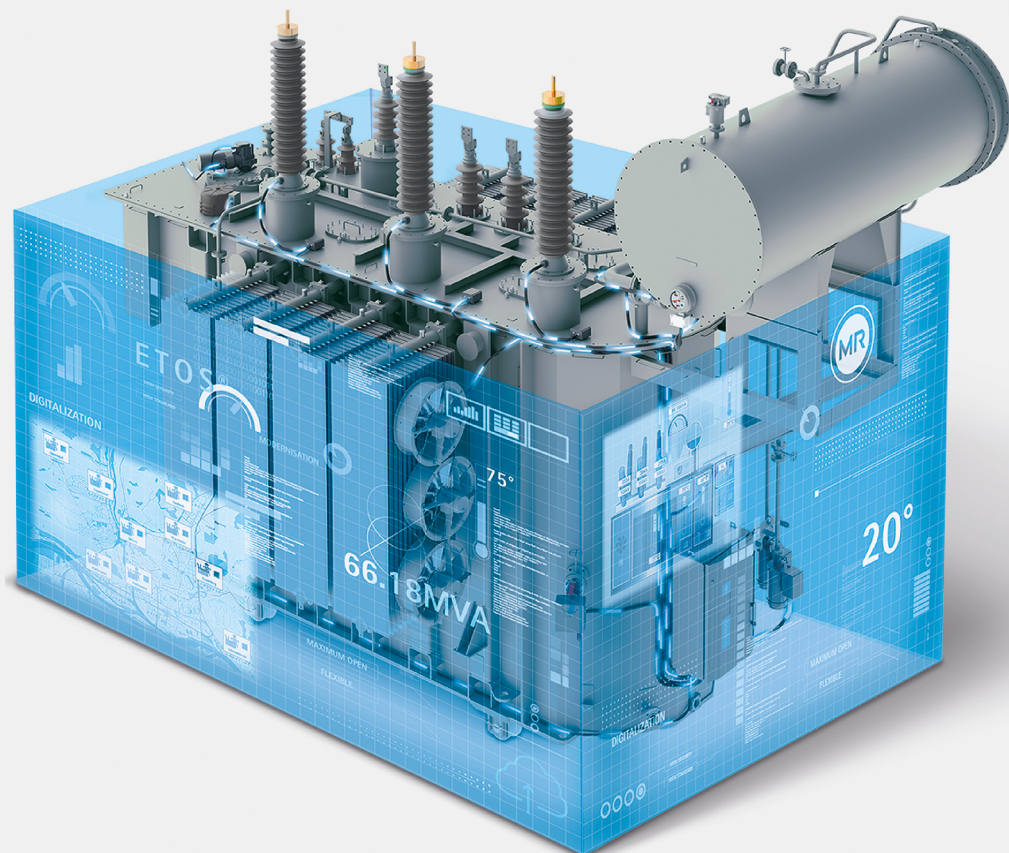




# Product catalog ETOS®

7966081/11 EN



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The product may have been altered since this document was published.

We reserve the right to change the technical data, design and scope of supply.

Generally the information provided and agreements made when processing the individual quotations and orders are binding.

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# 1 Introduction

With ETOS® (Embedded Transformer Operating System), we provide an open system solution for reliable monitoring, control, regulation and digitalization of power transformers.

This product catalog provides you with an overview of the functions that you can order in the standard scope of delivery. Special applications, such as controlling phase-shifting transformers, are available on request.

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## 1.1 Modular design and applications

ETOS® is characterized by a modular design that enables requirements from the widest range of applications to be met to the best possible extent.

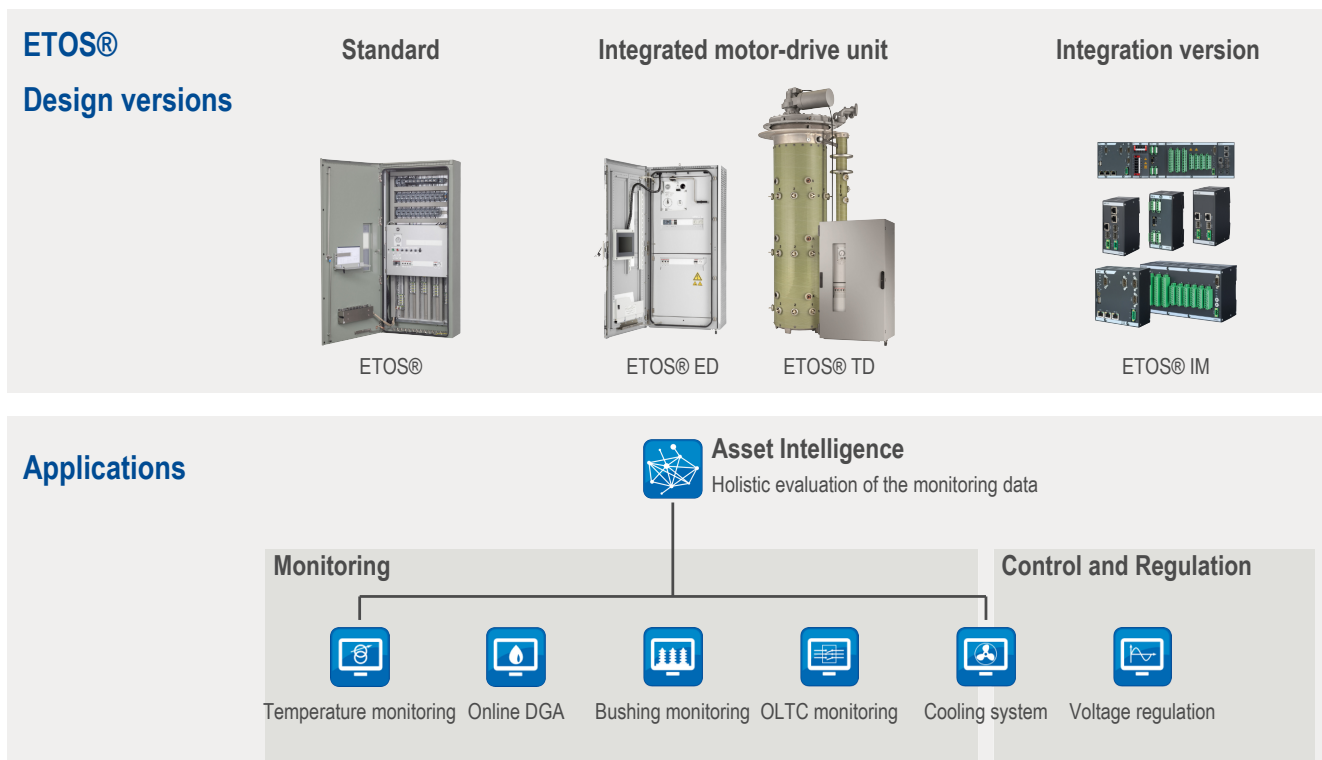


Figure 1: Versions and applications

## 1.2 MR sensor portfolio



Figure 2: MR sensor portfolio

You can monitor the condition of the transformer ideally with the sensors of the Maschinenfabrik Reinhausen portfolio.

### Intelligent sensors

- Winding temperature: MSENSE® FO
- High voltage bushings: MSENSE® BM
- Dissolved gas analysis: MSENSE® DGA
- On-load tap-changers: MSENSE® VAM
- Dehydrating breather: MESSKO® MTRAB® 2.5

### Conventional sensors

- Oil temperature:
  - MESSKO® COMPACT
  - MESSKO® BeTech
- Oil level:
  - MESSKO® MMK
  - MESSKO® MTO

# 2 ETOS® designs

## 2.1 ETOS®

The stand-alone version of ETOS® enables you to evaluate and record all relevant operating data of your power transformer, such as monitoring the tap changer and evaluating transformer utilization. ETOS® helps with the targeted planning of operation and maintenance. Our open ETOS® system can connect sensors from other manufacturers and combine all of the signals in the cabinet. ETOS® complements existing secondary control cabinets and tap-changer drives. Customized upgrades ensure you always have the best configuration for future tasks.



Figure 3: ETOS®

## 2.2 ETOS® ED

In addition to driving the on-load tap-changer, ETOS® ED enables you to evaluate and record all relevant operating data of your power transformer, such as monitoring the tap changer and evaluating transformer utilization. ETOS® ED helps with the targeted planning of operation and maintenance. The stable, proven housing protects both the motor-drive unit and the integrated monitoring

system. Optional automation solutions such as voltage regulation and cooling system control can also be included in the ETOS® ED order.



Figure 4: ETOS® ED

## 2.3 ETOS® TD

In the ETOS® TD drive for tap changers, the energy is made available precisely where it is needed – i.e. at the tap-changer cover. The drive commands generated in the control cabinet are transmitted via cable connection to the motor installed above (connection cable length: 6.5 m). This eliminates the need for a rigid drive-shaft connection and the complex and time-consuming task of installing it. Furthermore, ETOS® TD guarantees maximum safety during diverter switch operations on the tap changer being driven. The intelligent drive checks all key parameters via the OLTC PreCheck function.



Figure 5: ETOS® TD

## 2.4 ETOS® IM

With the ETOS® IM integration version, you can integrate the entire spectrum of ETOS® applications into your own control cabinet. This provides you with ultimate flexibility in utilizing the available installation space in your system.



Figure 6: ETOS® IM

# 3 Applications and functions

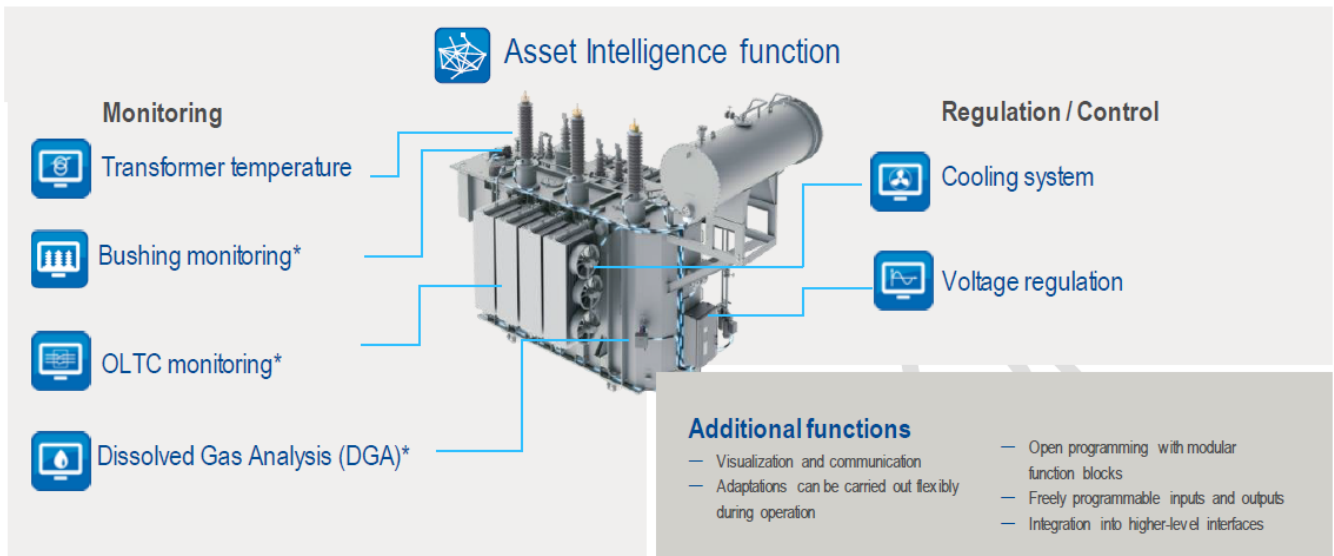


Figure 7: Modular system solution

## Asset Intelligence

Asset Intelligence utilizes the advantages of a powerful, local Edge computing system, integrated application, control and monitoring functions, comprehensive signal acquisition and analysis, and innovative algorithms for cognitive machine learning.

Asset Intelligence determines predictive maintenance indicators and provides you with support in troubleshooting processes. Depending on the selected scope of functions, Asset Intelligence determines possible causes of local events and derives recommendations for action.

## 3.1 General

You can select the following general control cabinet properties.

### Ambient temperature

- 25...+50 °C: Single-wall control cabinet design
- 40...+50 °C (arctic): Double-wall control cabinet design

### Protective coating color

- RAL 7032 (pebble grey)
- RAL 7033 (cement gray)
- RAL 7035 (light gray)
- RAL 7038 (agate gray)
- RAL 9001 (cream)
- RAL 9006 (white aluminum)
- ANSI 70 (light gray)
- BS381C632 (dark admiralty grey)

Special colors are available on request.

## Corrosivity category

You can select which corrosivity category the control cabinet is to comply with in accordance with ISO 12944-2.

- C4 high
- C4 very high
- C5 high
- C5 very high
- CX

## 3.2 Documentation

### Operating instructions

You can select the operating instructions language and the quantity to be delivered.

- Transformer manufacturer operating instructions: Copy for the OEM
- Operator operating instructions: Copy for the end customer

### Connection diagram

You can select the connection diagram language and the control cabinet signs and markings language.

If you select an additional connection diagram language, you will be supplied with another copy of the connection diagram in the selected language.



### VDE application rule

You can select whether the connection diagram is created in accordance with VDE-AR-E 2660-600-1.

### Connection diagram type

You can select the connection diagram type:

- Modular circuit diagram
- Multi-sheet version: Modular circuit diagram with additional assembly plan

### Connection diagram standard

You can select which standard the connection diagram complies with:

- IEC 60617
- ANSI
- CANA (Canada)

### Connection diagram version

You can select which material the connection diagram is printed on:

- Paper, DIN A4
- Tear- and water-resistant foil, DIN A4

### Operator standard

You can select whether the connection diagram is designed in accordance with an operator standard.

### Connection diagram number

You can enter the connection diagram number from a reference order. The device will then be configured as per the reference order as far as possible.

## User interface (GUI)

You can select up to 2 additional user interface languages for the device. English and German are included as standard.

## 3.3 Communication and protocols

### IT security

ETOS® is equipped with the following functions to ensure secure operation:

Option	Basic	Pro
Firewall in accordance with IEC 62443	•	•
Encrypted connection establishment in accordance with BSI TR 02102 (SSL/TLS; RSA and ECC in accordance with NIST)	•	•
Security log for recording security-relevant changes: Login, logout, changing values and settings, import, export configuration changes, event acknowledgement	•	•
"Role-Based Access Control (RBAC)" role-based user administration in accordance with IEC 62351	•	•
Password management in accordance with NERC-CIP: Password complexity and encoded password storage in accordance with FIPS-PUB 180-4	•	•
Defense in depth: Robust and durable operating-system-interface monitoring (option to deactivate non-essential hardware interfaces)	•	•
Safeguarding the integrity of firmware, software and data through cryptographic procedures	•	•
User authentication via RADIUS in accordance with RFC 2865	-	•

Table 1: Available options (• = included, ○ = optional, - = not available)

### Visualization (remote access)

You can select whether remote access to the web-based ETOS® user interface is possible. With this option, you can configure the device and import and export data remotely.

In addition, you can select the interface to be used:

- RJ45
- Fiber-optic cable LC 1310 nm

### Control system protocol

You can choose which control system you want to integrate ETOS® into. In addition, you can select the interface to be used:

Control system / interface	RJ45	OF LC 1310 nm	OF LC 1310 nm HSR	OF LC 1310 nm PRP
IEC 61850 Ed1 / Ed2 (MMS only)	○	○	○	○
IEC 61850 GOOSE	○	○	○	○
DNP3	○	○	○	○
Modbus TCP	○	○	○	○
IEC 60870-5-104	○	○	○	○

Table 2: Ethernet interfaces (• = included, ○ = optional, - = not available)

Control system / interface	RS232	RS485	RS232 OF FS-T 660 nm	RS232 OF FS-T 850 nm	RS232 OF FSMA 660 nm	RS232 OF FSMA 850 nm
DNP3	○	○	○	○	○	○
Modbus RTU	○	○	○	○	○	○
Modbus ASCII	○	○	○	○	○	○
IEC 60870-5-101	○	○	○	○	○	○
IEC 60870-5-103	○	○	○	○	○	○

Table 3: Serial interfaces (• = included, ○ = optional, - = not available)

### MR sensor bus

The MR sensor bus function lets you connect digital and analog sensors to the device via Modbus RTU. The MR sensor bus supports the connection of up to 31 sensors (Modbus slaves). The ISM® device operates as the Modbus master.

### IoT connection

You can select whether ETOS® is to transmit data to superordinate systems via MQTT. You can select the following options:

- ETOS® web server: No connection via MQTT. Manual data retrieval possible via the visualization.
- MQTT publisher: Provision of an MQTT interface in ETOS®
- MQTT connection to TESSA®: Provision of an MQTT interface in ETOS® and preconfigured data transmission to TESSA®

## TPLE

The TPLE function package lets you program simple logical links via the web-based visualization. You can also link the inputs and outputs available on the device using function modules.

## Additional inputs/outputs

You can select additional free inputs and outputs for the device. You can link these inputs and outputs to device functions using the visualization or create your own functions using the TPLE [► Page 11] functions.

### Additional digital inputs (GPDI)

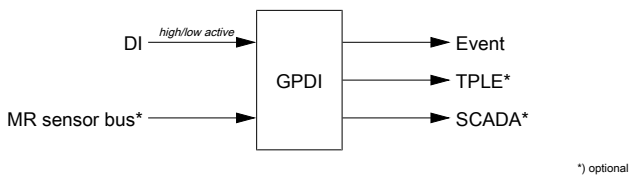


Figure 8: GPDI

You can configure the additional digital inputs in the device. You can link the additional digital inputs to event messages, digital outputs and control system messages.

You can select the number of additional digital inputs: 4, 8, 12 or 20.

### Additional digital outputs (GPDO)

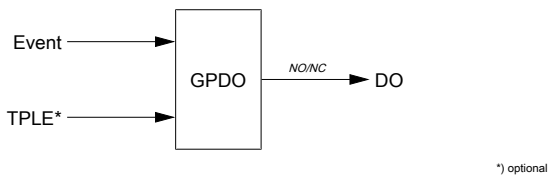


Figure 9: GPDO

You can configure the additional digital outputs in the device (NO, NC). You can link the additional digital outputs to event messages.

You can select the number of additional digital outputs: 4, 8, 12 or 20.

### Additional analog inputs (GPAI)

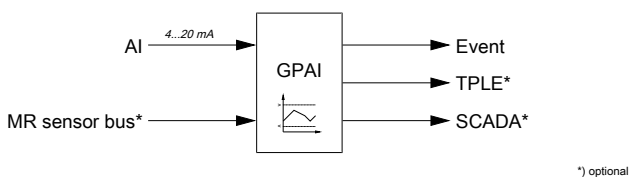


Figure 10: GPAI

You can configure the additional analog inputs in the device (signal type, min., max., decimal places, unit, correction factor, offset). You can configure and monitor 4 limit

values for each input. You can link the additional analog inputs to additional analog outputs or transmit the acquired values via the control system.

You can select the number of additional analog inputs: 1, 2, 3, 4, 6, 8, 10 or 12.

### Additional analog inputs for temperature measurement (GPAI)

You can configure the additional analog inputs for temperature measurement in the device (min., max., correction factor, offset). You can configure and monitor 4 limit values for each input. You can link the additional analog inputs to additional analog outputs or transmit the acquired values via the control system.

You can select the number of additional analog inputs: 1, 2, 3 or 4.

### Additional analog outputs (GPAO)

You can configure the additional analog outputs in the device (signal type, min., max., decimal places, unit, correction factor, offset).

You can select the number of additional analog outputs: 1, 2, 3, 4, 6, 8, 10 or 12.

## 3.4 Thermal monitoring

The thermal monitoring applications are comprised of various functions for monitoring the active part of the transformer.

### Thermal monitoring

You can select which thermal monitoring functions the device is to support:

Option	Basic	Pro
Monitoring the status of the protective devices (e.g., RS2001 protective relay, Buchholz relay, pressure relief device)	•	•
Grid measurement, monitoring and recoding of voltage, current, frequency, active power, reactive power, apparent power and power factor	•	•
Temperature monitoring (ambient temperature, top-oil temperature, calculation of hot-spot temperature in accordance with IEC 60076-7 or IEEE C57.91)	•	•
Loss-of-life and relative aging rate	•	•
Paper moisture determination and monitoring	-	•
Bubbling temperature calculation and monitoring	-	•
Dynamic transformer overload calculation	-	•

Table 4: Available options (• = included, ○ = optional, - = not available)

### Temperature sensors

You can select which temperature sensors are included in the delivery:

- Ambient temperature sensor
- Ambient temperature sensor and sensor for measuring the transformer top-oil temperature

### Direct winding temperature measurement (FO)

ETOS® includes the following functions for measuring the winding temperature via a dedicated sensor:

- 4 adjustable limit values for the winding temperatures
- Configurable event messages for limit-value violations
- Central ETOS® measured value memory
- Time series visualization in ETOS® with optional comparison of further data (e.g., load current)
- Data transfer to SCADA (optional)
- Cooling system control with measured FO winding temperatures (optional)

You can select which type of sensor you want to use for measuring the winding temperature:

- MSENSE FO: Connection of an MSENSE FO that is not installed in the control cabinet; the device is available or is supplied separately.
- 3rd party: Connection of a sensor with evaluation electronics from a third-party manufacturer via MR sensor bus, maximum 24 FO channels.
- Integrated FO measurement: Evaluation electronics for GaAs technology for fiber diameters of 62.5 µm or 200 µm for direct integration in ETOS®. Control cabinet mounting via DIN cap rail. Number of available inputs selectable:
  - 8 optical inputs
  - 12 optical inputs (only for 200 µm)
  - 16 optical inputs
  - 20 optical inputs (only for 200 µm)
  - 24 optical inputs (only for 200 µm)

### Grid measurement

Grid measurement is comprised of the monitoring and recoding of voltage, current, frequency, active power, reactive power, apparent power and power factor. You can select how you want to perform grid measurement:

- 1-phase measurement of current and voltage
- 3-phase measurement of current and voltage
- External load current measurement and provision as an analog signal (4...20 mA); no voltage or frequency measurement

### Hot-spot calculation HV/MV/LV

Hot-spot calculation on three different windings (HV, MV, LV) with individually adjustable calculation parameters in accordance with the thermal models of the IEC 60076-7 and IEEE Std C57.91 standards.

This option is only available if you have selected the "3-phase measurement" option for voltage and current measurement.

## 3.5 Online DGA

You can monitor the oil quality of the transformer and the on-load tap-changer with the online DGA application. Depending on the number of gases detected via one DGA sensor, ETOS provides the following monitoring functions:

- Trend analysis
  - 4 adjustable limit values for absolute values and gas increase rates
  - Configurable event messages for limit-value violations
  - Central ETOS® measured value memory
  - Time series visualization in ETOS® with optional comparison of further data (e.g., load current)
  - Data transfer to SCADA (optional)
- Analysis models
  - Integrated analysis models in accordance with Duval, Rogers, Dörnenburg and IEC 60599

ETOS® is preconfigured for the connection of the following sensors via the MR sensor bus (Modbus). Connecting sensors via analog signals (4...20 mA) is possible on request.

Sensor option <sup>1</sup>	Trend analysis	Analysis models
MSENSE® DGA 2 (H <sub>2</sub> O, H <sub>2</sub> )	•	-
MSENSE® DGA 3 (H <sub>2</sub> O, H <sub>2</sub> , CO)	•	-
MSENSE® DGA 5 (H <sub>2</sub> O, H <sub>2</sub> , CO, C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> )	•	•
MSENSE® DGA 9 (H <sub>2</sub> O, H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> , O <sub>2</sub> )	•	•
HYDROCAL 1001 (H <sub>2</sub> O)	•	-
HYDROCAL 1003 (H <sub>2</sub> O, H <sub>2</sub> , CO)	•	-
HYDROCAL 1005 (H <sub>2</sub> O, H <sub>2</sub> , CO, C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> )	•	•
HYDROCAL 1008 (H <sub>2</sub> O, H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> )	•	•
HYDROCAL 1009 (H <sub>2</sub> O, H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> , O <sub>2</sub> )	•	•
Transfix 9 (H <sub>2</sub> O, H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> , O <sub>2</sub> )	•	•
3 <sup>rd</sup> -party trend analysis	•	-
3 <sup>rd</sup> -party analysis models	•	•

Table 5: Scope of functions (• = available, - = not available)

### DGA sensor

You can select which DGA sensor from Maschinenfabrik Reinhausen is included in the scope of delivery:

#### MSENSE® DGA 3

- Measurement of H<sub>2</sub>O, H<sub>2</sub> and CO<sub>2</sub>
- Degree of protection IP66
- Ambient temperature -40...+60 °C
- Data transmission via MR sensor bus (Modbus RTU)

The following alternative versions are available:

- Measuring pipe length 285 mm, flange DN50, flat gasket PN16, housing RAL 7033 (cement gray)
- Measuring pipe length 285 mm, flange DN80, flat gasket PN16, housing RAL 7033 (cement gray)
- Measuring pipe length 285 mm, flange DN50, o-ring, housing RAL 7033 (cement gray)
- Measuring pipe length 507 mm, flange DN80, o-ring, housing RAL 7033 (cement gray)
- Measuring pipe length 507 mm, flange DN80, o-ring, housing RAL 7038 (agate gray)
- Dimensions [► Page 47]

#### MSENSE® DGA 5

- Measurement of H<sub>2</sub>O, H<sub>2</sub>, CO, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>
- Degree of protection IP55
- Ambient temperature -55...+55 °C
- Data transmission
  - MR sensor bus (Modbus RTU)
  - 5 analog outputs 4...20 mA (freely configurable)
  - 5 digital outputs for alarms and status messages (freely configurable)

The following alternative versions are available:

- 51110: Thread connection 1 1/2" DIN ISO 228-1, U<sub>N</sub> 230 VAC
- 52110: Thread connection 1 1/2" NPT ANSI B 1.20.1, U<sub>N</sub> 230 VAC
- 52210: Thread connection 1 1/2" NPT ANSI B 1.20.1, U<sub>N</sub> 120 VAC
- Dimensions [► Page 51]

#### MSENSE® DGA 9

- Measurement of H<sub>2</sub>O, H<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, O<sub>2</sub>
- Degree of protection IP55
- Ambient temperature -55...+55 °C
- Data transmission
  - MR sensor bus (Modbus RTU)
  - 10 analog outputs 4...20 mA (freely configurable)
  - 10 digital outputs for alarms and status messages (freely configurable)
- 92210: Thread connection 1 1/2" NPT ANSI B 1.20.1, U<sub>N</sub> 120 VAC
- Dimensions [► Page 53]

<sup>1</sup> H<sub>2</sub>O: Water content of the oil, relative or absolute (depending on the sensor)

## 3.6 OLTC monitoring

The OLTC monitoring function package is used for monitoring on-load tap-changers on power transformers/reactors.

	Basic <sup>2</sup>	Pro	Expert
Status of the motor-drive unit	•	•	•
Tap position capture	•	•	•
On-load tap-changer switching statistics	•	•	•
Oil temperature monitoring	•	•	•
Maintenance interval monitoring	•	•	•
Contact wear calculation (only for OILTAP® V, M, R, RM, MS, G, T)	•	•	•
Oil carbonization (only for OILTAP® V, M, R, RM, MS, G, T)	•	•	•
Torque monitoring	-	-	•
Motor Current Index (MCI)	-	○	-
Vibro-acoustic monitoring of the on-load tap-changer (VAM)	-	○	○

Table 6: Options (• = included, ○ = optional, - = not available)

### Maintenance interval monitoring

Monitoring of the maintenance of on-load tap-changers and accessories. This function enables status-based maintenance of the on-load tap-changer. In addition, a freely definable maintenance interval for on-load tap-changers (based on number of tap-change operations or based on time) and transformers (time-based) is available. A two-stage message is issued when maintenance is necessary (yellow message as notice).

With OILTAP® V, M, R, RM, MS, G and T-type on-load tap-changers, there is additional monitoring of the contact wear and oil carbonization.

### Torque monitoring

On-load tap-changer torque monitoring in real time, and the blocking of further tap-change operations in the event of specified limit values being exceeded. This function prevents extensive damage being caused to the on-load tap-changer and transformer in the event of errors or faults.

Tap-change sequence monitoring based on the following criteria:

- Correct function of the tap-change supervisory control
- Correct centering of the motor-drive unit and on-load tap-changer
- Synchronous switching of on-load tap-changer sets or

- On-load tap-changer combinations (multi-column versions)
- Motor-drive unit supply voltage monitoring

### Motor Current Index (MCI)

On-load tap-changer monitoring via measurement and recording of the motor current during the on-load tap-change. Application of the procedure in accordance with IEEE PC57.14-3.

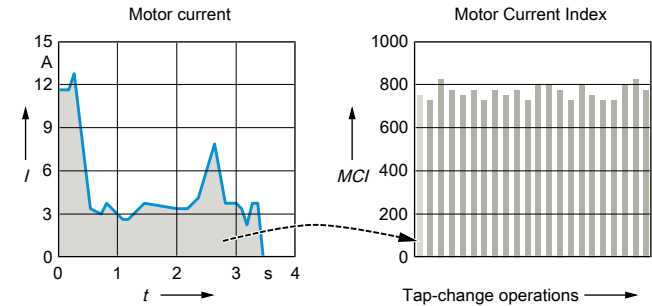


Figure 11: Example illustration of the temporal progression of the motor current I and of the Motor Current Index MCI calculated from this in comparison with the values of the MCI for further on-load tap-change operations

Performance features:

- Individual limit values for various switching types configurable
- Display of the Motor Current Index of the last 3,000 on-load tap-changes
- Display of the minimum and maximum values of the Motor Current Index

i

For the correct determination of the Motor Current Index, you must use a signaling module for the tap position that also signals the pass-through position as a separate tap position.

### Vibro-acoustic monitoring (VAM)

Acquisition and analysis of the vibro-acoustic signals during an on-load tap change. This function enables you to detect irregularities during the switching process and to plan appropriate measures before the on-load tap-changer fails.

### Tap position capture

i

The tap position capture function is automatically configured for ETOS® ED and ETOS® TD.

<sup>2</sup> Free-of-charge for VACUTAP® on-load tap-changers.

Acquisition of the tap position of an on-load tap-changer via the motor-drive unit tap-position message. The following options are available:

- BCD
- 4...20 mA
- 0...20 mA
- 0...10 V
- Resistor contact series
- Dual code
- Decadal contact series
- Gray code

## Motor-drive-unit monitoring (ETOS® ED and ETOS® TD only)

Monitoring the function of the motor-drive unit. The following options are available:

	ETOS® ED	ETOS® TD
Incomplete switching operation: Monitoring the motor-drive unit switching sequence. Message when switching is not completed correctly.	○	○
Active power transducer: Monitoring the motor-drive unit active power	○	-
Drive-shaft monitoring: Monitoring the drive shaft between the drive and the on-load tap-changer	○	-

Table 7: Options (● = included, ○ = optional, - = not available)

## Torque monitoring

If you have selected the on-load tap-changer torque monitoring function, you must specify the following information.

### Overcurrent blocking

Set from which load current on-load tap-changer switching is to be blocked.

### Selector temperature

Select whether the selector temperature is to be monitored.

### Load current measurement

Select how the transformer load current is to be measured:

- 4...20 mA
- Current transformer

With the 4...20 mA option, you must also specify the load current value for 20 mA.

With the current transformer option, you must specify the installation location of the current transformer (HV = high-voltage side, LV = low-voltage side) and the transmission ratio.

### Tap changer installation location

You must specify the installation location of the on-load tap-changer (HV = high-voltage side, LV = low-voltage side).

### Information on the MR tap changer

Enter the serial number, the type and the previous number of tap-change operations of the on-load tap-changer.

## 3.7 Bushing monitoring

The bushing monitoring function package is used to monitor capacitance graded bushings on power transformers. With the product you can monitor the status of the bushings during operation and identify errors in good

time. Bushing monitoring is available for oil-impregnated paper bushings (OIP) and resin-impregnated paper bushings (RIP) of voltage levels  $U_m = 66 \dots 420$  kV. Further voltage ranges are available on request.

The bushing monitoring function package is available in the following versions:

Option	BM-C3	BM-C6	BM-T3	BM-T6	BM-T6/1
Number of monitored bushings	3	6	3	6	6
Capacitance monitoring $\Delta C1$ with the 2/3 reference algorithm (compensation of temperature fluctuations and voltage fluctuations)	•	•	•	•	•
Dissipation-factor monitoring $\Delta \tan \delta$ with the 2/3 reference algorithm (compensation of temperature fluctuations and voltage fluctuations)	-	-	•	•	•
Compensation for grid asymmetry through active reference-system measuring	-	-	•	•	•
Number of reference system voltage measurements (3-phase)	-	-	1	2	1

Table 8: Options (• = included, ○ = optional, - = not available)

### MSENSE® BM-C

Bushing monitoring without reference system (3 or 6 bushings).

- Online monitoring of the bushing via capacitance measurement and monitoring with the 2/3 reference algorithm (compensation of temperature fluctuations and voltage fluctuations)
- Sum current method
- Suitable for symmetrical grids

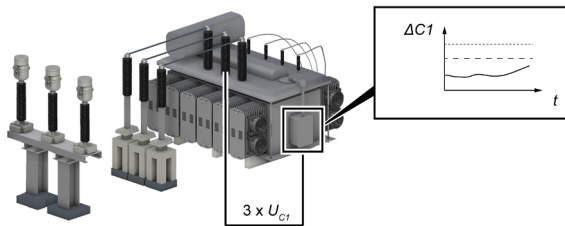


Figure 12: MSENSE® BM-C: Bushing monitoring without reference system (3 bushings)

### MSENSE® BM-T

Bushing monitoring with reference system (3 or 6 bushings).

- 3-phase voltage measurement of the reference system (when monitoring 6 bushings, one separate voltage measurement per field respectively). This allows asymmetries in the grid to be detected
- Online monitoring of the bushing via capacitance measurement and monitoring with the 2/3 reference algorithm (compensation of temperature fluctuations and voltage fluctuations)
- Online monitoring of the bushing via dissipation-factor measurement (reference voltage measurement) with the 2/3 reference algorithm (compensation of temperature fluctuations and voltage fluctuations)

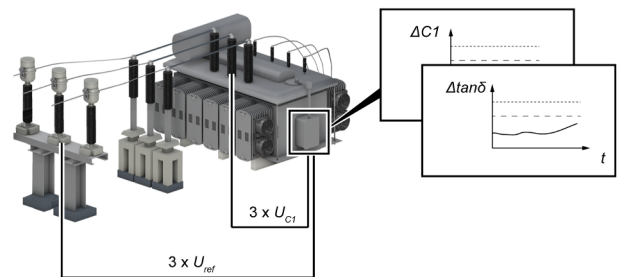


Figure 13: MSENSE® BM-T: Bushing monitoring with reference system (3 bushings)



## MSENSE® BM-T6/1

Bushing monitoring of 2 fields (6 bushings) with one reference system. Scope of functions as per MSENSE® BM-T, bushing monitoring on the high-voltage side and on the low-voltage side of a transformer. Measurement of the reference system only on the high-voltage side or low-voltage side.

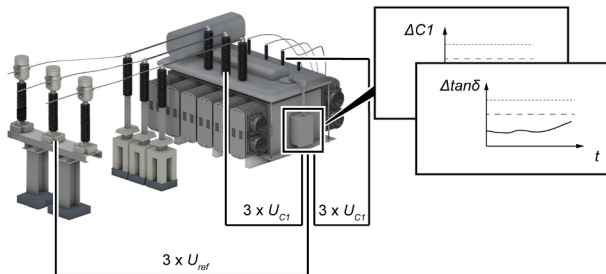


Figure 14: MSENSE® BM-T6/1: Bushing monitoring with reference system (6 bushings, 1 reference system)

## 3.8 Voltage regulation

The voltage regulation function package is used to automatically adjust the tap position of an on-load tap-changer with motor-drive unit. ETOS® provides the following options:

	Basic	Pro	Expert
Automatic voltage regulation with desired value, bandwidth, linear delay time T1	•	•	•
Integral delay time T1	-	•	•
Delay time T2 (fast switching)	-	•	•
Setting the desired voltage level remotely	-	○	○
Line drop compensation (R-X compensation, Z compensation)	•	•	•
Bandwidth monitoring	•	•	•
Function monitoring	•	•	•
Limit value monitoring (voltage, current, power, phase angle)	•	•	•
Switching interval monitoring	-	•	•
Parallel operation via CAN bus	-	•	•
Parallel operation with circulating reactive current measurement (XPA)	-	○	○
Detecting parallel operation via topology	-	-	○
Active power regulation	-	-	○
Reactive power regulation (shunt reactor)	-	-	○
Regulation of a three-winding transformer	-	-	○
Regulation of the high-voltage side or low-voltage side	-	-	○

Table 9: Options (• = included, ○ = optional, - = not available)

### Special applications

The regulation application bank parallel operation is made possible by integrating a TAPCON® into ETOS®.

### Grid measurement

You can select how the voltage and current is measured:

- 1-phase measurement
- 3-phase measurement

### Clamp-on current transformer

You can select whether a clamp-on current transformer for current measurement is to be included in the scope of delivery. With the clamp-on current transformer you can measure the current on the secondary side of the transformer's current transformer without contact. This

is particularly helpful for installation situations in which the secondary circuit of the transformer's current transformer cannot be separated (e.g. in existing systems).

The following clamp-on current transformers are available:

- 5 A clamp-on current transformer (15 A / 0.2 A) for load current measuring
- 2 A clamp-on current transformer (16 A / 0.2 A) for load current measuring

### Setting the desired voltage level remotely

You can select whether the device supports remote desired value setting. The following options are available:

- 3 desired values; selection of the active desired value via digital inputs or control system
- TDSC (TAPCON® Dynamic Setpoint Control); active power-dependent adjustment of desired voltage value
- Time-controlled: Desired value setting in accordance with the day profile
- 3 desired values, of which 1 desired value with step-wise remote desired-value setting; selection of the active desired value via digital inputs or control system

## 3.9 Cooling system

With ETOS®, you can control and monitor the cooling system of a transformer.

### Cooling system control

ETOS® supports cooling system control for the following control methods:

- Basic: Conventional control (on request)
  - 2 or 4 cooling stages
  - Control via rotary switch (manual) or pointer thermometer
- Pro: Intelligent control
  - 2 or 4 cooling stages
  - Cooling stages can be configured individually
  - Temperature-dependent switching point control with hysteresis and delay time
  - Load-dependent mode (for early activation of cooling stages)
  - Periodic mode (for regular activation of cooling stages)
  - Alternating mode (for equal loading of similar cooling stages)
- Expert: Frequency-based cooling system control
  - Stepless fan speed control
  - Input variables: Upper oil temperature and load factor of the transformer
  - Control of up to 32 fan motors

### Cooling system monitoring

The cooling system control function package is used for monitoring the cooling system of a power transformer.

	Basic	Pro
Number of cooling groups	2 or 4	4
Operating status	•	•
Number of starts	•	•
Operating duration	•	•
Calculation of the thermal resistance $R_{th}$ and graphical representation; local data storage, data transmission via control system possible	-	•

Table 10: Options (• = included, ○ = optional, - = not available)

## 3.10 Oil filter unit

With ETOS®, you can integrate the oil filter unit control directly in the control cabinet. ETOS® can control up to 3 oil filter units.

	Integrated
Number of oil filter units	1...3
Rotary switch for test operation	•
Time-controlled operation	•
Activation after tap-change operation	•
Temperature control	○
Monitoring the motor protective switch of the pump motor	•
Overpressure message for filter change	•
Operating duration	•
Control system	•

Table 11: Options (• = included, ○ = optional, - = not available)

### Temperature control

You can select the following options for the temperature control function:

- No temperature control
- Deactivation of the pressure signal for filter change as soon as the temperature of the insulating fluid drops below 25 °C
- Permanent operation of the oil filter unit as soon as the temperature of the insulating fluid drops below 0 °C

## 3.11 Control

### Visualization and operator devices

You can select the display and operating elements of the control cabinet.

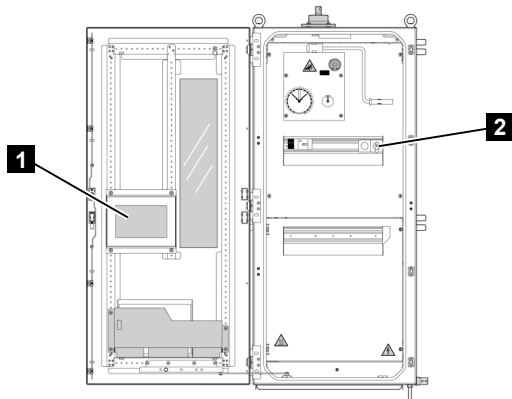


Figure 15: Display and operating elements

1	MCONTROL 10"	2	Mechanical operating elements in the operating panel
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### Visualization, operator devices

	Basic	Com- fort	Pro
Mechanical operating elements for the local control of the motor-drive unit functions	●	●	●
Additional Ethernet interface (RJ45) on the outside of the swing frame.	-	●	●
MCONTROL 10" touch panel display for local operation and display of the ETOS® graphical interface. Integrated graphical operating elements for the AVR function (e.g., control: raise, lower)	-	-	●

Table 12: Options (● = included, ○ = optional, - = not available)

### Main switch (ETOS® ED and ETOS® TD only)

You can select the design of the main switch:

- Fuse switch disconnecter
- Main switch for shutting down the motor-drive unit; fuse switch disconnecter design
- Main switch and additional fuse switch disconnecter

### Motor-drive unit control (ETOS® ED and ETOS® TD only)

- Step-by-step operation in accordance with IEC 60214
- Without step-by-step operation

- Step-by-step operation, with voltage and current blocking (U>, U<, I>)
- Without step-by-step operation, with voltage and current blocking (U>, U<, I>)

With the step-by-step operation option, the device only performs a single tap-change operation. A further tap-change operation will only be performed once the current tap-change operation is completed.

### Intermediate gear

You can set the transmission ratio of the intermediate gear (e.g., for retrofit applications).

### Automatic pass-through positions

You can enter the tap positions that are designed as pass-through positions (e.g., 9A, 9C).

### Local/remote switch

You can select the design of the local/remote switch:

- LOCAL/REMOTE switch with 1 floating contact
- LOCAL/REMOTE/AUTO switch with 1 floating contact
- LOCAL/OFF/REMOTE switch with 1 floating contact
- LOCAL/REMOTE/AUTO switch with 1 x floating change-over contact (CO) designed as a key switch
- LOCAL/OFF/REMOTE switch with 1 x floating change-over contact (CO) designed as a key switch

You can select the operating mode of the device using the local/remote switch:

#### LOCAL

In the **LOCAL** operating mode, you can only actuate the device using the operating elements in the control cabinet. Commands via digital inputs or SCADA are not possible. There is no automatic on-load tap-changer control.

#### REMOTE

In the **REMOTE** operating mode, you can actuate the device, depending on the setting of the Remote behavior parameter, only via external key or SCADA commands. You can activate (AR AUTO) or deactivate (AVR manual) the optional on-load tap-changer control function via digital inputs or SCADA.

#### OFF

In the **OFF** operating mode, you cannot operate the motor-drive unit via control switch or digital inputs. This operating mode is used to prevent the motor-drive unit from starting up inadvertently (e.g., during maintenance work).

## Auto

In the **Auto** operating mode, automatic on-load tap-changer control is active. You cannot actuate the motor-drive unit manually in this mode. Commands via SCADA are possible depending on the setting of the Remote behavior parameter.

## Key switch

If you select the key switch design, the switch can only be actuated when it is unlocked with the key. This prevents unauthorized operation if the control cabinet door is open.

## Switching delay (ETOS® ED and ETOS® TD only)

The switching delay prevents damage to the on-load tap-changer due to switching operations when inrush current impulses are present. On-load tap-change operations will only be executed once a delay time of approximately 10 seconds has expired after the transformer is switched on. To use this function, you must connect the signaling contact of the transformer circuit breaker to the motor-drive unit in accordance with the connection diagram.

## Temperature locking (ETOS® ED and ETOS® TD only)

The temperature locking function prevents damage to the on-load tap-changer caused by switching operations being performed when the temperature is outside the permissible oil temperature range. You can select the following options:

- Plus: Upper temperature limit
- Minus: Lower temperature limit
- Plus/Minus: Lower and upper temperature limit
- Redundant: Redundant design of the temperature sensors

## Drive messages (ETOS® ED and ETOS® TD only)

You can select which messages the device is to issue as digital signals:

- DIP: Direction-independent position transit contact
- DP: Direction-dependent position transit contact (1 per direction)
- SY: Synchronous contact
- Endpo.: End position signaling contact (1 per direction)
- HC: Hand crank inserted
- MPS: Motor protective switch

The following options are possible:

Option	DIP	DP <sup>3</sup>	SY	Endpo. <sup>3</sup>	HC	MPS
A	1x NO	-	-	-	-	1x NC
B	1x CO	-	-	1x CO	-	1x NC
BA	1x CO	1x CO	-	2x CO	1x CO	1x NC
BB	2x CO	-	1x CO	1x CO	1x CO	1x NC
C	3x CO	1x CO	-	2x CO	-	1x NC
CA	3x CO	1x CO	-	2x CO	1x CO	1x NC
D	3x CO	.	1x CO	1x CO	1x CO	1x NC
E	5x CO	1x CO	1x CO	2x CO	-	1x NC
F	7x CO	1x CO	-	2x CO	1x CO	1x NC

Table 13: Possible options for drive messages (NC = normally closed contact, NO = normally open contact, CO = change-over contact)

## Tap position message (ISM)

You can issue the current tap position up to 3 times as a signal via the ISM assemblies. The following signal types are available:

- 4...20 mA
- BCD code
- Decadal coding
- Gray code
- Dual code

## Tap-position messaging modules

You can configure up to 3 tap-position messaging modules. The following types are available:

- BCD code
- NO contact series
- Resistor contact series

### Resistor contact series

With the resistor contact series option, you can also select whether the resistors are to be bridged for pass-through positions. You can also select whether a series resistor is used.

## Position message with rotary encoder

- INCON 1292, 9° per step
- INCON 1292KS, 9° per step
- Preparation for INCON rotary encoders

<sup>3</sup> Number per direction respectively.

## Motor runtime

You can select the motor runtime:

- 1/1: Normal motor runtime (approx. 5.4 s)
- 1/2: Half of the normal motor runtime
- 1/3: One third of normal motor runtime
- 2/1: Double the normal motor runtime

# 4 Control cabinet

## 4.1 Design versions

Depending on the climate zone in which you want to use the control cabinet, you can configure the design of the control cabinet:

Option	Basic	Pro	Tropical	Arctic	Polar
Ambient temperature	-25...+50°C	-25...+55°C	-25...+55°C	-40...+50°C	-60...+50°C
Protective housing design					
- Single-wall	•	-	-	-	-
- Double-wall	-	•	•	•	•
- Rail profile <sup>4</sup>	○	-	-	-	-
- Vibration damping <sup>5</sup>	○	○	○	○	○
- Insulated mounting <sup>5 6</sup>	○	○	○	○	○
Heating					
- Thermostat control	•	•	-	•	•
- Hygrostat control	-	-	•	-	-
- Increased heating power	-	-	-	•	•

Table 14: Available options (• = included, ○ = optional, - = not available)

### Climate zone

You can configure the device for use in various climate zones. Depending on the selected ambient temperature, the following options are available:

- Basic: Permitted ambient temperature -25...+50 °C
- Pro: Permitted ambient temperature -25...+55 °C, double-wall protective housing for lower interior temperatures (peak temperature -10 K), ensuring a longer service life for the components.
- Tropical: Permitted ambient temperature -25...+55 °C, double-wall protective housing for lower interior temperatures (peak temperature -10 K), ensuring a longer service life for the components. Heating control via hygrostat.

- Arctic: Permitted ambient temperature -40...+50 °C, double-wall protective housing for lower interior temperatures (peak temperature -10 K), ensuring a longer service life for the components. Heating with increased heating power.
- Polar: Permitted ambient temperature -60...+50 °C, double-wall protective housing for lower interior temperatures (peak temperature -10 K), ensuring a longer service life for the components. Heating with increased heating power.

### Protective housing dimensions

The protective housing is available in the following sizes. Note the dimensional drawings [► Page 30].

Size	Single-wall	Double-wall	Rail profile
900	924 x 700 x 446	961 x 766 x 478	-
1200	1213 x 700 x 446	1249 x 766 x 478	1213 x 700 x 423
1500	1524 x 700 x 446	1560 x 766 x 478	1524 x 700 x 423
1800	1791 x 700 x 446	1825 x 766 x 478	-

Table 15: Protective housing dimensions (height x width x depth in mm)

### Protective housing type

You can select the protective housing type:

- Standard
- Rail profile: Housing with reduced depth. Particularly suitable for rail transport

### Vibration damping

Vibration-damped mounting of the control cabinet on the transformer tank via adapter console.

4 Only available with ETOS® ED.

5 Vibration damping and insulated mounting not possible in combination.

6 Not available with ETOS® TD.

## Insulated mounting

Insulated mounting of the control cabinet on the transformer tank via adapter console. Additional insulated grounding bar in the control cabinet.

- Insulation strength 5 kV
- Potential equalization between the control cabinet and transformer not necessary
- Enables leakage current monitoring of the insulated transformer tank



## 4.2 Operation

### Handle and door latching

You can select the handle for the control cabinet door:

- Basic: Standard handle without door latching
- Premium: Stainless steel handle with door latching

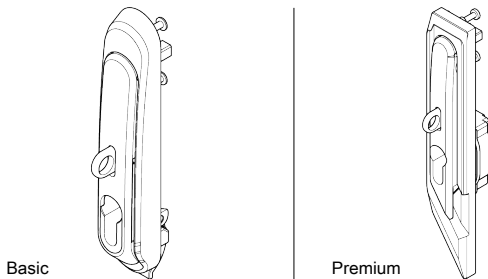


Figure 16: Handle versions

### Locking system

You can select the control cabinet locking system:

- Blind: Prepared for Euro profile lock cylinder 17 mm (blind cover)
- Padlock: Padlock included in the scope of delivery, prepared for Euro profile lock cylinder 17 mm (blind cover)

### Operating elements

You can select the position of the operating elements:

- Inside: Operating elements in the operating panel of the control cabinet. The control cabinet door has to be opened for operation.
- Outside: Additional operating elements on the outside of the control cabinet door. The operating elements are protected from harmful environmental influences by a cover. You can protect the cover from unauthorized access with a padlock.

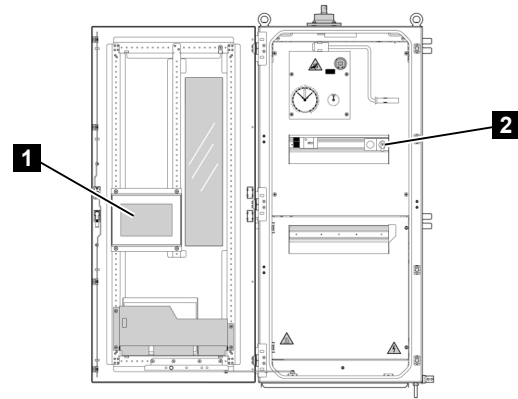


Figure 17: Operating elements inside

1	MCONTROL 10" (optional)	2	Mechanical operating elements in the operating panel
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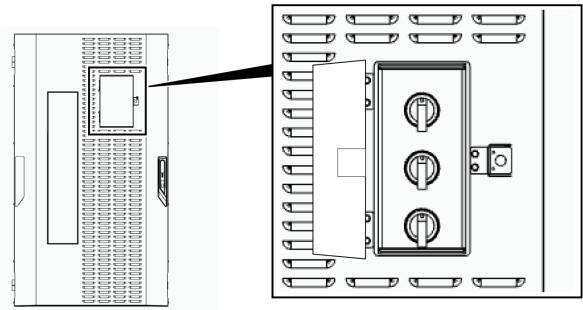


Figure 18: Operating elements on the outside of the control cabinet

### Door-hinge side

You can select on which side the door is hinged and in which direction the door can be opened.

- Left
- Right

### Door holder

You can select the desired opening angle of the door holder. The door latches into the selected position and is held open. Where necessary, you can open the door manually to an angle of 180° at any time.

- 90°
- 110°
- 130°
- 180°

## 4.3 Monitoring

Monitoring of the humidity and temperature in the control cabinet interior. If the humidity exceeds the set values after a specified latency time (default 90% relative humidity, 70 °C interior temperature), a warning message is generated. If a relative humidity value of 95% is exceeded, a red message is generated.

## 4.4 Wiring

### Terminal type

You can select the terminal type:

- Wago type 2002
- Phoenix UT 4 (replacement UK5/N)
- Phoenix UT 6
- Phoenix OTTA 2.5
- Phoenix PT 6-MT (knife-disconnect terminal)
- Phoenix URTK/S (test disconnect terminal)
- Phoenix URTK/S-BEN (test disconnect terminal)
- Phoenix UTME 4 (test disconnect terminal)
- ABB M6/8RS (line-up terminal with spring cage)
- Fuji TX-5.5 (line-up terminal with spring cage)

### Spare terminals

You can select up to 50 additional terminals as reserves.

### Wiring material

You can select the wiring material:

- H07V-K: MR standard
- H07Z-K: Halogen-free wire
- H07Z-K: Halogen-free wire, colored

### Identification sleeves

You can select whether identification sleeves are fitted to the conductors in the control cabinet and what information is printed on them:

- Connection pin
- Connection
- Connection, signal and destination
- Signal
- Connection and destination
- Destination

### Cable bushing in the base plate

- Blind plate for creating your own cable bushing
- Universal base plate with Roxtec CF32 cable bushing

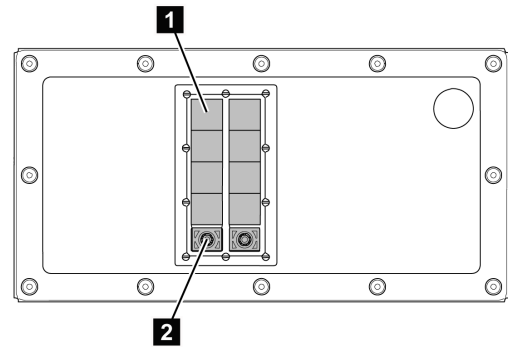


Figure 19: Base plate with Roxtec CF32 cable bushing

1	Dummy plug	2	Terminal module
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- Base plate with metric cable glands (2x M20, 20x M25, 5x M32, 3x M40)

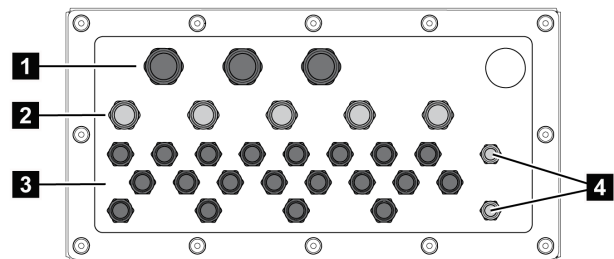


Figure 20: Base plate with metric cable gland

1	3x M40	2	5x M32
3	20x M25	4	2x M20

- Base plate with flange opening FL21

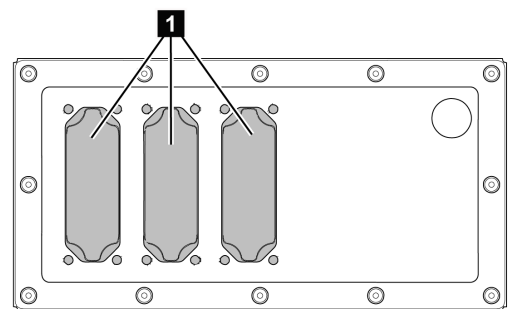


Figure 21: Base plate with FL21 flange openings

1	Flange opening with blank cover
---	---------------------------------

## Cable gland

If you have selected the base plate with metric cable glands (2x M20, 20x M25, 5x M32, 3x M40) for the cable bushing, you can also select how the cable gland is to be designed:

- Seal
- Seal and strain relief
- Seal, strain relief and kink protection

## 4.5 Power supply

### Grounding bar

You can select whether the device is equipped with a grounding bar for supporting the cable shield.

### Number of grounding terminals

You can select the number of grounding terminals in the control cabinet.

### Fuse protection in accordance with standard

You can select whether and how the standard-compliant fuse protection of the current circuits in the control cabinet is to be designed. You can also select whether all current circuits, only the control circuit and heating circuit or only the heating circuit are to be fused-protected separately.

- Miniature circuit breaker
- NH fuse (fuse link)

i

If you do not select fuse protection, you must fuse-protect the current circuits of the control cabinet yourself at the installation location in accordance with the legal provisions applicable at the location.

### Supply voltage monitoring

You can select whether the supply voltage of the control circuit and of the motor circuit are to be monitored. With this function, the voltage will be monitored with an upper limit (overvoltage) and a lower limit (undervoltage).

You can also select whether the voltage monitoring issues a message in the event of limit value violations and whether on-load tap-changer switching is also to be blocked.

### Motor circuit (ETOS® ED and ETOS® TD only)

The motor circuit supplies the electric motor of the drive. You can select the rated voltage, the grid type and the rated frequency of the power supply.

### Heating circuit

The heating circuit supplies the heating system of the control cabinet.

#### Supply

You can select how the heating circuit is to be supplied:

- Power supply from the main supply (motor circuit, ETOS® ED and ETOS® TD only)
- Power supply from the control circuit
- Separate power supply

If you select **Separate power supply**, you can select the rated voltage, the grid type and the rated frequency of the power supply.

#### External socket for emergency heating

The optional external socket for emergency heating is located in the floor panel of the control cabinet. The external socket allows you to start the heating of the control cabinet without having to connect the entire control cabinet to the power supply. This is necessary, for example, if you want to store the control cabinet at particularly low ambient temperatures or if you have to switch off the power supply for maintenance work.

### Control circuit

The control circuit supplies the control and regulation elements of the device.

#### Supply

You can select how the control circuit is to be supplied.

- Power supply from the main supply (motor circuit, ETOS® ED and ETOS® TD only)
- Power supply from the transformer
- Separate power supply

If you select **Separate power supply**, you can select the rated voltage, the grid type and the rated frequency of the power supply.

#### ISM supply

You can select how the ISM controller is to be supplied. The isolated power supply for the ISM® controller increases the operational safety of the device. It enables you, for example, to connect the device controller to an uninterruptible power supply so that messages can be received in the control room even in the event of a power failure.

- Power supply from the control circuit
- Separate power supply

If you select **Separate power supply**, you can select the rated voltage, the grid type and the rated frequency of the power supply.

## Coupling relays for control

You can select whether the device is to be fitted with coupling relays. In this case, the following signals will be realized via coupling relay:

- Raise/lower switching signal (K11, K12)
- Motor protective switch triggering (K13)

If you select the version with coupling relays, you can select the rated voltage, the grid type and the rated frequency.

## Plug socket

You can select whether the device is equipped with a plug socket in the operating panel in the control cabinet.

### Plug socket type

You can select the plug socket type.

## Supply

You can select how the plug socket is to be supplied:

- Power supply from the main supply
- Separate power supply

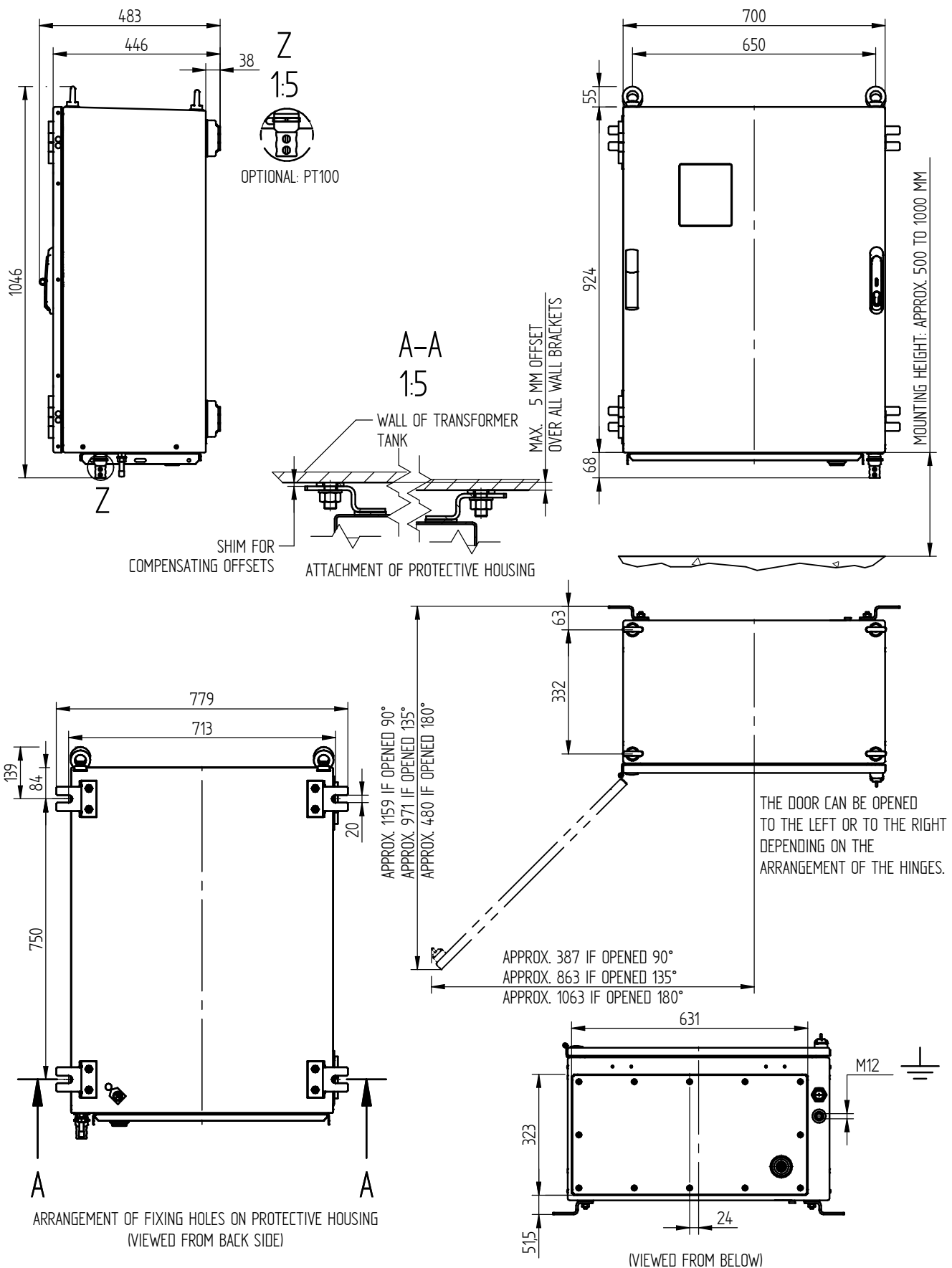
If you select **Separate power supply**, you can select the rated voltage, the grid type and the rated frequency of the power supply.

# 5 Drawings

## 5.1 ETOS®

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MOTOR-DRIVE UNIT ETOS®  
 ETOS® Cabinet 900  
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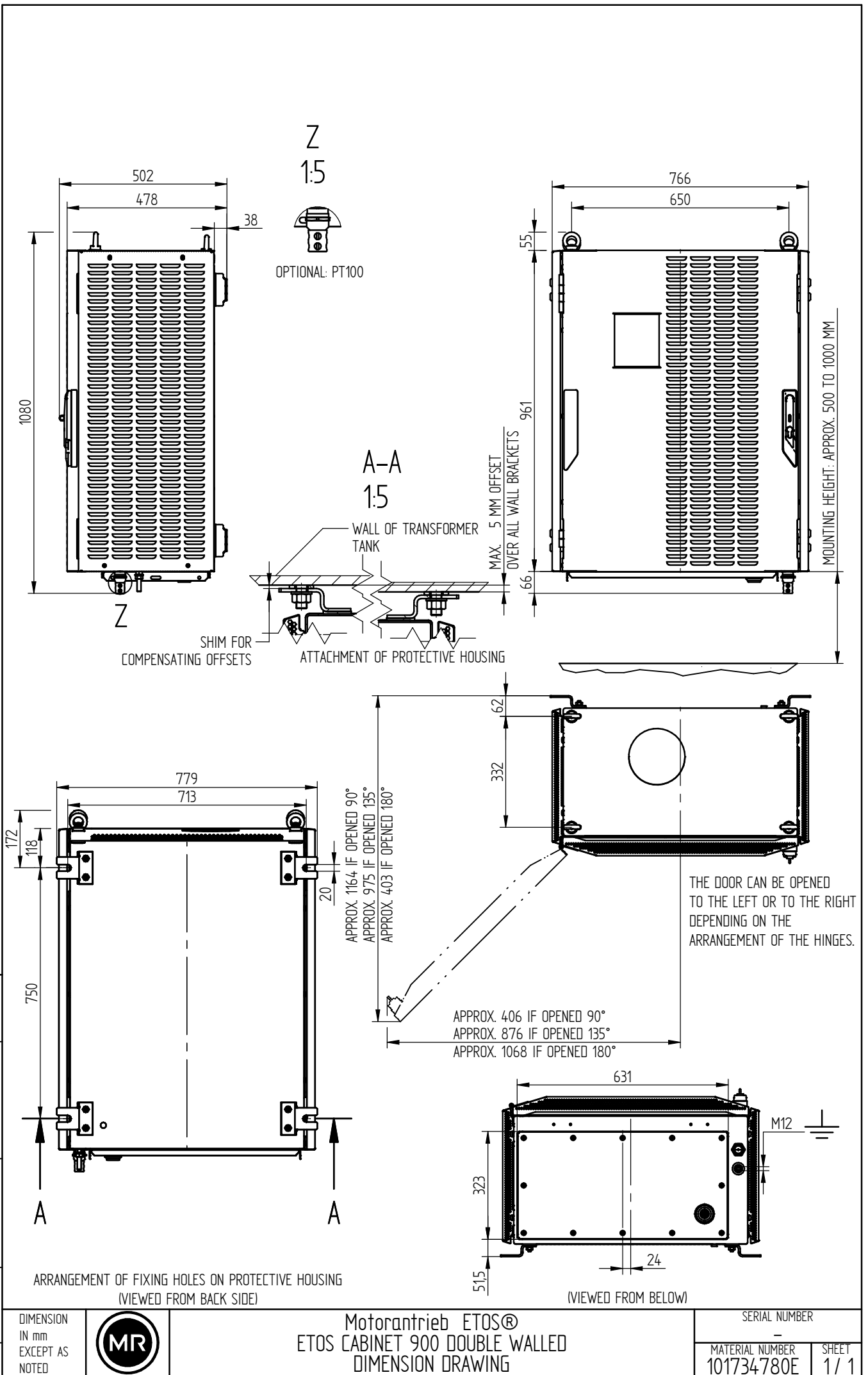
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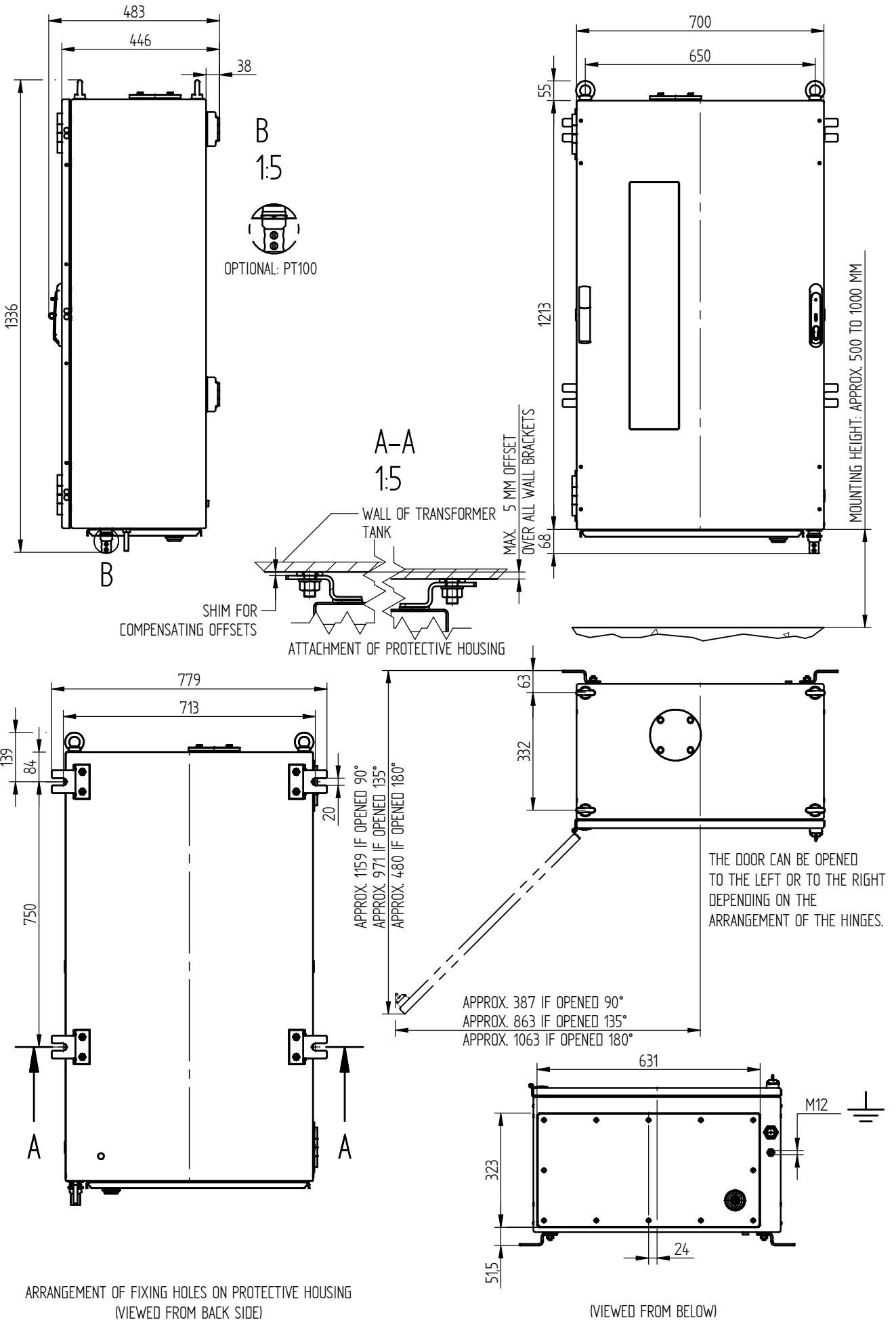
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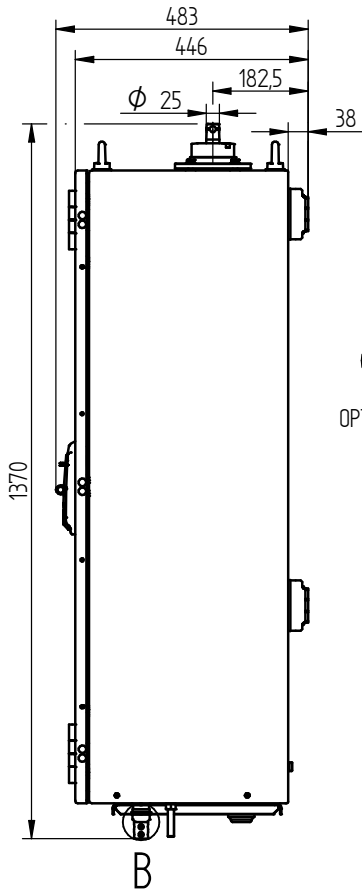


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 ETOS TOP DRIVE 1200  
 DIMENSION DRAWING

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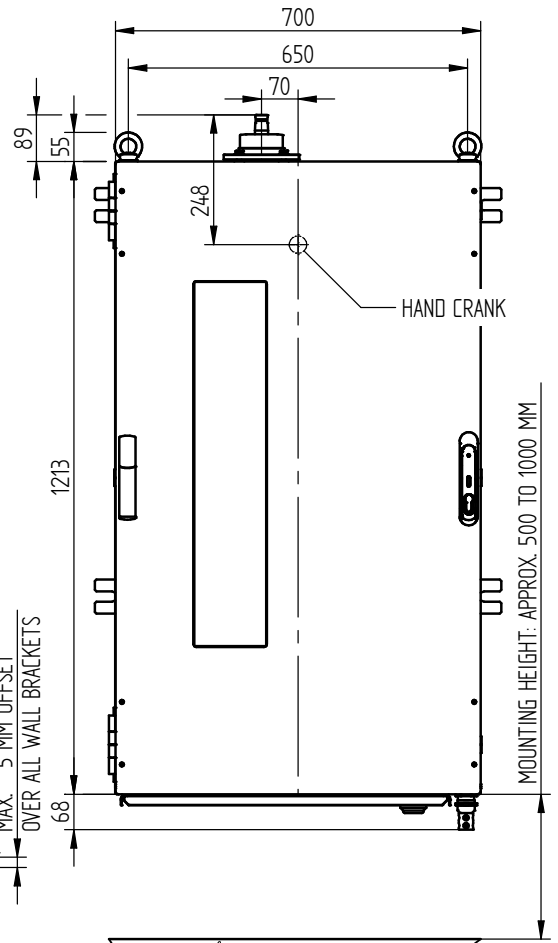
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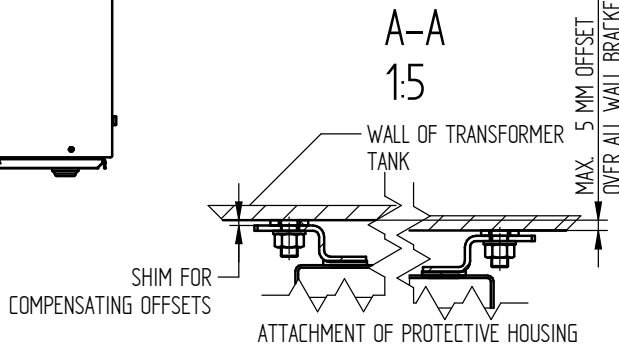
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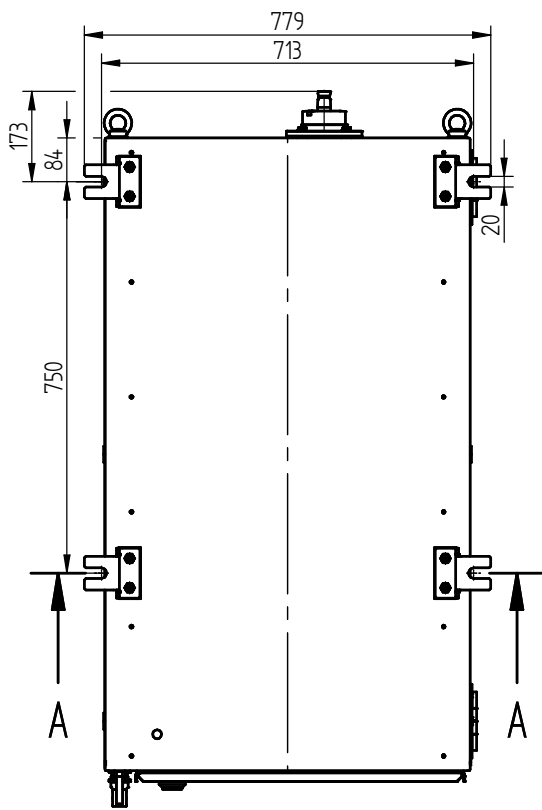
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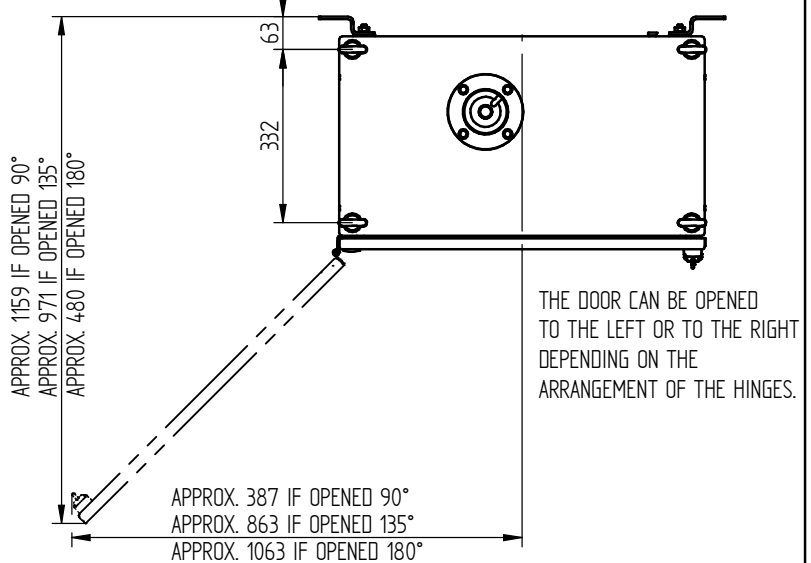
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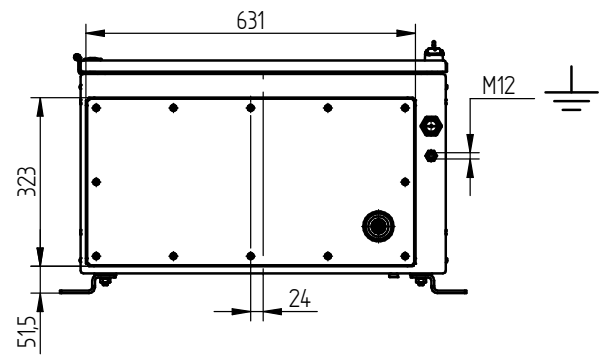
A-A  
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ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING  
(VIEWED FROM BACK SIDE)



THE DOOR CAN BE OPENED TO THE LEFT OR TO THE RIGHT DEPENDING ON THE ARRANGEMENT OF THE HINGES.



(VIEWED FROM BELOW)

DIMENSION IN mm EXCEPT AS NOTED



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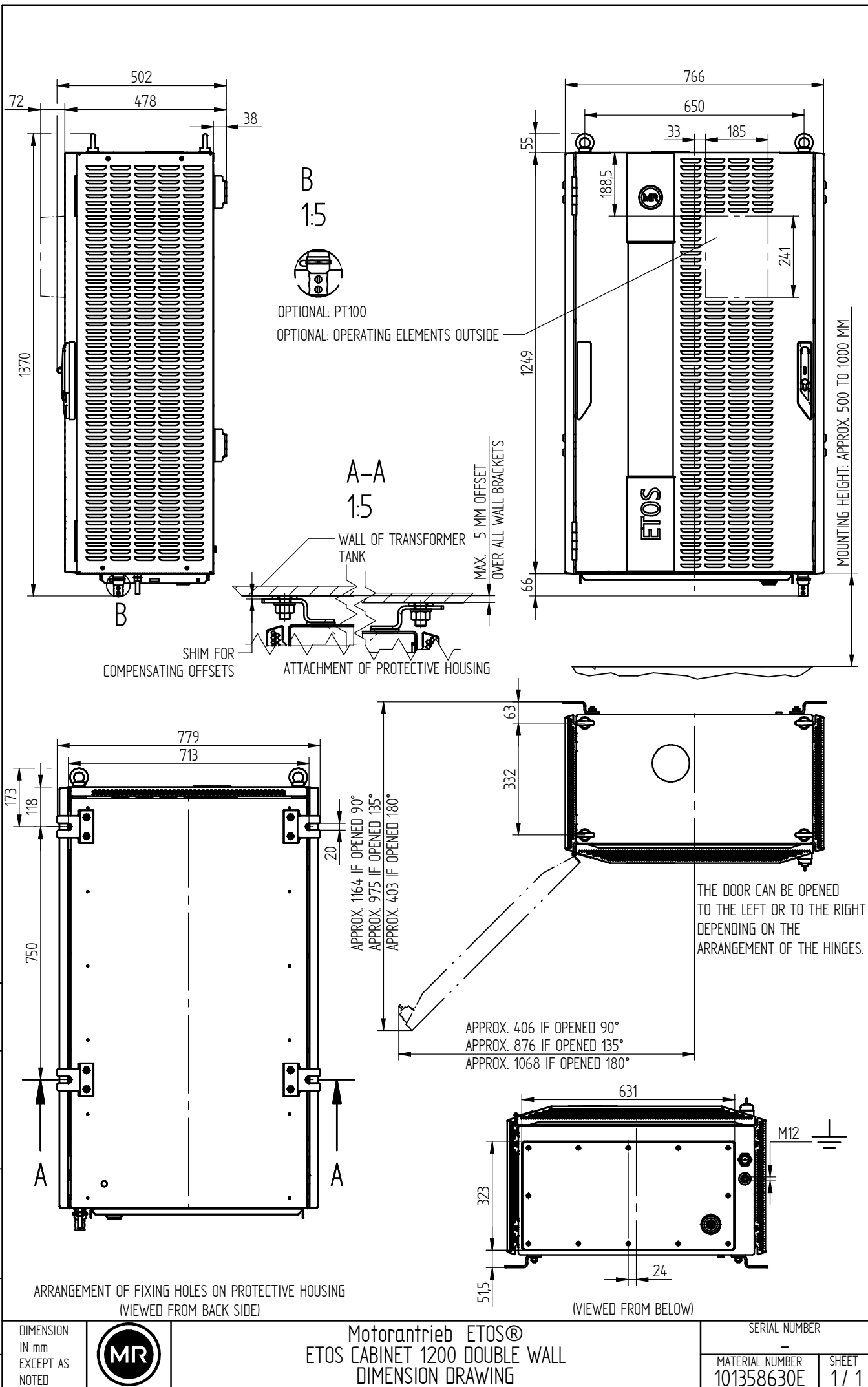
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ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING (VIEWED FROM BACK SIDE)

DIMENSION IN mm EXCEPT AS NOTED



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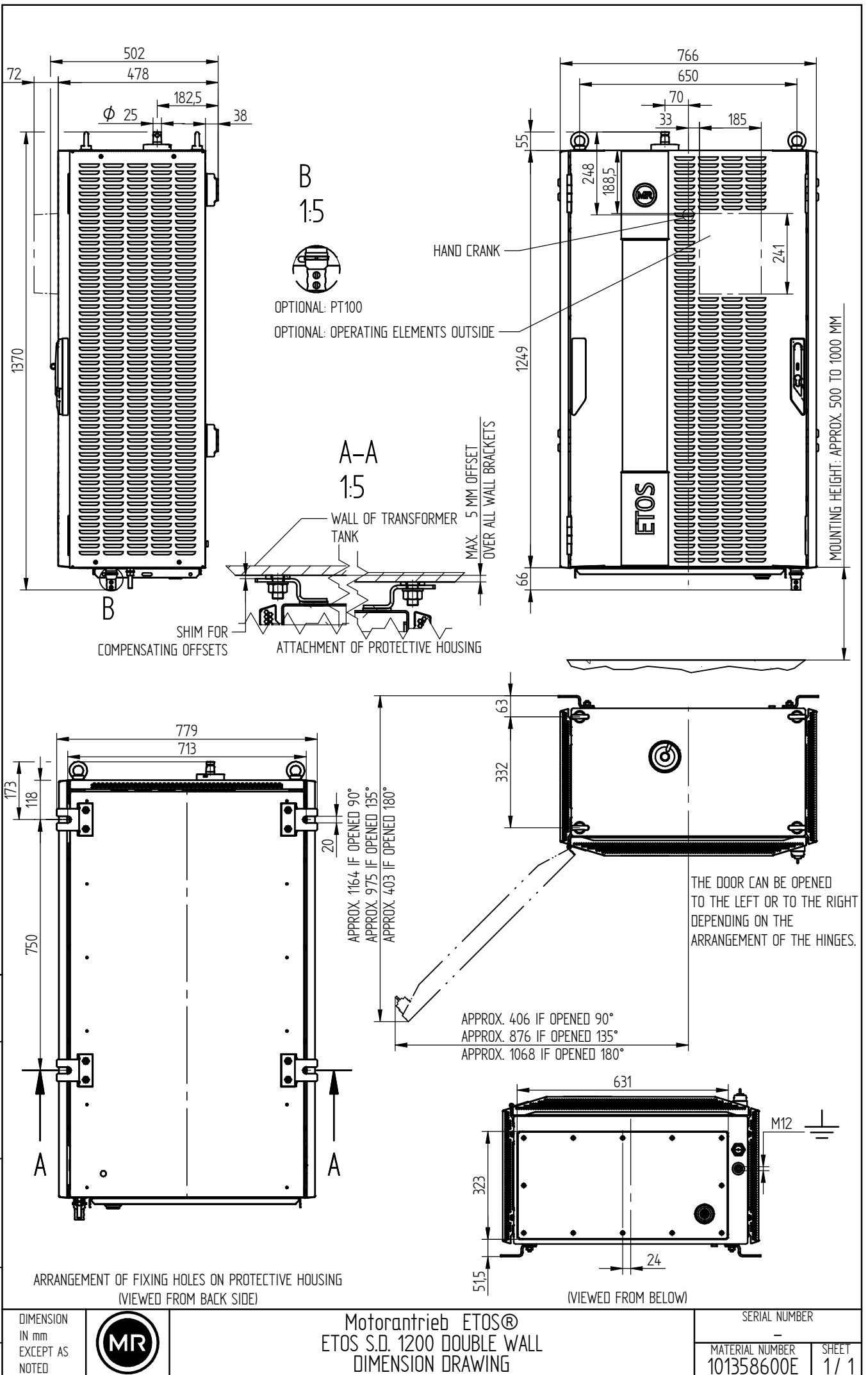
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MATERIAL NUMBER 101358630E

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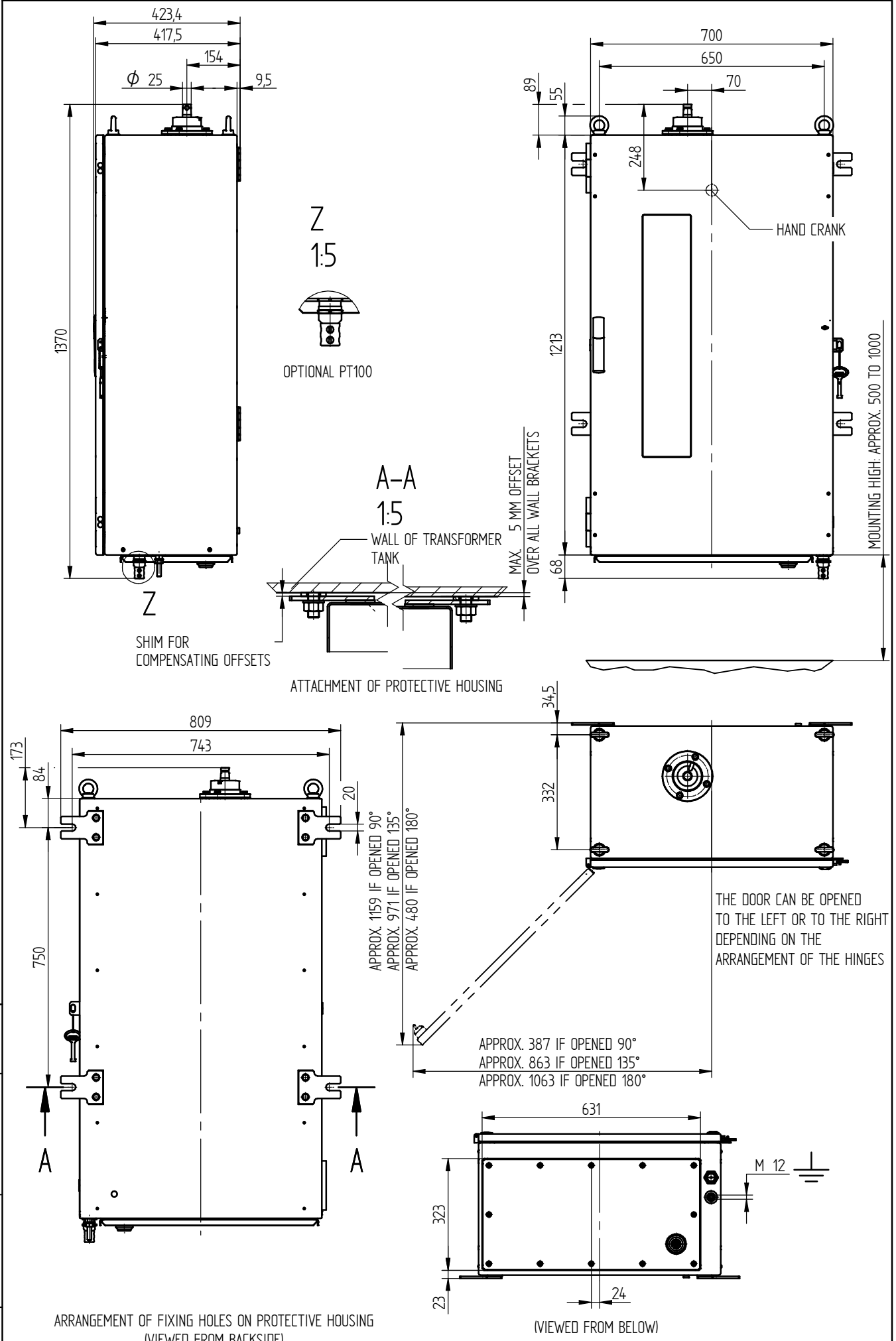
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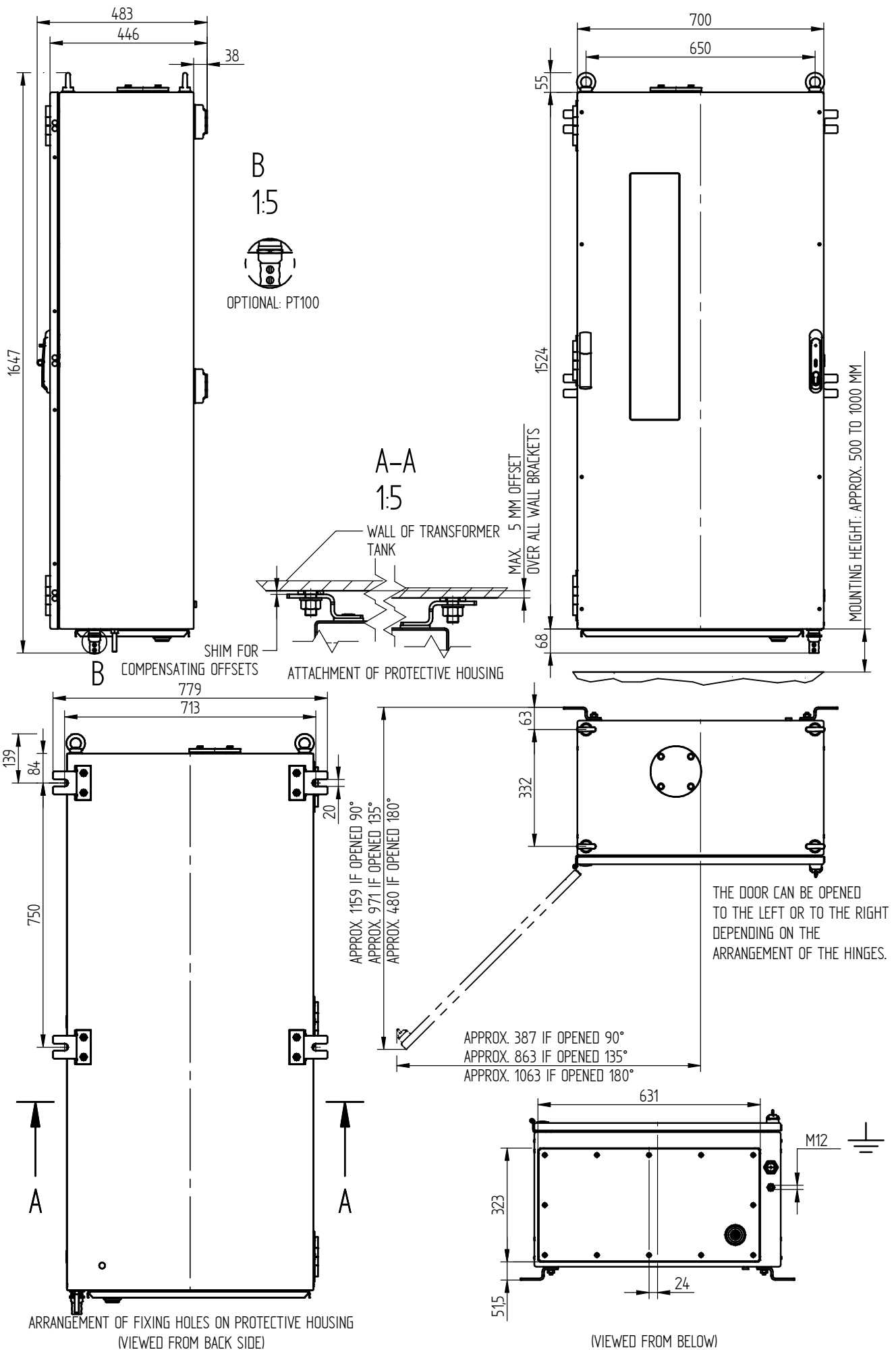
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08.03.2021	KLEYN	1106922
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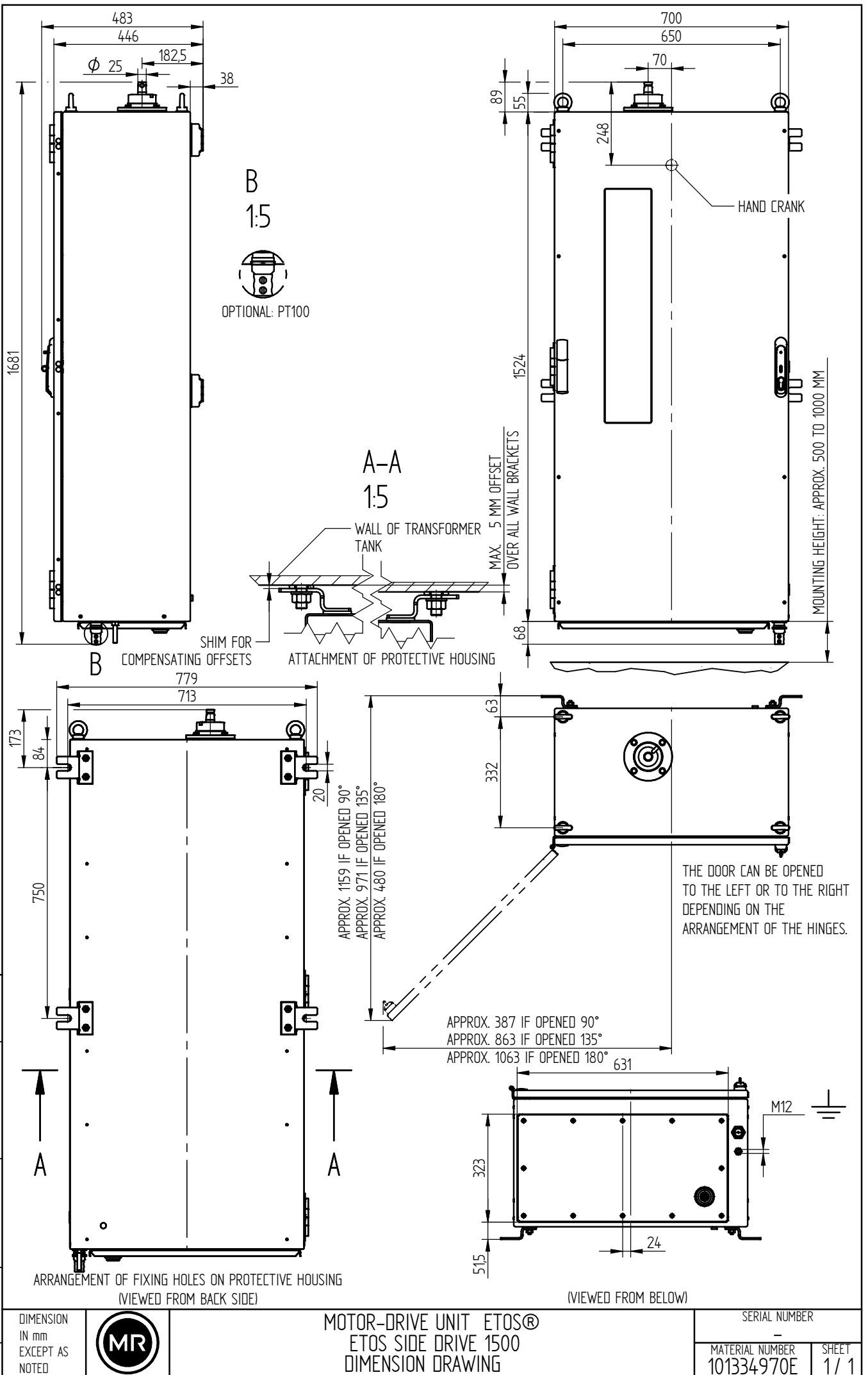


MOTOR-DRIVE UNIT ETOS®  
 ETOS TOP DRIVE 1500  
 DIMENSION DRAWING

SERIAL NUMBER	-
MATERIAL NUMBER	101334980E
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08.03.2021	KLEYN	1106922 1:10



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 ETOS SIDE DRIVE 1500  
 DIMENSION DRAWING

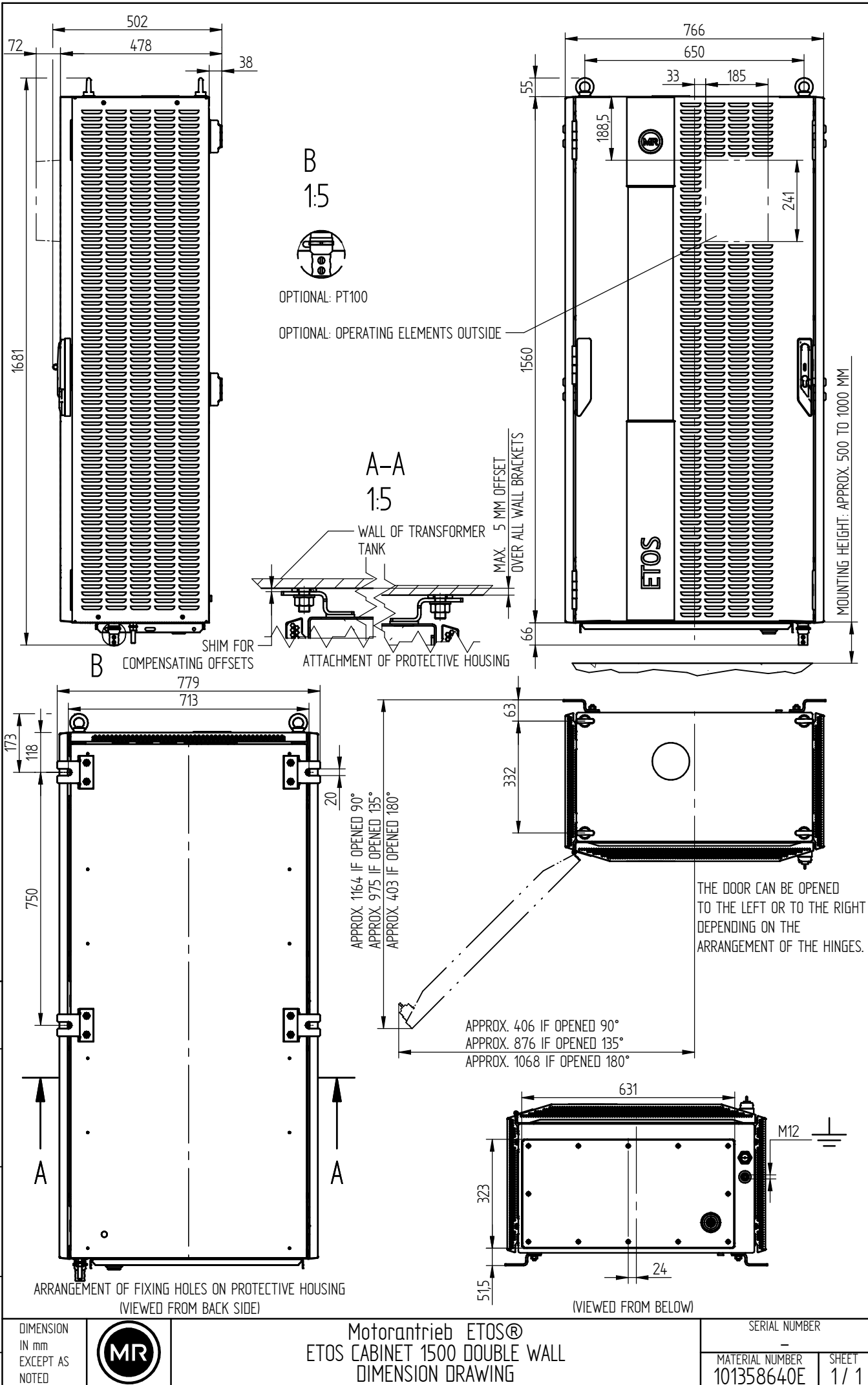
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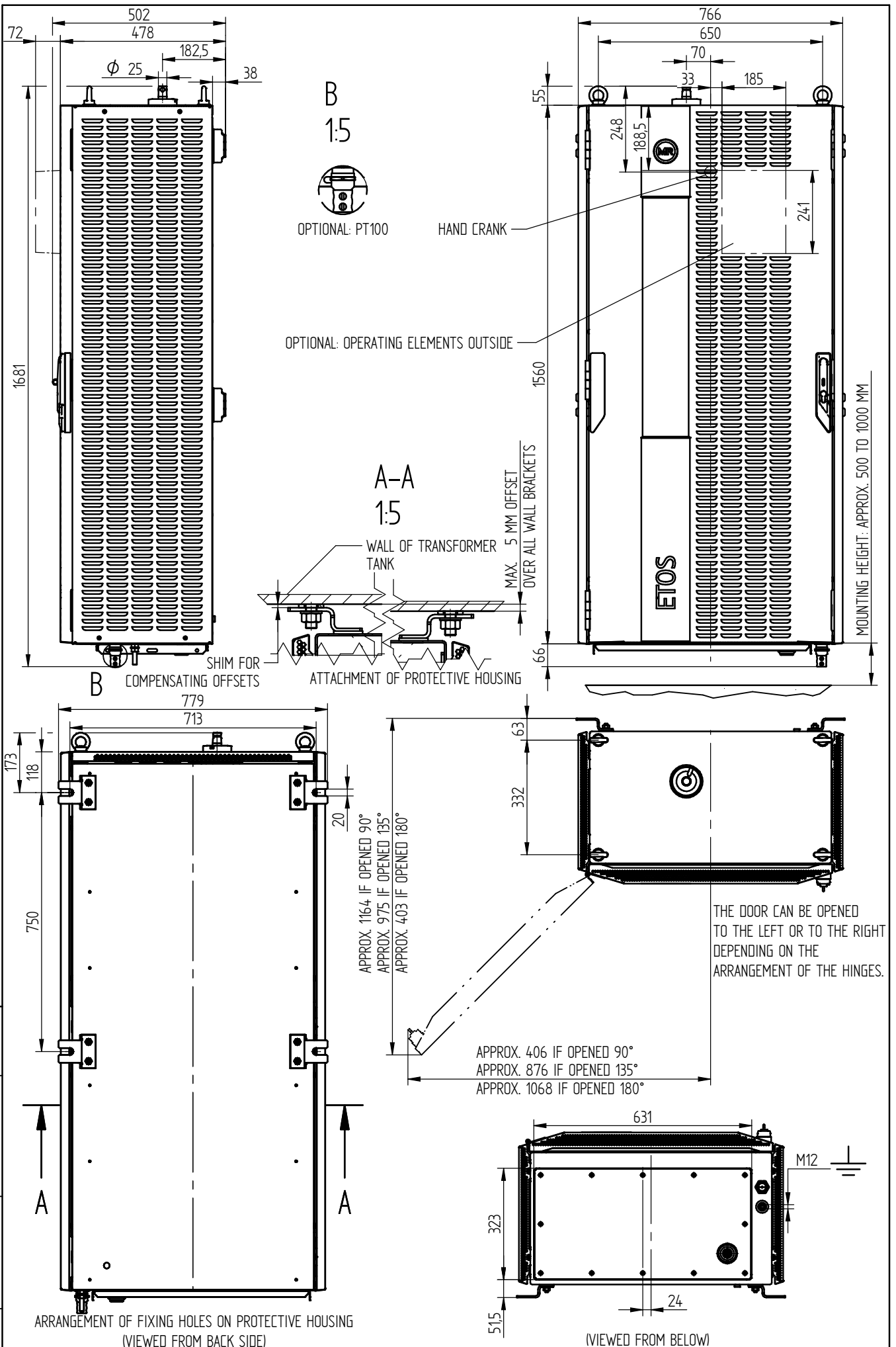
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 ETOS CABINET 1500 DOUBLE WALL  
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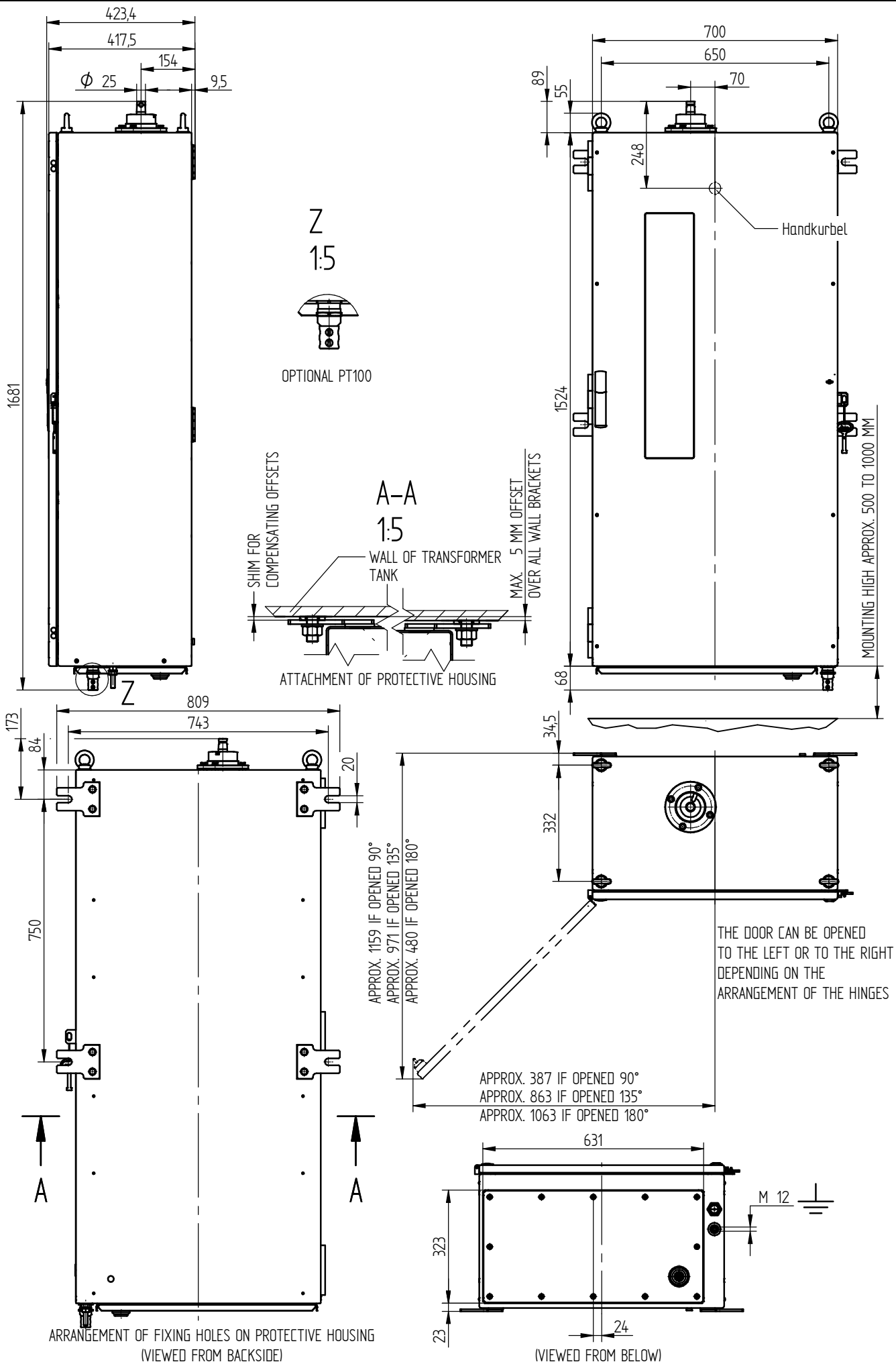


Motorantrieb ETOS®  
 ETOS S.D. 1500 DOUBLE WALL  
 DIMENSION DRAWING

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MATERIAL NUMBER	SHEET
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DIMENSION IN mm EXCEPT AS NOTED

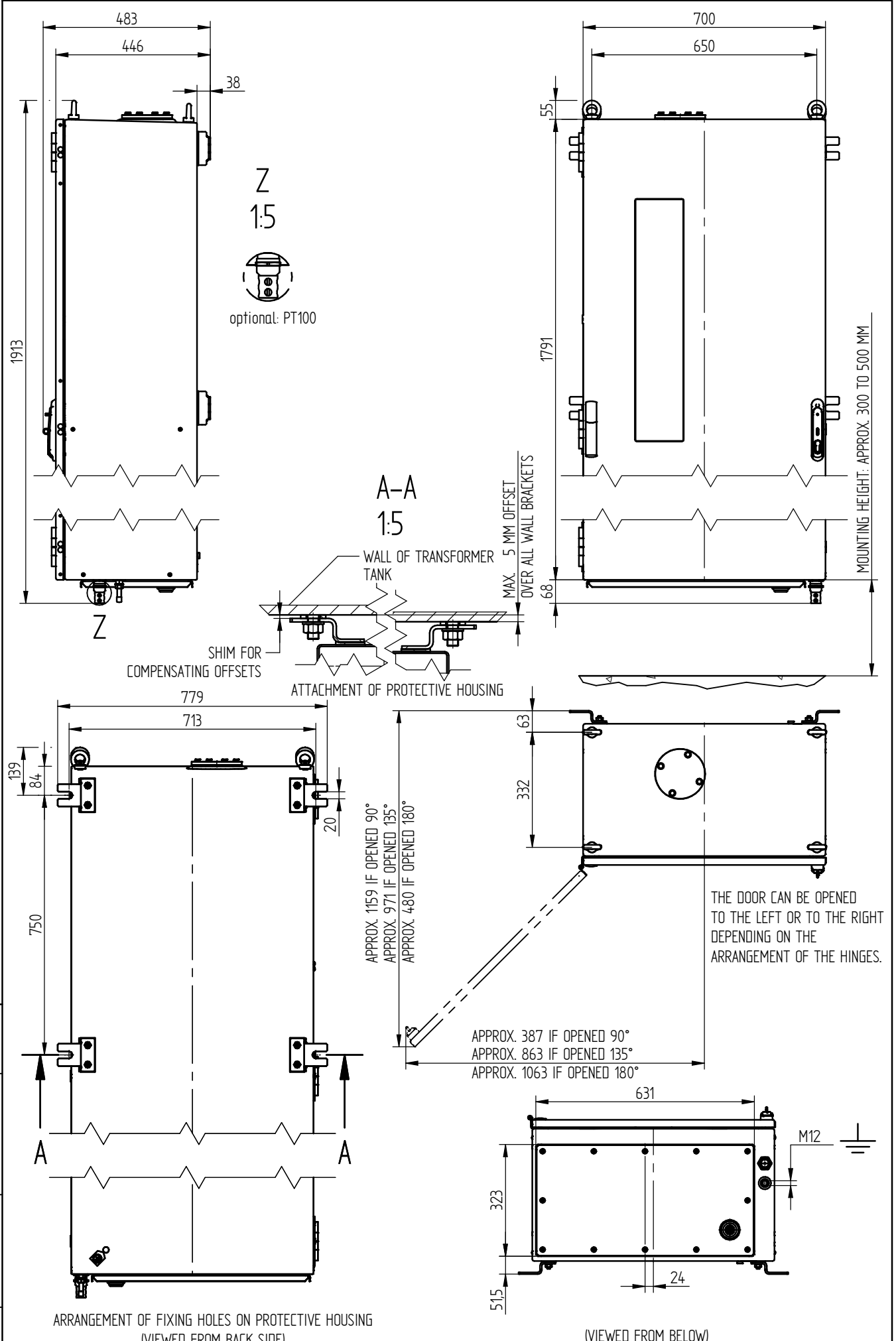


MOTOR-DRIVE UNIT ETOS®  
 ETOS SIDE DRIVE 1500 FLAT OPTION  
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CHKD.	STEMPFHUBERJ	CHANGE NO.
25.11.2022	KLEYN	1118344
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DIMENSION IN mm EXCEPT AS NOTED

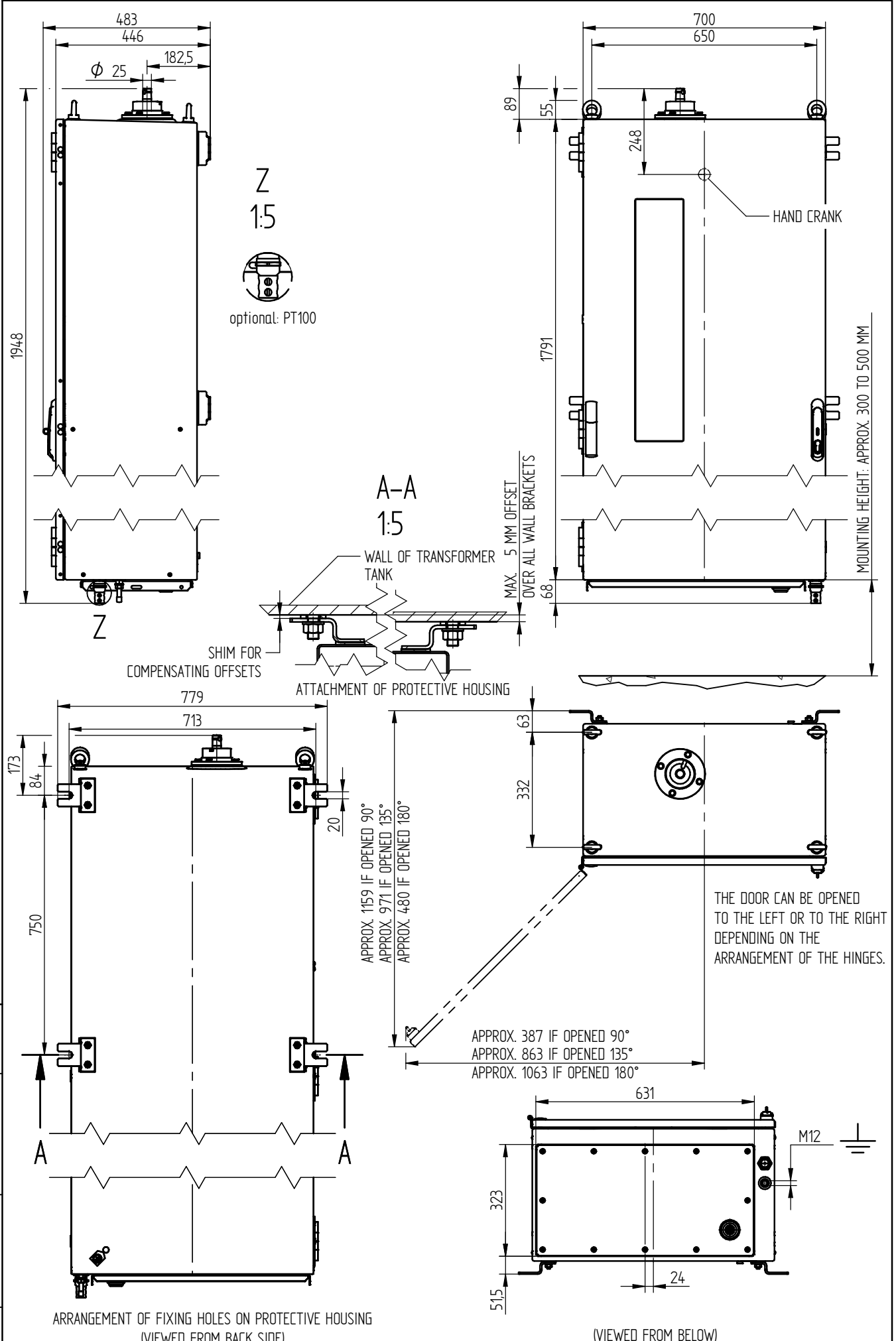


MOTOR-DRIVE UNIT ETOS®  
 ETOS CABINET 1800  
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STAND. 28.11.2022	KLEYN	1118344
		SCALE 1:10



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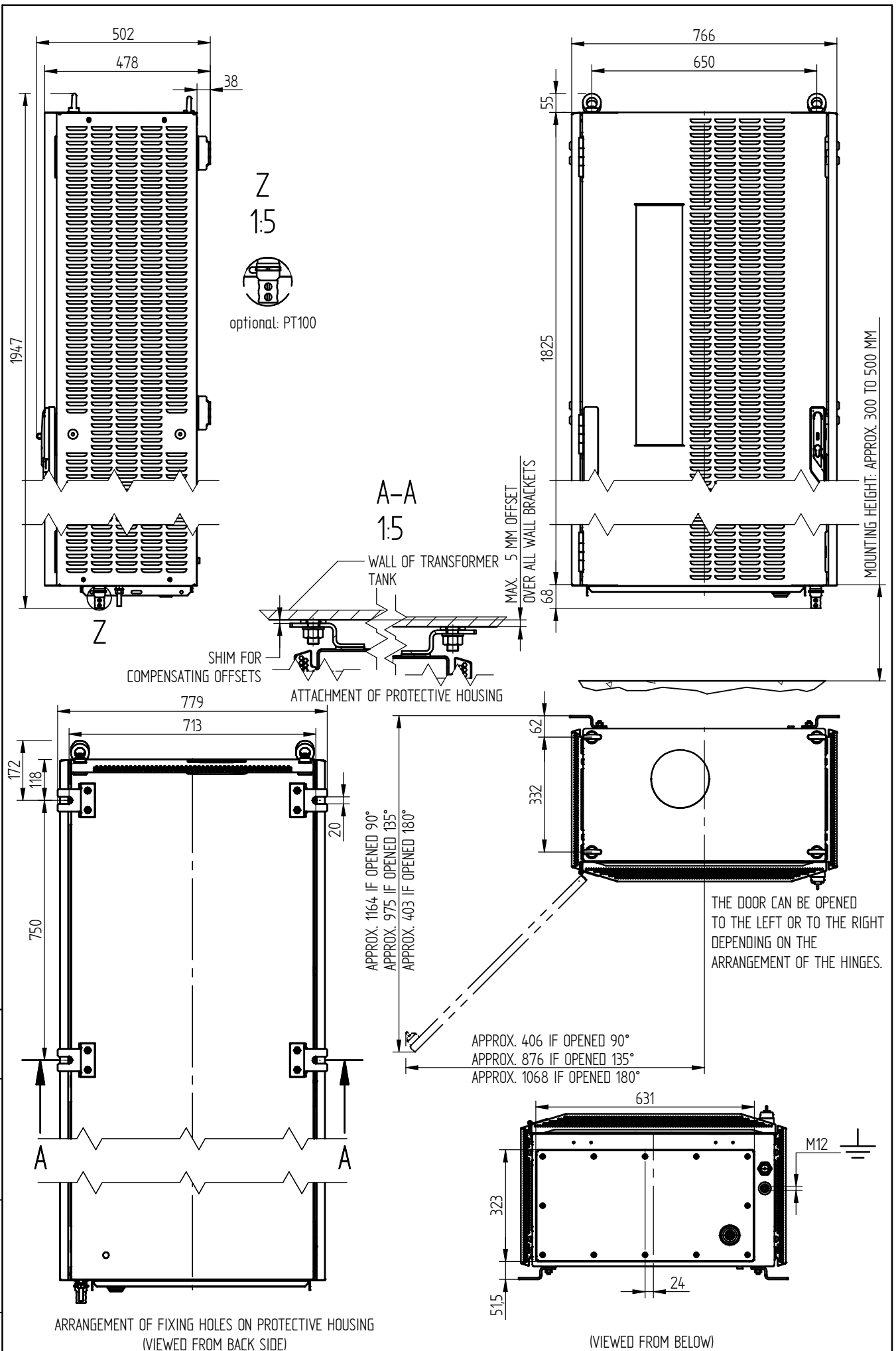


MOTOR-DRIVE UNIT ETOS®  
 ETOS SIDE DRIVE 1800  
 DIMENSION DRAWING

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25.11.2022	CHANGE NO.
STEMPFHUBERJ	1118344
SCALE	1:10
28.11.2022	KLEYN



DIMENSION  
 IN mm  
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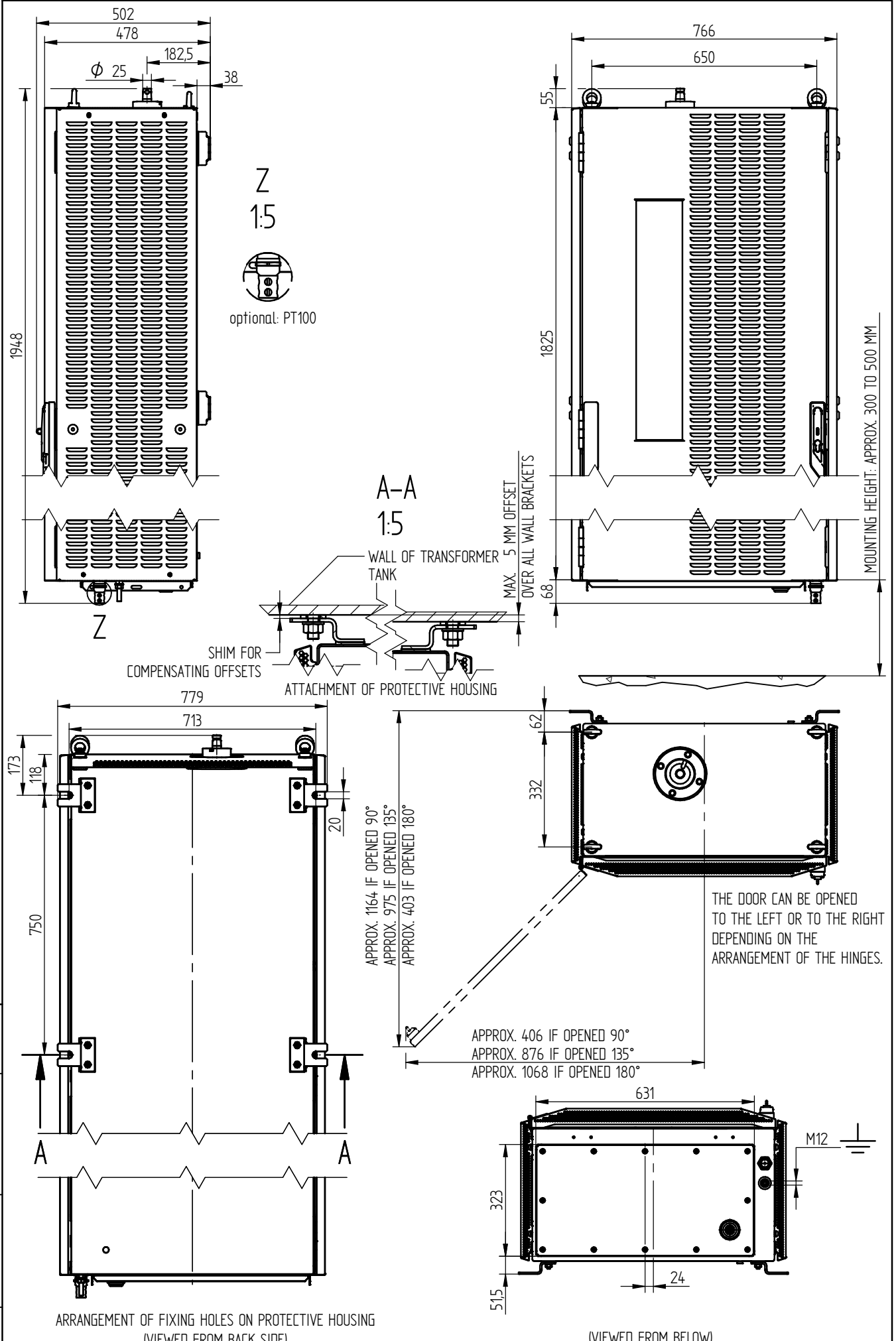


Motorantrieb ETOS®  
 ETOS CABINET 1800 DOUBLE WALL  
 DIMENSION DRAWING

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MATERIAL NUMBER	101734-800E
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STAND. 28.11.2022		KLEYN		



ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING (VIEWED FROM BACK SIDE)

(VIEWED FROM BELOW)

Motorantrieb ETOS®  
 ETOS S.D. 1800 DOUBLE WALLED  
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DIMENSION  
 IN mm  
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SERIAL NUMBER	-
MATERIAL NUMBER	101734790E
SHEET	1 / 1

## 5.2 MSENSE® DGA 3

### Device dimensions with 285 mm measuring pipe length

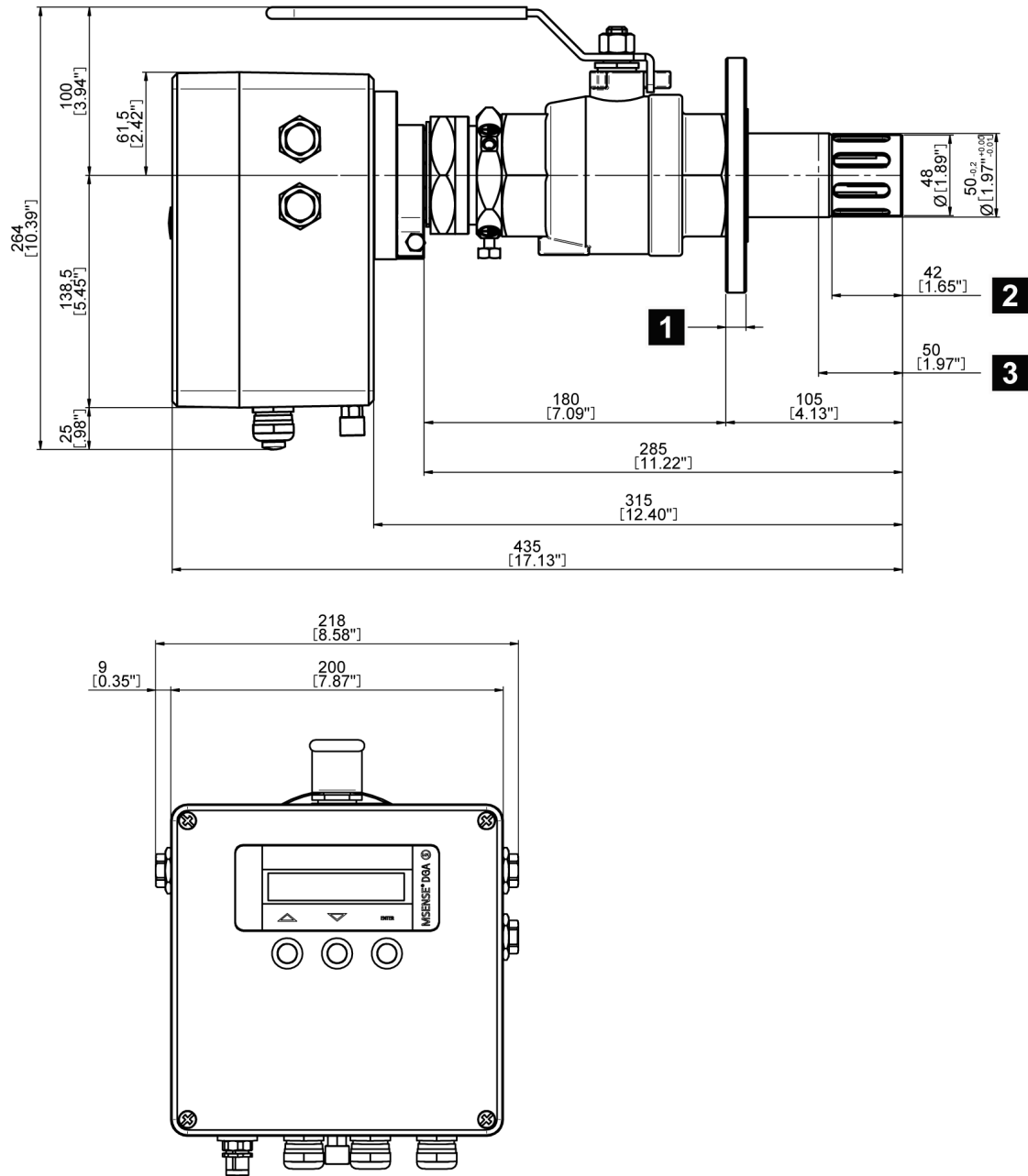


Figure 22: Device dimensions with 285 mm measuring pipe

1	Flange, see table [► Page 49]
2	Minimum immersion depth
3	Recommended immersion depth

## Device dimensions with 507 mm measuring pipe length

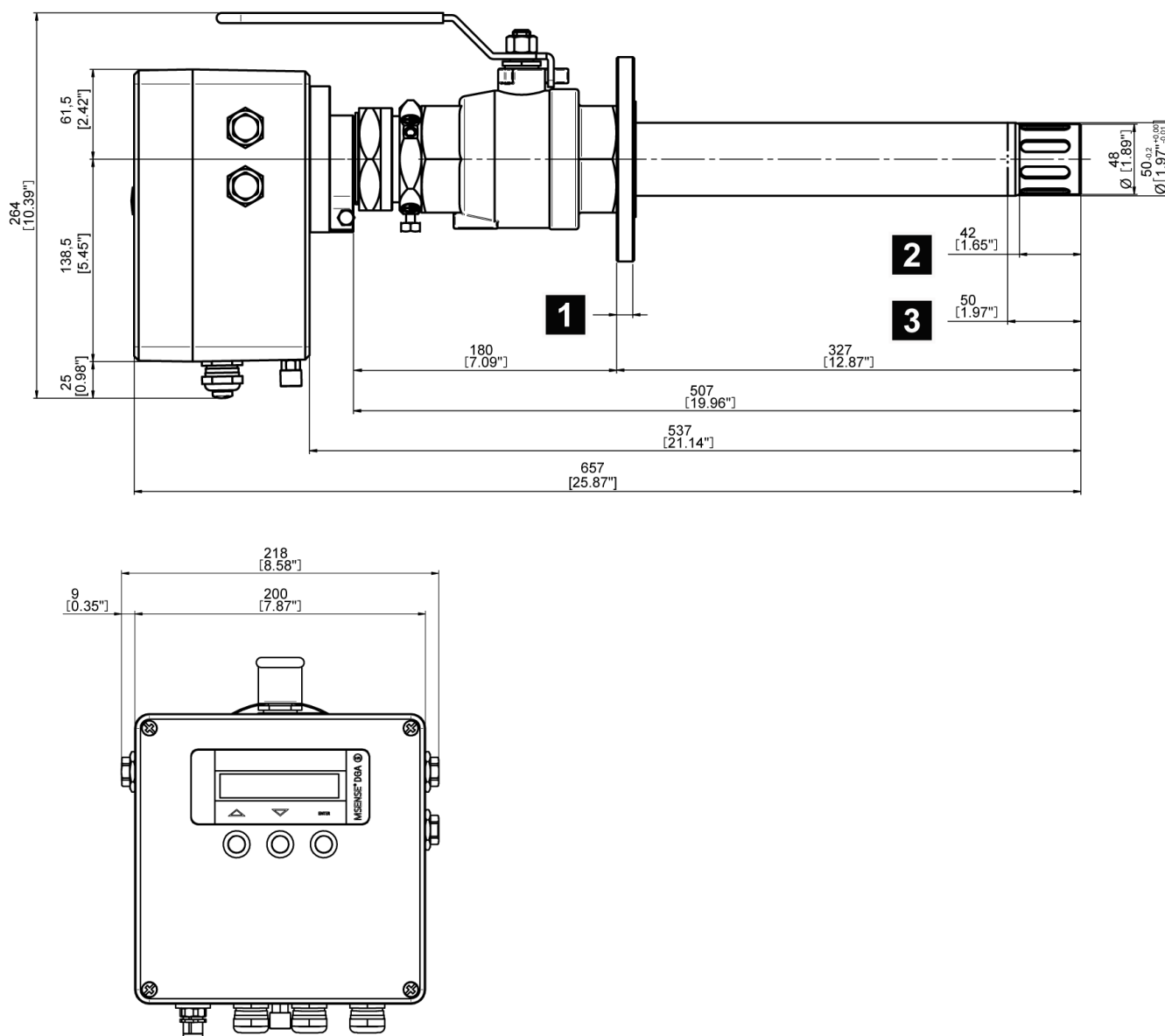


Figure 23: Device dimensions with 507 mm measuring pipe

1	Flange, see table [▶ Page 49]
2	Minimum immersion depth
3	Recommended immersion depth



## Connecting flange dimensions

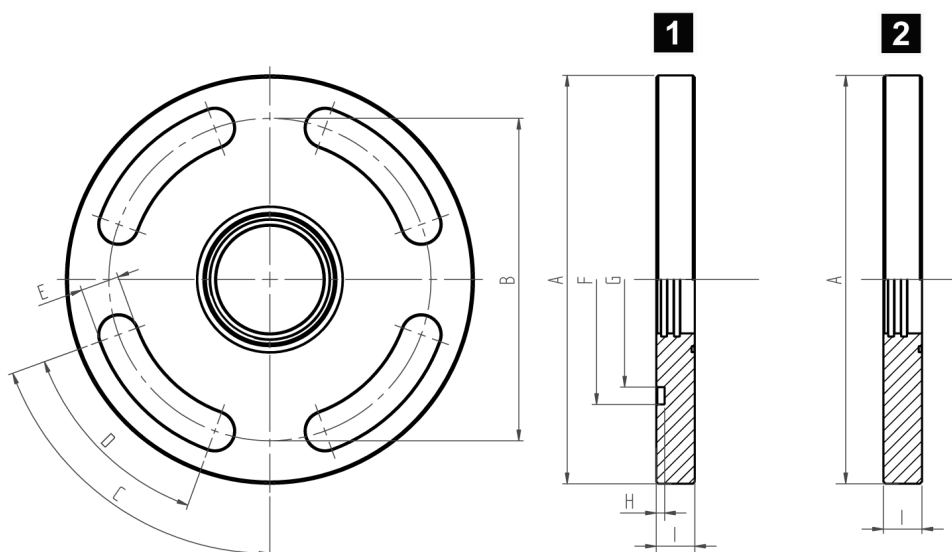


Figure 24: Flange DN50 PN6; DN50 PN16

1	For o-ring gasket (included in delivery)
2	For any gasket (gasket not included in delivery)

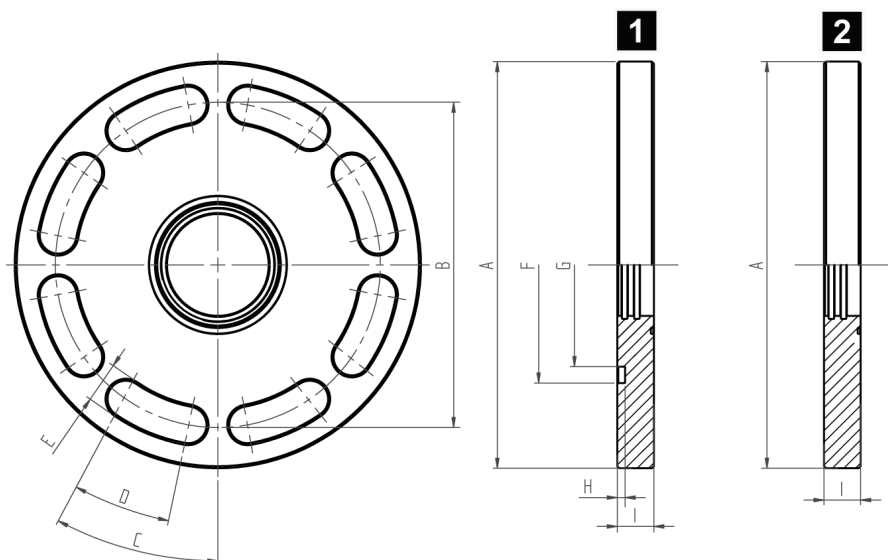


Figure 25: Flange DN80 PN16

1	For o-ring gasket (included in delivery)
2	For any gasket (gasket not included in delivery)

## Flange dimensions table

Flange version	A mm [inch]	B mm [inch]	C	D	E mm [inch]	F mm [inch]	G mm [inch]
DN50 PN6	Ø140 [5.51"]	Ø110 [4.33"]	70°	4 x 50°	Ø13 [0.51"]	Ø81 [3.19"]	Ø65 [2.56"]
DN50 PN16	Ø165 [6.50"]	Ø125 [4.92"]	70°	4 x 50°	Ø18 [0.71"]	-	-
DN50 PN16	Ø165 [6.50"]	Ø125 [4.92"]	70°	4 x 50°	Ø18 [0.71"]	Ø81 [3.19"]	Ø65 [2.56"]
DN80 PN16	Ø200 [7.87"]	Ø160 [6.30"]	34.5°	8 x 24°	Ø18 [0.71"]	-	-
DN80 PN16	Ø200 [7.87"]	Ø160 [6.30"]	34.5°	8 x 24°	Ø18 [0.71"]	Ø116.2 [4.57"]	Ø100 [3.94"]

## Gasket dimensions table

Flange version	H mm [inch]	I mm [inch]	O-ring gasket (di) x (da) x (t) mm [inch]
DN50 PN6	3 [0.12"]	12 [0.47"]	O-ring 67 [2.64"] x 79 [3.11"] x 4 [0.16"]
DN50 PN16	-	18 [0.71"]	For any gasket (gasket not included in delivery)
DN50 PN16	3 [0.12"]	18 [0.71"]	O-ring 67 [2.64"] x 79 [3.11"] x 4 [0.16"]
DN80 PN16	-	18 [0.71"]	For any gasket (gasket not included in delivery)
DN80 PN16	3.9 [0.15"]	18 [0.71"]	O-ring ID100 [3.94"] x Ø6 [0.24"]

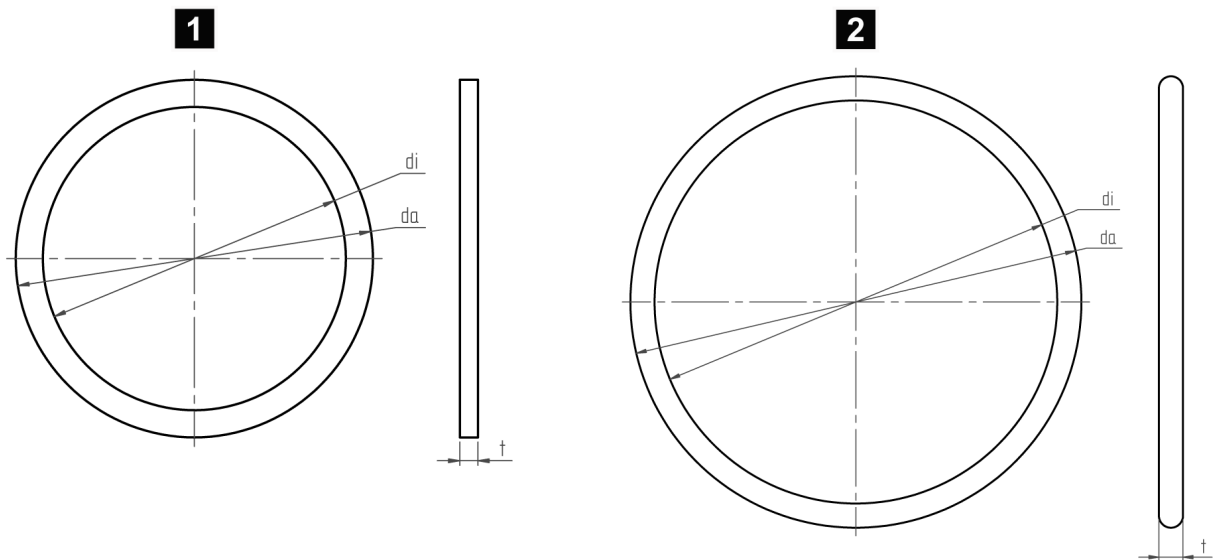


Figure 26: Flange gaskets

1	O-ring gasket for DN50/PN6/16
2	O-ring for DN80/PN16

### 5.3 MSENSE® DGA 5

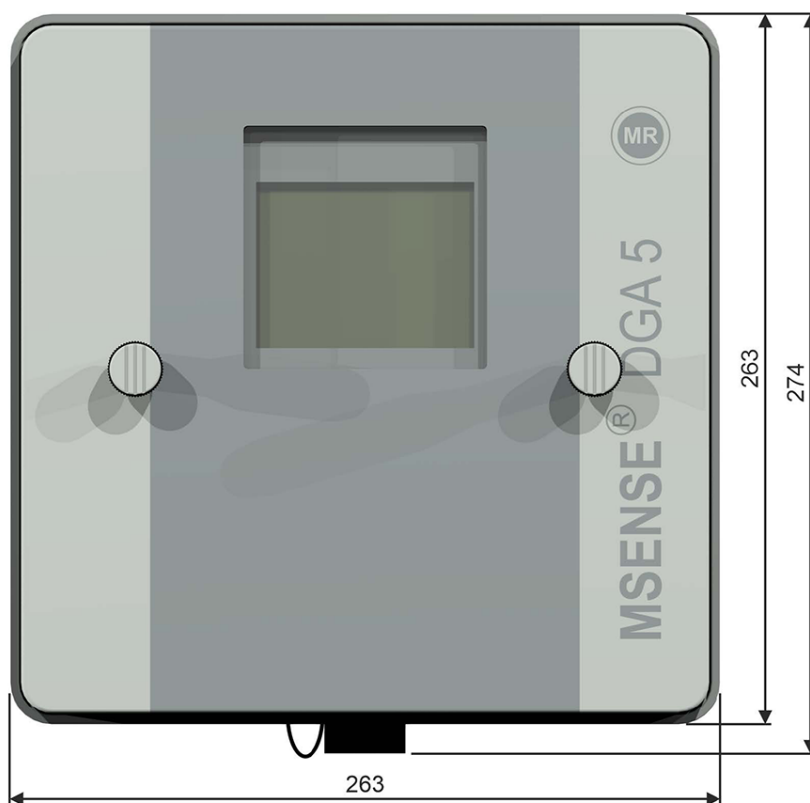


Figure 27: Dimensions (front view)

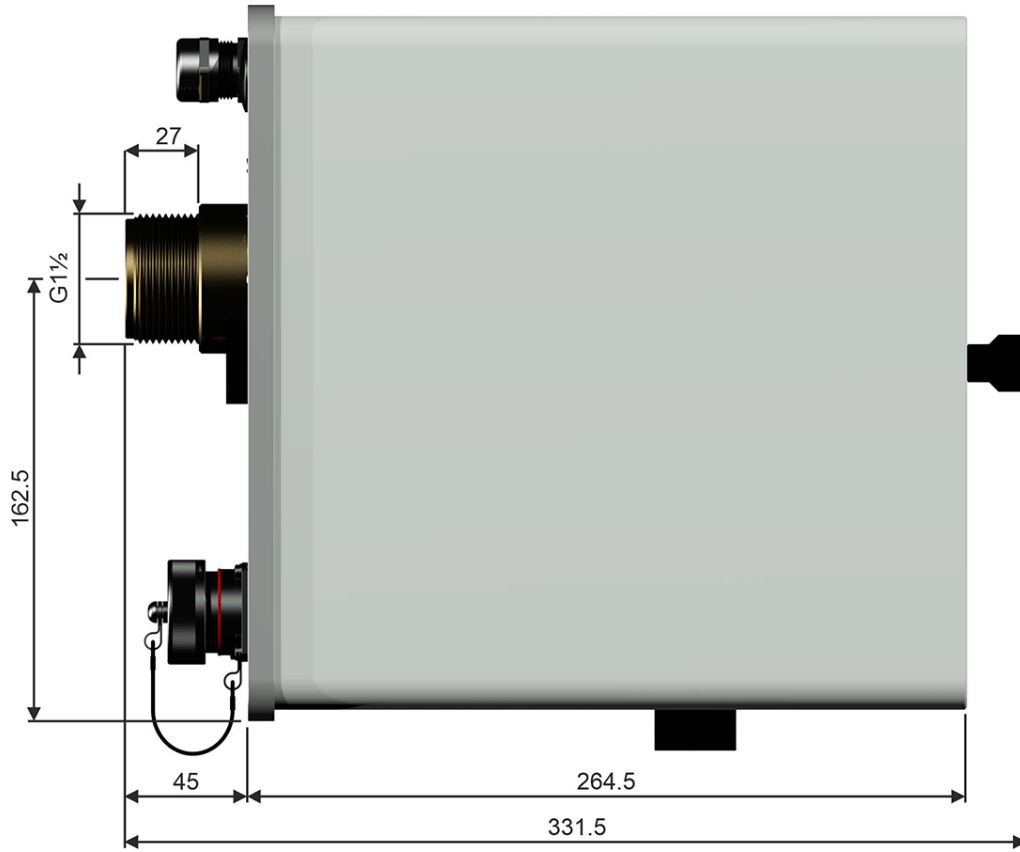


Figure 28: Dimensions (side view)

## 5.4 MSENSE® DGA 9

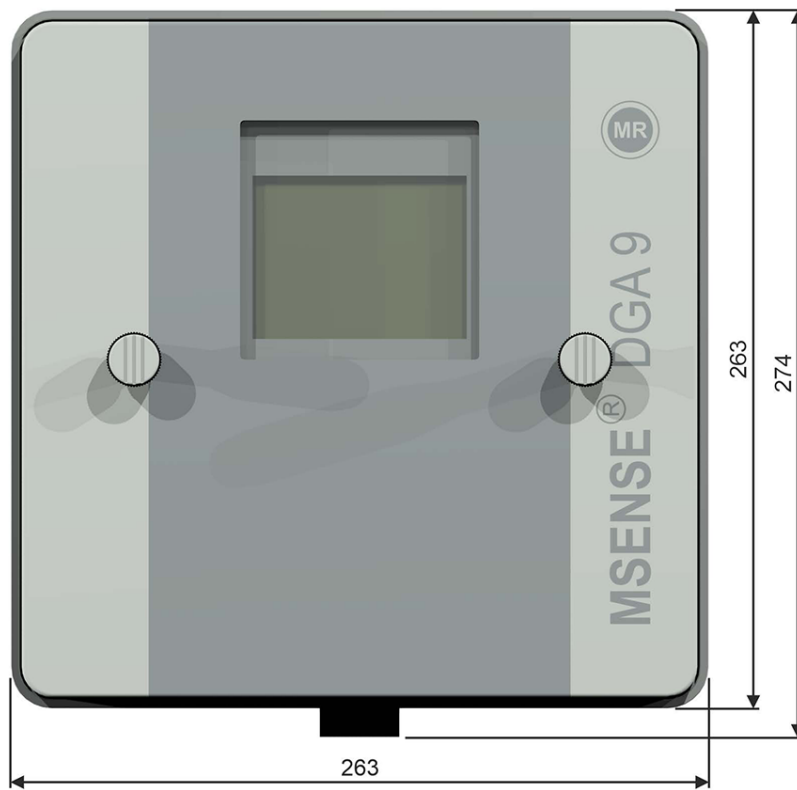


Figure 29: Dimensions (front view)

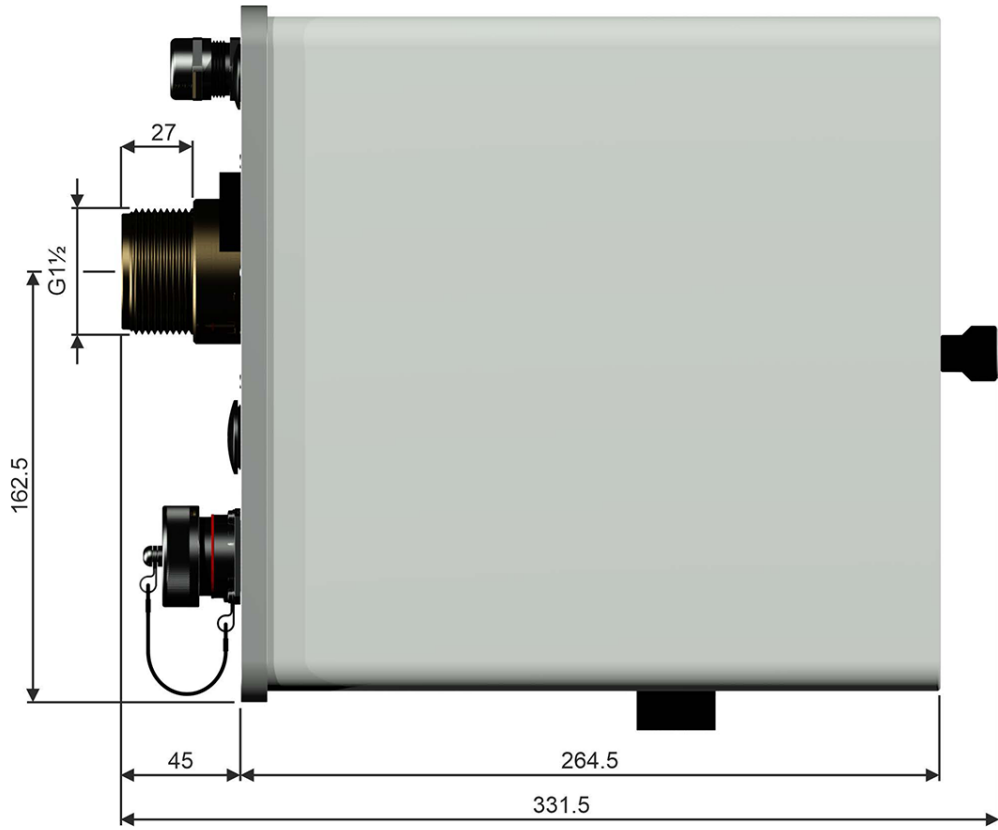


Figure 30: Dimensions (side view)

# Glossary

## DGA

Analysis of the gases dissolved in the oil (Dissolved Gas Analysis)

## GUI

Graphical user interface

## HSR

Redundancy protocol in accordance with IEC 62439-3 (High-availability Seamless Redundancy)

## MQTT

Message Queuing Telemetry Transport. A network protocol for machine-to-machine communication which enables the transmission of ISM® data in the form of messages between two devices.

## PRP

Redundancy protocol in accordance with IEC 62439-3 (Parallel Redundancy Protocol)

## TESSA®

Transformer Data Enrichment Smart Solutions Applications

## TPLE

Transformer Personal Logic Editor







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