No.: 3-529 145

LEGEND AND ABBREVIATIONS

S	Apparent power	
P	Active power	
Q	Reactive power	
V, U	Voltage	
I	Current	
Vg, Ug	Generator voltage	
Ig	Generator current	
Iw	Generator active current	
Ib	Generator reactive current	
If	Field current	
fg	Generator frequency	
3ph	Three phase	
DC	Direct current	
C	Command	
A	Annunciation	
B	Command (Befehl)	refers to digital signals
NB	No command	refers to digital signals
M	Annunciation (Meldung)	refers to digital signals
NM	No annunciation	refers to digital signals

Note: Index "n" means nominal, e.g. Vgn is generator nominal voltage.

1. INTRODUCTION

The THYNE3 excitation system is a fully compact excitation system comprising the complete power circuit part as well as the digital regulating and control functions. This operating manual shall assist to be able to use all features contained in the system and also supply the necessary information required for mounting, installing, commissioning and maintenance.

However, should there be any questions at all regarding this excitation system please contact our Head Office in Vienna.

2. PRODUCT DECLARATION AND CE-IDENTIFICATION

The excitation system THYNE3 was developed, designed and manufactured in accordance with the CE-identification Standard (93/68/EWG) with consideration of the EU-Standards for low voltage switch gear (73/23/EWG) as well as the EU-Standard for electromagnetic compatibility (89/336/EWG).

Standards considered:

VDE 160, EN 50178	<i>Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmitteln</i>	<i>Electronic equipment for use in power installations</i>
IEC 60146	<i>Halbleiter-Stromrichter</i>	<i>Semiconductor convertors</i>
IEC 60726	<i>Leistungs-transformatoren</i>	<i>Dry-type power transformers</i>
IEEE 421 B		<i>High Potential Test Requirements for Excitation Systems for Synchronous Machines</i>
IEC 61000-4	<i>Elektromagnetische Verträglichkeit</i>	<i>Electromagnetic Compatibility</i>

3. BASIC PRINCIPLE OF EXCITATION SYSTEMS

For the operation of a synchronous generator a magnetic rotor field is required which is produced by a DC current flowing in the rotor windings. This DC current is generated by the excitation system.

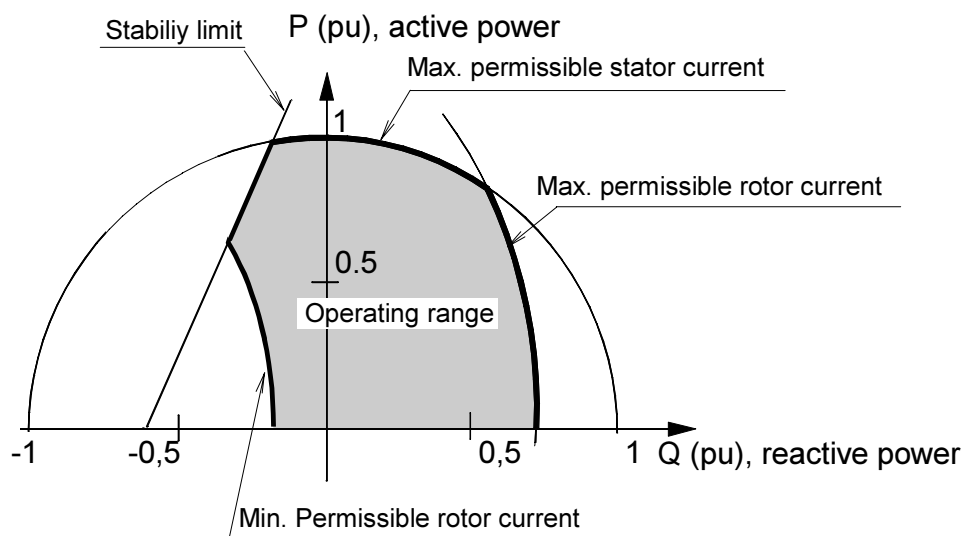
There are several kinds of excitation systems which are employing either rotating machinery or static elements. A static excitation system is connected via an excitation transformer to a power source. Should the source be the generator winding itself we are referring to a shunt field excitation system. When the excitation transformer is connected to an external power source, e.g. an AC generator on the rotor shaft or to the auxiliary supply of the plant, it is denominated as excitation system with external supply. The voltage output of the excitation transformer is rectified and regulated and is transmitted to the field winding via the rotor brushes.

A further possibility is the use of a pilot exciter machine which can either be a brushless AC exciter with flywheel diodes or, especially in older plants, a DC exciter machine. The pilot exciter is acting as an amplifier of the field current. The flywheel diodes are mounted on the common shaft of the generator rotor and pilot exciter and are supplying the necessary DC current for the rotor. The regulation of the pilot exciter field is performed via a voltage regulator with a fully controlled thyristor unit.

The excitation performs either

- production and regulation of the generator voltage when not connected to the power grid or when operating as an isolated system.
- production and regulation of the reactive power when operating in parallel with other units to the power system. Maintaining the voltage level is caused by the grid system itself provided that it is able to do so. When during on-line operation the rotor current is reduced too much then the stability of the generator set is also decreasing. This can lead to loss of synchronism with subsequent damage to the generator within a relatively short period due to additional currents circulating in the generator windings. Generator speed and active power output is solely determined by the turbine drive. permissible

The figure below shows the permissible load range for stable operation of the generator set.



4. BASICS OF THE THYNE3 SYSTEM

The THYNE3 system is an integrated compact static and numeric excitation system for excitation and regulation of small and medium sized synchronous alternators having either AC or DC exciter machines. The central component is the THYNE3 device which is containing the complete power circuit with a three phase fully controlled thyristor bridge as well as the integrated microprocessor system of the GMR3 family for all control and regulating operations. All system components, with the exception of the excitation transformer, the testing power supply and associated fuses, are contained in compact device of the 19" technique.

The excitation system THYNE3 supports all standard excitation systems, such as generator shunt field excitation, systems employing an excitation transformer supplied by auxiliary power and excitation via a permanent magnet generator PMG.

The THYNE3 device is not only suitable for new power plants but is also applied successfully and with advantage for refurbishment of existing plants due to easy and quick installation with a minimum amount of power outage.

The local control and alarm annunciation facilities enable the operating staff to locally control the excitation system, read the actual measured values and also provide swift and precise diagnosis and repair in case of component failure.

The compact THYNE3 device is designed as black-box with communication interface ports which is integrated easily and with it's flexible adaptation is a suitable and most qualified excitation system for generators with AC exciter machines. Due to it's small dimensions and compact finish, i.e. 19" rack, it is installed simply, without effort, into a cubicle or an existing panel and via an accessible terminal strip easily integrated into the peripheral plant equipment. The THYNE3 is of modern design, having a clear operating facility with LED indication and can optimally be adapted to any extension possibilities and options according to customer specific requirements and plant conditions.

The complete THYNE3 System is consisting of:

- THYNE3 Device

as well as following external components:

- HV excitation transformer with or without high voltage fuses ¹⁾
- Secondary fuses of the HV excitation transformer ¹⁾
- Excitation matching transformer ¹⁾
- Battery supply possibly with series resistor for initial excitation ¹⁾
- Control selector switch for changing from shunt field excitation to auxiliary power ²⁾
- Voltage actual value provided by a set of VT's (3 phase or single phase)
- Generator current provided by a set of CT's for the cross current comensation (3 phase or 1 phase)
- Current boost feature option for generator short circuit faults

1) These components are omitted when applying a PMG.

1) + 2) These components are omitted when using an auxiliary supply power source.

5. SUBSTANTIAL FEATURES

- Compact design (19"-rack)
- Suitable for excitation of an AC or DC exciter machine. Supply via external excitation transformer(s) in shunt field connection or an auxiliary supply source or a permanent magnet generator (PMG) up to a maximum of 3 x 250 VAC.
- Nominal frequency range between 50 Hz and 400 Hz
Operating range from 10 Hz to 440 Hz
- Field rating up to maximum 25 A and 210 VDC continuous
- Ceiling voltage up to max. 330 VDC and ceiling current up to max. 40 ADC / 10 sec.
- Integrated μ P-system of the GMR3 type for digital sequencer and regulation
- Voltage regulation in automatic mode with inner loop current regulating
- Field current regulation in manual mode
- Adjustable active and reactive load compensation
- Following limiters are provided in the standard design:
 - Max. and min. field current limiter with an instantaneous and delayed response
 - Overfluxing limiter (V / Hz)
 - Stator current limiter with current dependent delay (inverse time) for capacitive and inductive generator operation.
- Diode fault monitoring on AC exciter machines with flywheel diodes for open circuit or short circuit
- Soft-Start feature, i.e. start the initial raising of the generator voltage with a defined rate of rise without hunting
- Detection of isolated operation by frequency deviation
- Manual and automatic smooth transfer from automatic to manual operating mode
- Additional regulators: p.f. regulator or reactive power regulator selectable on the excitation unit
- All set value potentiometers are part of the software having no contacts and therefore require no maintenance.
- Three phase fully controlled bridge rectifier
- Field discharging of the excitation machine's field circuit
- Initial excitation effective for generator shunt field excitation
- Provisions to add an external current boost with saturation CT's
- Provision to add a change over selection for an external test supply from the auxiliaries
- Operation and indication unit for local operation at the device or excitation cubicle with the corresponding feedback, i.e. excitation ON and OFF, set value RAISE and LOWER, operating mode selection and resetting the alarm annunciation
- Above control unit comprises a keypad for the operating commands and a four line LC display for annunciation and measured values
- Real time sequence alarm display of an excitation failure
- Display of following measured values via the LC display of the control unit:
 - ⇒ Generator voltage
 - ⇒ Generator current
 - ⇒ Field current
 - ⇒ Generator active power
 - ⇒ Generator reactive power
 - ⇒ Generator power factor

- Alarm display in correct time sequence
- Redundant supplies from the existing station battery and the 3 phase thyristor circuit
- Defined communication interface ports with voltage-free inputs and outputs for remote control and annunciation, an input for protection trip commands, outputs for excitation alarm and trip and the generator circuit breaker trip output

6. THYNE3 DEVICE SPECIFICATION

The compact THYNE3 system is distinguished by a uniform hard- and software for all variants of the power circuit supply for the THYNE3 excitation system. Besides the power circuit it contains the voltage regulator, the field current regulator, additional regulators as well as the complete sub-automatic system necessary for the control of the individual components.

The THYNE3 device contains following components:

- Rectifier unit (fully controlled thyristor bridge and 3 phase circuit overvoltage protection)
- De-excitation equipment and DC overvoltage limiter
- Start up excitation / initial excitation
- Voltage regulator with limiters and additional regulators (for automatic operation)
- Field current regulator (for manual control)
- Automatic follow-up and transfer between voltage regulator and field current regulator
- Facilities for local control indication and alarm annunciation
- Inputs and outputs for interconnection with other systems (control system, protection)
- Integrated digital sequencer for internal control sequences

6.1. TYPES OF POWER SUPPLY

6.1.1. With Excitation Transformer in Generator Shunt Field Connection

The excitation power is provided by a three phase supply from the generator terminals in shunt field connection or from a three phase station auxiliary supply via the excitation transformer(s) as shown in Fig. 1. The rectified field voltage from the thyristor is connected to the field circuit via the field switch. When using a high voltage excitation transformer the secondary voltage output is 3 x 400 V and with an interposing excitation matching transformer of 3 x 400 V transformed to the field requirements of the excitation machine.

The THYNE3 internal regulating matching transformer is supplied with the 3 x 400 V providing with it's first secondary output the synchronising voltage of the regulator for thyristor commutation. The second transformer output is producing via rectifiers the buffered 24 VDC for the system. The high- and/or low voltage transformers are of dry cast-resin type.

This system supports two kinds of machine arrangement:

- AC exciter machines
- DC exciter machines

The field and rotor magnitudes can be operating within the following ranges:

- Field voltage positive and negative
- Field current: positive
- Rotor voltage and rotor current: positive

With a shunt field excitation the supply voltage is lost during close-up generator short circuit faults and the synchronous alternator is de-excited. In case of a continuous short circuit current from the generator is required by the protection system an optional fault current boost component can be connected in series with the excitation circuit which is supplied by the generator CT's. The transition from shunt field operation to boosted excitation during short circuit fault conditions is carried out without additional regulating assistance.

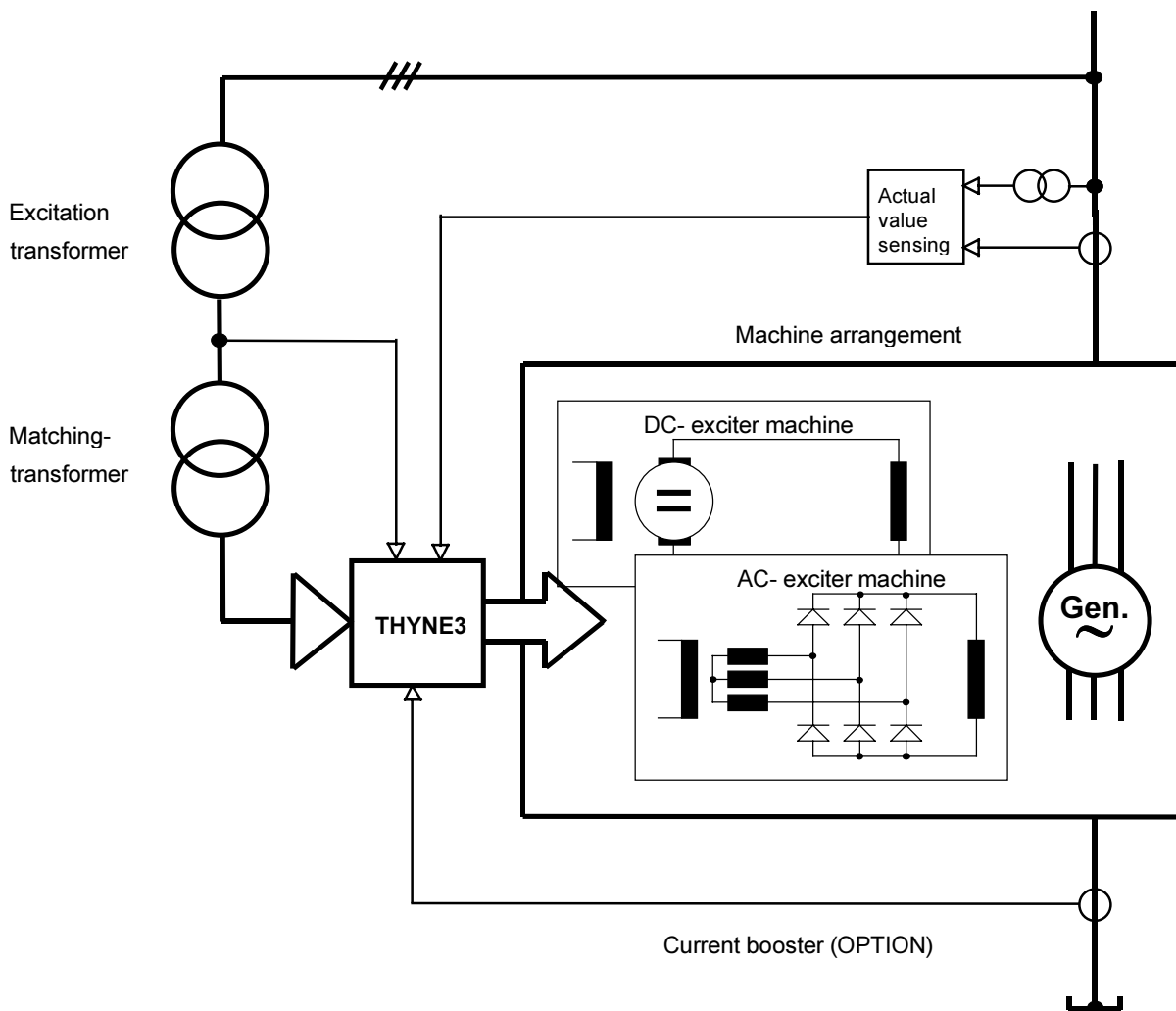


Fig. 1: Power circuit THYNE3 with shunt field excitation

6.1.2. With Permanent Magnet Generator (PMG)

The excitation supply is taken from a three phase PMG mounted on the generator shaft, see Fig. 2. From the thyristor regulating circuit the rectified field voltage is connected to the rotor circuit via the field switch. This type of supply is independent from the external system grid and is producing for generator close-up faults the whole excitation power.

From the PMG an interposing matching transformer with a secondary voltage output of 3 x 400 V supplies the THYNE3 internal regulating transformer. The latter provides with it's first secondary output the regulator with the required synchronising voltage for thyristor commutation. The second transformer output supplies via rectifiers a buffered 24 VDC voltage for the unit.

This system supports two machine arrangements:

- AC exciter machines
- DC exciter machines

The field- and rotor parameters can be operating within following ranges:

- | | |
|-----------------------------------|-----------------------|
| • Field voltage | positive and negative |
| • Field current | positive |
| • Field voltage and field current | positive |

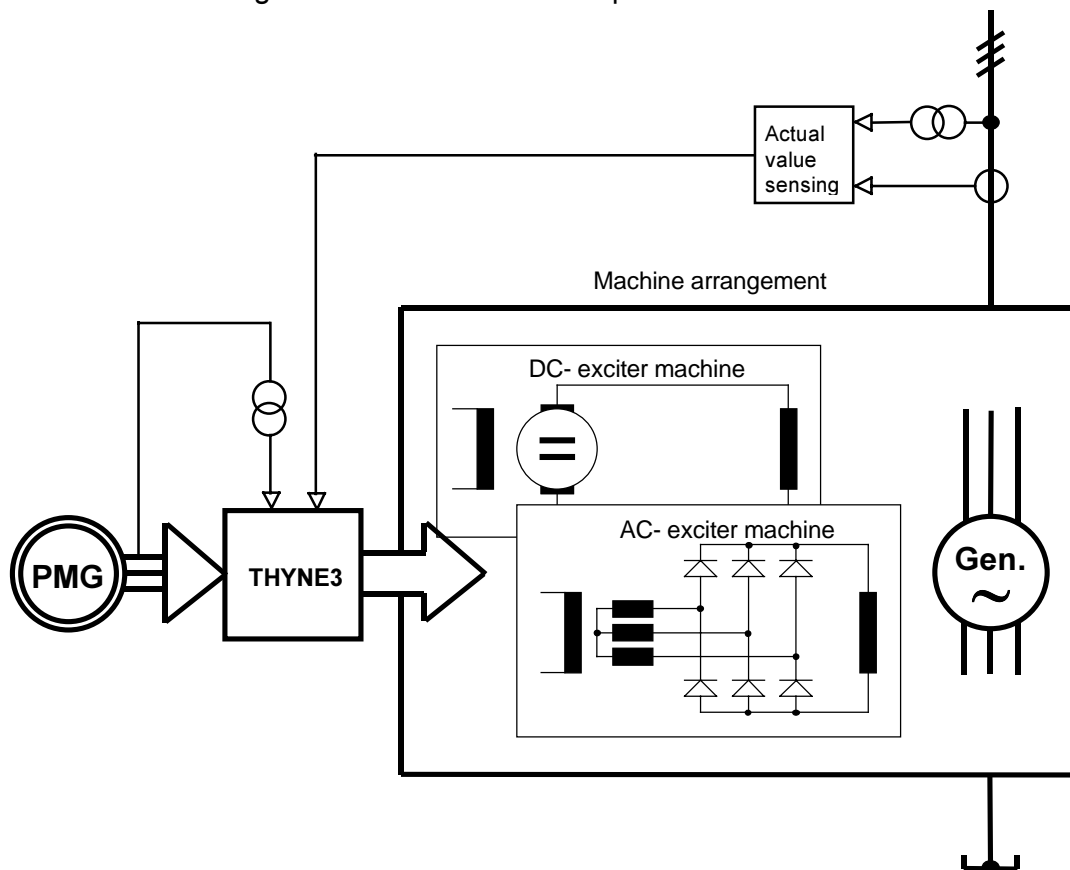


Fig. 2: Power circuit THYNE3 with PMG

6.1.3. External- and Test Supply from the Station Auxiliary System

During first commissioning, i.e. short circuit- and open circuit tests, heat run, protection and excitation setting and for subsequent periodic checks an external test supply not depending on the generator voltage output is necessary.

For this purpose an external supply from the auxiliary system can be taken whereby for this purpose the excitation is transferred via the matching transformer and a control selector switch to the station auxiliaries. The field current can now be adjusted in manual control with the field regulator from zero up to nominal current.

This auxiliary test supply is designed to also serve as a redundant power source for the voltage regulator with the generator in on-line operation.

In case of a safe AC supply, usually being available in thermal power plants, this supply can also be utilised for the excitation during normal on-line operation via the low voltage excitation transformer.

The external supply, when designed accordingly, provides the same power- and dynamic characteristics of the excitation system as the generator being on-line in shunt field operation. The difference may be that the external supply is more prone to temporary failure than the exclusive supply from the generator terminals.

6.2. POWER CIRCUIT DESIGN

6.2.1. Rectifier Unit and 3-Phase Overvoltage Protection

The input to the compact system THYNE3 from the power circuit for the supply of the rectifier unit is protected with semiconductor fuses in all three phases and further equipped with a 3-phase overvoltage protection of the Selen tiles type.

The rectifier unit is a fully controlled six-pulse thyristor bridge whereby each thyristor is provided with it's own snubber circuit. Positive and negative field voltage are permitted, i.e. generator or motor operation, with a resulting high speed regulator response.

The thyristor bridge is provided with a cooling element based on natural cooling making a cooling fan obsolete.

With the back-feed information of the regulator's micro processors the ignition of the thyristor control pulses are calculated. These pulses are amplified and sent via the impulse transfer circuit, being galvanic isolated from the thyristors.

6.2.2. De-excitation and Overvoltage Limiter

The de-excitation facility constitutes a safety system being independent from the thyristor bridge and regulators.

De-excitation by synchronous machines with AC exciter equipment is performed through interruption of the field circuit via the de-excitation contactor. Parallel to the field of the AC exciter machine a single phase rectifier bridge protective thyristor and resistor circuit is provided which is activated during the de-excitation process and thus the energy of the field is discharged very rapidly via the resistor.

A voltage dependent resistor (Semitrans) is connected in parallel to the thyristor and resistor circuit representing an additional safety feature which is also acting as an overvoltage protection for the field circuit during normal system operation. This way any possible transient overvoltages and voltage spikes occurring during short circuits and heavy rotor oscillations in the field circuit are limited.

To spare the contacts of the de-excitation contactor during normal shut down of the unit the thyristor bridge is regulated fully into converter mode thus decaying the field current and the contactor is opened after a time delay. During a protection trip this contactor is opened instantaneously and the field energy dissipated via the linear de-excitation resistor.

6.2.3. Field Flashing / Initial Excitation

Initial excitation during start up of a synchronous generator equipped with a shunt field excitation system can only be secured with additional measures since the residual voltage is not sufficient to provide the energy required.

The necessary energy is delivered by the station battery via diodes a limiting resistor and a start up contactor to the field circuit. During initial excitation this contactor is closed and as soon as the thyristor unit has taken over the field current opened again. Now the thyristor unit is regulating to the adjusted set value.

For excitation systems deriving the energy from an excitation transformer connected to the station auxiliaries or from a permanent magnet pole generator an initial excitation is not necessary.

6.3. DIGITAL PART / MICROPROCESSOR

6.3.1. Voltage Regulator (Automatic Mode)

The microprocessor controlled voltage regulator of the GMR3 family represents the heart of the excitation system.

The regulator and the grid regulator unit is a multi-processor voltage regulator for synchronous generator with a wide operating frequency range. It contains the complete voltage regulator with the necessary limiters and additional regulators, a grid regulator unit for three phase operation and the control logic necessary for the proper operation of an excitation system.

The system is of modular design and consists of altogether 4 processors, the digital and analog inputs and outputs, a signal processing module for the electrical machine data and a digital grid regulator unit.

The voltage supply is always performed redundant. At standstill the regulator is supplied from the station battery. In addition a second supply is provided as a "backup" from the three phase thyristor bus. This backup supply takes over via de-coupling diodes without interruption the supply for the regulator during operation.

Functional Principle:

The voltage regulator operates with two regulating loops. The first loop (for voltage regulation) with PID structure and internal integration feedback controls follow-up of the second regulating loop (for field current regulation) with a PI characteristic. Due to this two stage design a fast regulating dynamics as well as high stability during all operating- and load conditions is achieved.

The actual measured values are converted via potential free interposing CT's for the processing of the sub-processor.

Program Volume:

The software contains the operating system and the regulating program with the setting parameters on the main processor module and the various sub-programs on the sub-processor module. System- and User software are stored in an EPROM and plant specific parameters are stored in an EEPROM which can be modified according to requirements.

The operating system carries out the input and output conversion, co-ordinates the sequence of the regulating- and sequencer program and data exchange with the sub-processors and enables communication with the regulator via a serial interface.

All setting-, calibration- and set value potentiometers are part of the software without contacts and therefore require no maintenance.

The following limiters and additional features are provided in the standard design:

- Max. and min. field current limiter with an instantaneous and delayed response
- Overfluxing limiter (V / Hz)
- Stator current limiter with current dependent delay (inverse time) for capacitive and inductive generator operation.
- Diode fault monitoring on AC exciter machines with flywheel diodes for open circuit or short circuit
- Soft-Start feature, i.e. start the initial raising of the generator voltage with a defined rate of rise without hunting
- Detection of isolated operation by frequency deviation

In order to provide utmost safety during operation the system is provided with extensive hard- and software supervision features.

- Self-monitoring of the 4 processors
- Monitoring of the supply voltages
- Watchdog functions on the individual printed circuit boards.
- Self-monitoring of the most important variables
- Test switch on grid control unit for tests with open regulating circuit

Limiting- and additional functions can be installed as described in detail in chapter 14, "OPTIONS FOR THE THYNE3 DEVICE".

6.3.2. Field Current Regulator (Manual Mode)

For manual operation via the (internal) regulating loop the field current is regulated according to the adjusted set value. The potentiometer for the current regulator is again part of the software and also requires no maintenance.

To increase availability for this mode no limiters are effective with the exception of the field current set value is limited to a maximum value of "set value field current regulator upper range".

6.3.3. Automatic Follow-Up Change Over between Voltage Regulator and Field Current Regulator

A smooth transfer from voltage regulator (automatic mode) to field current regulator (manual mode) during operation is achieved either manual or automatic. Automatic change over takes place on faults in the voltage regulator system, e.g. failure of the generator voltage set value.

Transferring from field current- to voltage regulator mode can only be performed manually.

A follow-up regulator continuously adjusts the respective other operating mode so that in either way always balanced conditions are present. Thus no differential voltage meter is necessary and therefore not provided. When in manual mode the set value falls short of or is exceeded a change over is blocked.

6.3.4. Operation, Indication and Digital Sequencer

Digital sequencer, monitoring and alarm annunciation are integrated in the μ P-system as part of the software and are therefore provided with the same reliable supply voltage as the regulator. However the most important trip outputs are separate for safety reasons and are therefore independent from the function of the microprocessor.

For control, monitoring and alarms following functions are specified:

- Digital sequencer for proper initial excitation and de-excitation including operation of all necessary contactors.
- Input- and output signal processing (with potential free interface to the station control system)
- Monitoring of the excitation as well as alarm and trip output signals.
- Control and indication unit for local operation
- Local indication via LC-display for:
 - Generator voltage
 - Generator current
 - Field current
 - Generator active power
 - Generator reactive powerIndication of further measured values via the LC-display of the control unit when called upon is possible
- This control unit consists of a film key pad for the operating commands and a four row LC-display for alarm annunciation and measured values.
- Excitation alarms are stored locally and indicated with the correct time sequence on the LC-display. Further the resulting general alarms "excitation alarm" and "excitation trip" are put at disposal potential free on the cubicle terminal strip.
- Several test- and simulation facilities for commissioning and maintenance

6.3.5. Software package WINOPER

For operation, maintenance and diagnosis the software package WINOPER is available. It allows, by graphical display on a PC, a complete overview and user friendly operation. Furthermore monitoring of analogue and digital variables is possible in different ways. Thus, the facilities of the integrated LC-display and operation panel are considerably extended.

The PC is simply connected to the GMR3 processor board via serial interface RS232. WINOPER enables monitoring or change of plant-specific parameters. The modified parameters can be stored in an EEPROM.

NOTE

When connecting a PC to the serial port a optical isolated Cable should be used, so that the serial port will not be damaged due to high voltages.

7. ENGINEERING DESIGN, AND DIMENSIONING

CAUTION

Should there be any difficulties and obscurities occurring over technical data or calculations please contact our local agent or Head Office. We cannot take any responsibility whatsoever for incorrect calculations and their arising consequences!

7.1. EXTERNAL POWER CIRCUIT

This chapter comprises the selection, design and dimensioning of the external components of the power circuit.

7.1.1. HV Excitation Transformer

1. The excitation transformer for indoor use is of the vacuum impregnated dry- or cast resin type with natural cooling (AN) with a protection class IP00 or IP23).
2. The transformer's primary high voltage winding has to have an appropriate insulation class and there must be only one secondary winding. As a minimum standard for voltages between 1 kV and 10 kV an insulation class 10 should be selected. Provided that there is no suitable existing transformer available a new transformer should absolutely of the three phase type.
3. The nominal rating of the low voltage winding is 3 x 400 V (The adaptation to the exciter data is via the excitation matching transformer).
4. The nominal voltages are defined as no-load voltages and the design is for a continuous 10 % and 30 % short time (10s) overvoltage.
5. The magnetic characteristic of the converter transformer has to be designed for 45 Hz or 54 Hz for system frequencies of 50 Hz or 60 Hz respectively. The induction rating at nominal frequency f_{gn} and nominal voltage V_{gn} should be a maximum of 1.6 Tesla.
6. The transformer must be designed for a continuous load of a six-pulse fully controlled thyristor bridge with inductive load having a firing angle $\alpha = 60^\circ$ electrical and a continuous overload capability of 10 % as well as a short time thermal overload rating at ≥ 1.6 times nominal current for 10 seconds in 30 minute repetition cycles.
7. The short circuit impedance has to be 4 % - 6 % and shall not be below 4 % nor above 6 %. Within this range the most economic variant may be selected.
8. The vector group shall be Yd5.
9. The winding type and insulation of the HV winding has to comply to the relevant Standards and Regulations for partial discharge tests.
10. Between the HV and LV winding a grounded shield layer has to be provided.
11. Unless otherwise specified the transformer has to be designed for an ambient temperature of at least $\geq 40^\circ\text{C}$ for the relevant protection class, e.g. IP00, IP23, etc.
12. Standards: ÖVE-M20, VDE 0532, IEC 60726

FORMULAS for HV Excitation Transformers:

Sn	Same as excitation matching transformer + 100 VA (for supply of THYNE3)
Vprim	= Generator nominal primary voltage
Vsec	= 3 x 400 V phase to phase
Isec	= $S_n / 400 \text{ V} / \sqrt{3}$
fn	= fgn
fTr	= fgn x 0,9

Sn: Nominal apparent power of the excitation transformer
Vprim: Phase to phase primary voltage of the excitation transformer
Vsec: Phase to phase secondary voltage of the excitation transformer
Isec: Secondary current of the excitation transformer
fn: Nominal frequency of the excitation transformer
fTr: Frequency of the excitation transformer for the magnetic characteristic

EXAMPLE: Generator: 3,6 MVA, Vgn = 10,5 kV, Ign = 198 A, p.f. = 0,8, fgn = 50 Hz, 1500 rpm, with AC exciter machine and static excitation system THYNE3 with shunt field, Ifn = 14 A, Ifmax = 15 A, Rf(20) = 2,82 Ω (field connected in parallel), required ceiling factor Fst \geq 2

Sn = 2,3 kVA
Vprim = 10,5 kV
Vsec = 400 V
Isec = 3,3 A
fn = 50 Hz
fTr = 45 Hz

Minimum requirements to the manufacturer of the excitation transformer:

The *italic values* are taken from above example and have to be designed according to plant requirements:

Three Phase Dry Type Excitation Transformer

Nominal rating: Sn (2,3 kVA)
 Remark: probable type rating between 1 kVA and 4 kVA
 Primary voltage: Vprim (3 x 10,5 kV *phase to phase*)
 10 % continuous overfluxing, 30 % short time for 10 sec.
 Secondary voltage: 3 x 400 V phase to phase
 Secondary current: Isec (3,3 A), 1,6 times nominal current for 10 sec.
 Nominal frequency: fn (50 Hz)
 Magnetic design: fTr (45 Hz)
 Impedance. uk: 4 - 6 %
 Vector group: Yd5
 Load: inductive via 6-pulse thyristor bridge firing angle $\alpha = 60^\circ$ electric

Specification:	IP00, thermal rating for IP23 and ambient temperature up to 40 °C maximum, AN, Insulation class 10, Isolation type F, height above sea level < 1000m
Grounded shield:	to be applied between HV and LV windings
Standards:	ÖVE-M20, VDE 0532, IEC 60726, including shop tests
Partial discharge:	The type of winding and insulation of the HV winding have to comply with the relevant Standards and Regulations for a typical partial discharge and have to be verified at least by a type test certificate.

7.1.2. Excitation Matching Transformer

1. This is a three phase dry type transformer with natural air cooling (AN), isolating varnish or vacuum impregnated resin with protection class IP00 for mounting into the excitation cubicle or with enclosure IP23 for installation besides the cubicle due to lack of space.
2. The rated voltage (no-load voltage) is 3 x 400 V with an insulation class of 1 kV.
3. The low voltage side is designed according to the field data of the generator and the exciter machine; please refer to formulas.
4. The nominal voltages are defined as no-load voltages and the design is for a continuous overvoltage rating of 10 % and a 10s short time rating of 30 %.
5. The magnetic characteristic of the matching transformer has to be designed for 45 Hz or 54 Hz for system frequencies of 50 Hz or 54 Hz respectively.
6. The transformer must be designed for a continuous load of a six-pulse fully controlled thyristor bridge with inductive load having a firing angle $\alpha = 60^\circ$ electrical and a continuous overload capability of 10 % as well as a short time overload thermal rating at $\geq 1,6$ times nominal current for 10 seconds in 30 minute repetition cycles.
7. The short circuit impedance has to be $\geq 6 \%$.
8. The vector group must absolutely be Dd0.
9. Unless otherwise specified the transformer has to be designed for an ambient temperature of at least $\geq 40^\circ\text{C}$ for protection class IP23 (excitation cubicle or enclosure).
10. Standards: ÖVE-M20, VDE 0532, IEC 60726

Remark: Caution at two field windings with individual connection possibility in the terminal box which is typical and mainly with AC exciter machines make ELIN.

When the field is composed of two windings the two can either be connected in series or in parallel. Typically is a parallel connection for an overall field resistance between 2 Ohm and 8 Ohm. Further the data of the output rating of the THYNE3 excitation have to be considered, i.e. 25 ADC maximum / 210 VDC maximum continuously.

FORMULAS for Excitation Matching Transformer:

V_{prim}	= 3 x 400 V phase to phase
R_{fn}	= R _{f(20)} x 1,25 or R _{f(85)} or R _{f(120)} x 0,9
V_{forced}	= (I _{fn} x R _{fn} x F _{st} x 1,1 x 1,05) + 10 V [however ≤ 330 VDC]
V_{sec}	= V _{forced} / 1,35 [however ≤ 250 VAC]
I_{sec}	= I _{fmax} x 1,1 x 0,82
S_n	= V _{sec} x I _{sec} x $\sqrt{3}$
f_n	= f _{gn}
f_{Tr}	= f _{gn} x 0,9

V_{prim}: Primary phase to phase voltage of excitation matching transformer

R_{fn}: Field resistance of the exciter machine at approx. 85 °C

R_{f(20)}: Field resistance of the exciter machine at 20 °C

R_{f(85)}: Field resistance of the exciter machine at 85 °C

R_{f(120)}: Field resistance of the exciter machine at 120 °C

V_{forced}: Forced ceiling voltage, which can be selected up to a maximum of 330 VDC (at maximum forced ceiling current of 40 ADC)

I_{fn}: Nominal field current of the exciter machine

I_{fmax}: Maximum field current of the exciter machine

F_{st}: The force factor should be selected between 1.5 and 2. The higher the force factor the better is the regulating dynamics due to the higher forced ceiling voltage. A force factor above 2 is only necessary for especially high excitation response speed is required. An increase in fault current (high residual excitation) during power system short circuits can be achieved by selecting a higher force factor of up to 4.5 maximum with due consideration of the output rating of the THYNE3 in order to ensure operation of the protection (e.g. in case there is no current boost feature available or not possible due to restricted space or economic considerations).

V_{sec}: Secondary phase to phase voltage of excitation matching transformer

I_{sec}: Secondary current of excitation matching transformer

S_n: Apparent power of excitation matching transformer

f_n: Nominal frequency of excitation matching transformer

f_{Tr}: Frequency of excitation matching transformer for magnetic design

EXAMPLE: Data as in the example for the excitation transformer:

Generator: 3,6 MVA, V_{gn} = 10,5 kV, I_{gn} = 198 A, p.f. = 0,8, f_{gn} = 50 Hz, 1500 rpm, with AC exciter machine and static excitation system THYNE3 with shunt field, I_{fn} = 14 A, I_{fmax} = 15 A, R_{f(20)} = 2,82 Ω (field connected in parallel), required ceiling factor F_{st} ≥ 2

V_{prim} = 3 x 400 V phase to phase
R_{fn} = 3,5 Ohm
V_{force} = 123 VDC
V_{sec} = 91 V
I_{sec} = 14 A
S_n = 2,2 kVA
f_n = 50 Hz
f_{Tr} = 45 Hz

Minimum requirements to the manufacturer of the matching transformer:

The *italic values* are taken from above example and have to be designed according to plant requirements:

Three Phase Dry Type Excitation Transformer:

Nominal rating: S_n (2,2 kVA)
Primary voltage: 3 x 400 V phase to phase
10 % overexcitation continuous, 30 % short time for 10 sec.
Secondary voltage: V_{sec} (3 x 91 V *phase to phase*)
Secondary current: I_{sec} (14 A), 1,6 times nominal current for 10 sec.
Nominal frequency: f_n (50 Hz)
Magnetic design: f_{Tr} (45 Hz)
Impedance uk: ≥ 6 %
Vector group: Dd0
Load: inductive via 6-pulse thyristor bridge firing angle α = 60° electric
Specification: IP00, thermal rating for IP23 and ambient temperature up to 40°C maximum, AN, Insulation class 1, Isolation type F, height above sea level < 1000 m
Standards: ÖVE-M20, VDE 0532, IEC 60726

Remark: Probable type rating between 1 kVA and 4 kVA

7.1.3. Field Flashing (Initial Excitation)

To ensure initial excitation during unit start-up for shunt field excitation systems a field flashing equipment has to be incorporated. A typical field current produced by the initial excitation is in the order of 10 % to 20 % (50 % maximum) of the nominal no-load field current at generator rated voltage. Further, a maximum starting current of 3 A must not be exceeded due to the rating of the current limiting resistor of 10 Ω / 50 W in the field flashing circuit. The maximum short time rating of the initial excitation in case of faults, depending on internal supervision, is 5 sec.

The voltage for field flashing shall be completely independent from the 24 VDC supply of the THYNE3 and separately fused (do not use the 24 V DC/DC converter output!). A battery voltage of 24 VDC, 110 VDC or 220 VDC or an alternating voltage supply may be used since internally the system is provided with a rectifier, arc suppression and incorrect polarity protection.

Depending on the selected voltage supply and the required start-up current it may be necessary that an external current limiting resistor has to be incorporated into the circuit. The voltage supply for the THYNE3 system is connected to terminals -A1/X2:20 (preferably for the plus potential) and -A1/X2:21.

FORMULAS for the External Current Limiting Resistor:

$$\begin{aligned} I_{\text{ini.exc.}} &= 10 \% - 20 \% \text{ of no-load field current} \\ R_{\text{extern.}} &= (V_{\text{ini.exc.}} / I_{\text{ini.exc.}}) - R_{\text{fn}} - 10 \, \Omega \\ P_{\text{extern.}} &= (I_{\text{ini.exc.}})^2 \times 0,5 \times R_{\text{extern.}} \end{aligned}$$

$I_{\text{ini.exc.}}$: Initial excitation current
 $V_{\text{ini.exc.}}$: Battery voltage for initial excitation
 $R_{\text{extern.}}$: External current limiting resistor for initial excitation
 R_{fn} : Field resistance of the exciter machine at approx. 85 °C
 $P_{\text{extern.}}$: Rating of current limiting resistor for initial excitation

7.1.4. Excitation External Power Circuit Fuses

1.) *The excitation transformer has to be provided with primary side fuses:*

- a) By HV fuses with sockets and auxiliary alarm contact
- b) When the short circuit fault rating cannot be achieved with fuses then CT's have to be installed on the primary side and protection for the excitation transformer has to be provided by a two- or three phase high set instantaneous overcurrent relay which preferably can in addition have a time delayed overcurrent- and a thermal overload stage.
- c) When the excitation transformer is located within the protective zone of the generator differential protection the HV fuses may also be omitted.

2.) *The excitation transformer has to be provided with secondary side fuses:*

For reasons of short circuit withstand capability the fuses have to be located as near as possible to the transformer.

The protection can be done with a miniature circuit breaker (mcb) with auxiliary alarm contact up to a maximum of 25 A (fault interrupting capability for short circuits have to be checked) or via fuses with preferably an auxiliary alarm contact. Thereby it has to be considered that the thermal and/or magnetic operating characteristic of the protection is larger than the possible forced ceiling current.

3.) *The excitation matching transformer has to be provided with primary side fuses:*

- a) When supplied by the excitation transformer the excitation matching transformer is already protected by secondary side fuses of the excitation transformer.
- b) When the supply voltage is derived from the station auxiliaries protection by mcb with alarm contact up to 25 A maximum (please check fault interrupting capacity) or by fuses is pro-

vided. Thereby it has to be considered that the thermal and/or magnetic operating characteristic of the protection is above the maximum possible forced ceiling current.

4.) *The excitation matching transformer has to be provided with secondary side fuses:*

The secondary side of the excitation matching transformer is protected by semiconductor fuses in the THYNE3 device.

5.) *Measures taken in case of fuse/mcb protection operation:*

It is preferred that in addition to the internal monitoring- and tripping circuits of the THYNE3 the alarm contacts (N/O contact) of the external protection of the power circuit are used for monitoring, tripping, blocking and excitation ready and to integrate them into the interfaces (please refer to chapter 7.3.1, "Alarm Contacts of the Fused Protection for the Power Circuit").

7.1.5. Control Selector Switch for Change Over from Shunt Field Excitation to External Excitation

To transfer from shunt field- to external excitation a control selector switch (cam switch) with the necessary current carrying capacity has to be provided. The preferred manufacturer is the Austro Solenoid company.

The cam switch has 3 positions: Normal (shunt field) – 0 – Test (external)

In position "Normal" the three phases of the excitation transformer switched through whereas in position "Test" the external station supply voltage is connected and the current boost circuit is shorted in case of being provided. The position "0" has no wire connection.

7.1.6. Current Boost Feature

The shunt field excitation cannot prevent de-excitation during system short circuit faults or loss of system voltage since in this case the field supply voltage drops too low. However short circuit excitation can be sustained by the addition of a serial current booster in the power circuit of the shunt field excitation.

For this purpose the stator current of the synchronous machine is converted by three single phase CT's and transformed via saturating interposing CT's which are connected to a three phase bridge rectifier. The DC voltage drop produced by a resistor connected in parallel to the bridge rectifier is fed in series to the field circuit.

During normal operation the current booster contributes very little and only during system short circuit conditions the excitation is considerably supported to produce 1.8 times nominal short circuit current at the generator terminals for a maximum of 10 seconds.

The THYNE3 current boost circuit is incorporated only when required. It consists of three saturation interposing CT's, a three phase diode bridge, a support capacitor and a matching resistor.

When applying a current booster the same set of main CT's can be used as for the statics.

A) Current Transformer

The current booster is connected to three main CT's either existing or newly provided. A rated CT secondary current of 1 A or 5 A is required whereby 5 A is preferred. Rated power output and overcurrent factor of the CT's have to comply with following formulas.

For the design or checking of the main CT's following data have to be available:

If_{1,0K}:	Field current of the exciter machine for 100 % stator current three phase terminal faults and heated rotor, i.e. the expected operating temperature of the rotor which has to be given by the generator manufacturer.
If_{2,0K}:	Field current of the exciter machine for 200 % stator current three phase terminal faults and heated rotor which has to be given by the generator manufacturer.
R_{f(20)}:	Field resistance of the exciter machine at 20 °C
R_{fn}:	Field resistance of the exciter machine at 85 °C
R_{f(120)}:	Field resistance of the exciter machine at 120 °C
I_{gn}:	Nominal generator current
I_{wprim}:	Main CT's primary current
I_{wsec}:	Main CT's secondary current (i.e. 5 A or 1 A)
S_H:	Main CT's rated power
S_z:	Interposing CT's rated power
n_H:	Main CT's overcurrent factor (for example: n _H > 10)
n_z:	Interposing CT's overcurrent factor

FORMULAS for Current Booster:

a) Interposing CT's (saturating CT's), 3 pieces, Data for each:

$$\begin{aligned}
 I_{zprim} &= I_{gn} \times I_{wsec} / I_{wprim} \\
 I_{zsec} &= 0,95 \times 0,5 \times (I_{f1,0K} + [0,5 \times I_{f2,0K}]) \\
 R_{fn} &= R_{f(20)} \times 1,25 \text{ oder } R_{f(85)} \text{ oder } R_{f(120)} \times 0,9 \\
 V_{zsec} &= I_{f1,0K} \times R_{fn} \times 0,9 \\
 S_z &= U_{zsek} \times I_{zsek}
 \end{aligned}$$

CT design:

at **V_{zsec}** should n_z = 1,2 and B_n = 1,6 Tesla and
 at **V_{zsec} x 0,5** should n_z < 5 and accuracy class < 3 %

b) Main CT's:

$$S_H \geq S_z / n_H$$

I_{zprim}: Primary current of interposing CT

I_{zsec}:	Secondary current of interposing CT
R_{fn}:	Field resistance of the exciter machine at approx. 85 °C
R_{f(20)}:	Field resistance of the exciter machine at 20 °C
R_{f(85)}:	Field resistance of the exciter machine at 85 °C
R_{f(120)}:	Field resistance of the exciter machine at 120 °C
V_{zsec}:	Secondary saturation voltage of interposing CT
B_n:	Nominal induction of interposing CT

The primary rating of the main CT's are according to the generator data.

EXAMPLE: Data as in the example for the excitation transformer:

Generator: 3,6 MVA, V_{gn} = 10,5 kV, I_{gn} = 198 A, p.f. = 0,8, f_{gn} = 50 Hz,
 1500 rpm, with AC exciter machine and static excitation system THYNE3 with shunt
 field, I_{fn} = 14 A, I_{fmax} = 15 A, R_{f(20)} = 2,82 Ω (field connected in parallel), required
 ceiling factor F_{st} ≥ 2
 Additionally: I_{f1,0K} = 10,2 A, I_{f2,0K} = 21,6 A, I_{wprim} = 200 A, I_{wsec} = 5 A, n_H > 10

a) Design of Interposing CT's:

I_{zprim}	= 4,95 A, therefore selected 5 A
I_{zsec}	= 9,975 A, therefore selected 10 A
R_{fn}	= 3,5 Ohm
V_{zsec}	= 32,13 V, therefore selected 32 V
S_z	= 320 VA

Interposing CT characteristic:

at 32 V_{rms} should n_z = 1,2 and B_n = 1,6 Tesla at 320 VA and
 at 16 V_{rms} should n_z < 5 and accuracy class < 3 %

b) Design of Main CT's:

$$S_H \geq 32 \text{ VA}$$

Minimum Data for the Manufacturer of Interposing CT's:

The values chosen in above example have to be determined according to plant specifications.

3 pcs. Interposing CT (saturation CT)

Insulation class:	0,5/0,6/3 kV
Rated power:	S _z (320 VA)
Nominal frequency:	f _n (50 Hz)
Primary/secondary ratio:	I _{zprim} / I _{zsec} (5 / 10 A)
Secondary voltage:	V _{zsec} (32 V _{rms}) at n = 1,2 and B _n = 1,6 Tesla, V _{zsec} x 0,5 (16 V _{rms}) at n < 5, accuracy class < 3 %

(Recommended manufacturer J. Zelisko, 2340 Mödling, Austria, e.g. type RWZ3)

B) Boost Capacitor and Boost Rectifier:

For field currents up to I_{fn} 15 ADC a capacitor with 30 μF , $U \geq 250 \text{ V}_{\text{rms}}$ (e.g. 400 V_{rms}) and a boost rectifier type SKD30/12A1 with cooling element P1/120, make Semikron, are used (or with $I_{fn} < 10 \text{ A}$, type SKD50/12A1 without cooling element).

For field currents from I_{fn} 15 ADC to 25 ADC two capacitors with 30 μF each are connected in parallel and a boost rectifier type SKD50/12A1 with cooling element P1/120, make Semikron, are used.

C) Boost resistor:

The power rating of the boost resistor is according to the maximum voltage across the resistor. This is the case when the thyristor bridge is fully regulated to converter operation (factor 0.86). The resistor has to be adjustable

FORMULAS for Boost Resistor:

$$\begin{aligned} R_s &= 6 \times R_{f(20)} \\ P_s &= [(V_{\text{sec}} \times 1,35 \times 0,86)^2 / R_s] \times 1,3 \end{aligned}$$

R_s : Boost resistor
 $R_{f(20)}$: Field resistance of the exciter machine at 20 °C
 P_s : Rated power of boost resistor
 V_{sec} : Secondary phase to phase voltage of matching transformer

EXAMPLE: Data as in the example for the excitation transformer:
 Generator: 3,6 MVA, $V_{gn} = 10,5 \text{ kV}$, $I_{gn} = 198 \text{ A}$, p.f. = 0,8, $f_{gn} = 50 \text{ Hz}$,
 1500 rpm, with AC exciter machine and static excitation system THYNE3 with shunt
 field, $I_{fn} = 14 \text{ A}$, $I_{fmax} = 15 \text{ A}$, $R_{f(20)} = 2,82 \Omega$ (field connected in parallel), required
 ceiling factor $F_{st} \geq 2$

$$V_{\text{sek}} = 91 \text{ V}$$

R_s = 16,92 Ohm, selected 17 Ohm
 P_s = 853,6 W, selected 860 W

(e.g.: Make Benedikt & Jäger, type JW50/8, 22 Ω / 6,4 A; adjusted to 17 Ω)

7.2. INTERFACE OF THE THYNE3 DEVICE

The THYNE3 device can be integrated into a variety of operating systems, i.e. from simple local operation of the THYNE3 device to remote manual operation and supervision from the control room and the connection to an extensive sequence control and data acquisition with remote control and data transfer.

7.2.1. Voltages for the Supply and Inputs of the THYNE3 Device

- **Auxiliary Supply 24 VDC:**

The device has to be supplied from a safe 24 VDC voltage ($\pm 20\%$ tolerance) with a typical continuous current of 6 A and a maximum peak load of 10 A which is connected to terminals - A1/X2:11 (plus) and -A1/X2:12 (minus). A minimum cross section of 4 mm² for the supply wiring is required with an external 16 A mcb protection. The supply voltage must never, at any instant, exceed 36 V.

The preferred supply is derived directly from the station battery distribution. Should the battery voltage be higher than 24 V then an appropriate DC/DC converter with 24 V secondary output and 250 W rating has to be used (recommended Make Polyamp).

- **External Inputs Supply 24 VDC:**

The 7 digital inputs are electrically connected to a potential free input module via opto-isolators so that all external digital inputs must have a common 24 VDC supply having a maximum power consumption of 0.2 A.

Following voltages for the 24 V input supply of the THYNE3 device may be used:

- a) A voltage with it's own mcb or fuse protection as input voltage for the excitation from the DC distribution or from the output of an already required DC/DC converter for the THYNE3 device or
- b) a control voltage from the SCADA system or the control room, etc.

- **Protection Trip Voltage:**

The protection trip circuit is independent and potentially separated from the supply voltage of the THYNE3 device and shall use it's own trip supply. The protection trip supply has a capacity of 1.5 A maximum peak load and must be a safe supply completely independent from other supply voltages using a separate mcb or fuses. Either a specific unit protection supply or a supply directly taken from the DC distribution via a 6 A mcb can be employed.

Already in the ordering stage the THYNE3 de-excitation contactor's trip coil and the trip supply voltage have to be determined. A selection of the most common DC voltages of 24 VDC, 110 VDC or 220 VDC is available.

The selected protection trip supply must be connected to the THYNE3 device for the internal tripping of the de-excitation contactor, i.e. to terminals -A1/X41:11 plus and -A1/X3:105 minus.

7.2.2. Digital Inputs

- **Protection Trip:**

Connection: The protection trip supply for the THYNE3 device is connected to terminals -A1/X41:11 and -A1/X3:105 (please refer to previous item Protection Trip Voltage). The switched positive from the contact of the unit protection is connected to terminal -A1/X3:205.

Function: Direct trip to the de-excitation contactor's trip coil.

Signal type: Impulse with minimum duration of 0.5 sec.

- **B Excitation ON:**

Connection: Input contact between terminals -A1/X3:208 and -A1/X3:107.

Function: This command is for starting the excitation ON sequence

Signal type: Impulse with minimum duration of 0.5 sec

- **B Excitation OFF:**

Connection: Input contact between terminals -A1/X3:308 and -A1/X3:107.

Function: This command is for starting the operational excitation OFF sequence, i.e. no protection trip or emergency shut down.

Signal type: Impulse with minimum duration of 0.5 sec

- **B Excitation LOWER:**

Connection: Input contact between terminals -A1/X3:307 and -A1/X3:107.

Function: This command reduces the set value in the particular operating mode (voltage regulation, field current regulation or power factor / reactive power regulation)

Signal type: Impulse with minimum duration of 0.5 sec. (reduction is proportional to the impulse duration).

- **B Excitation RAISE:**

Connection: Input contact between terminals -A1/X3:207 and -A1/X3:107.

Function: This command raises the set value in the particular operating mode (voltage regulation, field current regulation or power factor / reactive power regulation)

Signal type: Impulse with minimum duration of 0.5 sec. (reduction is proportional to the impulse duration).

- **B Excitation AUTO:**

Connection: Input contact between terminals -A1/X80.2:A1 and -A1/X3:107.

Function: This command changes the THYNE3 from manual mode (field current regulator) to automatic mode (voltage regulator). This command can be given at standstill as well as at excitation in operation. During excitation operation the change-over is performed bumpless, only the generator voltage must be within the setpoint limits (generally between 0,9 and 1,1 pu.).

Signal type: Impulse with minimum duration of 0.5 sec

- **B Excitation MANUAL:**

Connection: Input contact between terminals -A1/X80.1:A1 and -A1/X3:107.

Function: This command changes the THYNE3 from automatic mode (voltage regulator) to manual mode (field current regulator). This command can be given at standstill as well as at excitation in operation. During excitation operation the change-over is performed bumpless.

Signal type: Impulse with minimum duration of 0.5 sec

- **B Additional Regulator (PF / VAR) ON:**

Connection: Input contact between terminals -A1/X81:A1 and -A1/X3:107.

Function: This command is for the selection of the additional regulators (power factor / reactive power regulator).

Signal type: Selectable either impulse with minimum duration of 0.5 sec. or continuous signal

Impulse input: 1. impulse = switch ON, 2. Impulse = switch OFF

Continuous signal input: the regulator is activated for the duration of the command

For corresponding parameter settings please refer to chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS".

7.2.3. Digital Outputs

The output supply voltage is independent from the internal functions of the THYNE3 device. Following should be observed:

- 10 digital outputs for the station control system are internally connected together to a potential free contact group so that these 10 outputs must have only one fused voltage supply (maximum contact rating 1 A at 24 VDC and 0.3 A at 220 VDC). The common potential connection of the 10 output contacts are joined at terminal -A1/X43:11 and are to be connected to the plus potential of the digital output supply.
- Additional 2 contacts, namely "A excitation fault" and "CB intertrip" are completely independent and each one potential free.
- For further 2 contacts to control an external de-excitation contactor please refer to chapter 7.2.6, "Integration of a 2. De-Excitation Contactor into the Rotor Circuit of the Main Generator" and chapter 7.2.7 "Integration of a 2. De-excitation Contactor Into the Field Circuit".

To protect the output contact when switching an inductive load (contactor coil) it has to be equipped with an arc suppression circuit , e.g. diode.

10 Output Contacts with Common Plus Potential:

- **M Excitation ON:**

Connection: Output contact between terminals -A1/X72:14 and -A1/X43:11.

Function: Excitation is in a defined ON-state .

Signal type: Continuous signal when excitation is ON.

- **M Excitation OFF:**

Connection: Output contact between terminals -A1/X72:12 and -A1/X43:11.

Function: Excitation is in a defined OFF-state (all contactors switched off).

Signal type: Continuous signal when excitation is OFF.

- **M Excitation AUTOMATIC:**

Connection: Output contact between terminals -A1/X73:12 and -A1/X43:11.

Function: Excitation operating mode automatic/voltage regulation selected

Signal type: Continuous signal as long as excitation automatic/voltage regulation selected.

- **M Excitation MANUAL:**

Connection: Output contact between terminals -A1/X73:14 and -A1/X43:11.

Function: Excitation operating mode manual/field current regulation selected.

Signal type: Continuous signal as long as excitation manual/field current regulator selected.

- **M Additional regulator (PF / VAR) ON:**

Connection: Output contact between terminals -A1/X71:14 and -A1/X43:11.

Function: additional regulator (power factor- or reactive power regulator) selected.

Signal type: Continuous signal as long as additional regulator is activated and not inhibited via the program's isolated operation recognition feature.

- **NM Additional regulator (PF / VAR) ON:**

Connection: Output contact between terminals -A1/X71:12 and -A1/X43:11.

Function: Inverted contact ("no indication") of "M additional regulator (PF / VAR) ON".

Signal type: Continuous signal as long as additional regulator is activated and not inhibited via the program's isolated operation recognition feature.

- **M Erregung READY:**

Connection: Output contact between terminals -A1/X74:12 and -A1/X43:11.

Function: Status indication that the THYNE3 system is ready for operation, no alarm is activated and an ON command be accepted if no simultaneous OFF/TRIP command is present. This indication refers only to the device functioning, i.e. for the actual switching on of the excitation all plant requisitions have to be given (unit at nominal speed, etc.)

Signal type: Continuous signal as long as no alarm is activated.

- **M Excitation ALARM:**

Connection: Output contact between terminals -A1/X74:14 and -A1/X43:11.

Function: Alarm annunciation that the excitation system is faulty. The excitation system will still remain in operation.

Signal type: Continuous signal as long as the alarm is activated, however for at least 0.5 seconds.

- **M Excitation TRIP 1:**

Connection: Output contact between terminals -A1/X43:12 and -A1/X43:11.

Function: Alarm annunciation that the excitation system is faulty and in this instant the de-excitation contactor has tripped.

Signal type: Continuous signal as long as the tripping signal is activated, however for at least 0.5 seconds.

- **NM Excitation TRIP 1:**

Connection: Output contact between terminals -A1/X43:14 and -A1/X43:11.

Function: Indication that no trip is activated.

Signal type: Continuous signal which disappears when a trip signal is activated.

Completely potential free Output Contacts:

• M Excitation TRIP 2:

Connection: Output contact between terminal -A1/X42:11 und 12. The contact rating is up to a maximum of 0.3 A at 220 VDC.

Function: The same function as the alarm annunciation excitation TRIP 1. This contact is provided for a protection system with a separate supply voltage, e.g. generator-transformer protection.

Signal type: Continuous signal as long as the tripping signal is activated, however for at least 0.5 seconds.

• CB INTERTRIP:

Connection: Output contact between terminal -A1/X3:201 and 301 (straight N/C auxiliary contact of the de-excitation contactor). This contact is suitable for a maximum rating of 0.3 A at 220 VDC.

Function: When the de-excitation contactor is opened the generator circuit breaker is inter-tripped.

Signal type: Continuous signal as long the de-excitation contactor is in the open position.

7.2.4. Power Supply and Synchronising Voltage for Thyristor Bridge

The synchronising voltage having 3 x 400 V_{rms} nominal voltage must absolutely be in equal phase relation to the power supply of the THYNE3 device with L1, L2, L3 and connected to terminals -A1/X15:2, 4 and 6 for a proper commutation of the thyristor bridge whereby the wiring cross section should not be less than 2.5 mm².

In comparison to the synchronising voltage the power supply of the thyristor bridge has to be connected to terminals -A1/X11:2, 4 and 6 with the correct phasing. Up to a rated field current of 15 A the interconnecting wiring has to be with a cross section of ≥ 4 mm² whereas for a nominal current of 25 A a cross section of ≥ 6 mm² is to be taken.

The power supply with correct phasing in relation to the synchronising voltage is operating correctly with either a clockwise or an anticlockwise phase sequence whereby the former should be preferred.

7.2.5. Connection of the Field Winding of the Exciter Machine

The output of the THYNE3 device for the supply of the field winding is carried out via terminals -A1/X1:2 (positive current) and -A1/X1:3 (negative current). Should an external field current ammeter be required a shunt has to be incorporated into the field circuit. Up to a maximum nominal field current of 15 A a shunt 25 A / 60 mV has to be used and for field currents up to 25 A a 50 A / 60 mV shunt is applicable.

Cross sections for the external wiring of the field circuit:

Nominal field current up to a maximum of 10 A: 4 mm²

Nominal field current up to a maximum of 15 A: 6 mm²

Nominal field current up to a maximum of 25 A: 10 mm²

7.2.6. Integration of a 2. De-Excitation Contactor into the Rotor Circuit of the Main Generator

With the application of a DC exciter machine sometimes a de-excitation contactor in the rotor circuit of the main generator is desired. This can also be controlled via the THYNE3 device.

The integration is described below and has to be done according to the drawing "THYNE3 – ADDITIONAL BLOCK DIAGRAM WITH 2. DE-EXCITATION CONTACTOR IN THE ROTOR CIRCUIT OF THE MAIN GENERATOR" / Dwg.No. 3-533 453. This drawing can be ordered on demand.

NOTE

For correct functioning of the excitation system all specified signals are to be wired up!

Connective Measures:

- **POWER CIRCUIT INTEGRATION:**
Directly into the rotor circuit.
- **B EXTERNAL DE-EXCITATION CONTACTOR ON:**
Connection: Potential free output contact to terminals -A1/X75:11 and -A1/X75:14.
Function: ON command for 2. de-excitation contactor.
Signal type: Impulse signal, however, especially by equipment failure may be active for longer periods.
- **B EXTERNAL DE-EXCITATION CONTACTOR OFF:**
Connection: Output contact supplied by protection voltage terminals -A1/X3:206 (plus) and -A1/X3:106.
Function: OFF command for 2. de-excitation contactor.
Signal type: Impulse signal, however, especially by equipment failure may be active for longer periods.
- **M EXTERNAL DE-EXCITATION CONTACTOR ON:**
Connection: Connecting jumper between terminals -A1/X3:101 and 102 is to be removed. The indication "M de-excitation contactor ON" is to be connected to terminals -A1/X3:101 and -A1/X3:103.
Function: Excitation ON condition as well as contactor trip supervision of the 2. de-excitation contactor.
Signal type: Position indicating contact of the 2. de-excitation contactor (ON indication).
- **M EXTERNAL DE-EXCITATION CONTACTOR OFF:**
Connection: The indication "M de-excitation contactor ON" is to be connected to terminals -A1/X3:204 and -A1/X3:304.
Function: Confirmation of the correct operating sequence during de-excitation.
Signal type: Position indicating contact of the 2. de-excitation contactor (OFF indication).
- **CB INTERTRIP:**
Connection: The CB intertrip feature for further de-excitation contactor has to be integrated into the trip circuit of the generator CB (similar to the chapter 7.2.3, "Digital Outputs").
Function: When the de-excitation contactor is opening the generator CB has to be opened at the same time (intertripped)
Signal type: Continuous signal as long as the de-excitation contactor is in the open position.

7.2.7. Integration of a 2. De-excitation Contactor Into the Field Circuit

In some plants a 2nd Protection supply is applied and for the most important shut down equipment a 2nd trip coil is provided. Since the de-excitation contactor incorporated into the THYNE3 system is only equipped with one trip coil a second external de-excitation contactor has to be connected into the field circuit.

The integration is described below and has to be done according to the drawing "THYNE3 – ADDITIONAL BLOCK DIAGRAM WITH 2. DE-EXCITATION CONTACTOR IN THE FIELD CIRCUIT" / Dwg.No. 3-533 454. This drawing can be ordered on demand.

NOTE

For correct functioning of the excitation system all specified signals are to be wired up!

Connective Measures:

- **POWER CIRCUIT INTEGRATION:**

Terminal jumper -A1/X1:1 to 2 as well as terminal jumper -A1/X1:3 to 4 have to be removed. The main contacts of the second de-excitation contactor are to be connected according to the Dwg. No. 3-533 454.

- **B EXTERNAL DE-EXCITATION CONTACTOR ON:**

Connection: Potential free output contact to terminals -A1/X75:14 and -A1/X75:11.

Function: ON command for 2. de-excitation contactor.

Signal type: Impulse signal, however, especially by equipment failure may be active for longer periods.

- **B EXTERNAL DE-EXCITATION CONTACTOR OFF:**

Connection: Output contact supplied by protection voltage terminals -A1/X3:206 (plus) and -A1/X3:106.

Function: OFF command for 2. de-excitation contactor.

Signal type: Impulse signal, however, especially by equipment failure may be active for longer periods.

- **M EXTERNAL DE-EXCITATION CONTACTOR ON:**

Connection: Connecting jumper between terminals -A1/X3:101 and 102 is to be removed. The indication "M de-excitation contactor ON" is to be connected to terminals -A1/X3:101 and -A1/X3:103.

Function: Excitation ON condition as well as contactor trip supervision of the 2. de-excitation contactor.

Signal type: Position indicating contact of the 2. de-excitation contactor (ON indication).

- **M EXTERNAL DE-EXCITATION CONTACTOR OFF:**

Connection: The indication "M de-excitation contactor ON" is to be connected to terminals -A1/X3:204 and -A1/X3:304.

Function: Confirmation of the correct operating sequence during de-excitation.

Signal type: Position indicating contact of the 2. de-excitation contactor (OFF indication).

- **CB INTERTRIP:**

Connection: The CB intertrip feature for further de-excitation contactor has to be integrated into the trip circuit of the generator CB (similar to the chapter 7.2.3, "Digital Outputs").

Function: When the de-excitation contactor is opening the generator CB has to be opened at the same time (intertripped)

Signal type: Continuous signal as long as the de-excitation contactor is in the open position.

7.2.8. CT / VT and Actual Measured Value Connections

The actual measured values of the generator voltage and current can be applied as either three phase- or single phase quantities whereby the three phase evaluation is qualitatively preferred (the definition whether 3-phase or 1-phase quantities are measured is by parameter setting as outlined in chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS").

The actual measured values collection can be with either a clockwise or anticlockwise phase rotation whereby the former is preferred.

CAUTION

The correct allocation of the current vectors and voltage vectors has to be strictly observed!

When a current boost feature is incorporated then the same main CT's can be used for the static.

a) *Single Phase Machines:*

With single phase measuring by single phase machines the phases L1 and L2 of the voltage transformer are allocated to terminals -A1/X5:151 for L1 and 153 for L2. The phase current of the CT L1 is connected to terminals -A1/X5:156 (→) and 256 (5 A ←) or 356 (1 A ←).

b) *Three Phase Machines with 3-phase Measuring:*

When measuring three phase quantities phase L1, L2, L3 of the voltage transformer the associated terminals are -A1/X5:151, 152, 153 respectively. The phase currents from CT's L1 and L2 are allocated to terminals -A1/X5:156 (→) and 256 (5 A ←) or 356 (1 A ←) for L1 and terminals -A1/X5:157 (→) and 257 (5 A ←) or 357 (1 A ←) for L2.

c) *Three Phase Machines with 1-phase Measuring:*

When measuring single phase quantities phase L1 and L3 of the voltage transformer the associated terminals are -A1/X5:151 for L1 and 153 for L3. The phase current from CT L2 are allocated to terminals -A1/X5:157 (→) and 257 (5 A ←) or 357 (1 A ←).

Note: 156 (→) means, the current is entering terminal 156 of the THYNE3 device

256 (5 A ←) means, at a 5 A - CT the current is leaving terminal 256 of the THYNE3 device

356 (1 A ←) means, at a 1 A - CT the current is leaving terminal 356 of the THYNE3 device

The allocation of the phases can be cyclic exchanged, e.g. VT phases L2 and L1 are connected to terminals -A1/X5:151 for L2 and 153 for L1, and the L3 CT current connected to terminals -A1/X5:352 (→) and 252 (←).

The phase to phase actual value measuring of the generator voltage is rated for a nominal VT voltage of 100 Vrms or 110 Vrms / ≥ 10 VA, accuracy class 1, 50 / 60 Hz with a power consumption of 3 VA. The secondary cabling should have a cross section not less than 2,5 mm².

The actual value measuring of the generator current for each phase is rated for a secondary CT current of 1 A or 5 A / ≥ 10 VA, minimum accuracy class 3, $n < 5$, 50 / 60 Hz, with a power consumption of 3 VA. The CT wiring should have a minimum cross section of 2,5 mm² and 4 mm² for 1 A and 5 A Ct's respectively.

7.2.9. Current Booster

When applying the current boost option it has to be integrated into the DC circuitry of the excitation system. Thereby the terminal jumper -A1/X1:7 to 8 has to be removed and the current boost circuit looped in such that the DC current is flowing out from terminal -A1/X1:8 of the THYNE3 device and returning from the booster circuit through terminal -A1/X1:7.

7.3. INTEGRATION OF SIGNALS IN CONNECTION WITH A HIGH LEVEL CONTROL AND DATA ACQUISITION SYSTEM

7.3.1. Alarm Contacts of the Fused Protection for the Power Circuit

Via the interfaces of the THYNE3 device also the auxiliary contacts of the external mcb or fuse protection can be incorporated into the alarm- and trip circuits. This will provide additional safety since all AC-voltages are internally monitored anyway.

The alarm contacts of the external mcb or fuse protection (N/C contacts, please also refer to chapter 7.1.4, "Excitation External Power Circuit Fuses") can be connected in parallel, depending on the selected operating three phase power supply, via the control selector switch of the excitation.

- a) parallel to the common alarm annunciation output "excitation TROUBLE" or
- b) a higher level alarm annunciation system or
- c) operate an auxiliary relay whereby a N/O contact of the relay is connected to the "PROTECTION TRIP" input and N/O contact(s) parallel to the output of the common alarm excitation "M ALARM" and/or excitation "M TRIP"

Item c) ensures additional safety to the internal fault detection as well as a definitive closing interlock as long as the fault is present. Similar to item a) and b) the external alarms are activated as long as the fault is present.

7.3.2. MCB for Actual Value CT

Also the voltage from the VT mcb output is monitored internally by the software. Again, to increase safety the auxiliary contact of the mbc can be included into the alarm- and trip circuits. Especially when for example the mbc trip should also be supervised during standstill.

The N/C contact of the auxiliary contact can be connected in parallel to the output of the excitation "M ALARM" or also transferred to a higher level alarm annunciation system. The external annunciation is activated as long as the mcb is in the open state.

A N/O auxiliary contact can be included as a blocking interlock for the external excitation start command "B Excitation ON" with the control selection "M Excitation AUTOMATIC".

7.3.3. Ready to Start-up Condition

The ready to start condition is to be produced by the station control system. We recommend to create following conditions.

- a) Depending on the control selection "M AUTOMATIC" or "M MANUAL" for switching the excitation ON from the control room, the station control system, etc.:

The selection of the operating mode as a precondition for externally switching the excitation ON (control room, control system, etc.) is by way of the desired operating philosophy. For normal remote operation with a fully automatic station control system only the excitation AUTO operating mode is of importance. In the excitation MANUAL mode the unit should only be able to be brought to nominal speed and the command "B Excitation ON" should only be manually enabled.

It is also to consider whether for safety reasons with the control selection in MANUAL mode an excitation ON should only be possible via the operating terminal of the THYNE3 device.

- b) Precondition for unit start up and switching on of the excitation is the indication "M Excitation OFF".
- c) Dependence from the annunciation "M ALARM" and indication "M READY TO START":
The annunciation "M ALARM" of the THYNE3 device as well as the external alarm contacts connected in parallel point out a limitation of the excitation's operation readiness which at least is preventing a successful start in automatic mode, e.g. VT mcb faulty. The indication "M READY TO START" is the inverted alarm signal and shows the start-up or ready to switch on state of the THYNE3 equipment.
- d) Dependence from the alarm "M TRIP":
The alarm "M TRIP" of the THYNE3 device as well as the external trip contacts connected in parallel, e.g. the fuse protection of the power circuit, prevents independent from the operating mode any switching ON of the excitation.
- e) The existing control selector switch for the selection of the power supply shall not be in "0" position (please also refer to chapter 8.3.5, "Changing Between Shunt Field- and External Excitation Operating Mode With the Control Selector Switch").
- f) Integration of protection- and input/output voltage monitoring of the excitation system and device THYNE3.

Items a) to f) are by no means pointing out all possibilities, however, depending on plant configurations, they convey important functional conditions of the excitation system THYNE3 to enable to recognise before unit start up whether the excitation is ready to be switched ON.

7.3.4. Operating Mode Control Selector Switch

This mode control selector switch is used to transfer to external excitation from the 3x400 V station supply distribution, e.g. for test purposes (cam type switch, please refer to chapter 6.1.3, "External- and Test Supply from the Station Auxiliary System" and chapter 7.1.5, "Control Selector Switch for Change Over from Shunt Field Excitation to External Excitation").

Possibilities and variants for the inclusion of the selector switch position for indication and /or monitoring:

- a) Position "0" is suitable for maintenance. The indication can either be connected in parallel to the output "M excitation ALARM" or transferred to a higher level alarm annunciation system or operational indication.
- b) Position "Test" (external supply from the station auxiliaries) can be specified as ALARM or operational indication since not the same safety and operational independence as in shunt field excitation mode can be achieved. When the power rating of the external supply is limited or it's only use is for test purposes then operation in manual mode "M MANUAL" can be specified or the ready for start-up condition blocked in the automatic mode "M AUTOMATIC".
- c) The indication control selection in position "0" can also be connected in parallel to the excitation input "PROTECTION TRIP" being an additional electrical interlock to the internal monitoring of the system.

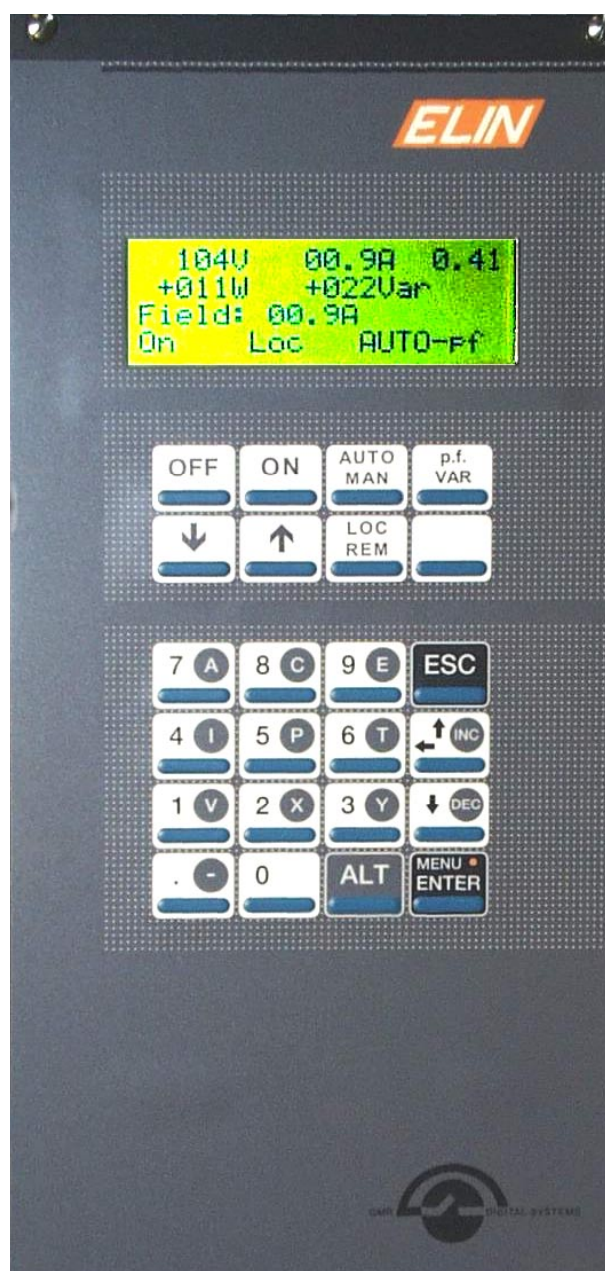
8. CONTROL AND OPERATION

The following chapters are dealing with the operation of the excitation system's control, functionality and alarms primarily related to the THYNE3 and a correct design and integration into the excitation system THYNE3 and the plant structure is taken for granted.

8.1. LOCAL OPERATION

8.1.1. Normal Operation



For local operation of the excitation system with the User terminal of the THYNE3 device a 4-row LC display and two rows with 4 keypads each with corresponding indication on the LC display is provided.



User Keypad:

OFF ↓	ON ↑	AUTO MAN LOC REM	p.f. VAR (no function)
----------	---------	-------------------------------	----------------------------------

NAME	FUNCTION
OFF	<p>The "OFF command" of the User terminal is provided for operational shut down of the excitation. It is always accepted and initiates de-excitation of the exciter machine respectively the generator. The sequence is terminated when the de-excitation contactor has reached the OFF position.</p> <p>a) <i>Operational de-excitation with "OFF command" at generator no-load conditions:</i> When the "OFF command" is given when reaching a minimum stator current an operational shut down takes place by converter end limit position and the de-excitation contactor is opened time delayed under no-load conditions.</p> <p>b) <i>"OFF command" with generator stator current:</i> When a stator current is present the de-excitation contactor is opened instantaneously thereby immediately intertripping the generator CB.</p> <p>During the OFF sequence the "stop" indication is flashing and changes to an "OFF" indication as soon as the OFF state has been reached.</p> <p>The shut down sequence is checked by a run-time supervision delay until a definite OFF condition is attained. During system failure conditions a "excitation TRIP" is initiated with a corresponding indication "stop overtime trip" on the LC display.</p> <p>A continuous "OFF command" results in a blocking of the excitation ready state for start up of the excitation after the definite OFF condition is reached.</p> <p><i>Note:</i> 1) <i>This command is accepted independent from the LOCAL/REMOTE control selection</i> 2) <i>With an external "excitation OFF" command the same control sequence is produced</i></p>

NAME	FUNCTION
ON	<p>The "ON command" is accepted when no "protection TRIP", no "excitation TRIP" and no "OFF command" is carried out and a definite OFF state has been reached. Further, the LC display has to indicate the "ready" state and the unit speed has to be recognised as not being below 95 % (depending on the value of the generator residual voltage).</p> <p>During the start up sequence the "start" indication is flashing and is reverting to an "ON" indication when the start sequence is finished.</p> <p>With the acceptance of the ON command the definite ON condition is checked by a runtime supervision. Exceeding the supervision time delay a shut down with "excitation TRIP" is performed and the indication "start overtime trip" is shown on the display.</p> <p><i>Note:</i> 1) This command will only be accepted in LOCAL control position 2) The same control sequence is initiated by an external "excitation ON" command</p>
AUTO MAN	<p>Operation of this key produces a transfer of the excitation operating mode either from auto / voltage regulation to manual / field current regulation or vice versa from manual to automatic depending on the operating mode when the key has been operated.</p> <p>When changing over from "AUTO" to "MANUAL" the additional regulator is also switched off.</p> <p>This transfer can take place either in the "excitation OFF" state or during system operation. During operation a <u>smooth</u> change over is performed. For limitations of the change over please refer to chapter 8.3.4, "Change Over Between the Automatic and Manual and Power factor / Reactive Power Regulation Mode".</p> <p>The LC display indication "AUTO" or "MAN" gives information about the actual operating mode.</p> <p>Operation of this key will only be accepted when being in a definite excitation "ON" or "OFF" operating mode.</p> <p><i>Note:</i> This command will only be accepted locally.</p>
 	<p>The keys excitation set value "RAISE" ↑ and excitation set value "LOWER" ↓ are acting in either operating mode ("MANUAL", "AUTOMATIC" or additional regulator (power factor- or reactive power regulation)). Depending on the duration of the control impulse will lead to a raising or lowering of the set value and also of the excitation (respectively generator voltage, field current, reactive power).</p> <p>These commands will only be accepted in the excitation "ON" position.</p> <p><i>Note:</i> 1) These command will only be accepted in LOCAL operation. 2) The external inputs raise and lower are having the same function.</p>

NAME	FUNCTION
<p>p.f. VAR</p>	<p>With this key following operating sequence can be selected:</p> <ul style="list-style-type: none"> a) Selection of the additional regulator with power factor regulation with "p.f." display indication or b) Selection of the additional regulator with reactive power regulation with "VAR" display indication or c) Switching off the additional regulator (no display indication) <p>These commands are only accepted in "AUTO" operating mode and the switch-over is always performed <u>smoothly</u>.</p> <p>The status indication "AUTO-pf" or "AUTO-VAR" on the LC-Display shows the actual operation mode of the additional regulator.</p> <p><i>Remark:</i> This key will only select the additional regulator. It's activation can only be carried out via the external input "additional regulator (PF / VAR) ON.</p> <p><i>Note:</i> After DC power supply loss the selection of the additional regulator shall not be lost. To ensure this, the parameter modification has to be stored ("UPD" to the right and then to the left again, see chapter 11.3.6, "Saving Settings"). A re-boot of the system is not necessary in this case.</p> <p><i>Note:</i> This command is only accepted in LOCAL position.</p>
<p>LOC REM</p>	<p>This key produces a change over for enabling operation from the User terminal on the device ("LOCAL") to operation from remote ("REMOTE") (control room, station control system, etc.) and vice versa.</p> <p>The indication "LOC" or "REM." On the LC display provides information of the state of control enabled.</p> <p>When selected to "REM." Local operation via the User terminal of the excitation system, with the exception of key "LOC/REM.", key "OFF" and alarm accept/reset via key "MENU/ENTER", see chapter 9.1, "ALARM ANNUNCIATION"; is blocked.</p> <p>Transferring to "LOC." will result in an external alarm "M excitation ALARM" to indicate restriction of the remote operating mode. This alarm function can be deactivated (please refer to chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS").</p> <p>The exclusive local point of control is for safety reasons (disconnection from the station control system) especially for test purposes and during primary tests of advantage.</p> <p><i>Note:</i> This command is accepted independent from the LOCAL/REMOTE control selection.</p>

8.1.2. Setting Parameters and Actual Values on User Terminal

Regarding password and parameter setting configuration and modification please also refer to chapter 11.3, "PARAMETER CHECKS AND -ENTRIES".

8.1.2.1 Parameter Setting Keys

The lower 16 keys are allocated for parameter functions as well as modifying regulator settings. The **ENTER** key is applied when changing from the basic display into the main menu. The **ESC** key will return you to the previous higher level main menu. Going back to the basic LC display is also carried out by operating the **ESC** key.

The ALT key will enable to enter the parameter designations in terminal mode (A, C, E, I, P, T, V, X, Y).

The SCROLL-UP, BACKSPACE, ALT-INCREMENT keys are 3-fold allocated. The BACKSPACE function is available when configuring parameter settings or entering new parameters in terminal operating mode, otherwise the SCROLL-UP key enables scrolling through the various menu items. When the ALT key is simultaneously pressed with the SCROLL-UP key the selected parameter setting value is increased.

8.1.2.2 Basic Display

During "excitation ON" conditions following basic indication is shown on the LC display:

102V	0.79A	+.85	Stator voltage, stator current, power factor
+134W	-37VAr		Generator active power, reactive power
Field: 12.3A	Alarm		Field current, flashing alarm text at alarm conditions
On Rem Auto-VAR			Status line display

During "excitation OFF" or trip conditions the measured values display is deactivated.

A '+' polarity sign at the power factor means generator overexcited, a '-' sign means generator underexcited.

A '+' polarity sign in the active power display denotes active power delivery to the system grid whereas a '-' sign active power consumption. A '+' polarity sign in the reactive power display indicates reactive power export (overexcited operation) and a '-' sign means reactive power import (underexcited operation).

After pressing the **MENU/ENTER** key the main menu, consisting of 5 menu items, will appear:

1 Alarms, Trips	2 Actual values	↑
2 Actual Values	3 Regulator Settings	
3 Regulator Settings	4 Maintenance	
4 Maintenance	5 Terminal Mode	

NOTE

Whenever the Scroll Up Symbol ↑ or Scroll Down Symbol ↓ appears scrolling through the menu items with the Scroll Up- or the Scroll Down is enabled.

By operating keys 1,2,3,4 or 5 the corresponding function is activated or the corresponding menu item called up. The **ESC** key will return you to the basic display.

8.1.2.3 Setpoints and Actual Values

Upon selection of this menu item the most important operating data of the synchronous machine are displayed in per unit values. All per unit values are referring to the nominal values of the synchronous machine (please refer to chapter 13, "PARAMETER FOR OPERATION (MEASURED- AND SETTING VALUES)").

Two values are simultaneously indicated on the display whereby 2 lines are available for each parameter. The first line gives the internal designation of the parameter (e.g. V500) and it's significance in plain text (e.g. excitation current). With the internal short text you can follow every variable according chapter 13, "PARAMETER FOR OPERATION (MEASURED- AND SETTING VALUES)". The second line shows the actual value of the variable. Since the displayed values are continuously refreshed they always represent the actual values being processed in the regulator.

By operating the Scroll key the next parameter contained in this menu item is displayed.

V500 Excit. Current +00.8995	Cursor →
V11 Gen.Vol.Ref.Val +01.0005	

The parameter setting value selected can now be raised or lowered via the **ALT-INC** or **ALT-DEC** keys.

When the selected parameter is write-protected and the correct password has not been entered yet a request for entering the password is now given. After being authorised by entering the correct password the variable can be modified as necessary (please refer to chapter 11.3.1, "Password – Write Protection").

Operating the **ESC** key will revert to the main menu.

8.1.2.4 Parameter Setting Values

When selecting the menu item **Regulator Settings** a sub-menu containing the functional units of the excitation system is entered.

```
1 Current Regulat.IF
2 Voltage Regulat.UG
3 Exc.Cur.IF-Limiter
4 Gen.Cur.IG-Limiter
```

By activating the Scroll key the next menu item is displayed.

From this sub-menu groups of functional related variables can be selected.

```
V825 Max.Ref.Val.IF
+01.2002
V826 Min.Ref.Val.IF
+00.0000
```

Modification on the now displayed variables can now be performed as outlined in menu item **Actual Values**.

8.1.2.5 Service and Maintenance

Under the item Maintenance the limiters can be activated and deactivated. The corresponding list is to be found in chapter 13, "PARAMETER FOR OPERATION (MEASURED- AND SETTING VALUES)".

8.1.2.6 Terminal Operating Mode

In this mode all parameters used by the regulator, including those not shown in other menu items, can be displayed and modified.

CAUTION

Entering and modifying parameter settings must only be performed with utmost care and after preceding rigorous checks. Incorrectly entered parameters or changing parameter setting in an unreliable way may lead to ultimate misbehaviour of the THYNE3 system!

We cannot take any responsibilities whatsoever for such incorrect entries and the resulting consequences!

By initial call of this menu item a request for entering the first parameter is followed.

```
Parameter Edit:
```

```
_
```

```
Parameter Edit:
```

```
V100_
```

By terminating the procedure via the ENTER key the parameter is displayed in the same way as outlined in menu items 2 and 3.

```
V100  
+01.0002_
```

Now further parameters can be entered which are queued behind the last respective setting displayed. Thus a list of issued parameters is created.

```
V100  
+01.2002 V109_
```

```
V100_  
+01.2002 _  
V109  
-00.0005
```

Within this list you can scroll up and down arbitrarily as well as enter new parameter denominations any time. A list of up to a maximum of 20 entries can be made. When a further parameter is added the oldest entry is deleted.

These parameters can now be altered and modified as described in chapter 11.3, "PARAMETER CHECKS AND -ENTRIES". In this position it is enabled to change all regulator parameter settings and a dangerous operating status is reached. Therefore to carry out modifications in this mode it is requested to enter the highest level of password protection.

A subsequent entry of the menu item **Terminal Mode** from the main menu will immediately access the output mode in which the parameter settings of the previously created are displayed.

8.2. REMOTE CONTROL

Remote control is enabled via the signals:

- B excitation OFF
- B excitation ON
- B excitation RAISE
- B excitation LOWER
- B excitation AUTO
- B excitation MANUAL
- B additional regulator (PF / VAR) ON

The commands

- B excitation OFF
- B additional regulator (PF / VAR) ON

are functioning either in position "LOCAL" or in position "REMOTE".

The commands

- B excitation ON
- B excitation RAISE
- B excitation LOWER
- B excitation AUTO
- B excitation MANUAL

are functioning only in "REMOTE" position.

For the description of the function in principle the same applies as with local control (chapter 8.1, "LOCAL OPERATION"), with the additions:

- **B excitation OFF:**

- a) *With selection "AUTO"*

- When selected to "AUTO" the command is only active below a minimum stator current. With a current above a minimum stator current (on-load operation) this command will not be accepted.

- b) *With selection "MANUAL"*

- When selected to "MANUAL" the command is accepted all the time. With the presence of a stator current the de-excitation contactor is opened without delay to immediately intertrip the generator circuit breaker.

- c) *A "PROTECTION TRIP" is in any case effective.*

In addition to the "OFF command" an operational switching off and de-excitation in unit on-load operation can be carried out, especially for steam- and gas turbines, by the reverse power protection by the input "Protection TRIP".

- **B additional regulator (PF / VAR) ON**

As soon one of the two additional regulators (power factor- or reactive power regulator) is locally selected the additional regulator can be activated via this input.

Activation can be performed in 2 ways:

- *impulse input:* 1. *Impulse = switching on*, 2. *Impulse = switching off*
- *continuous signal input:* *the regulator is activated as long as the command is given.*

For corresponding parameter setting please refer to chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS".

Activation and de-activation is always carried out smoothly. As soon as the additional regulator is switched on it will move to a pre-set setting value.

An signal "isolated operation" or "isolated power grid" from the turbine regulator or power station unit should result in an interruption of the selection (continuous signal input) or switching off (impulse input).

- Note:*
- This input is only functioning when an additional regulator has been selected (with key "p.f./VAR").
 - This input is also functioning "LOCAL" position.

8.3. OPERATING MODES

8.3.1. Voltage Regulator (Automatic Mode)


For shunt field excitation systems the initial excitation is switched on with the beginning of the excitation sequence and deactivated when a minimum thyristor voltage is reached.

When selected to "AUTO" the start-up sequence has been finished after reaching 80 % of rated generator voltage (factory setting 1.0 pu V_g)

In this operating mode the generator voltage is regulated to the adjusted set value. The setting range for the set value is adjusted to the permissible limits of the generator and can be viewed and changed with the User terminal in the menu **Regulator Settings** as "*Max. Reference Value U_G*" or "*Min. Reference Value U_G*" (refer to chapter 8.1.2, "Setting Parameters and Actual Values on User Terminal").

The regulator is locally brought to this operating mode with the AUTO/MANUAL key.

When the ON command is given an internal automatic sequence is executed which is first closing the de-excitation contactor. When all commands are accomplished and all feedback signals available then the "EXCITATION ON" indication is set and displayed locally and also the "M excitation ON" output activated. After completing the start-up sequence the machine is always regulating to the set "*Start Reference Value U_G*".

After the **ON** indication the voltage can be controlled either from remote or locally with the  keys. Thus in on-load operation the voltage and therefore also the reactive power is regulated.

8.3.2. Field Current Regulator (Manual Control)

a) Selection "MANUAL" with shunt field excitation:

With a shunt field excitation system the starting sequence is terminated when a minimum value of thyristor voltage is attained and the field current is then regulated to the starting value (factory setting 0.05 pu Ifn).

b) Selection "MANUAL" with external excitation:

With an external excitation system the starting sequence is ended by presence of thyristor voltage with de-excitation contactor ON and the field current is regulated to the initial value (factory setting 0.05 pu Ifn).

This operating mode is applied for test purposes as well as case of actual value loss of the voltage regulator. During on-load operation in this mode the generator values have to be permanently checked and when necessary in case of power system fluctuations or generator load changes the generator voltage respectively the reactive power controlled accordingly. Further, no limiters are active and also the additional regulator cannot be selected and activated.

The regulator is pre-selected for this operating mode via the AUTO/MANUAL key. After start-up the current regulator is regulating to the starting set value "Start Reference Value IF", the generator is excited to a value corresponding to this field current and can be brought from there on to nominal voltage with the \uparrow key.

The starting set value is factory set to 0.1 Ifn. When the excitation is changed to external excitation with the control selector switch with position "Test" (i.e. supply for the power circuit is available then the starting set value is brought to 0).

The control sequence and the start conditions are analogous to the automatic mode of operation. The setting range for the set value can be viewed and modified under option "Max. Reference Value IF" and "Min. Reference Value IF".

8.3.3. Power factor / Reactive Power Regulation

In addition to the voltage regulation feature also two higher level regulators are available (optional power factor- or reactive power regulator) in the automatic channel which are acting onto the set value of the voltage regulator. This way the regulating range of voltage regulator can never exceed or fall below the limit.

This regulator must be selected locally via the "p.f. / VAR" key. Only after setting the input "B additional regulator (PF / VAR) ON" this additional regulator will be activated.

In any case activation and de-activation will be performed smoothly. There are following possibilities:

- Activation of the additional regulator:
When activating the additional regulator by the input "B Additional Regulator (PF / VAR) ON" the regulation is according to the pre-adjusted start position. Or – as a second possibility – the setpoint is left unchanged since the last shut-down. The selection of these possibilities is done by the variable V1011 (see chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS").
- De-activation of the additional regulator:
When de-activating the additional regulator (switchover to voltage regulator) the setpoint is left unchanged on its present value.

NOTE

This additional regulator cannot operate in isolated operation but only when the generator is connected to the grid. So at generator currents $< 5\%$ Ign this regulator is blocked and the voltage regulator is active. Only at generator currents $> 5\%$ Ign the additional regulator starts acting.

Power factor regulator: If with V1011 the selection is done to the start setpoint after activation, then the power factor is regulated to the value "*Start Reference Value TAN*" (chapter 13.3.4, "Power factor / Reactive power regulator") as set in the menu **Regulator Settings** (outlined in chapter 8.1.2, "Setting Parameters and Actual Values on User Terminal").

When the regulator is activated then the setpoint of this regulator can be changed from remote or locally via the \uparrow \downarrow keys.

The setting range of the setpoint can be checked and modified under "*Max. Reference Value TAN*" or "*Min. Reference Value TAN*". All values are entered as $\tan\phi$ values, e.g. the value 1 corresponds to a load angle ϕ of 45° which is equivalent to a power factor of 0.71.

Reactive power regulator: If with V1011 the selection is done to the start setpoint after activation, then the rective power is regulated to the value "*Start Reference Value Q*" (chapter 13.3.4, "Power factor / Reactive power regulator") as set in the menu **Regulator Settings** (outlined in chapter 8.1.2, "Setting Parameters and Actual Values on User Terminal").

When the regulator is activated the setpoint of this regulator can be changed from remote or locally via the \uparrow \downarrow keys.

The setting range of the setpoint can be checked and modified under "*Max. Reference Value Q*" or "*Min. Reference Value Q*".

In isolated operation the regulator has to be switched off in any case. Deactivation of the regulator is performed via the input "B additional regulator (PF / VAR) ON" or by isolated operation software recognition (during larger frequency deviations). The frequency limits for this detection can be adjusted (see chapter 13.3.9, "Isolated Operation Detection").

In case of remote control of the additional regulator is not specified or complete operation of the excitation system is carried out via the User terminal then in order to activate the additional regulator the input "B additional regulator (PF / VAR) ON" has to be permanently connected to the voltage supply.

This can be achieved by:

- Connecting terminal -A1/X81:A1 to +24 V, preferably interlocked with the annunciation "NOT isolated operation" and "NOT isolated grid system" from the turbine regulator or the unit as well as connecting terminal -A1/X3:107 to -24 V.

Thereby, the parameter for the selection "impulse signal/continuous signal" has to be set to continuous (see chapter 11.3.6, "Saving Settings", I1017=1).

NOTE

After DC power supply loss the selection of the additional regulator shall not be lost. To ensure this, the parameter modification has to be stored ("UPD" to the right and then to the left again, see chapter 11.3.6, "Saving Settings"). A re-boot of the system is NOT necessary in this case.

8.3.4. Change Over Between the Automatic and Manual and Power factor / Reactive Power Regulation Mode

The operating modes can be changed locally:

- At standstill (generator not excited) as pre-selection.
- During operation whereby an automatic follow-up feature will ensure matching between the active and not active channel whereby at any time a smooth transfer is taking place.
- By failure of the automatic operating mode an automatic change over to manual mode is performed. This transfer is initiated upon loss of the generator voltage actual value. A transfer from manual- to automatic mode can only be performed locally by hand.
- When the "AUTO" mode is pre-selected the additional regulator can be selected locally via the "p.f. / VAR" keys. Only by activating the additional input "B additional (PF / VAR) ON" this additional regulator will be in service.
- In case the power factor- or reactive power regulator is active and it is transferred to "MANUAL" then the previous operating mode is stored and when it is changed back to "AUTO" the power factor- or reactive power regulator is active again.

When during operation the operating mode is transferred to manual then it will also remain in this state during shut down, standstill and re-start as long as the AUTO/MANUAL key of the excitation is operated.

Note: In case a transfer from manual- to automatic operating mode is blocked then possibly the generator voltage is outside the automatic regulating range.

8.3.5. Changing Between Shunt Field- and External Excitation Operating Mode With the Control Selector Switch

It can be transferred between shunt field excitation ("normal") and external excitation ("test") with operating mode control selector switch.

CAUTION

This control selector switch must only be operated in the "M excitation OFF" state. An operation during the unit being excited would immediately result in a shut down due to the internal software supervision.

8.4. DE-EXCITATION

De-excitation can be performed during normal operation or due to a protection trip. The "EXCITATION OFF" command can be given from remote or locally.

During an operational shut down first of all the thyristor will internally change into converter operation. Thus the energy stored in the field is dissipated and the de-excitation contactor opened with a time delay and therefore for it's main contacts under no-load conditions.

During an external protection trip as well as an internal forced shut down the de-excitation contactor is directly and immediately operated and a follow-up of the control circuits is carried out.

9. MAINTENANCE AND TROUBLE SHOOTING

9.1. ALARM ANNUNCIATION

9.1.1. General and Accepting/resetting

CAUTION

Opening the THYNE3 device and working in the THYNE3 system under voltage is dangerous and therefore strictly prohibited until all supplies have been switched off.

The more important components which are catering for correct operation and provisions for safety are partly supervised by electrical contacts or monitored via the software.

Each abnormal condition in the excitation system is indicated on the LC display and depending on it's cause and importance will produce an alarm annunciation, a trip or a transfer of operating mode. A common external annunciation for alarm and trip is included in the system.

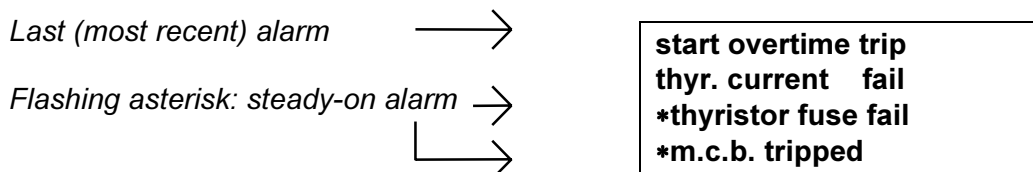
The alarm menu is accessed by either pressing **MENU/ENTER** or by operating any of the number keys.

Each alarm annunciation is displayed by a text line, yet a fault can also initiate several annunciations thus providing additional information of the occurring fault condition (e.g. "voltage actual value failure" and "mcb trip alarm").

A flashing * asterisk on the left of the annunciation indicates an alarm status which can only be reset once the fault has disappeared. It could also happen that a fault is cancelled by a shutdown and reoccurs when starting up again (e.g. a missing actual value, an excessive operating sequence runtime, etc.).

The order of the annunciation corresponds to the time sequence of the faults occurring and is independent from the alarm being either steady-on or gone. The uppermost line represents the most recent alarm.

Example:



By operating the scroll down key the earlier alarms occurred are displayed.

It is recommended that at each fault displayed to refer to the following fault check list, to find and rectify the cause to exchange a possibly faulty component.

Have all LED's on the MRB2/MRB3 module gone out then the power supply has failed and also the User operating unit cannot provide information anymore. In this case the watchdog facility will trip the de-excitation contactor and initiate an external alarm.

NOTE

When changing to "LOCAL" control an external annunciation is given, i.e. "M excitation alarm" to point out the restricted external operation control. This alarm is locally NOT indicated!

This alarm function can be suppressed if desired (please also refer to chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS").

9.1.2. List of Possible Alarm Annunciations

901 start overtime trip	919 thyristor volt. fail	523 PIM0-B program stop
902 stop overtime trip	920 thyr. current fail	524 PIM0-C program stop
903 volt. sensing fail	944 gen. short circuited	525 PIM0 communic.error
904 field breaker fail	949 invalid parameter	526 PIM0 proc. A,B fail
906 AC supply fail	520 PIM0 man.gate contr	527 PIM0 proc. C fail
914 speed < trip	522 PIM0-A synchr. fail	
918 rotating diode fail	521 PIM0-A program stop	

9.1.3. Detailed Specification

901 Start overtime trip	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Runtime supervision (internal software logic).</p> <p><i>Cause:</i> Excessive starting time during start-up sequence; Initial excitation voltage missing; Malfunctioning of a relay or contactor; Malfunction of module IVN3 inputs or outputs; Malfunction of de-excitation contactor; Missing feedback signal.</p> <p><i>Measures:</i> Check all voltage supplies; Check inputs and outputs of interace relays; Check contactors and feedback signals.</p>
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902 Stop overtime trip	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Runtime supervision (internal software logic).</p> <p><i>Cause:</i> Excessive starting time during shut down sequence; Malfunctioning of a relay or contactor; Malfunction of module IVN3 inputs or outputs; Missing feedback signal.</p> <p><i>Measures:</i> Check all voltage supplies; Check inputs and outputs of interface relays; Check contactors and feedback signals.</p>
903 Volt. sensing fail	<p><i>Result:</i> Transfer to MANUAL when AUTO mode; Alarm when in MANUAL mode.</p> <p><i>Supervised:</i> Internal software logic;</p> <p><i>Cause:</i> Loss of VT voltage during operation; VT mcb trip; Generator VT or interposing VT fault; Disruption of actual value circuit.</p> <p><i>Measures:</i> Check VT and VT-wiring; switch on VT mcb; slowly raise voltage in manual mode and measure generator voltage(also internal variable UGK V501 – see chapter 13.3, "PARAMETER"); Change back to AUTO mode.</p>
904 Field breaker fail	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Position indication circuit of field breaker; Additional information to runtime supervision.</p> <p><i>Cause:</i> Fault in the field breaker ON/OFF control circuit; Malfunction of field breaker; Start overtime or stop overtime time trip; Field breaker switched off during operation; Fault in the position indication circuit; Missing feedback signal.</p> <p><i>Measures:</i> Check all voltage supplies; Check field breaker and ON/OFF circuits; Test trip circuits; (field breaker can also be manually de-latched); Check mechanical functioning of de-latching.</p>
906 AC supply fail	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Internal software logic or fuse -F01 or mcb -F05 trip.</p> <p><i>Cause:</i> Gate control set cannot synchronise impulses; Lack of thyristor voltage during operation; Thyristor fuse -F01 trip; Regulator mcb -F05 trip (regulator supply); Excitation transformer HV fuse blown; Control selector switch S01 selected to 0 position; Short circuit or overload of 3-phase circuits.</p> <p><i>Measures:</i> Switch on mcb or replace fuse; Check excitation transformer or regulator transformer; Check thyristor fuse -F01; Check power supply cables.</p>

916 Speed < trip	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> internal software logic – frequency supervision.</p> <p><i>Cause:</i> Speed drops below 90 % of nominal speed; ON command was given at too low speed; ON command was given at not running generator;</p> <p><i>Measures:</i> Raise generator speed.</p>
918 Rotating diode fail	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Software monitoring (evaluation of field current higher harmonics).</p> <p><i>Cause:</i> Short- or open circuit of rotating diode.</p> <p><i>Measures:</i> Check flywheel diodes rectifier in rotor circuit; Replace defective parts.</p> <p><i>Note:</i> When fault occurs during normal operation without any diode fault then the trigger value for diode failure supervision has to be increased a little.</p>
919 Thyristor volt. fail	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Internal software logic - additional information to run-time supervision.</p> <p><i>Cause:</i> Start-up overtime; After starting AC thyristor voltage is not established; Thyristor fuse -F01 blown; Station supply too low or not available (at external excitation); Initial excitation voltage too low or not available.</p> <p><i>Measures:</i> Measure station supply voltage; Check supply fuses; Check thyristor fuses -F01; Check initial excitation circuit; Check matching transformer; Check power supply cable.</p>
920 Thyr. current fail	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Internal software logic - additional information to run-time supervision.</p> <p><i>Cause:</i> Start-up overtime; After starting thyristor current is not established; Thyristor fuse -F01 blown; Initial excitation voltage too low or not available.</p> <p><i>Measures:</i> Check initial excitation voltage and supply fuses; Check thyristor fuses -F01; Check initial excitation circuit; Check matching transformer; Check power supply cable.</p>
944 Gen. short circuited	<p><i>Result:</i> Trip</p> <p><i>Supervised:</i> Internal software logic.</p> <p><i>Cause:</i> Stator current rising during initial excitation; Generator terminals are short circuited.</p> <p><i>Measures:</i> Check generator busbar.</p>

949 Invalid parameter	<i>Result:</i> Trip <i>Supervised:</i> Software monitoring. <i>Cause:</i> No valid parameter set in EEPROM processors. <i>Measures:</i> Load and save BIN-file or change MRB2/MRB3 module.
520 PIM0 man.gate contr	<i>Result:</i> Alarm <i>Supervised:</i> Internal software logic. <i>Cause:</i> Switch HST on PGS3 module set to 1. Gate control is switched to manual operation, regulator is disabled! <i>Measures:</i> After finalising tests change switch back again.
522 PIM0-A synchr. fail	<i>Result:</i> Trip <i>Supervised:</i> Software; Additional information to 3-ph. supply failure <i>Cause:</i> Grid regulator unable to synchronise impulses ; <i>Measures:</i> Refer to "3-ph. supply failure"; Check and measure voltages on regulator supply transformer T05; Check plug-in connector PGS3 - IWN3
521 PIM0-A prog.stop 523 PIM0-B prog.stop 524 PIM0-C prog.stop 525 PIM0 comm.error 526 PIM0 proc. A,B f. 527 PIM0 proc. C fail	<i>Result:</i> Alarm or trip, depending on type of failure <i>Supervised:</i> Internal software logic <i>Cause:</i> Defective circuit on PGS3-module, or communication with the main processor module MRB2/MRB3 failed. <i>Measures:</i> Replace PGS3-module.
NO LOCAL ANNUNCIATION, HOWEVER A PERMANENT TRIP	<i>Result:</i> Trip; external annunciation <i>Supervised:</i> Regulator watchdog. <i>Cause:</i> Regulating supply failure; Microprocessor stopped, therefore no alarm indication . <i>Measures:</i> Check regulator supply
NO LOCAL ANNUNCIATION, HOWEVER A PERMANENT ALARM	<i>Result:</i> Alarm; external annunciation. <i>Supervised:</i> Software. <i>Cause:</i> Manually change over to LOCAL. <i>Measures:</i> None; however should alarm at transfer be not required this function can be suppressed (please refer to chapter 11.2, "LIST OF THE CONFIGURATION PARAMETERS").

9.2. FAULTFINDING

NOTE

In case of a fault it sometimes helps when all procedures outlined in chapter 12, "COMMISSIONING" are carried out step by step and possibly re-calibration is performed.

Check whether the THYNE3 device is selected to voltage regulation mode (AUTO) and not to MANUAL since the latter operating mode only regulates the field current and not the generator voltage.

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
Generator voltage not being established	Voltage supply for initial excitation not connected	Connect voltage supply for initial excitation to terminals -A1/X2:20, 21 (possibly with series resistor)
	Regulator selected to "MANUAL" operating mode	Change regulator to "AUTO" mode
	De-excitation contactor in open position	Check control circuits (as outlined further below)
	Unit not on nominal speed	Raise speed to nominal
	No- or no voltage on terminals -A1/X11:2, 4, 6	Check fuses, wiring and rating of power transformers
	No connection between THYNE3 and field of exciter machine	Check wiring
	Generator output short circuited or heavily overloaded	Remove overload or short circuit
Generator voltage only 2...3 % of V _{gn}	Thyristor fuses not inserted or blown	Check nominal value and insert fuse
	Exciter machine or rotating diode wheel faulty, open circuit in rotor	Shut down unit and measure diodes of exciter machine, otherwise contact generator manufacturer
	Regulator selected to "MANUAL" operating mode	Change regulator mode to "AUTO"

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
Terminal voltage is rising to approx. 80 % V _{gn} and falls back again	After initial excitation the thyristors do not take over the field current because of:	
	Thyristors faulty	Check thyristors: G-C circuit: R=5...100R C-A circuit: R>100K (+) and (-)
	Thyristor fuses not inserted or defect	Check fuse rating and insert fuses
Terminal voltage too high and uncontrollable	No firing impulse on thyristors	Regulator module PGS3 does not produce impulses, therefore replace module
	No actual value on terminals - A1/X5:151, 152, 153	Check wiring
	Actual value mcb open position	Close actual value mcb
	Actual value circuit connected to wrong voltage	Check VT rating and wiring
Terminal voltage is not exactly rising to nominal voltage	Voltage set value not calibrated correctly	Re-calibrate voltage set value properly (NormUg V813)
	Thyristors faulty, continuous firing	Check thyristors: see preceding page
Terminal voltage too high or too low but controllable	Parameter for start-up set value incorrectly adjusted	Set parameter for start-up set value SWAU V827 to 1,0
Terminal voltage too low but controllable	Actual value circuit connected to wrong voltage	Check VT rating and wiring
	Voltage set value calibrated not correctly	Adjust voltage set value properly (NormUg V813)
Terminal voltage too low but controllable	Unit not on nominal speed, additional frequency control is operating prematurely	Adjust speed to nominal value
	Regulator selected to "MANUAL" mode	Change regulator to "AUTO" mode of operation

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
Inaccurate or slow regulation	According to the machine data required excitation voltage at full load is larger than the maximum THYNE3 output voltage; Field section connected in series	Check design and/or contact VA TECH HYDRO / dept. CC-SE
	Regulator not optimised	Optimise regulator
	Fault in generator, excitation machine or the rotating diode wheel, increased field current	Shut down unit and check diodes; replace if necessary
	Reactive power static (BSTAT V831) not in 0 position (only recognised in isolated operation, is all right for system on-load operation)	Does not represent a fault since for stability when operating in parallel to the grid a reactive static is required (either natural transformer static and or static of voltage regulator). Accuracy can be enhanced by varying static into 0 direction (caution! A machine with a too low static will be unstable in on-load operation).
	Generator unit not on nominal speed	Adjust to nominal speed
Terminal voltage excessive overshoot during start-up	Thyristor fault in power circuit	Measure thyristors as outlined before
	Soft-Start parameter not properly adjusted	Set parameter for Soft-Start properly (see chapter 13.3.3, "Soft-Start")
Terminal voltage oscillates	Frequency unstable	Optimise turbine regulator, fault not within excitation system

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
Terminal voltage oscillates (continued)	System voltage oscillation due to loading or unloading high consumers	Represents no fault since the consumers are causing voltage dips or raise when connected or disconnected which only can subsequently be compensated by the voltage regulator. Oscillations can possibly be reduced by raising the reactive static from 0 further to negative direction (BSTAT V831) or varying VPU V872
	Intermittent fault in generator, in exciter machine or in diode wheel	Shut down unit and check diodes of the exciter machine, otherwise contact the machine manufacturer
When connected in parallel to the grid system no reactive load static can be attained (reactive current is running off) or the voltage regulator is responding too violently on small system changes or when operating in parallel with other units the reactive power distribution is oscillating	Reactive power static (BSTAT V831) set too low or to 0	Increase reactive power static from 0 into negative direction (BSTAT V831)
	Static CT or VT actual value not connected to the correct phases or wrong polarity	Check wiring and correct if necessary. With single phase measuring the CT has to be located in the phase which is not used for voltage measuring
	Static CT polarity not correctly connected or even still short circuited	Check wiring and CT terminal strips Check and calibrate active- and reactive power to a value and polarity according to chapter 13.3.2, "Voltage Regulator"
	CT ratio incorrect (at unit rated current app. 1 A should be flowing into the terminals -A5/X5:156,157 and app. 1 A should come out of the terminals 356,357 or app. 5 A out of the terminals 256, 257)	Check CT ratio. When not correct replace CT

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
Reactive power sharing not equal but stable	Reactive power static (BSTAT V831) not equally set on units operating in parallel	Check setting and equally adjust reactive power static (BSTAT V831)
Power factor / reactive power regulator is deactivated on it's own	Internal software monitoring detects isolated operation due to excessive frequency variations	Increase limits for permissible frequency deviations (V806, V807), also please refer to chapter 13.3, "PARAMETER"
Unable to control THYNE3 device	System is selected to "REMOTE"	Change operating mode to "LOCAL"
Some control functions cannot be executed	Some inputs or outputs faulty	Replace module IWN3
	User terminal defect	Replace User terminal
Diode failure supervision is activated during normal system operation	Fault in rotating diode wheel	Shut down unit and check diodes of excitation machine, otherwise contact the machine manufacturer
	If diodes are in order:	Increase trip setting (V1003) (see chapter 13.3, "PARAMETER")

9.3. FAULTY PRINTED CIRCUIT CARDS

When the digital system is running, on the pcb MRB2/MRB3 following LED's must be active:

RUN, HWOK, POWER (RESET, UPD, and REM must not be active or flash)

If one of the LED's is not active, then each of the cards can be the reason for this. By change of the individual cards the defective card can be fixed.

If spare cards are delivered, then these spare cards are identical with the cards in operation. That means, they have installed the same software, parameters and jumpers. Nevertheless before changing a card an optical check should be performed:

- Is there a visual mechanical or electrical damage?
- Do all jumpers match with the original card?
- Do all switch positions (f.e. DIP switches) match with the original card?
- Can you conclude from different EPROM labels to different program versions?
- Do the IC equipment match with the original card (especially EPROM's)?

Each pcb is fixed by screws on the front plate (top and bottom screws). To pull out and to plug in a card the voltage supply must be switched off (the best is to switch off the).

CAUTION

Switching off the mcb -A1-F06 results in every case in a trip of the excitation!

After change of the card and restoration of the operation conditions (fix all plugs and screws) the voltage can be switched on again by operation the mcb.

If all card are ready, then after switching on the voltage supply the LED "POWER" on the MRB2/MRB3 card must be active. After an initialisation time of the MRB2/MRB3 card of approx. 8 sec. the LED's RUN and HWOK must become active. Then the THYNE3 is ready for operation again. The user terminal needs (approx.) 8 sec. more for readiness of indication and commands.

If not so, then the replaced card was not the reason for the failure and faultfinding resp. changing of cards must be continued.

After replacement of a card we recommend to perform a complete start/stop procedure of the excitation until reaching nominal voltage of the generator. During this sequences the function of the excitation shall be observed.

9.3.1. Change of the pcb MRB2/MRB3

At replacement of the MRB2/MRB3 card only the above described procedure has to be observed. After plug in don't forget to fix the screws.

9.3.2. Change of the pcb PGS3

Pull out the card PGS3 for approx. 2 cm. Afterwards pull off both flat cables (connection to IWN3). Then the card PGS3 can be pulled out completely.

The plug in has to be performed in reverse sequence (including fixing both flat cables). After plug in don't forget to fix the screws.

9.3.3. Change of the pcb IWN3**Pull out of the pcb:**

- First pull out the card PGS3 for approx. 2 cm.
- Afterwards pull off both flat cables (connection to IWN3).
- Remove all external plugs on the IWN3.
- Remove the following wires (connections of CT circuits between IWN3 and terminal strip) at the terminal strip and pull them through the mounting panel (the wires are marked with ferrules).
 - A1/X1:1 and 5
 - A1/X5: 156, 256, 356, 157, 257, 357
- Then the card IWN3 can be pulled out completely.

Plug in of the pcb:

- Plug in the card IWN3 to an extension of approx. 5 cm.
- Lead the wires (CT circuits) through the mounting panel.
- Fix plugs X50 and X51 on IWN3.

- Plug in the card IWN3 completely.
- Fix all other plugs on IWN3.
- Reconnect the following wires (CT circuits) on the terminal strip (internal side):
 - A1/X1:1 and 5
 - A1/X5: 156, 256, 356, 157, 257, 357
- Fix again flat cable plugs on the card PGS3.
- Plug in the card PGS3.
- After plug in don't forget to fix all screws.

9.4. PERIODIC MAINTENANCE

With the exception of relays and contactors there are no other moving parts in the excitation and therefore the system can be referred to as being almost maintenance-free. The equipment should be cleaned at regular intervals, the terminal connection checked and tightened if necessary.

It is recommended that a periodic inspection of the de-excitation contactor and the initial excitation is carried out approximately once a year. The mechanical and electrical functions can be tested at standstill by pressing the ON key (an external command must not be activated). After approximately 2 second a "speed < trip" is initiated by the internal supervision.

10. INSTALLATION

CAUTION

- 1) Insulation- and high voltage tests can internally be done only by the power circuits. Improper application can severely damage semiconductors or solid state modules of the THYNE3 device!
- 2) Assembling of the THYNE3 device and the external components must be carried out very careful with due consideration of the technical data of the synchronous generator and the CT's and VT's. Even short operation with incorrect connections may destroy the excitation equipment.

All necessary components have to be designed according to chapter 7, "ENGINEERING DESIGN, AND DIMENSIONING". Assembling and integration into the plant is to be done according to chapter 7.2, "INTERFACE OF THE THYNE3 DEVICE".

10.1. INSTALLATION OF THE HV EXCITATION TRANSFORMER

CAUTION

The HV excitation transformer must be installed by authorised personnel only according to the relevant standards for high voltage equipment.

We recommend to install the excitation transformer into a closed high voltage cubicle to avoid endangering personnel by flying parts in case of heavy internal transformer faults.

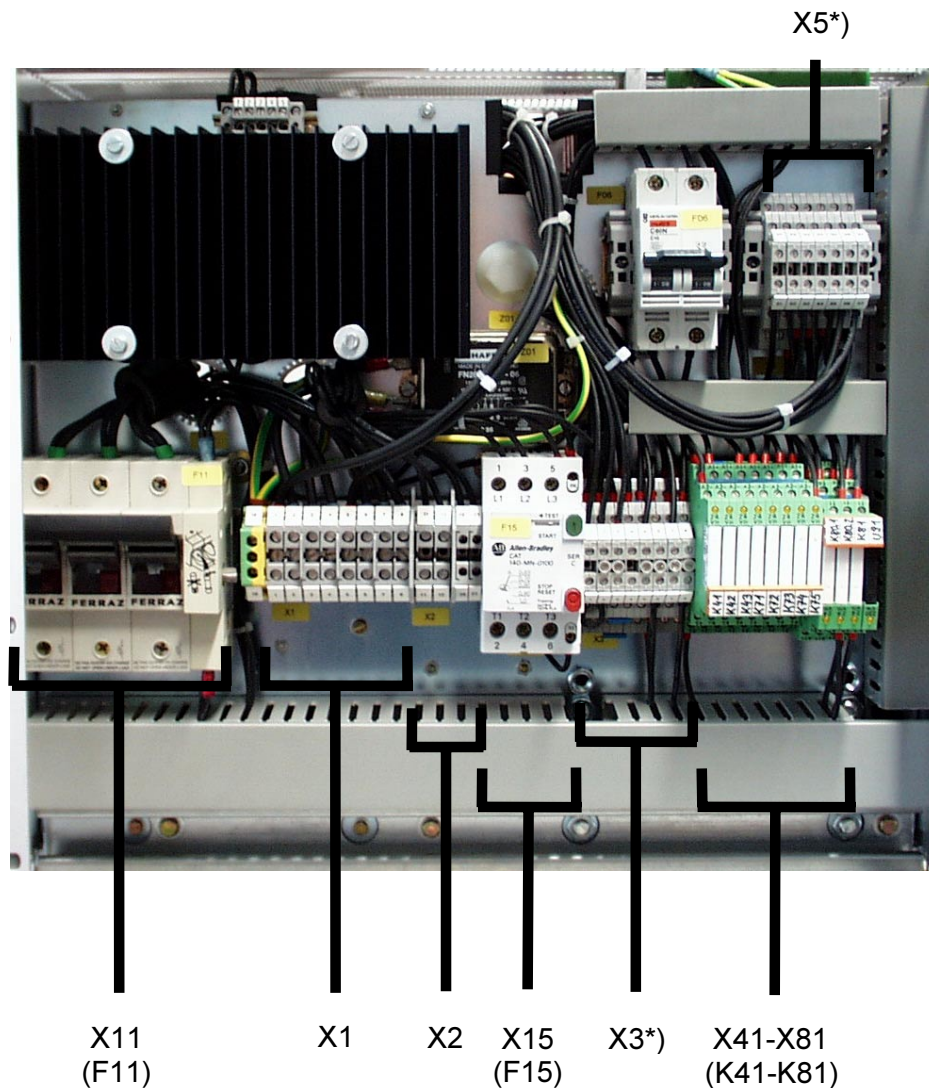
10.2. MOUNTING THE THYNE3 DEVICE

The THYNE3 device can either be installed on a swing frame with 19" racks or, with a corresponding panel cut out, mounted into a control board. The installation has to be such that the device can be operated from the front and that the terminals and mcb's are accessible from the rear.

The THYNE3 device can be supplied loose or with all options completely mounted in a cubicle, wired up and factory tested (additional charge).

The THYNE3 device as well as all other corresponding devices is naturally cooled and should not be mounted in the vicinity of heat producing equipment or installed in such enclosed cubicles where the ambient temperature is exceeding the maximum permissible operational temperature. For optimum cooling and the User interface only vertical installation is permitted.

10.3. VIEW OF THE TERMINAL ARRANGEMENT



Note: *) Terminals 101 - 199: top level
 Terminals 201 - 299: medium level
 Terminals 301 - 399: bottom level

Terminal strips X11, X1, X2, X15, X3, X41-X81 are to be connected from below.
 Terminal strip X5 is connected from above. The cables are placed in the upper and right hand side cable duct.









10.4. INSTALLATION OF THE REMAINING COMPONENTS

All other low voltage components are to be mounted and wired according to the corresponding circuit diagrams. For installation the same regulations are applicable as for the THYNE3 device.

11. PRE-SETTINGS FOR COMMISSIONING

11.1. SWITCHES ON MRB2/MRB3 MODULE

The DIP switches on the front plate of the MRB2/MRB3 module have always to following positions (for parameter setting as well as for operation). Merely for loading a modified parameter into the EEPROM switch 7 (UPD) has to be positioned to the right and afterwards to the left again (when the UPD-LED is dark again; please also refer to chapter 11.3.6, "Saving Settings").

OUT EN	1		N O R M
AUTRES	2		
AUTSTA	3		
NOQUIT	4		
LOCAL	5		
HW EN	6		
UPD	7		
RAM WE	8		

11.2. LIST OF THE CONFIGURATION PARAMETERS

Following parameters are required for configuration and have to be verified and if necessary corrected before commissioning.

Testing and setting is carried out via the User terminal in terminal operation mode (please refer to chapter 8.1.2.6, "Terminal Operating Mode").

NOTE

After parameter modification these data have to be stored ("UPD" to the right and then to the left again, see chapter 11.3.6, "Saving Settings"). The system has to be re-booted to make the changed parameters effective.

Booting is performed by switching the supply voltage on off and on again via mcb –F06. For correct operation all specified signals have to be wired up!

Text	Variable	Function	Factory setting	act. value
With this variables it can be determined whether a change from "REMOTE" to "LOCAL" control will initiate an alarm	I1016=0: I1016=1:	No alarm at change over Alarm at change over <i>Name of I1016: Alarm/Umsch.</i>	I1016=1	
With this variables it can be determined whether the ON command for the additional regulator is performed with an impulse (1. Impulse = switch ON, 2. Impulse = switch OFF) or interpreted as continuous signal (additional regulator is switched ON as long as the signal is activated)	I1017=0: I1017=1:	Impulse signal Continuous signal <i>Name of I1017: B_ZR Dauer</i>	I1017=1	
With this variables the number of phases of the thyristor voltage is determined. <i>Note.: the normal version of the THYNE3 is with three phase operation. Single phase operation is provided by a special model</i>	V1000	0.0005 Single phase op. 0.0015 Three phase op. <i>Name of V1000: 1/3PHASsyn</i>	0.0015	
With this variables the number of phases of the actual value measuring is determined. (also refer to chapter 7.2.8, "CT / VT and Actual Measured Value Connections")	V1001	0.0005 Single phase mach. 0.0015 Three phase machi. with 3-ph. measure 0.0020 Three phase mach. with 1-ph. measure <i>Name of V1001: 1/3PHASg</i>	0.0015	
With this variables the frequency of the exciter machine (for diode fail supervision) is configured	V1002	Frequency/100 f.e.: 100 Hz: V1002=1.0 <i>Name of V1002: RESFBP</i>	1.0 (100 Hz)	
Setting parameter for User terminal: field current	V1004	Setting according to chapter 11.4, "CALIBRATION OF LC-DISPLAY" <i>Name of V1004: scale If</i>	0.1221 (25 A)	
Setting parameter for User terminal: generator power	V1005	Setting according to chapter 11.4, "CALIBRATION OF LC-DISPLAY" <i>Name of V1005: scale Pg</i>	0.4883 (100 W)	

Text	Variable	Function	Factory setting	act. value
Setting parameter for User terminal: generator current	V1006	Setting according to chapter 11.4, "CALIBRATION OF LC-DISPLAY" <i>Name of V1006: scale Ig</i>	0.0049 (1 A)	
Setting parameter for User terminal: generator voltage	V1007	Setting according to chapter 11.4, "CALIBRATION OF LC-DISPLAY" <i>Name of V1007: scale Ug</i>	0.4883 (100 V)	
Language	V1008	0.0000 German 0.0005 English 0.0010 Spanish <i>Name of V1008: Sprache</i>	As ordered	
Setting parameter for the thyristor voltage frequency	V1009	3.75 for 16 2/3 Hz 1.25 for 50 Hz 1.0415 for 60 Hz 0.1563 for 400 Hz <i>Gen. formula: V1009=62,5/f</i> <i>Name of V1009: NORMFSYN</i>	As ordered	
Setting parameter for die generator voltage frequency	V1010	3.75 for 16 2/3 Hz 1.25 for 50 Hz 1.0415 for 60 Hz <i>Gen. formula: V1009=62,5/f</i> <i>Name of V1010: NORMFG</i>	1.25	
With this variables it can be determined whether after activation of the additional regulator the setpoint is according to the start value or according to the last setpoint after de-exctitaion or after switching off the additional regulator	V1011	0.0000 last setpoint 0.0010 start setpoint <i>Name of V1011: ANFQ_SEL</i>	0.000	
Delay time for switching off the filed breaker in the main rotor circuit: If an external field breaker in the <u>main rotor circuit</u> is used, then the delay time for switching off without current has to be increased up to 5 sec.	V956	0.02 = 2 sec. 0.05 = 5 sec. <i>Name of V956: Tverz_OFF</i>	0.02	

- ➔ After completion store parameters ("UPD" to the right and then again to the left) (please refer to chapter 11.3.6, "Saving Settings").
- ➔ After that re-boot the system in order to make the set parameters effective. System booting is carried out by switching the power supply OFF and then ON again via mcb -F06.

11.3. PARAMETER CHECKS AND -ENTRIES

11.3.1. Password – Write Protection

To each variable of the digital system a corresponding access level protection is assigned. There are altogether 4 write protection stages.

Level 0	No write protection
Level 1	Write authorisation with password 1
Level 2	Write authorisation with password 2
Level 3	Write authorisation in terminal mode only with password 2

At the first attempt to modify a variable of protection level 1 or 2 it is requested to enter the appropriate password. The regulator itself contains 2 passwords. When the entered password corresponds with password 2 stored in the regulator the User is authorised to modify variables of the level 1 and 2.

When the entered password corresponds with password level 1 the User is authorised to access variables of the 0 and 1 level. On the attempt to modify a level 2 variable the indication '**read only**' is displayed in any case.

When the entered password doesn't correspond with either one stored only write authorisation 0 can be attained. In addition the User is again requested by any further attempt to modify a variable level 1 and 2 to enter the appropriate password.

Level 3 variables can only be modified in **Terminal Mode**. Any attempt to alter a level 3 parameter in **Set-Actual Value Operation** or in **Parameter Setting Mode** will result in a '**read only**' output without any password enter request.

In **Terminal Mode** all variables to be edited have level 3 write protection (please refer to chapter 8.1.2.6, "Terminal Operating Mode").

11.3.2. Changing the Password

When the entered password corresponds to password 2 then both passwords are displayed immediately after the entry is made enabling the User to change both of them. When the entered password conforms with password 1 it is possible to modify this one.

The password numeric range lies between 0 and 65535.

A new password setting must then be transferred from the MRB2/MRB3-RAM memory to the EEPROM of the MRB2/MRB3 module otherwise it would get lost by a system re-boot. The copying process is performed by moving DIP switch 7 ("UPD") to the right position ("NORM"). After storage DIP switch 7 is returned to its original position in order to prevent saving of unintentional modified data (please refer to chapter 11.3.6, "Saving Settings").

NOTE

On delivery of the regulator always both passwords are set to '0'. At the first attempt to modify a write protected variable of level 1 or 2 a password entry is requested. By entering '0 ENTER' both passwords are displayed and the User can now select and store the desired passwords.

Leading zeroes are ignored when entering the password!

11.3.3. Parameter Modification

To change a parameter setting available in the menu it has to be selected by the cursor in the corresponding line. The value of the selected parameter can now be increased by means of the key combination **ALT-INC**, or decreased by means of the key combination **ALT-DEC**, or else, a new value can be entered.

When the selected parameter is write protected and when the corresponding password has not yet been entered, the User is requested to enter a password. When entry of the password enables writing the variable may be modified as desired. With no write authorisation the message '**Read Only**' appears whenever an attempt is made to modify a variable or another request appears, i.e. to enter the password.

11.3.4. Direct Parameter Entry

All analog variables of the regulator, i.e. the variables designated P, V, X and Y, have a valid numerical range from -16.0000 to +15.9995. The applicable values for the digital variables A, C, E and I are 0 and 1. Variables with the designation T and in the service menu also variables denominated with V represent internal constants of the regulator with a range from 0 to 65535.

If a new parameter value is entered directly it is transmitted to the regulator once the ENTER key and deleted from the display. During entry the edited characters can be deleted again by means of the SCROLL UP / BACKSPACE keys. The ESCAPE key removes all entered characters.

If the entered value is beyond the applicable range of values then the regulator sends an error message which is displayed on the terminal. The regulator only accepts values within permissive range of values. During the next program cycle on the terminal, the up-to-date value is read out and displayed. The displayed value represents the entered value with a possible rounding error due to the binary notation of the regulator. Internal transfer parameters will be overwritten by the regulator program and cannot be modified.

11.3.5. Parameter Modification With ALT-INC and ALT-DEC Keys

The selected parameter can be modified directly by means of the ALT-INC and ALT-DEC keys. In this case the terminal increments or decrements the present parameter value by a certain amount (step) within the setting range as long as the keys are actuated. Starting with the smallest step that the regulator can display, i.e. 0.0005 for analogue parameters and 1 for T variables, the step is gradually increased depending for how long the key is pressed.

If the selected value does not change when pressing the keys ALT-INC or ALT-DEC, then the value is an internal transfer parameter which the regulator program overwrites immediately.

Digital variables cannot be changed with the ALT-INC or ALT-DEC keys.

11.3.6. Saving Settings

All modifications of parameters described above have so far only been stored in the working memory of the MRB2/MRB3 board and are therefore lost during a subsequent system re-boot.

When the set values are to be stored permanently they must be copied from the RAM memory of the MRB2/MRB3 module into the MRB-EEPROM. To do so DIP switch 7 ("UPD") on the MRB2/MRB3 module must be moved to the right (NORM position) and the changes are now automatically saved in the EEPROM. During saving the LED UPD is flashing. When this LED is dark again the DIP switch has to be returned to its original position, i.e. to the left, in order to avoid any unwanted overwriting of the EEPROM.


11.4. CALIBRATION OF LC-DISPLAY

In order that the measured value shown on the LC display correspond with the actual physical ranges have to be calibrated. Calibration is carried out in a way that the entered value according to the instructions below is corresponding to the 1 pu value of the variable.

The representation of the calibration parameter is based on a diminished floating point format whereby the last digit of the parameter is interpreted as exponent and the first four as mantissa.

The corresponding variable is computed with the computing format, a 5-digit integer number. For the input into the User terminal it has to be converted to the entry format (decimal point in format +00.0000).

Format: XXXXE



e.g.: V1005 = 01006 (computing format): 100*10E6 = 100 MW
 V1005 = 00103 (computing format): 10*10E3 = 10 kV

Largest value of mantissa: 6553

Largest value of exponent: 6 (above values are not considered).

Following calibration parameters and actual values are used:

	Actual value	Calibration parameter
Generator voltage	V501	V1007
Generator current	V503	V1006
Active power	V574	V1005
Reactive power	V65	V1005
Field current	V500	V1004

Converting the computing format (CF) into entry format (EF):

$$0 \leq V(CF) \leq 32767: V(EF) = V(CF) / 2048 \quad (V \text{ with positive sign})$$

$$32768 \leq V(CF) \leq 65535: V(EF) = V(CF) / 2048 - 32 \quad (V \text{ with negative sign})$$

Example: $V(RF) = 1006 \Rightarrow V(EF) = 0.4912$
 $V(RF) = 40004 \Rightarrow V(EF) = -12.4668$

Note: After the decimal point there must be 4 digits whereby the last digit is rounded (from 0, i.e. with negative integers rounded to negative: $-12.46679 \Rightarrow -12.4668$)

Output Format:

The terminal is operating with 2 output formats, which are specified in the terminal text file.

Format 1: 4 digits, including decimal point: only negative sign is issued.

Format 2: 4 digits, including decimal point: correct sign is always issued.

The choice of the exponents influences the number of digits after the decimal point. The number of digits before the decimal point is fixed. There are always 4 digits produced including zeroes before the point. In case of an overflow the output will exceed 4 digits.

Entering kVA Ratings:

Machine nominal rating	V1005 (CF)	Output format
<2 kVA	XXXX0	+yyyy VA
2...20 kVA	XXXX1	+yy.yy kVA
20...80 kVA	XXXX2	+yyy.y kVA
80 kVA...2 MVA	XXXX3	+yyyy kVA
2...20 MVA	XXXX4	+yy.yy MVA
20...80 MVA	XXXX5	+yyy.y MVA
80...6553 MVA	XXXX6	+yyy MVA

Example: $S_{nom}=40 \text{ MVA}$: $V1005(RF) = 40004$ Output at P_{nom} : +40.00 MW
 $V1005(RF) = 04005$ Output at P_{nom} : +040.0 MW
 $V1005(RF) = 00406$ Output at P_{nom} : +040 MW

Example THYNE3: $S_{nom}=100 \text{ VA}$: $V1005(RF) = 01000$ Output at P_{nom} : 100 W
 $V1005(EF) = 0.4883$

Entering Voltages:

Machine nominal votage	V1007 (RF)	Output format
<6553 V	XXXX0	Yyyy V
<8 kV	XXXX1	(y)y.yy kV
>8 kV	XXXX2	yy.y kV

<u>Example:</u> Vnom =8 kV:	V1007 (RF) = 08001	Output at Vnom: 8.00 kV
	V1007 (RF) = 00802	Output at Vnom: 08.0 kV
<u>Example THYNE3:</u> Vnom=100 V:	V1007 (RF) = 01000	Output at Vnom: 100 V
	V1007 (EF) = 0.4883	

Entering Currents:

Stator-/ Field nominal current	V1004, V1006 (RF)	Output format
$I \leq 10 \text{ A}$	XXX8	y.yy A
$I \leq 25 \text{ A}$	XXX9	yy.y A
$I \leq 300 \text{ A}$	XXXX0	(y)yyy A ($I > 50 \text{ A}$) (y)yy.y A ($I < 50 \text{ A}$)
$I > 300 \text{ A}$	XXXX0	Yyyy A
$I > 1000 \text{ A}$	XXXX1	y.yy kA

<u>Example:</u> Inom=1000 A:	V1006 (RF) = 01001	Output at Inom: 1.00 kA
	V1006 (RF) = 10000	Output at Inom: 1000 A
	V1006 (RF) = 10000	Output at Inom: 1000 A

Example THYNE3: Inom=25 A: V1004 (RF) = 00250 Output at Inom: 25.0 A
 V1004 (EF) = 0.1221

Inom=13,5 A: V1004 (RF) = 01359 Output at Inom: 13.5 A
 V1004 (EF) = 0. 6636

Inom=8,5 A: V1004 (RF) = 08508 Output at Inom: 8.5 A
 V1004 (EF) = 4.1543

Note: For currents < 50 A a digit after the decimal point is produced.
(y).... 'Overflow', can also be applied intentionally.
For values > 1000 A optionally XXXX1 or XXXX0 can be used.

12. COMMISSIONING

12.1. PREPARATION FOR COMMISSIONING

Before commissioning it has to be checked whether the ordered and delivered THYNE3 device models are identical to plant requirements – especially the voltage range.

CAUTION

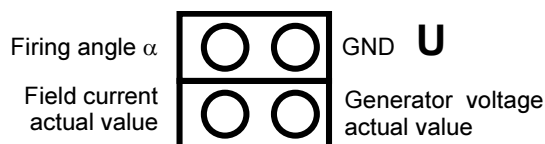
Following items have strictly to be verified to ensure perfect operation of the excitation system:

- | | |
|--|------------------|
| 1) Check design and external components | Chapter 7 |
| 2) Correct installation of all components | Chapter 10 |
| 3) All fuses removed and mcb's switched OFF | -F11, -F15, -F06 |
| 4) Check interface to plant, station control and protection | Chapter 7 |
| 5) CT/VT wiring check | Chapter 7 |
| 6) All voltage circuits to be checked | |
| 7) Preliminary setting of all configuration parameters | Chapter 11.2 |
| 8) Preliminary setting calibration values for LC display | Chapter 11.4 |
| 9) If a field breaker in the main rotor circuit is provided, the correct installation, wiring and function has to be checked | |

Note: For items 7) and 8) the THYNE3 device has to be energised. Therefore these items can only be tested out only during chapter 12.4, "CARRYING OUT COMMISSIONING".

12.2. MEASURING POINTS

Starting with the THYNE3-serial number 980021 there are on the pcb. PGS3 test jacks for measuring of signals as well as for setting and optimising the regulator. These test jacks have the following signals:



Designation	Name	Variable	Calibration
U GND	Common Ground		
Firing angle α	ALPHIW	V509	0 ... 5 V = 0 ... 180 °el.
Field current actual value	IPIW	V500	2,5 V = 100 % Ifn
Generator voltage actual value	UGK	V501	2,5 V = 100 % Ugn

Tolerance for all 3 measuring signals: $\pm 10\%$

12.3. CONSIDERATIONS

12.3.1. Calibration Principle

Within the regulator several calibrations have to be performed in order that the regulating quantities correspond with the actual values of the plant equipment. For example: so that the generator current actual value (IGIW) is really equal to 1 pu (100 %) in the regulator at an actual 100 % generator current flow. The calibration sequence should be applied according to this protocol in order that by adjusting the calibration setting value there is no influence on the momentarily regulation. For example the IGIW calibration should be carried out at rated generator current which is possible during primary short circuit tests where the excitation is in field current regulating mode and the generator current does not represent any regulating quantity in that operating mode.

For calibration the terminal mode has to be selected on the User terminal (please refer to chapter 8.1.2.6, "Terminal Operating Mode"). After calibration the new parameter setting have to be stored permanently (please refer to chapter 11.3.6, "Saving Settings").

The calibration values of the THYNE3 device are pre-set :

- S_n = 100 VA Generator apparent power
- V_n = 100 V Generator terminal voltage
- I_n = 1 A Generator stator current

The following values have to be calibrated or the calibration must be checked according to the generator data:

- Generator terminal voltage
- Generator stator current
- Field current

Calibration of the generator terminal voltage:

- 1.) Set V813 to 1
- 2.) Read V501 and substitute it in the following formula
- 3.) Measure the generator terminal voltage (secondary side of the VT)
- 4.) Calculation:

$$V813 = \frac{1}{V501} * \frac{U_g}{U_{gn}}$$

V813 Calibration factor for generator voltage NormUg
 Ug actual value of the voltage, measured at the VT
 Ugn VT secondary voltage at generator nominal voltage

- 5.) Enter the calculated value of the variable V813
- 6.) Afterwards the variable should be at nominal voltage: UGK V501 = 1,0

Calibration of the generator stator current:

- 1.) Set V817 to 1
- 2.) Read V503 and substitute it in the following formula V503
- 3.) Measure the generator stator current (secondary side of the CT)
- 4.) Calculation:

$$V817 = \frac{1}{V503} * \frac{I_g}{I_{gn}}$$

V817 Calibration factor for generator stator current NormI_g
 I_g actual value of the current, measured at the CT
 I_{gn} CT secondary current at generator nominal current

- 5.) Enter the calculated value of the variable V817
- 6.) Afterwards the variable should be at nominal current: IGIW V503 = 1,0

Calibration of the field current:

The calibration for the field current is factory set to 25 A. At calibration to the nominal field current of the generator the calibration factor only has to be multiplied:

- 1.) Calculation:

$$V805 = \frac{25A}{I_{fn}}$$

V805 Calibration factor for the field current NormI_f
 I_{fn} Generator – nominal field current

Calibration of thyristor voltage (=supply voltage):

- 1.) Set V803 to 1
- 2.) Read V537 and substitute it in the following formula
- 3.) Measure the incoming supply voltage at the terminals X15:2,4
- 4.) Calculation:

$$V803 = \frac{1}{V37} * \frac{400V}{U_{Thy}}$$

V803 Calibration factor for the thyristor voltage NormU_s
 U_{Thy} Incoming supply voltage at the terminals X15:2,4

- 5.) Enter the calculated value of the variable V803
- 6.) Afterwards the variable should be: USYNIW V501 = 1,0

12.3.2. Principle for Optimising the Regulator

The purpose of optimisation is that the regulating value (field current or generator voltage) is reacting as rapidly as possible to sudden changes without oscillation (to be recognised on the firing angle α). Therefore the firing angle α has to be oscilloscoped (on test jacks of module PGS3).

Procedures:

1. First of all optimise the regulator is with small value signals (step functions with 3 - 5 %)
2. only then later with large jumps (step functions with 10 %)
3. and then excitation raising from zero

At optimising with small value signals always optimise from the inner loop to the outer loop, that means:

1. Field current regulator (PI)
2. Voltage regulator (PID)
3. Limiters and additional regulator (reactive power or p.f. regulator)

ad 1) + 2) Field current regulator and Voltage regulator

Optimising is carried out by increasing the P-gain until the respective regulator starts oscillation (firing angle α). Then decrease the gain slightly again until oscillation stops. Afterwards adjust the integration time with step functions (in that way, that actual value reaches the new setpoint with small or without overswinging). Then at excitations with exciter machines optimise the differential part (D-part) with the same procedure (increase the D-gain until overswinging at step functions or until oscillation of the firing angle α , afterwards adjust the differential damping).

When during on-load operation the control voltage is starting to oscillate then the P-gain has still to be reduced.

NOTE

General statement: At a high gain the regulator tends to oscillate, but has a fast regulation. A low gain increases the stability, but results in poor regulation

Note: Generally pre-setting of the D-part is sufficient without any further modifications.

ad 3) p.f. and reactive power regulator

At the p.f. and reactive power regulator the regulation part with the gain is integrated in the feedback. Therefore the considerations regarding the stability and oscillation is exactly reverse. That means, a low gain results in high oscillation tendency, at a higher gain the regulator tends to stability. Generally the presettings can be left unchanged.

12.3.3. Recommended Settings

Normally with the factory settings in chapter 13, "PARAMETER FOR OPERATION (MEASURED-AND SETTING VALUES)" the THYNE3 can be operated without or with slightly parameter changes. If nevertheless parameters have to be changes due to poor regulation (oscillation, too much overswinging, slow regulation) we recommend the following ranges:

Recommendation for the field current regulator:

V870	VPI	Gain field current regulator	2.00 ... 5.00
V900	TNI	Integration time field current regulator	0.03 ... 0.05 = 30 ... 50 ms

Recommendation for the voltage regulator:

V872	VPU	Gain voltage regulator	5.00 ... 8.00
V902	TNU	Integration time voltage regulator	0.20 ... 0.70 = 0.2 ... 0.7 s
V871	KDU	Differential gain voltage regulator	0.50 ... 1.00
V901	TDU	Differential damping voltage regulator	0.005.. 0.02 = 0.5 ... 2 ms

Recommendation for the p.f. and reactive power regulator:

V877	KPQRF	Gain p.f. / reactive power regulator	8.0 ... 16.0
V957	TIQRF	Integration time p.f. / reactive power regulator	0.02 ... 0.1 = 5 ... 10 s

Delay time for switching off the field breaker:

If an external field breaker in the main rotor circuit is provided, the delay time for switching off this field breaker must match the time constant of the rotor. This delay time shall be set for switching off the field breaker without current. Normally an increase from 2 sec. up to 5 sec. is sufficient.

12.4. CARRYING OUT COMMISSIONING

CAUTION

Before initial energising of the THYNE3 the previously specified checklist according to chapter 12.1, "PREPARATION FOR COMMISSIONING" has to be gone through!

- Operating mode control selector switch to be put to position "Test".
- The internal supply voltage (24 VDC) has to be connected to terminals -A1/X2:11, 12.
- The voltage for initial excitation is to be connected to terminals -A1/X2:20, 21 (possibly via a series resistor).
- Fuse -F11 inserted and mcb -F15 switched on.
- By closing mcb -A1-F06 the control supply voltage is switched on. After completion of the boot sequence of module MRB2/MRB3 (approx. 8 sec.) and the User terminal (approx. a further 8 sec.) the control supply is energised and the THYNE3 is ready for operation.
- Operating mode "MANUAL" is to be selected.

NOTE

- These items of the commissioning instructions must be completed.
- *We recommend that these items of the commissioning instructions are to be fulfilled in order to ensure that the safety for correct functioning of the integration is guaranteed.*

NOTE

The nominal generator data as well as a description of the various parameters is to be found in chapter 13, "PARAMETER FOR OPERATION (MEASURED- AND SETTING VALUES)".

12.4.1. Tests at Standstill

If no test supply is provided, the corresponding items have to be cancelled.

- Protection trip checks
- Checking and measuring supply voltages in test mode
Check of thyristors voltage (=supply voltage) USYNIW (V37 = 0.9 ... 1.1). Only if V37 is out of the range of 0.9 ... 1.1, this variable has to be calibrated:
 - 1.) Set V803 to 1
 - 2.) $\text{NormUs V803} = 1/V37 * 400 \text{ V}/U_{\text{Thyr}}$
- Check of thyristors voltage frequency for value and polarity FSYNIW (V78 = +1.0)
Positive sign: Clock wise phase rotation
Negative sign: Anti-clock wise phase rotation
- During standstill operate the excitation ON key and slowly raise the field current until I_{fn} is reached (or as far up as possible)
- *Check and calibration of the field current IPIW:*
- *At nominal field current has to be $V500=1$*

➔ After that store setting parameter ("UPD" dip switch to the right and then to the left again, please refer to chapter 11.3.6, "Saving Settings")

12.4.2. Short Circuit Tests – If Applicable

- Operating mode "MANUAL" and "Test" is to be selected
- Generator terminal short circuited
- Generator brought to nominal speed
- Check of integrity of CT circuits whether all are closed but not short circuited with residual current or minimum current (0.1pu)
- Life trip check from a protection relay
- Calibration of generator current IGIW:
 - 1.) Set V817 to 1
 - 2.) Normlg V817 = $1/V503 \cdot I_g/I_{gn}$ (I_g is actual generator current)

➔ After that store setting parameter ("UPD" dip switch to the right and then to the left again, please refer to chapter 11.3.6, "Saving Settings")

- Check of current boost feature (when provided):
 - ➔ *Caution: This current booster test sequence has strictly to be observed. Especially after the test the original parameters have to be set back*
 - Plus and minus of the thyristor bridge –G01 to be short circuited (vertical bars at the thyristor bridge); observe current charge of approx. 25 A for short time
 - Generator terminals outside the terminal CT's short circuited
 - Generator run up to rated speed
 - Mode control selector switch set to "Normal"
 - Set generator overcurrent protection (undelayed) to 2 x nominal current
 - Parameter P35 (=0.0498) set to 2.0 (threshold for I_g measuring)
 - Parameter V962 (=0.02) set to 0.05 (time supervision for excitation start-up sequence set from 1 sec. to 5 sec.)
 - Select operation mode "AUTO"
 - Pressing excitation ON key: generator current must reach 2 times nominal current very fast with a subsequent excitation trip "generator short circuited" → current booster correct
 - With no excitation trip at " generator short circuited " then the trip will occur at "speed < trip" after 5 seconds or excitation can be switched off manually → current booster not correct (probably not correctly designed or adjusted)
 - The re-setting of the parameters is simplest carried out by switching the THYNE3 supply voltage off and on (re-booting)

Note: When no primary short circuit tests are performed the generator current can be calibrated during on-load operation.

12.4.3. Open Circuit Voltage Tests

- Operating mode "MANUAL" and "Test" is to be selected
- Generator terminal short circuit is removed
- Generator brought to rated speed
- Check of residual voltages at actual value input
- Check of residual voltages at excitation transformer input
- Excitation ON and raising excitation up to nominal voltage
- Check of thyristor voltage VSYNIW ($V_{37} = 0.95 \dots 1.05$)
- Check of thyristor voltage frequency for value and polarity FSYNIW ($V_{78} = +1.0$)
- Positive sign: Clock wise phase rotation
- Negative sign: Anti-clock wise phase rotation
- Calibration of generator voltage UGK:
 - 1.) Set V813 to 1
 - 2.) $\text{Norm}U_g V_{813} = 1/V_{501} * U_g/U_{gn}$ (U_g being the actual generator voltage)
- Check of voltages at all transformers
- Optimisation of current regulator gain (preliminary $V_{PI}=3$, final adjustment in shunt field operation mode) and integration time
- Change over to voltage regulator mode (key "AUTO/MANUAL")
- Change over to field current regulator mode (key "AUTO/MANUAL")
- De-excitation
- Change over from test- to shunt field supply
- Operating mode "MANUAL"
- Excitation ON, optimising gain and integration time of current regulator
- Change over to voltage "AUTO"
- Optimising gain and integration time of voltage regulator
- De-excitation with voltage regulator
- Check and optimising of Soft-Start by excitation in voltage regulator mode to nominal voltage: generator voltage must not swing over (see figure in chapter 13.3.3, "Soft-Start")
- Start-up and de-excitation with voltage regulator
- Oscilloscopic record of a set value jump $95 \% \rightarrow 105 \% \rightarrow 95 \% V_{gn}$
- Oscilloscopic record of an excitation process from 0 to nominal voltage
- Oscilloscopic record of a de-excitation process (operational de-excitation)
- Generator shut down, 1 diode in excitation machine shorted or disconnected (for diode fault supervision), run up unit to rated speed again.
 - Parameter V1003 (max. amplitude for trip) set to 15.0
 - Variable V518 (Supervision output signal) to be measured (should be 0.0)
 - Operating mode "MANUAL" and "Test" is to be selected
 - Excitation ON, adjust field current to approximately $\frac{1}{2}$ open circuit voltage value, but at least 0,2 U_g
 - Variable V518 (Supervision output signal) to be measured (should be bigger as 1.0)
 - Variable V1003 (max. amplitude for trip) set just under value of V518 resulting in an excitation trip
 - Generator shut down, remove diode short circuit or open circuit
- Check of remote operation control
- **Prior to synchronising: check CB intertrip**

➔ After that store setting parameter ("UPD" dip switch to the right and then to the left again, please refer to chapter 11.3.6, "Saving Settings")

12.4.4. On load Tests

NOTE

- 1) When after synchronising the reactive current suddenly rises above 100 % I_{gn} (generator over-excited and field current high) or drops to 40...80 % I_{gn} (generator underexcited, field current zero) and the voltage regulator does not get any response then the generator has to be immediately disconnected from the power system and the external wiring is to be checked because the CT polarity and/or CT allocation is incorrect.
- 2) When after synchronising small changes of the setting value will result in considerable fluctuations of the reactive current then the reactive power static is to be increased in negative direction. This is especially important when there is no generator-transformer and therefore no natural static or when several generating units are connected in parallel.

After paralleling the generator to the grid system it can be observed that the response of reactive power output is without influence on the active power. When the CT's and VT's are connected correctly then after synchronising the generator current will remain stable at a low level and can be adjusted with the voltage controller.

When the interrelation between set value changes and reactive power changes cannot be verified the external wiring has to be re-checked again.

- Check current polarity (reactive current $V504=I_{BIW}$, active current $V505=I_{WIW}$)
 - Positives sign: *Current export*
 - Negative sign: *Current import*
- Check actual value of active power ($P_{WIW}=V574$) and reactive power ($P_{BIW}=V65$)
 - Positives sign: *Power export*
 - Negative sign: *Power import*
- Check actual value of power factor ($CFR=V57$)
- Calibrate generator current I_{GIW} (if not performed as outlined in chapter 12.4.2, "Short Circuit Tests – If Applicable"):

$$\text{Norm}I_g V817 = 1/V503 * I_g/I_{gn} \text{ (} I_g \text{ is the actual generator current)}$$
- Check of the regulator behaviour by setpoint changes or setpoint steps (in on-load operation the regulator behaviour is different to no-load operation). If the regulation is not satisfactory, it can be optimised by gain and integration time of the voltage regulator.

- Check reactive power static:
 1. Reactive power static V831 set to -0.02 (should already be 0.02)
 2. Select load position with reactive power export into grid.
 3. Increase reactive power static V831 step by step in negative direction (-0.03, -0.04), thereby the actual value of generator voltage and also the reactive current (reactive power) has to decrease (otherwise the CT connection is wrong).
- Measure the grid system static: $XN = \dots\dots\dots\%$
 Measuring procedures:
 Measuring of a load position (active current between 0...20 % I_{gn} , p.f. approx. 1): $UG1, IB1$ (in pu)
 Increase voltage (reactive power), then
 measuring of a second load position: $UG2, IB2$ (in pu)

$$XN > \frac{UG2 \cdot UG1}{UG1 + (IB2 \cdot IB1)} + 100 \quad (\text{result } XN \text{ in } \%)$$

- Load rejections at various loads with oscillograph recording of the load rejection.
- Smooth transfer between automatic- and manual operating mode (in both directions)
- Check following limiters by approaching the limit value with the raise and lower commands.
 - Field current limiter (max., delayed)
 - Stator current limiter
 When the respective limiter shows no response the calibration is not correct
- Setting following additional regulators:
 - power factor regulator / reactive power regulator
- Heat run
 During heat run following temperature rises are to be checked:
 Excitation transformer, cable connections, cubicle heating, etc.

→ After that store setting parameter ("UPD" dip switch to the right and then to the left again, please refer to chapter 11.3.6, "Saving Settings")

12.4.5. Remaining Activities

- Final parameter saving ("UPD" dip switch to the right and then to the left again, please refer to chapter 11.3.6, "Saving Settings")
- Check spare parts (if applicable) and set parameters on spare MRB2/MRB3 module
- Write and distribute the commissioning test sheets

⇒ **1 copy for reasons of Quality Control and Service Support has absolutely to be sent to CC-SE!**

13. PARAMETER FOR OPERATION (MEASURED- AND SETTING VALUES)

13.1. NOMINAL DATA

We recommend to fill in the nominal data listed below in order to facilitate setting and especially calibration.

NOMINAL DATA

BASIS FOR INTERNAL REGULATOR CALIBRATION

100 % S_N	=	MVA	Apparent power
100 % U_{gn}	=	kV	Generator voltage
100 % I_{gn}	=	A	Generator current
100 % I_{fn}	=	A	Field current
100 % f_{gn}	=	Hz	Generator nominal frequency
p.f.	=		
Field resistance:		Ohm at	°C
100 % U_{thy}	=	V	Thyristor voltage

Voltage transformer ratio:	that means	sec. Nom. volts
Current transformer ratio:	that means	sec. Nom. amps

SCALINGS

Variable	Signal	Function	Internal value
V500	IPIW	Field current	1.00 = 100 % I_{fn}
V501	UGK	Generator voltage	1.00 = 100 % U_{gn}
V503	IGIW	Generator current	1.00 = 100 % I_{gn}
V504	IBIW	Generator reactive current	1.00 = 100 % I_{gn}
V505	IWIW	Generator active current	1.00 = 100 % I_{gn}
V38	DEIW	Rotor angle	1.00 = 100 ° el
V45	FGIW	Generator frequency	1.00 = 100 % f_{gn}
V574	PWIW	Generator active power	1.00 = 100 % S_N
V65	PBIW	Generator reactive power	1.00 = 100 % S_N
V37	USYNIW	Thyristor voltage	1.00 = 100 % U_{thy}
V78	FSYNIW	Frequency of thyristor voltage	1.00 = 100 % f_{thy}
V509	ALPHIW	Thyristor firing angle	16.00 = 180 °
V99	TANIW	Generator tan-phi (power factor)	

Note: The variable V99 (TANIW) is actually $\tan\phi = IB / IW$.

Calibration:	1	....	$\tan\phi = 1$	....	p.f. = 0,7 overexcited
	0	....	$\tan\phi = 0$	....	p.f. = 1
	-1	....	$\tan\phi = -1$	....	p.f. = 0,7 underexcited

V900 - V949	Timing range	1.00 = 1 sec.
V950 - V999	Timing range	1.00 = 100 sec.

13.2. CALIBRATIONS

Variable	Signal		Factory Setting	Actual Value
V803	NormUs	Calibration Factor for thyristor voltage	approx. 1.5	_____
V805	NormIf	Calibration Factor for field current	1.00 = 25 A	_____
V813	NormUg	Calibration Factor for gen. voltage	approx. 1.2 = 100 V	_____
V817	NormIg	Calibration Factor for gen. current	approx. 1.25 = 1 A	_____
V892	NormUn	Calibration Factor for system voltage	approx. 2.5 = 100 V	_____

13.3. PARAMETERS

13.3.1. Field Current Regulator

V824	SWAI	Set point for start-up field current regulator	0.05 = 50 % I_{fn}	_____
V825	SWPI	Positive limit for set point field current regulator	1.1 = 110 % I_{fn}	_____
V826	SWNI	Negative limit for set point field current reg.	0.005 = 0,5 % I_{fn}	_____
V870	VPI	Gain field current regulator	3.00	_____
V900	TNI	Integration time field current regulator	0.05 = 50 ms	_____

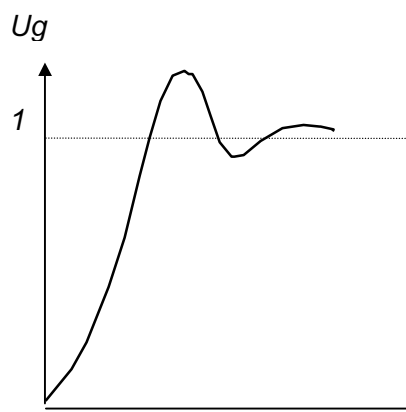
13.3.2. Voltage Regulator

V830	WSTAT	Active power compensation	0.00 = 0 %	_____
		<i>Note:</i> Neg. active power compensation means decreasing excitation at raising active current Pos. active power compensation means increasing excitation at raising active current		
V831	BSTAT	Reactive power compensation	-0.02 = -2 %	_____
		<i>Note:</i> Neg. reactive power compensation means decreasing excitation at raising reactive current = increasing the stability Pos. reactive power compensation means increasing excitation at raising active current = compensation of transformer or line		
V827	SWAU	Set point for start-up voltage regulator	1.00 = 100 % U_{gn}	_____
V828	SWPU	Positive limit for set point voltage regulator	1.10 = 110 % U_{gn}	_____
V829	SWNU	Negative limit for set point voltage regulator	0.90 = 90 % U_{gn}	_____
V872	VPU	Gain voltage regulator	5.00	_____
V902	TNU	Integration time voltage regulator	0.20 = 0,2 sec.	_____
V871	KDU	Differential gain voltage regulator	1.00	_____
V901	TDU	Differential damping voltage regulator	0.001 = 1 ms	_____

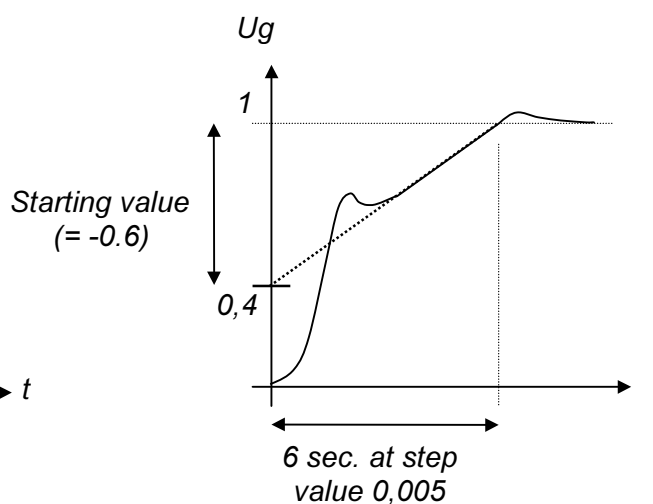
Variable	Signal	Factory Setting	Actual Value
----------	--------	-----------------	--------------

13.3.3. Soft-Start

V920 Step values 0.005
V921 Starting value -0.4 = 60 % U_{gn} _____



Generator voltage
WITHOUT Soft-Start



Generator voltage
WITH Soft-Start

The Soft-Start-up follows an adjustable slope. The slope begins at the starting setpoint minus starting value. The step value is related to 50 ms.

Example: Starting value = -0,6 \Rightarrow Slope starts at 40 % U_{gn}
Step values = 0,005 \Rightarrow Gradient of slope: 0,5 % in 50 ms
60 % in 6 sec.

13.3.4. Power factor / Reactive power regulator

V839 SWAC Set point for start-up p.f.regulator 0.00 (PF = 1) _____
V835 SWPC Positive limit for set point p.f.regulator 0.75 (PF = 0.8 ov.e.) _____
V837 SWNC Negative limit for set point p.f.regulator -0.3 (PF = 0.96 u.e.) _____

Note.: The calibration is made in $\tan\phi = IB/IW$.

Calibration:	1	....	$\tan\phi = 1$	....	p.f. = 0,7 overexcited
	0.75	....	$\tan\phi = 0.75$	..	p.f. = 0,8 overexcited
	0	....	$\tan\phi = 0$	....	p.f. = 1
	-0.3	....	$\tan\phi = -0.3$	....	p.f. = 0,96 underexcited
	-1	....	$\tan\phi = -1$	....	p.f. = 0,7 underexcited

Variable	Signal	Factory Setting	Actual Value
V838 SWAQ	Set point for start-up reactive power regulator	0.00 = 0 % S_N	_____
V834 SWPQ	Positive limit for set point reactive power reg.	0.6 = 60 % $S_{Nov.e.}$	_____
V836 SWNQ	Negative limit for set point reactive power reg.	-0.3 = 30 % $S_{Nu.e.}$	_____
V877 KPQRF	Gain p.f. / reactive power regulator	16.0	_____
V957 TIQRF	Integration time p.f. / reactive power regulator	0.1 = 10 sec.	_____

13.3.5. Field Current Limiter

V820 IPMIN	Min. field current limit	0.1 = 10 % I_{fn}	_____
V821 IPMAXU	Max. field current limit, undelayed	1.50 = 150 % I_{fn}	_____
V842 IPMAXV	Max. field current limit, delayed	1.0 = 100 % I_{fn}	_____
V873 KPMIN	Gain min. field current limiter	1.00	_____
V903 TIMIN	Integration time min. field current limiter	0.8 = 0,8 sec.	_____
V874 KPMAXU	Gain max. field current limiter, undelayed	1.5	_____
V904 TIMAXU	Integration time max. field current limiter	0.06 = 60 ms	_____
V952 TVIPB	Delay time field current limiter	0.3 = 30 sec.	_____
I1000 IFminON	Activation min. limiter (H = ON)	H	_____
I1001 IFmaxON	Activation max. limiter (H = ON)	H	_____

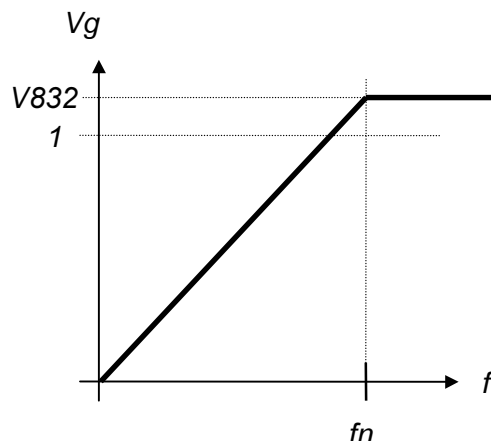
Note: The min. field current limiter acts only, if the generator current is above >5 % I_{gn} (that means, not at no-load operation or after load rejections)!

13.3.6. Generator Stator Current Limiter

V841 IGMAX	max. stator current limit	1.0 = 100 % I_{gn}	_____
V951 TVIGB	Delay time stator current limiter	0.3 = 30 sec.	_____
I1002 IGmaxON	Activation stator current limiter (H = ON)	H	_____

13.3.7. V/f Limiter

V832 FGMXUG	max. generator voltage limit	1.07 = 107 % U_{gn}	_____
V950 TIF	Integration time Volts/Hertz limiter	0.025 = 2,5 sec.	_____
I1004 U/fmxON	Activation Volts/Hertz limiter (H = ON)	H	_____



Note: The voltage limitation is acting in that way, that the generator voltage always will be below the thick line.

Variable	Signal	Factory Setting	Actual Value
----------	--------	-----------------	--------------

13.3.8. Diode Failure Supervision

V1002	RESFBP	Frequency of exciter machine	1.0 = 100 Hz	_____
V518	BPOUT	Output signal of supervision		_____
V1003	DIOMAX	Max. amplitude for trip	0.2	_____

Note: With V1003 DIOMAX (max. amplitude for trip) the trip operating sensitivity can be adjusted.

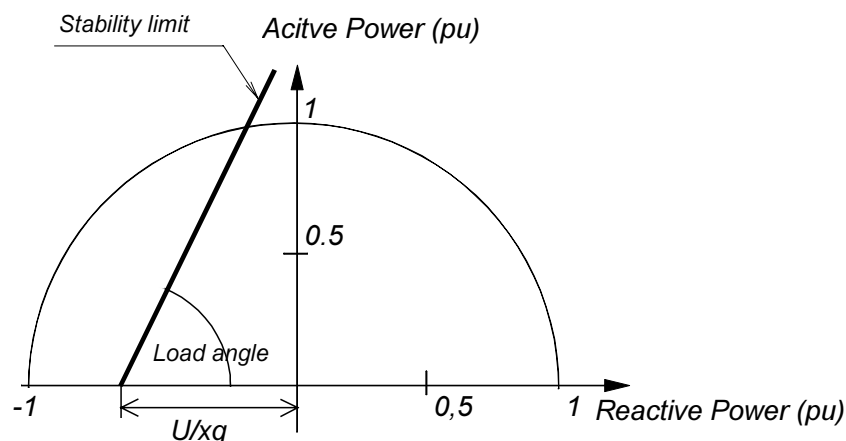
13.3.9. Isolated Operation Detection

V922	FG+INS	Upper frequency detection f. isolated operation	1.05 = 105 % fgn	_____
V923	FG-INS	Lower frequency detection f. isolated operation	0.95 = 95 % fgn	_____

13.3.10. Underexcitation (Rotor Angle-) Limiter (if applicable - see type code)

This limiter is not performed in the standard THYNE3 design!

V818	Xq	Quadrature axis reactance	0.5 = 0,5 pu	_____
V819	XN	Net reactance	0.12 = 0,12 pu	_____
V823	DESW	Max. load angle limit (stationary)	0.70 = 70 °	_____
V822	DESWD	Max. load angle limit (dynamic)	0.75 = 75 °	_____
V876	KPUEB	Gain underexcitation limiter	0.0	_____
V906	TIUEB	Integration time underexcitation limiter	2 = 2 sec.	_____
V875	KDUEB	Differential gain underexcitation limiter	1.5	_____
V905	TDUEB	Differential damping underexcitation limiter	0.10 = 0,1 sec.	_____
I1003	DELTON	Activation underexcitation limiter (H = ON)	L	_____



Note: The voltage regulation is acting in that way, that the reactive power voltage always will be on the right side of the thick line.

13.3.11. Power System Stabiliser (PSS) (if applicable - see type code)

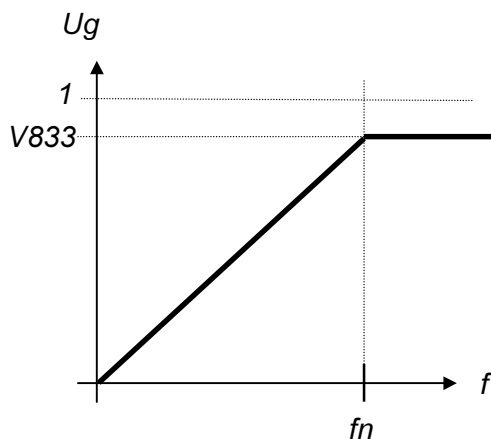
This limiter is not performed in the standard THYNE3 design!

V886	PHASE	Phase displacement of the stabilizing signal	0.00		_____
V887	AMPL	Gain of the stabilizing signal	0.50		_____
V890	BEGR+	Pos. limitation of the amplitude of the stab. sig.	0.02	= 2 % U_{gn}	_____
V891	BEGR-	Neg. limitation of the amplitude of the stab. sig.	-0.02	= -2 % U_{gn}	_____
I1007	PSS ON	Activation PSS (H = ON)	L		_____

13.3.12. Minimum Voltage Limiter (if applicable - see type code)

This limiter is not performed in the standard THYNE3 design!

V833	FGMNUG	Min. generator voltage limit	0.00	= 0 % U_{gn}	_____
V950	TIF	Integration time Volts/Hertz limiter (same variable as at V/f Limiter)	0.025	= 2,5 sec.	_____
I1005	U/fminON	Activation limiter (H = ON)	L		_____



Note: The voltage limitation is acting in that way, that the generator voltage always will be above the thick line.

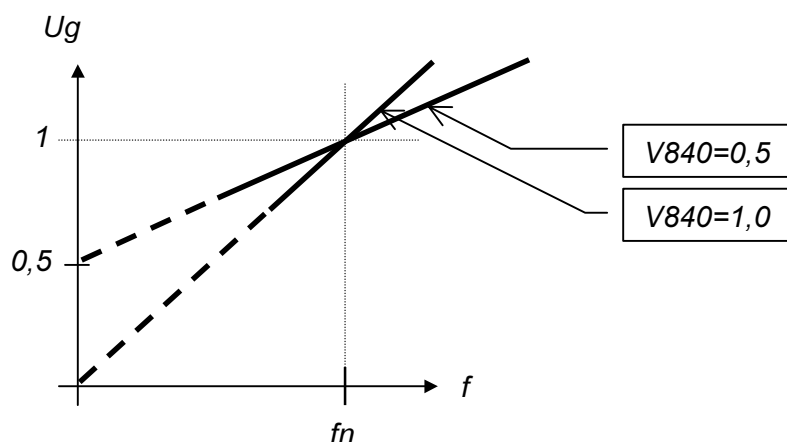
13.3.13. Voltage Increase with Frequency (if applicable - see type code)

This limiter is not performed in the standard THYNE3 design!

V840 KFI Gain frequency share
I1006 Fr.dr.ON Activation limiter (H = ON)

1.00

L



Note: The generator voltage is regulated according to the thick line.

13.3.14. Analog Inputs (if applicable - see type code)

V511	ANA1	Analog input 1	1.00	= 10 V
V911	TANA1	Filter time constant analog input 1	0.01	= 10 ms
V512	ANA2	Analog input 2	1.00	= 10 V
V912	TANA2	Filter time constant analog input 2	0.10	= 100 ms
V513	ANA3	Analog input 3	1.00	= 10 V
V913	TANA3	Filter time constant analog input 3	0.10	= 100 ms
V514	ANA4	Analog input 4	1.00	= 10 V
V914	TANA4	Filter time constant analog input 4	0.10	= 100 ms

14. OPTIONS FOR THE THYNE3 DEVICE

Following optional features are not contained in the basic model but can be made available without additional hardware extensions:

- Underexcitation limiter (rotor angle), instantaneous
- Power system stabiliser (PSS)
- Minimum voltage limiter
- Voltage increase with frequency
- Analogue signal processing 0 ... 100 VAC, e.g. for voltage pre-matching
- Processing of 2 analogue signals 0 ... 10 V, e.g. for analogue set point

15. ORDERING SELECTION AND MODEL TYPES

Model type: THYNE3/abcdeeff.xx

<i>a ... Three phase supply:</i>	1 30 - 65 VAC, 3-phase 2 60 - 125 VAC, 3-phase 3 125 - 250 VAC, 3-phase
<i>b ... Supply frequency:</i>	1 16 2/3 Hz 5 50/60 Hz 9 Specify
<i>c ... CT inputs:</i>	not applicable (must be letter "C") for older devices: 1 1 A 5 5 A
<i>d ... Language:</i>	d German e English s Spanish
<i>ee ... DC trip circuit voltage:</i>	02 ... 24 VDC nominal voltage 04 ... 48 VDC nominal voltage 11 ... 110 VDC nominal voltage 22 ... 220 VDC nominal voltage
<i>ff ... limiters:</i>	00 ... Standard limiter design 01 ... with underexcitation limiter and power system stabiliser (PSS) 02 ... with minimum voltage limiter and function for voltage increase with frequency 03 ... functionality of 01 + 02
<i>xx ... Special models (to be specified in writing)</i>	

Example: THYNE3/35Ce2200.

is a THYNE3 device with:

- Three phase supply 125 - 250 VAC
- Supply frequency 50 or 60 Hz
- CT current inputs for 1 A and 5 A CT secondary current (selectable by terminal connection)
- Language English
- DC trip circuit voltage: 220 VDC nominal voltage
- Standard limiter design
- No further options

16. TECHNICAL DATA

16.1. CASE AND DIMENSIONS OF THYNE3 DEVICE

The THYNE3 device is designed as 19"-rack with 9 U height and 84 HP width.

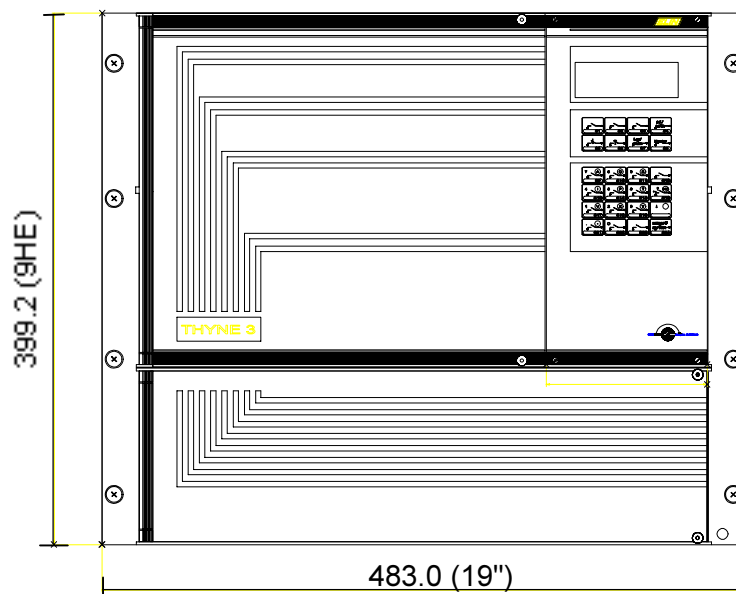
From the front you have direct access to the User terminal for operation and indication. After opening the big front plate you see the individual p.c.b.'s. These cards are connected together with a wiring print to a functional unit. So every module can be easily replaced in case of failure.

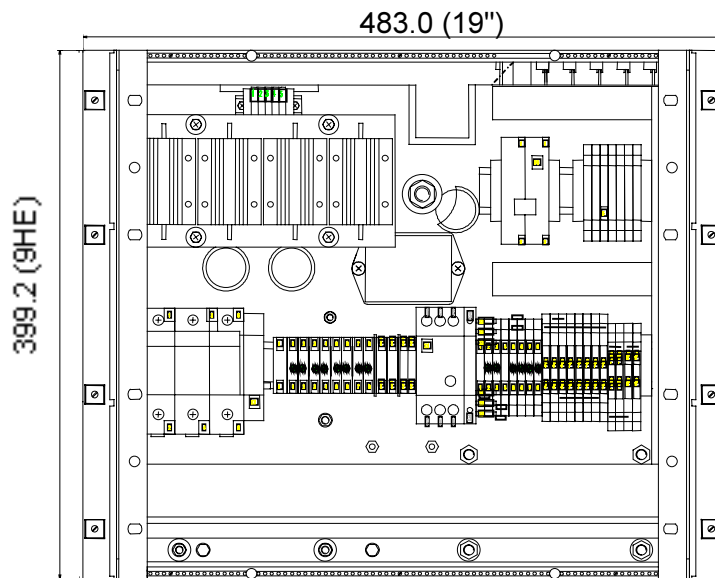
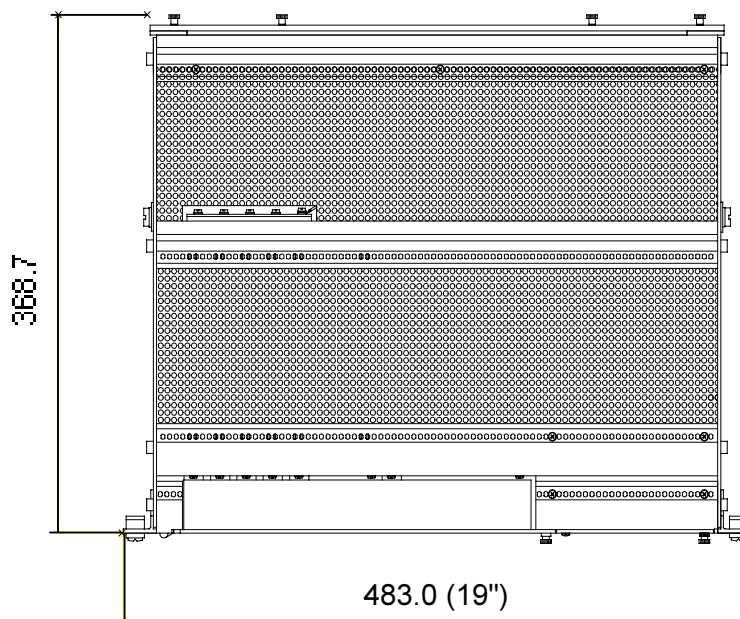
At the rear the terminal strip is located (accessible from the rear). On this terminal all external wires – power, control signals and protection – have to be connected.

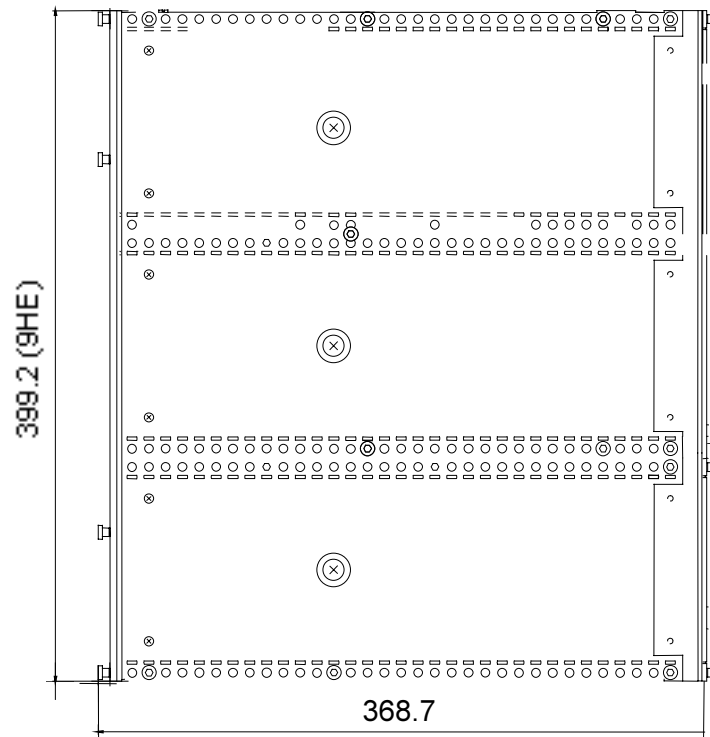
The power elements are fixed on a mounting plate which is accessible from the front and from the rear.

The THYNE3 device has covers for shock protection.

Front View (Dimensions in mm):



Rear View (Dimensions in mm):**View from Above (Dimensions in mm):**

Side View (Dimensions in mm):**16.2. EMC COMPATIBILITY**

The micro-processor system is manufactured according standard IEC 61000-4 and type tested by an international approved institute.

IEC 61000-4: EMC for industrial process automation

- | | | |
|-----------|-----------------------------------|---|
| • Part 1: | General introduction | |
| • Part 2: | ESD (Electrostatic discharge) | class 4: 8 kV |
| • Part 3: | HF / Electromagnetic fields | class 3: 10 V/m |
| • Part 4: | Fast transient / Burst | class 4: 4 kV supply
2 kV input / output |
| • Part 5: | Surge immunity (1,2 / 50 μ s) | class 4: 4 kV |

16.3. ELECTRICAL AND MECHANICAL DATA**Standard Model:**

Power circuit:	Input:	max. 3 x 250 VAC (nominal voltage) (terminals X11:2,4,6; cross section max. 16 mm ²)
	Output:	max. 210 V / 25 ADC continuous max. 330 V / 40 ADC forced (terminals X14:2,3; cross section max. 10 mm ²)
Required voltage supply from battery:		24 VDC, max. 5 A continuous (range 19...36 VDC), terminals X2:20,21; fuse 16 A, cross section max. 4 mm ²
Required voltage supply from transformer:		3 x 400 VAC / 300 VA max. 1 A, internal fuse 1A terminals X15:2,4,6; cross section max. 1,5 mm ²
Absolute voltage maximum from supply transformer.		3 x 530 VAC (RMS), this value must not be exceeded also not for short time, otherwise the THYNE3 will be destroyed!
Required voltage supply initial excitation:		24 V...220 V AC/DC (>48 V AC/DC with external series-resistor), internal resistor R04=10 Ohm; terminals X2:11,12; cross section max. 4 mm ²
Supply of the digital electronics:		from the station battery and from the AC-thyristor bus
Voltage sensing:		100 V _{rms} ...115 V _{rms} / 3 VA, Class 1, 3-phase or 1-phase, cross section max. 2,5 mm ²
Current sensing:		1 A and 5 A / 3 VA , Class 3, n<5, 3-phase or 1-phase, cross section max. 4 mm ² (current selection by terminal connection)
Voltage regulating range:		Adjustable, usually 0,9 ... 1,1 of nominal gen. voltage
Active current compensation, adjustable:		0 ... 20 %, rising or falling
Reactive current compensation, adjustable:		0 ... 20 %, rising or falling
Voltage regulator structure:		PID regulator (AVR) with inner loop PI field current regulator
Regulating accuracy:		better than ±0,5 % U _{gn}
Nominal frequency:		50 Hz ... 400 Hz
Operating frequency range:		10 Hz ... 440 Hz

Digital inputs: for commands:	24 VDC potential free via opto-couplers: Excitation ON Excitation OFF Excitation RAISE Excitation LOWER Excitation AUTOMATIC Excitation MANUAL Additional regulator ON
Digital outputs for station control system: for following signals:	potential free relay contacts, with common switched positive, max. 24 VDC / 1 A or max. 220 VDC / 0,3 A, ohmic burden: M excitation ON M excitation OFF M excitation AUTOMATIC M excitation MANUAL M additional regulator ON NM additional regulator ON M excitation ALARM M excitation READY TO START M excitation TRIP (1) NM excitation TRIP (1)
Digital outputs for protective functions:	potential free relay contacts, max. 220 VDC / 0.3 A: Excitation TRIP (2) CB intertrip
Digital outputs for 2.De-excitation contactor:	potential free relay contacts, max. 24 VDC / 1 A or max. 220 VDC / 0,3 A, ohmic burden
Operating temperature range:	0...45 °C
Dimensions:	19" rack, 9 U height / 84 HP width, depth 368.7 mm
Weight:	approx. 30 kg
Test voltage:	Power circuit: 2,5 kV _{rms} according to IEEE421B Solid state circuits according to VDE160
Standards according to VDE 160, IEC 60146 and IEC 60726	

Special Options in Addition to the Standard Model (According to Chapter 14, "OPTIONS FOR THE THYNE3 DEVICE":

Analogue inputs:	2 spare analogue inputs, common potential: 0 ... 10 V 1 spare analogue input, potential free: 0 ... 100 VAC
------------------	--

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Technical Notes

Pt 100 Sensors

Technical Data of Pt 100 Sensor

Pt 100 Sensor

The most exact temperature measurement can be made by using platinum sensors. With the Pt100 sensor (platinum sensor with 100 Ohm nominal resistance with 0°C) you can measure temperatures from -254,3°C. With the latest platinum sensors you can even measure temperatures up to +1100°C. The exact accuracy (which can be minor 0,1°C, it depends on the sensor used) is a result of the measurement method but also depends on the platinum material used. Platinum sensors have an excellent long-time stability, reproducibility (i.e. the sensors are exchangeable among one another) and are resistant to corrosion. The measurement is based on the fact that the electrical resistance of the platinum has to change proportional to the temperature. The resistance variation of the platinum behaves in average to 0,35 Ohm/K (0,39 Ohm/K at 0°C) and is not linear. A non-linearity can be avoided by using the suitable measuring method.

Connection of Pt100 Sensor

The temperature measurement with Pt100 sensors is based on the resistance variation of the platinum. The resistance variation is measured electronically and is transformed to a strengthened temperature proportional signal. For the measurement of resistances different methods are used. Usually the resistance which has to be measured repose in a bridge-connection (wheatstone-bridge). As the resistance variations of Pt100-resistance only behave to approx. 0,35 Ohm/K the lead wire resistance have to be taken into consideration. Pt100 temperature sensors are connected with 2-, 3- or 4-wire technique.

Specifications / Norms

Platinum resistances were defined according to ITPS865 as primary standard. All over the world the EN 60751 norm and the British Standard of 1964 BS 1904/JISC 1604 is valid. According to EN 60751 all platinum sensors with 100 Ohm nominal resistance can be calculated as follows:

$$R_t = R_0 (1 + At + Bt^2 + C(t - 100)t^3) \quad \text{for } -200^\circ\text{C bis } 0^\circ\text{C}$$

$$R_t = R_0 (1 + At + Bt^2) \quad \text{for } 0^\circ\text{C bis } 850^\circ\text{C}$$

$$A = 3.90802 \times 10^{-3} / ^\circ\text{C}$$

$$B = -5.802 \times 10^{-7} / ^\circ\text{C}^2 \quad C = -4.27350 \times 10^{-12} / ^\circ\text{C}^4$$

Tolerances:
class A: $\Delta t = \pm (0,15^\circ\text{C} + 0,002 \times |t|)$
class B: $\Delta t = \pm (0,3^\circ\text{C} + 0,005 \times |t|)$

Specifications Pt 100

Sensor	Pt 100 (platinum resistance, wounded or covered) in or on ceramic material
Nominal resistance at 0°C	100,00 Ohm/Alpha = 0,003850 K ⁻¹
Resistance tolerance at 0°C limited Tolerances other standards	class A $\pm 0,06 \Omega$, class B $\pm 0,12 \Omega$ 1/3, 1/5, 1/10 DIN class B BS 1904, BS2G. 148, JIS C 1604
Measuring range	Standard -200°C up to +600°C, up to 850°C on request
Thermal Response time	The thermal response time depends on the diameter of the ceramic tube and is therefore different for each sensor. The response time can lie between 0,03 sec and 2,2 sec for a jump of temperature of 10 K in flowing water.
Long-term stability	Better than $\pm 0,05 \%$ / year Already as a component of the production an artificial aging process takes place. Between -50 and +450°C the temperature stability of ceramic sensors are unreachable. The value of 0°C shows a maximum discrepancy of 0,04% after 10 temperature shocks of -200 up to +600°C.
Recommended measuring current:	1mA (max. 5mA)
Self heating	Less than $\pm 0,015^\circ\text{C}$ at 1mA measuring current
Shock und vibration	Max. 30 g of 10 Hz up to 1 kHz (when inserted correctly)
Connection wires	Up to $\varnothing 1,6$ mm pure platinum, from $\varnothing 1,6$ mm Platinum/Palladium, must have 8 mm length
Winding method	Bipolar (therefore minimal capacities and inductivities)
Calibration	All resistances are checked 5 mm of the ceramic tube at 0°C and 100°C (calibration point: 5mm of the ceramic material). Certificate is deliverable against a charge.
Norms	The current characteristic line of Pt100 sensors correspond to DIN IEC 751 (DIN 43760). Other norms on request.
Options	Double Pt100 (two windings in the ceramic material), triple Pt100, Pt30, Pt500, Pt1000, Ni 1000, Longer connection wires.



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Technische Erläuterungen

Technical Notes

Messwiderstände Sensors

Messwiderstände – Grundwerte Resistance Thermometers - basic values

	Pt100	Pt500	Pt1000	Ni1000	Ni1000 Tk5000	NTC 5 kΩhm	NTC 10 kΩhm	KTY 81-110	KTY 81-210	KTY 81-122	LM 235Z
°C	Ω										mV
-50	80,31	401,55	803,10	743,00	790,88	333914,00	667830,00	515,00	1030,00	520,00	
-40	84,27	421,35	842,70	791,00	830,83	167835,00	335670,00	567,00	1135,00	573,00	
-30	88,22	441,10	882,20	842,00	871,69	88342,00	176680,00	624,00	1247,00	630,00	
-20	92,16	460,80	921,60	893,00	913,48	48487,00	96670,00	684,00	1367,00	690,00	
-10	96,09	480,45	960,90	946,00	956,24	27649,00	55300,00	747,00	1495,00	795,00	
0	100,00	500,00	1000,00	1000,00	1000,00	16325,40	32650,00	815,00	1630,00	823,00	
10	103,90	519,50	1039,00	1056,00	1044,79	9951,80	19900,00	886,00	1772,00	895,00	2832,00
20	107,79	538,95	1077,90	1112,00	1090,65	6246,80	12490,00	961,00	1922,00	971,00	2932,00
25	109,74	548,70	1097,40	1141,00	1113,99	5000,00	10000,00	1000,00	2000,00	1010,00	2982,00
30	111,67	558,35	1116,70	1171,00	1137,61	4028,00	8060,00	1040,00	2080,00	1050,00	3032,00
40	115,54	577,70	1155,40	1230,00	1185,71	2662,40	5320,00	1122,00	2245,00	1134,00	3132,00
50	119,40	597,00	1194,00	1291,00	1234,97	1800,49	3600,00	1209,00	2417,00	1221,00	3232,00
60	123,24	616,20	1232,40	1353,00	1285,44	1243,53	2490,00	1299,00	2597,00	1312,00	3332,00
70	127,07	635,00	1270,00	1417,00	1337,14	875,81	1750,00	1392,00	2785,00	1406,00	3432,00
80	130,89	654,45	1308,90	1483,00	1390,12	628,09	1260,00	1490,00	2980,00	1505,00	3532,00
90	134,70	673,50	1347,00	1549,00	1444,39	458,06	920,00	1591,00	3182,00	1607,00	3632,00
100	138,50	692,50	1385,00	1618,00	1500,00	339,32	680,00	1696,00	3392,00	1713,00	3732,00
110	142,29	711,00	1422,00	1688,00	1556,98	255,03	510,00	1805,00	3607,00	1823,00	3832,00
120	146,06	730,00	1460,60	1760,00	1615,36	194,30	390,00	1915,00	3817,00	1934,00	3932,00
130	149,82	749,10	1498,20	1883,00	1675,18	149,91	300,00	2023,00	4008,00	2044,00	
140	153,58	767,90	1535,80	1909,00	1736,47	117,04	230,00	2124,00	4166,00	2146,00	
150	157,31	786,55	1573,10	1987,00	1799,26	92,39	180,00	2211,00	4280,00	2233,00	
200	175,84	879,92	1758,43	2407,00							
250	194,07	970,35	1940,81								
300	212,02	1060,09	2120,30								
400	247,04	1235,19									
500	280,90	1404,48									
600	313,59	1567,97									

Grenzabweichungen für Pt-Messwiderstände nach IEC 751 und für Ni-Messwiderstände nach IEC 43760 Limit deviations for Pt Sensors in accordance with 751 and for Ni Sensors in accordance with IEC 43760

Temperatur Temperature	Pt100 Messwiderstände Kl. A Pt100 sensors class A		Pt 100 Messwiderstände Kl. B Pt 100 sensors class B		Ni Messwiderstände Ni sensors	
°C	Ω	entspr. °C	Ω	entspr. °C	Ω	entspr. °C
-200	± 0,24	± 0,55	± 0,56	± 1,3		
-100	± 0,14	± 0,35	± 0,32	± 0,8		
- 60					± 1,0	± 2,1
0	± 0,06	± 0,15	± 0,12	± 0,3	± 0,2	± 0,4
100	± 0,13	± 0,35	± 0,30	± 0,8	± 0,8	± 1,1
200	± 0,20	± 0,55	± 0,48	± 1,3	± 1,6	± 1,8
250					± 2,3	± 2,1
300	± 0,27	± 0,75	± 0,64	± 1,8		
400	± 0,33	± 0,95	± 0,79	± 2,3		
500	± 0,38	± 1,15	± 0,93	± 2,8		
600	± 0,43	± 1,35	± 1,06	± 3,3		
700			± 1,17	± 3,8		
800			± 1,28	± 4,3		
850			± 1,34	± 4,6		



Dial/
Contact dial
thermometers
Class 1
with slow-break/
magnetic snap-action
contact

Operating Instructions

03.04/00403311

1 General



Please read these Operating Instructions before commissioning the instrument.
Please assist us to improve these instructions, where necessary.
Your suggestions will be appreciated.
Phone: +49 661 6003-0
Fax: +49 661 6003-07



If any difficulties should still arise during start-up, please do not undertake any unauthorized manipulations on the instrument. This will endanger your rights under the instrument warranty!
Please contact your supplier or the main factory in such a case.

JUMO GmbH & Co. KG is a company which is certified according to ISO 9001. You have purchased a product which meets high requirements and fulfils, or surpasses, all the specifications listed.
Nevertheless, if you have any reason for complaint, please return the instrument to us, with a detailed description of the fault you have observed.
These operating instructions do **not cover** all conceivable applications. So if you cannot find advice on your particular task, please contact the nearest subsidiary or the main factory.
None of the dial thermometers described in these operating instructions requires any maintenance. They do not contain any components that can be repaired or replaced by the user. Repairs can only be carried out in the factory!

2 Description

Dial thermometers with rigid stem or capillary are filled with an organic liquid or with gas, and operate on the principle of liquid expansion or pressure change. The resulting movement is converted into a rotation of the pointer, without any gearing.
The built-in electrical limit signal contact (slow-break or magnetic snap-action contact) is an auxiliary circuit switch which, depending on the direction of the movement, opens or closes an electrical circuit at the set limits, by means of a contact arm moving with the pointer.
Provided you observe the instructions below, you can be sure of problem-free operation.



Danger

With dangerous measurement media such as oxygen, acetylene, flammable and toxic substances, as well as in refrigeration equipment, pressure vessels etc., the relevant regulations and requirements must be observed.

Accessories

The necessary accessories are inside a bag which is enclosed together with the thermometer. Please check the package carefully!

3 Electrical connection



Danger

The electrical connection must only be carried out by qualified personnel.

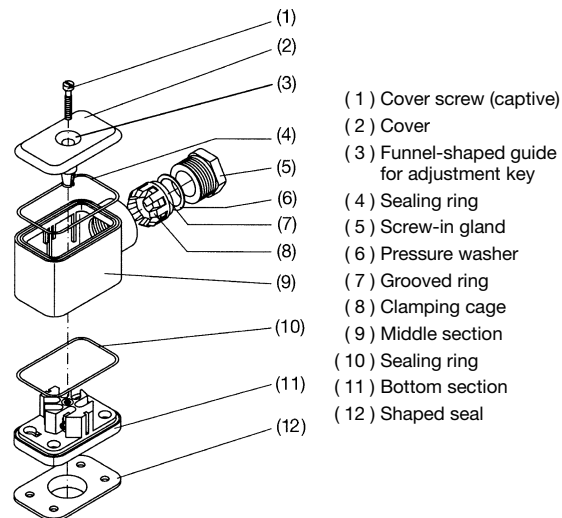
Wire up in accordance with the connection diagram (nameplate)!



The enclosure protection specified will only be achieved if the cable/terminal box is mounted correctly.

Assembly of the terminal box

6-pole with earth terminal, conductor cross-section up to 2.5 mm², suitable for cable diameters 6.5 to 13 mm.



- (1) Cover screw (captive)
- (2) Cover
- (3) Funnel-shaped guide for adjustment key
- (4) Sealing ring
- (5) Screw-in gland
- (6) Pressure washer
- (7) Grooved ring
- (8) Clamping cage
- (9) Middle section
- (10) Sealing ring
- (11) Bottom section
- (12) Shaped seal

Recommended contact loading

Voltage AC / DC	Slow-break contact			Magnetic snap-action contact		
	resistive load		inductive load	resistive load		inductive load
	AC mA	DC mA	p.f. > 0.7 mA	AC mA	DC mA	p.f. > 0.7 mA
230 / 220	40	45	25	100	120	65
110	80	90	45	200	240	130
48	120	170	70	300	450	200
24	200	350	100	400	600	250

Limits for contact loading

	Slow-break contact		Magnetic snap-action contact	
	Max. values	Min. values	Max. values	Min. values
for contact loading with resistive load				
Nom. operating voltage $U_{r.m.s}$	250 V	24 V	250 V	24 V
Nom. operating current:				
switch-on curr.	0.7 A	---	1.0 A	---
switch-off curr.	0.7 A		1.0 A	
cont. current	0.6 A		0.6 A	
Contact rating	10 W / 18 VA	0.4 W / 0.4 VA	30 W / 50 V	0.4 W / 0.4 VA

4 Installation



Caution

- ❑ Do not expose the dial thermometer directly to corrosive media. Take the protection rating into account when installing.
- ❑ If the thermometer is subject to strong shock and vibration, this will impair the function and life of the instrument. The installation site should therefore be largely free from vibration.

Ambient temperatures

Dial thermometers exhibit the highest measurement accuracy at an ambient temperature of +23°C at the case and capillary. Other ambient temperatures will lead to indication errors. The corresponding influence on the housing or capillary and the permissible ambient temperatures for storage and transport can be taken from the appropriate data sheet.

Nominal operating position any

Arrangement of the capillary

- ❑ The capillary should not be run closely to sources of cold or heat.
- ❑ Protect the capillary from possible damage.
- ❑ Kinks or breaks in the capillary will disable the instrument.

Minimum bending radius: 50 mm

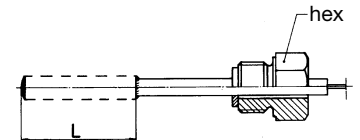
- ❑ If the probe is subject to shock and vibration, the capillary should be arranged in several loops between the last fixing point and the probe, so that it can swing freely.

Probe installation

The temperature probe must be so installed that its active portion (marked length L) is completely immersed in the medium to be measured, otherwise a measurement error will occur.

When deciding on the temperature probe location, the temperature distribution in the medium has to be taken into account.

When using protective pockets, the heat transfer resistance between the outside of the probe and the inner wall of the pocket can be reduced by filling it with a thermal contact medium.



5 Operation

Setpoint adjustment

Setpoints can be adjusted by means of the rotary knob in the center of the window.

With version "Setpoint adjustment by key", the setpoints can be adjusted through the adjustment lock (key is with the terminal box).

Indication correction

If the ambient temperature at the case and capillary deviates from the calibration temperature (+23°C), there is a permanent error at constant ambient temperatures, or a variable error under changing ambient temperatures, see Installation/Ambient temperatures.

Dial thermometers with indication correction can be adjusted at constant ambient temperatures. The adjustment is made on the back using a screwdriver, after removal of the closing plug.



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Dial Thermometer

- temperature indicator for panel mounting or self-supporting
- stainless steel housing with bayonet lock
- Class 1
- IP65 protection
- housing sizes: 100 mm and 160 mm dia.

Brief description

Dial thermometers are universal instruments for temperature measurement and monitoring. The volume change in a liquid-filled measuring system as an effect of temperature, or the change of pressure with temperature inside a gas-filled system, is converted into a rotation of the pointer by means of a Bourdon tube, without any intermediate gearing.

The pointer is directly linked to the measuring system, which makes the overall system extremely torsionally rigid. Vibrations are transmitted to the pointer only to a minor extent.



Type 608225/1016

Technical data

Housing	housing with bayonet lock in stainless steel (1.4301)
Enclosure protection	IP65 to EN 60 529
Window	glass, with extra code 434: polycarbonate
Scale	white, black lettering
Accuracy class	Class 1 to EN 13190
Reinforcement spring	instruments with capillary: on housing and temperature probe
Indication adjustment	at the back (no indication adjustment on Style 01)
Limit temperatures	for transport and storage -20°C to +70°C (for the 0 to +60°C range: up to 65°C)
Nominal position (NL)	unrestricted

	liquid-filled	gas-filled
Measuring system	indication range $\leq 350^{\circ}\text{C}$	indication range $\geq 400^{\circ}\text{C}$
Time constant $t_{0.632}$	approx. 12 sec, measured in water bath, with a 6 mm dia. copper probe	approx. 4 sec, measured in oil bath, with a 10 mm dia. stainless steel probe
Ambient temperature effect	in % of indication range (referred to the deviation from the +23°C reference value)	
on housing	0.15% of indication range per °C ambient temperature change	0.05% of indication range per °C ambient temperature change
on capillary (per m)	0.03% of indication range per °C ambient temperature change	no effect
	higher ambient temperature – higher temperature indication – lower switching point	

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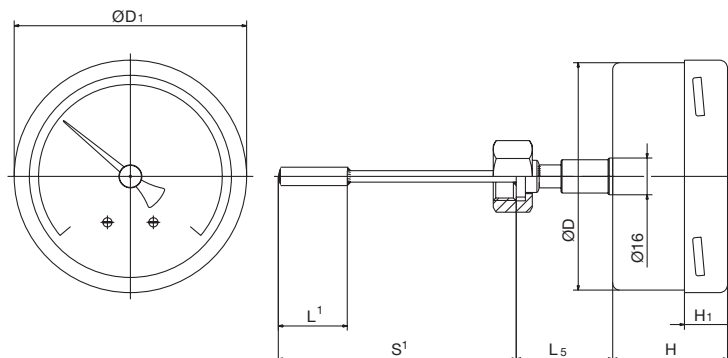
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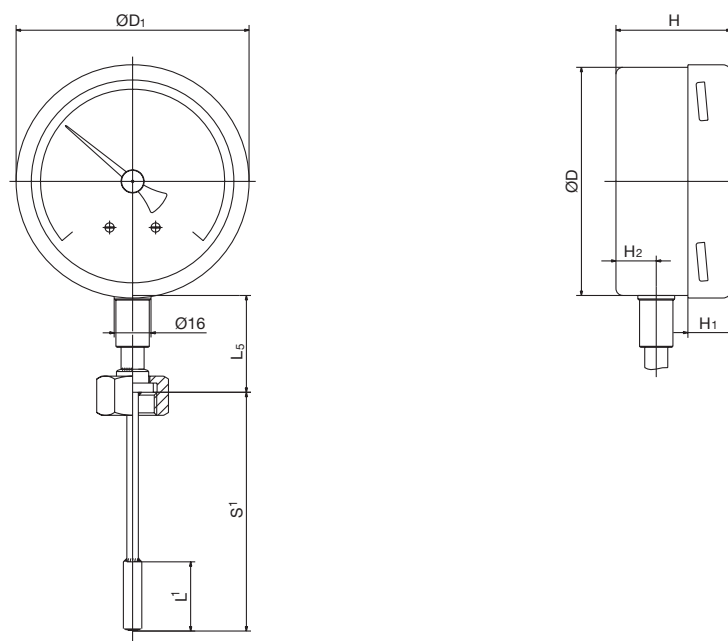


Dimensions

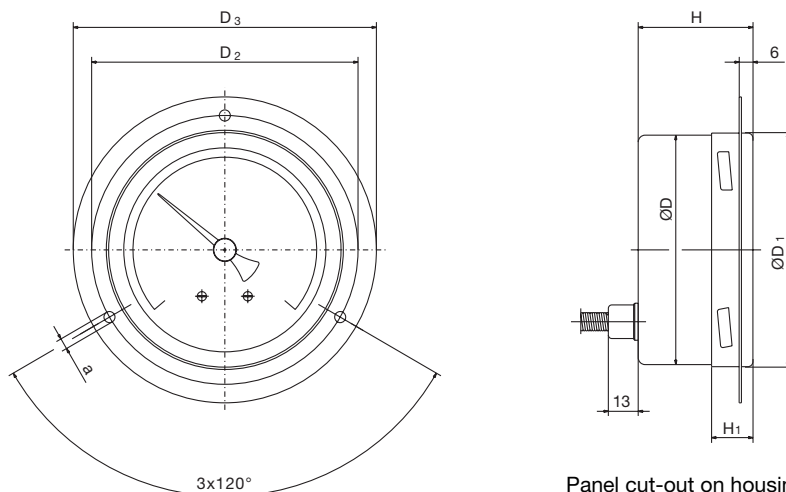
Types: 608225/0110
 608225/0116



Types: 608225/1010
 608225/1016



Types: 608225/2010
 608225/2016



Panel cut-out on housing:
 100mm dia. = $105.5^{+0.5}_{-0.5}$ mm
 160mm dia. = $165.5^{+0.5}_{-0.5}$ mm

¹ see Data Sheet 60.8730 for details about lengths

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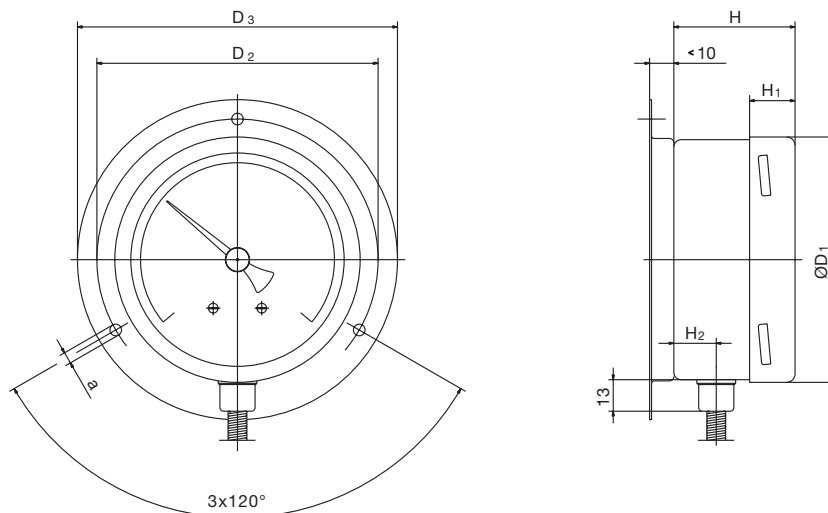
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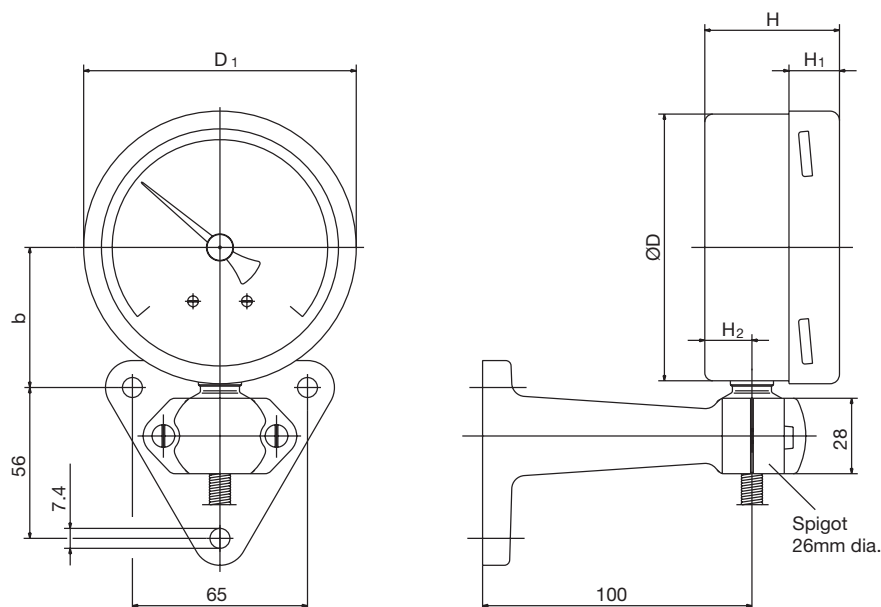


Dimensions

Types: 608225/2210
 608225/2216



Types: 608225/2310
 608225/2316



Mounting bracket to DIN 16 281

Housing dia.	H	H ₁	H ₂	D	D ₁	D ₂	D ₃	a	b	L ₅
100	50	19	17.5	99	101.5	116	132	4.8	52	40 ¹
160	50	21		159	161.5	178	196	5.8	82	

¹ for probe mounting TA 02 L₅ is ≤69 mm

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Order details

Dial thermometer Class 1, Type 608225

Order code	(1) Basic type	
608225	Mechanical dial thermometer	
	(2) Basic type extension	
0110	Style: 01; housing size: 100 mm dia.	
0116	Style: 01; housing size: 160 mm dia.	
1010	Style: 10; housing size: 100 mm dia.	
1016	Style: 10; housing size: 160 mm dia.	
2010	Style: 20; housing size: 100 mm dia.	
2016	Style: 20; housing size: 160 mm dia.	
2210	Style: 22; housing size: 100 mm dia.	
2216	Style: 22; housing size: 160 mm dia.	
2310	Style: 23; housing size: 100 mm dia.	
2316	Style: 23; housing size: 160 mm dia.	
	(3) Indication range (AB)	
469	-40 to +40°C; range -30 to + 30°C	Accuracy 1.0°C
566	-30 to +50°C; range -20 to + 40°C	Accuracy 1.0°C
807	0 to +60°C; range +10 to + 50°C	Accuracy 1.0°C
810	0 to +80°C; range +10 to + 70°C	Accuracy 1.0°C
814	0 to +100°C; range +10 to + 90°C	Accuracy 1.0°C
818	0 to +120°C; range +20 to +100°C	Accuracy 2.0°C
826	0 to +160°C; range +20 to +140°C	Accuracy 2.0°C
832	0 to +200°C; range +20 to +180°C	Accuracy 2.0°C
834	0 to +250°C; range +30 to +220°C	Accuracy 2.5°C
840	0 to +300°C; range +30 to +270°C	Accuracy 5.0°C
843	0 to +350°C; range +50 to +300°C	Accuracy 5.0°C
848	0 to +400°C; range +50 to +350°C	Accuracy 5.0°C
854	0 to +500°C; range +50 to +450°C	Accuracy 5.0°C
	(4) Capillary type (FL) ¹	
00	none (for rigid stem mounting)	
04	FL04 stainless steel capillary (1.4571), 2.2 mm dia.	
	(5) Capillary length ¹	
0	none (for rigid stem mounting)	
1000	1000 mm	
2000	2000 mm	
3000	3000 mm	
4000	4000 mm	
5000	5000 mm	
...	special length (details in plain text: in 1000 mm steps, maximum length 10000 mm)	
	(6) Process connection (PA) ¹	
750	TF01 temperature probe with shouldered support tube	
753	TF05 temperature probe with plain support tube	
752	TF11 temperature probe without support tube	
843	TA02 stem with union nut and loose nipple ²	
161	TA03 stem with loose union nut (on TF01)	
846	TA04 stem with fixed hexagon screw-in spigot ²	
847	TA06 sliding clamp fitting on support tube ²	
891	SH05 screw-in pocket, assembled ² (with 14 mm dia. only)	
913	SH07 screw-in pocket, assembled, with clamping clip and fixing screw ²	

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Order details

Dial thermometer Class 1, Type 608225

Order code	(7) Diameter of process connection (PA) ¹
6	ø 6 mm
8	ø 8 mm
10	ø 10 mm
14	ø 14 mm (SH05 only)
	(8) Thread for process connection (PA) ¹
000	no thread (TF01, TF05 and TF11)
103	thread G 3/8
104	thread G 1/2
105	thread G 3/4
	(9) Material of process connection (PA) ¹
26	stainless steel (1.4571)
97	stainless steel (1.4571)-TF / brass -TA, SH
	(10) Fitting length of process connection (PA) ¹ (dimension "EL" or "S")
0	minimum fitting length TF 11 (active probe dimension)
50	50 mm
100	100 mm
150	150 mm
200	200 mm
...	special length (details in plain text, in 50 mm steps)
	(11) Extra codes (TZ)
000	no extra code
434	peak-reading pointer adjustable with screwdriver, protected by cover
522	scale to customer specification

Special versions on request !

Order code

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11)
 608225 / ... - ... - .. - - ... - .. - ... - .. - ... / ... , ...

Order example

608225 / 2010 - 818 - 04 - 2000 - 750 - 8 - 000 - 26 - 100 / 000³

¹ For description and special features see Data Sheet 60.8730

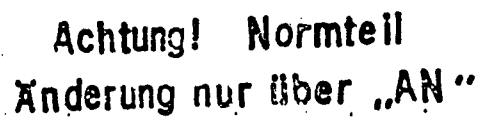
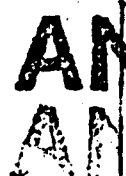
² Screw-in spigot to DIN 3852 Form A

³ List extra codes in sequence, separated by commas



Technical Datasheet: NWT-SH 2x6x150 Pt100 B2

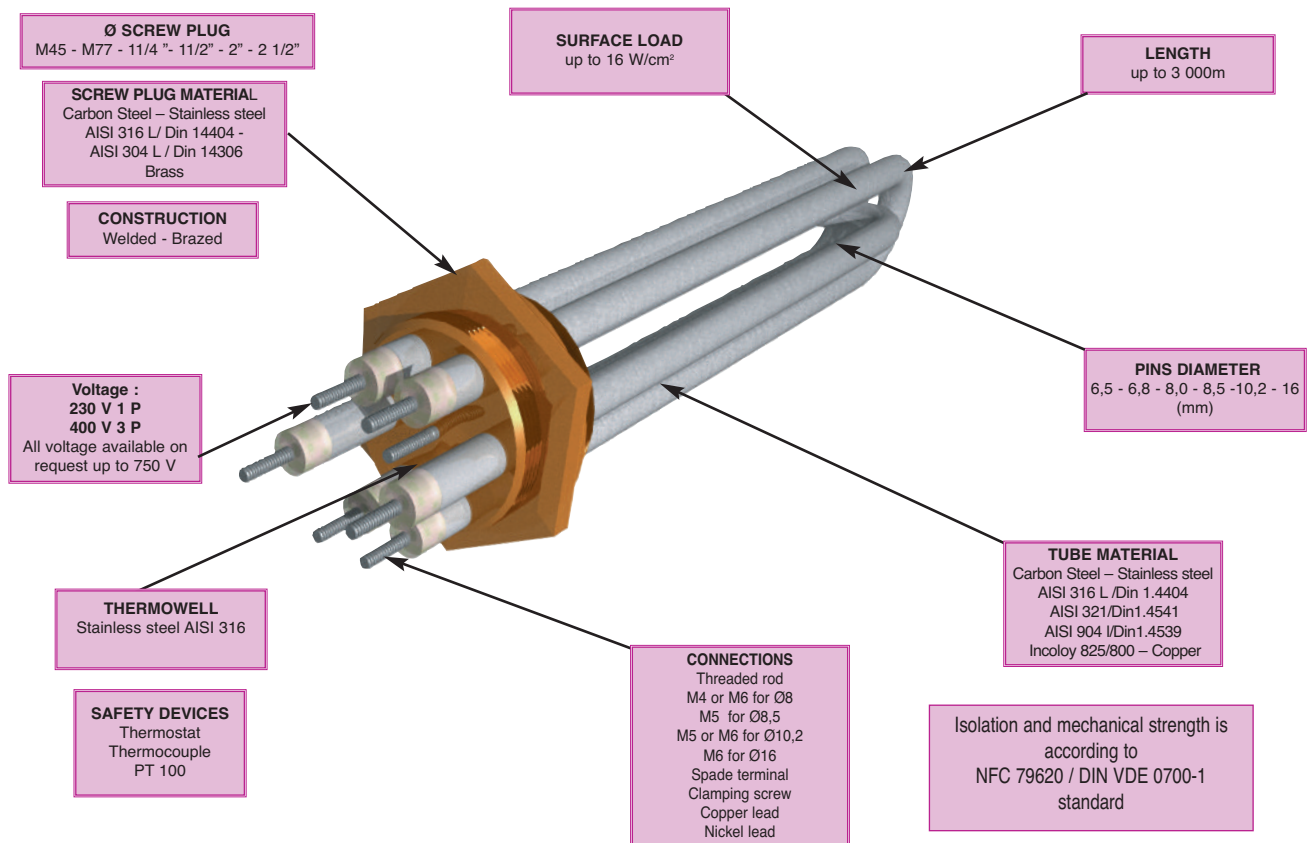
Item / Unit	NWT-SH, Art.-No. 901 070 102 000 001
Design	platinum wire with bifilar winding, attached to a carrier body, relieved from pressure, casted with silicone compound for permanent flexibility, with PTFE shrinking tube insulation
Operating temperature	-40° C ... +180° C, short term up to +200° C
Nominal resistance	100 Ω / 0° C
Circuitry	2-wire circuitry
Measuring current	suggested: 1 to 2 mA max: 10 mA
Operating voltage	max. 60 V
Dielectric strength	3 kV / 50 cps, 1 min
Tolerance class	B acc. to DIN EN 60751 ($\pm 0,12\Omega$ / 0° C)
Dimensions (TxWxL)	2 x 6 x 150 mm
Conn. lead typet	single wire, Cu-silver plated, PTFE-insulated, AWG20/7, wire ends bared and tinned
length	7.000 mm
colorcode	rd/wh
conn. structure	2 x AWG20/7
Temperature-change stability	hysteresis free using shock like temperature changes



EL 150 5 437531
EL 200 5 437532
EL 250 5 437533

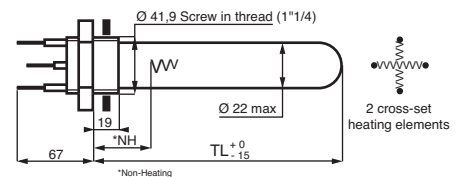
Type

						1983	gezeichnet	geprüft	gesehen	II ELIN II	5 - 437531-533				A 4									
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						Name	Hendrich	Kohl	Ko															
						Schenk - Resistance thermometer										And. Ziffer		1						
						PT 100 Widerstandsthermometer										Ersatz für								
						φ 12 x 150, 200, 250										Ersetzt durch								
1	Engl. Text nachgetr.					1983	Kohl												Masse Temp. Überw. Karte					
Nr.	Art der Änderung					Tag	Name	Gep.																



1"1/4 SCREW PLUG IMMERSION HEATERS WITHOUT ELECTRICAL BOX

Made of 2 U-shaped heating elements, welded on a screw plug with WP+ seal
Terminals : loop clamptype
Voltage 230 V 1P



Softened or treated water up to 100°C

AISI 321/Din1.4541 stainless steel tube, 2 circuits in single pin
Ø 6,8 load 4 W/cm² welded nickel plated steel screw plug.

P/N.	Power +5 - 10%	TL (mm)	NH (mm)	Weight (kg)
2041-01	750 W	205	30	0,7
2041-02	1000 W	250	30	0,8
2041-03	1500W	400	30	0,9

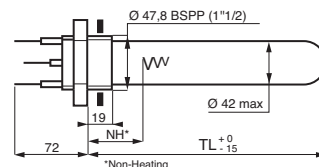
Softened or treated water up to 100°C

AISI 321/Din1.4541 stainless steel tube, 2 circuits in single pin
Ø 6,8 load 4 W/cm² welded nickel plated steel screw plug.

P/N	Power +5 - 10%	TL (mm)	NH (mm)	Weight (kg)
2041-04	2000 W	500	30	1
2041-05	3000 W	750	30	1,1

1"1/2 SCREW PLUG IMMERSION HEATERS WITHOUT ELECTRICAL BOX

Made of 3 U-shaped heating elements brazed on a screw plug with WP+ seal
Terminals : loop clamptype
Voltage : 230/400 V 3P.



Oil up to 110°C

Oiled steel tube, brazed protected-steel screw plug , load 2 W/cm², 3 single Ø 10,2 heating elements.

P/N.	Power +5 -10%	TL (mm)	NH (mm)	Weight (kg)
2045-31	1000 W	315	30	1,5
2045-32	1500 W	450	30	1,7
2045-33	2000 W	590	30	2
2045-34	3000 W	860	30	2,7

Softened or treated water up to 110°C

AISI 316L/DIN 1.4404 stainless steel tube scoured and passivated, brazed protected-steel screw plug, load 4 W/cm², 3 single Ø 10,2 heating elements.

P/N.	Power +5 -10%	TL (mm)	NH (mm)	Weight (kg)
2045-41	1000 W	180	30	1
2045-42	2000 W	320	30	1,2
2045-43	3000 W	450	30	1,5
2045-44	4500 W	660	30	2
2045-45	6000 W	860	30	2,5

Water up to 110°C

Scoured copper tube, brazed brass screw plug , load 8 W/cm², 3 single Ø 8 heating elements.

P/N.	Power +5 -10%	TL (mm)	NH (mm)	Weight (kg)
2045-51	2000 W	215	30	0,9
2045-52	3000 W	300	30	1
2045-53	1500 W	175	30	0,9
2045-54	4500 W	425	30	1,2
2045-55	6000 W	550	30	1,4

DATA SHEET

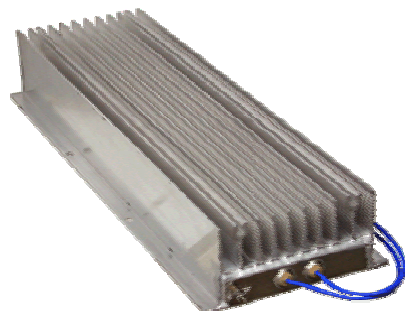


Resistors GmbH

Series:




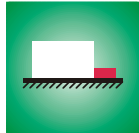


GWK

Compact Resistor



Applications:

As braking and chopper resistors
In variable-speed drives
In lifts and conveyors
In the printing and paper industries
In the packing, plastics and textile industries and in machine construction
In the wire and wood processing industries

Types		GWK 150	GWK 200	GWK 300	GWK 500
Pulse Power $T_U=25^\circ\text{C}$	c.d.f. 5%*	14,0 kW	16,0 kW	20,0 kW	22,0 kW
	c.d.f. 10%*	7,5 kW	8,0 kW	10,0 kW	13,0 kW
	c.d.f. 20%*	4,0 kW	4,2 kW	5,0 kW	8,0 kW
	c.d.f. 40%*	2,0 kW	2,1 kW	2,5 kW	4,0 kW
	Continuous rating at $T_U=25^\circ\text{C}$	1,0 kW	1,2 kW	1,5 kW	2,0 kW
	Pulse power Continuous rating at $T_U=25^\circ\text{C}$	In case of horizontal installation the above performance is reduced by 20%.			
Mean energy absorption capacity 5% - 40% c.d.f.		90 kW s	100 kW s	120 kW s	190 kW s
Weight		2,5 kg	3,5 kg	5,0 kg	8,5 kg
Resistance values		2,2 - 150 Ω	4 - 180 Ω	6 - 180 Ω	7 - 180 Ω
Resistance tolerance		$\pm 10\%$			
Connection		2 x 2,5 mm ²			
Degree of protection (DIN EN 60529)		IP 65			
Housing temperature at nominal rating $T_U=25^\circ\text{C}$		$\leq 400^\circ\text{C}$			
Cooling		Natural convection			
Storage temperature		$-25 \dots +85^\circ\text{C}$			
Insulation resistance		$\geq 10 \text{ M}\Omega$			
Test voltage		= 4,5 kV AC			
Max. permissible operating voltage		$\leq 1,0 \text{ kV}$			
Temperature coefficient of resistance material		$+300 \dots +400 \cdot 10^{-6}/\text{K}$			
Inductance at 100 kHz		3 ... 300 μH			
Approvals		CE			
Mounting Positions					

* bezogen auf eine Zyklusdauer von 120 s

Technische Änderungen vorbehalten

www.heine-resistors.com



pr\data sheet gwk_ okk_geschw_ip65.doc\ 08/07/2005

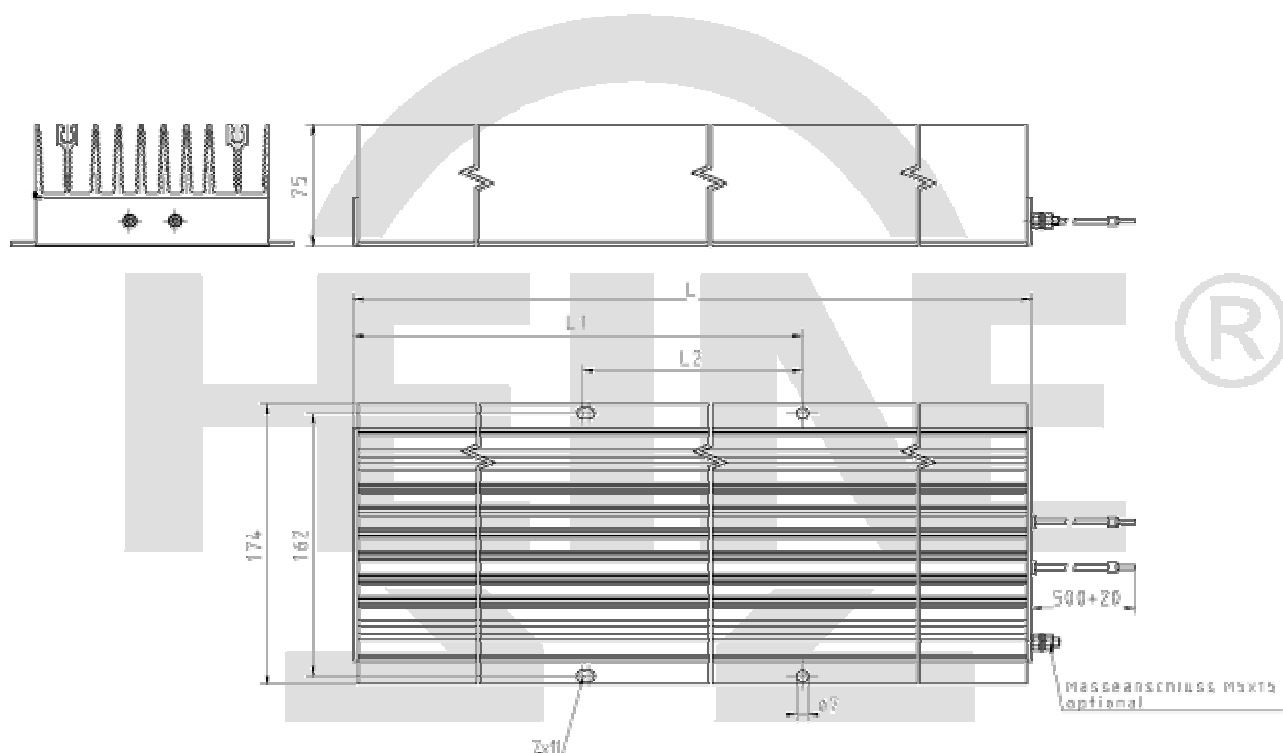
Series:

GWK

Compact Resistor

The compact intrinsically safe type series uses a high-quality resistance alloy which is embedded in a special ceramic base contained in an extruded sectional aluminium housing. This design ensures a high energy absorption capacity. The very high degree of protection is achieved by the fact that the housing and cover are in close contact with each other.

Drawing:



Resistors GmbH

Subject to technical modifications

Dimensions:

GWK 150:	166 x 174 x 75 (LxWxH)	L1: 138	L2: 110
GWK 200:	216 x 174 x 75 (LxWxH)	L1: 188	L2: 160
GWK 300:	316 x 174 x 75 (LxWxH)	L1: 238	L2: 160
GWK 500:	516 x 174 x 75 (LxWxH)	L1: 338	L2: 160



Brüel & Kjær Vibro

VIBROCONTROL 920

C102 833.002

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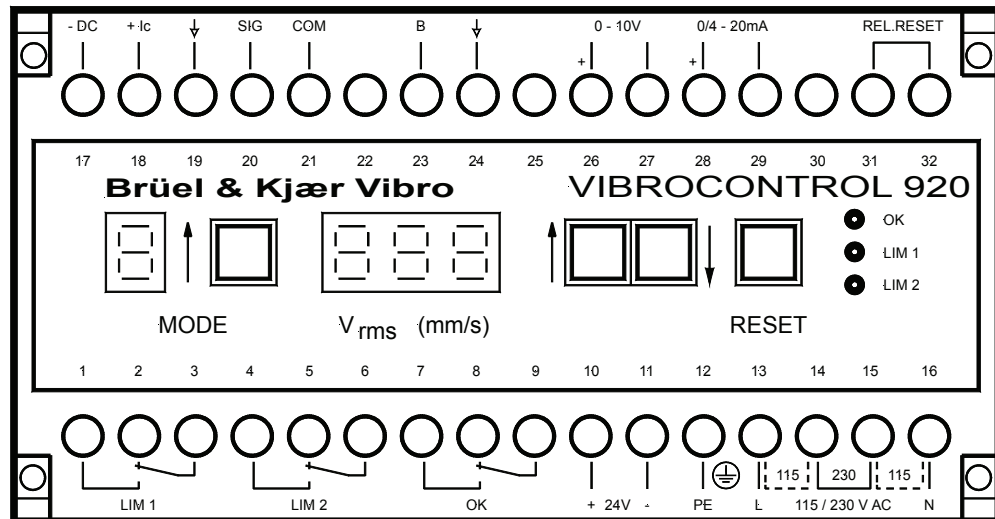
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VIBROCONTROL 920



VC920 (030224)

1 General

VIBROCONTROL 920 is an instrument for measurement, monitoring and display of bearing resp. housing vibrations. The amplitude of the current measurement is displayed as the effective (rms) value of vibration velocity directly at the instrument on a three-digit, seven-segment LED display.

The standard sensor connected to the VIBROCONTROL 920 is normally a vibration velocity sensor. When an acceleration sensor is used the signal is integrated to the corresponding value of vibration velocity.

Two adjustable limit values, within the same full scale range, are available for signalling alarms. To prevent the alarm relays being activated by short-term high vibration levels which exceed the alarm values, a time delay can be activated for each individual alarm relay. Limit value exceedances are displayed on the VIBROCONTROL 920 by alarm LEDs while the exceedances can be signalled further using the respective potential-free alarm relay contacts.

Setting up of the instrument for the measurement and monitoring task is done by means of setup parameters.

A diagnosis output (terminals B / ↓) is available for checking purposes and enables analysis of the input signal with correct phase.

All cable connections to the instrument are made by means of screw terminals.

1.1 OK Monitoring

Self-monitoring of the power supply, the internal microprocessor system as well as the sensor status is done by the OK monitoring system.

An existing OK error is displayed by an LED and signalled by the change-over of potential-free contacts of the OK relay. In the case of a fault the light-emitting diode will go off and the contacts of the corresponding relay will change over.

1.2 VIBROCONTROL 920 operation after switch-on or power return

The instrument automatically executes a self-test lasting approximately 6 secs. each time it is switched on. Through this a calibration constant for the measuring circuit is determined which is then calculated into the results of all future measurements. During this self-test phase the status of the OK and limit relays is retained as defined for an error-free condition.

After completion of the self-test the instrument switches to the monitoring operation. After this time any exceedances of the pre-defined limit and calibration values lead to corresponding event signals.

2 Technical Data

Power supply	115 / 230 V AC 50 / 60 Hz	+/- 15 %;
	24 V DC	-25 % / +33 %
Load	AC: P_{\max} : 12 VA DC: P_{\max} : 7 W	
Standard delivery	230 V AC	
Fuses	24 V DC: fine-wire fuse 300 mA/tr 115 / 230 V AC: temperature fuse in the transformer	

Caution

Only one type of power may be connected at one time.

Measurement variable	Effective (rms) value of vibration velocity
Frequency range	1 ... 1000 Hz ¹ 10 ... 1000 Hz
Accuracy	± 5 %, in relation to displayed value
Internal resistance	$R_{i\ AC}$ = 35 k Ω $R_{i\ DC}$ = 39 k Ω

Sensor types

Vibration acceleration sensor

Sensitivity	10 mV/g x (0.1 ... 1.99) 100 mV/g x (0.1 ... 1.99)
Power requirement	-24 V DC / 5 mA
Current requirement	+ 4 mA / $R_i < 4\ k\Omega$

Vibration velocity sensor

Sensitivity	75 mV/mm/s x (0.1 ... 1.99) 100 mV/mm/s x (0.1 ... 1.99)
-------------	---

Analog outputs

Short-circuit proof	0 ... 10 V 0 / 4 ... 20 mA	$R_L > 10\ k\Omega$ $R_L < 500\ \Omega$
---------------------	-------------------------------	--

¹ Type VC-920-2k = 10 ... 2000 Hz

Diagnostic outputs (Buffer) frequency range

Input	1 Vpp; 10 Hz < f_o < 1 kHz
Transmission factor	1 : 1 (see note)
Amplitude error	< 0.5 % in relation to input signal
Phase error	< 0.5 % in relation to input signal
Load resistance	> 3,3 k Ω

Note

This indication applies to the connecting cable AC-185 not longer than 20 m.

Relay outputs

Potential-free contacts

Contact load:	Ohmic load: 100 W / 600 VA max. 30 V DC; 300 V AC, 3 A
---------------	---

Caution

With an inductive load a suitable spark-suppression device must be employed. The spark-suppression device must be installed as near as possible to the source of the interference.

Temperature ranges	0 ... 50 °C working temperature range -10 ... 70 °C storage temperature range
Protection type	IP 20
Fire protection class	according to UL94: V - 0 according to VDE 0304: Class IIb
Cable connection	Screw terminals Connection cross-sectional area max. 2,5 mm ²
Weight	920 g
Dimensions	150 mm x 78 mm x 115 mm (W x H x D)

Executed Environmental Tests

The VIBROCONTROL 920 conforms to the following prescribed standards and guidelines:

73/023/EWG

Low-voltage guideline

EN 61010-1

89/336/EWG

EMV-Guideline

EN 61326 : 2004 - 05

WEEE-Reg.-No. DE 69572330

product category / application area: 9

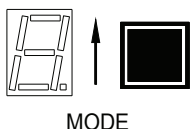
Safety category according to EN-954-1

- Safety category B (Sk B) according to EN-954-1
- Safety category 1 (Sk 1) according to EN-954-1 under the following conditions:
 - If the system is used for applications requiring safety functions of the vibration monitoring system according to safety category 1, the relays have to be used in a closed circuit system.
 - The OK-relay has to be integrated into the safety chain in a way that the safety function is activated as soon as the relay responds.
 - All adjusting devices have to be protected in a way that they cannot be unintentionally misadjusted during operation. This can be done for instance by mounting the adjusting device in a closed housing resp. switch cabinet. Any opening of the housing/switch cabinet resp. changing of system parameters may only be done by duly trained, authorized staff and has to be documented.

3 Display and operating elements

3.1 Button: MODE

The operating mode of the instrument is changed by pushing the MODE button.



Normal operation

One push of the button; Preparation for parameter entry resp. check mode.

Parameter mode

Roll function; Each push of the button switches to the next operating mode

3.2 Measured Value / Parameter



Measurement value display

Three-digit, seven-segment LED display

The display resolution is automatically selected to correspond to the selected measurement range.



Buttons: Corresponding to the direction of the arrows, the setup value of the selected parameter will be increased or decreased by one step. If the button is pushed and held the single-step function will change to a rolling function.

3.3 Display period

The period the seven-segment LED display stays on can be defined between "Off after 3 minutes" or "Permanently on" and 3 levels of display brightness for each parameter can be selected. The display switches on when any of the function buttons is pushed.

3.4 Status signals

OK error

Green LED / OK relay

The occurrence of an OK error is signalled by the LED lighting up and the OK relay de-energizing.

LIM 1, LIM 2 error signals

The behaviour of the limit relays is determined by the connection status of the terminals 31/32 (Relay Reset).

Terminals 31/32 not connected resp. Contacts open

Limit value exceedances are stored - the limit relays remain energized - until the Reset button is pushed. A reset of the limit relay is only possible if the measurement value is lower than the corresponding limit value.

Terminals 31/32 connected by push-button

The energized limit relay contacts will be reset. A reset of the limit relay is only possible if the measurement value is lower than the corresponding limit value.

Terminals 31/32 permanently connected (Standard delivery)

The limit exceedance is signalled only for as long as the limit value is exceeded. If the measurement values fall lower than the limit values the LIM LEDs and the limit relays will be reset.

Limit value LIM 1

Yellow LED / LIM 1 Relay

If the current measurement value is higher than the limit value and remains at this level for longer than the set time delay, the LED will light up. The LIM 1 relay will react according to the defined setup. It will be energized when set up as normally de-energized and will be de-energized when set up as a normally energized relay.

If an OK error occurs during a LIM1 activation, the limit signal (LED and relay) will be reset to the normal status for the duration of the OK error.

Limit value LIM 2

Red LED / LIM 2 Relay

If the current measurement value is higher than the limit value and remains at this level for longer than the set time delay, the LED will light up. The LIM 2 relay will react according to the defined setup. It will be energized when set up as normally de-energized and will be de-energized when set up as a normally energized relay.

If an OK error occurs during a LIM2 activation, the limit signal (LED and relay) will be reset to the normal status for the duration of the OK error.

3.5 Reset



RESET

Normal operation

Reset the event signal as well as the associated relay.

The "REL.RESET" terminals have no function in connection with an OK error.

Parameter mode

Leave the parameter setup mode. Changes to the parameter values are not activated.

3.6 Store



MODE



RESET

Push Mode and Reset simultaneously:

Leave the parameter setup mode. Changes to the parameter values are activated.

4 Internal Tests and Error Signals

After switching the instrument on a number of tests are executed. If the result of the test reveals an error in the operation of the instrument, this is displayed on the measurement value field in the form of an error message.

4.1 Test of the LED display and alarm LEDs

The LED seven-segment displays are checked by displaying the figure 8, and the associated decimal points are switched on. The alarm LEDs light up in the sequence green - yellow - red. This test lasts for approx. 4 seconds.

4.2 Displaying the program version

In the mode display field a "v" is displayed and in the measurement value display field the version number is displayed.

4.3 Displaying the calibration constants

In the mode display field a "c" is displayed and in the measurement value display field the calibration constants are displayed.

4.4 Error messages

The error messages are displayed in the form of an "E" followed by a number. The display of the measurement value is overwritten for the duration of the error message. In addition to the visual error signal, an error message is always signalled by activation of the corresponding limit or OK relay.

If the input of the measured value is overmodulated, the display shows „ccc„.

Error " E 01"

The value of the calibration constants lies outside the permissible range. A value between 0.5 and 2.0 is permitted. Occurrence of this error means an error in the instrument's internal acquisition electronics. The instrument should be removed from the monitoring application and returned to the nearest service station for repairs.

Error " E 02"

The values of the internal voltages lie outside the permissible limits. For a check see Group 3: Parameter 3 (+ 5 V) and Parameter 4 (+ 17 V). Occurrence of this error means an error in the instrument's power supply. The instrument should be removed from the monitoring application and returned to the nearest service station for repairs.

Error " E 03"

The temperature inside the instrument housing has exceeded the 90 °C ($\pm 10\%$) limit. If this error message occurs the instrument should be removed from the monitoring application and returned to the nearest service station for repairs.

Error " E 04"

OK-error identification

Always	Power failure
Vibration acceleration sensor	Cable break
	Short-circuit between the conductors
Vibration velocity sensor	Cable open circuit

In the event of this error the analog output will be switched to 0 volt resp. 0 / 4 mA. The OK LED will go off and the OK relay will de-energize and can only be reset using the RESET button. Until the cause of this error is eliminated the OK error signal will remain.

Error " E 05"

Failure of the OK monitoring function. This error shows a failure of the OK monitoring function. If this error message occurs the instrument should be removed from the monitoring application and returned to the nearest service station for repairs.

Error " ccc "

The measured value input is overmodulated. If the measured value is situated again within the measuring range the error message disappears.

5 Setups

General

The parameters are divided into three Groups each with respectively seven parameters. The parameters in Groups 1 and 2 are concerned with configuration parameters while those in Group 3 are concerned with service parameters.

Viewing or making changes to parameter values can only be done after first entering a code number associated with the Group. Parameter entries only take effect and are stored after leaving the entry mode, i.e. after simultaneously pushing the MODE + RESET buttons. Changes to the parameters are ignored when the entry mode is exited by pushing the RESET button.

5.1 Function: Displaying parameters

MODE button

Push once. The number 1 is displayed in the mode display field.

[↑] resp. [↓] buttons

Push repeatedly until the desired code number is displayed in the measurement value field.

MODE button

The mode selection is accepted. Now the parameter number 2 is displayed and the associated parameter value is displayed in the measurement value field.

MODE button

Pushing the MODE button switches to the next parameter.

RESET button

Pushing the RESET button exits the display mode. The corresponding value of the input signal is displayed in the measurement value field.

5.2 Function: Changing parameter values

MODE button

Push once. The number 1 is displayed in the mode display field.

[↑] resp. [↓] buttons

Push repeatedly until the code number associated with the corresponding parameter Group is displayed.

Parameter Group	Code Number
1	11
2	22
3	3

MODE button

The mode selection is accepted. Now the parameter number 2 is displayed and the associated parameter value is displayed in the measurement value field.

[↑] resp. [↓] buttons

Switching the parameter values to next higher resp. next lower value.

MODE button

By pushing the MODE button you can switch to the next parameter. If changes are made to the parameter values, these are saved in an intermediate memory until you exit the parameter mode.

MODE + RESET buttons

All parameter settings are accepted and take immediate effect. The parameter mode is exited; the corresponding value of the input signal is displayed in the measurement value field.

RESET button

Changes made to the parameter settings are ignored. The previous parameter values are retained. The parameter mode is exited; the value corresponding to the input signal is displayed in the measurement value field.

5.3 Parameter: Group 1

Mode 1 Code number

Value: 11

Mode 2 Range allocation for analog output

Default value: 20 mm/s

Value	Equals
10	0 ... 10 mm/s
20	0 ... 20 mm/s
50	0 ... 50 mm/s
100	0 ... 100 mm/s

Switching of measuring ranges

Switching from a smaller range to a larger range:

The defined limits values are retained.

Switching from a larger range to a smaller range:

As long as the defined limit values are larger than the new full scale they will be converted to the new full scale. If the defined limit values are lower than the new full scale they will be retained.

The automatic change in limit values will be signalled by flashing of the respective alarm limit LEDs (LIM 1 and LIM 2). To reset this flashing the limit value settings must first be changed, i.e. limit values lower than the full scale must be set and the instrument switched off and then on again for the change to take effect.

Mode 3 Limit value LIM 1

Default value: 4.5 mm/s

The adjustable range of the limit value is from 0 to the full scale value of the selected range. The resolution of the steps in the adjustment is in every case dependent on the selected range.

Range	Resolution
0 ... 10 mm/s	0,1 mm/s
0 ... 20 mm/s	0,1 mm/s
0 ... 50 mm/s	0,2 mm/s (x,0 - x,2 - x,5 - x,7)
0 ... 100 mm/s	1 mm/s

Mode 4 Limit value LIM 2

Default value: 7 mm/s

The adjustable range of the limit value is from 0 to the full scale value of the selected range. The resolution of the steps in the adjustment is in every case dependent on the selected range.

Range	Resolution
0 ... 10 mm/s	0,1 mm/s
0 ... 20 mm/s	0,1 mm/s
0 ... 50 mm/s	0,2 mm/s (x,0 - x,2 - x,5 - x,7)
0 ... 100 mm/s	1 mm/s

Mode 5 Time delay LIM 1

Default value: 10 s

The range of the adjustable time delay is from 0 ... 100 s. in steps of 1 second. The parameter is only effective when there is a limit exceedance.

Note:

The minimum setting „0“ corresponds to a time delay of 1 second.

Mode 6 Time delay LIM 2

Default value: 5 s

The range of the adjustable time delay is from 0 ... 100 s. in steps of 1 second. The parameter is only effective when there is a limit exceedance.

Note:

The minimum setting „0“ corresponds to a time delay of 1 second.

Mode 7 High-pass filter value

Default value: 10 Hz

Entered value	Active filter value
1	1 Hz (Vers. > 2.8)
10	10 Hz

5.4 Parameter: Group 2

Mode 1 Code number

Value: 22

Mode 2 Sensor sensitivity

Default value: 100 mV/mm/s

At the same time the sensitivity of an acceleration sensor is selected, the integration for conversion of vibration acceleration to vibration velocity is activated.

Selection	Value	Sensor for	Requirement
1	75 mV/mm/s	v	
2	100 mV/mm/s	v	
3	100 mV/g	a	-24 V
4	10 mV/g	a	+ 4 mA
5	100 mV/g	a	+ 4 mA
6	10 mV/g	a	-24 V

Meaning: a = Vibration acceleration
v = Vibration velocity

Mode 3 Correction factor

Default value: 1.00

To allow sensors which have a sensitivity other than those listed in parameter 2 of Group 2 to be used with the instrument, the selected value can be corrected with a factor in the range 0.1 to 1.99.

Mode 4 DC Current output range

Default value: 4 ... 20 mA

Selection	Range
0	0 ... 20 mA
4	4 ... 20 mA

Mode 5 Limit relays operating mode

Default value: 0

This parameter affects both limit relays.

Selection	Mode
0	Normally energized
1	Normally de-energized
Normally energized:	The relay de-energizes when the limit is exceeded
Normally de-energized:	The relay energizes when the limit is exceeded

Mode 6 LED 7-segment display

Default value: 0

With this parameter the duration and intensity of the LED seven-segment display is set up.

Selection	Mode
0	after 3 minutes the LED display goes off.
1 ... 3	The display switches on with maximum brightness. After 3 minutes the brightness is reduced to the selected factor.
brightness	Larger number = Brighter display
4	Permanent display with maximum brightness

Mode 7 Analog output and Display test

Default value: 1

For test purposes various constant values, besides the standard signal, are switched to the analog outputs. To leave this test function activate RESET button.

Selection	Result
1	U 26/27 → corr. measurement signal I 28/29 → corr. measurement signal
2	U 26/27 → 0 V I 28/29 → 0 / 4 mA
3	U 26/27 → 10 V I 28/29 → 20 mA
4	U 26/27 → 5 V I 28/29 → 10 / 12 mA

The LED seven segments are switched on one after the other to display an 8 and the respective decimal points are switch on. The alarm LEDs flash in the sequence: green – yellow – red.

The current status of the OK and limit relays are not influenced during this test.

5.5 Parameter: Group 3 Service Parameter

Mode 1 Code number

Value: 3

Mode 2 DC rest voltage of the sensor

The DC rest voltage of the sensor is displayed. This should be in case of sensors

- type AS-02x between -14 V DC and -10 V DC
- Typ AS-06x bei 12,5 V \pm 1,5V supply powered sensors
- type AS-06x (CCS) 13 V DC \pm 1,5 V constant-current powered sensors
- type VS-080 0,8 V DC

With more negative voltages the display will flash.

Mode 3 Internal voltage 5 Volt

The 5 Volt power for the internal components of the instrument is displayed. The value should be in the range 4.8 V to 5.2 V. Values outside this range lead to the error message 'E 02'.

Mode 4 Internal voltage 17 Volt

The 17 Volt power for the internal components of the instrument is displayed. The value should be in the range 16.8 V to 19.0 V. Voltage values outside this range will lead to the error message 'E 02'.

Mode 5 Housing internal temperature

The temperature inside the instrument housing is displayed in °C. If the temperature inside the instrument exceeds the predefined limit the error message 'E 03' will be displayed.

Mode 6 Input amplifier amplification factor

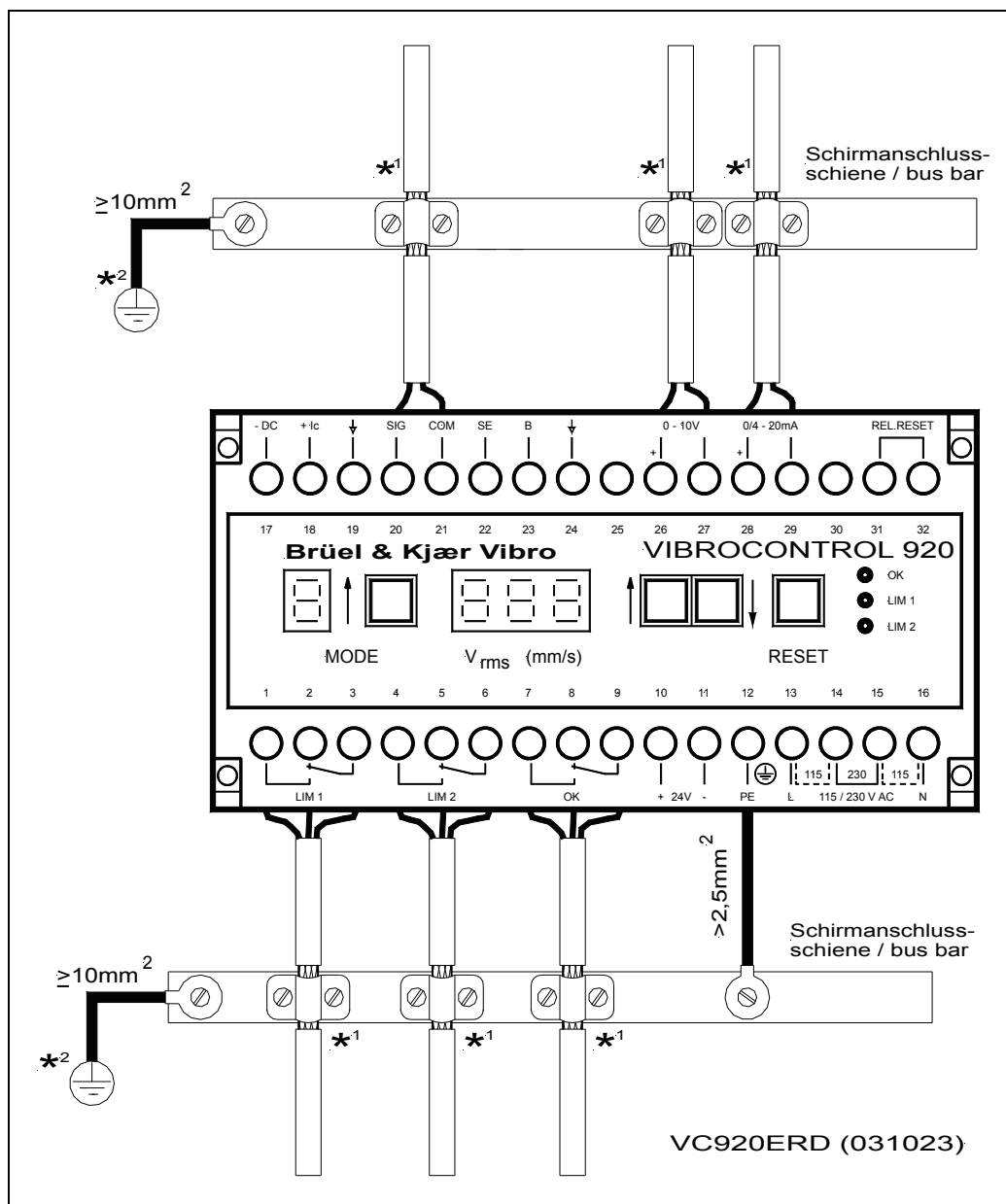
The current amplification factor of the input amplifier is displayed in steps of 1 - 2 - 4 - 8 - ... 128.

Mode 7 Output of the D/A converter

The display range of 0 ... 127 corresponds to 0 ... 20 mA

6 Mounting and Installation

6.1 Mounting and Installation Instructions



**1, *2 see the following page*

The quality of the measurements and the security of the electromagnetic resistance is dependent on a fault-free interference discharge and thus also on the cabling **and disturbance-free grounding at the installation.**

The connecting cables for the

- sensor,
- analog outputs,
- the RESET contacts and the
- relay contacts

must be shielded.

6.2 Connecting Cable shields (*¹)

- ◆ The connections for the cable shields **must have as large an area as possible.**
- ◆ Use a grounding rail for connecting the shields (e.g. type 210-133 / Fa. Wago) with suitable shield clamping saddles (e.g. type 790-108 / Fa. Wago up to 8 mm cable diameter).
- ◆ Expose and shape the cable shield in the form of a ring at the height of the grounding rail **only to the width of the grounding rail**, so that the cable remains shielded right up to close to the VC-920. The cable shield must be exposed only over the grounding rail.
- ◆ Connect the grounding rail with short cable having a cross-sectional area of min. 10 mm² to an interference-free ground.

6.3 Shield earth (*²)

- ◆ Prerequisite for a fault-free interference discharge is a low-resistance and **interference-free** ground connection.

Important!

Observe our „General grounding recommendations,, before cabling the system.

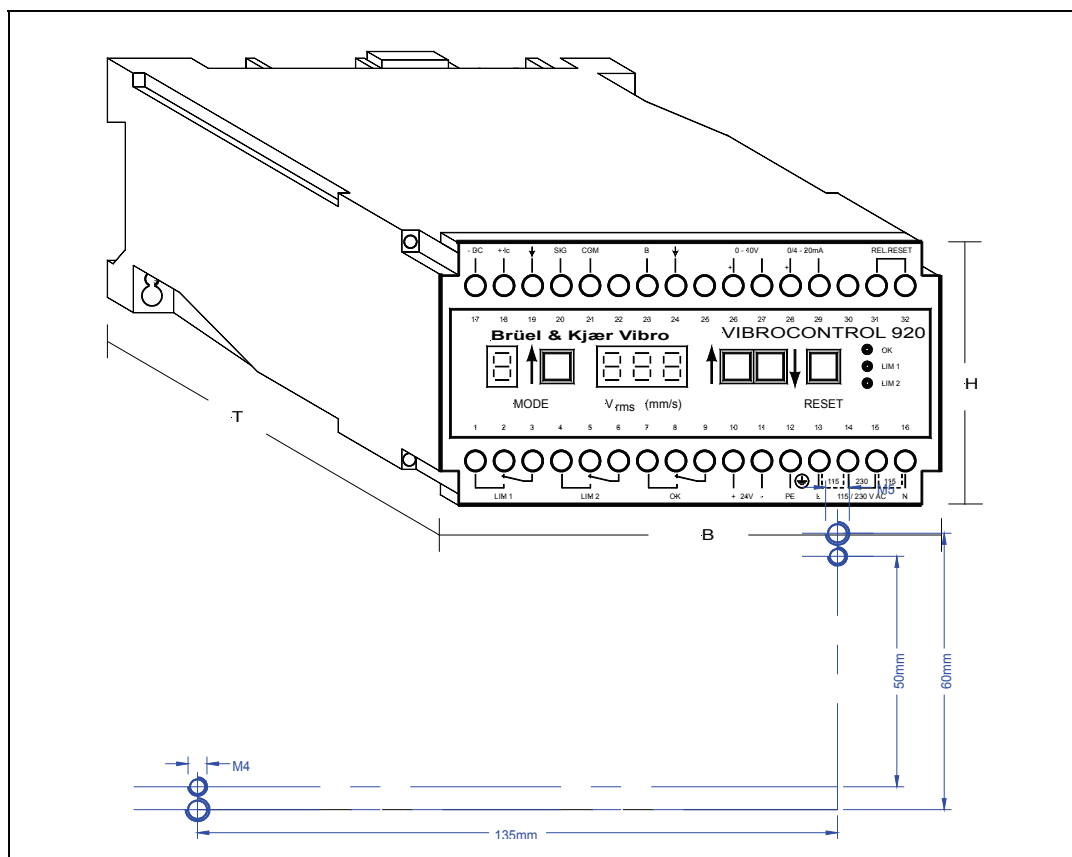
6.4 Mounting

Real panel mounting

2 M4 x 15 screws or
2 M5 x 15 screws

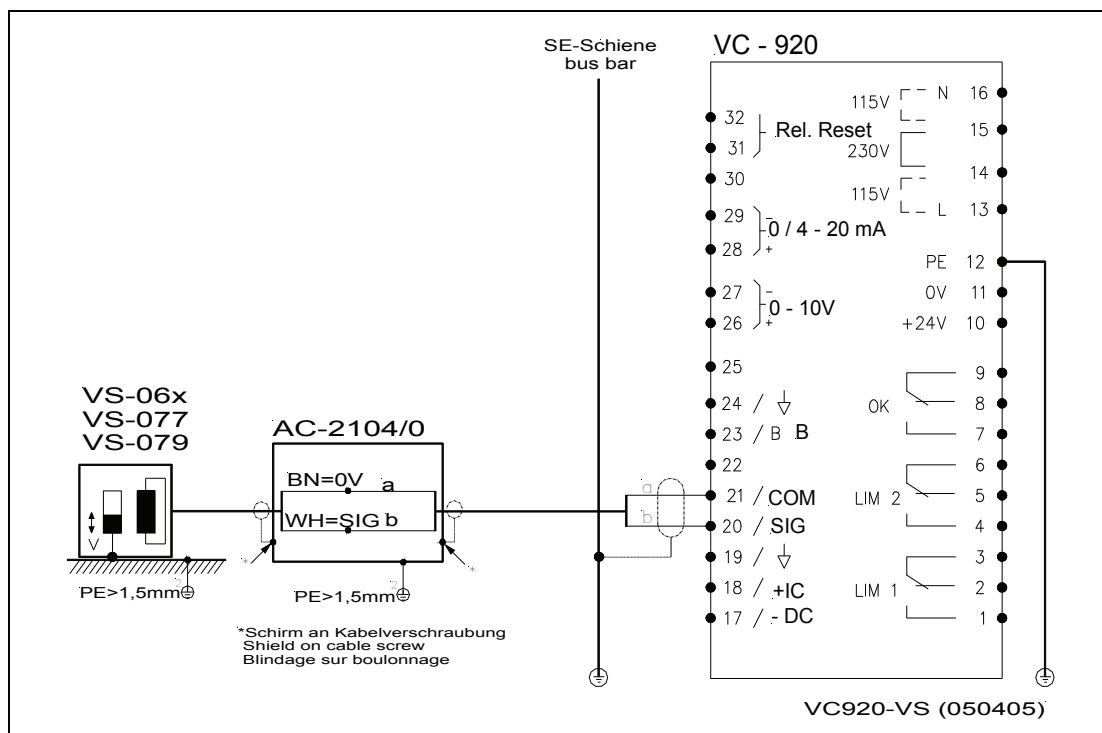
Rail mounting

35 mm profile rail (EN 50 022)

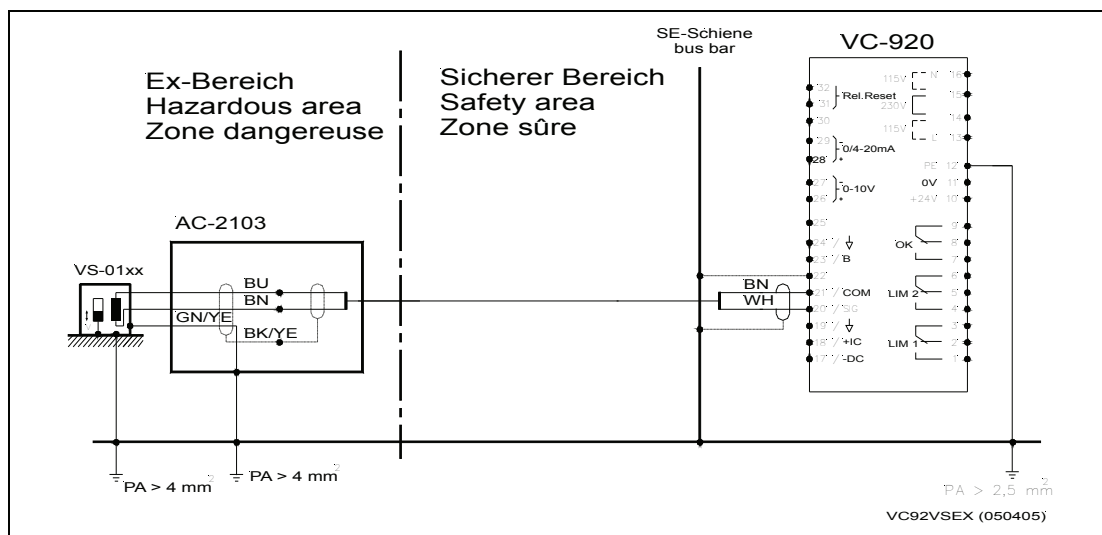


This page is for your notes.

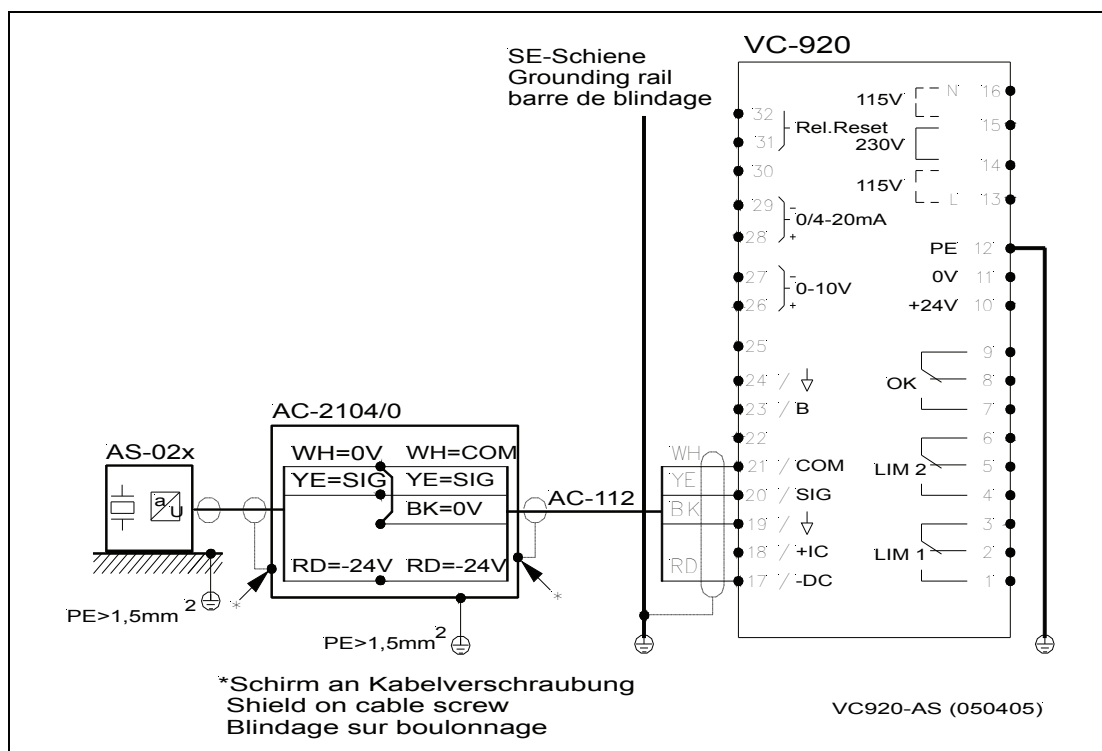
7 Wiring diagrams



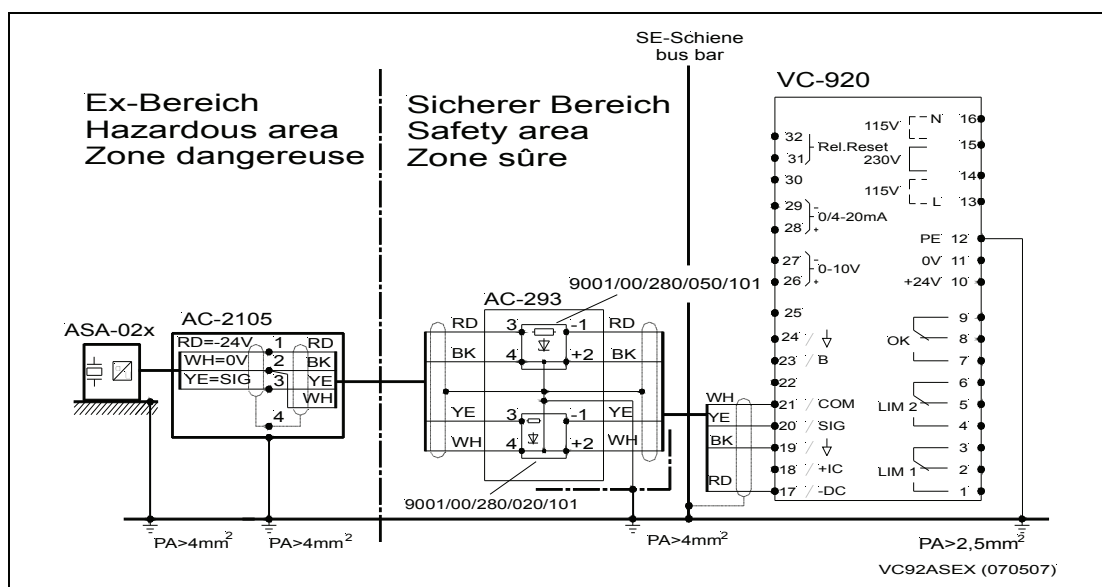
Vibration velocity transducer; standard connection (WH = white, BN = brown)



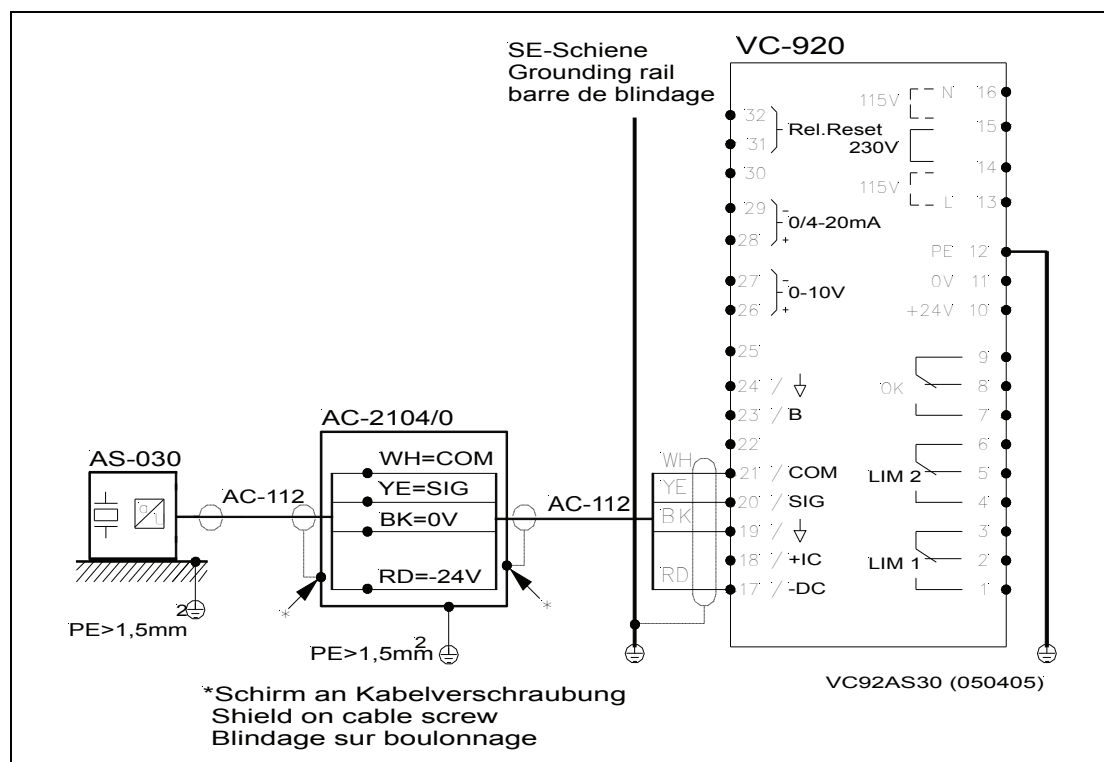
Vibration velocity transducer in Ex- area
(BU = blue, bn = brown, GN/YE = green/yellow, BK/YE = black/yellow, WH = white)



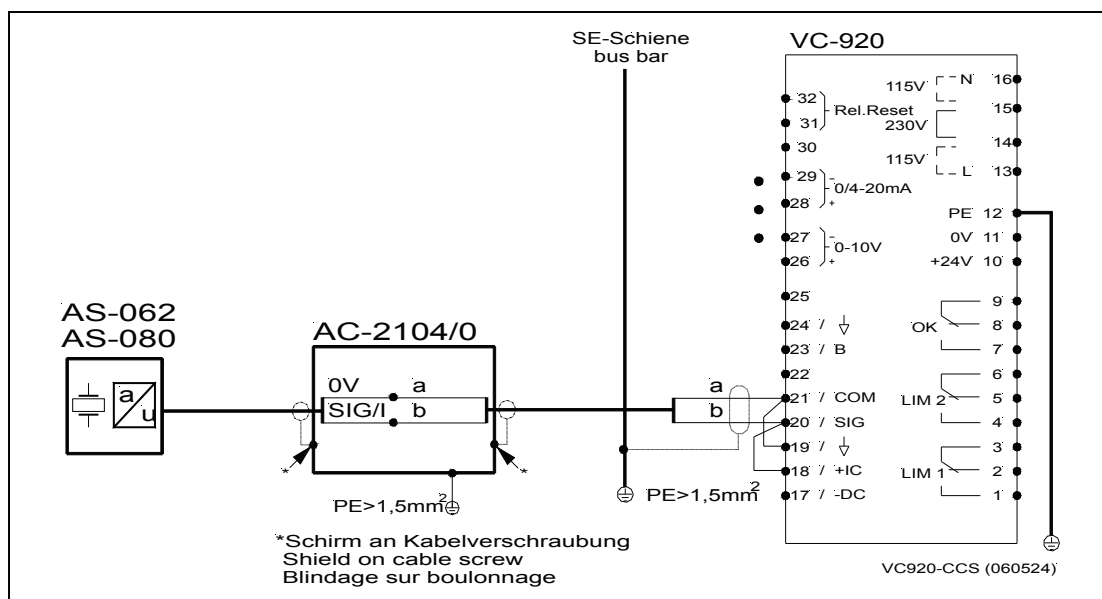
Vibration accelerometer; standard connection (WH = white, YE = yellow, RD = red)



Vibration accelerometer in Ex- area (RD = red, WH = white, YE = yellow, BK = black)

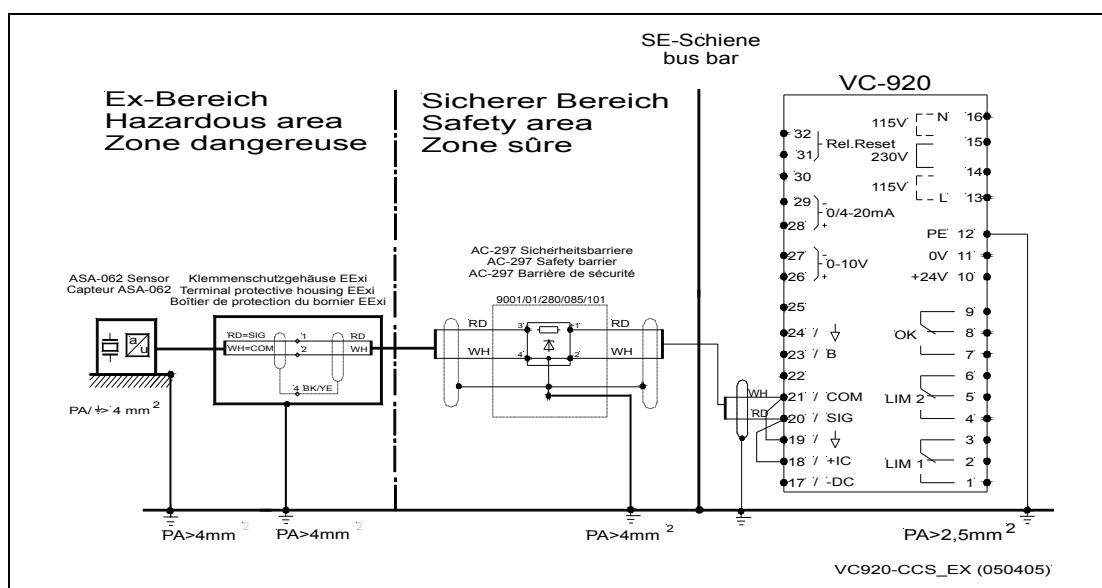


Vibration accelerometer; standard connection (WH = white, YE = yellow, RD = red)



Vibration acceleration sensor with constant-current power requirement

Connection of constant-current sensors by a co-axial cable is not permitted.



Vibration acceleration sensor with constant-current power requirement in hazardous area (RD = red, WH = white)

8 Service

In accordance with general valid quality assurance measures the instrument should be subjected to testing, calibration and/or adjustment at regular intervals. This can be done either by the on-site service personnel, at the Brüel Kjær Vibro Ltd manufacturing facility or at one of the authorized Brüel Kjær Vibro service stations. An inspection of this type is recommended at intervals of 5 years.

The time interval at which the calibration constants of the instrument should be subjected to automatic correction is 12 months.

9 Instrument versions

Version < 2.8

Filter settings

The value for the lower filter frequency amounts to 3 Hz resp. 10 Hz

Conduct at switch-on

During the self-test after switch-on or return of power, the OK relay and limit relays will be in the de-energized condition.

Version < 3.0

Full scale changes

If the full scale value

- Parameter group 1 Mode 2-
changes, the defined limit values
 - LIM 1: Group 1 Mode 3 and
 - LIM 2: Group 1 Mode 4
- are retained.

Analog output test

Selecting the analog output test function

- Parameter group 2 Mode 7 / 4 -
switched an AC voltage of 5 V and 195 Hz to the diagnostic output.

10 Parameter list

Instrument number

Measurement point

.....
.....

Parameter Group 1

Mode 2 Range assignment for analog output mm/s

Mode 3 Limit value LIM 1 mm/s

Mode 4 Limit value LIM 2 mm/s

Mode 5 Time delay LIM 1 s

Mode 6 Time delay LIM 2 s

Mode 7 High-pass filter value Hz

Parameter Group 2

Mode 2 Sensor sensitivity

Mode 3 Correction factor

Mode 4 DC Current output range mA

Mode 5 Limit relay operating mode

Mode 6 LED display

Mode 7 Analog outputs

Parameter Group 3

Mode 2 Sensor power V

Mode 3 Internal voltage 5 Volt V

Mode 4 Internal voltage 17 Volt V

Mode 5 Housing internal temperature °C

Mode 6 Input amplifier factor *

Mode 7 Output of D/A converter *

* The value is dependent on the actual input signal.



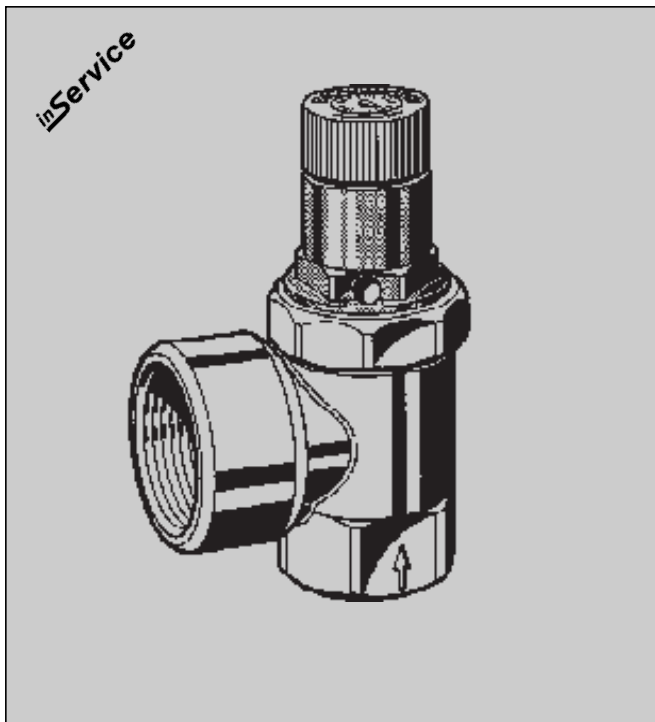
Brüel & Kjær Vibro

EG-Konformitäts-Erklärung
*Declaration of conformity*Hiermit bescheinigt das Unternehmen / *The company*Brüel & Kjær Vibro GmbH
Leydheckerstraße 10
D-64293 Darmstadtdie Konformität des Produkts / *herewith declares conformity of the product*Bezeichnung / *Designation***Mess- und Überwachungsgerät / Measuring and monitoring equipment****VIBROCONTROL 920**Typ / *Type***VC - 920 (ab Seriennummer 00004314)**mit folgenden einschlägigen Bestimmungen / *with applicable regulations below*
EG-Richtlinie / *EC directive***89/336/EWG
73/23/EWG****EMV-Richtlinie
Niederspannungsrichtlinie**Angewendete harmonisierte Normen / *Harmonized standards applied***DIN EN 61326 : 2004 - 05
DIN EN 61010**Angewendete nationale technische Spezifikationen / *National technical specifications applied*Gemeldete Stelle, EG-Baumusterprüfung / *Notified body, type test*Bereich / *Division*
Brüel & Kjær Vibro GmbHUnterschrift / *Signature*
CE-BeauftragterOrt/Place **Darmstadt**
Datum / *Date* **24.11.2005**
(N. Karg)

SM 152

Diaphragm safety valve for closed water heaters

Product specification sheet



Construction

- Angled housing
- Safety valve exchange insert, approved and comprising:
 - Screw-in section with hexagon
 - Spring bonnet
 - Security cap with certification and rating plate
 - Venting knob
 - Sealing disc
 - Diaphragm
 - Setting spring

Materials

- Brass housing
- High grade synthetic material screw-in section (for up to 6.0 bar set pressure) or brass (for set pressures above 6.0 bar)
- High grade synthetic material spring bonnet
- High grade synthetic material security cap
- High grade synthetic material venting knob
- Hot water resistant elastomer seal disc
- Hot water resistant elastomer diaphragm
- Spring steel setting spring

Application

Type SM 152 diaphragm-type safety valves are used to protect pressurised water heaters according to the requirements of DIN 4753, Part 1 and DIN 1988.

In accordance with statutory requirements, the diaphragm safety valve is preset to the required fixed set pressure by the manufacturer and is sealed with an embossed security cap marked with the test badge and pressure rating to prevent unauthorised tampering with the setting. Subsequent alteration of the setting is not permitted and is impossible without destroying the security cap. The preset pressure is embossed on the security cap.

The unique Honeywell Braukmann **inService** facility enables the valve to be serviced without removal from the pipework.

Special Features

- Tested to TRD 721
- Easy venting
- Replacement insert makes servicing simple
- **inService** – can be serviced without removal from the pipework
- Complies with KTW requirements
- Standardised discharge connection

Range of Application

For closed water heaters in compliance with DIN 4753, Part 1 and DIN 1988. Tested to TRD 721 for pressure range 1.0 bar to 10.0 bar.

Medium Water

Technical Data

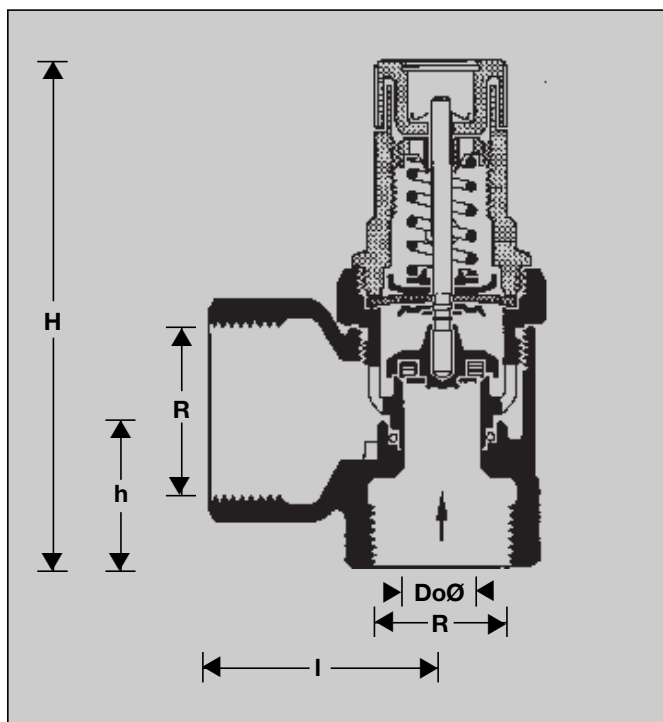
Installation position Horizontal with spring bonnet upwards
Set pressure Set by manufacturer at 6.0, 8.0 or 10.0 bar.

Special settings between 1.0 bar and 10.0 bar are also available. Subsequent alteration of the setting is not permitted and is impossible without destroying the security cap.

Operating temperature Maximum 95° C

Connection sizes 1/2" to 1 1/4"

Valve size is defined by the size of the inlet connection.



Method of Operation

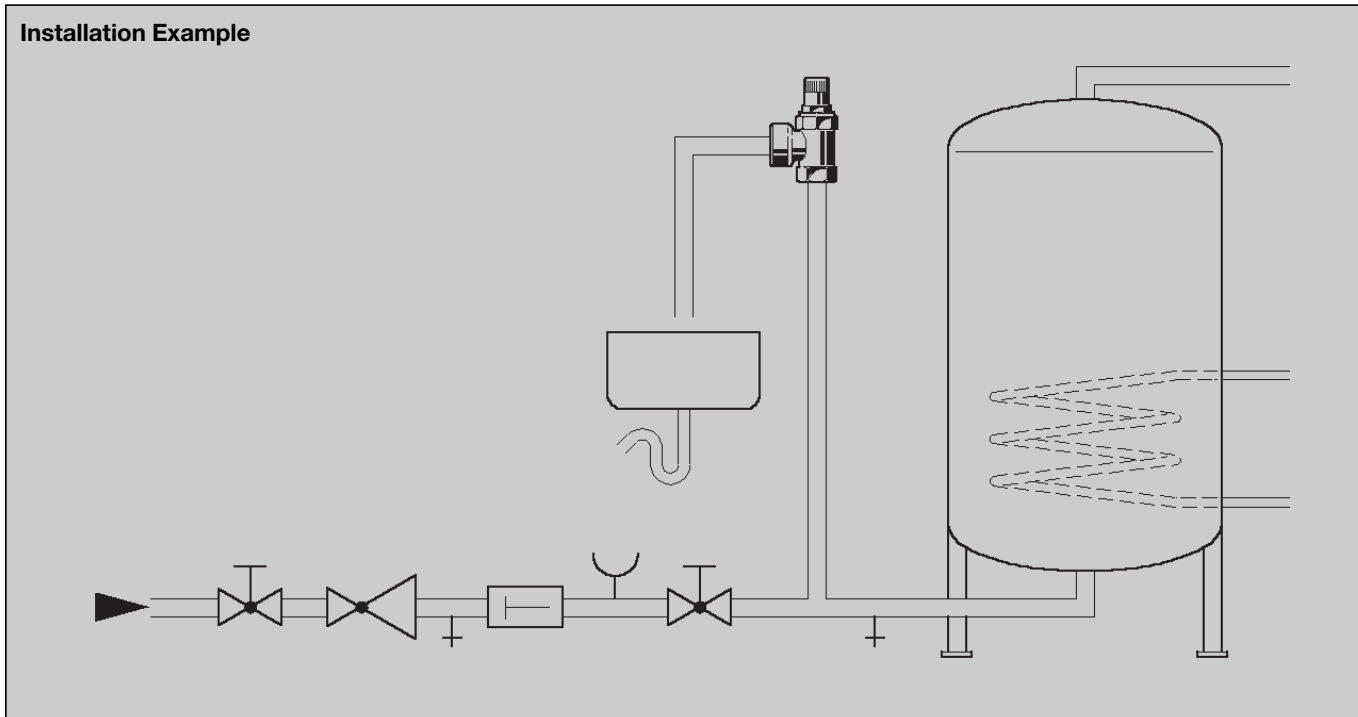
SM 152 diaphragm-type safety valves are direct-acting safety valves in which the disc is pushed up by the pressure from the system against a spring which is holding the valve closed. If the opening force exceeds the force exerted by the spring, then the valve disc is lifted off the valve seat and the valve discharges the medium. In accordance with the requirements of the standard, the full discharge capacity of the valve will be achieved when the system pressure climbs to no more than 10% above the set pressure of the valve. Full shutoff must be achieved if the system pressure falls to below 80% of the nominal set pressure of the valve. For valves rated up to 3.0 bar, the closing pressure can be taken as 0.6 bar minimum.

Options

SM 152- ... AA = Not chrome plated, set pressure 6.0 bar
 SM 152- ... AB = Not chrome plated, set pressure 8.0 bar
 SM 152- ... AC = Not chrome plated, set pressure 10.0 bar
 SM 152- ... BA* = Chrome plated, set pressure 6.0 bar
 SM 152- ... BC* = Chrome plated, set pressure 10.0 bar
 * 1/2" connection size only
 put in R Inlet
 Special versions available on request

Connection sizes					
Inlet	R	1/2"	3/4"	1"	1 1/4"
Outlet	R	3/4"	1"	1 1/4"	1 1/2"
Dimensions (mm)					
H		87	91	123	130
h		23	28	40	47
I		36	42	50	55
ø Do		14	14	18	18
For water heaters with capacity (litres)		up to 200	up to 1000	up to 5000	over 5000
Maximum permissible heat input (kW)		75	150	250	2200
TÜV Approval Nos.		TÜV · SV · 93 - 617 · (1/2" + 3/4", 1") · W · p (6-10 bar) TÜV · SV · 93 - 616 · 1 1/4" · W · 2200 · p (1-10 bar) TÜV · SV · 92 - 700 · (1/2" + 3/4") · W · p (1-6 bar)			

Installation Example



Installation Guidelines

- The safety valve must be installed in the cold water supply pipework before the water heater.
- The installation must be carried out so that:
 - There are no shutoff valves or fittings, narrowing of the pipework or strainers between the water heater and the safety valve.
 - Good access is provided for service and maintenance.
 - The safety valve is fitted above the top of the water heater to avoid the need for draining down when exchanging the safety valve insert.
 - If there is no drainage facility in the room where the heater is installed, then the safety valve may be fitted in an adjacent area.

Typical Applications

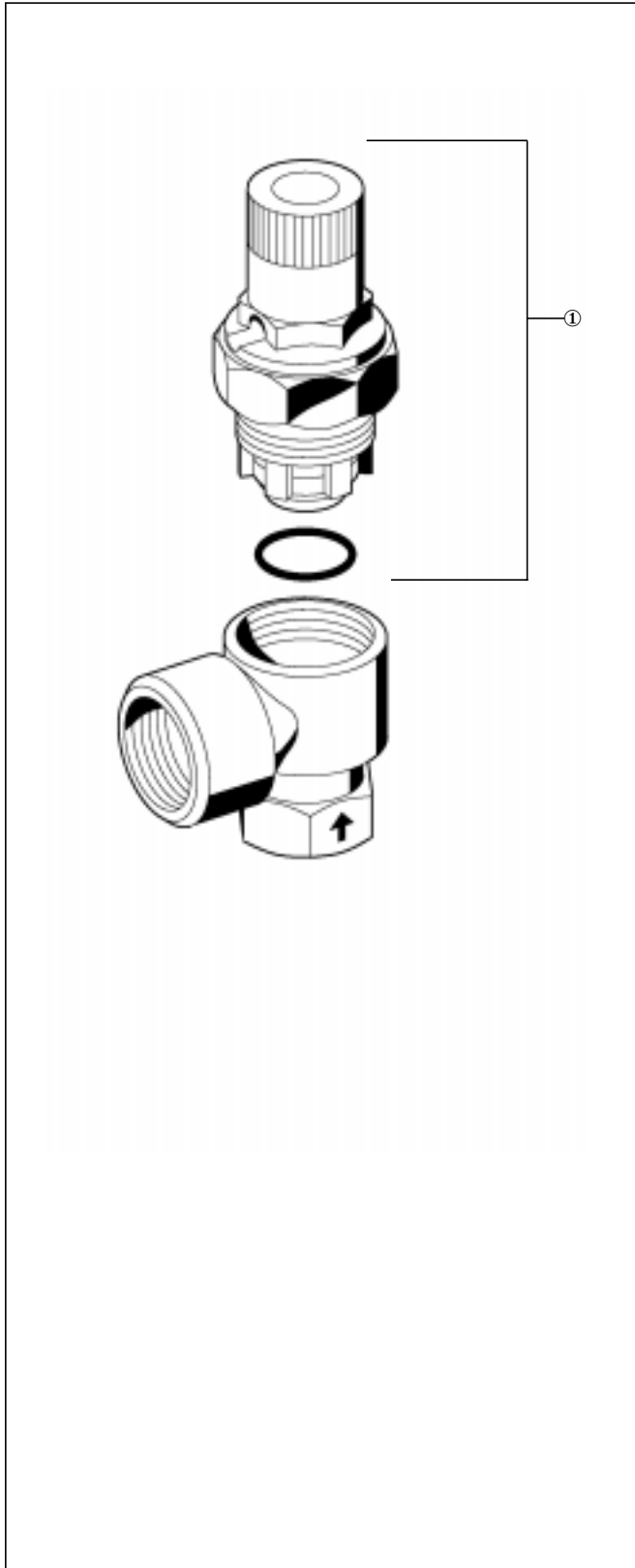
Diaphragm safety valves are installed in accordance with their specification upstream of water heaters. The following are some typical uses

- Central hot water supply systems
- Hot water storage units

Inspection and Maintenance

In accordance with DIN 1988, Part 8, the following operations should be carried out regularly. A planned maintenance scheme is recommended.

	Operation	Interval	Carried out by
Inspection and test	Check operation: Vent the valve during normal operation of the system. The discharged water should run away properly and the valve then fully shut off when released.	Every six months	User or specialist
Maintenance	If the valve does not function properly, venting several times may correct the situation. If not, a full overhaul of the valve will be necessary.	Annually	Specialist



Spare Parts for SM 152 Diaphragm Safety Valves (From 1981 onwards)

Description	Nominal Size	Part No.
① Safety valve insert		
Approval No.	TÜV · SV · 83/88/93 - 617- $\frac{1}{2}$ " + $\frac{3}{4}$ " · W · p	
Approval No.	TÜV · SV · 83/88/93 - 617-1" · W · p	
Approval No.	TÜV · SV · 83/88/92 - 700- $\frac{1}{2}$ " + $\frac{3}{4}$ " · W · p	
6.0 bar	$\frac{1}{2}$ " + $\frac{3}{4}$ "	A 152 - $\frac{3}{4}$ AA
	1"	A 152 - 1 AA
8.0 bar	$\frac{1}{2}$ " + $\frac{3}{4}$ "	A 152 - $\frac{3}{4}$ AB
	1"	A 152 - 1 AB
10.0 bar	$\frac{1}{2}$ " + $\frac{3}{4}$ "	A 152 - $\frac{3}{4}$ AC
	1"	A 152 - 1 AC
Safety valve insert with chrome plated body		
Approval No.	TÜV · SV · 83/88/93 - 617- $\frac{1}{2}$ " + $\frac{3}{4}$ " · W · p	
8.0 bar	$\frac{1}{2}$ " + $\frac{3}{4}$ "	A 152 - $\frac{3}{4}$ BB
10.0 bar	$\frac{1}{2}$ " + $\frac{3}{4}$ "	A 152 - $\frac{3}{4}$ BC
Safety valve insert		
Approval No.	TÜV · SV · 83/88/93 - 616-1 $\frac{1}{4}$ " · W · (2200) · p	
6.0 bar	1 $\frac{1}{4}$ "	A 160 - 1 AA
8.0 bar	1 $\frac{1}{4}$ "	A 160 - 1 AB
10.0 bar	1 $\frac{1}{4}$ "	A 160 - 1 AC

Subject to change 08/98

Honeywell AG

P.O. Box 1347 · D-74819 Mosbach (Germany)

☎ (+49) 0 62 61/8 10 · Fax (+49) 0 62 61/8 13 09

Honeywell
Braukmann

Flow Regulating Valve for fine flow control of fluids

The regulating valves used by RENK are employed for fine flow control of fluids. They will permit precise adjustment of oil flow rates as required for the lubrication of bearings (external oil circulation or hydrostatic jacking), particularly in combination with a RENK flow meter.

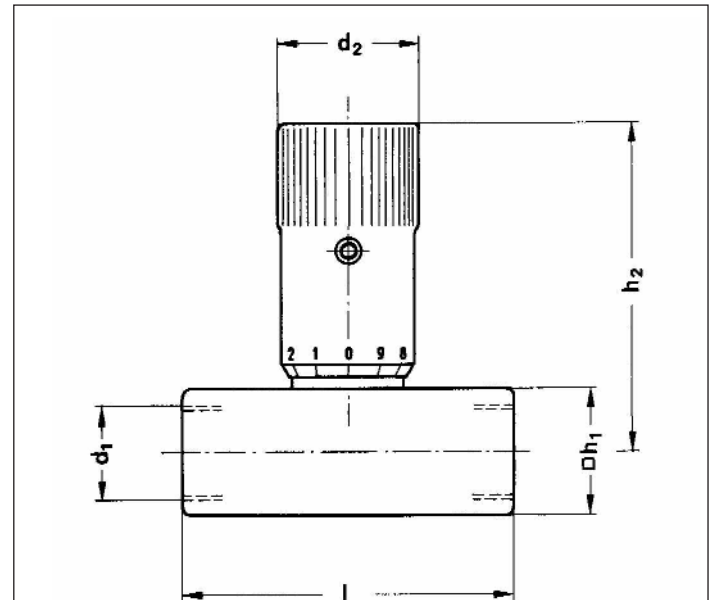
Six coloured rings and a vernier scale permit optimal control, easy read-out and excellent reproducibility.

Design and Operation

The square valve body is made of steel with internal threads (pipe threads DIN ISO 228) at either end for inline operation.

Adjustment is via a two-stage needle which permits very accurate setting of low rates for the first 3 turns. After further 3 turns the valve is fully open. The regulating cylinder or hexagon can be set in any position by means of a locking screw with hexagon socket. The valve can operate in optional position.

It should be noted that the oil throughput depends upon viscosity and pressure (see Fig. 1 and Fig. 2).



With size G 1 the knurled knob is replaced by a hexagonal adjusting knob SW 48

Dimensions in mm

d ₁	d ₂	h ₁	h ₂	l	max. operating pressure	max. throughput
G ½	30	32	68	67	350 bar	11 l/min
G ¾	35	38	83	83	210 bar	25 l/min
G 1	–	45	121	108	210 bar	55 l/min

Diagrams

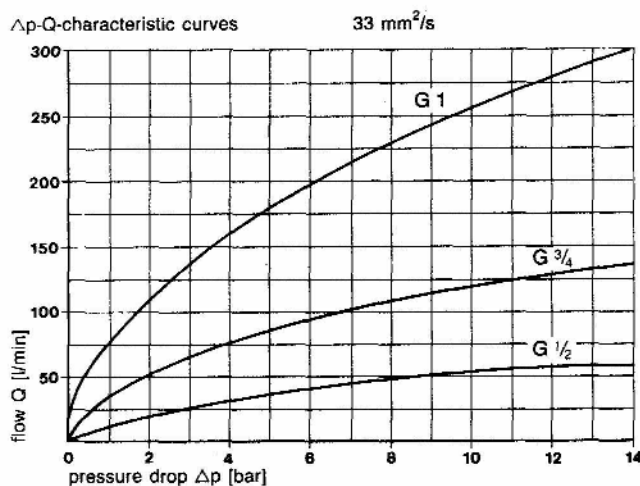


Fig. 1

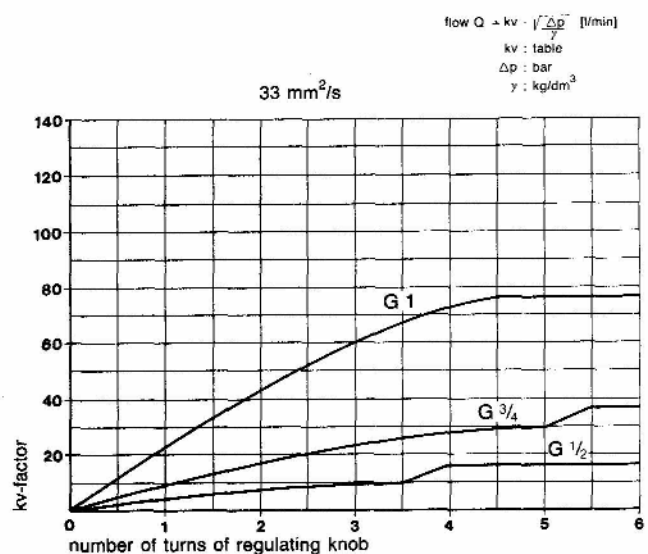


Fig. 2

EG-Konformitätserklärung

EC-Declaration of Conformity

Hersteller: ELIN EBG Motoren GmbH
Manufacturer: Elingasse 3
A-8160 Weiz

Beschreibung der Komponente
Description of product: Drehstrom-Synchrongenerator mit Trommelläufer
Three-phase synchronous generator with cylindrical rotor

Typ: HTM
Model:

Als Hersteller drehender, elektrischer Maschinen bescheinigen wir die Übereinstimmung der genannten Komponente mit folgenden Europäischen Richtlinien:

As a manufacturer of rotating electrical machines we hereby confirm the conformity of the above product with the following European directives:

73/23 EWG mit Änderungen durch 93/68/EC
73/23 EEC as per 93/68/EC
89/336/EWG mit Änderungen durch 93/68/EC
89/336/EEC as per 93/68/EC

Niederspannungsrichtlinie
Low Voltage Directive
EMV-Richtlinie
EMC Directive

Weitere Bestimmungen:
Further Directives:

98/37/EG
98/37/EEC

Maschinenrichtlinie
Machinery Directive

Weitere Angaben über die Einhaltung dieser Richtlinien sind auf Seite 2 ersichtlich.
Please continue on page 2 for further information on compliance with above directives.

Synchrongeneratoren sind Komponenten einer Maschine im Sinne der Maschinenrichtlinie 98/37/EG. Die Inbetriebnahme ist solange untersagt, bis die Konformität des Endproduktes mit dieser Richtlinie festgestellt ist (vgl. Anhang II, Absatz B der Richtlinie).

In accordance with EC Directive 98/37/EG, synchronous generators are intended solely for integration into other machines. Commissioning is prohibited until conformity of the end product with EC Directive 98/37/EG has been established (refer to Annex II, Section B of said Directive).

Ort, Datum: Weiz, 10.01.2006
Place, date


Ing. Gustav Hauschka
Geschäftsführer
managing director
Karl Schorna
Leiter Material Management
head of the material management department

EG-Konformitätserklärung

EC-Declaration of Conformity

**Diese Erklärung beinhaltet keine Zusicherung von Eigenschaften des Gerätes.
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.**

*Please note: this declaration will not imply warranty of any product properties.
Safety instructions must be observed according to the product documentation.*

Das umseitig angeführte Produkt entspricht folgenden Normen:

Above product complies with the following standards:

EN 292

Sicherheit von Maschinen. Grundbegriffe, Allgemeine Gestaltungsleitsätze

EN 292

Safety of machinery. Basic concepts, general principles for design

EN 60034 Reihe IEC 60034 series

Drehende elektrische Maschinen Rotating electrical machines

EN 60204-1

Sicherheit von Maschinen. Elektrische Ausrüstung von Maschinen. Teil 1: Allgemeine Anforderungen

EN 60204-1

*Safety of machinery - Electrical equipment of machines;
Part 1: General requirements*

Failure report for industry machines

1. Supplier

Company: ELIN EBG Motoren GmbH Elingasse 3 8160 Weiz Austria	Fax: (++43/3172) 5850
	Phone: (++43/3172) 606-2463
	E-mail: serviceemg@elinebgmotoren.at
Contact persons department services:	Mr. Günther Pöttler, Mr. Josef Nistelberger Mr. Manfred Schlagbauer

2. Customer

Company:	Fax:
	Phone:
	E-mail:
Contact person:	
Address of the plant:	<input type="checkbox"/> Description of way

3. Machine data

Serial number:	First starting up:
Project name:	Running hours:

4. Failure description

Date of breakdown:	Initiated by:
Failure description:	
Attach possibly existing recordings please!	
Plant in operation: <input type="checkbox"/> YES <input type="checkbox"/> NO	

Eichreihe für Platin-Widerstandsthermometer **Calibration for Platinum-Resistance Thermometers**

°C	Ohm	°C	Ohm
-100	59,90	+ 11	104,33
- 95	61,95	+ 12	104,72
- 90	64,00	+ 13	105,11
- 85	66,04	+ 14	105,50
- 80	68,08	+ 15	105,90
- 75	70,11	+ 16	106,29
- 70	72,14	+ 17	106,68
- 65	74,15	+ 18	107,07
- 60	76,18	+ 19	107,45
- 55	78,19	+ 20	107,83
- 50	80,20	+ 25	109,76
- 45	82,20	+ 30	111,70
- 40	84,20	+ 35	113,63
- 35	86,19	+ 40	115,56
- 30	88,18	+ 45	117,49
- 25	90,11	+ 50	119,42
- 20	92,14	+ 55	121,34
- 15	94,06	+ 60	123,26
- 10	96,08	+ 65	125,17
- 9	96,45	+ 70	127,08
- 8	96,85	+ 75	128,99
- 7	97,25	+ 80	130,90
- 6	97,64	+ 85	132,80
- 5	98,03	+ 90	134,70
- 4	98,42	+ 95	136,60
- 3	98,72	+ 100	138,50
- 2	99,21	+ 110	142,28
- 1	99,61	+ 120	146,04
0	100,00	+ 130	149,78
+ 1	100,39	+ 140	153,52
+ 2	100,79	+ 150	157,24
+ 3	101,18	+ 160	160,96
+ 4	101,58	+ 170	164,66
+ 5	101,97	+ 180	168,36
+ 6	102,36	+ 190	172,04
+ 7	102,75	+ 200	175,70
+ 8	103,15		
+ 9	103,54		
+ 10	103,92		