Operating Instructions

DW-ROSON-ST 200
Winch 1500m

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Technical details

DW-ROSON-ST 200

1. DW-ROSON-ST 200

Dimensions L x W x H	:	2.3 x 3.5 x 4.3 m
Dimensions L x W x H CPT ready	:	3.5 x 3.5 x 4.5 m
Weight on deck (CPT "ready")	:	15,200 kg (27,700 kg)
Subsea weight (CPT "ready")	:	13,300 kg (24,100 kg)

2. Lifting frame 350 kN

Dimensions L x W x H	:	1.2 x 1.2 x 0.5m
Weight on deck	:	500 kg
Subsea weight	:	450 kg

3. Ballast plate set 3,5m – 100 mm (optional configuration 1 – "MIN")

Dimensions L x W x H	:	3.5 x 3.5 x 1.0m
Weight on deck	:	9,300 kg
Subsea weight	:	8,100 kg

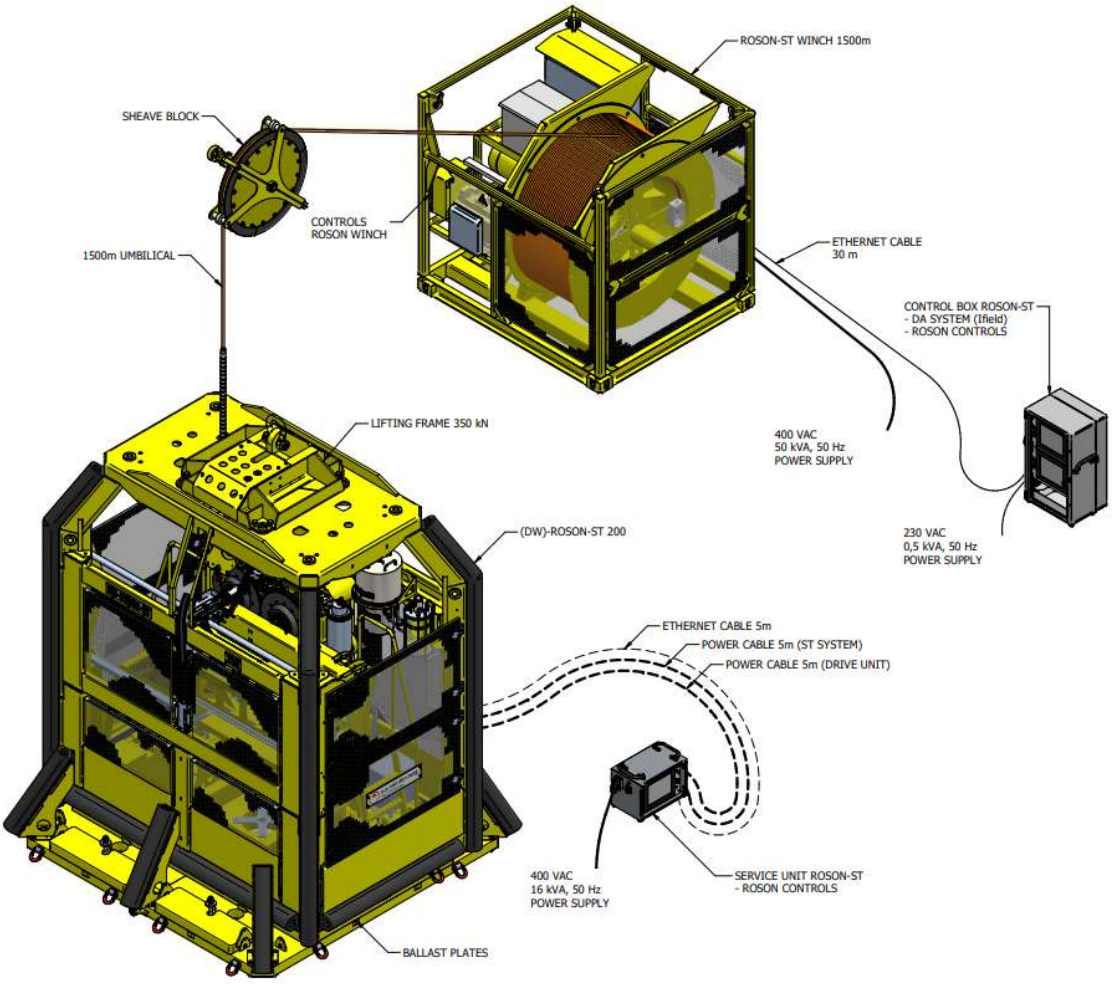
4. Ballast plate set 3,5m – 200 mm (optional configuration 2 – "MAX")

Dimensions L x W x H	:	3.5 x 3.5 x 1.0m
Weight on deck	:	12,600 kg
Subsea weight	:	11,000 kg

5. Seismic ballast set 3,5m – 600 mm (optional configuration 3)

Dimensions L x W x H	:	3.5 x 3.5 x 2.5m
Weight on deck	:	10,200 kg
Subsea weight	:	8,900 kg

Number of operators (deck crew not counted)	:	2



ROSON-ST winch and Control box

1. ROSON-ST winch with 1500 m umbilical

Dimensions L x W x H	:	2.4 x 2.0 x 2.18 m
Weight on deck	:	4,500 kg

2. Control box

Dimensions L x W x H	:	0.5 x 0.6 x 1.1 m
Weight on deck	:	50 kg

Table of Contents

Foreword

This User Operating Manual contains all necessary information for the proper use of the equipment.

This User Operating Manual has been prepared for the people who will operate the equipment and the people who will service and repair the equipment. However, the person who operates the equipment could service and perhaps even repair the equipment if said person has the proper capabilities to do so. A.P. van den Berg Ingenieursburo is able to give training to your employees.

If you have not operated this equipment before, it is suggested that you read all chapters. This will give you a feel of how it works and how to work it.

If you are familiar with operating this equipment you should at least read Chapters 2, 4, and 5 "Safety Instructions", "Preparing the machine before use" and "Electric testing" , before you start. There is a chance that this equipment is not quite the same as you have worked with before.

If you are servicing or repairing this equipment you should at least read Chapters 2, 6 and 7 "Safety Instructions", "Service" and "Problems", and the relevant paragraphs of the Chapters 4 and 5 "Preparing the machine before use" and "CPT testing", before you start.

Two copies of this manual have been supplied with the equipment. Keep one copy close to the equipment so it will be at hand when questions about operating or operation of the equipment arise. Keep the second copy in a safe place so it will be available during the time a new one is ordered due to damage or loss of the first copy.

The complete User Operating Manual set consists of the following parts:

- User Operating Manual of the machine (this manual);
- User Operating Manual of the electronic data acquisition system;
- User Operating Manual of the compression apparatus;

This User Operating Manual contains the following chapters:

- Chapter 1 "Introduction" deals with the purpose of the equipment, the operators of the equipment and the equipment operations.

- Chapter 2 "Safety Instructions" describes the most important safety measures the operator needs to take to operate the equipment. Some safety instructions from the other manuals are also listed here.

- Chapter 3 "Description and Operation" describes the parts and how they function.

- Chapter 4 "Mobilization on board the vessel" describes how to locate all parts on the vessel.

- Chapter 5 "Preparing the ROSON before use" describes how to transport the equipment and prepare the ROSON system before testing.

- Chapter 6 "CPT testing" describes how to operate the equipment and how a CPT test must be carried out.

- Chapter 7 "Seismic testing" describes how to operate the Seismic source and how a seismic test must be carried out.

- Chapter 8 "Vane testing" describes how to operate the Icone vane and how a vane test must be carried out.
- Chapter 9 "Service" informs you on how service work on the equipment must be carried out and how and where to order spare parts at A.P. van den Berg Ingenieursburo
- Chapter 10 "Troubleshooting" informs you on how you can solve minor problems of the equipment.
- Chapter 11 "Decommissioning" describes how you decommission the equipment when it has lost its functional value.
- In the "Glossary" you will find an explanation of the most frequently used terminology.
- Appendix A: the most important specifications of the equipment.
- Appendix B: Test Certification as filled out at delivery of the equipment.
- Appendix C: hydraulic and electrical diagrams together with their parts lists.
- Appendix D: technical drawings.
- Appendix E: technical information of OEM parts.
- Appendix F: spares and consumables list.

If in this manual is referred to a drawing number (e.g. 007215 or 12-1909-001) you will find this drawing in Appendix D.

For information on components supplied to us, we refer to the relevant operating instructions and documentation of these components. Read in particular the safety instructions before you start operating the equipment.

The supplied equipment can differ from the configurations described in this manual. Some of the described parts are optional, and not all options can be combined.

A.P. van den Berg Ingenieursburo keeps the right to alter parts at any time, without informing the buyer. The contents of this manual may be altered also.

A.P. van den Berg Ingenieursburo cannot be held responsible for any damage to the equipment, caused by improper use of the equipment, by neglecting safety instructions, by using poor spare parts and/or non-original accessories or by incorrect repairs and/or adjustments. We suggest you let us repair your equipment.

We at A.P. van den Berg Ingenieursburo hope you will enjoy your new equipment.

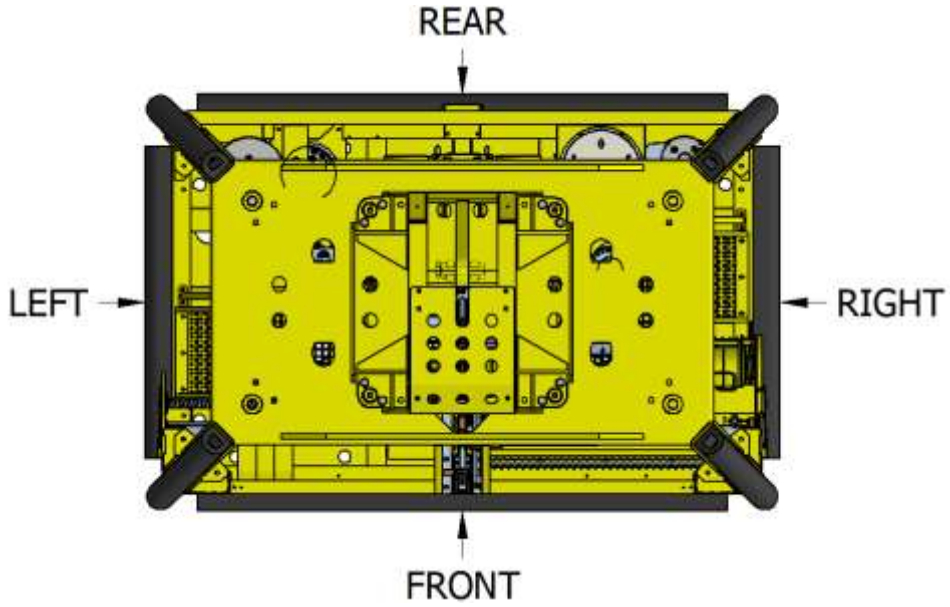
Chapter 1 Introduction

1.1 Purpose of the equipment

The purpose of the equipment is to perform geotechnical and environmental soil examination. The equipment pushes for that purpose a CPT string into the soil.

In this manual the following terminology is used for the DW-ROSON-ST 200:

"Front" means: At the side where the opening of the ROSON frame is
"Rear" means: At the side opposite the front
"Left" means: At the left side of the machine, seen from the front.
"Right" means: At the right side of the machine, seen from the front



1.2 Do's

Use the equipment for soil examination;
Use the equipment for taking soil and/or water samples;
Use the equipment for environmental examination;
Use the equipment for placing CPT rods.

1.3 Don'ts

Do not use the equipment as a press;
Do not use the equipment for pressing other items than a CPT string into the soil;
Do not use the equipment for pulling out other items than a CPT string out of the soil;

Only use genuine A.P. van den Berg Ingenieursburo testing parts with your equipment. Please refer to A.P. van den Berg Ingenieursburo if you want to use other kind of parts.

1.4 Abbreviations

Next abbreviations are used throughout this manual:

CPT	:	Cone Penetration Testing.
ISO	:	International Organization for Standardization.
CF	:	Icone with tip resistance (C) and local friction (F) measurement.
CFP	:	Icone with CF and pore water pressure (P) measurement.

1.5 Symbols

The following symbols used within this manual call your attention to specific types of information:

WARNING: Indicates a situation in which serious bodily injury or death could result if the warning is ignored.

Caution: Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.

Note: Provides useful supporting information on how to make better use of your equipment.

Chapter 2 Safety Instructions

This chapter deals with the precautions you have to take to be able to safely operate the equipment. The safety instructions are divided into three groups. The first group deals with the safety of personnel; the second one with organisational precautions and the last one deals with improving safety and safety measures for the equipment.

See chapter 1.5 "Symbols" for an explanation of the safety and warning signs used throughout this manual.

2.1 Safety precautions personnel

- Only qualified staff may operate the installation. Pay attention to the legally permitted age of your personnel.
- Personnel must be aware of rules on board of a vessel.

- **Caution:** Only a qualified electrician may service and repair the equipment.

- **Caution:** Only a qualified hydraulic engineer may service and repair the hydraulic system.
- Personnel, which are going to work with the installation, must first read this manual, particularly this chapter " Safety Instructions".
- Service personnel must first read the relevant chapters of the Operating Instructions before doing any service and/or repair work.

- **Caution:** Personnel may not have loose long hair, loose clothing or wear jewellery, including rings. You can get injured.
- All personnel should wear safety boots, safety helmet and safety goggles. (PPE)

2.2 Safety precautions working area

Advise your staff of the following general measures:

- This User Operating Manual should be kept with the equipment at all times.
- Adhere to the law and follow rules and regulations in order to prevent accidents and pollution.

- **Caution:** The equipment has to be shut down immediately as soon as sizeable changes occur that may affect safety.

- **Caution:** No alterations shall be made to the equipment that can endanger safety such as removing safety features or safety valves or by any welding to the frame of the winch. If there is a need for alterations you should consult with A.P. van den Berg Ingenieursburo first.
- Spare parts have to comply with the specifications.
- All tools have to be suitable for routine service.
- Make sure all staff knows where the fire extinguisher is located and knows how to activate it.

- The equipment can only be used if it is in good technical condition. Anything that can affect safe operation of the equipment shall be properly dealt with before any use.

- The equipment shall be used only for what it is intended (see chapter 1 "Introduction"). The manufacturer will not accept any liability if the equipment is used for any purpose other than for which it is intended.

2.3 Safety precautions equipment

Caution: The equipment has been manufactured to the highest standards available, in particular those concerning safety. Notwithstanding our efforts, dangerous situations for man and machine may occur.

- Don't experiment with the equipment.

- Make sure unauthorized persons are at a safe distance of the installation and stay there.

- **Caution:** Inform yourself as to where the electricity cables, telephone cables, water pipes, gas pipes and sewer pipes are located underground before any testing takes place.

- There should be no hydraulic pressure in tubes or hoses when performing service or repair work. You can reduce pressure in the system by operating the equipment with the electric motor shut down.

- **WARNING**: Oil can eject from very small holes not visible for the human eye. Do not try to locate oil leaks by hand. High pressure can perforate your hand easily which leads to very serious injuries. Use cardboard to find small holes. If you ever get hydraulic oil UNDER your skin you have to immediately call for a doctor who is familiar with this kind of injuries.

- Replace a hose as soon as it is shows wear and tear.

- Make sure that all warnings and operating stickers are legible. Replace by new ones if necessary.

- **Caution:** Make sure the vessel has sufficient lifting capacity to pick up the ROSON from the seabed. Be aware that pulling the ROSON out of a soft seabed the required lift capacity can be a factor of two higher than the ROSON weight! Make sure the weight of the lifting cable, the required constant tension force and the spare force is taken into consideration when calculating the required lifting capacity.

- Make sure, that no loose material or items can roll or drop off of the ROSON when it is transported.

- Make sure nobody is on or near the ROSON when it is transported.

- Make sure the sounding rod between the wheels has been taken out or is turned to the upper position during transport, because it can be damaged.

- **Caution:** The winch has to be connected firmly to the ships earth, to avoid injury from electrocution by lightning, or damaged cables.

- The brake of the winch is very important for holding the cable weight. Never try to lubricate the brake.

- Never remove the protection bars from the winch. Otherwise you can get caught by the winch and be pulled in. The protection bars are not fully enclosed, because the umbilical needs free space when a kink occurs.
  Caution: Therefore the winch may never be operated when personnel is standing directly besides the drum (minimum distance 3 m).

- The winch has to be secured to the vessel at a minimum pull capacity of 50 kN (5 metric tons).

- Laser radiation: Inside the termination the glass fibre optic data connection is transformed from light to an electrical signal, and vice versa. This laser light comes from the winch cabinet and from the circuit board in the termination.
  Caution: The light is invisible, but harmful for your eyes! Never look in to it and always have the mains supply switched of when working on it.

2.4 Safety precautions electrical system ROSON

Caution: The ROSON system has a power supply with a long umbilical cable that makes is necessary to have a **high voltage** power supply. To work with this high voltage it is essential that great care is taken to avoid accidents.
Be sure the personnel has an appropriate experience and training.

2.4.1 Do's

- Before working on the system switch off the system and check if the power is really switched off (measure voltage on main leads.)
- Keep the whole installation clean, so no current leaks can develop.
- Keep connectors absolutely clean and dry.
- Check at regular intervals the mechanical and electrical condition of the umbilical and connectors.
- When measuring the system always first check for the maximum voltage range of the measuring instrument.
- For safety reasons always make a safety plan before starting work.
- Instruct personnel before work starts.
- Wear protective and insulating clothes and gloves.
- Always be with two persons minimally.
- Remove the power supply of the control unit before working on the electrical installation of the ROSON system.

2.4.2 Don'ts

- Never measure the voltage of the umbilical, motors, etc. without protective clothing and spectacles.
- Never "repair" a cable by means of tape. Always repair in a professional manner.
- Never leave the power on the system while working on the electrical system.
- Never work alone.
- Never disconnect or connect the subsea connectors while the main switch on the ROSON winch cabinet is on.
- Never use water to clean the electrical system.

Chapter 3 Description and operation

This chapter describes the parts of the DW-ROSON-ST system and how they function.

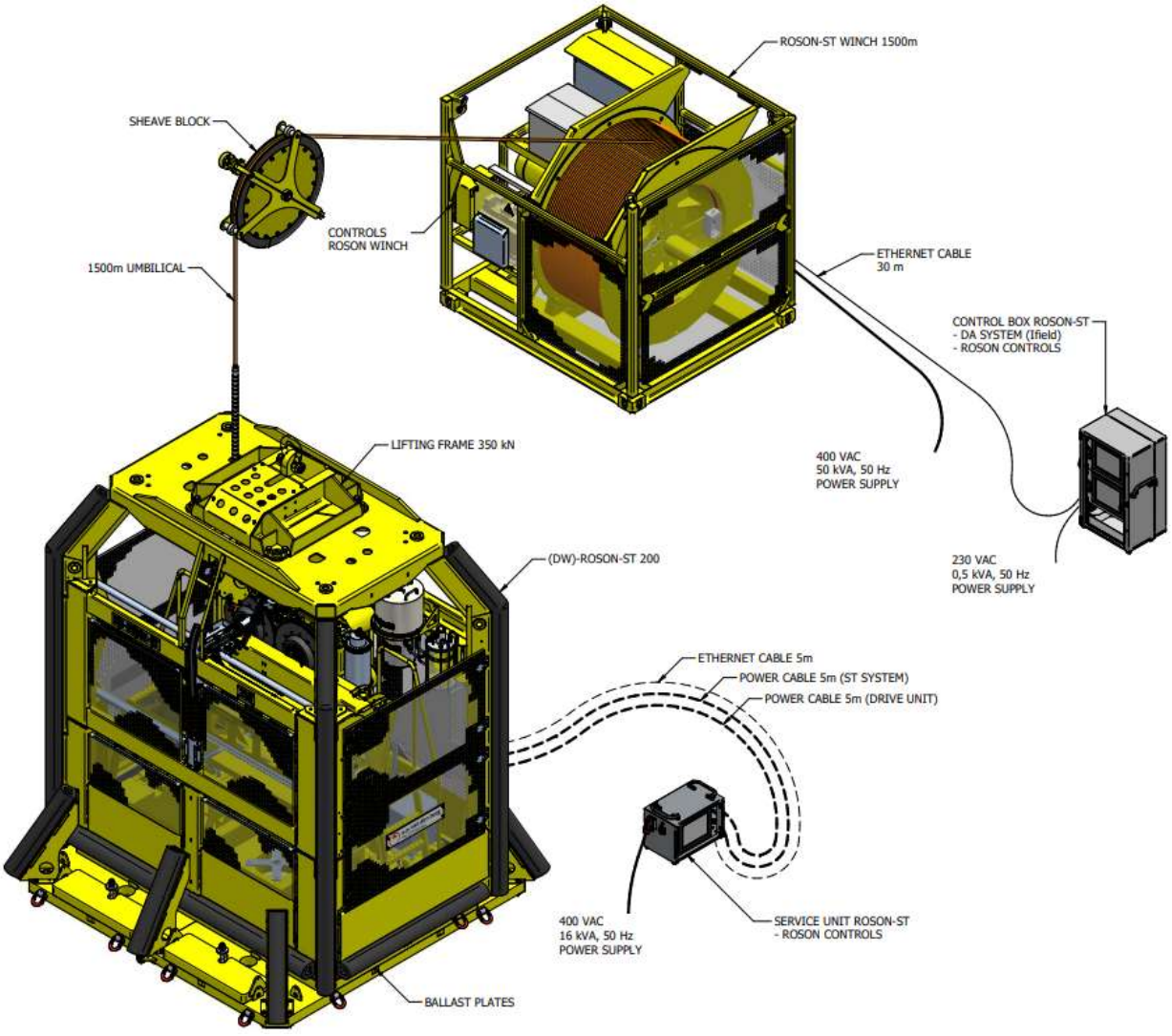
The equipment consists of a single ROSON module for pushing up to 200 kN and a ST system to create a solid CPT string up to 80 meter. All parts are built in a solid base frame.

The control box and ROSON winch are connected to the subsea junction boxes by means of an umbilical cable. The umbilical ensures a stable power and communication line and allows control and communication between the vessel and the ROSON system.

The service unit ROSON-ST can be connected directly to the ROSON system for service purposes.

The following subsystems will be described in this chapter:

- ROSON winch and sheave block
- DW-ROSON-ST 200
- Control box ROSON-ST
- ST cycle
- CPT string
- ROSON-ST service tools
- Base frame
- Seismic source (optional)
- Icone vane (optional)



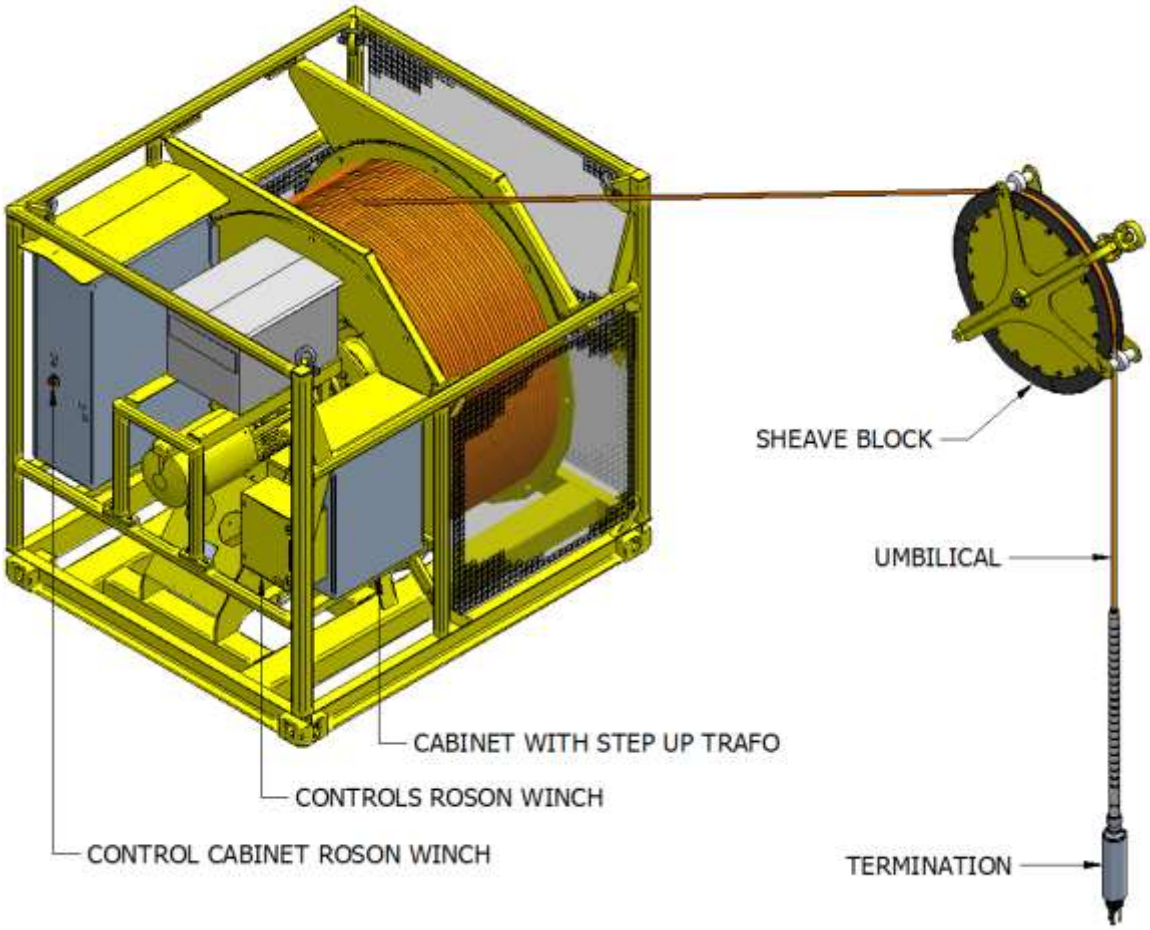
3.1 ROSON winch and sheave block, drawing 027880

The ROSON winch is used for storage and handling of the ROSON umbilical. The umbilical is guided by a sheave block to make sure the umbilical can run freely without any obstructions. A transformer is used to step up the voltage to compensate for the power losses due to the long umbilical.
With 1500 m umbilical spooled on the drum it has 9 layers. This results in a force from layer 1 to 10 of 7500 – 5500 N (760 – 560 kg) with a speed of 1.6 – 2.2 m/s.

To enlarge the operational weather window, increase safety and extend the umbilical life the winch is provided with a constant tension function. This function is able to keep the umbilical on a constant line-pull between winch and DW-ROSON-ST during deployment.

The following subsystems will be described in this chapter:

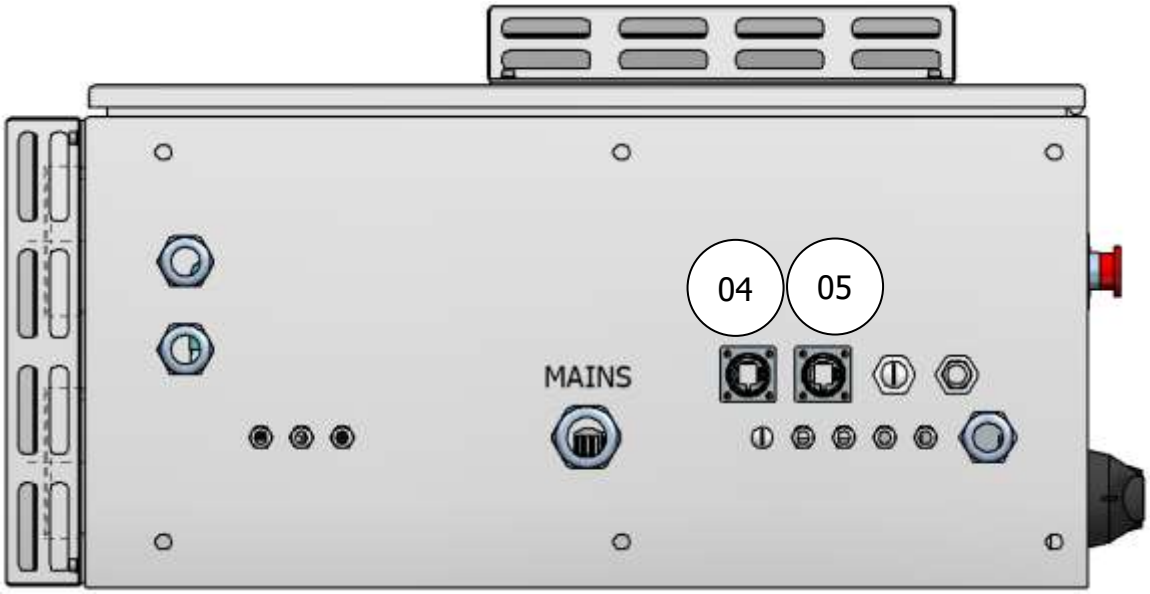
- Control cabinet
- Cabinet with step up trafo
- Controls ROSON winch
- Umbilical
- Sheave block
- DW-ROSON-ST termination



3.1.1 Control cabinet ROSON winch, drawing 044087

The control cabinet contains all the electrical components for the ROSON winch.

No.	Component type	Function
01	Push-button w/ light	Reset emergency circuit
02	Push-button	Emergency stop
03	Switch	Main switch
04	Ethernet connector	Connection for cable to Control box ROSON-ST
05	Ethernet connector	Connection for cable to Transformer Cabinet (06)

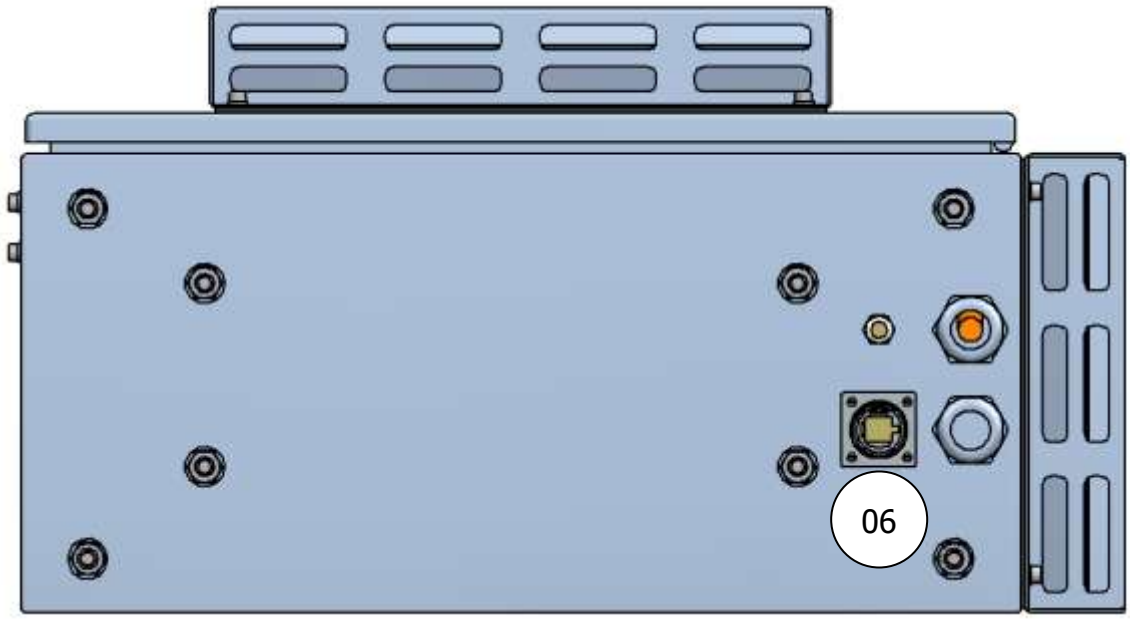


Control cabinet bottom side

3.1.2 Transformer cabinet ROSON winch, drawing 048021

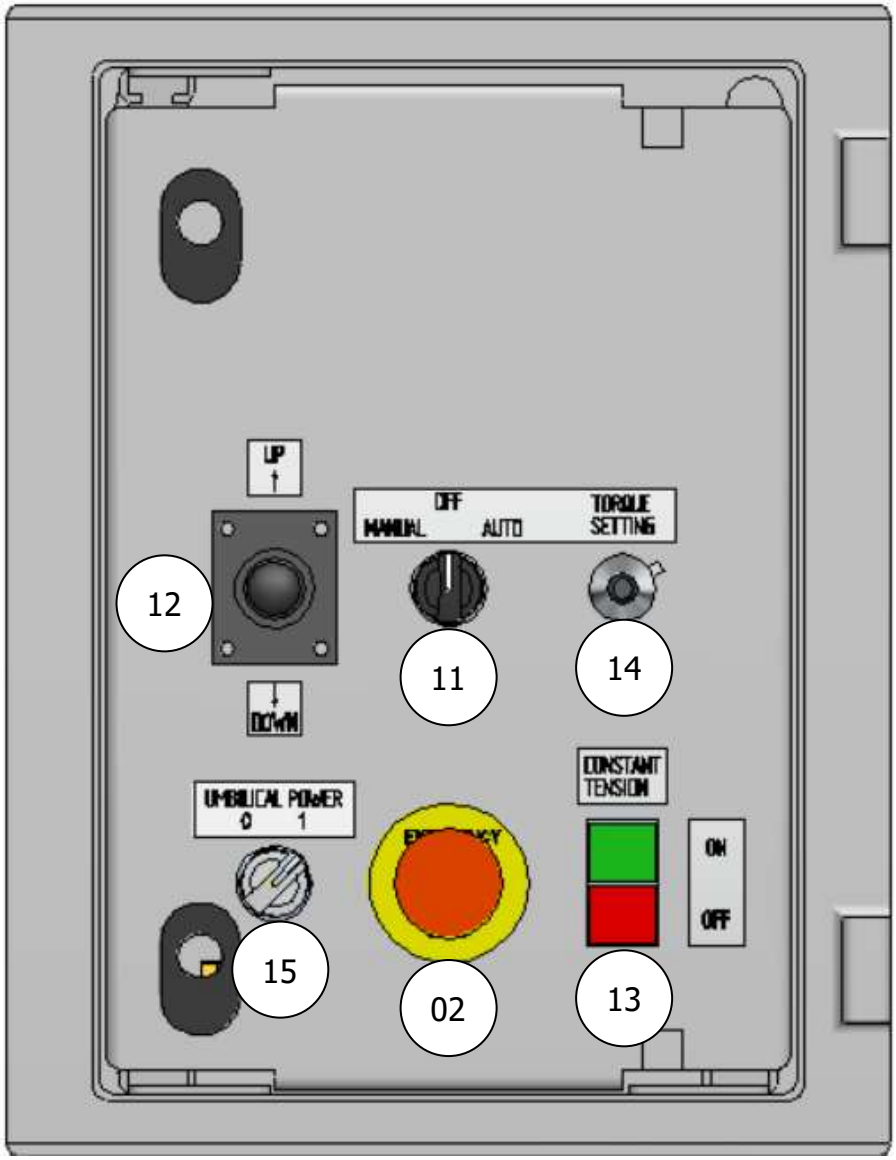
The Transformer cabinet contains the step up transformer and the Umbilical power feedback.

Caution: The ROSON system has a power supply with a long umbilical cable that makes is necessary to have a **high voltage** power supply. To work with this high voltage it is essential that great care is taken to avoid accidents.
Be sure the personnel has an appropriate experience and training.



No.	Component type	Function
06	Ethernet connector	Connection for cable to Control cabinet (05) for power feedback

3.1.3 Controls ROSON winch, drawing 045485



No.	Component type	Function
02	Push-button	Emergency stop
11	Switch	Manual operation (joy-stick) Off Auto operation (constant tension)
12	Joy-stick	Rotate drum "up" or "down"
13	Push button /w light	Green: Constant tension "ON" (light on) Red: Constant tension "OFF" (light off)
14	Dial	Torque setting constant tension
15	Switch /w light	Umbilical power "ON" or "OFF"

Note: When the umbilical power is "ON" it takes about 30 seconds before the PLC is started.

3.1.4 Umbilical

The umbilical ensures a stable power and communication line and allows control and communication between the vessel and the ROSON system. The umbilical is reinforced with an aramid braiding with a safe working load of 20 kN. The umbilical has an outer diameter of 25 mm and a minimum dynamic bending radius of 500 mm.

The umbilical has the following components:

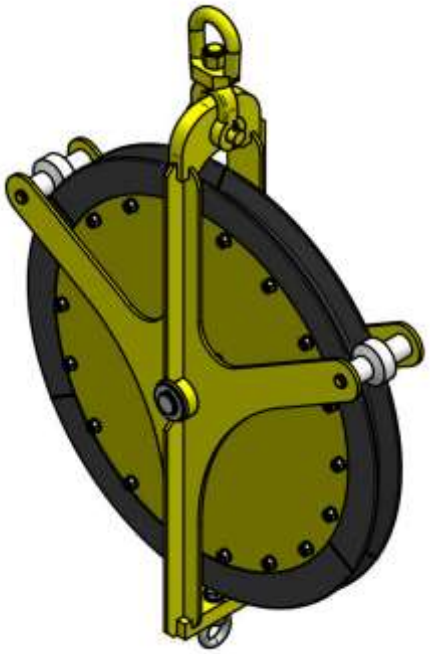
- Three 4 mm^2 power conductors to power the motors of the ROSON drive unit.
- Three 4 mm^2 power conductors to power the ST-system.
- Four Single mode fibers: one is used for fiber optic communication, three are prepared as spare fibers.

A slip ring unit with 6 electrical passes and 1 fiber optic pass connects the umbilical in the drum with the stationary winch frame.

Note: Avoid damages of the outer sheet to avoid ingress of seawater. In case of long-time storage direct sunlight must be avoided.

3.1.5 Sheave block

The sheave block is used to guide the umbilical over the edge of the vessel. The diameter is based on the minimum required dynamic bending radius, the frame is designed and tested for the required safe working load.



3.1.6 DW-ROSON-ST termination, drawing 048266

The DW-ROSON-ST termination is the connection between the umbilical and the DW-ROSON-ST 200 system.

The termination has the following functions:

- Mechanical connection
- Electrical connection
- Conversion from Fiber optics to Ethernet communication

The termination is an atmospheric housing containing terminals for the power conductors, a DC-DC converter and a fiber optics to ethernet converter.

No.	Component type	Function
21	Connector male (red)	Subsea connection to JB Trafo (4 pin connector – 950 VAC – Power drive unit)
22	Connector male (black)	Subsea connection to JB Trafo (4 pin connector – 950 VAC – Power ST system)
23	Connector male	Subsea connection to Junction box Main JM09 (13 pin connector - Ethernet communication + 24 Vdc power)
24	Umbilical	Power (3 + 3 wires) and comms (Fiber optics)

Caution: Make sure the power supply is off (main switch (3) and umbilical power switch (15)) when the umbilical is connected to or disconnected from the junction box.

3.2 DW-ROSON-ST 200, drawing 048914

The DW-ROSON-ST 200 is a seabed system which is lowered to the seabed to perform the CPT. The frame consists of two drive motors with drive wheels to push and pull the CPT string in and out of the soil.

The DW-ROSON-ST is a system to create a solid CPT string up to 80 meter. The ST system has three main components:

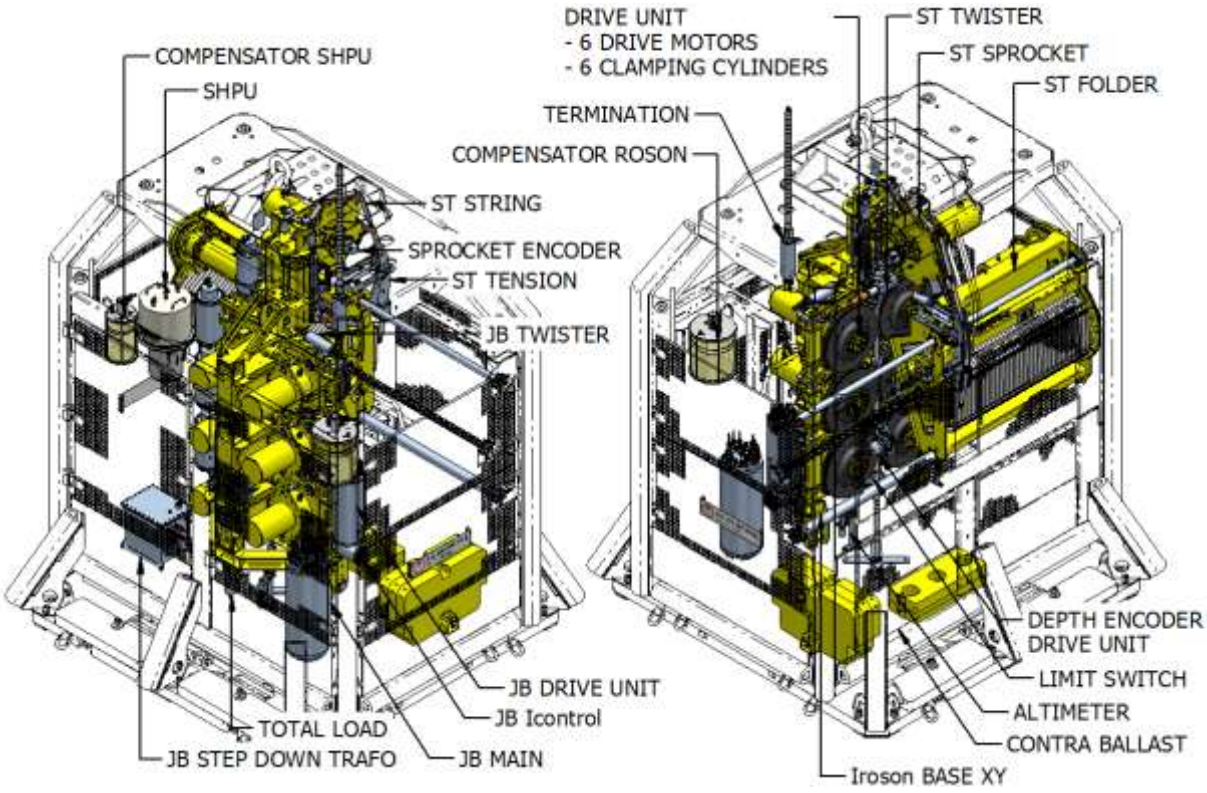
- ST Folder, for storage of the ST rods and to keep tension on the ST string
- ST Sprocket, for feeding / removing the ST string to and from the ROSON
- ST Twister, for connecting and disconnecting the ST rods

All the sensors and motors are connected with subsea cables to the junction boxes, which are connected to the termination of the ROSON winch. The system has three atmospheric junction boxes:

- Junction box Step-down Trafo
- Junction box Main DW-ROSON-ST
- Junction box Drive unit DW-ROSON-ST 200
- Junction box Icontrol ST
- Junction box Twister

The above mentioned and the following subsystems will be described in this chapter:

- Drive unit DW-ROSON-ST 200
- Drive motor
- Clamping cylinder
- Subsea Hydraulic Power Unit (SHPU)
- Pressure compensation system
- Limit switch and dirt scraper
- Depth encoder DW-ROSON-ST
- Depth encoder DW-ROSON-ST drive unit
- Total load measurement
- Iroson base P200 XY
- Altimeter

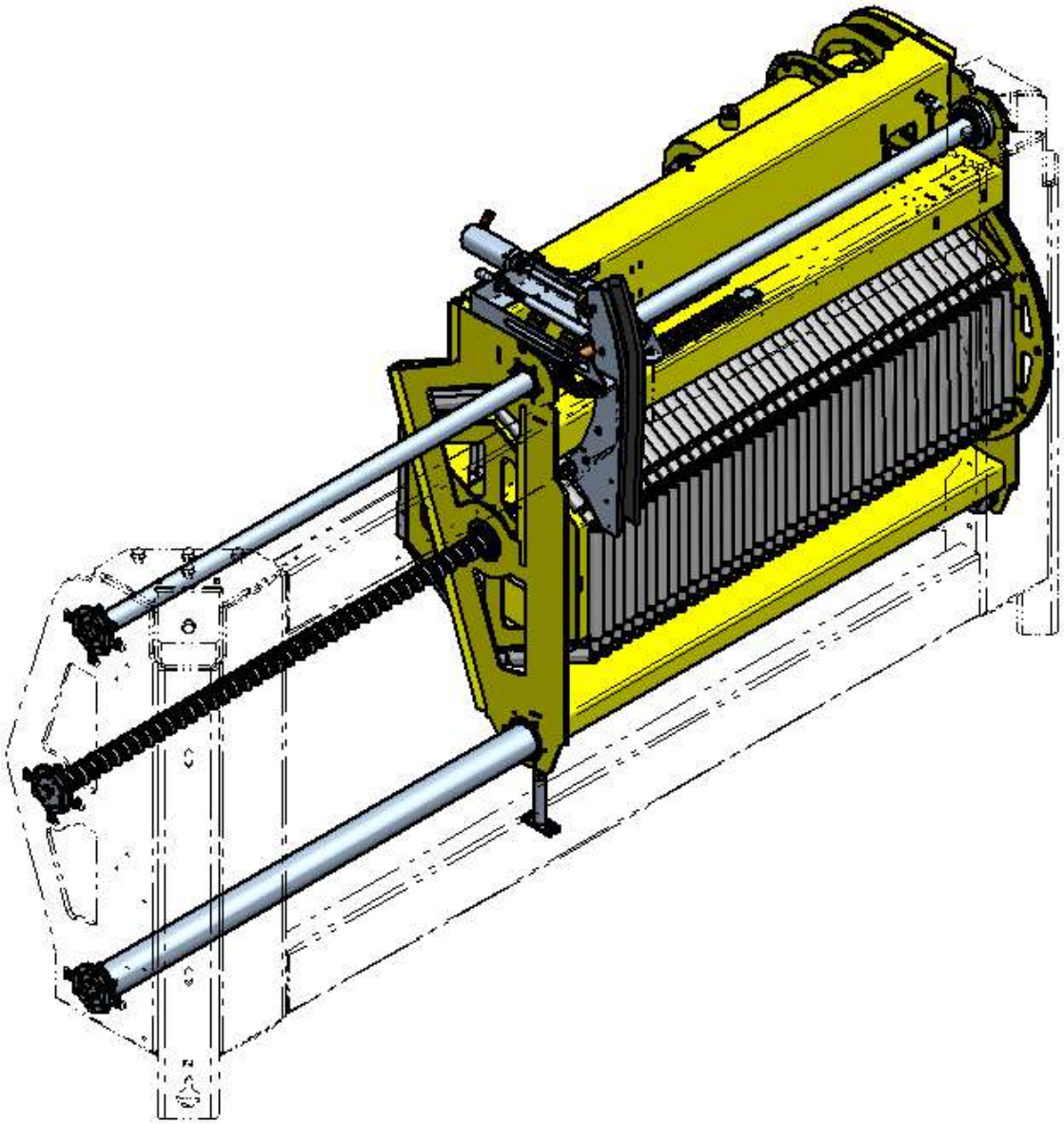


3.2.1 ST Folder, drawing 048718

The ST Folder stores the ST rods on a drum, and keeps tension on the ST String to make sure the string is folded correctly on the drum. While rotating the drum, the Folder translates in horizontal direction to make sure the ST String is removed/placed in correct order.

The ST Folder is driven by an electric motor which follows the Sprocket motor. The ST Tension sensor checks the tension on the string during the ST cycle. During the init cycle the ST Tension sensor is used to create a zero-point for the follow mode.

The ST Folder has a storage capacity of 80 meter ST string, a maximum push/pull force of 7000 N and a maximum speed of 60 mm/s. To ensure communication with the Icone, a slip ring unit is inside the drum to transfer the communication signals.

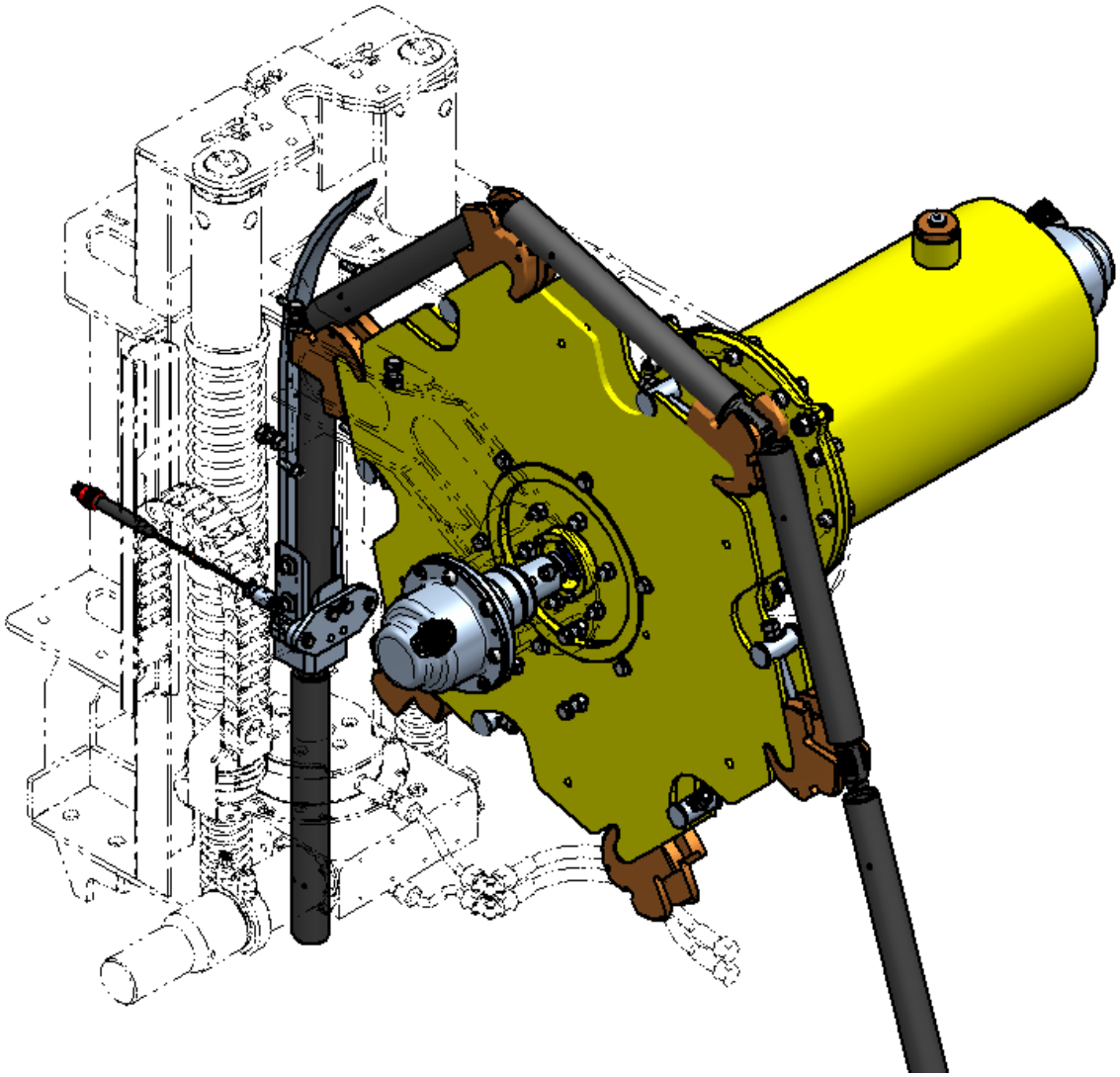


3.2.2 ST Sprocket, drawing 048926 / 044202

The ST Sprocket feeds the ST rods to and from the ROSON drive unit. The Sprocket makes sure the ST rods are pushed in each other, or removed from each other, at the right moment in the ST cycle.

The Sprocket is driven by an electric motor, which is controlled by a frequency inverter in maximum speed and torque. The position encoder connected to the Sprocket wheel is used for timing of the ST cycle. A proximity switch is placed below the ST guiding, and is able to check in the pull cycle if a rod is removed, or locked.

The Sprocket has a maximum push / pull force of 2250 N and a maximum speed of 40 mm/s.

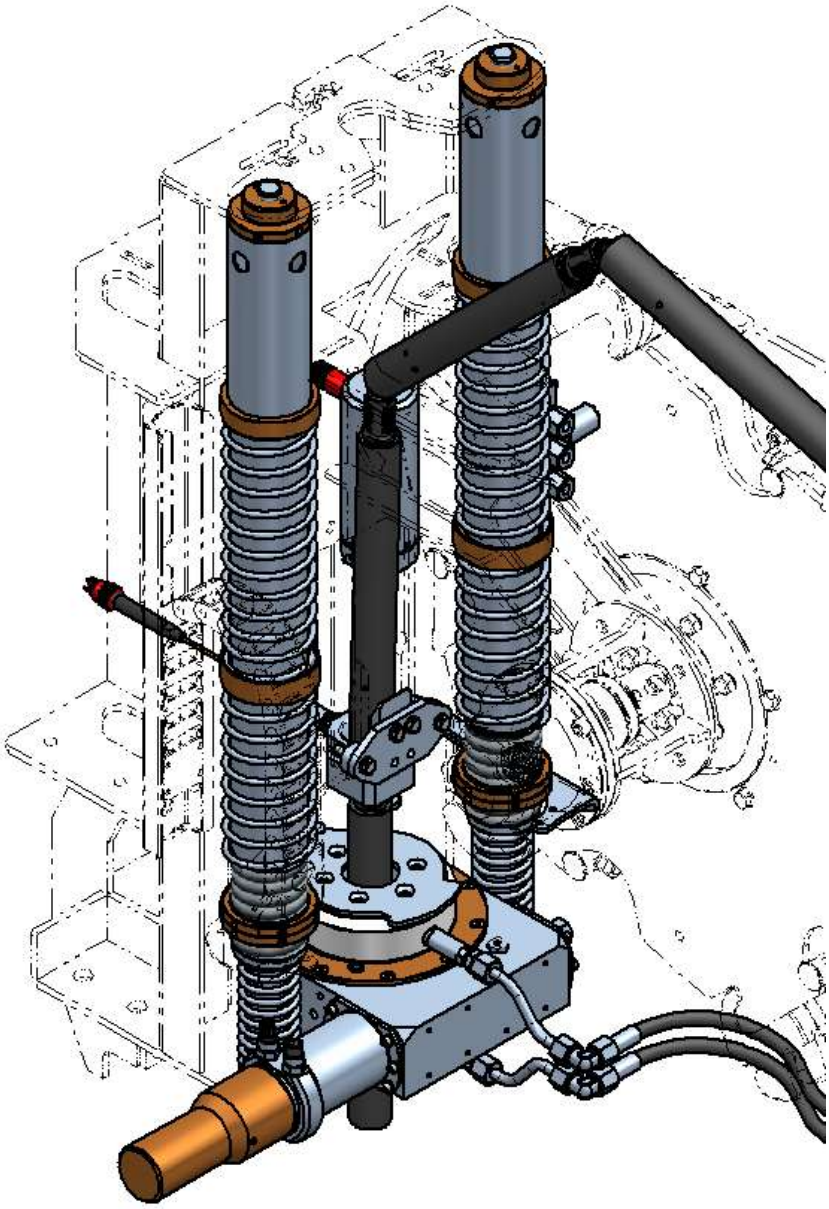


3.2.3 ST Twister, drawing 023453

The ST Twister clamps and rotates the ST rods which are feeded by the Sprocket. The Twister is able to tighten the ST rods to the string to create a stiff and strong CPT string required for a deep CPT test. When untightening the ST rod, the string transforms to a flexible and foldable string for compact storage on the Folder.

The Twister is connected to a suspension system actuated by springs. This suspension system allows the Twister to follow the moving CPT string while (un-)tightening the ST rods and resets to the start position when the clamp is opened. The Twister clamp is driven by hydraulics, supplied by the SHPU. The rotation of the clamp is driven by an electrical motor. The vertical position is monitored by a position sensor and two proximity switches are placed to detect the end positions of the rotation of the Twister clamp. The rotational position, speed and torque is derived from the hall sensors and motor current from the motor.

The Twister can reach a maximum torque of 550 Nm and a maximum speed of 30 °/s.

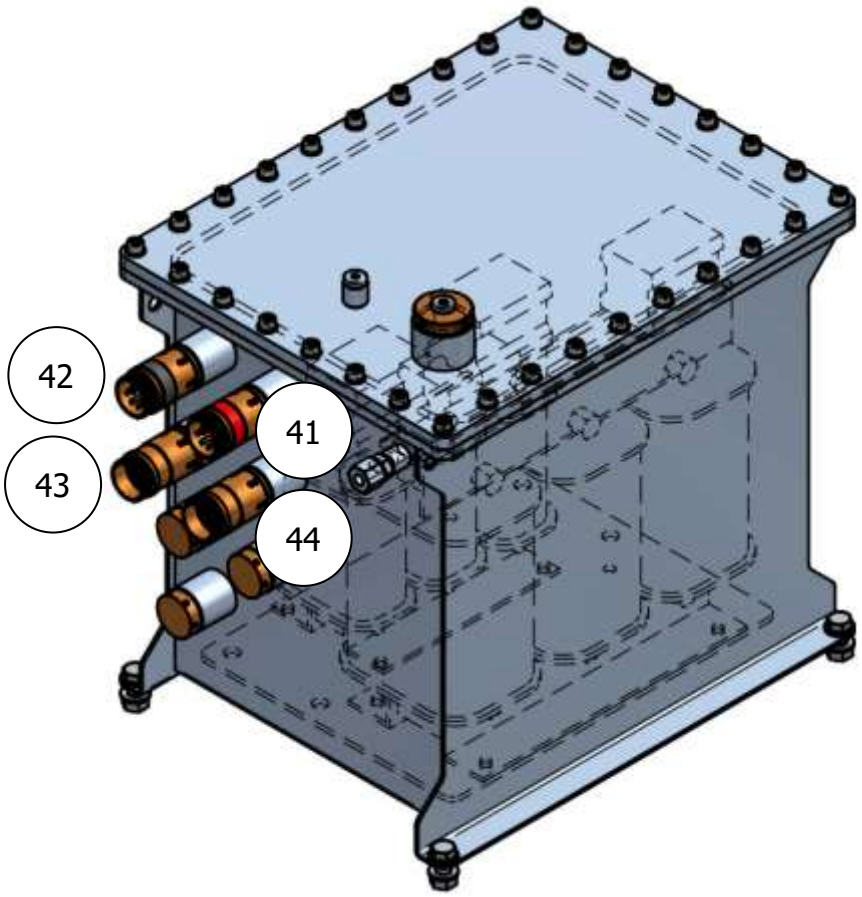


3.2.4 Junction box Step-down Trafo, drawing 048309

The Junction box step-down trafo (JB Trafo) is connected with two cables to the Termination, which is connected to the umbilical cable of the ROSON winch to supply the power.

The JB Trafo is connected with one cable to power the Junction box Main.

Layout drawing 049855 shows an overview of all cables between each junction box, actuator or sensor.

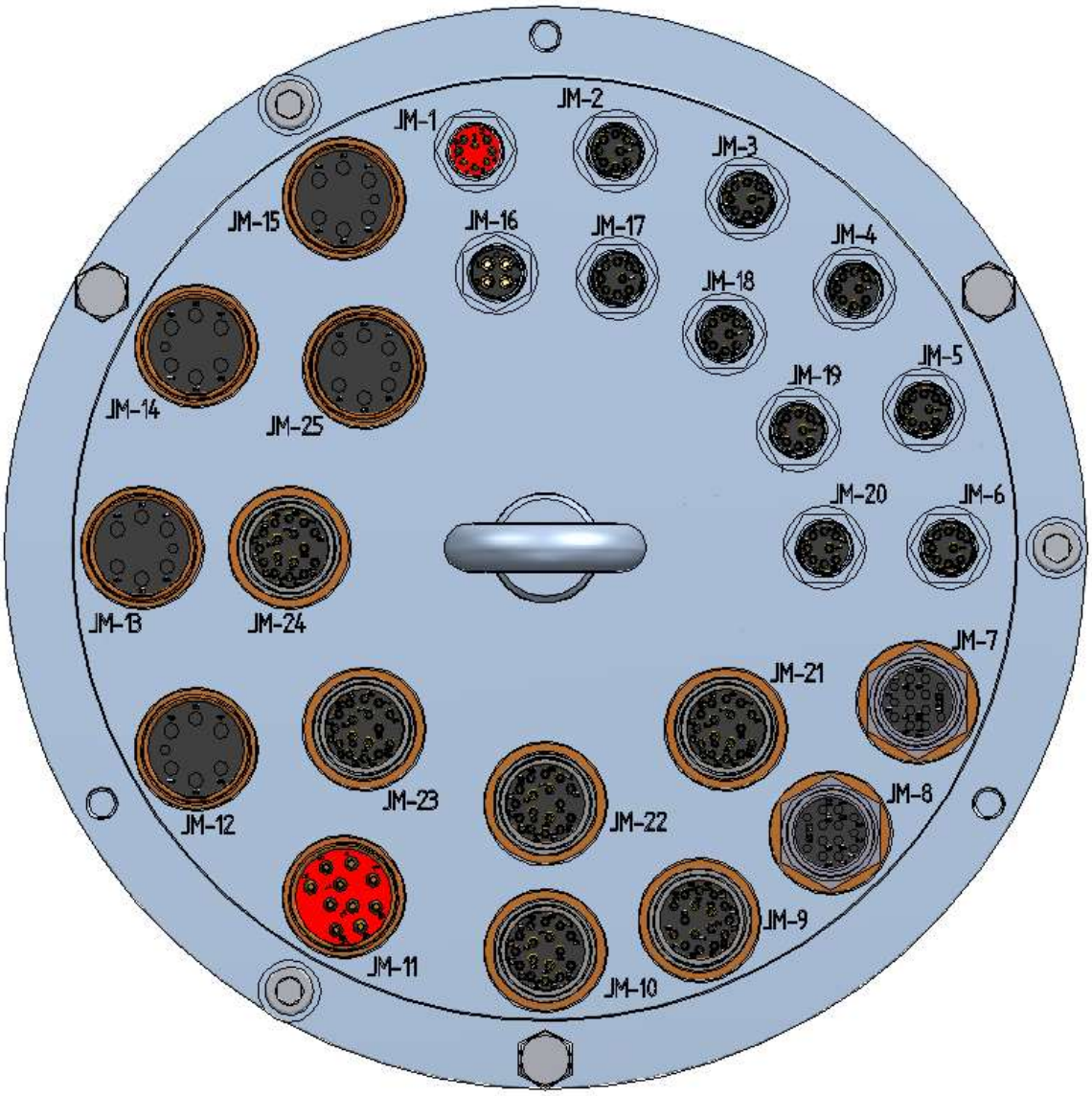


No.	Component type	Function
41	Connector male (red)	Subsea connection from Termination (4 pin connector – 950 VAC – Power drive unit)
42	Connector male (black)	Subsea connection from Termination (4 pin connector – 950 VAC – Power ST system)
43	Connector female	Subsea connection to Junction box Main JM11 (10 pin connector – 500 VAC – Power ST system)
44	Connector female	Subsea connection to Junction box Drive unit JD7 (10 pin connector – 500 VAC – Power drive unit)

3.2.5 Junction box Main DW-ROSON-ST, drawings 048238 + 049855

The junction box Main (JB Main) is connected one cable to the JB Step-down trafo and one cable to the Termination, which is connected to the umbilical cable of the ROSON winch. The Junction box Icontrol ST, Junction box Twister, the drive motors and sensors are connected to the Junction box Main. Layout drawing 049855 shows an overview of all cables between each junction box, actuator or sensor.

The Junction box Main contains the PLC, the drives for the Sprocket/Folder/SHPU, the relays for the drive unit, the DC power supplies and the Ethernet switch.



No.	Component type	Function
JM-1	Connector male 8p	Subsea connection to JB Icontrol ST
JM-2	Connector female 8p	Subsea connection to JB Icontrol ST
JM-3	Connector female 8p	Subsea connection to Twister vertical position
JM-4	Connector female 8p	Subsea connection to JB Twister
JM-5	Connector female 8p	Subsea connection to pressure sensor (TW clamp open)
JM-6	Connector female 8p	Subsea connection to pressure sensor (TW clamp closed)
JM-7	Connector female 13p	Subsea connection to Termination / Service unit (Ethernet)
JM-8	Connector female 13p	Subsea connection to JB drive unit (Ethernet)
JM-9	Connector female 16p	Subsea connection to JB drive unit (Power + I/O)
JM-10	Connector female 16p	Subsea connection to JB Twister (Power)
JM-11	Connector male 10p	Subsea connection to JB Step-down (Power)
JM-12	Connector female 6p	Subsea connection to drive motor Folder
JM-13	Connector female 6p	Subsea connection to drive motor Sprocket
JM-14	Connector female 6p	Subsea connection to drive unit motor 1 *)
JM-15	Connector female 6p	Subsea connection to drive unit motor 2 *)
JM-16	Connector female 4p	Subsea connection to ST guiding switch
JM-17	Connector female 8p	Subsea connection to ST tension sensor
JM-18	Connector female 8p	Subsea connection to Compensator ST
JM-19	Connector female 8p	Subsea connection to Compensator ROSON
JM-20	Connector female 8p	Subsea connection to Altimeter
JM-21	Connector female 16p	Subsea connection to SHPU sensors and valves
JM-22	Connector female 16p	Subsea connection to position encoder Sprocket
JM-23	Connector female 16p	Subsea connection to motor encoder Folder
JM-24	Connector female 16p	Subsea connection to motor encoder Sprocket
JM-25	Connector female 6p	Subsea connection to motor SHPU

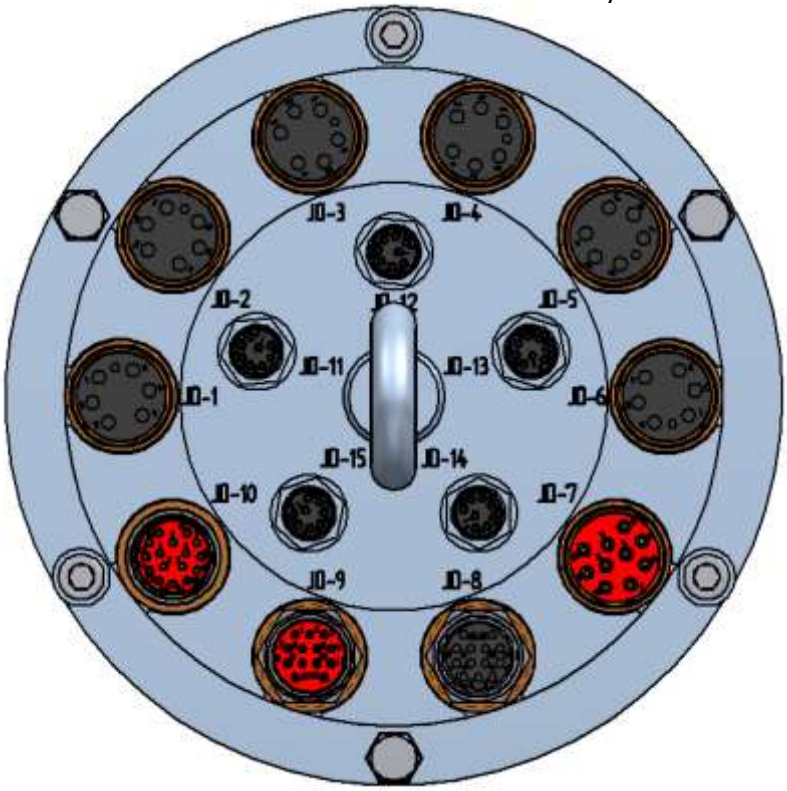
Caution: Make sure the power supply is off (main switch (3) and umbilical power switch (15)) when the Termination or drive units are disconnected from the junction box.

*) When JB Drive unit (JM-8) is used, these connections need to be plugged.

3.2.6 Junction box Drive unit DW-R-ST 200, drawing 048531

The junction box Drive unit (JB Drive unit) is connected with one cable to the JB Step-down trafo and two cables to the JB Main. The drive motors, pressure sensors and SHPU (additional signals) are connected to the Junction box Drive unit.

The Junction box Drive unit contains the drives + relays for the drive unit.

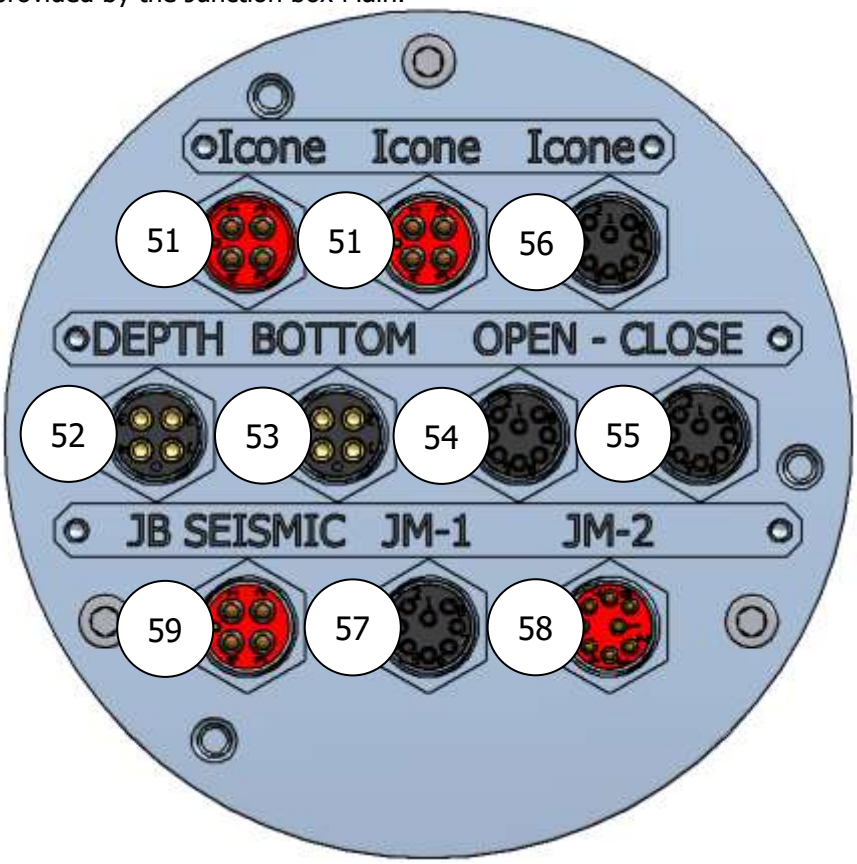


No.	Component type	Function
JD-1/2	Connectors female 6p	Subsea connections to drive motors 1 and 2
JD-3/4	Connectors female 6p	Subsea connections to drive motors 3 and 4
JD-5/6	Connectors female 6p	Subsea connections to drive motors 5 and 6
JD-7	Connector male 10p	Subsea connection to JB Step-down trafo
JD-8	Connector female 13p	Spare subsea connection (Ethernet)
JD-9	Connector male 13p	Subsea connection to JB main (Ethernet)
JD-10	Connector male 16p	Subsea connection to JB main (Power + I/O)
JD-11	Connector female 8p	Subsea connection to SHPU
JD-12	Connector female 8p	Subsea connection to pressure sensor (Drive unit 2 clamp open)
JD-13	Connector female 8p	Subsea connection to pressure sensor (Drive unit 2 clamp closed)
JD-14	Connector female 8p	Subsea connection to pressure sensor (Drive unit 3 clamp open)
JD-15	Connector female 8p	Subsea connection to pressure sensor (Drive unit 3 clamp closed)

3.2.7 Junction box Icontrol ST, drawing 045779

The Junction box Icontrol ST is connected to the Icone sensors, the limit switch, the pressure sensors for the drive unit clamp and the ST string (slip ring unit).

The Junction box Icontrol ST contains the Icontrol PCB, the required 24 VDC power supply is provided by the Junction box Main.



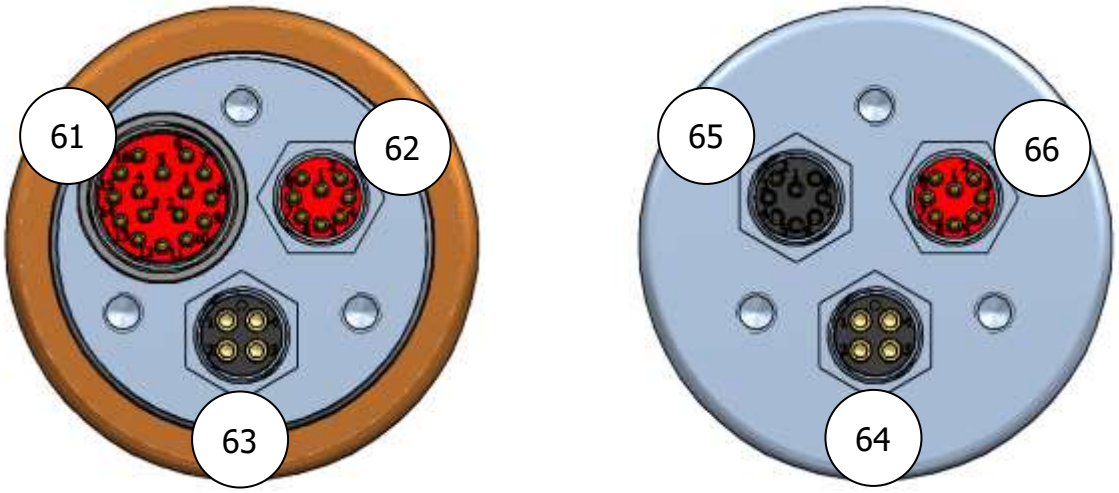
No.	Component type	Function
51	Connector male 4p	Subsea connection to Icone total load / water depth base XY
52	Connector female 4p	Subsea connection to depth encoder drive unit
53	Connector female 4p	Subsea connection to bottom limit switch
54	Connector female 8p	Subsea connection to pressure sensor (Drive unit 1 clamp open)
55	Connector female 8p	Subsea connection to pressure sensor (Drive unit 1 clamp closed)
56	Connector female 8p	Subsea connection to ST string (Slip ring unit)
57	Connector female 8p	Subsea connection to JM-1
58	Connector male 8p	Subsea connection to JM-2
59	Connector male 4p	Subsea connection to JB Seismic source

Note: The Icone vane requires additional power. To increase the operable string length (cable length) the voltage of connection 56 can be increased from 24 VDC to 42 VDC.

3.2.8 Junction box Twister, drawing 023362

The Junction box Twister is connected to the Twister and two limit switches.

The Junction box Twister contains the Twister PCB which controls the Twister motor. The required 42 VDC power supply is provided by the Junction box Main.



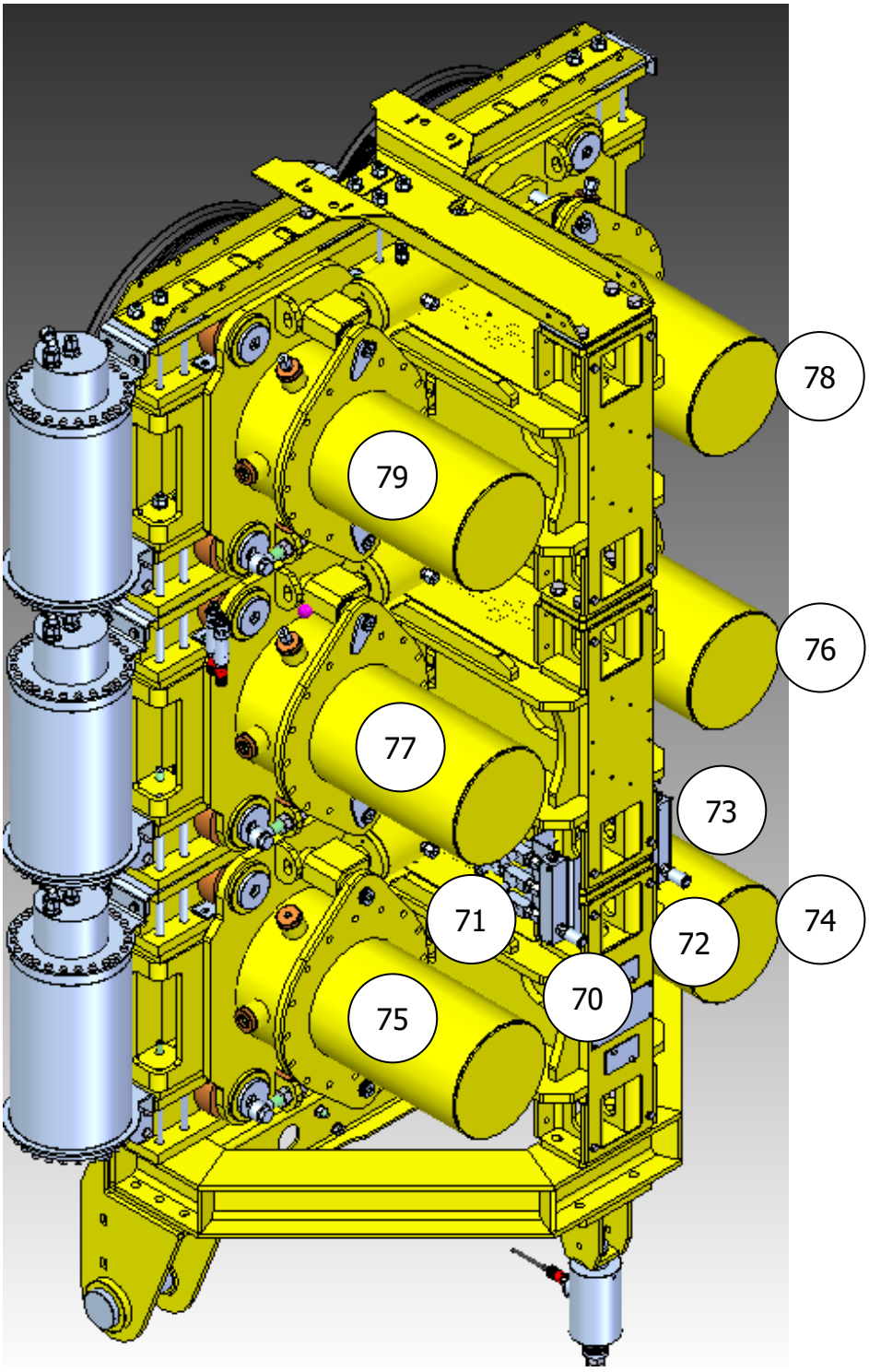
No.	Component type	Function
61	Connector male 16p	Subsea connection to JM-10 (Power + data)
62	Connector male 8p	Subsea connection to JM-4 (USB connection)
63	Connector female 4p	Subsea connection to end switch Twister CW
64	Connector female 4p	Subsea connection to end switch Twister CCW
65	Connector female 8p	Subsea connection to Twister motor (power)
66	Connector male 8p	Subsea connection to Twister motor (hall sensors)

3.2.9 Drive unit ROSON-ST 200, drawing 048675

The drive unit has a capacity of 200 kN pushing force. This capacity can be reached with three pairs of friction wheels.

The maximum pushing force of 200 kN can only be generated when the CPT rods and drive wheels are in good condition.

Tip: Smooth new rods might reduce the maximum pushing capacity. The grip will improve when running the rods a couple of times through the wheels with high clamping force (130 bar).



No.	Component type	Function
70	Quick coupling	Hydraulic connection for clamping cylinder "clamping pressure"
71	Valve	Open: During (de-)pressurizing clamping cylinder (hand pump) Closed: Normal operation
72	Quick coupling	Hydraulic connection for clamping cylinder "opening pressure"
73	Valve	Open: During (de-)pressurizing clamping cylinder Closed: Normal operation
74	Drive motor	Drive motor 1
75	Drive motor	Drive motor 2
76	Drive motor	Drive motor 3
77	Drive motor	Drive motor 4
78	Drive motor	Drive motor 5
79	Drive motor	Drive motor 6

3.2.10 Drive motor, drawing 048366

Each friction wheel is driven by an electric motor in line with a planetary gear box. This combination is mounted into a pressure compensated housing. The drive unit consists of two drive motors. Each drive motor is configured with a drive wheel suitable for 40 mm ST rods.

3.2.11 Clamping cylinder, drawing 014910

By means of two hydraulic cylinders the friction wheels are clamped against the CPT rod. One pressure compensated accumulator takes care for a constant pressure in the hydraulic cylinder, thus for a constant clamping force on the CPT string. By means of the SHPU or the hand pump the hydraulic cylinder can be pressurized.

We advise to set the clamping force to 120 bar. This is sufficient to generate a pushing capacity of 150 kN. To generate the maximum pushing force of 200 kN a clamping pressure of 150 bar is advised.

Caution: The maximum pressure of the clamping cylinder is 200 bar. Higher clamping forces can result in damage of the drive motors. Also the life time of the ST string is reduced when using the maximum clamping pressure.

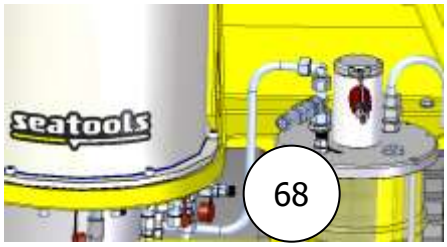
3.2.12 Subsea Hydraulic Power Unit, diagram 049405

The Subsea Hydrauilic Power Unit (SHPU) is a pressure compensated power pack to generate the hydraulics required by the Twister clamp. Also the clamping cylinder of the drive unit can be (de-)pressurized with the SHPU up to 200 bar.
A manual of the SHPU is attached in appendix E.

3.2.13 Pressure compensation system, diagram 049405

The system is provided with two pressure compensators. One 15 liter + 1,4 liter compensator connected to the drive motors, Twister, Slip ring unit and JB Step down trafo. One 6 liter compensator is connected to the SHPU. The compensators are provided with an oil level indicator, which allows the operator to monitor the oil level during operation. The maximum volume is reached at 200 mm, a bleeding valve is placed to protect for overpressure.

The compensators allow the system to compensate for the compression of the oil due to high water pressure (the oil level will reduce), but also to compensate for expansion of the oil due to temperature differences (the oil level will increase).



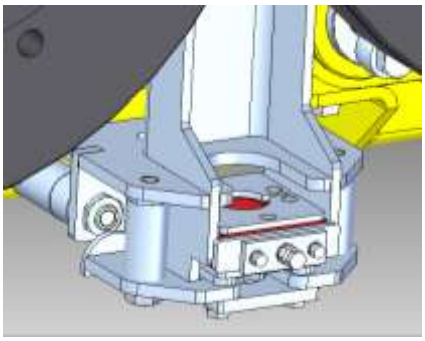
No.	Component type	Function
67	Quick coupling	Hydraulic connection for pressure compensation of the drive motors, Twister, Slip ring unit and JB Trafo step down
68	Quick coupling	Hydraulic connection for the tank/compensator of the SHPU

Caution: Fill the hydraulic tank/compensator (68) only with clean hydraulic oil. Never use hydraulic oil from the pressure compensation system (67), this oil is contaminated with dirt particles from the gear boxes

Caution: Check the compensators each time before the ROSON is lowered in the sea water.

Information how to check, drain or fill the compensator is described in chapter "Service".
A manual of the compensator is attached in appendix E.

3.2.14 Limit switch and dirt scraper, drawing 040325



At the bottom of the drive module a limit switch with proximity switch is mounted to switch off the system when the CPT string has reached its highest position (out of the soil). Directly behind the cone a friction reducer is mounted, this friction reducer has a bigger diameter than the CPT rods, so they will actuate the limit switch.
The proximity switch is connected with a cable to the junction box Icontrol ROSON-ST.

Above the limit switch, and between drive unit 2 and 3 split dirt scrapers are placed. Dirt on the CPT rods be scraped off to maximize the friction between the drive wheels and the CPT rod and to keep the ST string as clean as possible.

Note: The available length between limit switch and the bottom of the seabed frame is 750 mm. In case the Icone module(s) are longer, ballast plates are required to create additional space.

3.2.15 Depth encoder DW-ROSON-ST, drawing 045689

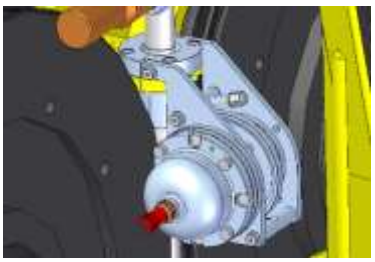
Two depth encoders are used for motor feedback of the Sprocket and Folder, these encoders are integrated in the drive motor of each unit and use the incremental signal.

The third encoder is connected to the Sprocket wheel and is used for timing of the ST cycle. As the ST string acts like a timing belt, the absolute encoder signal is able to define in which state the machine is. Even when the umbilical power has been shut off, the actual position is given by the encoder. During the CPT test the CPT depth is derived from the Sprocket encoder.

The absolute + incremental encoder is located in a watertight housing and actuated by a magnetic coupling. The depth encoder is connected with a cable to the Junction box Main.

3.2.16 Depth encoder DW-ROSON-ST drive unit, drawings 047584 + 047480

A fourth encoder is used for measuring the CPT depth.



This encoder is clamped against the ST string with a friction wheel. The string movement is measured by the rotation of the friction wheel.

The incremental encoder is located in a watertight housing and actuated by a magnetic coupling. The depth encoder is connected with a cable to the Junction box Icontrol.

3.2.17 Total load measurement, drawing 001426

The ROSON system is fitted on the base frame with an electrical load cell for measuring the total load exerted by the drive wheels. The load cell is connected with a cable to the junction box Icontrol ROSON-ST.

Note: It is possible to stop the ROSON automatically at a pre-set load, for more information see the Ifield manual.

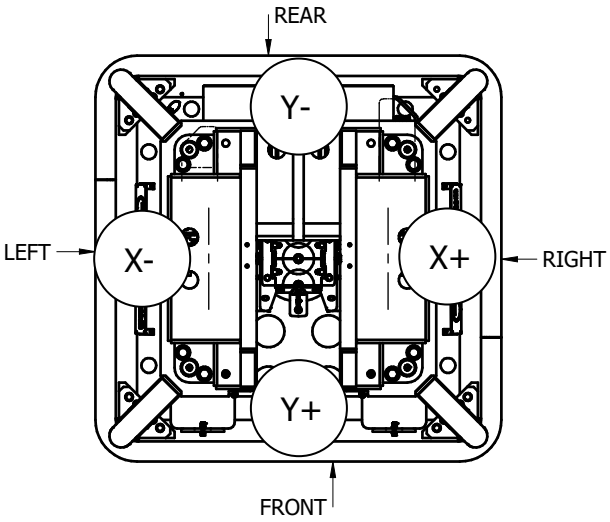
Note: The scaling factor of the ROSON system is 1:5. To give the correct Total force values, a load cell with the same scaling factor needs to be mounted. The scaling factor can be checked on the calibration certificate.

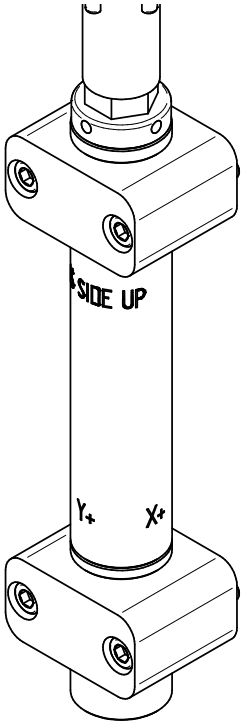
3.2.18 Iroson BASE P200 XY, drawing 007029

A sensor is mounted on the frame to measure the inclination of the frame, the base inclination. Also a water pressure sensor is integrated, this to give an indication of the water depth.
The Iroson BASE is connected with a cable to the junction box Icontrol ROSON-ST.

Note: Make sure the sensor is orientated correctly (Y+ = front).

Note: It is possible to stop the ROSON automatically at a pre-set base inclination, for more information see the Ifield manual.





3.2.19 Altimeter, drawing 047147

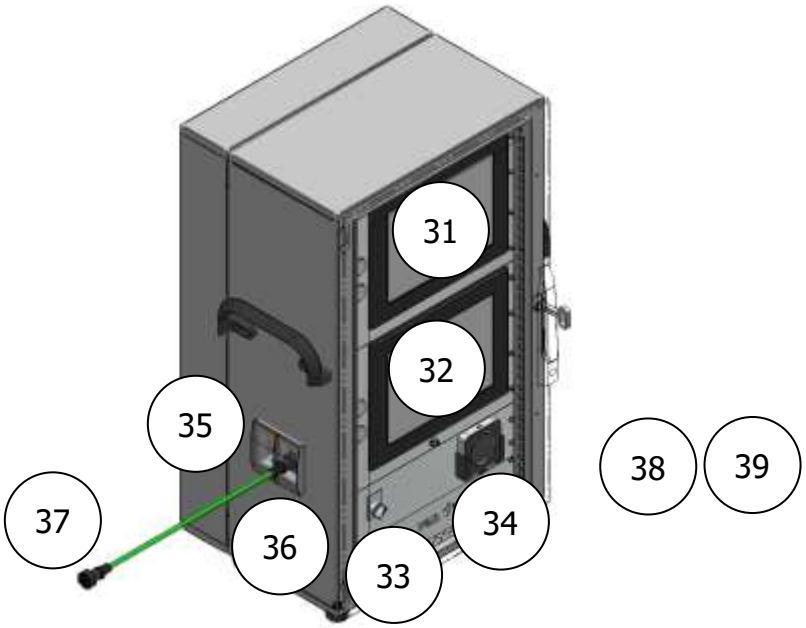
An altimeter is mounted on the ROSON frame to indicate the distance between frame and seabed. The sensor can be adjusted up- and downwards for about 300 mm. This adjustment in combination with the applied ballast needs to be set in the HMI software. The sensor is connected with a cable to the Junction box main.

Note: The sensor is designed to measure in seawater, this means on deck level the sensor will not give a reliable signal. This will result in about 70 m distance shown on the HMI.

3.3 Control box ROSON-ST, drawing 000874

The control box contains 2 touch screen PC;s with the following software installed:
- Ifield software, for registration and real time display of the CPT data.
- HMI user interface, for control and monitoring of the ROSON-ST system
- Icontrol (inside the control box), for checking Icones / modules
- VPN router (inside the control box), for APB remote support

The Touch screen PC's (31+32) are connected to the Icontrol ROSON, the Icontrol ROSON is connected to the ROSON winch by the DA cable (37). The ROSON winch is connected to the subsea junction boxes by means of an umbilical cable. The umbilical ensures a stable power and communication line and allows control and communication between the vessel and the ROSON system.



No.	Component type	Function
31	Touch screen PC	PC for Ifield
32	Touch screen PC	PC for HMI user interface
33	Switch /w light	Power control box "ON" or "OFF"
34	Mobile router	Wifi hotspot for remote support
35	Cover	Cable entry for 230 VAC
36	Connector	Connection for communication cable
37	Cable	Communication cable (length 30 m)
38	Icontrol	Icontrol to check Icones / modules (inside box)
39	VPN router	VPN router for remote support (inside box)

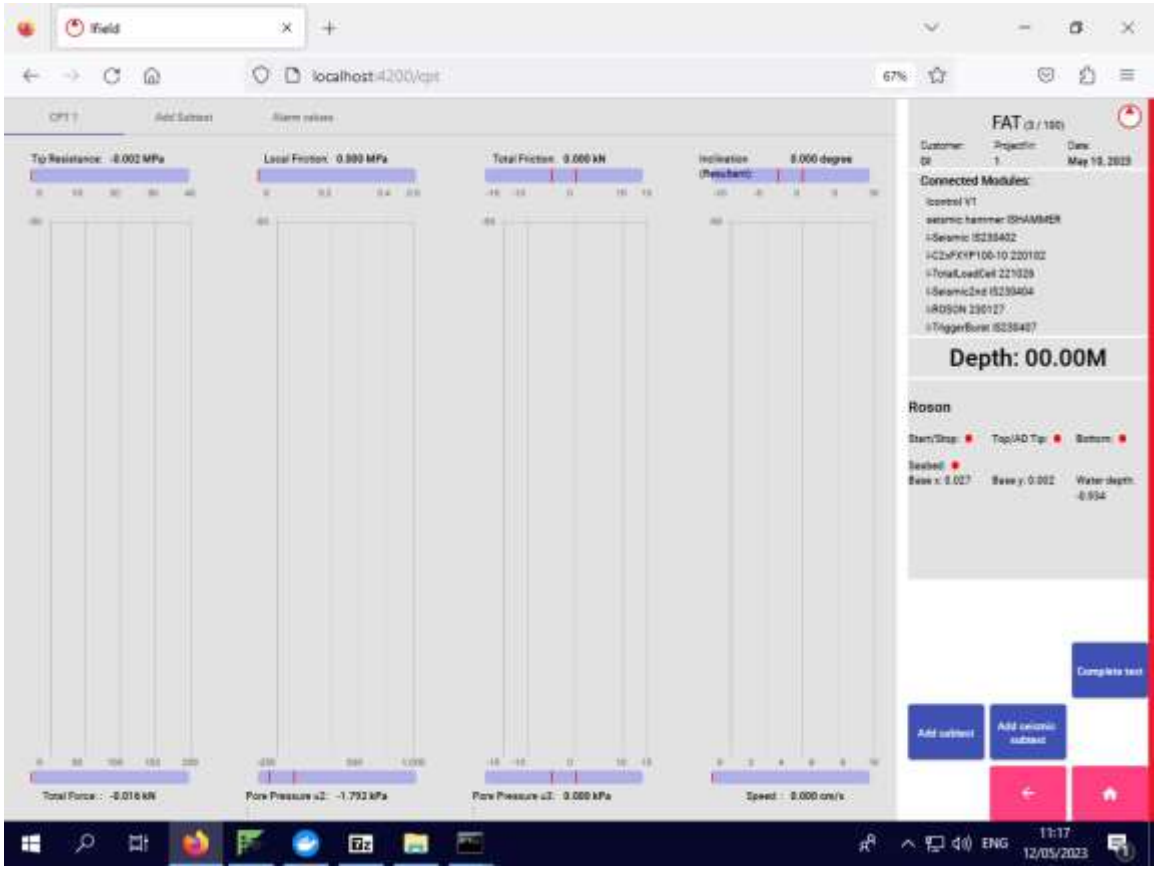
Note: When the 230 VAC is applied, it takes about 1 minute before the VPN router is started and communication with the ROSON-ST is established.

3.3.1 Ifield software

The Ifield software is for registration and display of the CPT data. During CPT testing the data is shown real time, graphs are created based on the CPT length.

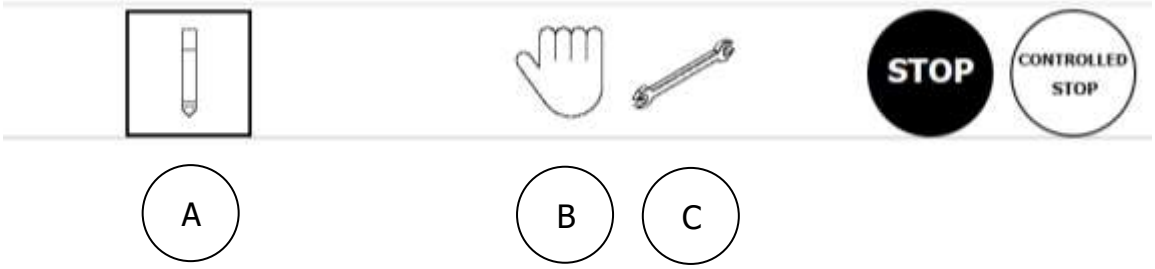
Besides the importance of the CPT data for the soil investigation, the real time data is important to reduce the risk of bending or breaking the CPT string. Alarm levels can be set for most of the measured channels, e.g. Tip resistance, Inclination, Total force and Base inclination.
It is advised to start the project using "safe" alarm settings, e.g. 30 MPa tip, 3° inclination, 50 kN Total force and 3° Base inclination. During the CPT the alarm levels can be increased based on the CPT operators experience. After a couple of CPT's in the specific soil conditions, in combination with the specific ROSON-ST ballast configuration, a set of alarm levels can be determined for future tests.

For more information regarding Ifield: see the corresponding manual.



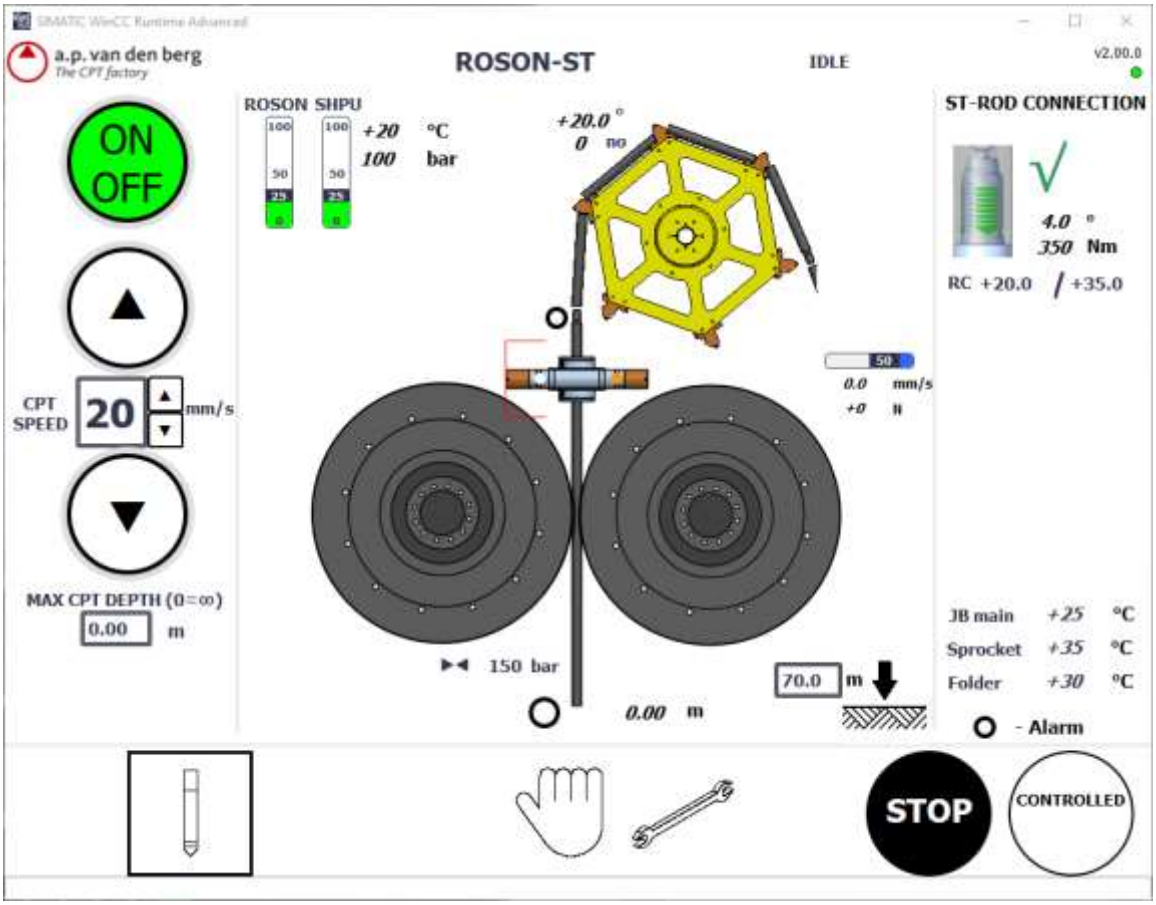
3.3.2 HMI user interface.

The HMI user interface consists of three screens.

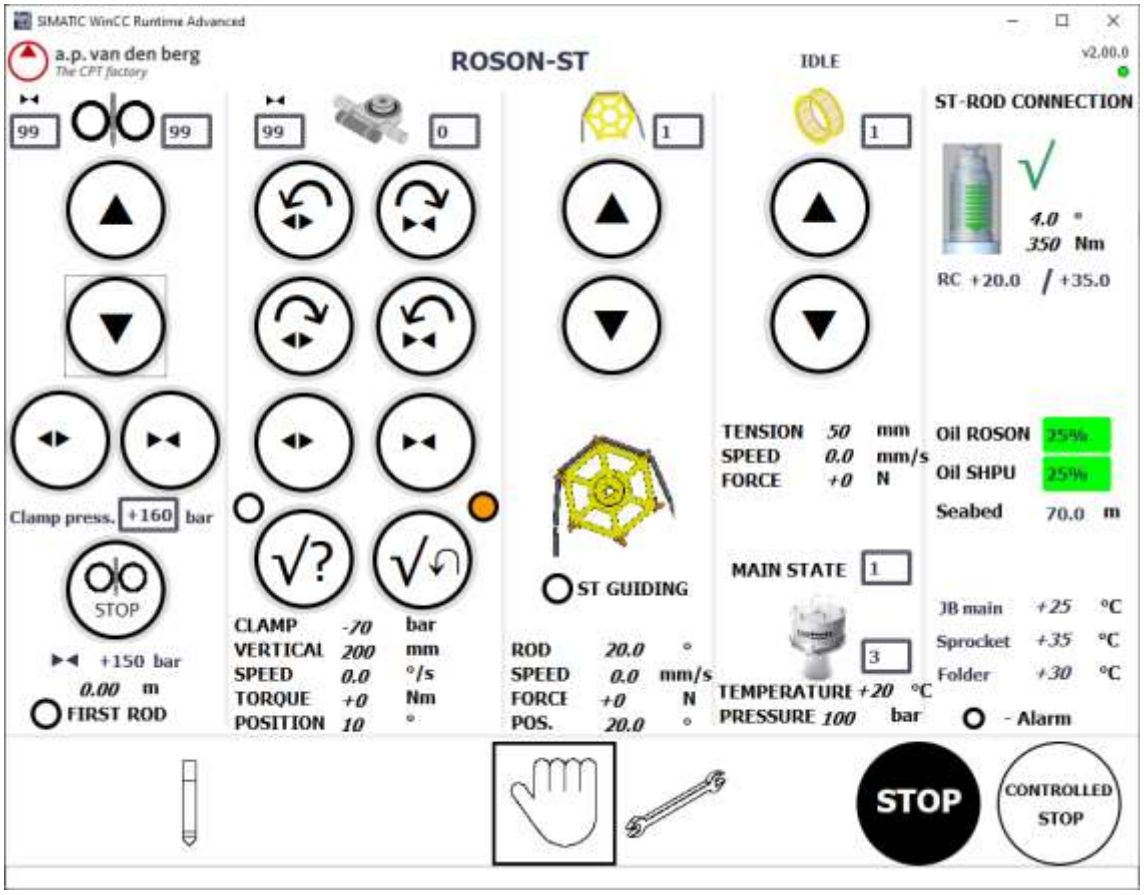


No.	Function
A	Screen to control the ROSON-ST system during the CPT operation
B	Screen for manual control of each ROSON-ST function
C	Screen with settings and additional diagnostics of the ROSON-ST system
STOP	Stop all movements of the ROSON-ST, the SHPU will restart automatically
Controlled STOP	Stop the drive unit and pull the string on tension with Folder and Sprocket, this to avoid a "locked rod". The controls (except STOP) are disabled during this process.

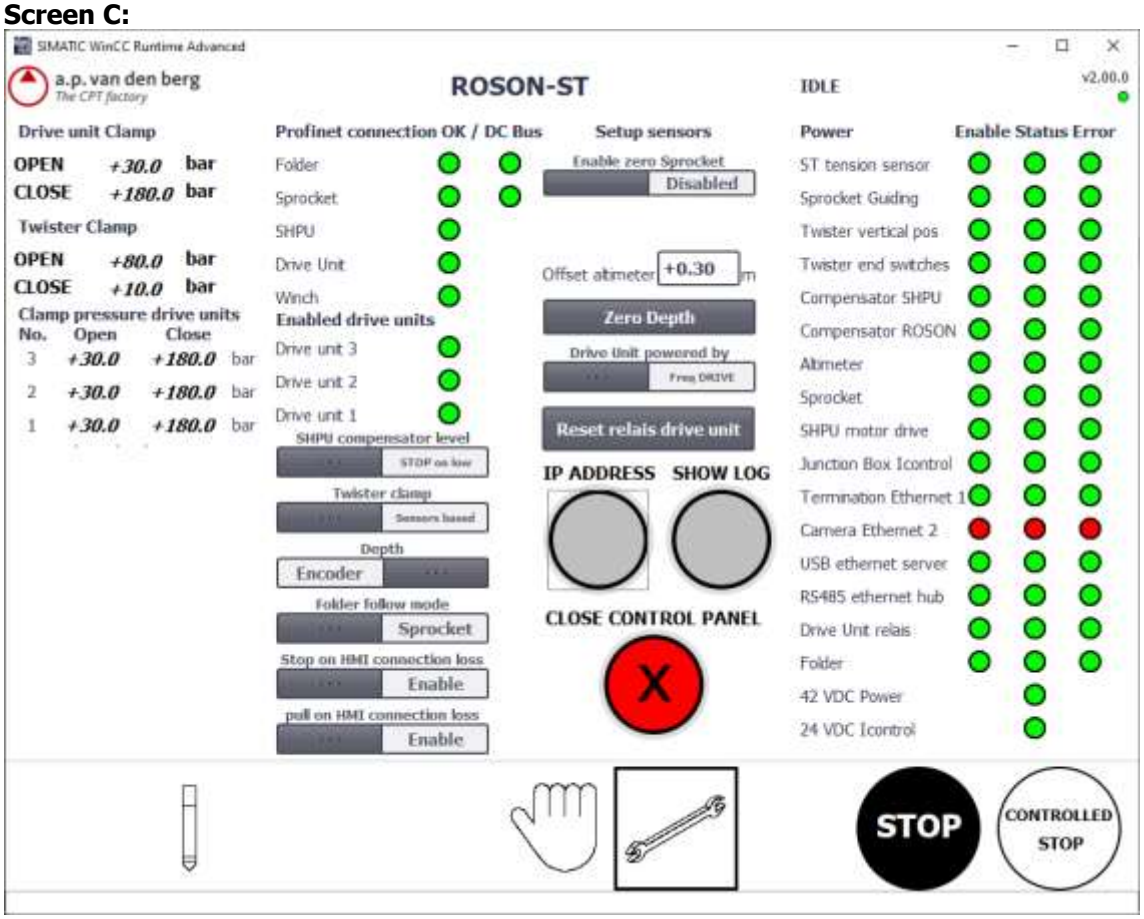
Screen A:



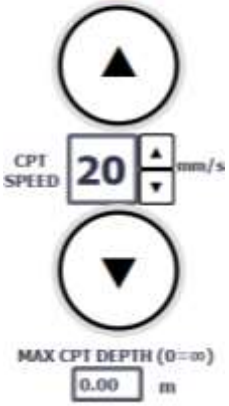
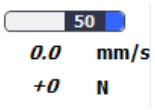
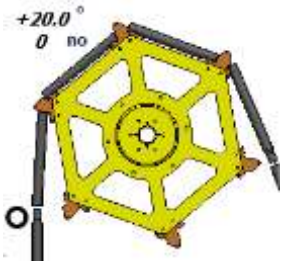
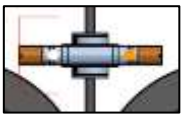
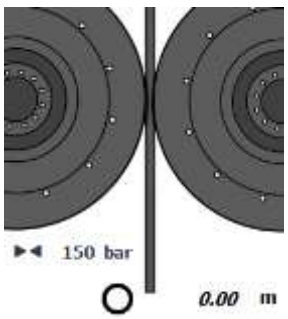
Screen B:



Screen C:

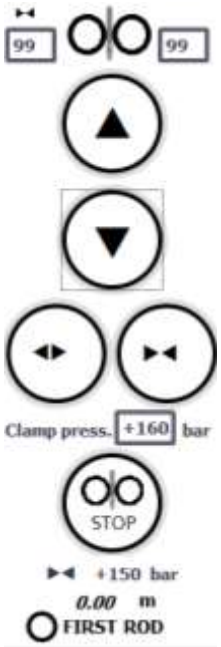


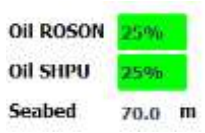
3.3.2.1 ROSON-ST Controls - Screen A

Item	Function	
	ON (orange) ON (green) OFF (red)	Power up cycle started Power "ON" for the ROSON-ST actuators and sensors Power "OFF" for the ROSON-ST actuators and sensors
	Pull button "Orange" "Green" CPT speed Push button "Orange" "Green" Max. CPT Depth	Starts the automatic ST pull cycle Init Pull active Pull cycle active Set speed @ 5, 10, 15 or 20 mm/s Starts the automatic ST push cycle Init Push active Push cycle active Setting of automatic stop when CPT depth is reached (0.00m ignores the automatic stop)
	ST tension . . . mm/s . . . N	Tension between Folder and Sprocket (0-110mm) Folder speed Folder force
	Rod position Rod number Sprocket ST guiding	–30° till + 30° measured by Sprocket encoder Rod 0 till 144 (50,4m) or 230 (80,5 meter) Image rotates, actual position is shown Indication if rod is locked, normal operation: white: Rod position >14° and <20° orange: Rod position <11° and >23°
	"arrow" "green" "orange" "red boundary"	Rotating (direction screw / unscrew) Clamp closed End switch (left = start position unscrew) Default the Twister is positioned in the middle
	Wheels Wheels . . . bar *Clamping pressure blinking orange: < 100 or > 150 bar* Limit switch . . . m	Clamped or open (/ unknown) Image rotates when wheels are rotating Clamping pressure 120 – 150 bar "red": rod is in the upper position CPT length

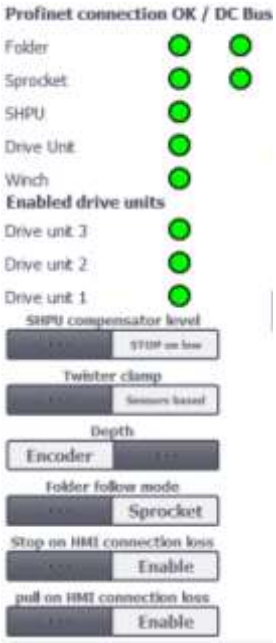
Item	Function	
	. . . m	Distance between ROSON-ST and Seabed
		High power (42 VDC instead of 24 VDC) on APB bus. Only used with Icone Vane
	0-100% 0-100% *Oil level blinking orange: level <10% or >100%* . . . °C . . . bar *Pump pressure with red background (and 0 bar): oil level SHPU <5%, SHPU stopped by system. Override stop function or disable compensator to continue.*	Compensator level ROSON-ST system (Drive motors, Twister, Slip ring unit, JB Trafo) Oil level SHPU Oil temperature SHPU Pump pressure of SHPU
	Feedback ST connection Error Twister Warning Twister Error ROSON-ST cycle . . . °C . . . °C . . . °C Alarm	 Temperature Junction box Main Temperature Sprocket motor Temperature Folder motor "red": Alarm from Ifield

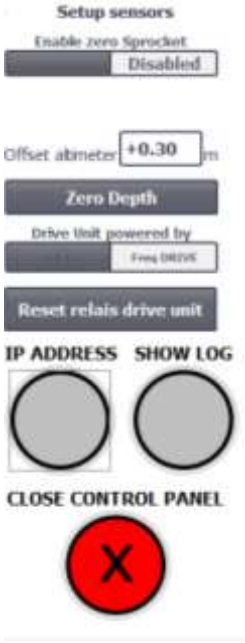
3.3.2.2 Manual controls - Screen B

Item	Function	
ROSON drive unit 	State number State number Pull button *"Green"* Push button *"Green"* Clamp open *"Green"* Clamp closed *"Green"* Clamp pressure STOP drive unit . . . bar . , . . m Limit switch	Shows clamp state number of drive wheels Shows drive unit state number Starts rotating the drive wheels *Drive motors rotating in pull direction* Starts rotating the drive wheels *Drive motors rotating in push direction* Starts opening the drive wheels *Opening valve active* Starts clamping the drive wheels *Closing valve active (SHPU pressurizing)* Setting the clamping pressure for clamping Stops rotating/opening/clamping of drive wheels (other functions, eg. Twister clamp, stay active) Clamping pressure drive wheels CPT length "red": rod is in the upper position
Note: During "manual operation" the drive wheels are not stopped when the limit switch is active.		
ST Twister 	State number State number Reset to tight *"Green"* Tight *"Green"* Reset to untight *"Green"* Untight *"Green"* Clamp open/close *"Green"* *"Green blinking"* *"Orange"* Left Right Twister check Warm up cycle "*Green*" . . . bar . . . mm . , . °/s . . . Nm . . °	Shows Twister clamp state number Shows Twister state number Rotate Twister (clamp open) CCW to CW sensor *Moving to reset position tight* Tight ST rod CW *Tightening ST rod* Rotate Twister (clamp open) CW to CCW sensor *Moving to reset position untight* Untight ST rod CCW *Untightening ST rod* Open / close Twister clamp *Open / close* *Opening / closing* *State unknown (>-60 and < 60 bar)* "orange": End switch CCW active "orange": End switch CW active Checks rotation, clamping and end switches Rotating Twister to warm up the oil *Twister check / warm up cycle running* Twister clamp pressure (< -70 open; >70 closed) Vertical position of Twister (100 up; 300 down) Twister rotating speed Twister torque (derived from motor current) Twister rotational position

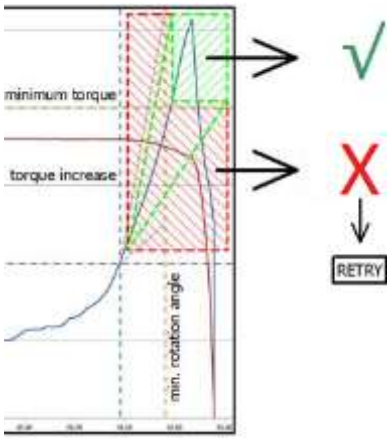
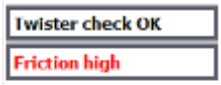
Item	Function	
Sprocket 	State number Pull button "Green" Push button "Green" Sprocket ST guiding Rod position Speed Force Pos.	Shows Sprocket state number Starts rotating the Sprocket Sprocket in pull mode Starts rotating the Sprocket Sprocket in push mode Image rotates, actual position is shown Indication if rod is locked, normal operation: white: Rod position >15° and <20° orange: Rod position <11° and >23° –30° till + 30° measured by Sprocket encoder Sprocket speed Sprocket force Sprocket position (0° – 60°)
Folder 	State number Pull button "Green" Push button "Green" ST tension . . . mm/s . . . N State number State number . . . °C . . . bar	Shows Folder state number Starts rotating the Folder Folder in pull mode Starts rotating the Folder Folder in push mode Tension between Folder and Sprocket (0-110mm) Folder speed Folder force Shows Main state number Shows SHPU state number Oil temperature SHPU Pump pressure of SHPU
	0-100% 0-100% . . . m	Compensator level ROSON-ST system (Drive motors, Twister, Slip ring unit) Oil level SHPU Distance between ROSON-ST and Seabed

3.3.2.3 Diagnostics - Screen C

Item	Function	
	. . . bar . . . bar . . . bar . . . bar . . . bar . . . bar . . . bar . . . bar . . . bar . . . bar	Highest pressure drive wheel open side (1/2/3) Lowest pressure drive wheel clamp side (1/2/3) Pressure Twister clamp opening side Pressure Twister clamp closing side Pressure drive wheel opening side, drive unit 3 Pressure drive wheel clamping side, drive unit 3 Pressure drive wheel opening side, drive unit 2 Pressure drive wheel clamping side, drive unit 2 Pressure drive wheel opening side, drive unit 1 Pressure drive wheel clamping side, drive unit 1
	"Green" "Green" "Green" "Green" "Green" "Green" "Green" Drive unit 3 Drive unit 2 Drive unit 1 SHPU comp level Twister clamp Depth Sprocket/ encoder Folder follow mode Connection loss	Profinet connection with Folder drive "OK" Profinet connection with Sprocket drive "OK" Profinet connection with SHPU drive "OK" Profinet connection with JB drive unit "OK" Profinet connection with Winch drive "OK" DC bus fuses Folder "OK" DC bus fuses Sprocket "OK" Toggles drive unit 3 "ON / OFF" Toggles drive unit 2 "ON / OFF" Toggles drive unit 1 "ON / OFF" Toggles between "stop on low level" or "ignore" Toggles between "pressure sensor based" and "time based" Toggles between source of measurement CPT depth (encoder is most accurate setup; avoid to change this setting during a CPT) Toggles between follow mode based on motor encoder feedback ór ST tension feedback Toggles between "stop when connection is lost" or "ignore". In case this function is enabled, the "auto pull" function can be enabled/disabled.

Item	Function	
	Enable zero SP	Enable to zero Rod position
	. , . . m	Offset altimeter from seabed
	Zero Depth	Zero's CPT length
	DU powered by	Toggles between "relais" (JB Main) and frequency drive (JB Drive unit)
	Reset relais DU	Resetting the drive unit relays. Wait 20 minutes after the crosses appear (on drive wheels and DU push/pull buttons). In case the relays do not reset automatically, the relays can be reset manually with this function.
	IP Address	Show the IP address of the HMI PC
	Show log	Opens log file with ST connection data
	Close	Closes the HMI software
	Power state of each function. Enable: "Green" "Red" Status: "Green" "Red" Error: "Green" "Red" In case of short circuit each function can temporary be disabled manually by touching the specific "enable" dot. The corresponding sensor/actuator will disappear in Screen A. To solve the issue we advise to use chapter "Troubleshooting" and/or the electrical/hydraulic diagrams. In case a function is disabled: *ST tension* *Tw vert. pos.* *Tw end switches*	 Power supply enabled Power supply disabled Power supply "ON" Power supply "OFF" No errors Error (eg. short circuit / broken wire) *Follow mode folder check is disabled* *Twister vert. position alarms are disabled* *Perform Twister check to initialize*

3.3.2.4 Feedback ST connection / Twister / ROSON-ST cycle

Item	Function
	In the upper right corner the ROSON-ST state is shown, it describes the current action / state of the system. The green indicator shows the connection with the PLC
	√ Rod connection approved by Twister X Rod connection rejected by Twister Connection data is stored in a daily log file for review Rod connection is checked on a minimum torque (Nm) and a minimum rotation angle (°), in combination with a smooth torque increase (RC min/max). 
	Error Twister (additional feedback ST connection/Twister) Warning Twister (feedback Twister)
	Error ROSON-ST cycle (feedback from ROSON-ST cycle)

3.3.2.5 Feedback ST connection / Twister

Twister error codes:

Code	Message	Information
1	Clamping time too long	Clamping or opening of the clamp takes too long
2	Rotating time too long	Maximum required rotation time of Twister reached
3	Torque too low	Minimum required torque ST connection not reached
4	Rotating time too short	Minimum required rotation time of Twister not reached
5	End switch	End of rotation reached
6	Not enough rotation	Minimum required rotation angle of ST connection not reached
7	Torque gradient	Torque increase (RC min/max) out of range
8	Max retry unlock rod	After detection "locked rod", ROSON error 34, the max. Twister movements is reached and was not able to unlock rod
9	Position twister wrong	If start postion of Twister is not correct for the expected action (tight / untight)
10	Friction too HIGH	The rotational friction of the Twister during the reset movement is too high, this might result in over tightening of the ST connection
100	Twister check OK	Rotational friction, end switches and twister clamp OK

Twister warnings codes (will reset after starting a new CPT cycle):

Code	Message	Information
1	Friction high	Rotational friction is too high, this might result in over tightening of the ST connection(s)
2	Untight torque high	Untight torque is high, risk of over tightened ST connection(s)

ROSON-ST cycle error codes:

Code	Message	Information
1	Bottom switch active	CPT string fully retracted, limit switch activated by the friction reducer
11	Sprocket too slow	Sprocket speed less than CPT speed
12	Sprocket not accelerated	No sprocket acceleration detected after untightening ST connection, rod not removed
13	Sprocket not enough rotation	Sprocket not enough rotated after untightening ST connection, rod not fully removed
14	Sprocket too much rotation	Sprocket rotated too much after untightening ST connection, ST joint might be disconnected/broken
15	Folder too slow	Folder speed less than Sprocket speed
16	Folder too fast	Folder speed higher than Sprocket speed

20	Error with Twister	Twister action not completed, see feedback ST connection for possible reason
21	Error INIT PUSH FAILED	ST connection failed after all retry actions
22	Error PUSH to position failed	Movement of sprocket not possible
23	First PUSH before PULL	Risk for locked ST rod, so adviced to push to a safe position to start pull cycle
24	Error Sprocket drive	Sprocket drive stopted due to problem with drive, temperature, power or communication, in most cases the drive automatically resets
25	Error Folder drive	Folder drive stopted due to problem with drive, temperature, power or communication, in most cases the drive automatically resets
26	Error with ST connection	ST connection failed after all retry actions
27	Error Advice to Pull	Advice to pull due to worn out ST connection
28	Error Vert. Pos. Twister	Twister reached vertical limit
29	ALARM FROM ICONTROL	An alarm from the Ifield software received, eg. Tip resistance, (base) inclination or Total Force
30	ST-Guiding	Risk for locked ST rod, based on sensor between Sprocket and Twister
31	ST-Tension	Maximum tension on ST string reached (between Folder and Sprocket)
32	ST stuck	ST rod cannot be removed
33	Error ROSON Drive unit	Relais Drive unit in error state
34	Error LOCKED ROD	Risk for locked ST rod, based on Twister movement during controlled stop cycle
35	Rod not placed	Sprocket not enough rotated in push cycle
36	Twister not ready	Twister in wrong state for required action
37	Move to safe start pos	Push the string to a safe position for placing rod
38	Rod not fully placed	Rod not fully placed on string for tightening
39	Rod removed	Rod removed from string, ready for next action
40	ST Tension OFF	ST Tension sensor is disabled and "Folder follow mode" is set to ST tension
41	SHPU not running	SHPU is shut down, eg. due to oil level too low
42	Slip detected	Rod speed too low (only available using the encoder as source for the CPT depth)
43	Max depth	Setting of maximum CPT depth reached

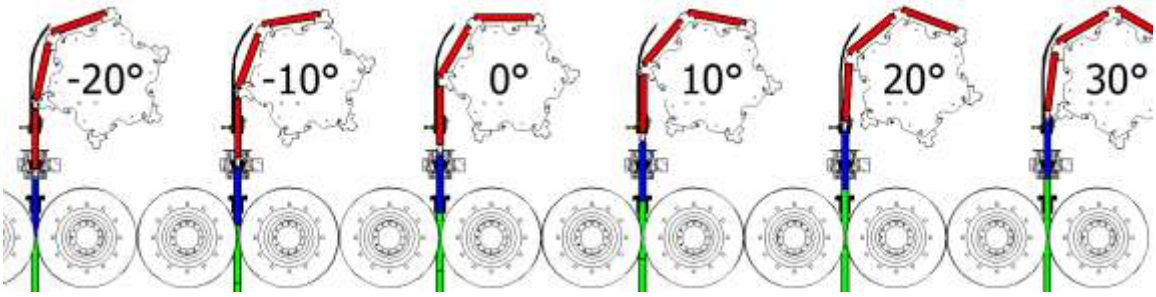
3.4 ST cycle

The DW-ROSON-ST 100 is programmed with a ST cycle to create a solid CPT string while pushing the cone into the soil, and disassembling the CPT string when pulling the cone from the soil.

The timing of the ST cycle is based on the sprocket position, the so called "rod position".
As the ST string is acting like a timing belt, this rod position is able to define the correct actions to start a ST push cycle or a ST pull cycle. To be able to start a push/pull cycle the system will perform an "Init push" or "Init pull" to define the rod state. When the rod state is defined the system is able to start the ST cycle. In general it will check if the ST connection is "OK" before it starts pushing, or check if the ST rod is disconnected before it starts pulling.

3.4.1 Rod position

The rod position is between the values -30° till +30°, this to cover 60° rotation of the sprocket which equals 1 ST rod.

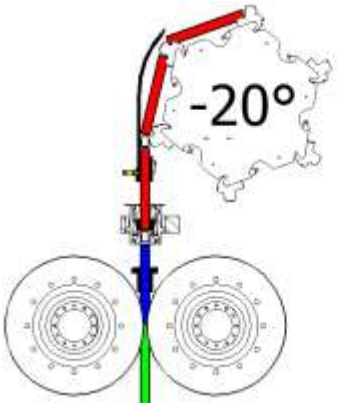


To measure the correct rod position, the system standard keeps tensions on the ST string. In case of manual operation "Sprocket pull" is used to apply the tension manually.

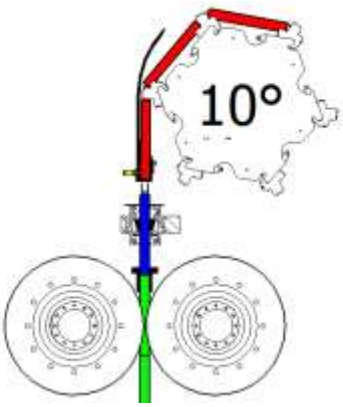
When the system is stopped (automatically or with "controlled stop") the Folder and Sprocket will automatically pull the string on tension.

3.4.2 Rod state

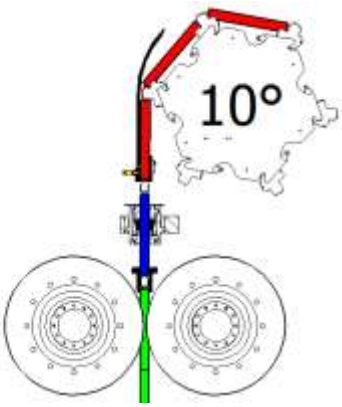
During normal operation we can define the following 3 rod states:



1. On ST string, ST "OK"



2. On ST string, ST "unknown"



3. Removed from ST string

3.4.3 ST init push cycle

Depending on the rod position, the init push will define which actions are required to safely start the push cycle.

Range > -20° or < 0° - Start ST push cycle (rod state = "on ST string, ST "OK" ")

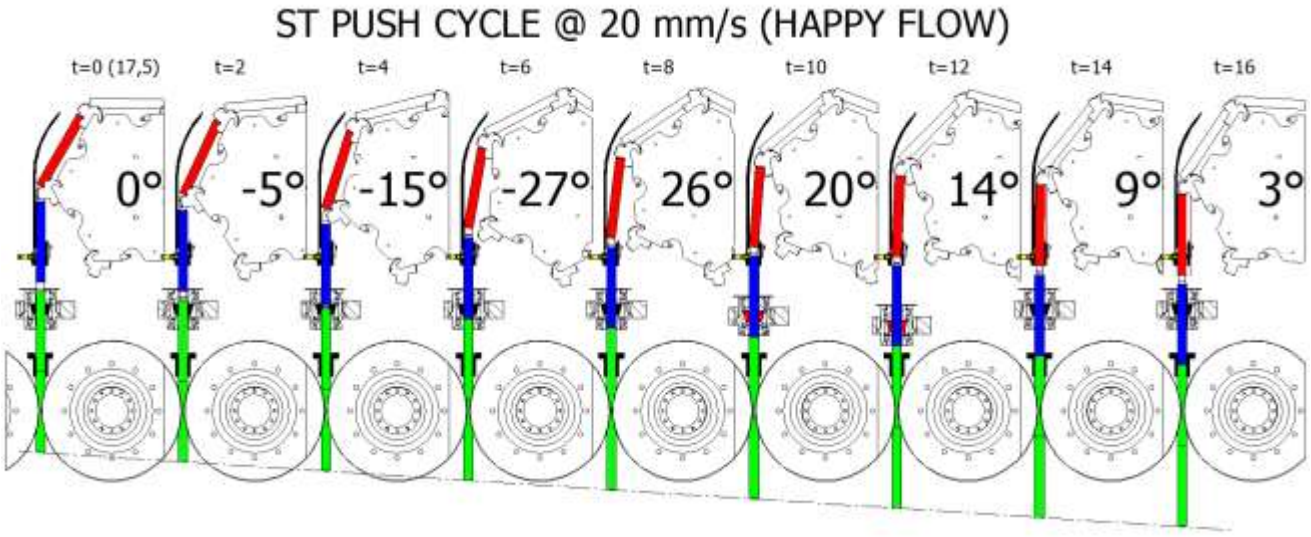
Range ≤ -20° and > 25° - Move ST string with drive unit to safe start position,
- Check rod state
- Connect ST rod
- Start ST push cycle when "ST OK"

Range ≥ 0° and ≤ 25° - Check rod state
- Connect ST rod
- Start ST push cycle when "ST OK"

3.4.4 ST push cycle

Depending on the rod position, the ST cycle performs the following actions:

25° Start Twister to tightening ST connection
5° Check position if "ST = OK", else stop for retry actions
0° Last/lowest position for Twister to screw
-6° Start accelerating Sprocket to place new rod



3.4.5 ST init pull cycle

Depending on the rod position, the init pull will define which actions are required to safely start the pull cycle.

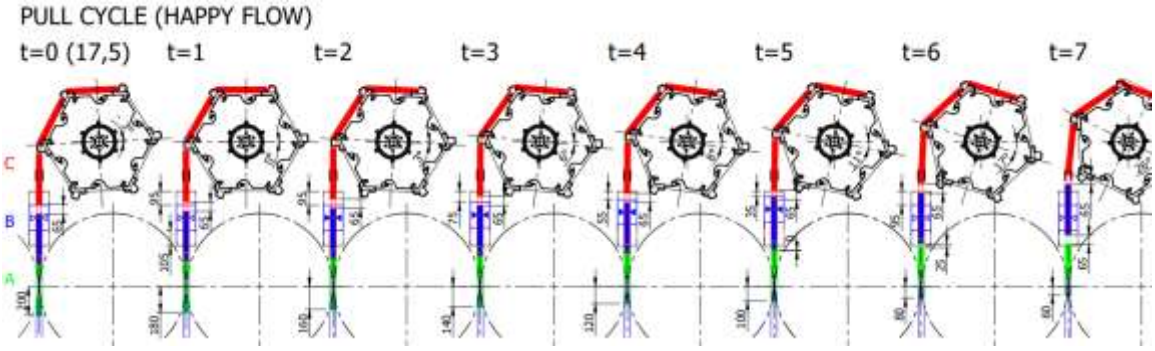
Range > -30° or < 0° - Start ST pull cycle, rod state is "on ST string, ST "OK" "

Range ≥ 0° and ≤ 30° - Check rod state
- Disconnect ST rod (if required)
- Start ST push cycle after "ST OK"

3.4.6 ST pull cycle

Depending on the rod position, the ST cycle performs the following actions:

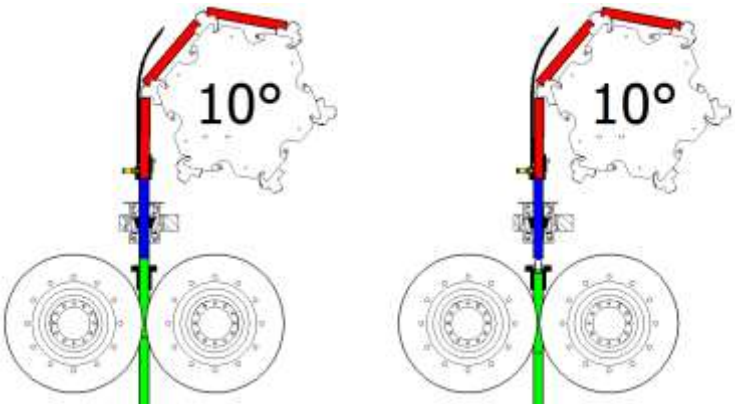
3° Start Twister to untighten ST connection
16° Check position if "ST = OK", else stop for retry actions
20° Last/highest position for Twister to unçscrew



3.4.7 Locked rod situation

During normal operation the ST connections slide easily in each other, or from each other. In case a rod connection is damaged or not sufficiently greased, there might be some more resistance. This can create a risk of a "locked rod", when changing the ST cycle from "push" to "pull" direction. In case of high pushing forces (>75 kN) the ST string will bounce back when the drive unit is stopped, this behaviour increases the risk of a "locked rod".

A "locked rod" is the situation when the "red" rod is pushed in the "blue" rod, and the Sprocket is not able to pull them apart. See picture below with the 2 rod states in "locked rod" situation.



1. On ST string + locked 2. Removed from ST string + locked

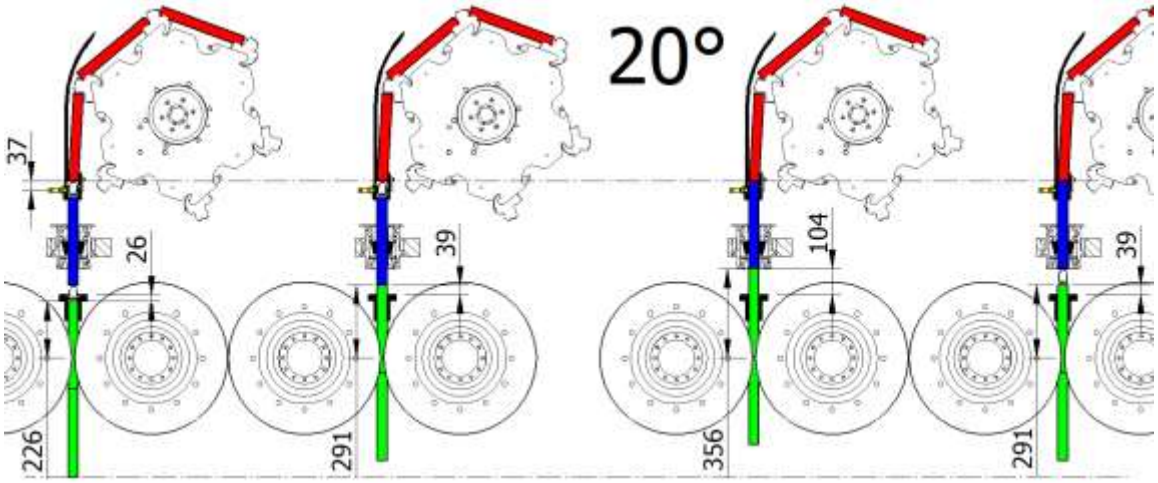
Caution: In case of a "locked rod" the pull cycle cannot be started. Moving the string upwards will damage the ST connection and Sprocket fingers.

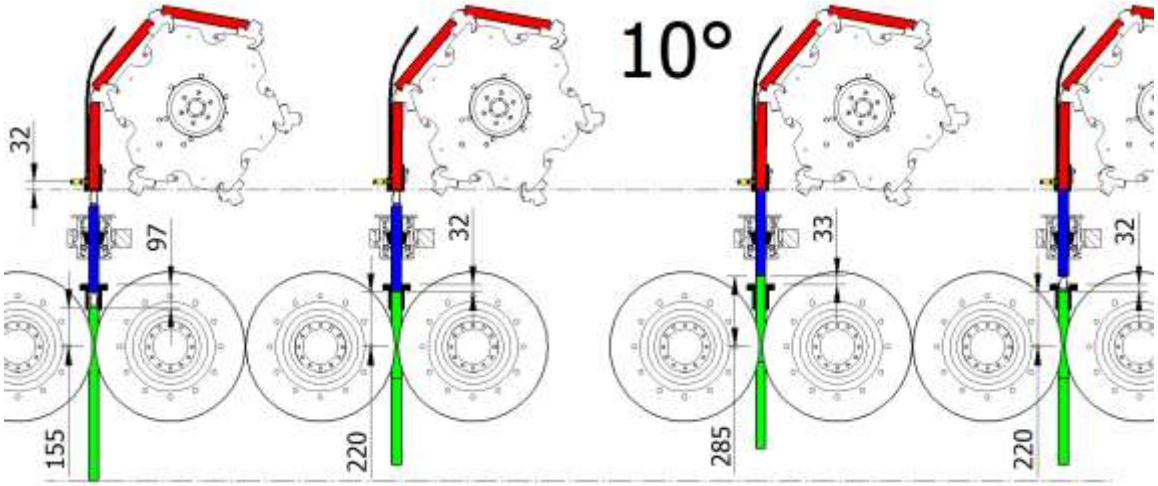
Also be aware that "untightening" the blue ST rod from the ST string with the Twister will "tighten" the blue / red ST rods

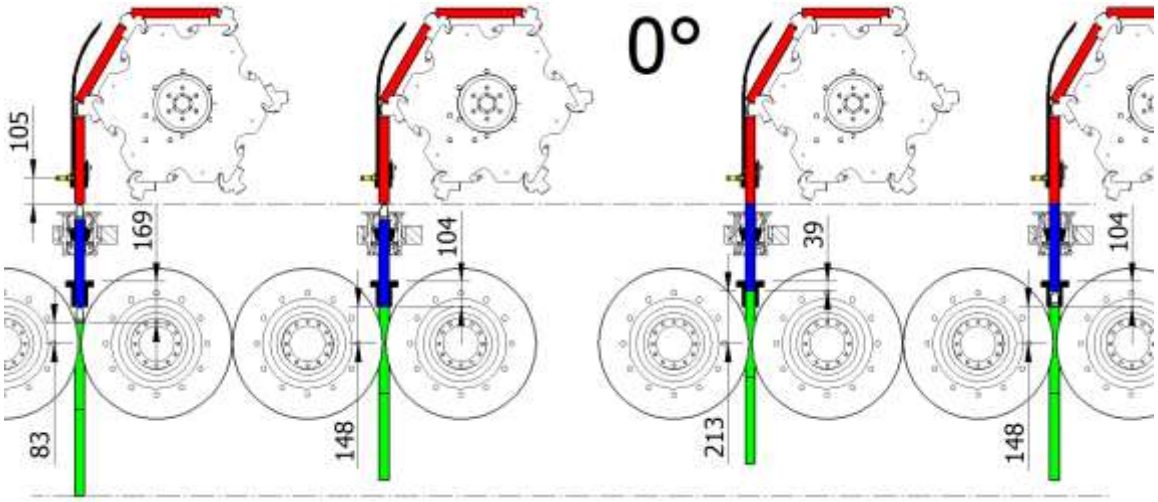
3.4.8 Manual operation

In case manual operation is required, it is advised to stay between the 0° and 20°. The pictures below show 4 rod states at 20°, 10° and 0°.

Caution: In manual operation it is easy to damage the ST string or the sprocket fingers. Make sure to have sufficient practical experience with the machine before using the manual operation.



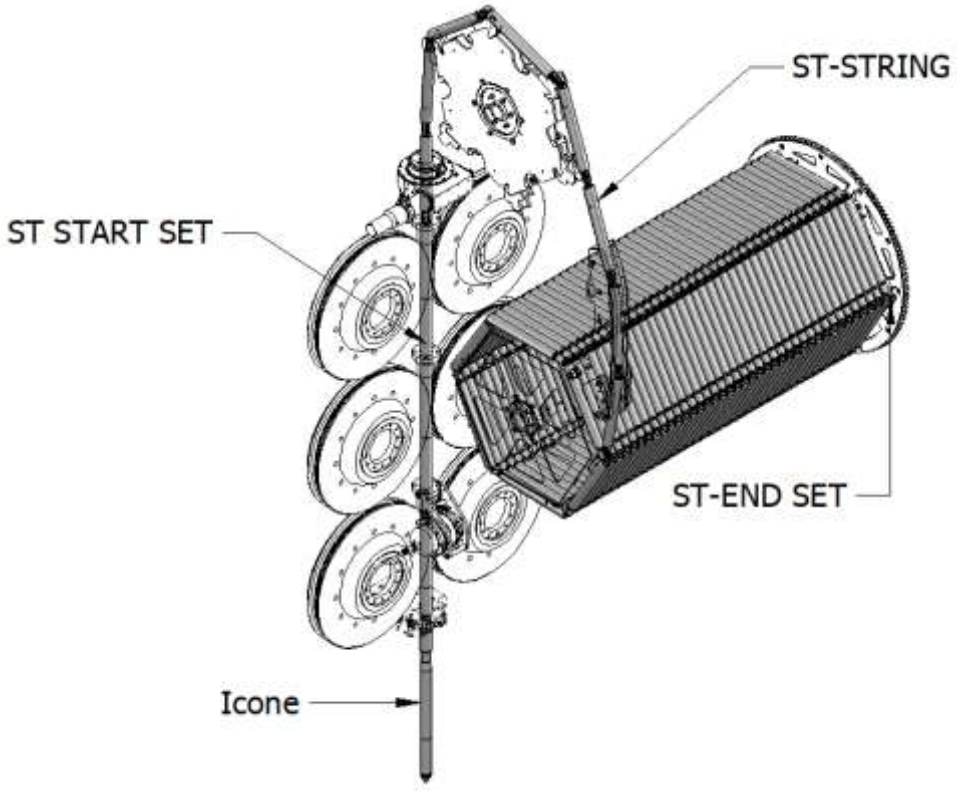




3.5 CPT string

To perform a CPT test, a CPT string is used to push the sensor into the soil. The CPT length/depth is based on the maximum length of the string, but also depending on the soil conditions.

The CPT string is built up with ST rods which are tightened to each other with a high torque, to create a stiff and secure connection. All ST rods together create a stiff and strong CPT string which is required for deep CPT's. A CPT string consists of a ST start set, 29 ST strings and a ST end set, forming a string with a length of about 85 meter. This string allows a CPT of 80 meter into the soil.



In general, the longer the CPT length the higher the risk of bending or buckling the CPT string. Depending on the type of soil (layers) the tip resistance and/or total friction around the string will increase while pushing deeper. The CPT operator has to interpret the CPT data to determine if the soil gives sufficient support for the required pushing force.
For example, during a CPT the cone reaches a hard sand layer resulting in high tip forces. This means high pushing force is required to penetrate this layer. In case of a soft layer above the hard layer, this soft layer will not be able to support the string against buckling. A combination of the thickness of the soft layer, the required pushing force (tip resistance) for the hard layer, the inclination of the cone and base inclination (stability) of the ROSON-ST system is giving the risk to assess if the CPT can be continued or has to be stopped.
Therefore, to avoid the risk of damaging the equipment, it is important to define clear stopping criteria before starting a project.

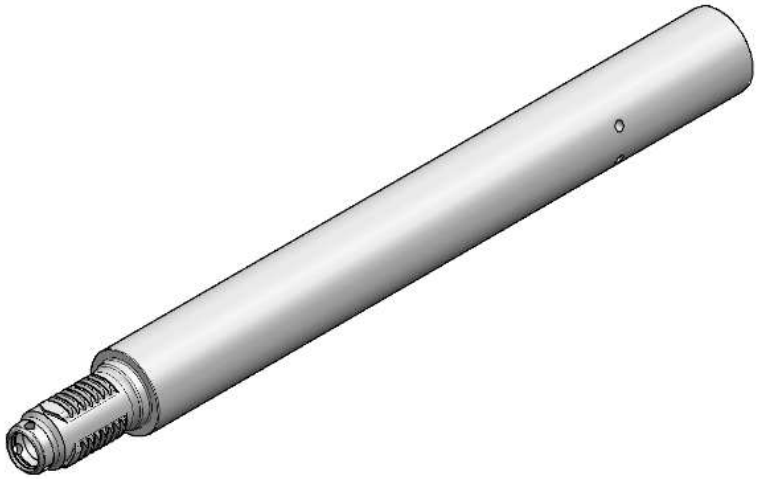
The following subsystems will be described in this chapter:

- ST rod
- ST measuring cable
- ST string
- ST start set
- ST end set

3.5.1 ST rod

The ST rod is the connecting link and the base of the ST technology. The new developed connection is a hybrid design of standard thread in combination with a bayonet connection, creating an optimum of both advantages. The connection is as strong as the proven conical AR thread, and is connected very quickly. The connection is made in a Single Twist, abbreviated ST, which is the name of this new CPT technology.

The effective length of each rod is 350 mm, for compact storage and feeding of the rods. For an optimum of strength the outer diameter of the rod is 40 mm.



3.5.2 ST measuring cable

The ST measuring cable ensures a stable electrical connection between the ROSON-ST system and the Icone module in front of the CPT string. The cable is used for power supply and communication with the module. Each measuring cable is configured with 8 ball joints and spirals. A ball joint is the connection between two ST rods, keeping the rods together and creating the required flexibility for storage. The ball joint protects the cable when the ST rods are (dis-)connected.

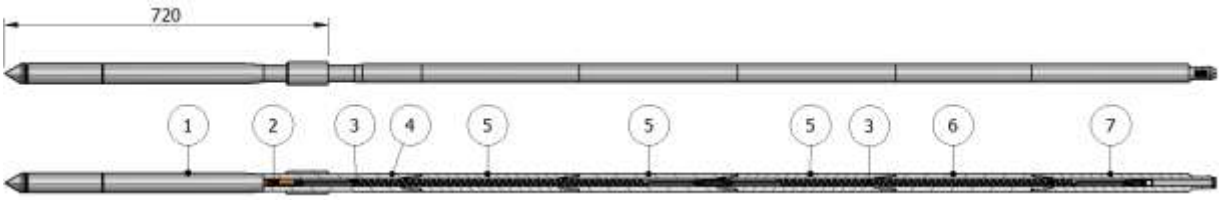
3.5.3 ST string, drawing 043990

The ST rods and measuring cable form together a ST string. The ST rods are connected to each other by means of a ball joint. In this way the string is flexible and can be folded on the ST folder. Twelve ST rods connected with ball joints is called a ST string. When formed as a rigid string, see picture below, the effective length is 2.8 meter.

3.5.4 ST start set, drawing 049754

The ST start set is the front of the CPT string, which contains the Icone module, the friction reducer and the adapter rods between AR thread and the ST connection. Behind the Icone module a connector cross over is placed from CC4 connector to the 5 pin offshore connector. Two short measuring cables are connected between the cross over and ST string.

The standard setup is using the Icone, but also other Icone modules can be placed.



For more information regarding the Icone or Icone modules, see the corresponding manual.

Note: The available length between limit switch and the bottom of the seabed frame is 750 mm. In case the Icone module(s) are longer, ballast plates are required to create additional space.

The start set is built up with the following parts:

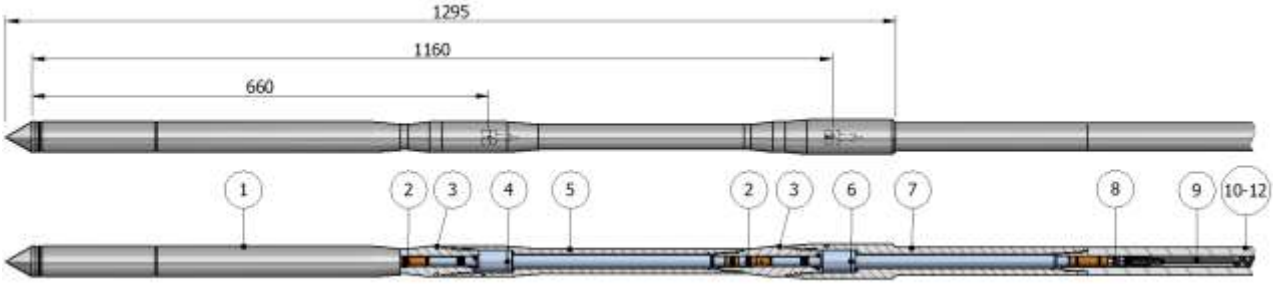
1. 0100299A – Icone ELCI-CFXYP100-15-AR
2. 1801010A – Icone Cross over CC4-TC5M
3. 18290k9B – Cable Icone ST TCIL5F-0,8/1,0-TCIL5M (2x)
4. 0280005A – Rod friction reducer 36/40-350 AR-AR
5. 0280003A – CPT rod 40-350 AR-AR (3x)
6. 0280007A – CPT rod 40-300 ARmale-ARmale
7. 0280016A – ST rod 40-AR-350-ST

3.5.5 ST start set Seismic (optional)

The ST start set can be configured for Seismic testing.

The start set for Seismic testing is built up with the following parts:

1. 0100299A – Icone ELCI-CFXYP100-15-AR
2. 1500700B – Cross over CC4-Quadrax (2x)
3. 0101411B – Seismic rod AR-male (2x)
4. 0101401B – Seismic module Icone 1
5. 0101412B – Seismic rod AR-female
6. 0101402B – Seismic module Icone 2
7. 0101414A – Seismic rod AR-female Ø40
8. 1801010A – Icone Cross over CC4-TC5M
9. 18290k9B – Cable Icone ST TCIL5F-0,8/1,0-TCIL5M (2x)
10. 0280003A – CPT rod 40-350 AR-AR (3x)
11. 0280007A – CPT rod 40-300 ARmale-ARmale
12. 0280016A – ST rod 40-AR-350-ST



3.5.6 ST start set Icone Vane (optional)

The ST start set can be configured for Icone Vane.

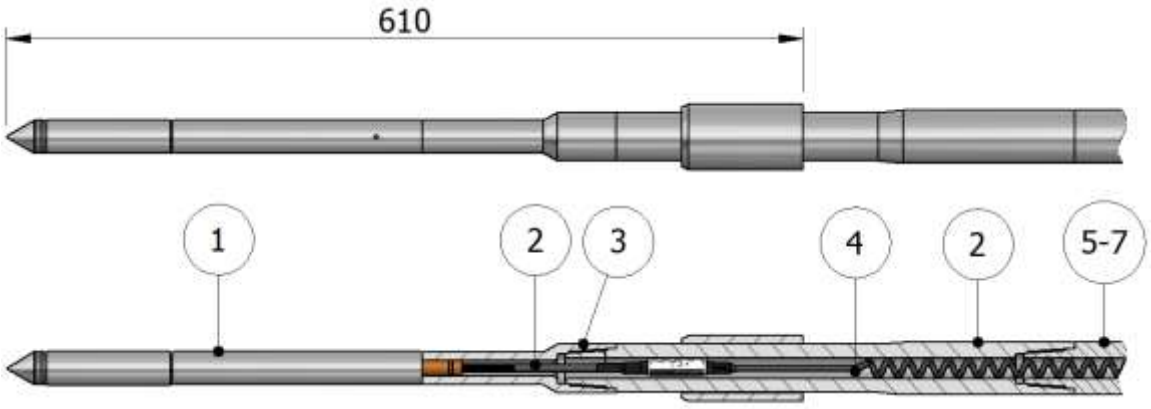
Note: In case of the Icone vane the maximum ST string is limited due to the required power of the Icone vane motor. With the maximum string length of 18 ST strings, the maximum available torque at remoulding speed (6 °/s) is 10 Nm. With 3 ST strings (8 meter pushing capacity) the maximum torque at remoulding speed is 50 Nm.

3.5.7 ST start set Icone 5 (optional)

The ST start set can be configured for Icone 5.

The start set for Icone 5 is built up with the following parts:

1. 0100472A – Icone ELCI-CFXYP100-5
2. 1885030A – Cable Icone ST CCM4-0k3-TCIL5M
3. 0905131A – Adapter 25/37 Icone-5
4. 18290k9B – Cable Icone ST TCIL5F-0,8/1,0-TCIL5M (2x)
5. 0280003A – CPT rod 40-350 AR-AR (3x)
6. 0280007A – CPT rod 40-300 ARmale-ARmale
7. 0280016A – ST rod 40-AR-350-ST



3.5.8 ST end set, drawing 046676

The ST end set is a ST string, reduced with 2 ST rods. The reduced length of this string optimizes the total string length, to be able to push the maximum of 80 meter. The end of the cable is connected to the slip ring unit inside the Folder.

3.5.9 ST string accessories

1. 1501030A – Connection cross over CC4-TC5M
2. 40012011 – Retaining ring 10 DIN 6799 stainless
3. 1501040A – Cover cross over CC4-TC5M
4. 1500407A – Icone connector screw
5. 1501050A – TCBH locking sleeve
6. 1501070A – TCBH locking clip
7. 77680288 – Spring retainer 16 DIN 7993B
8. 40001001 – Pin 4,5x30 DIN 1481

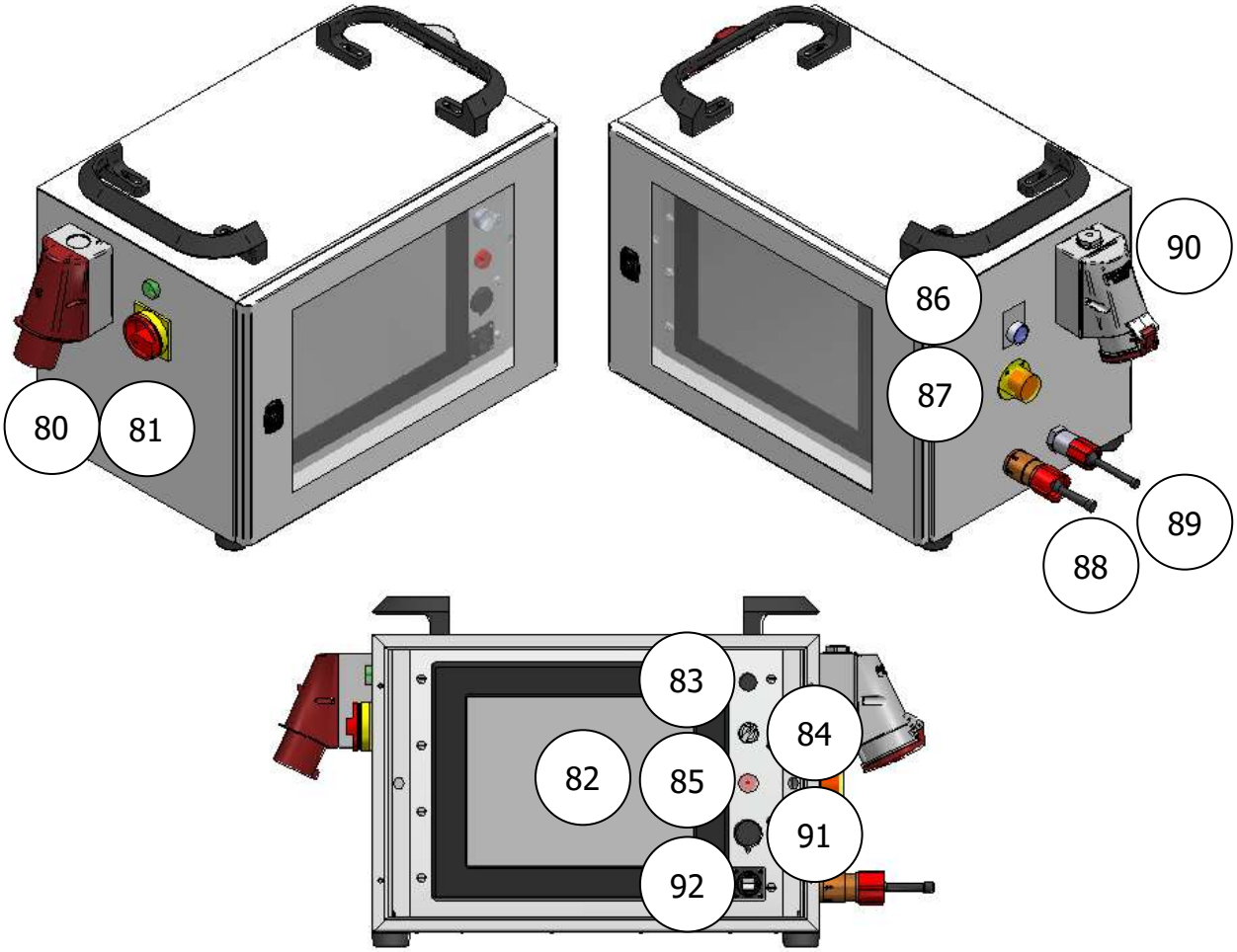
3.6 ROSON-ST service tools

3.6.1 Service unit ROSON-ST, drawing 046347

The service unit can be connected to the ROSON-ST system for service purposes at deck level. The Service unit is positioned nearby the ROSON-ST system to provide a good overview of the maintenance engineers when servicing the ROSON-ST system.

The service unit can also be used to by-pass the umbilical, which might be useful in case of trouble shooting.

The HMI screens are identical as the HMI screens A, B and C in the Control box. This means the same controls are available when the Service unit is connected.



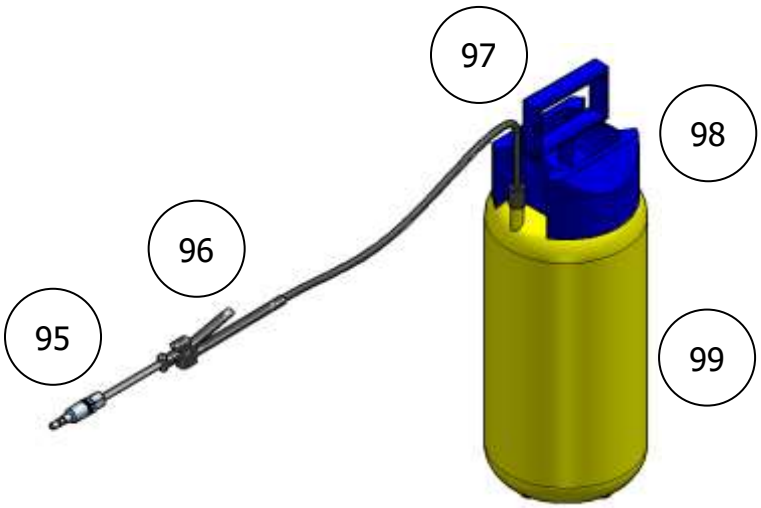
No.	Component type	Function
80	CCE form 5P male	Mains 400 VAC / 32A
81	Switch	Main switch (with green led when "ON")
82	Touch screen PC	PC for HMI user interface
83	Push button	STOP
84	Switch w/ light	By-pass "ON"
85	LED	Phase error main supply when "ON"
86	Push-button w/ light	Reset emergency circuit
87	Push-button	Emergency stop
88	Connector female	Subsea connection to Junction box Main JM11 (10 pin connector - 550 VAC Power)
89	Connector male	Subsea connection to Junction box Main JM07 (13 pin connector - Ethernet communication)
90	CCE form 5P female	Output 400 VAC / 32A (for JB drive unit JD07 or optional hydraulic fill unit)
91	USB connector	USB connection Touch screen PC
92	Ethernet connector	Ethernet connection Touch screen PC

Caution: Make sure the communication cable of the Service unit is connected to JM07 of the Junction box Main. JM07 allows control of a hardware STOP + identification of the Service unit to disable the Control box.

Note: In some cases a fuse (F3) can trip after resetting the emergency switch. This happens normally when the seabed system is not used for a while. In case this occurs, remove the front panel (8 screws) and reset the fuse. Reset the emergency switch and check if the fuse is in the correct position. Re-assemble the front panel.

3.6.2 Compensator pump, drawing 014696

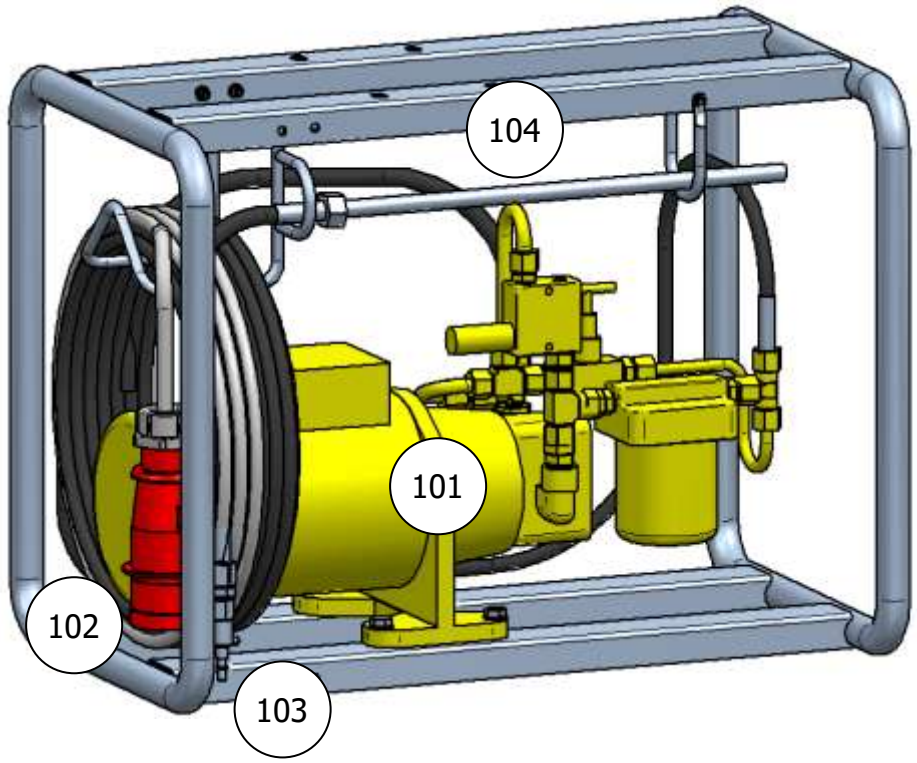
The compensator pump can be used to add or remove small quantities of oil from the compensator systems (ROSON or SHPU).



No.	Component type	Function
95	Quick coupling	Hydraulic connection for compensator system
96	Valve	Manual lever to apply / remove oil
97	Pump	Pump to apply air pressure to the tank
98	Safety valve	Valve to release pressure
99	Tank	Oil tank, filled with Tellus 32 or equivalent

3.6.3 Hydraulic fill unit (optional), drawing 046369

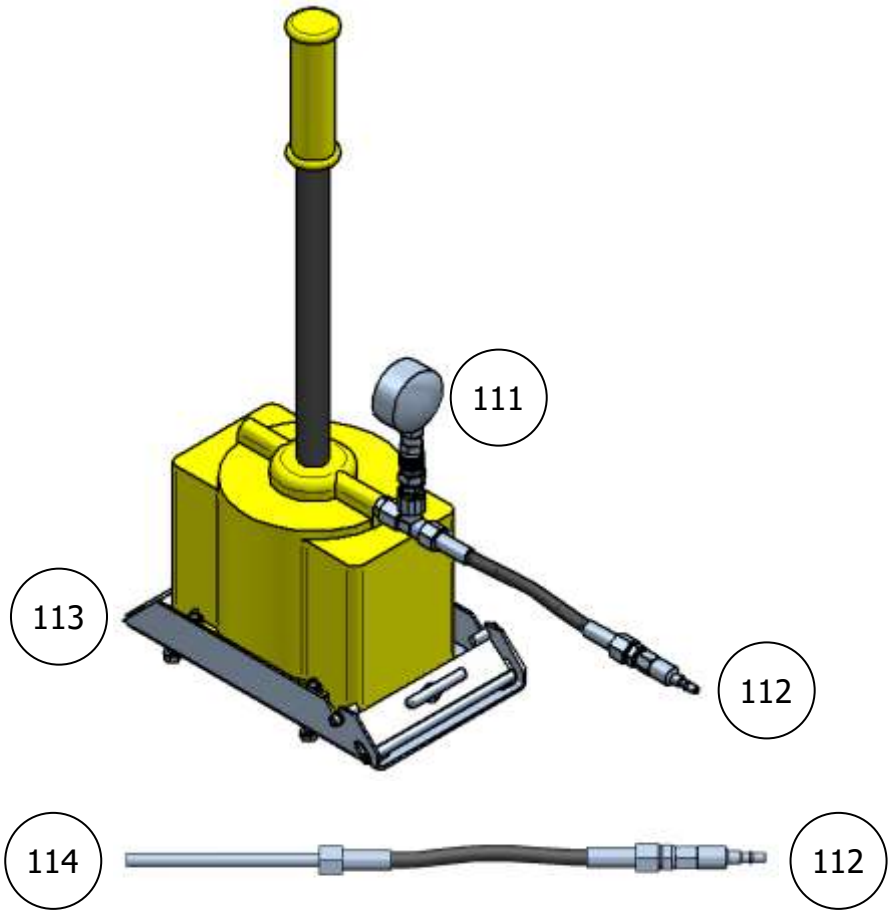
The hydraulic fill unit can be used to fill the compensator system for the ROSON or SHPU, the hydraulic fill unit can be used in case a large amount of oil has to be filled.



No.	Component type	Function
101	Pump unit	Hydraulic pump unit, 12 l/min / 20 bar
102	CCE form 5P male	Mains 400 VAC / 32A
103	Quick coupling male	Hydraulic connection for clamping cylinder drive unit (71 / 73)
104	Hydraulic pipe	Suction connection

3.6.4 Hand pump clamping cylinder, drawing 014581

The hand pump clamping cylinder can be used to clamp or open the drive wheels of the drive unit. During normal operation the SHPU is used for clamping the drive wheels. The hand pump is used in case the opening pressure has to be changed, or as back-up system. The drain hose (drawing 050329) is used to release the return oil into the tank of the hand pump when clamping or opening the cylinder.



No.	Component type	Function
111	Pressure gauge	Checking the clamping or opening pressure of the clamping cylinder of the drive unit
112	Quick coupling male	Hydraulic connection for clamping cylinder drive unit (71 / 73)
113	Frame	Pump frame which is mounted on the ROSON base frame
114	Drain hose	Hydraulic line for the return oil to the tank of the pump (remove the venting plug to access the tank)

Note: Make sure the hand pump is removed from the ROSON frame before it is lowered into the seawater.

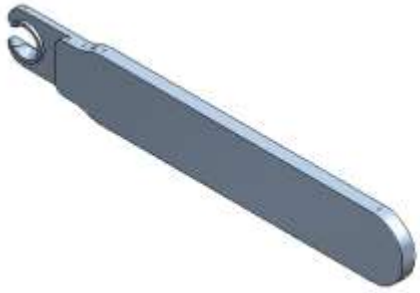
Note: When using the pump, open de the venting plug (anti clock wise). Make sure to close it (clock wise) after using to avoid rainwater entering the oil.

Caution: The maximum pressure of the clamping cylinder is 200 bar. Higher clamping forces can result in damage of the drive motors. Also the life time of the ST string is reduced when using the maximum clamping pressure.

3.6.5 ST string tools

For maintenance and (re-)placing ST strings on the ROSON-ST system the following tools are supplied:

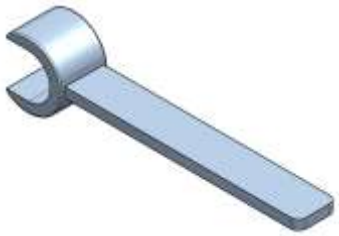
- ST tool for rod connection, part number 2805099A



- Tool for spiral cable, part number 0199028A

- Pin punch 4 mm
- Screw driver 3 mm
- Hammer
- Tool scraper ST, part number 0070199A

- Wrench ST rod, part number 2805098A



- ST check rod, drawing 050893

3.6.6 ST rod analyser

The ROSON-ST system is logging each ST connection. The data is stored in a daily log file for review. The log file can be loaded in the ST rod analyser for a quick review of the data.

Importing the log file in Excel can be helpful for further analysing the data if required.

3.7 Base frame

The base frame is a rigid frame to protect the drive unit, junction box and sensors. The frame is provided with rubber fenders on each leg, to protect the frame and its environment against damages.

3.7.1 Anti-buckling ring

The anti-buckling ring has to be mounted on the base plate of the ROSON frame to prevent buckling of the CPT string during testing. In case of Icone Vane or t-bar testing the anti-buckling ring has to be removed to create sufficient space for the sensor.

3.7.2 Contra ballast

To level the ROSON contra ballast is placed front / left in the frame, this to improve the stability of the system on the seabed during CPT testing. The lifting frame is lifting off-center, so when lifting the ROSON the base frame will tilt slightly to the front. The off-center lifting will help releasing the suction from the seabed.

3.7.3 Ballast/skirt configurations (optional)

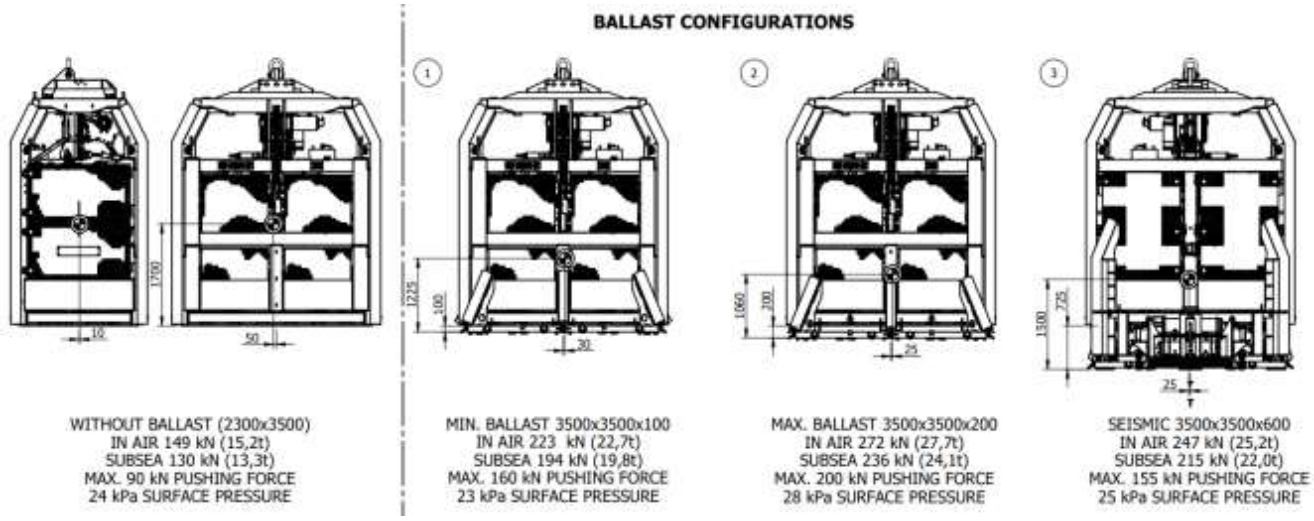
Ballast plates can be added to the base frame to increase the pushing capacity of the system. Also the center of gravity can be lowered by using ballast plates: this improves the stability of the system on the seabed.

For the maximum thrust of 200 kN larger ballast plates (3,5 x 3,5m) are required to improve the stability and reduce the required surface pressure.

A skirt can be used to decrease the surface pressure on the seabed. Other advantages are more stability because the bigger area (about 8,5 m^2) and more reaction force because of the suction of the skirt.

Note: In case of soft soils, a larger foot print (lower surface pressure) will avoid the system in sinking into the mud. In case a larger foot print is not possible, increasing the constant tension force of the lifting facilities can reduce the surface pressure. The mud can affect the ST cycle in a negative way in case the dirt accumulates inside the (female) ST connections, causing rejection of ST connections. Another risk of mud inside the ROSON-ST frame is obstruction of the Folder, causing failure of the ST cycle and risk of losing the ST string.

Below 3 example configurations (see also drawing 049482):



3.8 Seismic Source (optional)

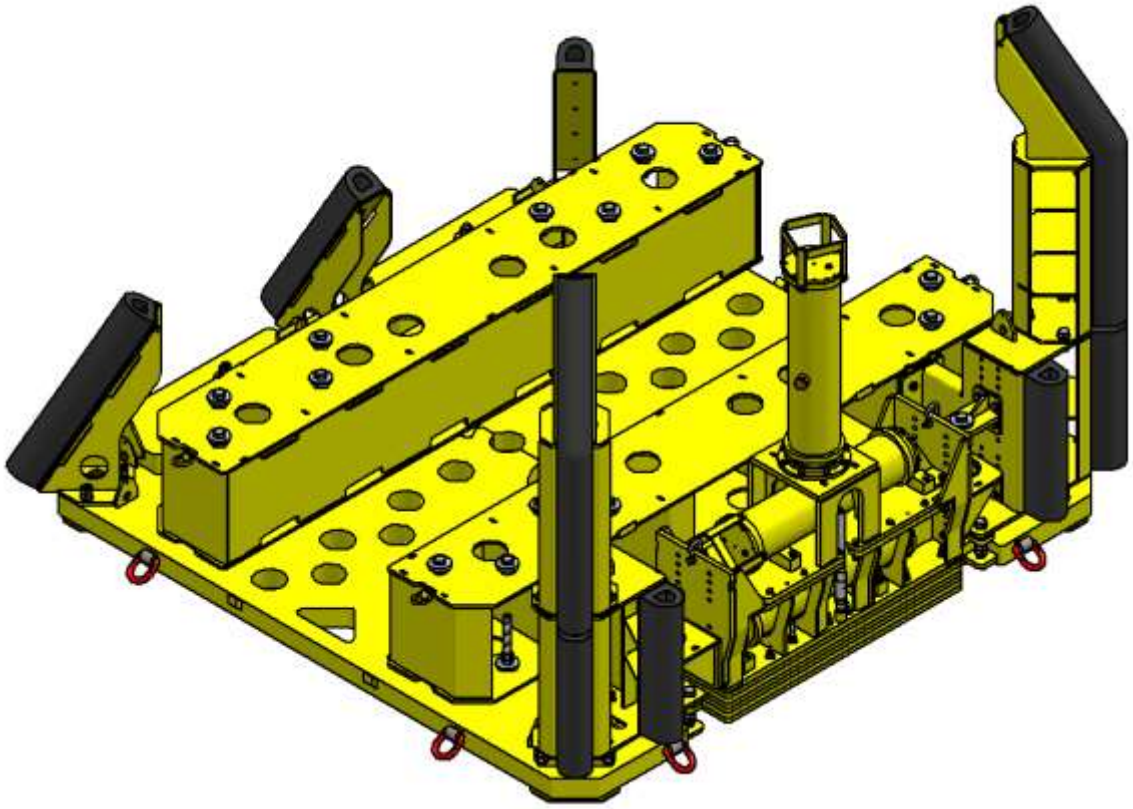
This chapter describes the parts of the Seismic source unit and how they function.

The equipment consists of a seismic source with three hammers to generate seismic waves at the seabed. The seismic source is suspended in the ballast frame in a way to be stable during lifting and isolated from the ballast when placed on the seabed.
An extension frame is designed to create sufficient length for a double set of seismic sensors in the CPT string.

The Junction box Seismic is connected to the Junction box Icontrol for power and communication with the ROSON system. To operate the seismic source the Ifield software is used.

The Seismic source can be ballasted to match the ballast configuration of the ROSON system. For the ROSON-ST 200 the surface pressure of the unit is about 25 kPA, which corresponds with one "bottom plate ballast" and four times a "ballast plate 25 mm".

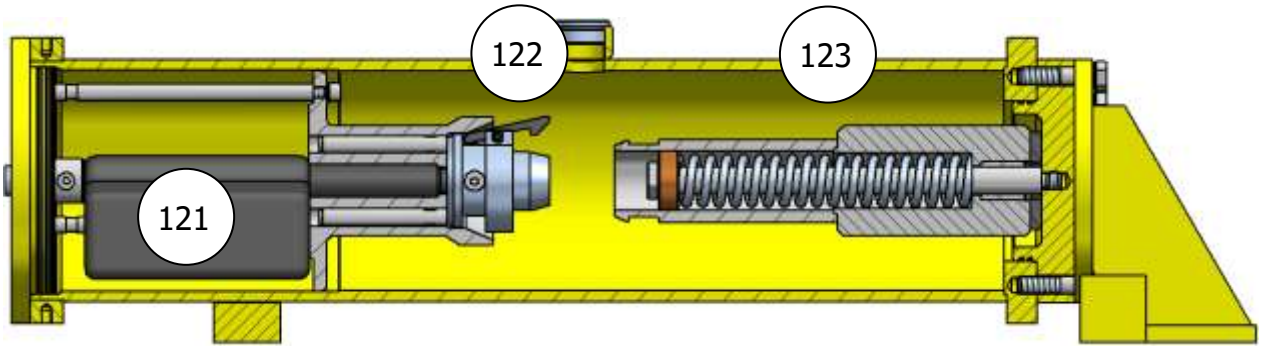
Caution: When the Seismic source is used the maximum pushing force is limited for two reasons: The center point of gravity is higher, causing a decrease of reaction force when the unit is tilted. The weight of the Seismic source is suspended, so will not be used as reaction force when the unit is placed on the seabed. For more information, see chapter 5.



3.8.1 Seismic hammer, drawing 011670

The Seismic source consist of 3 hammers. Two horizontal hammers for shear wave left and right and a vertical hammer for compression wave.

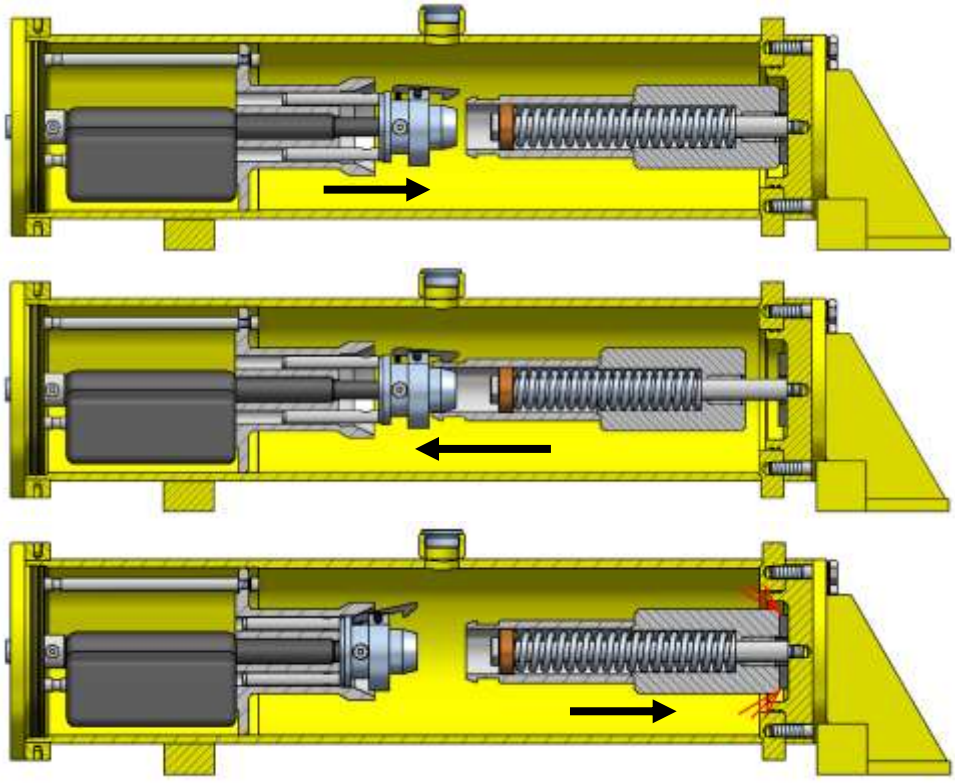
The waves are generated by a spring loaded hammer that hits an anvil.



No.	Component type	Color	Function
121	Linear actuator	black	Pull weight against compression spring
122	Snapper	steel	Hold and release weight
123	Spring loaded hammer	steel	Generate wave

3.8.2 Seismic hammer cycle

- The snapper will move forward to catch the hammer.
- The snapper pulls the hammer against the compression spring.
- At the end of stroke, the snapper releases and the hammer will hit the anvil.

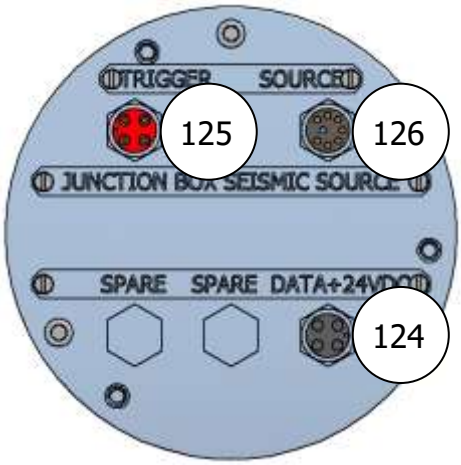


1 HAMMER RESETTING
(MOTOR STATE 3)

2 HAMMER ARMED
(MOTOR STATE 6-7)

3 TRIGGER RECEIVED
HAMMER STOPPED
(MOTOR STATE 8)

3.8.3 Junction box Seismic, drawing 022090

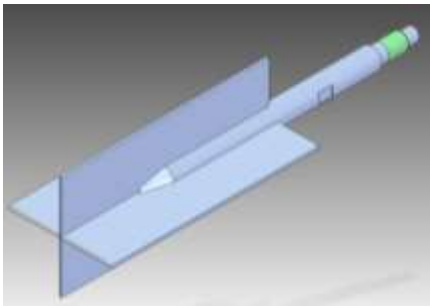


No.	Component type	Color	Function
124	Connector female 4p	black	Subsea connection to JB Icontrol ST (51)
125	Connector male 4p	black	Subsea connection to Icone Seismic trigger
126	Connector female 8p	black	Subsea connection to Seismic source

Note: In case a connector is not used, make sure it is covered by a blanking plug.

3.9 Icone Vane (optional)

The Icone vane blade consists of four plates fixed at 90° to each other. The plates have a fixed length/width ratio of 2. For example a vane blade with a 50 mm diameter has a length of 100 mm and a thickness of 2 mm. This is taken down as 100x50x2. See drawing 015014 for available vane type's.



See table below for relationship of the soil undrained shear strength s_u and the suggested vane diameter D according to the ISO 22476-9 standard.

Caution: If the soil conditions are unknown before the vane test, you better start with the smallest vane diameter to prevent damage to the vane.

Suggestions for vanes dimensions (EN ISO 22476-9 (2010))		
Soil type	Undrained shear strength s_u kPa	Vane diameter D suggestion mm
Very stiff to stiff clays and silts	50 – 300	30 – 50
Medium stiff clays and silts	20 – 50	50 – 75
Soft clays and silts	10 – 20	75 – 100
Very soft clays	< 10	≥ 100

The relationship between the undrained shear strength s_u, torque T and vane diameter D is given in next equation:

$$s_u = 273{,}000 \times T / D^3$$

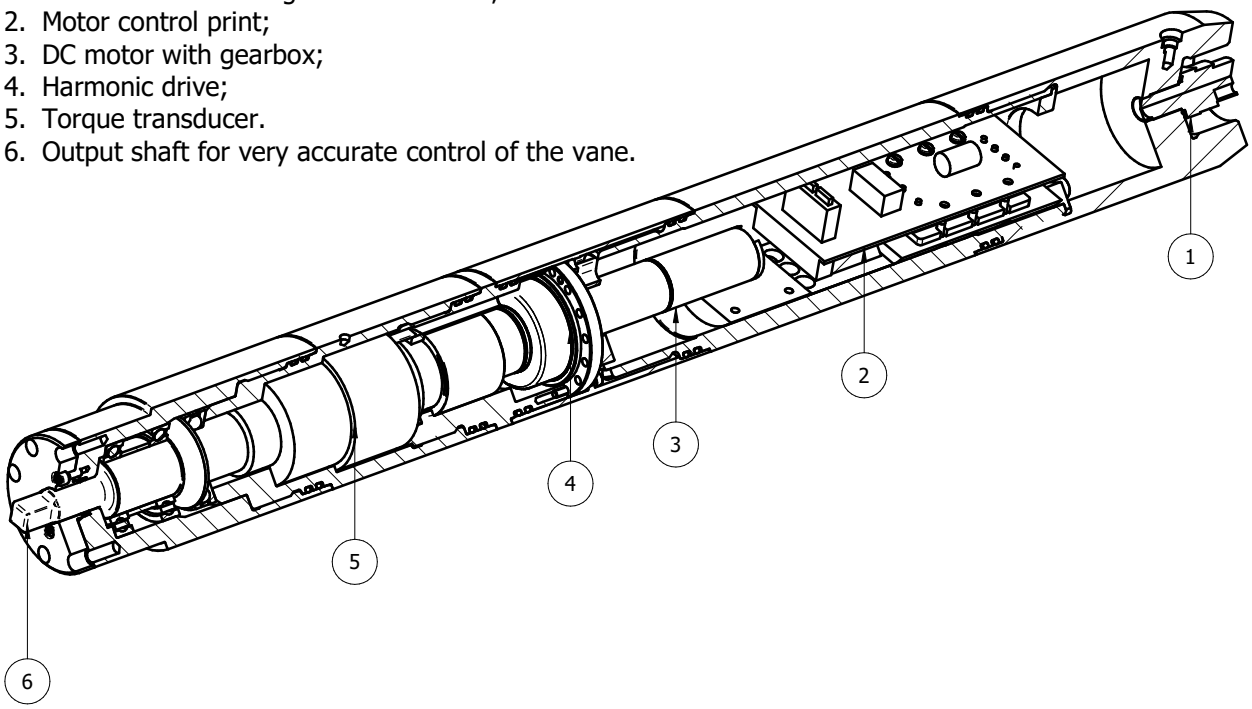
Where:

s_u in kPa
T in Nm
D in mm

Caution: Be aware that the vane you are using has a limited strength. The torque of the drive unit is able to bend the blades of the vane. Especially in non-homogeneous soils the vane blades could easily be damaged by stones etc. Use the vanes with a larger diameter for soft soils and the vanes with a smaller diameter for the stiffer soils. In the table on drawing 008145 you can read out the maximum allowable torque for the different types of vanes. During the test you have to check this value at the screen and stop the test immediately when the measured value is reaching the maximum allowable value. You can use alarm levels in the Ifield software that will stop the drive unit at a pre-set value.

The drive unit consists of the next main parts:

1. Power and measuring cable connector;
2. Motor control print;
3. DC motor with gearbox;
4. Harmonic drive;
5. Torque transducer.
6. Output shaft for very accurate control of the vane.



The connector of the drive unit is connected to the Icontrol data logger by means of a measuring cable. The drive unit is powered by the Icontrol.

The motor control print controls the angular rotation, -speed and -torque. The electronic print also contains an inclinometer. It supplies data for the data acquisition system.

The harmonic drive is a high ratio gear reduction for driving high torques.

The torque transducer measures the torque. The vane is mounted to an extension shaft which is connected to the output shaft of the drive unit.

The drive unit is connected to the Icontrol data logger by a plug adapter and Icone measuring cables.

The sensor used for torque measurement inside the Icone vane has an accuracy of 0.2 Nm. When calibration and system faults taken into account the overall Icone vane system has an accuracy of at least 0.5 Nm. For measurements of the rotation angle, the system accuracy is at least 1 degree. According to the application classes that are described in various standards the Icone vane tester is suitable for all test situations.

A new calibration should be carried out after tests have been done under difficult conditions when the Icone vane system has been loaded close to or over its maximum capacity. A recalibration is also needed when the measuring system reading is significant before start of the test at zero load.

A periodic recalibration of the Icone vane is recommended. The criteria for recalibration have to meet the requirements of your quality system. For example a certain time period can be used or a certain number of tests performed.

Note: In case of the Icone vane the maximum ST string is limited due to the required power of the Icone vane motor. With the maximum string length of 18 ST strings, the maximum available torque at remoulding speed (6 °/s) is 10 Nm. With 3 ST strings (8 meter pushing capacity) the maximum torque at remoulding speed is 50 Nm.

Chapter 4 Mobilization on board the vessel

Before starting an offshore project it is recommended to check availability of spare parts and consumables, see Appendix F for an overview.

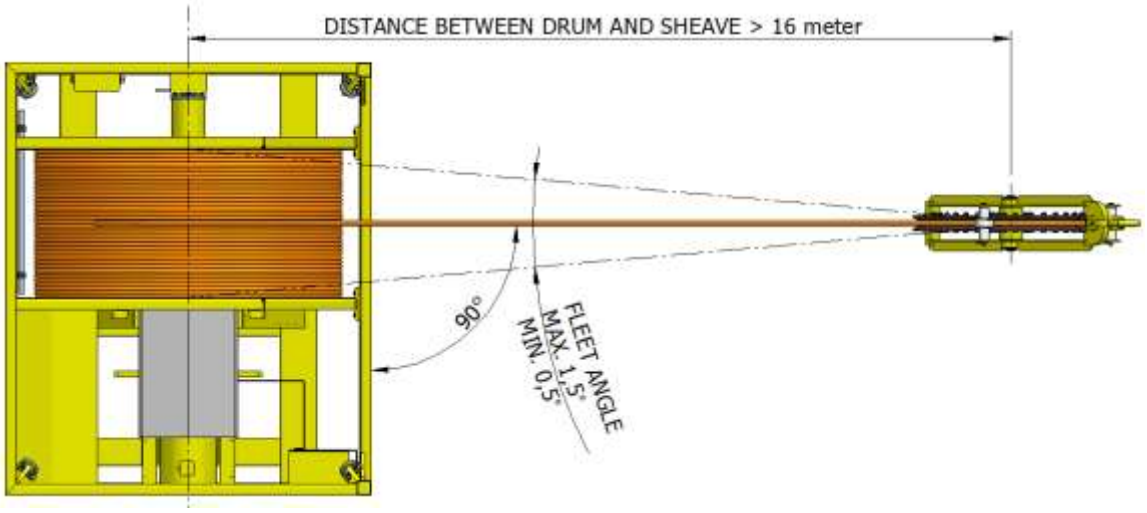
4.1 Vessel requirements for the ROSON system

Make sure the vessel has the following requirements or better:

- Lifting facilities with sufficient lifting capacity to pick up 35 tons from the seabed (25 tons subsea weight + 10 tons suction force). Make sure the applied ballast, the weight of the lifting cable, the required constant tension force and the spare force is taken into consideration when calculating the required lifting capacity.
- Space for constant tension winch, and sufficient length between drum and sheave
- Safe working area around ROSON for preparing/maintenance
- CPT cabin for positioning control cabinet and data acquisition system, A/C preferred due to electronics
- CPT container for storage of spares and consumables
- Work bench with tools (inside CPT cabin/container)
- DP or anchoring system for positioning vessel
- Good communication and corporation between bridge and deck crew

4.2 Winch positioning on deck

The winch has to be positioned in such a way that the umbilical will always be in a straight angle towards the axle of the winch. The winch has to be secured to the deck according to the regulations. The maximum force during operation is 7500 N (100%) or 11250 N (150%, short duration). See also the figure below with information about the distance to the sheave block and the minimum and maximum fleet angle. For dimensions see drawing 027880.



4.3 Winch connection to mains

Connect the winch to a stable 3 phase electrical power source, 380-440 V AC (50 Hz.). The required power for the system is 50 kVA, the required supply cable is a suitable 4*16 mm² cable. Only a qualified electrician is allowed to connect the power supply to the winch.

When the supply cable is connected to the winch, the winch can be switched on by the main switch. Check the power control relay. In case of "phase error" change 2 phases of the supply cable (main supply).

	The power control relay indicates the status of the connected board-voltage: Un: Nominal voltage 400 V (default setting) >U: Over-voltage (default setting 10%) <U: Under-voltage (default setting 10%) LED Def.: Error (eg.: phase sequence fault, over/under-voltage) LED Un: Indicates Voltage O.K. if present. LED R: Indicates O.K. if running Function of operation: see data-sheet. Absolute maximum ranges for the frequency controller (winch) to be able to operate: **DANFOSS FC 302 : 380 – 500 VAC** **Do not adjust the relay beyond these values!**
	When the system is O.K. the lower two LED's are lit: - Def.: off - Un: Green - R: Yellow

Note: Make sure the transformers are configured according to the power of the vessel. The primary voltage should be connected to the same (or higher) value as the voltage of the vessel. For example, when 405 VAC is measured, the primary trafo setting is 420 VAC.

4.4 Control box location and power supply

Place the Control box indoors. Preferably with a free view on the ROSON system when operating the ROSON on deck. The maximum distance between the Control box and winch is 20 meters, the lead of the DA-cable is 30 meters.
The Control box can be plugged into any grounded wall socket 230 volt (50/60 Hz.) it requires 500 VA.

Note: Earth loops can cause noise (errors) and damage of the communication system, make sure the earth of the ROSON winch is connected to the earth of the Control box.

4.5 Constant-tension adjustment

The winch can be operated in "manual mode" and "auto mode" (switch 11). In manual mode the drum speed can be controlled with a joy stick (12), in auto mode the drum torque is kept constant by the frequency converter. The constant tension can be activated with push button (13) and set with dial (14). To extend the life time of the umbilical, the self-tensioning is adjustable and needs to be set as low as possible.

The standard setting should be around 62% (60 Nm) of the maximum tension 100% (98 Nm).

When working in deep water the weight of the umbilical (pay out) increases, but the pulling force of the winch increases also (by decreasing diameter of the drum). Therefore the self-tensioning setting can be kept on a constant value, see also the table below with the theoretical values.

Layer	Pay out of umbilical (m)	Pulling force winch @100% (N)	Weight of umbilical (in sea-water) (N)	Required tension (N)	Constant tension setting (%)	Constant torque motor (Nm)	Dial
10	0-110	5505	216	2500	49%	48	
9	110-290	5667	569	2500	54%	53	
8	290-460	5840	903	2500	58%	57	
7	460-620	6024	1216	2500	62%	60	
6	620-780	6219	1530	2500	65%	64	
5	780-930	6428	1825	2500	67%	66	
4	930-1080	6651	2119	2500	69%	68	
3	1080-1230	6890	2413	2500	71%	70	
2	1230-1370	7147	2688	2500	73%	71	
1	1370-1500	7424	2943	2500	73%	72	

Note: To check the motor torque or percentage of torque of the winch motor on the display of the frequency converter, the system has to be in "auto mode" (frequency converter has to be in "contant torque mode".)

Note: At higher sea-states the torque can be put higher as standard, to keep sufficient tension on the umbilical.

4.6 Transport of ROSON-ST

This chapter describes how the ROSON-ST can be transported. Due to the height of the ROSON-ST in vertical position, the system can also be transported horizontal.

Before you start working, you should have read and understood chapter "Safety Instructions".

Wear protective gloves and safety footwear when performing the operations described in this chapter.

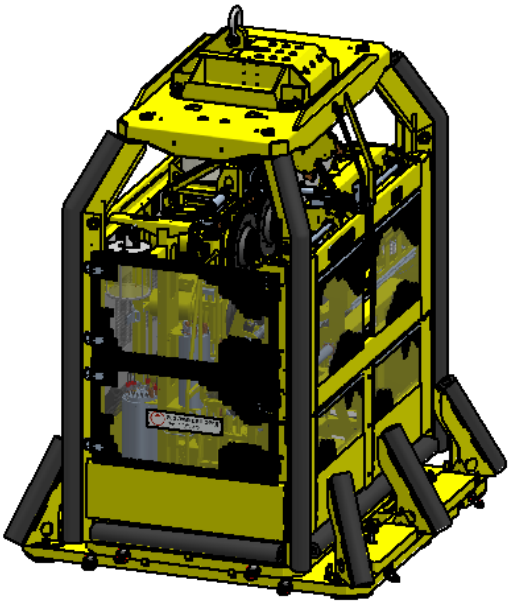
WARNING: Be aware of the weight of the system and the capabilities of the lifting facilities. The SWL is depending on the method of lifting:

- SWL Pewag PLDW 24t, 4 legs, Angle of inclination 0° – 45°: 50,900 kg
- SWL Pewag PLDW 24t, 4 legs, Angle of inclination 45° – 60°: 36,000 kg
- SWL Pewag PLDW 24t, 2 legs, Angle of inclination 0° - 45°: 33,900 kg
- SWL Chain Sling KWB 16 mm grade 100, Angle of inclination 0° - 45°: 21,200 kg
- SWL Chain Sling KWB 16 mm grade 100, Angle of inclination 45° - 60°: 15,000 kg

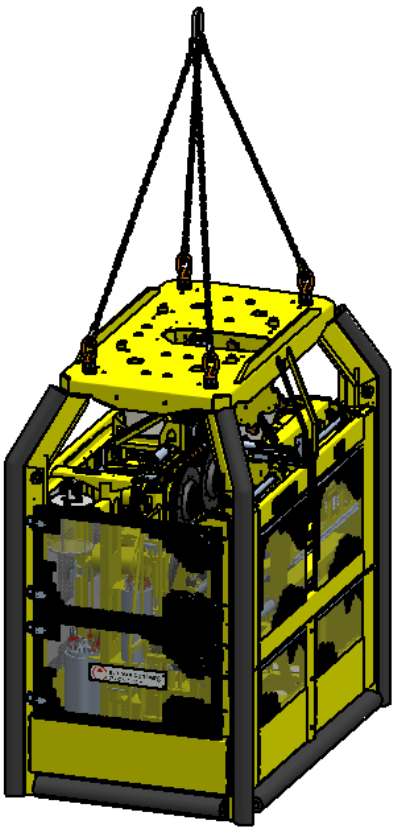
Note: Remove the Pewag lifting points and Chain Sling after lifting to avoid corrosion by sea water.

4.6.1 Vertical transport

In vertical position the system can be lifted with the lifting frame or with the Chain Sling set.



ROSON-ST with 35t lifting frame
Lifting weight 27.7t
Lifting weight w/o ST string 27t



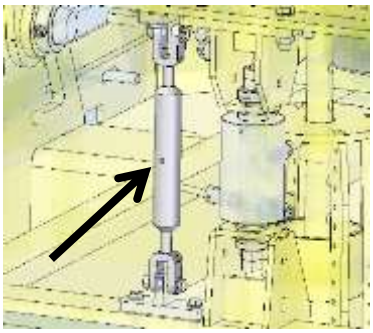
ROSON-ST with 15t Chain Sling set
Lifting weight 14.7t
Lifting weight w/o ST string 14.0t

4.6.2 Horizontal transport

In horizontal position the system can be lifted with the Chain Sling set.

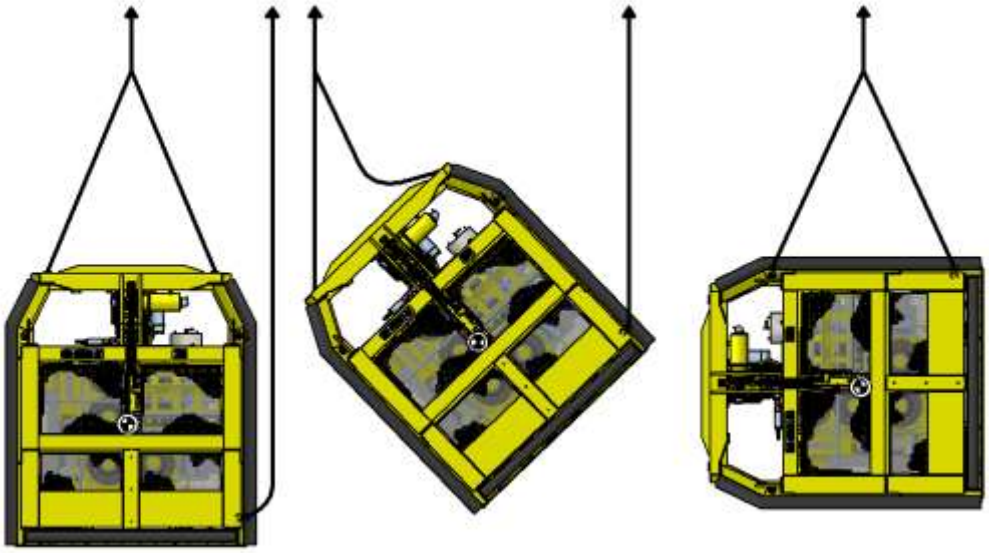
WARNING: Make sure the ballast plates are removed when lifting the unit in horizontal position. In horizontal position the maximum lifting capacity of the Chain Sling set is 15t.

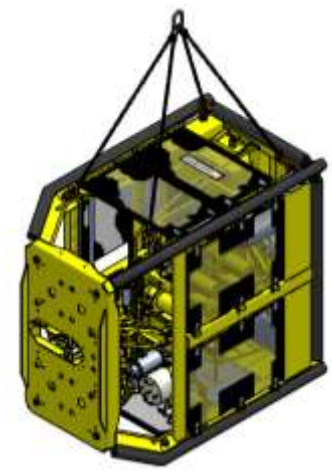
Note: Place the rigging screw between the ROSON frame and drive unit before tilting the frame horizontal. Make sure the rigging screw is removed before the unit is used for CPT testing.



Rigging screw

In the pictures below is shown how to tilt the frame from vertical to horizontal position:





ROSON-ST with 15t Chain Sling set
Lifting weight 14.7t
Lifting weight w/o ST string 14.0t

Chapter 5 Preparing the ROSON-ST before use

This chapter describes preparing the ROSON-ST before use. This means: preparing the ROSON-ST with ballast, with a ST string and perform functional checks on deck of a vessel.

How to mobilize the ROSON system is described in the previous chapter, how to operate the ROSON system is described in the next chapter.

Before you start working you should have read and understood chapter "Safety Instructions".

Wear protective gloves, helmet, safety glasses, offshore overall and safety boots when performing the operations described in this chapter.

In the following text the words "Check" and "Make sure" mean that you have to check if the given situation is identical with the real situation. If not, make sure the given situation is met, before you continue.

5.1 Building up the frame

Assemble the ROSON with lifting frame according to drawings 021838 and 048914. Make sure the correct mounting torques, see drawing or chapter “Service”, for more information.

Depending on the project requirements and the seabed condition the system has to be configured with ballast and / or an enlarged footprint. A lifting facility with constant tension is advised to add flexibility during operation.

Defining the correct setup is based on the required maximum pushing force, and so the minimum required ballast in combination with the maximum surface pressure of the seabed.

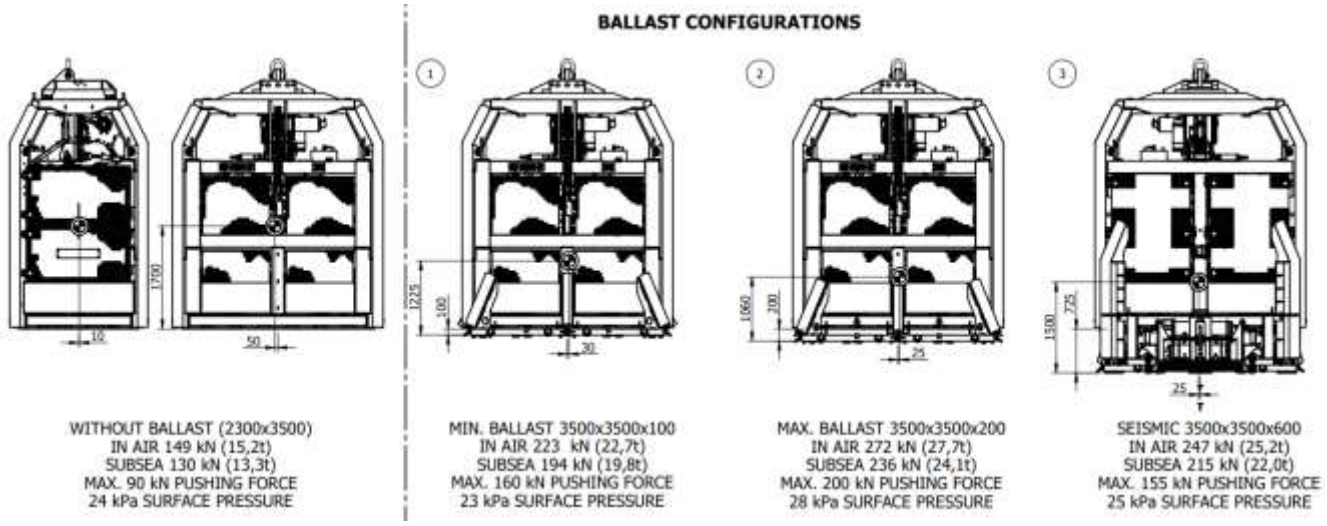
The maximum pushing force depends on the following criteria:
- The own weight of the ROSON in seawater
- The additional weight (ballast) in seawater
- The angle of the base frame
- The reduced weight in case of constant tension force on the lifting cable
- The stability on the seabed (risk of sliding / tilting)

Caution: Unstable positioning on the seabed might cause sliding or tilting of the ROSON system. This can result in damage/loss of the CPT string. Always closely watch the base inclination when high pushing forces are required.

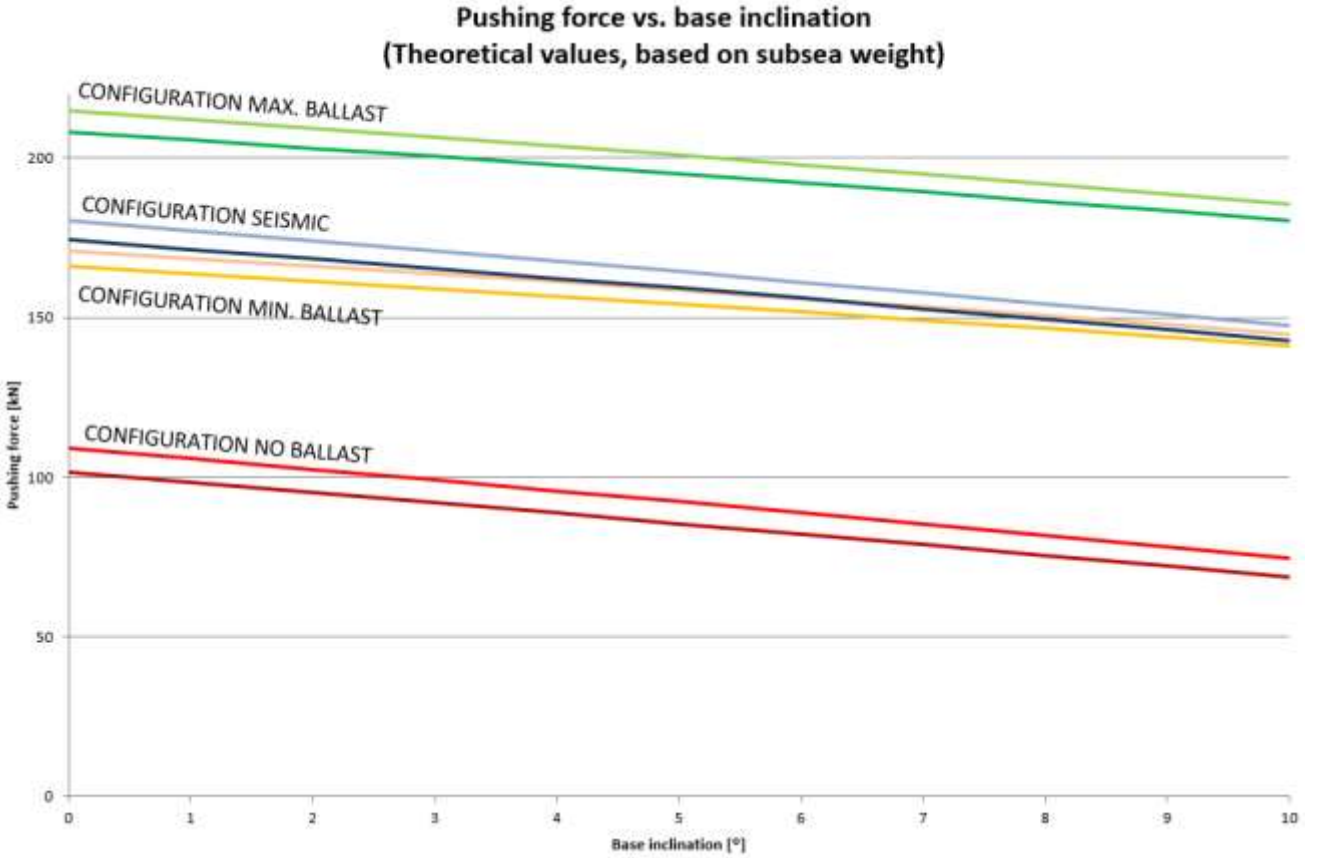
Note: In case of soft soils, a larger foot print (lower surface pressure) will avoid the system in sinking into the mud. In case a larger foot print is not possible, increasing the constant tension force of the lifting facilities can reduce the surface pressure. The mud can affect the ST cycle in a negative way in case the dirt accumulates inside the (female) ST connections, causing rejection of ST connections. Another risk of mud inside the ROSON-ST frame is obstruction of the Folder, causing failure of the ST cycle and risk of losing the ST string.

5.1.1 Configure ballast

As many ballast configurations are possible we have 3 example configurations prepared in the drawing below. This information can also be found on drawing 049482.



The next graph shows the maximum load that can be obtained with the ROSON when a certain amount of ballast is mounted and when it is placed at an angle on the seabed.



Note: During operations we advise not to exceed 5° tilting of the frame.

Note: Each configuration has two lines in the graph, the upper line is with a fully loaded ST folder, the lower line is when the ST folder is completely empty.

5.2 Mechanical and hydraulic checks

Visual check the mechanical and hydraulic condition of the system. Look at all actuators and sensors and check on loose bolts connections. Visually check all hydraulic connections to check for any leakages.

- Visually check the condition of the limit switch, dirt scraper and ROSON drive wheels.
- Double check if the bolts of the drive wheels, drive unit frame and ROSON base frame are tightened.
- Visually check the condition of the Total load sensor, the ROSON Base sensor and Seabed sensor.
- Visually check the condition of the Junction box main, Junction box Icontrol ST, Junction box Twister and Termination.
- Visually check the condition of the SHPU, pressure sensors and clamping cylinder. Check for leakages.
- Move the Twister manually up and down, the Twister should run smoothly. The neutral position is just above the middle. This means a free stroke of about 95 mm above and 105 mm below the Twister. Check the Twister on leakage and if the bolts of the Twister are tightened. See chapter "Service" how to tighten the bolts of the Twister.
- Rotate the Sprocket manually, this should run smoothly. Check the guiding and ST guiding sensor on wear or damage. Check if all 6 sprocket fingers are in a good condition.

Note: For the ST cycle it is important the fingers are not bent outwards or damaged. Repair or replace if necessary, see also chapter "Service" for more information.

- Move the ST tension sensor manually, this should run smoothly and the springs should be able to push it till it's end position.
- Rotate the Folder manually, this requires some force but should be able to rotate by hand. Apply grease to the 2 rotating bearings and the spindle nut.
- Visual check the oil level in both compensators, it is advised to have about 50 mm of oil visible in the compensator. This is about 25% of the 6 or 15 liter capacity. Both compensators should not show air above the oil, and the SHPU compensator (78) should contain visible clean hydraulic oil.

Note: In case the oil level is low, this can be applied with the compensator pump. Make sure the pump is clean and filled with clean hydraulic oil. Pressurize the pump and apply connection (95) to connection (67) or (68). For more information see chapter "Service".

Caution: Fill the hydraulic tank/compensator (68) only with clean hydraulic oil. Never use hydraulic oil from the pressure compensation system (67), this oil is contaminated with dirt particles from the gear boxes

Caution: Check the compensators each time before the ROSON is lowered in the sea water.

5.3 Connecting the motors and sensors, layout drawing 049855

In the following steps all cables between Junction boxes and motors or sensors are placed or checked.

Caution: Make sure the power supply is off (main switch (3) and umbilical power switch (15)) before connecting or disconnecting the cables.

- Check if all electrical connections on the ROSON system are in good condition. Clean and degrease the connectors after disconnection. Use a little silicon grease (Molykote 44M) before mating a connector, cable or plug.
- Connect all the cables between the Control box, the ROSON winch, ROSON junction boxes, drive motors and sensors according to drawing 049855.
- Use dummy plugs on unused connectors of the Junction boxes, eg. JM-8, JM-14 or JM15.
- Use the Subconn connector supports 050837 (4P) / 050829 (6/10P) on the high power cables to reduce mechanical stress on the connector.

Caution: Connectors and cables can cause unexpected errors when launching the system. Make sure the connectors stay in good condition. Always use the 44M grease and clean if necessary. Properly ti-rap the cables on the frame to avoid stress or misalignment of the connectors. Make sure not to overtighten the EMC connectors (metal shell versions), avoid mechanical stresses on the pins by holding the cable while tightening the stainless steel locking sleeve.

The system is now ready to check the drives and sensors.

5.4 Check the drives and sensors

In the following steps a communication and functional check of the system is performed.

- Power the Control box, this will start up the 2 Touch Screen PC's (Ifield and HMI) and the VPN router. See for more information about Ifield the corresponding manual.

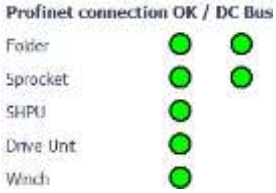
Note: When the 230 VAC is applied, it takes about 1 minute before the VPN router is started and communication with the ROSON-ST is established.

- Switch on the ROSON winch (3) (mains on).
- Switch on the umbilical power (15).

Note: When the umbilical power is "ON" it takes about 2 minutes before the PLC is started.

- When the VPN router and PLC are started, check the communication between the Control box and ROSON system. The HMI software should show a green indicator in the top right of the screen, and normal digits will appear instead of ####.
- When the connection is established, press the "ON/OFF" button of screen "A" on the HMI to power "ON" the ROSON-ST actuators and sensors. The button will turn orange while starting up, and turn green when ready.

- Go to screen C, and check if all profinet connections are "OK". The indicators will turn green when the drives are started.



- Check the status of each sensor / drive.

- Go to screen "B" and press "STOP". Check the state numbers of the Sprocket and Folder, both should be "1".

- Perform a Twister check, the Twister will perform a cycle to check the sensors, clamping action and rotational friction. In case the temperature is low (and the rotational friction of the motor in oil is high), the Twister will repeat the cycle till the rotational friction is below a certain level.

- Check on screen "B" the vertical position of the Twister, this should be between 195 – 200 mm.

- Check on screen "B" the ST tension sensor. When fully pushed in (manually) the value should be about 105 mm. During each Init push/Init pull cycle the Folder will pull the ST string till the tension is > 100 mm, if this condition is not reached the init cycle will fail.

- Check the movement of the Sprocket and Folder. Make sure both can run freely without obstruction.

Tip: For preparing or servicing the system, the Service unit can be connected to the Main Junction box and Junction box drive unit with the communication cable (JM-7) and the power cables (JM-11) + (JD-7).

- Check the limit switch and ST guiding signal by holding a screwdriver near the proximity switch. The signal should appear on HMI screen A.

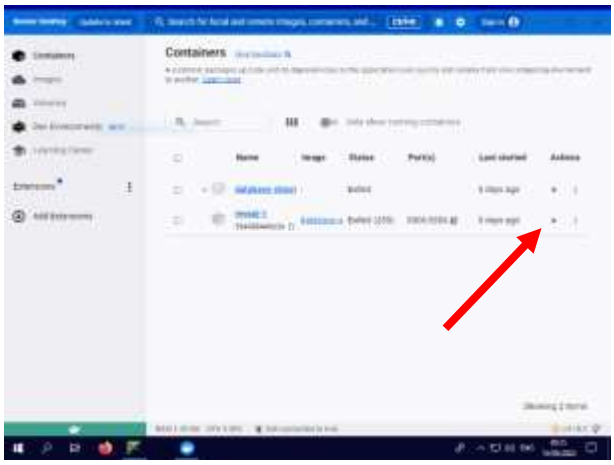
- Check if the compensators volumes are corresponding with the visual inspection.

The system is now ready to prepare Ifield and check the connected Icone modules.

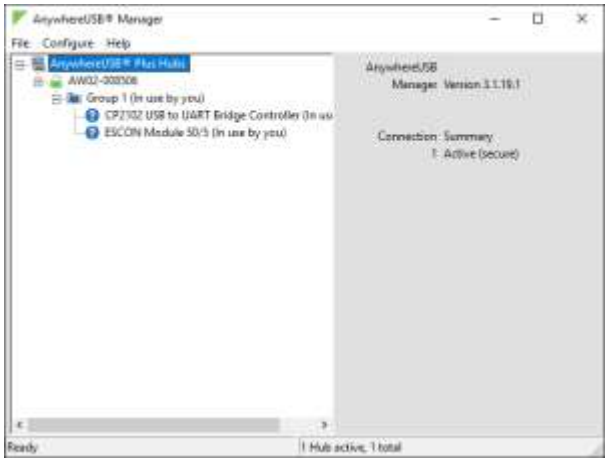
5.5 Prepare Ifield and check connected Icone modules

In the following steps a project is created in Ifield and the connected Icone modules are checked if they are available on the APB bus and appear in the Ifield software.

- The "docker" software will start up automatically. Press one of the two "play" buttons to start the container.

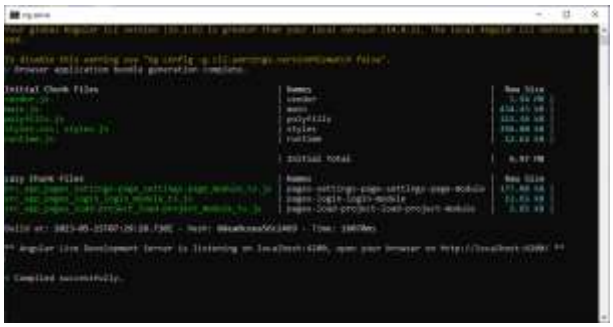


- Check in the USB anywhere manager if the USB to UART Bridge controller is "in use by you".



- Press "start.bat" to start the background software.

- Two terminal screens will appear, check if they started correctly:

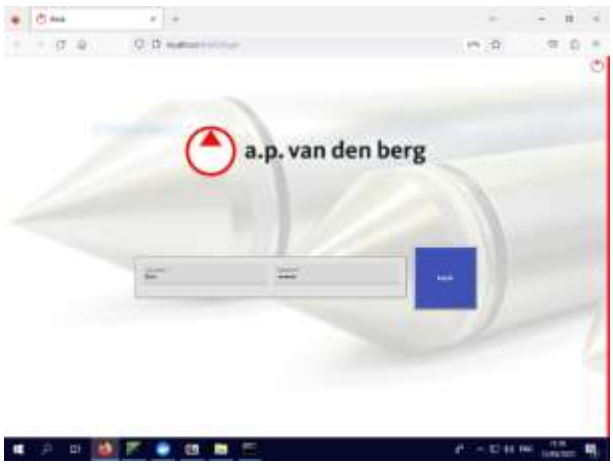


"Compiled successfully"

"Back end running"

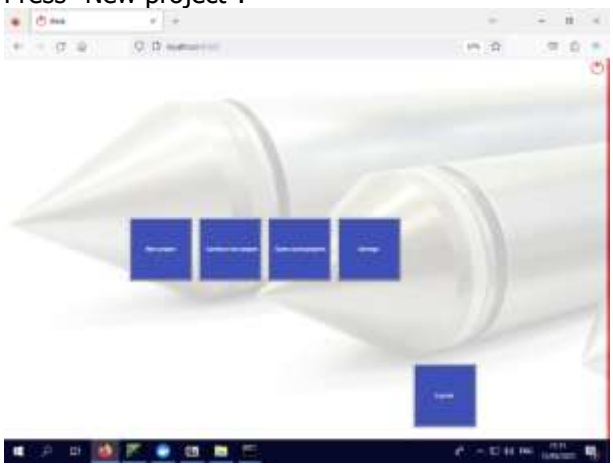
- Start "Chrome", the Ifield webpage will start automatically.

- User name: Operator; Password: cpt; Press "Log in" to start the software.



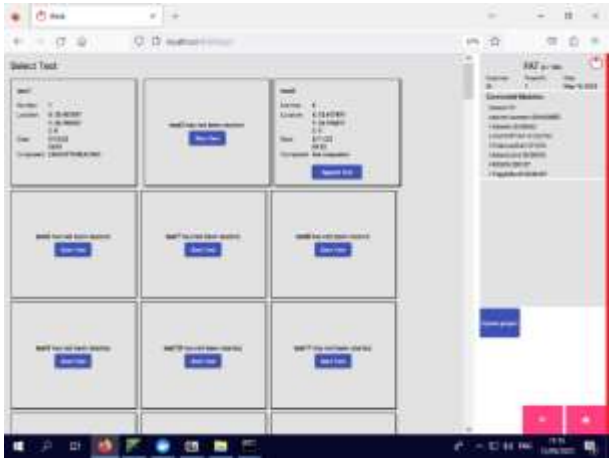
Note: In case the "log in" doesn't work (error message containing "localhost:3004"): Type https://localhost:3004. A message "your connection is not private" appears. Press "advanced" to reset the log in status.

- Press “New project”.



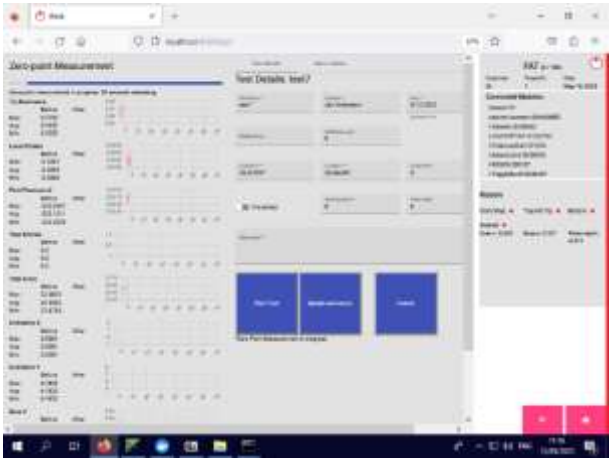
- Fill in all mandatory fields, and press “Create”.

- Temporarily connect an Icone with cross over and (Start set) cable to the slip ring unit.
- Check in Ifield if all connected Icone modules (e.g. Icontrol V1, Icone (I-C2xFXYP100), I-ROSON, I-TotalLoadCell, etc.) are recognized by the Ifield software.



Note: If one of the modules is not shown in the Ifield software, restart the Ifield software by closing both Terminal screens and restart with "start.bat". Log in and return to the project. Wait till all the Icone modules appear in the Ifield software. In some cases the Icontrol power needs to be turned "off" and "on" to reset the APB bus.

- Start a new test in Ifield, the "Zero-point Measurement" screen will appear.



- Check in the "zero " if the cone, total load, water depth and base inclination signals are stable.
- Press "Cancel" to stop the zero reading.
- Remove the Icone and cable.

The system is now ready to place the Start set with Icone.

5.6 Place the Start set and Icone, see drawing 049754

In the following steps the Start set and Icone are placed and clamped between the ROSON wheels.

- Prepare the Start set according to drawing 049754. Make sure the rods are tightened properly.

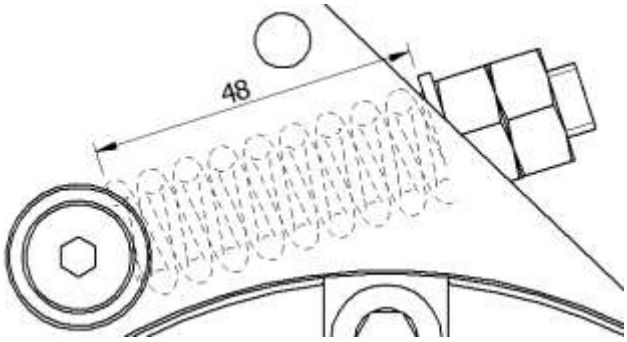
Note: Use anti-seize paste, eg. Molykote TP42, for the thread connections of the CPT-rods.

Note: Use the cover (1501040A) with circlip (40012011) and Tool for spiral cable (0199028A) to prevent the cable to be pulled back inside the rod.

Tip: To pull the spiral cable through the rods: extend a dummy plug, e.g. with a ti-rap, to extend the spiral cable.

- Open the drive wheels by pressing the "Clamp open" button in screen B. This will take about 1 minute. Press "STOP" when the wheels are fully opened.

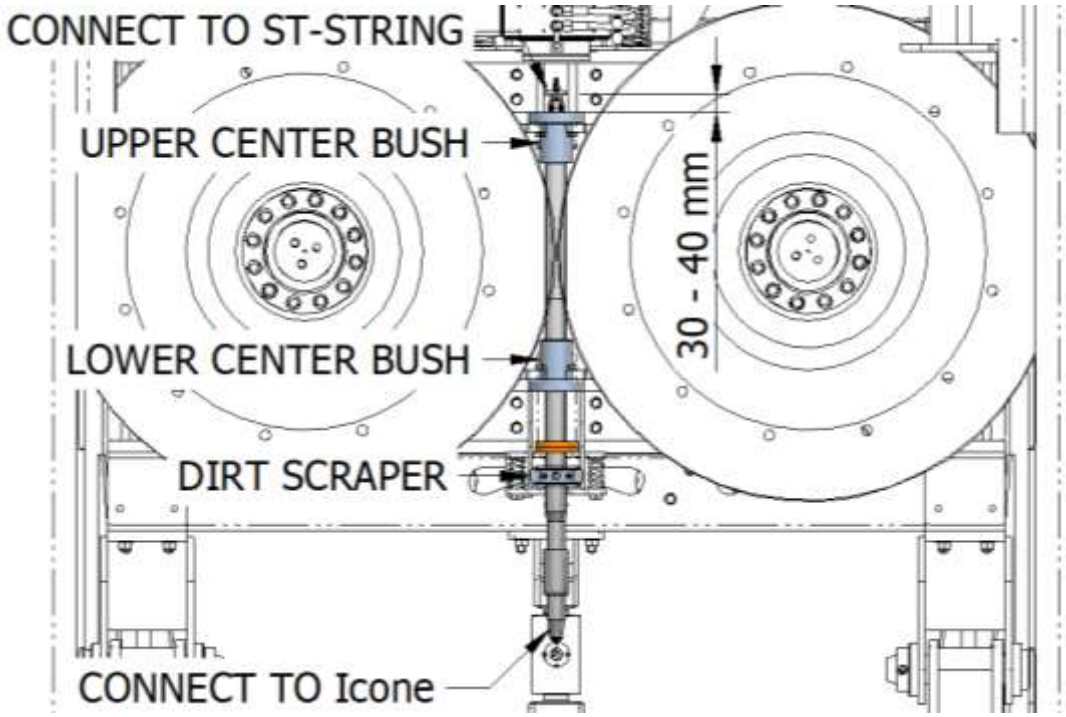
- Open the dirt scraper.
- Place the Start set between the drive wheels. If needed remove the spring tension of the encoder.
- Place back the dirt scraper.
- Make sure the spring tension of the encoder is set correctly (approximately 48 mm).



- Align the Start set with the upper center bush (ST connection about 30-40 mm above the upper center bush, see picture below) and tighten the dirt scraper.
- Clamp the drive wheels by pressing the "Clamp closed" button in screen B. Press "STOP" when the clamping pressure is reached, e.g. 130 bar.

Note: When pressing "STOP" the clamping pressure normally decreases 10-20 bar. Repeat the clamping procedure to get the required value.

Caution: The maximum pressure of the clamping cylinder is 200 bar. Higher clamping forces can result in damage of the drive motors. Also the life time of the ST string is reduced when using the maximum clamping pressure.



- Connect the Icone to the measuring cable or cross over.
- Turn the Icone with cable about 5 times anti-clockwise. The measuring cable is now twisted.
- Mount the cone on the CPT string.

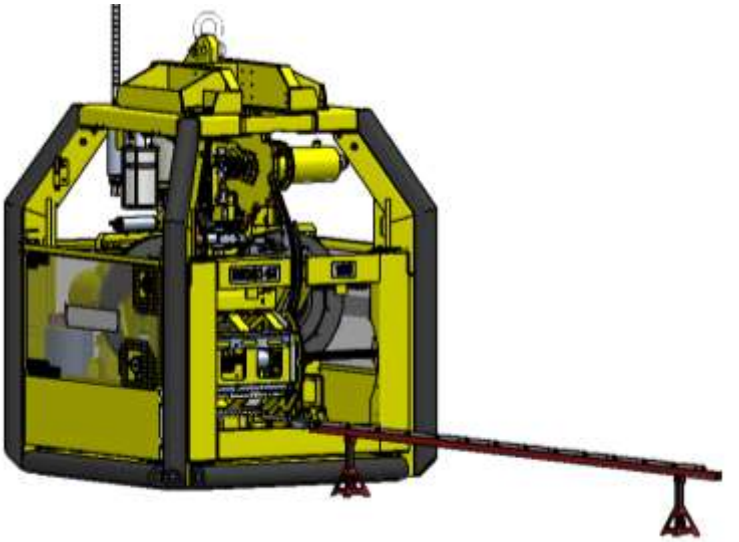
Note: Make sure the cone is prepared and de-aired according to the corresponding manual. A condom should be placed around the cone to prevent draining of the silicone oil from the pore pressure filter. In case of very soft soils it is recommended to remove the condom just before the system is launched in the water.

The start set is now ready to be connected to the ST string.

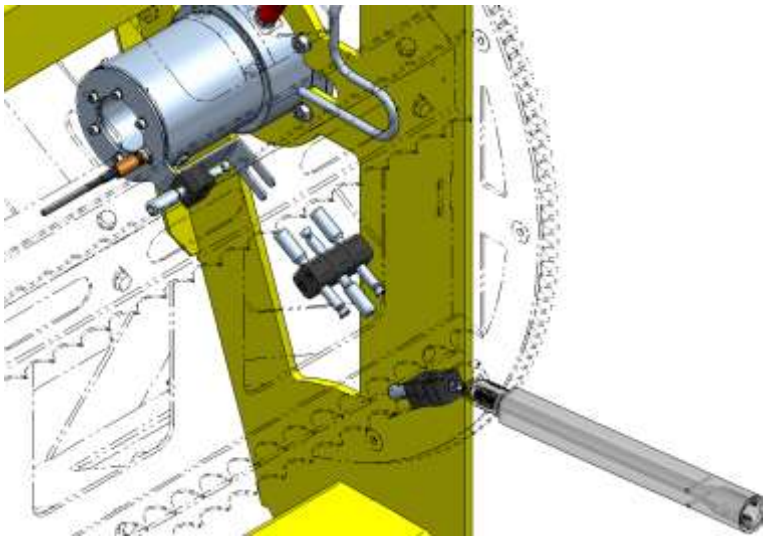
5.7 Place the End set and ST strings

In the following steps the End set and ST strings are placed on the folder and connected to the Start set. Determine which CPT length is required and place the required quantity of strings on the system.

Caution: Make sure the ST connections are clean and applied fully with TP42 grease. This will slow down corrosion significantly and improve the ST cycle. When the string was submerged in seawater it is advised to fully clean the rods with fresh water and re-apply the TP42 grease. See chapter "Service" for more information.

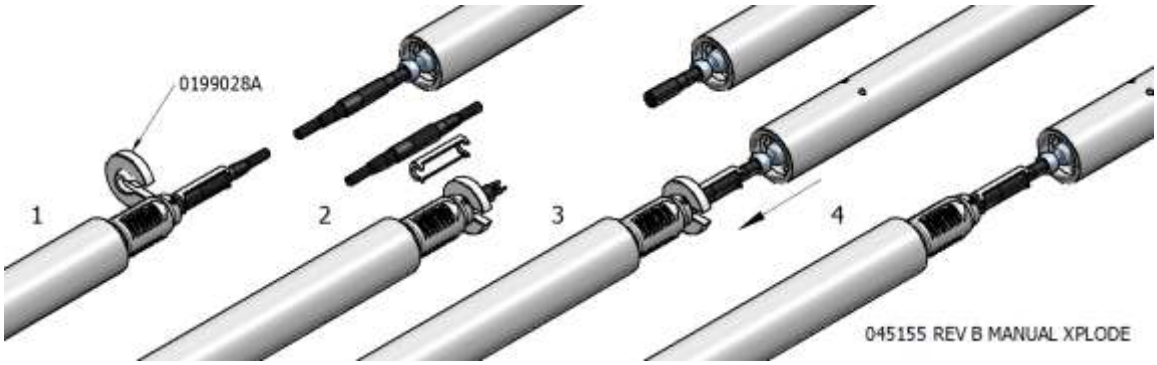


- Remove the small fences and prepare the ST string support.
- Make sure the starting point of the Folder is visible and aligned with the ST string support. Move the Folder to the correct position if necessary.
- Place an End set on the ST string support, connect the ball joint to the Folder drum with 2 clamps.
- Use 4 clamps to connect 3 ball joints inside the Folder drum, and 1 on the Slip ring unit
- Connect the 5 pin connector to the slip ring unit and ti-rap the cable to the Folder drum.



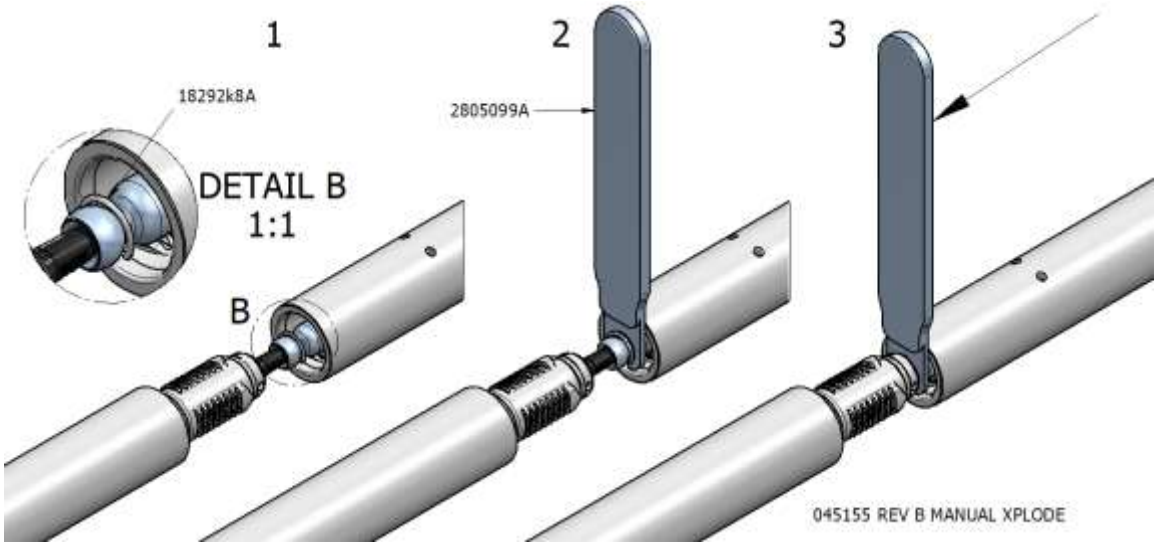
- Pull the End set on the Folder. This can be done manually, but also using the manual control on the HMI screen. Make sure to press the "STOP" button (instead of the "controlled STOP").

- Place a ST string on the ST string support.
- Connect the cable of the ST string to the cable of the End set.



Note: Use a little Molykote 44M on the female connector before mating the connector, this will lengthen the lifetime of the connectors. Plug both dummy connectors in each other to avoid dirt contamination.

- Connect the ball joint between both strings with a cir-clip (77680288).

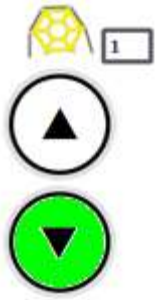


- Pull the ST string on the Folder.
- Repeat above actions till sufficient ST strings are connected.

Note: It is recommended to fill the ST folder only with the required length for the project. This to avoid life time reduction of the unused part of the string. For example when a push of 10 meter is required, place 5 or 6 ST strings of 2.8 meters.

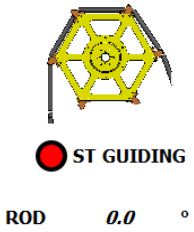
- Guide the other end of the ST string inside the Sprocket, and manually push the string inside the guiding and Twister.
- Connect the cable and ball joint between the ST string and Start set.
- Check if the cone is recognized by the Ifield software.
- Manually pull the Folder on tension and check the alignment between the ST string and ST tension guiding. If required re-adjust the Folder as described in chapter "Service".

- Push the ST rod on the Start set by pushing the sprocket.

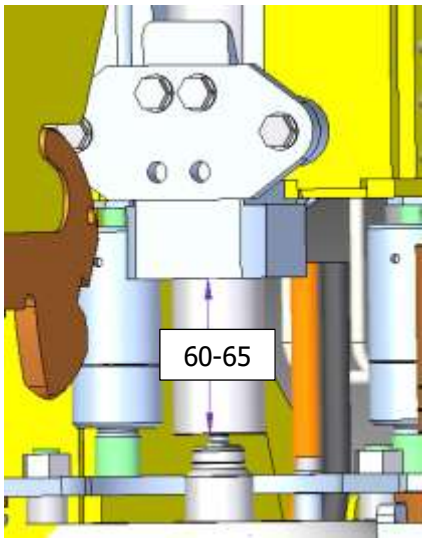


- Set the Twister to "Tight" position, Tighten the rod with the Twister, and check if the connection is OK. Press "Controlled stop" to inactivate the Sprocket and to keep the string on tension.

- Check the rod position, the Sprocket on the HMI should be in the same orientation as the Sprocket of the system.
- Check if there is sufficient clearance between deck-level and Icone. Push the drive unit till the sprocket is horizontal, and the rod position about 0°.



- Check the distance between the sprocket frame and the ST rod, this should be 60-65 mm. Push / pull the ST string till the distance is 60-65 mm. Ideal the Sprocket is in pull mode to make sure the Sprocket position stays in this position and all connection are under tension.



- Screen C: Slide the "Enable zero Sprocket" and press "Zero Sprocket".

- The rod position will become 0.0° and the rod number will become 0.
- Press "Pull" in screen A. During the Init pull the button will be orange, when the pull cycle is started the button becomes green. The system pulls till the friction reducer reaches the limit switch.
- Check the available CPT length below the Icone and press "Push" in screen A. When the Init push is ready the push cycle will start.
- Stop when the maximum available space is reached, ideal is a test run of 6 rods (2 meters push) to confirm if the ST cycle is performing OK.
- Pull the string back to the limit switch.

Note: Make sure the removed safety fences are placed back in position .

The system is now ready to perform a CPT test.

5.8 Cleaning / removing the ST string.

Following actions describe how to proceed after a CPT-test to clean and/or disassemble the ST string and start set. Proper maintenance will increase the lifetime of the ST string.

In case the system is not used for a couple of days, it is recommended to clean the ST string and start set with fresh water, this to remove the sea water to slow down the corrosion effect. If required the male threads can be cleaned to re-apply the grease (TP42).

In case the system is not used for a longer time, e.g. after a project is finished, we advise to clean the ST string and start set with fresh water, and disassemble the ST string completely. Clean the male and female threads, re-apply the grease (TP42) and store each string in the PVC liner with covers.

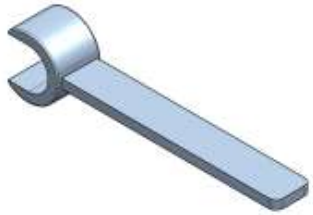
5.8.1 Cleaning the ST string

In the following steps the Start set and ST string is cleaned:

- Remove the Icone.
- Remove the ST string from the Start set, and remove it from the Sprocket.

Tip: Mark the position of the first ST rod on the Sprocket, in this case the rod can be placed back in the same position. The rod numbers will stay the same.

- Remove and clean the Start cable.
- Clean the inside of the Start set by flushing water. Clean the AR thread and ST connection and re-apply the TP42 grease.
- Ti-rap the ST string on the Folder, to be able to rotate the Folder.
- Flush 1 row of the vertical ST rods in the folder with fresh water (fill the female connections). If needed rotate the rods with the Wrench ST rod to create clearance for the water.



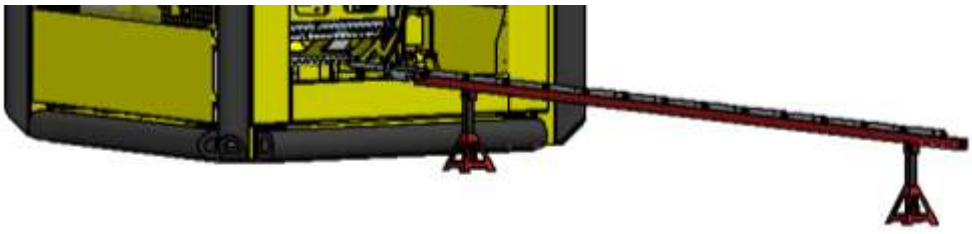
- Repeat this for the remaining 5 rows.
- Rotate the folder back to it's original position.
- In case the ST connections require new grease, the ST connections can be cleaned (e.g. with wire brush and cleaning cloth) during the flushing process described before. Apply sufficient grease (TP42) covering all the machined surfaces. To access all surfaces, the Wrench ST rod is used to rotate the rods.

Tip: As alternative it is possible to clean the ST connections (male and female) with a high pressure cleaner.

5.8.2 Remove the ST string

In the following steps the ST string is removed and re-packed in the PVC tubes.

- Flush the ST string with fresh water as described in the previous paragraph.
- Remove 1 ST string and lay it on the ST string support.



- Clean each ST connection (e.g. with wire brush and cleaning cloth) and apply sufficient grease (TP42) covering all the machined surfaces. Check the ST connections by manually tightening the rods.
- Hand tighten all rods and slide the string inside the PVC tube.

- Clean and degrease the connectors after disconnection. Use a little silicon grease before mating a dummy plug.
- Place the string under an angle and let the string dry for a while.
- Cover the PVC tube and store the ST string.
- Repeat this with all the ST strings on the Folder. (The ST connections of the end set are less critical, as these are not connected during the ST cycle).

Tip: Number the strings (e.g. rod nr. 1-8 + date; 9-16 + date; etc), this might be useful when analysing the ST connection data to determine the condition of each string.

5.9 Disconnecting the ROSON-ST winch and control box

Caution: Make sure the power supply is off (main switch (3) and umbilical power switch (15)) when the umbilical (termination) is connected to or disconnected from the junction box.

- Turn off the ROSON winch, main switch (3).
- Turn off the umbilical power, switch (15).
- Disconnect the two cables (power and communication).

Note: Clean and degrease the connectors after disconnection. Use a little silicon grease before mating a connector/cable/dummy plug. Place dummy plugs on the connectors to protect the connector against dirt and water.

- Spool the remaining umbilical on the ROSON winch.
- Fix the Termination safely on the ROSON winch frame.
- Cover the winch (or at least the umbilical) to avoid long-time storage in direct sunlight, see the Nexans handling guidelines for more information.

Chapter 6 CPT testing

CPT testing means you are making a CPT (Cone Penetration Test) with an electric cone assembly. The measured CPT-data is displayed and stored by means of the data acquisition system.

Before testing one has to read and understand the chapter "Safety Instructions".

Wear protective gloves, helmet, safety glasses, offshore overall and safety boots when performing the operations described in this chapter.

WARNING: Inform yourself as to where the electricity cables, communication cables, water pipes, gas pipes and sewer pipes are located underground before any testing takes place.

Item numbers in the text refer to components as described in the chapter named "Description and operation".

In this chapter it is assumed you are familiar with the operation of the ROSON-ST and the ROSON-ST is prepared as described in the previous chapter.

In all cases act as follows:

- Check all the connections between the Control box, the ROSON winch, the ROSON junction boxes, drive motors and sensors according to drawing 049855.
- Check the main power supply.
- Apply power to the Control box, both touch screen PC will start up.

Note: When the 230 VAC is applied, it takes about 1 minute before the VPN router is started and communication with the ROSON-ST is established.

- Switch on the ROSON winch (3) (mains on).
- Switch on the umbilical power (15).

Note: When the umbilical power is "ON" it takes about 2 minutes before the PLC is started.

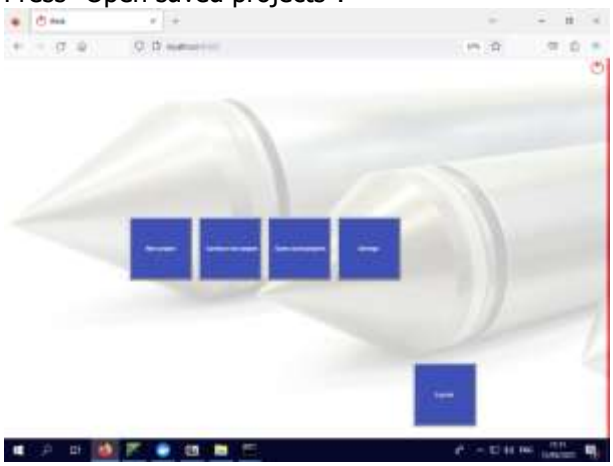
- Press "ON" on the HMI screen (Screen A).

Note: The start up cycle takes about 1 minute before the communication and drives are available.

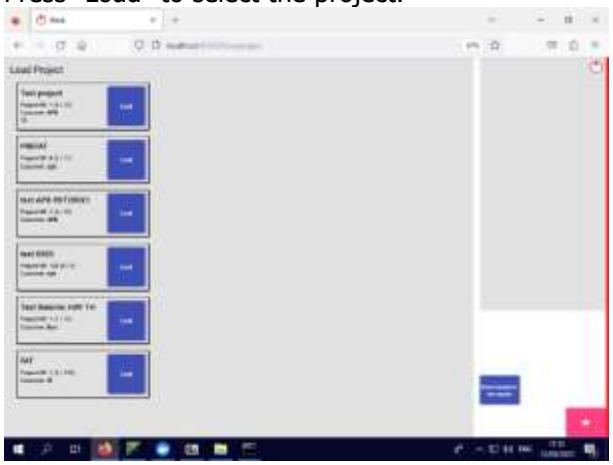
- Check the diagnostics/sensors (power, oil levels, temperatures, pressures, position sensors, limit switches).
- Start the Ifield software
  1. Press "play" in the "Docker" software
  2. Check "in use by you" in the "USB anywhere" software
  3. Press "start.bat" to start the background software.
  4. Check the two terminal screens: "compiled successfully", "back end" running
  5. Start the "Firefox" software to start the Ifield webpage

Tip: See Chapter 5.5 "How to prepare Ifield and check connected Icone modules".

- Press "log in"
- Press "Open saved projects".

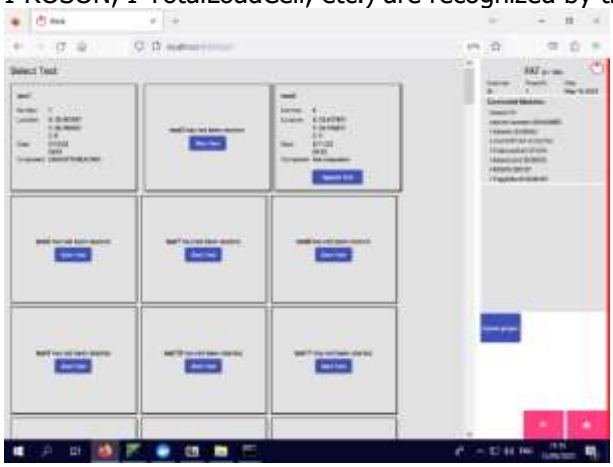


- Press "Load" to select the project.

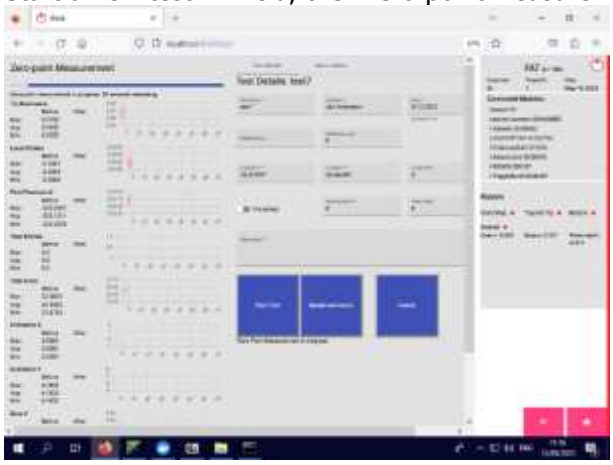


- Press "Continue project" to start the project.

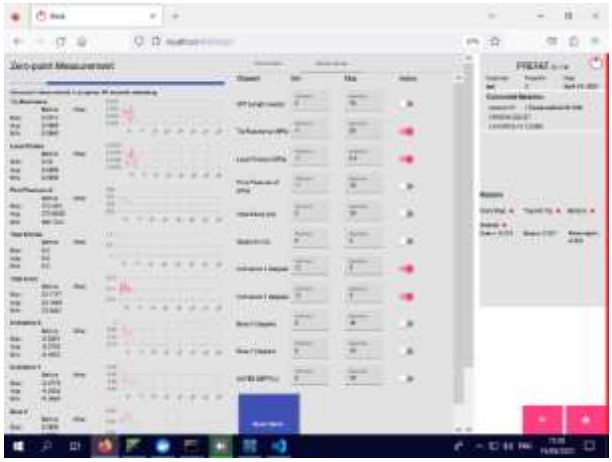
- Check in Ifield if all connected Icone modules (e.g. Icontrol V1, Icone (I-C2xFXYP100), I-ROSON, I-TotalLoadCell, etc.) are recognized by the Ifield software.



- Check if the ROSON is ready for deployment, as described in the previous chapter.
- Use the lower HMI screen to perform the Twister checks till "Twister check OK".
- Double check if the Icone is in the correct position (e.g. cone tip about 50 mm above the lower guiding) and if the rods are stored correctly on the Folder.
- Check if the CPT length is around 0 m, it is possible to zero the CPT length by pressing the "Zero CPT length" button (Screen C).
- Start a new test in Ifield, the "Zero-point Measurement" screen will appear.



- Prepare the Alarm levels in Ifield by pressing "Alarm values", these are depending on the project requirements, the ballast configuration and stability/inclination of the frame on the Seabed.



Note: When starting in unknown conditions, it is advised to start with low alarm levels. Safe values are around 50 kN Total force, 30 MPa tip resistance and 5° cone inclination. When reaching one of these alarm levels the levels can be increased based on experience.

Note: The alarm levels can be set for the "minimum" and "maximum" value. To ignore an alarm on the "minimum" value, you can choose high negative values like "-100" (or eg. "-10000" for Pore pressure).

Note: The alarm levels can also be set during a CPT. Make sure to "Inactivate" the channel before changing the value. This to avoid a unwanted alarm.

Note: When setting the alarm levels, use a "dot" as decimal sign. In case a "comma" is used, the setting field will turn red.

- Check the cone signals for value and stability, after 60 seconds the average value can be written down as the "zero-values deck level".

Note: Wait 15 minutes before starting the testing process. The load cells and electronics inside the cone and sensors need to warm up, the 15 minutes start from the moment the Icontrol ROSON-ST is powered ("ON" screen A).

Note: Always closely watch the cone resistance, cone inclination, total force and the base inclination during testing. When the cone resistance/inclination/total force/base inclination increases suddenly, there is a serious risk of bending or breaking the CPT string.

Note: The preferred stop is pressing the white "Controlled STOP" button, the drive unit will stop and the Folder + Sprocket pull the ST string on tension. The controls (except STOP) are disabled during this process.

Note: By pressing the black "STOP" button, all movements will stop, the SHPU will restart automatically. This can be used in case of an unwanted situation where all movements should be stopped as soon as possible.

- **Caution:** Make sure unauthorized persons are at a safe distance of the ROSON and the winch and stay there. **Never stay in the line of cables under tension!!!**

6.1 Lowering the ROSON onto the sea bottom.

Before the ROSON can be lowered onto the sea bottom it must have been prepared as written in chapter 5 "Preparing the ROSON-ST before use" and the preparations of the previous paragraph must have been done.

The way of lowering the ROSON onto the seabed depends on the size and type of the ship. In general you have to deal as follows:

6.1.1 Lowering the ROSON onto the sea bottom.

Before lowering the ROSON into the sea water, start up a new test in the Ifield software and make sure the "Zero-point Measurement" is active. Monitor the "zero values" during lowering.

- **Note:** To avoid damage onto the vessel use always bumpers between the ROSON-ST 200 and the vessel.

- During lowering you have to pay attention to the position of the CPT string. When the cone is outside of the ROSON it can damage easily.

- Attention must be paid to the fact that the speed will not become too high; in case of a high speed the ROSON might tilt. So it is important to check the inclinometers during lowering.

- Use the base inclinometers to place the ROSON levelled on the sea bottom. Is the angle of one of the base inclinometers more than 5°, lift the ROSON for a few meters and place it back on the same place. In case the situation doesn't improve the ballast configuration should be reconsidered.

- Double check the ballast configuration vs. the angle of the base inclination in the graph of chapter 5.1. Don't overload these values, the ROSON will turn over or slide. For the ST operation we advise not to exceed the 5° angle.

- The maximum pushing force depends on the own weight of the ROSON in seawater, including ballast, minus the constant tensioning force.

- Before you start a test be sure the ROSON is in a stable situation on the seabed.

6.2 Performing a CPT test

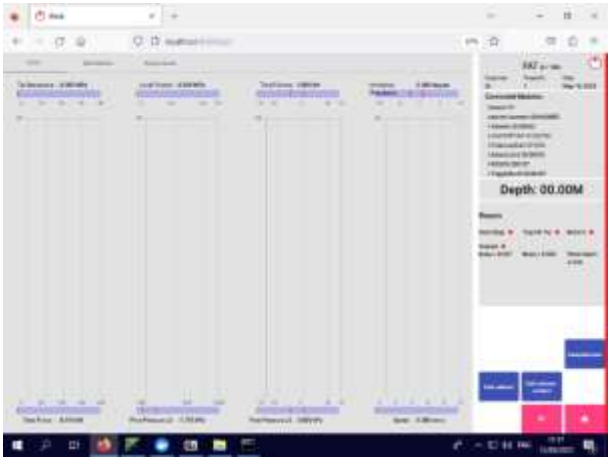
- Inform yourself as to where the electricity cables, telephone cables, water pipes, and gas pipes are located underground before any testing takes place.

Note: Always closely watch the cone resistance, cone inclination, total force and the base inclination during testing. When the cone resistance, inclination, total force or base inclination increases suddenly, there is a serious risk of bending or breaking the CPT string.

- Make sure unauthorised persons are at a safe distance of the ROSON winch and stay there.

- When the ROSON-ST is placed stable on the seabed and the inclination is as small as possible and within 5°, you are ready to perform a CPT test.

- Make sure the cone is not preloaded (not touching the seabed), and wait at least 60 seconds after the ROSON-ST is placed on the seabed. Press "Start test" in Ifield to take the zero offsets. The test is started in Ifield.

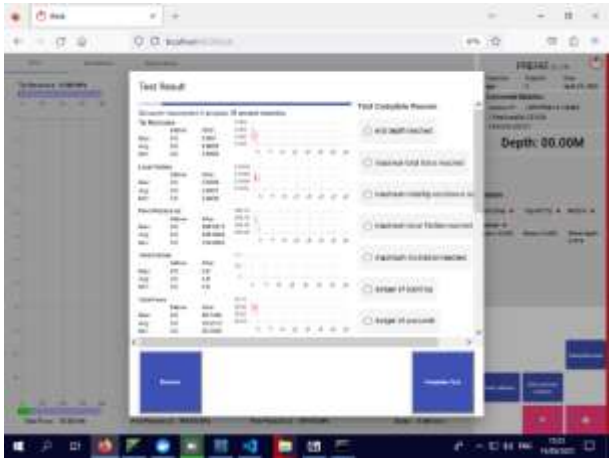


Note: Avoid using "Complete test", "Back" and "Home" button during CPT testing.

- Push the CPT string down by the "Push button" the HMI screen A, the button will turn from white to orange when the Init cycle is started. The button will turn green when the penetration has been started. You will see the depth counting (HMI and Ifield) and the cone values in Ifield should increase.

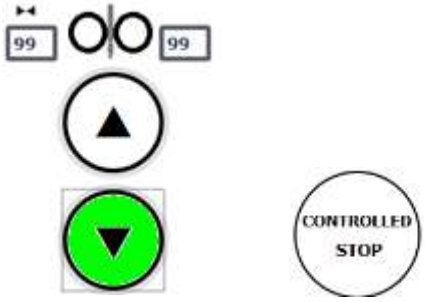
- Stop the test when one of the stopping criteria is reached. Depending on the project stopping criteria can be defined. An example of these criteria are: max. cone resistance, max. base inclination, max. total force, max. penetration depth, or a combination of these criteria. Stop the ROSON by pushing the "Controlled STOP" button.

- Press "Complete test" to stop the test in Ifield, the zero-values screen will appear.



Caution: When changing the ST cycle from "push" to "pull" direction, there is a small risk of a "locked rod". In case of high pushing forces (>150 kN) the ST string will bounce back when the drive unit is stopped, this behaviour increases the risk of a "locked rod".

Note: To reduce the risk the following corrective action can be performed:
Screen B: Push the drive unit (without Sprocket/Folder) for about 80-100 mm (4-5 seconds) and press "Controlled stop". Check the "ST tension" and "rod position" while moving the drive wheels.



Note: In case the rod is not locked, the sprocket (rod position) will follow the drive unit directly, in case the rod was locked the sprocket will have a short delay (or even move in the opposite direction) before following the drive unit. The ST tension will increase, as the Folder is not following the Sprocket rotation.

Note: Using above corrective action (which is without a Twister action) the string might be pushed beyond the check point (< 0°) to tighten the ST connection. Always follow the corrective action with starting the pull cycle.

Note: When you have stopped the test at a high total force or tip resistance, but decided to proceed the test by pushing further, pull the string a little before you continue pushing. Pulling back for about 1 or 2 meters will reduce the friction around the CPT string and might result in deeper penetration.

Note: When the maximum length of string is reached, the ST tension sensor will stop the ROSON.

- Start the pull cycle to retrieve the CPT string.

Caution: During the pull cycle it is advised to keep an eye on the untightening torques. In case the values exceed the 400 Nm it is advised to clean and re-grease the rod connections. In case the value exceeds above the 450 Nm there is a risk the Twister is not able to untighten the rods.

- When the complete CPT string is retrieved it is stopped when the "bottom switch" is activated. In case a minimum alarm is set for "CPT length" at "0 meter", the Ifield alarm will stop the system near the same position where the cone is started.
- Select the "Test Complete Reason".
- Check the differences between the average "Before" and "After" values to confirm the cone is not over-stressed during the CPT test.
- When the cone is retrieved, and unloaded for 60 seconds, press "Complete test" to take the zero values.
- The Test is now ended in Ifield.

Note: In case "Append Test" is required to restart a test due to an error with the system/software, the Ifield needs to be restarted (close terminals, press "start.bat"). A "Completed test" (including completion reason) is not able to append.

In case the ROSON system is pulled back to deck, a new test can be started to log the data between the seabed and deck level. This data can be used as "offshore logging".

It is also possible to perform another test near to the spot you've done without bringing the unit back to deck. In this case the ROSON is pulled for a safe distance from the seabed (eg. 100 meter) and moving to the next spot.

- After two or three tests (to be learned from experience) the ROSON must be brought back to deck level in order to replace the Icone due to the condition of the pore pressure filter. Also check if the umbilical is entangled and/or if the ROSON has rotated around its vertical axis.

- After eight to ten tests (to be learned from experience) the ROSON must be brought back to deck level in order to maintain the ST connections. Clean and re-grease the connections to avoid too high untightening torques during the pull cycle.

- When the ROSON system is back on deck (or at least out of the water), press "Complete test" in Ifield and take the deck level "zero values".

Note: Always be sure that there are no facilities near to the ROSON-ST 200 where the cables can ensnare.

Chapter 7 Seismic testing (Optional)

Seismic testing means you are making a CPT (Cone Penetration Test) with an Icone and one or two seismic modules. The CPT test is paused at different depths to measure the travel time of a seismic wave through the soil.

Before testing one has to read and understand the chapter "Safety Instructions".

Wear protective gloves, helmet, safety glasses, offshore overall and safety boots when performing the operations described in this chapter.

WARNING: Inform yourself as to where the electricity cables, communication cables, water pipes, gas pipes and sewer pipes are located underground before any testing takes place.

Item numbers in the text refer to components as described in the chapter named "Description and operation".

In this chapter it is assumed you are familiar with the operation of the ROSON-ST and the ROSON-ST is prepared as described in chapter 5. You are familiar to perform a CPT test as described in the previous chapter.

7.1 Prepare the ballast configuration, drawing 049558

Make sure the ballast configuration is prepared as described in chapter 5. See also drawing 049558 for more information.

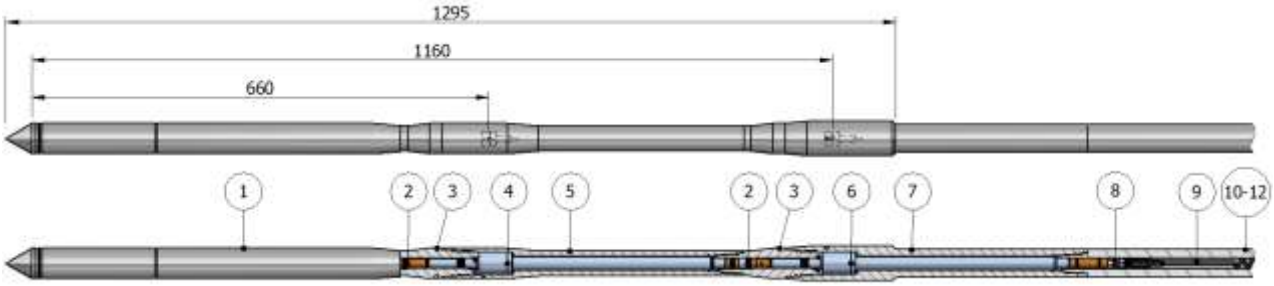
Makes sure the Seismic source is ballasted correctly to match the ballast configuration of the ROSON system. For the ROSON-ST 200 the surface pressure of the unit is about 25 kPA, which corresponds with one “bottom plate ballast” and four times a “ballast plate 25 mm”.

Caution: When the Seismic source is used the maximum pushing force is limited for two reasons: The center point of gravity is higher, causing a decrease of reaction force when the unit is tilted. The weight of the Seismic source is suspended, so will not be used as reaction force when the unit is placed on the seabed. For more information, see chapter 5.

7.2 Prepare the ST start set, drawing 049754

Prepare the ST start set for Seismic testing. See also the Icone Seismic manual, chapter 3 of this manual and drawing 049754.

Make sure the orientation holes of the Seismic sensors are aligned as described in the Icone Seismic manual.



7.3 Sensor displacements

The seismic sensors are placed at different positions. This means that displaying the measuring data to depth, the sensor displacement should be taken into account. Sensor displacement is measured from the cylindrical part of the Icone, immediately following the conical part of the cone tip.

Icone 10:

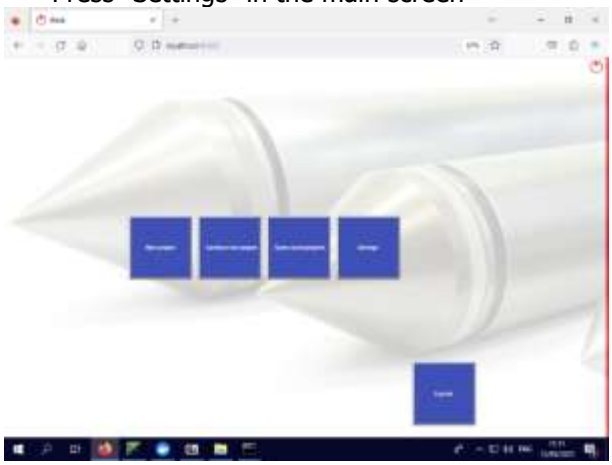
- Seismic sensor 1 530 mm
- Distance (between 1&2) 500 mm

Icone 15:

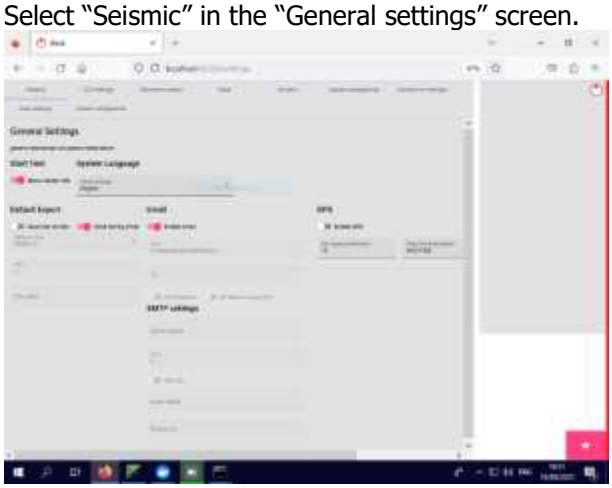
- Seismic sensor 1 660 mm
- Distance (between 1&2) 500 mm

The sensor displacement can be adjusted in the setting screen.

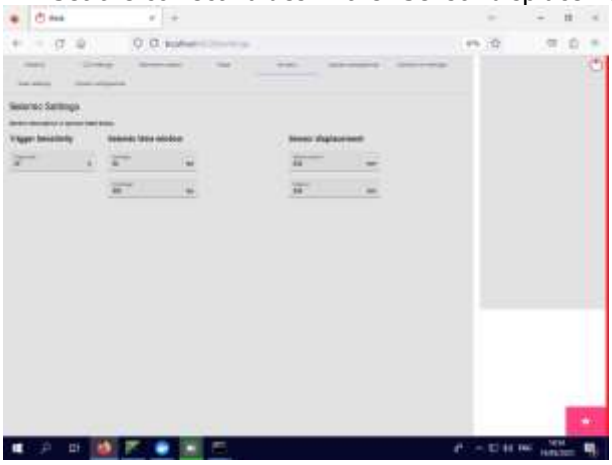
- Press "Settings" in the main screen



- Select "Seismic" in the "General settings" screen.



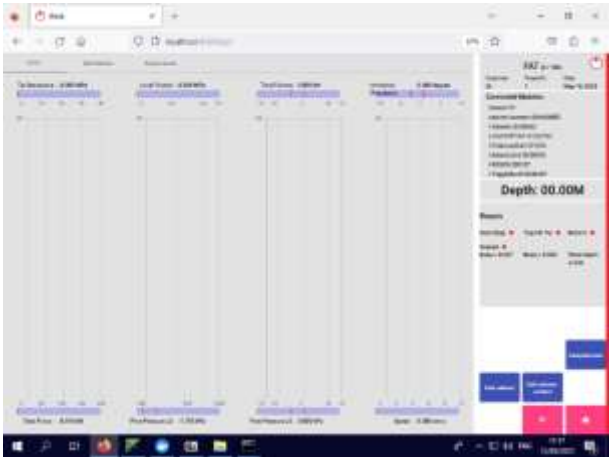
- Set the correct values in the "Sensor displacement" area.



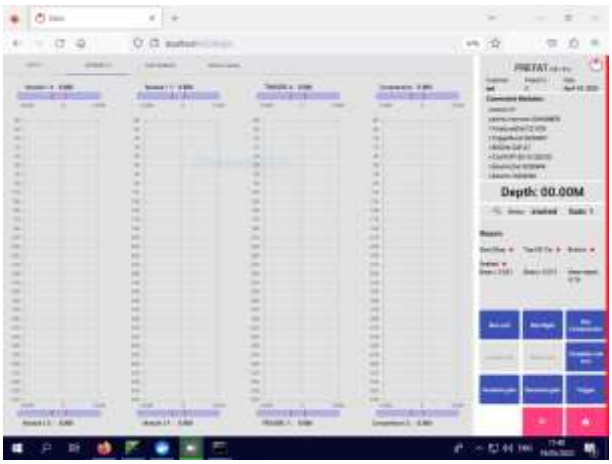
7.4 Perform a check at deck level

When all preparations are performed as described in the previous paragraphs, the system should be checked at deck level.

Make sure all Icone modules which are connected to the system are recognized by the Ifield software. Check the stability of the signals in the zero screen.

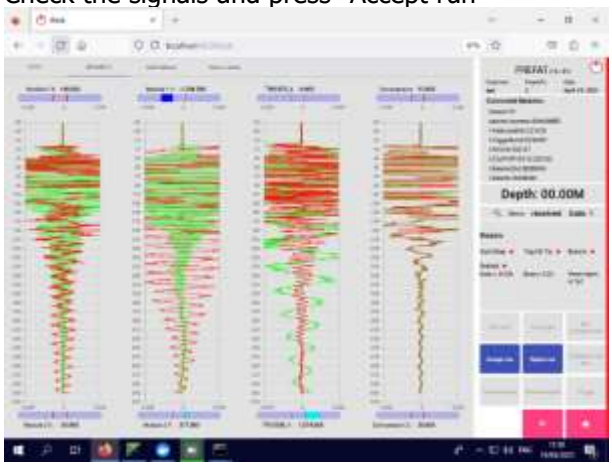


- Press "Add seismic subtest".



- Press "Run Left", after about 30 second a "Trigger received" message appears, and all modules are transferring the seismic data.

- Check the signals and press "Accept run"



- Repeat above for "Shear Right" and "Compression"

Make sure all hammers (shear left, shear right and compression) are functional. Check the received trigger sensor data to confirm the quality and consistency of each wave.

7.5 Perform a seismic test

Before the ROSON and Seismic source can be lowered onto the sea bottom the preparations of the previous paragraph must have been done.

Perform a seismic test following the next steps:

- Lower the ROSON and perform a CPT test as described in chapter 6.
- Stop the ROSON drive unit when the first test depth is reached for the Seismic test.
- Press "Add seismic subtest" to start a subtest Seismic in Ifield.
- Press "Run Left" to generate a wave with the shear left hammer.

Note: Adjust the gain in case the signal amplitude is too low / high.

Note: To improve the signal / noise ratio, the signal can be "stacked" by generating additional waves with the shear left hammer.

- Check the seismic data and press "Accept run" to accept the seismic signals.
- Repeat this procedure for "shear right" and "compression".
- When all seismic waves are recorded, the seimic subtest is ready.
- Press "Complete subtest" to return to the CPT and push till the next depth.

The seismic tests can be performed in 0,5 or 1,0 meter intervals, to create a full seismic profile.

Chapter 8 Vane testing (optional)

8.1 Purpose of the equipment

The field vane test is used to determine undrained shear strength s_u of cohesive soils, by pushing a rectangular vane body into cohesive soil and rotating it. During rotation the torque and rotation can be measured, depending on the test type. From the measured torque and the dimensions of the vane, the undisturbed shear strength, the residual shear strength and the remoulded shear strength can be derived.

The equipment is designed and built according to EN ISO 22476-9 (2010), ASTM D-2573-08, DIN 4094-4:2004, NEN 5109:1980, NORSOK G001:2004 (only Vane 80x40x2, 110x55x2, 130x65x2) where applicable. This relates also to this manual.

8.2 Working principle

The vane is pushed at the desired depth in undisturbed, soft soil.
Caution: Be aware that a vane easily can be damaged if it is used in hard soils.

As described in standard ISO 22476-9 the operator has to start the vane test 2 minutes after the vane is pushed to the test depth, but within 5 minutes.

When the Icone vane drive unit is connected to the Icontrol data logger, the system is ready to start a vane test.

During the vane test the vane turns clockwise and undergoes the resistance of the soil. This resistance is measured by the torque transducer. Depending on the stiffness of the soil, different sizes of vanes can be used. A small vane for stiffer soil and a bigger vane for softer soil. When the soil is too hard or the chosen vane too big, the vane blades can damage easily. See next paragraph for a table of maximum allowable torque loads on different sizes of vanes.

The vane and the torque measuring device are directly connected to each other, so the test will not get subjected to any other force or torque.

After finishing the test, the Icone vane can be pushed to the next test depth, or retract the system to the seabed level.

The Icone vane is controlled by Ifield which is installed on a laptop.

8.3 Maximum torque on available vanes

Caution: Be aware that the vane you are using has a limited strength. The torque of the drive unit is able to bend the blades of the vane. Especially in non-homogeneous soils the vane blades could easily be damaged by stones etc. Use the vanes with a larger diameter for soft soils and the vanes with a smaller diameter for the stiffer soils. In next table and on the table on drawing 008145 or 008147 you can read out the maximum allowable torque for the different types of vanes. During the test you have to check this value at the screen and stop the test immediately when the measured value is reaching the maximum allowable value. You can use alarm levels in the Ifield software that will stop the drive unit at a pre-set value.

In case the soil is not sheared off during the vane test, because the maximum torque load is reached, the system has to be retracted to downsize the vane.

Vane size mm (H x D x t)	Item number	Max. torque load Nm	s_u at max. torque kPa
60x30x2	-	27	275
80x40x2 (standard)	2100105B	36	155
88x44x2	2100108B	40	128
100x50x2 (standard)	2100102B	45	99
110x55x2	2100106B	50	82
130x65x2	2100107B	59	59
150x75x2 (standard)	2100101B	68	44

8.4 Duration of undisturbed, remoulding and remoulded phase

Your Icone vane is equipped with two speeds of rotation. During the undisturbed phase where the undisturbed shear strength is been measured, the rotation speed is 0.2 °/sec. When the vane is rotated for 180° as described in standard ISO 22476-9, the undisturbed phase will take about 15 minutes.

During remoulding the rotation speed is 12 °/sec maximum. However depending on the torque load on the vane and the total cable length that is used, the actual speed will be between 4 and 12 °/sec. This means that a full remoulding of ten revolutions as described in above mentioned standard, will take 5 to 15 minutes.

During the remoulded phase the vane is rotated at 0.2 °/sec for 180° again. This will take another 15 minutes.

8.5 Accuracy and recalibration

The sensor used for torque measurement inside the Icone vane has an accuracy of 0.2 Nm. When calibration and system faults taken into account the overall Icone vane system has an accuracy of at least 0.5 Nm. For measurements of the rotation angle, the system accuracy is at least 1 degree. According to the application classes that are described in various standards the Icone vane tester is suitable for all test situations.

A new calibration should be carried out after tests have been done under difficult conditions when the Icone vane system has been loaded close to or over its maximum capacity. A recalibration is also needed when the measuring system reading is significant before start of the test at zero load.

A periodic recalibration of the Icone vane is recommended. The criteria for recalibration have to meet the requirements of your quality system. For example a certain time period can be used or a certain number of tests performed.

8.6 Prepare the ROSON for Icone vane

This chapter describes preparing ROSON and the Icone vane tester before use.

Before you start working, you should have read and understood chapter "Safety Instructions".

Wear protective gloves and safety footwear when performing the operations described in this chapter.

WARNING: Inform yourself as to where the electricity cables, telephone cables, water pipes, gas pipes and sewer pipes are located underground before any testing takes place.

Caution: Make sure the Icone vane tester is pushed in soft soils. The vane blades can be damaged easily by pushing the Icone vane tester through hard layers.

Note: The vane should stay undamaged during the test. The blades should stay parallel with the extension rods and no distortion of the rods is allowed. Inspection of the vane condition in relation to the mentioned aspects should be performed prior to each test or series of tests per location.

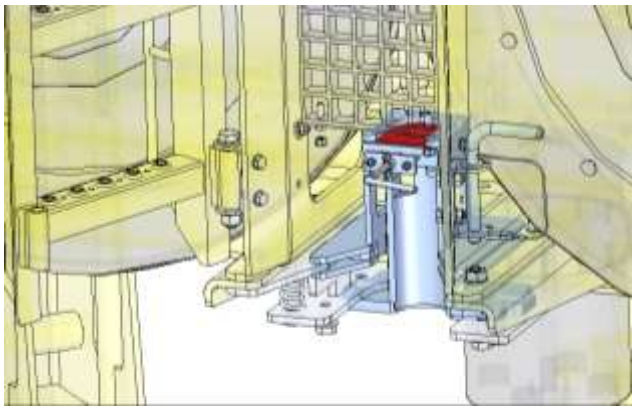
Tools for Icone vane		
Item No.	**Description**	**Qty.**
-	Torque wrench 20-100 Nm /w 17 open end fitting	1
-	Spanner 17	1
-	Vane connection tool	1
70700890	Allen key 5	2
70700768	Hook Spanner 34/36	1
70700770	Hook Spanner 45/50	1
70700771	Hook Spanner 58/62	1

Make sure the ROSON frame is configured with sufficient ballast plates. At least 200 mm free space below the ROSON frame is required to create space for the extra length.

Open the safety fence on the front, make sure the other safety fences are mounted and closed. There should be only one operator inside the ROSON frame with the handheld control.
Make sure the handheld control is connected to the control unit, in this situation the drive wheels can only rotate using the handheld. Always make sure the ROSON drive wheels are not rotating when adding CPT rods.

- Remove the Icone and friction reducer from the CPT string. Use protection caps for the connectors.
- Remove the dirt scraper clamp and the two conversion plates from the lower limit switch.
- Remove the anti-buckling ring.
- Move the CPT string upwards by rotating the drive wheels with the handheld. Make sure there is sufficient space to add the vane scraper housing.

- Place the vane scraper housing and the vane center plate 2. Open the dirt scraper to make sure the CPT rod can be pushed through.



- Move the CPT string downwards by rotating the drive wheels with the handheld. The CPT rod should be just below the vane center plate.

- Prepare the Icone vane drive unit, make sure all parts are clean. See also drawing 008145.

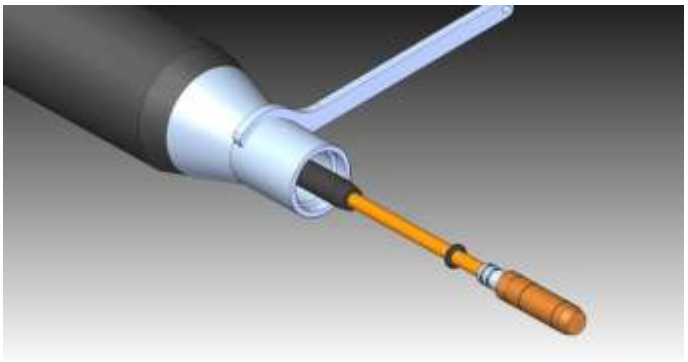
Connect the measuring cable on the Icone vane drive unit and place the Subconn lock ring.

Note: Use a little silicone grease on the rubber for better fitting.

Use protection caps on the cable to prevent damage of the connector.

Screw the cross over 36-AR on the Icone vane drive unit.

The Icone vane is now ready to be pushed unprotected into the soil or into a pre-drilled hole.

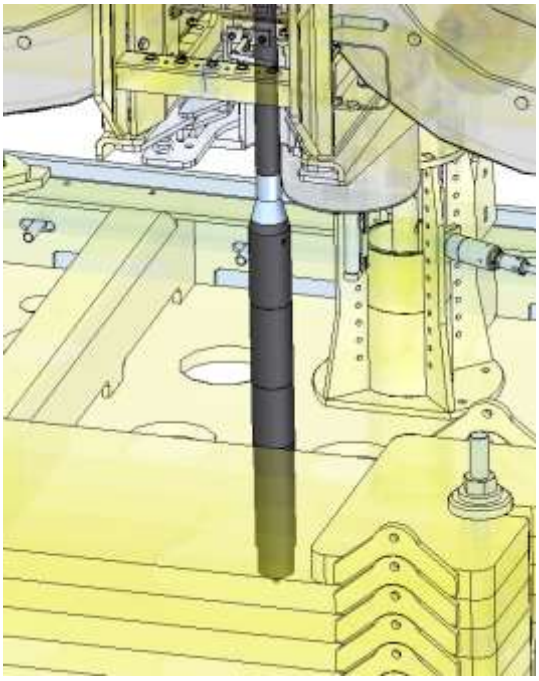


- Connect the measuring cable from the CPT string to the measuring cable on the Icone vane drive unit.

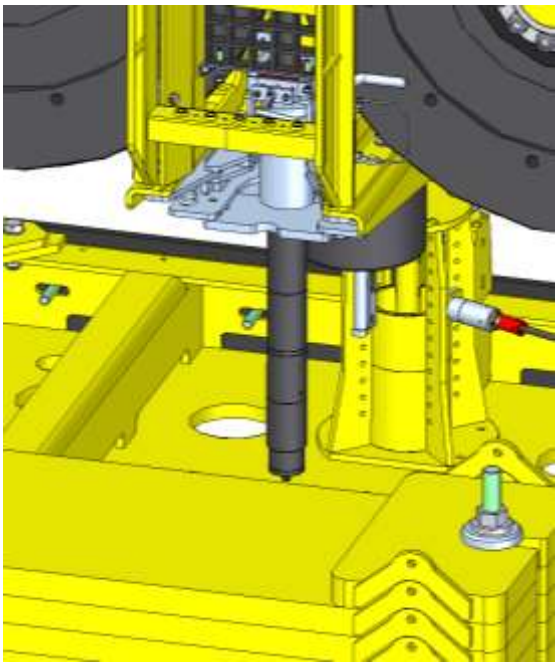
- Pull the over length of the measuring cable through the cable track.

- Turn the Icone vane drive unit with cable about 5 times anti-clockwise. The measuring cable is now twisted.

- Mount the Icone vane drive unit on the CPT string. Properly tighten the CPT rod connection.



- Connect the measuring cable to the junction box, and check the Icone vane signals in the Ifield software. Check the Icone vane drive unit by performing a new test (Nm) in Ifield, check the low speed and high and the "zero" torque values.
- Ti-rap the over length of the measuring cable on a safe place in the frame.
- Place the vane center plate 1 of the Icone vane adaption set.
- Tighten the dirt scraper.
- Move the CPT string upwards by rotating the drive wheels with the handheld. The drive unit should almost hit the limit switch.

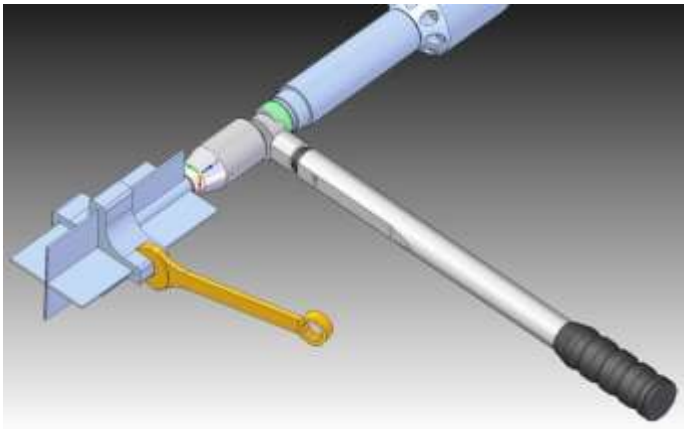


- Assemble a vane on the Icone vane drive unit.

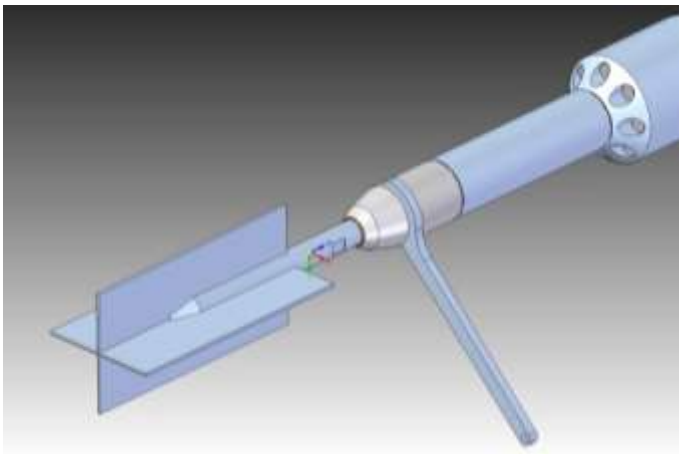
Choose a vane size for the soil type to investigate, use the table of the previous chapter for the available vane sizes and its characteristics.

Make sure the vane and extension rods are firmly tightened with the max. torque according to this table.

The vane size has to be marked in the data acquisition system, see the Ifield manual.

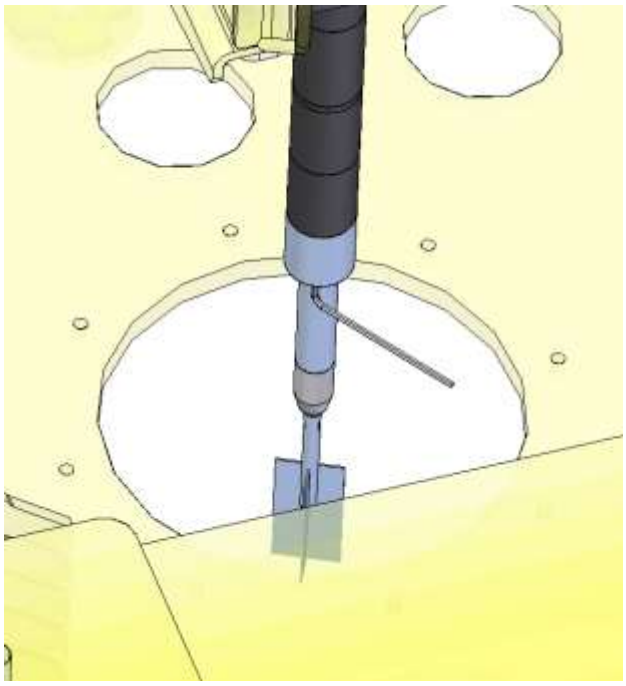


Connect the front bearing

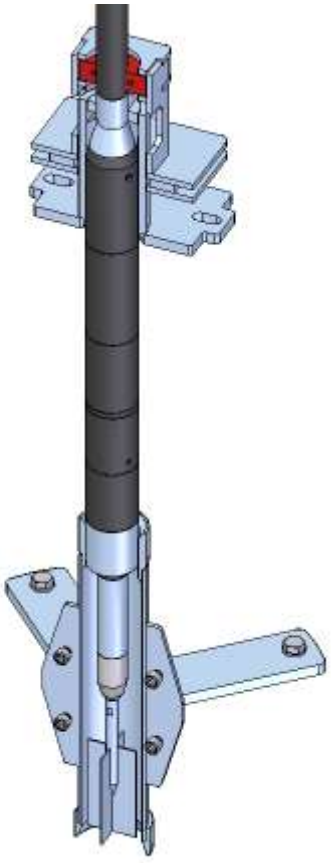


Assemble the guiding tube on the Icone vane drive unit.

Thighten the four M6 bolts.



- Place the anti-buckling support vane.



- Double check the Icone vane drive unit to check the "zero" torque values. The vane should run freely in the anti-buckling support vane.

8.7 Taking zero-values from Icone vane

To perform an accurate measurement it is necessary to take zero readings of the Icone Vane before use. When taking zero readings it is important that the Icone Vane with the vane blade used for the test is running idle in air or when testing offshore at a water depth directly above the seabed floor. During zero-ing the friction of seals, bearings, etc. is measured and registered. These friction loads are compensated during the vane measurement so the output shows only the load values needed to shear off the soil.

It is highly recommended to take also zero readings after the vane test. When doing so, you are able to compare both zero-values. The difference of the two values is a measure for the influence of pollution and possible overload during the test. In practice, there will always be a difference value. We advise to consult the standard for vane testing you use to assess when a test result may be approved or not.

If the zero-value is significant even after the Icone Vane has been cleaned, vital parts may be damaged by overloading. Please contact A.P. van den Berg if repair and recalibration is needed. See also the previous chapter about accuracy and recalibration.

8.8 Performing a vane test

This chapter explains performing a vane test with the Icone vane tester in combination with a pushing device. Vane testing means you are testing with an electric vane assembly and that readings are recorded by means of a data acquisition system.

Before testing one has to read and understand the chapter "Safety Instructions".

Start a vane test in the Ifield Software, see the Ifield User manual for more information.

- Setup an Icone vane test with the Ifield software, see chapter 5 in the Ifield manual. Set the rotation velocity of the drive unit to slow (0,2 °/s) and start a test.
- Look at the data acquisition system and watch until the soil shears off.
- You are able to abort a test at any time and start a new test.
- After a test, the vane tester can be pushed to the next depth of investigation or the system can be totally retract from the soil.

Chapter 9 Service

When ordering spare parts we need the following information:

1	Machine-type	This machine: ROSON-ST 200
2	Order number	See identification tag
3	Drawing number or item list showing the part	If present
4	Amount, length or amount of litres	
5	Item number	If known
6	Item list description	If present
7	A.P. van den Berg Ingenieursburo part number	If present
8	OEM part number	If present
9	Method of shipment	As specified by customer
10	Mailing address	
Orders by phone require written confirmation All orders are subject to our delivery and payment conditions.		
Our address is: A.P. van den Berg Ingenieursburo Postbus 68 8440 AB Heerenveen The Netherlands		IJzerweg 4 8445 PK Heerenveen The Netherlands
Tel. +31(0)513 63 13 55 E-mail info@apvandenberg.nl		

Note: When you order any after-market parts specifications have to match those of the original equipment parts.

This chapter describes the service requirements for the equipment. Do take time to read this chapter carefully. If you stick to the service requirements you assure yourself of satisfying performance of the equipment for years to come.

The service schedules of the different parts are shown on the next few pages. More information on servicing follows these schedules.

SERVICE SCHEDULE All service work to be performed at operating temperature		Operational hours			
		10	50	250	500
1	General overview of system (damage, loose bolts, oil leaks, etc...)	X			
2	Check the condition of the umbilical cable(s).			X	
3	Check for leaks on pipes, tubes, etc. **Note:** While assembling the rod string, make sure the other part does not rotate.		X		
4	Check hydraulic oil and replace if sample test results indicates replacement.			X	
5	Check for oil leaks on hydraulic piping / hoses. **Note:** Replace hydraulic hoses after 5 years.	X			
6	Pressure check hydraulic controls.			X	
7	Check the condition of the drive wheels.			X	
8	Check mounting of the drive units.			X	
9	Check and or replace the dirt scrapers.	X			

SERVICE SCHEDULE All service work to be performed at operating temperature		Operational hours			
		10	50	250	500
10	Check and or fill the compensators	X			
11	Check and or repair the frame.			X	
12	Check and or adjust the clamping cylinder.		X		
13	Overall check for damage, cracks, tears, leaks, etc. in the whole system.	X			
14	Check and or adjust the depth encoder.		X		
15	Check and or adjust the limit switches.		X		
16	Check and or calibrate the total load cell.			X	
17	Check and or calibrate the Iroson base XY/water depth			X	
18	Check and or replace the electric cables.			X	
19	Check the junction box(es) on leakage and connections.	X			
20	Check and or adjust the Twister and its sensors	X			
21	Check and or adjust the Sprocket and its sensors	X			
23	Check and or adjust the Folder and its sensors	X			
24	Test run.		X		
25	Check the spare parts.			X	
26	Check or replace the warning labels and operating instruction labels.			X	
27	Clean the CPT rods.			X	
28	Reconfigure the CPT string (to make sure equal wear of CPT rods).			X	
29	Clean the cone assemblies.	X			
30	Test the cone assemblies and the measuring instruments.		X		
31	Check electrical installation			X	

9.1 General information

People assigned to service and repair the equipment should read the chapters dealing with the service and repair before they get started doing so.

Note: No alterations shall be made to the equipment that can endanger safety such as removing safety features or safety valves or by any welding to the frame. If there is a need for alterations you should consult A.P. van den Berg Ingenieursburo first.

All tools have to be suitable for routine servicing.

Caution: Service and repair work should only take place when the equipment has been shut down completely. Make sure there is no chance the electric motor(s) can be switched on by accident when performing any service or repair work.

Caution: There should be no hydraulic pressure in tubes or hoses when performing service or repair work.

Damaged or worn out parts should be replaced.

Pay close attention to proper installation of the parts.

Make sure all danger and instruction labels stay legible, replace if necessary.

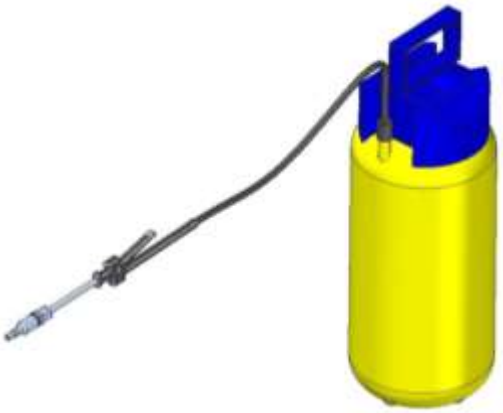
Torque the bolts and nuts down with the moments as shown in the table below.

Torque [Nm]															
Bolt	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
8.8	1,3	3,3	6,5	11	27	54	93	148	230	329	464	634	798	1176	1597
10.9	1,9	4,8	9,5	17	40	79	137	218	338	469	661	904	1136	1674	2274
12.9	2,3	5,6	11	19	47	93	160	255	395	549	773	1057	1329	1959	2662
Torque – metric thread - greased μ = 0,14															
Bolt	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
A4-70	1	2,2	4,4	7,7	19	37	64	103	159	221	310	418	535	791	1076
A4-80	1,4	3	5,9	10,2	25	49	85	138	211	295	414	558	713	n.v.t.	n.v.t.
Torque - Stainless steel metric thread - greased μ = 0,14															

Torque Nord-lock [Nm]															
ring	NL3	NL4	NL5	NL6	NL8	NL10	NL12	NL14	NL16	NL18	NL20	NL22	NL24	NL27	NL30
8.8	1,5	3,6	6,9	12,1	29	57	99	157	240	336	470	642	809	1183	1613
10.9	2	4,5	8,9	15,5	37	73	126	201	306	429	600	818	1034	1509	2058
12.9	2,3	5,3	10,3	18	43	85	146	233	355	498	696	948	1199	1749	2386
Torque - metric thread - greased μ = 0,14															
ring	NL3ss	NL4ss	NL5ss	NL6ss	NL8ss	NL10ss	NL12ss	NL14ss	NL16ss	NL18ss	NL20ss	NL22ss	NL24ss	NL27ss	NL30ss
A4-70	0,8	1,8	3,6	6,3	15	30	51	81	124	173	243	330	418	609	831
A4-80	1,1	2,4	4,8	8,4	20	39	68	108	165	231	323	440	557	812	1108
Torque - Stainless steel metric thread - greased μ = 0,14															

Check all hardware which holds the drive boxes to the frame regularly and retorque when necessary to the appropriate specifications.

9.2 Maintenance of the pressure compensation system



The condition of the compensators have to be checked regularly.

Visual check the oil level in both compensators, it is advised to have about 50 mm of oil visible in the compensator. This is about 25% of the 6 (or 15) liter capacity. Both compensators should not show air above the oil, and the SHPU compensator (78) should contain visible clean hydraulic oil.

9.2.1 Draining the compensation system

The compensators are spring loaded, which means there is a little overpressure (about 0.2 bar) inside the pressure compensation system. This over pressure makes sure that in case the sealing capacity is lost no sea-water can enter the system. This to protect the system against electric short cuts or other damage.

Note: Before draining the compensator system, always make sure the pressure is relieved. De-pressurizing is described below.

De-pressurizing the compensator:

- Remove the caps from the quick connect couplings (67 or 68 and 95).
- Connect the compensator pump to the quick connect coupling (67 or 68).

Drive motors / Twister / Slip ring unit

SHPU tank

- Make sure the pressure of the compensator pump is removed (94)
- Open the valve (92) of the pressure compensating system.
- Now the oil will run back into the pressure compensating system and the drive unit and junction box will be de-pressurized.
- Wait until no oil is visible before opening any part of the drive motors / Twister / Slip ring unit / SHPU.

Now each system can be drained by removing the plugs / valves on each unit. Make sure the used drip tray has sufficient volume to store the oil.

9.2.2 Filling the compensation system with the compensator pump

In case the oil level of one of the compensators is too low, this can be filled with compensator pump.

Caution: Fill the hydraulic tank/compensator (68) only with clean hydraulic oil. Never use hydraulic oil from the pressure compensation system (67), this oil is contaminated with dirt particles from the gear boxes.

Filling (pressurizing) the compensator:

- Clean the compensator pump and fill it with clean oil (Shell Tellus 32 or equivalent).
- Remove the caps from the quick connect coupling (67 or 68 and 95).
- Pressurize the pump.
- Connect the compensator pump to the quick connect coupling (67 or 68).
- Open the valve of the pump until the oil level in the compensator is sufficient (about 50 mm oil is about 25% of the 6 liter capacity).
- In case air is visible above the oil, partly drain and re-fill the compensator. Continue till all the air is out of the system.
- Disconnect the pressure compensating system.
- Mount the caps back on the quick connect couplings.

9.2.3 De-airing the compensation system

The pressure compensation is optimal when all the air is removed from the system. The air will compress while lowering the unit to the seabed, causing the compensator volume to decrease.

To de-air the SHPU compensation system, the following items should be checked for air:

- Compensator
- SHPU
- Buffer
- ST Twister clamp

To de-air the ROSON compensation system, the following items should be checked for air:

- Compensator
- Small compensator in Folder
- Slip ring unit in Folder
- Drive motors ROSON
- Drive motors Folder and Sprocket
- ST Twister housing
- Step down trafo

Tip: Also check the hydraulic layout diagram 049045.

As air will be trapped on top of each housing, try to find a plug or hydraulic connection on the highest point of the housing. Untighten the plug, or crack the hydraulic coupling, and check for air. Make sure all air is removed before lowering the unit to the seabed. Perform this for all housings connected to the compensation system.

If water entrance is suspected in the compensation system, try to find a plug or hydraulic connection on the lowest point of the housing. Untighten the plug, or crack the hydraulic coupling, and check for water. Make sure all water is removed, from all the housings, before filling and de-airing the unit.

9.3 Drive unit

The drive wheels have to be checked regularly on wear. Worn out drive wheels decrease the pushing capacity of the system. Replace the wheels if they are worn out.
In case of wear of the seal or speedi-sleeve there can be leakage. In case of leakage replace the seal and lipseal before using the equipment, see section 8.3.2 for details.

Note: In case the ROSON is not used for a long time, or if the rod is clamped without using the ROSON for a while, there might be a minor leakage. Rotate the wheels for 1 or 2 hours to check if the sealing capacity improves. The seals need to run in for optimum sealing performance.

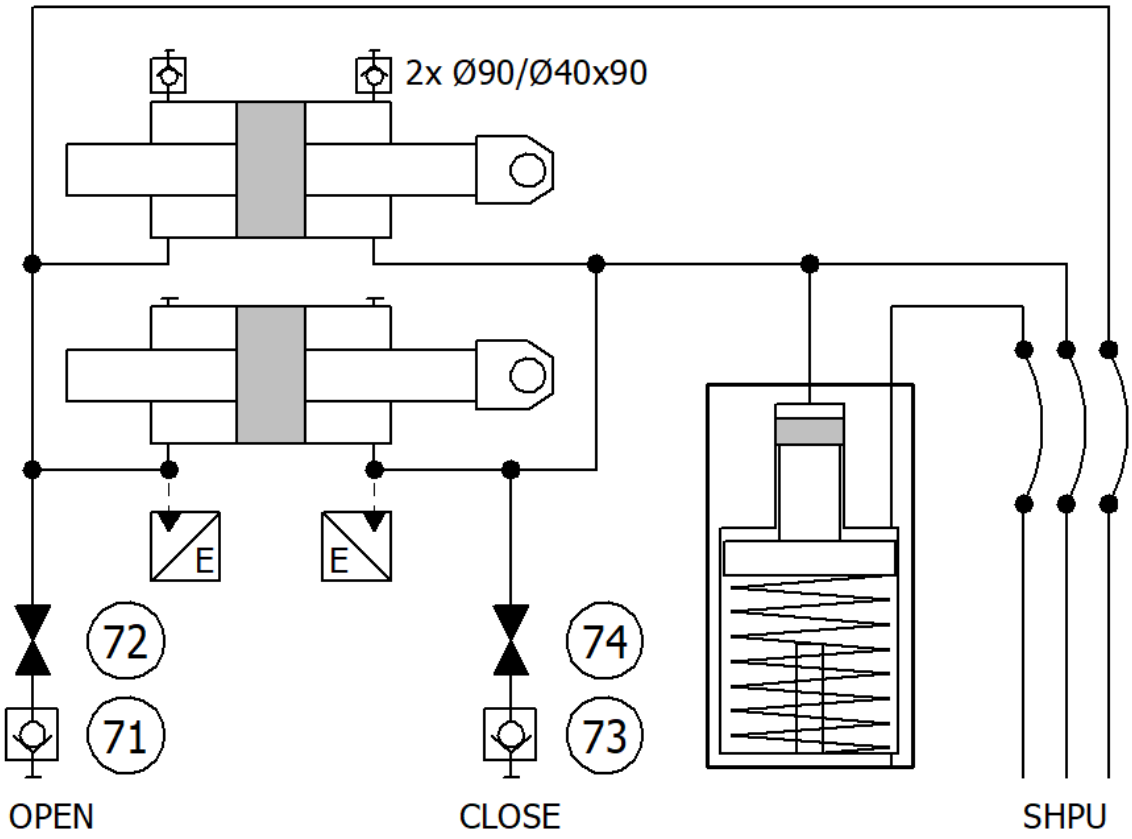
The best way to determine if a seal needs to be replaced is to monitor the pin movement of the compensator. A couple of mm pin movement for 24 hours shouldn't be a problem. In case of a movement of more than 10 mm in 24 hours the seal should be replaced.

Note: Due to the overpressure in the compensation system the leakage will always be from the inside to the outside, as long as the compensator is not at the end of its stroke.

Caution: Water in the hydraulic oil will reduce the electric insulation and give short circuits and corrosion.

9.3.1 Clamping cylinder

The clamping system on the ROSON works as follows: two hydraulic cylinders with a pressure compensated accumulator providing the clamping force of the wheels. The hydraulic diagram shows all the hydraulic connections.



The pressure compensated accumulator is used to keep the clamping pressure constant and compensates for minor leakage.

Note: The valves (72) (74) have to be closed after applying pressure, depressurize the hand pump and disconnect the quick couplings (71) (73).

Note: Also the SHPU can be used for clamping / opening. In case the clamping pressure is released with the hand pump, be aware the level of the hand pump increases.

Caution: The maximum pressure of the clamping cylinder is 200 bar. Higher clamping forces can result in damage of the drive motors.

Open the drive wheels:

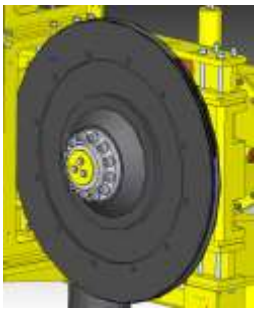
- Remove the plugs from the hydraulic connections (71, 73 and 112).
- Connect the hand pump to hydraulic connection 73 (opening side), make sure the valve on the hand pump is closed.
- Connect the drain hose to connection 71 (clamping side), clean the hydraulic line and place it in the tank of the hand pump.
- Slowly open valve 72 to release all the pressure.
- Open valve 74, and apply pressure with the hand pump. The drive unit slowly opens.
- Close valves 72 and 74.
- Disconnect both hoses from 71 and 73, plug all connections (71+73+2x 112) to avoid dirt entering the hydraulic system.

Closing the drive wheels:

- Connect the hand pump to the hydraulic connection (71) (clamping side), make sure the valve on the hand pump is closed.
- Connect the drain hose to connection 73 (opening side), clean the hydraulic line and place it in the tank of the hand pump.
- Open valves 72 and 74, and apply pressure with the hand pump till the required pressure is reached. Do not exceed the 200 bar clamping pressure.
- Close valve 72 and 74.
- Remove the pressure in the hydraulic hose by opening the valve on the hand pump.
- Disconnect both hoses from 71 and 73, plug all connections to avoid dirt entering the hydraulic system.

9.3.2 Assembly speedi sleeve and lipseal

Make sure the following drawings, tools and spares are available:
- Drawing 046713 Drive unit and 048366 Drive motor
- Small chain hoist
- Spanner set
- Allen key set
- Screw drive set
- Side cutter
- Small file
- Compensator pump (dwg. 014696)
- Mounting tools lipseal and speedi sleeve (part nr. 1210290A)
- Loctite 603 or 638
- Grinding paper (grit 240 or higher)
- TF250 grease (or equivalent, eg. silicon grease)
- TP42 grease (or equivalent)
- Lipseal (part nr. 72320026)
- Modified speedi sleeve (part nr. 1210037A)
- Hydraulic oil, each drive motor contains about 30 liter oil.

<table>
<tr>
<td> 

De-pressurize the compensator system.

Remove the oil from the drive motor.</td>
<td> 

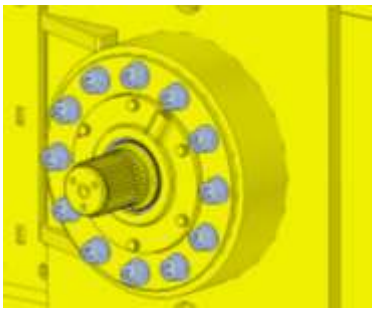
De-pressurize the clamping cylinder.

Connect a chain hoist between the ROSON frame and the drive wheel.

Remove the bolts between the flange and drive wheel.</td>
</tr>
<tr>
<td> 

Remove the 3 small bolts in the centre and remove the small Brevini cap.

Make sure the drive wheel is supported by the chain hoist.

Remove the Brevini flange from the spline shaft.</td>
<td> 

Remove the drive wheel.</td>
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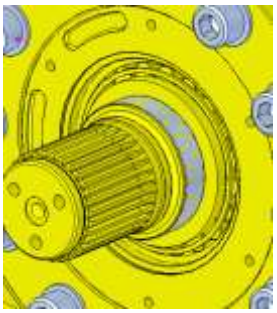
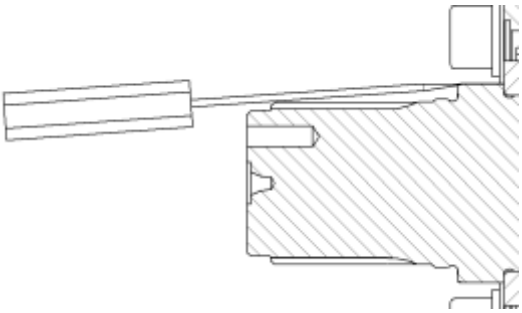


Remove front cover of the gear box.

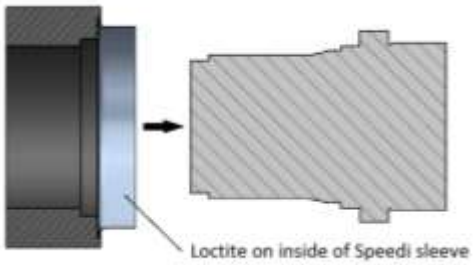


Remove the old speedi sleeve. Use a small screw driver to break the speedi sleeve without damaging the drive shaft.

Clean the drive shaft.

Remove the old lip seal out of the front cover, without damaging the surface of the front cover.

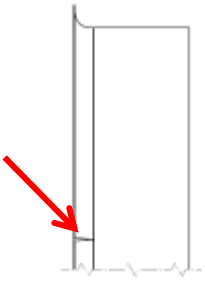
Clean the front cover.

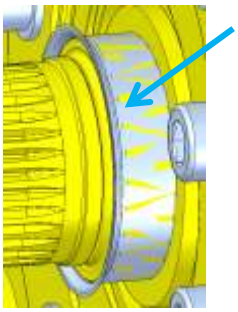


Apply loctite on the inside of the speedi sleeve and mount it with the mounting tool speedi sleeve.

Remove the excess Loctite.

Let the loctite cure for 1 hour.





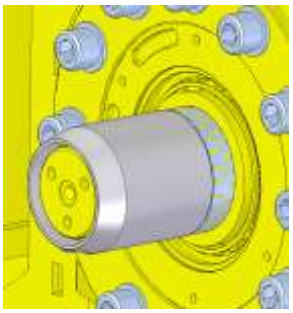
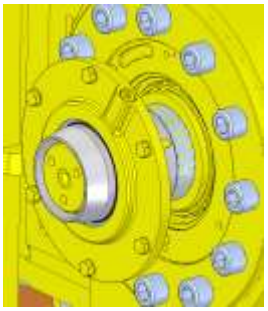
Remove the flange at the breaking edge:
- Cut the flange in small steps till the breaking edge (red arrow).
- Gently pull and rotate the flange to snap off along the breaking edge (blue arrow).

Avoid deformation of the speedi sleeve
- Pull the flange in one smooth movement till it is completely removed.

File the breaking edge away.

Polish the breaking edge/chamfer with grinding paper.

Make sure there is no sharp edge at the speedi sleeve, and the speedi sleeve has no deformation after removing the flange.

 Apply loctite in the cover of the gearbox and mount the new lipseal. Use the mounting tool lipseal 2 and a vice to push the lipseal inside the cover. Remove the excess Loctite. **Make sure the lipseal is aligned properly before clamping**	 Place the mounting tool lipseal 1 on the drive shaft, the front of the mounting tool will fit in the speedi sleeve. Apply TF250 grease (or hydraulic oil) all around the mounting tool and speedi sleeve.
 Apply some TF250 grease on the speedi sleeve and on the lipseal (between both lips). 1 person holds the mounting tool in place. The 2nd person slides the front cover+lipseal gently, but in one smooth movement, in place. **Make sure of proper allignement and preperation, the lipseal damages easily on the edge of the speedi sleeve.**	Fill the drive motor with oil and pressurize the compensator till storage level. Make sure there is no air in the drive motor. Let the drive unit run for an hour, the seals need to run in for optimum sealing performance. Also de-air the drive motor again when the motors are running. If there is no leakage, the drive wheel + spline flange can be mounted again. Use TP42 grease on the spline shaft and bolts.

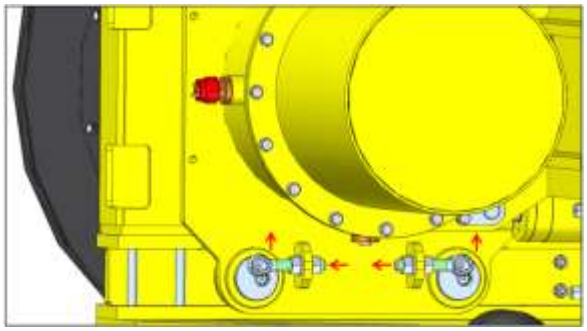
Note: Above described procedure is similar to replace the seal/speedi sleeve of the drive motor sprocket/folder.

9.3.3 Adjusting the horizontal linear guiding

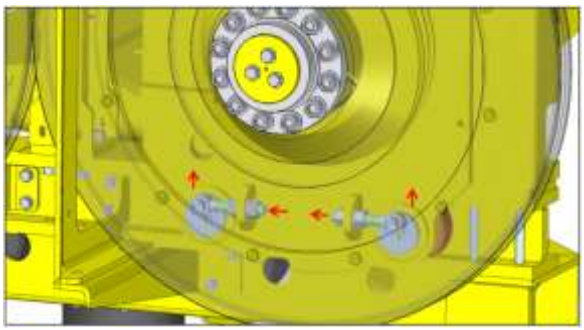
- Make sure the drive motors are hanging in the upper guiding (the blocks which are not adjustable)
- Rotate the lower guiding blocks till it is touching the stainless steel strip.
- Lock the two nuts to make sure the setting is not affected by sliding the drive motors.
- Clamp and unclamp the drive motors to check if the drive motors can slide over the full length of the guiding. (20 bar openings pressure should be sufficient)
- Adjust the guiding blocks if necessary.

When following the pictures below, the guiding block will move towards the stainless steel guiding strip. The reverse direction will result in movement away from the stainless strip.

Rear side (motor side)



Front side (wheel side)



9.4 ST-system

9.4.1 ST string

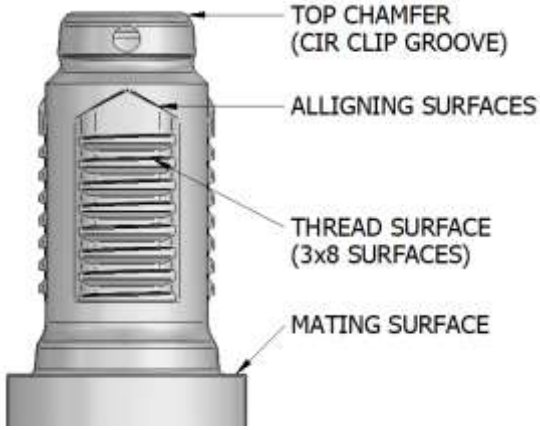
The ST-system performance is depending on a good ST string. All connections should be in a good condition to be able to reach the required CPT depth. Cleaning the string with (high pressure) fresh water regularly, at least after each operation, is recommended to slow down the corrosion effect and extend the lifetime of the string.

Besides corrosion the threads can also get damaged. Therefore is good to monitor the connections during operation, or check all connections afterwards with the ST analyser. When a bad connection is noticed during a CPT, this connections can be cleaned, checked and re-greased for the next operation.

The HMI stores the connection data based on a rod number. Rod connection 0 is the male thread of the Start set (rod number 0) and the female thread of rod number 1. This means all connection data is referred to the male thread of the rod.

TIP: Marks on the folder can be helpful to identify the joints of each string, also helping to find the correct rod number.

When a rod connection is cleaned, the connection can be checked visually. Closely look for damages on the top chamfer, the aligning surfaces, the thread surfaces and the mating surface. For the female thread only the mating surface and the aligning surfaces can be checked.



In case the above mentioned surfaces are OK, the connection can be checked manually.
The rods should easily slide in each other, and engage by hand.

Place the "ST check rod", drawing 050893, in a vice. Connect the female connection of the cleaned/checked rod. Connect the rod "hand tight", and mark the rod. Then rotate the rod fully "untight" and check the rotation in mm on the indicator. The distance should be between 10 – 15 mm. Repeat above for the male connection.

In case a damaged connection is noticed, or the rotation is out of limit, the rod should be rejected to avoid malfunction during the ST cycle.

TIP: Make sure to clean the removed string with fresh water, to be able to re-use the ST rods which are still in good condition. If time is available best is to dismantle the string as soon as possible. Use a pin punch to remove the 2 pins and use a small screw drive to remove the cir clips. Protect the measuring cable to avoid damages on the cable and connectors.

TIP: In case the new strings are assembled from the harvested rods, they should be ordered on diameter (eg. Ø40-Ø39,5; Ø39,5-Ø39; etc.). When all diameters are corresponding, try to order the rods on condition of the ST thread.

9.4.2 ST Folder

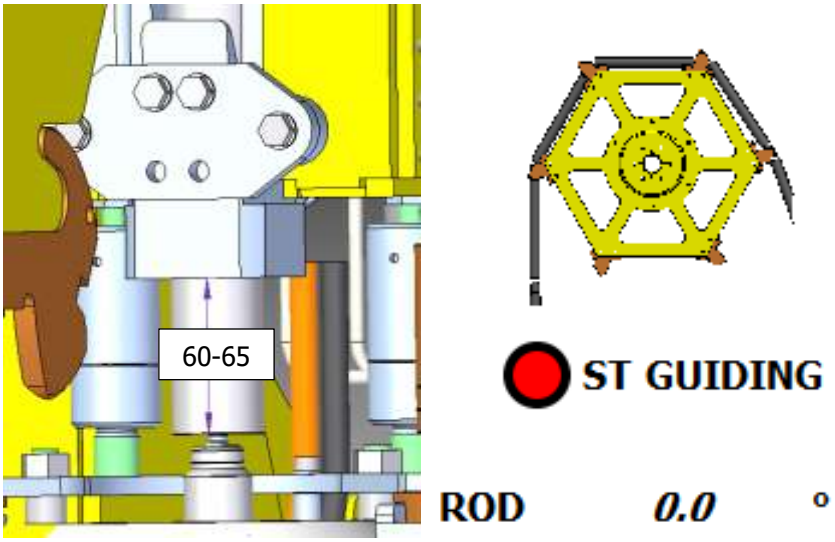
TO DO:
- description of axial alignment
- greasing spindle

9.4.3 ST Sprocket

The Sprocket has to be checked regularly. The following items need to be checked:
- Check if the sprocket fingers do not have excessive wear
- Check if the sprocket fingers are not bend "outwards"

The Sprocket wheel is used for the timing of the ST cycle. Therefore it is important to check the "rod position" on regular basis.

The rod position should be 0.0° in the following situation (with the ST sprocket in "pull" mode to make sure the ST string is under tension):



How to bring the system to this "check position", and how to "zero the Sprocket encoder" is described in Chapter 5 "Preparing the ROSON-ST before us".

9.4.4 ST Twister

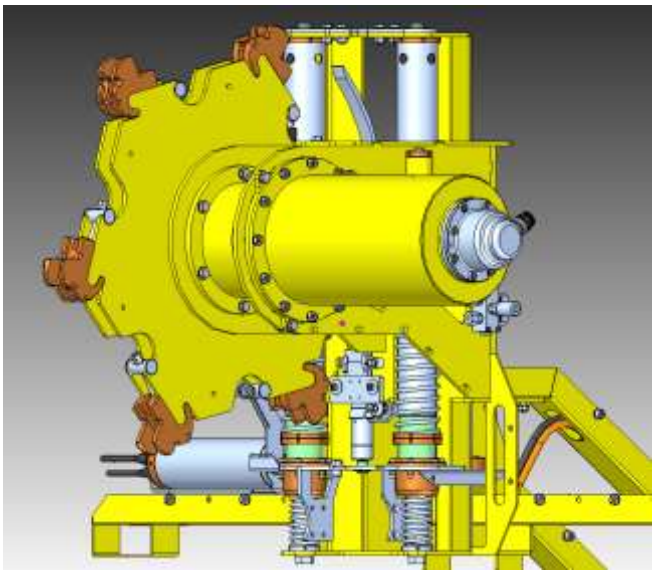
TO DO:
- Check if all bolts of the Twister are tightened
- Check the Twister collet
- How to replace the rotary seal

9.4.5 Spring guiding ST Twister, drawing 045583

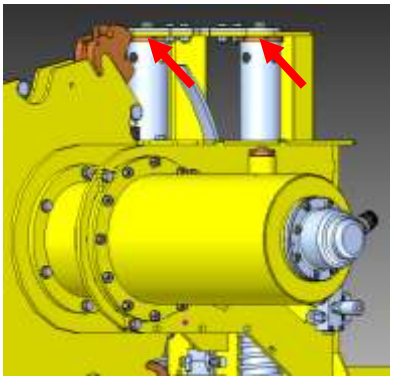
In case the ST Twister neutral position is too low, the springs can be re-adjusted to move the ST Twister upwards.

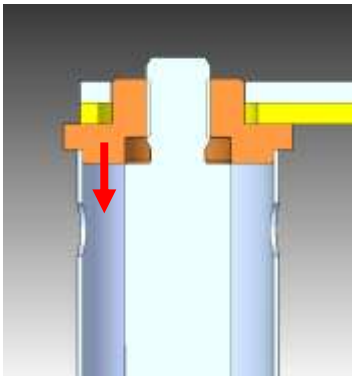
In case the springs need to be replaced, the following steps can be performed:

- Remove the Twister.

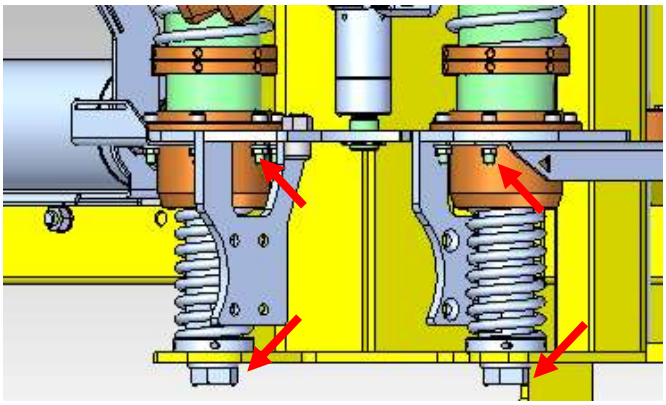


- Screw the fixing nut (pos. 08) downwards to create space.

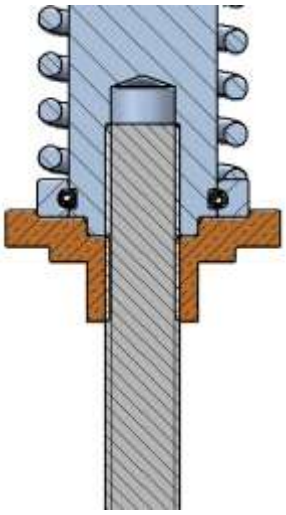




- Remove the 12 M6 bolts and the lower 2 M20 bolts.



- Now both spring guiding's can be removed from the frame.
- Connect the spring tensioner, make sure the brass nut is tightened against the lock washer (pos. 12).



- Remove the 2 pins (pos. 14).
- Release the spring tension by rotating the brass nut.
- Replace the springs and assemble in the opposite order.

9.5 Electrical installation

Only a certified electrician should service and repair the electrical part of the equipment.

Caution: When servicing or repairing the electrical system or performing any welding on the equipment, the power supply of the ROSON should be disconnected. Make sure the ground connector of the welding equipment is connected close to the area where the welding takes place.

Some regular checks are advised on the electrical installation:

- Visually check of all the electrical components (relays, terminals, etc...).
- Visually check of all the wires, cables and connectors.
- Retighten the screws of the electrical components (relays, terminals, etc...).

9.5.1 Umbilical check on continuity and isolation

In case the umbilical or umbilical connector is damaged the umbilical needs to be checked on continuity and isolation. Check the electrical diagram to understand the wiring between the fuses

Follow the instruction below to prepare the measurement:

- Tag out the winch to make sure the power supply is disconnected.

- Remove the 6 fuses of the umbilical, and remove the isolation caps.

- Prepare the Fluke 1664 FC multimeter (or equivalent, isolation test @ 1000 Vdc)

Setting (F1): L – PE


Connections: L – PE


R_{ISO} or R_{LO}

- Check the 4 pin male test cable on continuity (R_{LO}) and isolation (R_{ISO}) resistance.
- Make sure all three connectors of the Termination are removed.

Follow the instruction below to perform the continuity test on the "red" 4 pin connector (Power drive unit):

- Connect the 4 pin male test cable on the "red" 4 pin connector of the Termination.
- Connect one side of the multimeter to the first fuse with the "blue" wire.

- Connect the other side of the multimeter to the "black" wire of the 4 pin male test cable.
- Check the continuity (R_{LO}) of the umbilical, a 1500m 4 mm² conductor has a resistance of approximate 7 Ohm.
- Repeat this for the other combinations and fill in the table below:

Measurement (Continuity, R_{LO})	Umbilical wire colour @ fuse	Wire colour 4 pin test cable	Resistance [Ohm]
1	Blue	Black	
2	White	White	
3	Orange	Blue	
4	Earth	Red	

Note: Measure point for earth (approximate 12 Ohm):

Follow the instruction below to perform the isolation test on the "red" 4 pin connector (Power drive unit):

- Connect one side of the multimeter to the "black" wire of the 4 pin male test cable.
- Connect the other side of the multimeter to the "white" wire of the 4 pin male test cable.
- Check the isolation (R_{ISO}) of the umbilical, a 1500m 4 mm² conductor will take about 10 seconds to reach the >1000 MOhm value. (Measurement 8, 9 and 10 will take about 20 seconds).

Note: Make sure to "discharge" the conductors after each isolation test. Discharge by making a "short circuit" by touching the wires of the test cable to each other.

Note: Perform an isolation test for a maximum of 60 seconds. In case the >1000 MOhm is not reached, write down the maximum measured value.

- Repeat this for the other combinations and fill in the table below:

Measurement (Isolation, R_{ISO})	Wire colour 4-pin test cable - (umbilical wire)	Wire colour 4-pin test cable - (umbilical wire)	Isolation [Ohm]	Time [s]
5	Black - (Blue)	White - (White)		
6	Black - (Blue)	Blue - (Orange)		
7	White - (White)	Blue - (Orange)		
8	Red - (Black)	Black - (Blue)		
9	Red - (Black)	White - (White)		
10	Red - (Black)	Blue - (Orange)		

Perform the continuity test on the "black" 4 pin connector (Power ST system):

Measurement (Continuity, R_{LO})	Umbilical wire colour @ fuse	Wire colour 4 pin test cable	Resistance [Ohm]
11	Green	Black	
12	Red	White	
13	Yellow	Blue	
14	Earth	Red	

Perform the isolation test on the "black" 4 pin connector (Power ST system):

Measurement (Isolation, R_{ISO})	Wire colour 4-pin test cable - (umbilical wire)	Wire colour 4-pin test cable - (umbilical wire)	Isolation [Ohm]	Time [s]
15	Black - (Green)	White - (Red)		
16	Black - (Green)	Blue - (Yellow)		
17	White - (Red)	Blue - (Yellow)		
18	Red - (Black)	Black - (Green)		
19	Red - (Black)	White - (Red)		
20	Red - (Black)	Blue - (Yellow)		

Note: In case the continuity is not equal (more than 1 Ohm difference) and/or the isolation resistance is less than 1000 MOhm @ 1000 V (or if it takes > 40 seconds to reach this value with a 1500m umbilical length) there is an issue with the umbilical. Try to locate the issue, solve the issue and repeat above measurements.

Test sheet umbilical measurements

System :
Date :
Time :
Measurement : Fuse – JB frame – Slip ring - JB drum – Terminal Termination – 4p Test cable

Perform the continuity test on the "red" 4 pin connector (Power drive unit):

Measurement (Continuity, R_{LO})	Umbilical wire colour @ fuse	Wire colour 4 pin test cable	Resistance [Ohm]
1	Blue	Black	
2	White	White	
3	Orange	Blue	
4	Earth	Red	

Perform the isolation test on the "red" 4 pin connector (Power drive unit):

Measurement (Isolation, R_{ISO})	Wire colour 4-pin test cable - (umbilical wire)	Wire colour 4-pin test cable - (umbilical wire)	Isolation [Ohm]	Time [s]
5	Black - (Blue)	White - (White)		
6	Black - (Blue)	Blue - (Orange)		
7	White - (White)	Blue - (Orange)		
8	Red - (Black)	Black - (Blue)		
9	Red - (Black)	White - (White)		
10	Red - (Black)	Blue - (Orange)		

Perform the isolation test on the "black" 4 pin connector (Power ST system):

Measurement (Continuity, R_{LO})	Umbilical wire colour @ fuse	Wire colour 4 pin test cable	Resistance [Ohm]
11	Green	Black	
12	Red	White	
13	Yellow	Blue	
14	Earth	Red	

Perform the isolation test on the "black" 4 pin connector (Power ST system):

Measurement (Isolation, R_{ISO})	Wire colour 4-pin test cable - (umbilical wire)	Wire colour 4-pin test cable - (umbilical wire)	Isolation [Ohm]	Time [s]
15	Black - (Green)	White - (Red)		
16	Black - (Green)	Blue - (Yellow)		
17	White - (Red)	Blue - (Yellow)		
18	Red - (Black)	Black - (Green)		
19	Red - (Black)	White - (Red)		
20	Red - (Black)	Blue - (Yellow)		

9.5.2 Re-termination of the umbilical (drawing 044040)

In case the umbilical or umbilical connector is damaged, and needs to be shortened the termination needs to be replaced. Follow the instruction below to replace the termination.

- Cut the umbilical safely above the expected point of failure.

TO DO

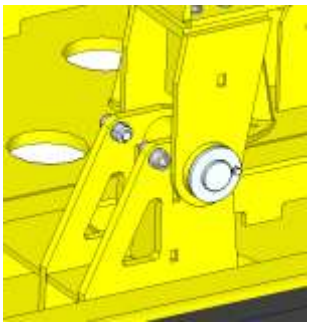
9.6 Testing equipment

Note: Load cells with their measuring equipment have to be calibrated at least every 6 months according to the NEN-EN-ISO 22476.

For service schedules of specialized testing equipment one has to consult their accompanying user manuals. This section only gives the service schedules for the common testing equipment.

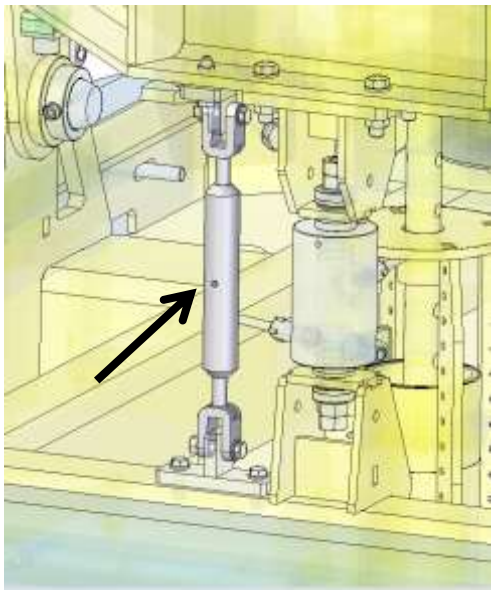
9.6.1 Total load cell

In case the Total load cell is damaged or need to be recalibrated the load cell has to be removed as described below.



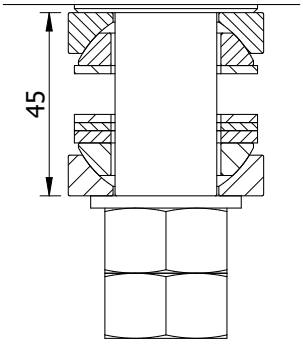
Caution: Due to the heavy drive wheels, the drive unit will tilt when removing the total load cell. Use the supplied rigging screw for tilting the drive unit to remove the total load cell. Four bolts (see picture) are mounted to prevent fully tilting of the drive unit.

- Check how many shims are placed and write down the configuration (or take a picture).
- Place the rigging screw.



- Remove the bolts and rings from the total load cell.
- Lift the drive unit with the spanner to remove the total load cell.

- Place the spare total load cell.
- Make sure the shims are placed in the same configuration (total length should be 45 mm).
- Lower the drive unit with the rigging screw and position the rings.
- Hand tight the nuts and secure the nut with a second nut.
- Check if the drive wheels are perpendicular to the base frame, reconfigure the shims if necessary.
- Remove the rigging screw.



9.7 Hydraulic system

Only adequately trained technicians with specific hydraulic experience should service and repair the hydraulic system on the equipment.

All warranty will be voided if modifications in any way are made to the hydraulic system without prior written approval from A.P. van den Berg Ingenieursburo

Caution: Depressurize the system before maintaining the hydraulic system. Therefore the SHPU has to be set in "state 9" to release the pressure stored in the buffer. Closely watch the pump pressure on the HMI screen to double check the pressure is released.

See also the manual of the SHPU (Appendix E) regarding the maintenance of the unit.

Note: It is recommended to keep good records on the equipment such as dates for oil changes, replacements of seals and parts, etc.

Several areas of the hydraulic system need to be checked regularly. What those areas are and how often they need to be checked can be found in their service schedule. A clarification follows below.

Note: Inspection of the hydraulic system is best performed in the direction of the oil flow. Take the following steps:

Check oil before starting up the system. Make sure the equipment is as level as possible. Excess oil use or oil leakages need to be located and taken care off immediately.

Add small amounts of hydraulic oil when necessary. Adding oil should never replaces changing oil.

Caution: Do not try to locate oil leakages by hand. If you ever get hydraulic oil UNDER your skin you have to immediately call for a doctor who is familiar with this kind of injuries.

Check the oil tank for leakages.

Note: Check the suction line and/or suction hose for leaks. They should not show any sign of damage.

Check the pump for leaks.

Check the pressure lines for leaks.

Check the return lines for leaks.

Check the filters. If the element is fouled up it needs replacement.

Check the air filter in the filler cap. If necessary clean with a solvent and blow dry with compressed air.

Replace hydraulic hoses within 5 years.

9.7.1 System service

It is advised to get the system serviced after a certain amount of operating hours. Spacing of services depends on operating circumstances and may vary between one and five years, but shorter as well as longer intervals may be possible.

Note: The first service has to be after 250 hours of operating.

A service consists of the following items:

Check all line mountings.

Check if all line connections are tight.

Clean all components and lines from the outside. Especially mud and dust should be removed.

Clean all drip pans.

Check the oil for oxidation and contamination (see next section).

Change oil if necessary.

Note: Check the adjustments of the pressure relief valves. The original settings are mentioned on the hydraulic diagram.

Note: Replace a hydraulic hose when it shows the slightest damage or wear. Replace hydraulic hoses every five years in any case. This is also the case for the bellows of the junction box and the compensator. Replace the hoses with hoses which match or have higher ratings than the original hoses. Check the documentation of the hoses. Use the same type of hose connectors as to be assured of the same movement abilities as the original ones.

9.7.2 Servicing the hydraulic oil

Seventy percent of all problems with hydraulic systems originate in the less than optimal condition of the hydraulic oil.

A hydraulic system will not perform properly if the oil contains water or other contaminants. Water in the oil will cause corrosion inside the hydraulic system. Contaminants will cause excessive wear or clogging of components.

To check the condition of the oil you need to take a sample for testing.

Note: Special sample bottles are available.

Note: Compare the oil sample taken with an unused oil sample. Comparison with smell and colour can tell you a lot already. If the oil is contaminated the contaminants can tell you a lot about the condition of the hydraulic system.

Aluminium particles point at problems with the pump;
Rubber particles point at defective cylinder seals;
Sediment points at dirty air, sucked in through the tank;
A different colour may point at oil that has been overheated.

Keep the oil overnight. If it shows sediment in the morning the oil needs to be changed. When in doubt it is advisable to send the sample to a test laboratory before changing the oil. Remember it is very important to send the oil sample in a superbly cleaned bottle.

Note: Check if there is any water in the oil. When in doubt carefully heat 2 - 3 cc and listen if you can detect little pops (explosions). This points at water escaping as vapour.

9.7.3 Changing the hydraulic oil

In order to change the hydraulic oil the old oil needs to be removed. After performing this task the equipment has to be de-aired. The following sections will show how this should be done.

9.7.3.1 Draining the oil

Make sure the equipment is level.

Take the pressure from the system, the compensator has to be de-pressurized.

Place a sufficiently sized drip pan under the drain valve.

Remove the drain plug.

Wait until the oil stops dripping. The oil has now been removed from the system. The valves need not be drained.

Dispose of the hydraulic oil according to local government laws and regulations.

Note: Change all filters. It is advisable to keep two filters of each type in stock.

Dispose of the used filters according to local government laws and regulations.
Check the air filter in the filler cap. If necessary clean with a solvent and blow dry with compressed air.

Close the drain valve.

Put the drain plug back in place.

Note: Remove the hydraulic oil tank cover only if the return filter is dark grey and clean the tank thoroughly .

9.7.3.2 Filling the system with new hydraulic oil

Reconnect all disconnected hoses and lines.

Check if all flanges and fittings are seated properly and hardware is tightened.

Make sure there is a sufficient amount of hydraulic oil of the right grade.

Ready the oil filling system.

Take the filler cap off the filler neck. Put the cap in a clean place.

Fill the tank until the oil level is fully filled.

Make sure that NO dirt can enter the system in any way!

Put the filler cap back in place.

9.8 Cleaning

The ROSON can be cleaned by means of a high pressure cleaner. Do not put full pressure on the seals of the drives.

The winch can also be cleaned by means of a high pressure cleaner. Do not put full pressure on the seals of the drives and to the control unit and other equipment.

Big quantities of dirt have to be removed by means of a shovel or something like that.

Note: All the connectors has to be protected. An open connector can get contaminated by sea water and get damaged.

Chapter 10 Troubleshooting

A problem is caused by what? It is either an electrical problem or a mechanical problem. To help you solve certain problems, we have compiled for you a list containing possible problems, what causes them and how to solve them. This list appears on the next page.

Read the relevant paragraphs in chapter "Service" first before solving a problem.

Note: Do not experiment. Always read this user manual again. Call or fax A.P. van den Berg Ingenieursburo if you cannot solve the problem.

We suggest you always let repair A.P. van den Berg Ingenieursburo your equipment. We are well equipped for that kind of work.

The equipment may only be used when it is in a good technical condition. Problems endangering the safety must be solved immediately.

Problem	
CPT rods are bent.	
Possible cause	**Solution**
1. The scrapers are off line with the friction wheels. 2. The drive unit is off line with the guiding mast. 3. The bolts of the drive unit are loose.	1. Align the scrapers. 2. If possible align the drive unit. 3. Tighten the bolts with a torque as described in chapter "Service".

Problem	
The drive wheels of the ROSON refuse to go up or down.	
Possible cause	**Solution**
1. The umbilical is not connected. 2. The control unit is switched off. 3. The power supply is not connected. 4. An alarm level is reached in Ifield 5. One of the limit switches is activated. 6. The handheld is connected to the control unit	1. Connect the umbilical. 2. Switch on the control box (mains on). 3. Connect the power supply. 4. Ignore the alarm in Ifield 5. Move the wheels into the opposite direction 6. Check movement with the handheld or disconnect handheld

Problem	
The total load is not working properly.	
Possible cause	**Solution**
1. The cables are not connected. 2. One of the cables is damaged. 3. The load cell is damaged.	1. Connect the cable. 2. Replace the damaged cable. 3. Replace the damaged load cell.

Problem	
The pushing force is too low.	
Possible cause	**Solution**
1. The clamping cylinder is de-pressurised. 2. The CPT rod(s) is (are) worn out	1. Check the pressure settings and if necessary re-adjust the pressure. 2. Replace the CPT rod(s).

Problem	
Depth registration is not functioning (properly).	
Possible cause	**Solution**
1. The tension on the spring of the depth encoder are not adjusted properly anymore. 2. Some connectors have been connected incorrectly. 3. Encoder wheel is in bad condition	1. Increase the spring pressure or place the depth encoder closer onto the CPT rod. 2. Connect all cables according to the layout drawing. 3. Replace encoder wheel

Problem	
The compensator of the junction box cannot be pressurized.	
Possible cause	**Solution**
1. The membrane is damaged. 2. The tubing of the system is leaking. 3. The junction box or one of the connectors is leaking	1. Replace the membrane. 2. Tighten the tubing. 3. Tighten the leak or replace the connector or O-ring.

Problem	
Number of revolutions of the motor is lower than rated. (ROSON)	
Possible cause	**Solution**
1. Lower frequency of power supply 2. Too low voltage at the ROSON	1. set right frequency 2. Apply the correct voltage to the control unit.

Problem	
Leaking motor at the shaft. (ROSON)	
Possible cause	**Solution**
1. ROSON is not used for a while, or CPT rod was clamped during storage 2. Shaft seal is worn out.	1. Fill the compensator till "storage position" and rotate drive wheels for a couple of hours. Monitor the leakage and check if the sealing is improved. 2. Replace the shaft seal.

Problem	
Loss of contact between ROSON and control unit / data acquisition system	
Possible cause	**Solution**
1. Connector is loose / broken. (CPT-cable / umbilical / cable to data acquisition) 2. Cable is broken (CPT-cable / umbilical / cable to data acquisition)	1. Try to locate which connector is causing the problem: clean and fasten or replace connector. 2. Try to locate which cable is causing the problem: repair or replace cable

Problem	
Loss of contact Icone module and Ifield software	
Possible cause	**Solution**
1. Icontrol dongle is not in the computer 2. Connector is loose / broken. (CPT-cable) 3. Cable is broken 4. Cone recognition failed	1. place Icontrol dongle 2. fasten or replace connector 3. repair or replace cable 4. Switch off control unit (mains off); wait till all modules are removed, turn on control unit (mains on)

Frequency inverter gives Torque limit error (W12)	
Possible cause	Solution
1. The electrical motor brake is not released.	1. Remove the electrical motor cover and check/repair the motor brake.

TO DO: ST errors vs. possible solutions

Chapter 11 Decommissioning

Decommissioning means you must remove all fluids from the equipment first and disassemble all parts as much as possible.

In the text below you will find: what measures to take before disassembling the equipment; how to remove the hydraulic oil and components and where to pay attention to when disassembling the rest of the parts of the equipment.

11.1 General measures

- Make sure there is no chance the ROSON can be switched on by accident.
- There should be no hydraulic pressure in tubes or hoses when disassembling the equipment. How to reduce the pressure in the system is described in the chapter "Maintenance".

11.2 Removing the hydraulic oil from the compensation system

Note: Depressurize the compensator before removing the hydraulic oil. How to de-pressurize the compensator is described in the chapter "Maintenance".

- Place a sufficiently sized oil resistant drip pan under the drain plugs of drive units, Twister, Slip ring unit or SHPU.
- De-pressurise the compensator.
- Remove the plug(s) below the drive unit and/or junction box. Prevent any spills.
- Remove the plugs(s) on top of the drive unit (this will speed up the draining).
- Wait until the oil stops dripping. The oil has now been removed from the system.
- Dispose of the hydraulic oil according to local government laws and regulations.

11.2.1 Removing the hydraulic compensator

Note: You only may remove the hydraulic compensator when it is de-pressurized. How to de-pressurize the compensator is described in the chapter "Maintenance".

Assure yourself there is no pressure in the compensator.

Now you can remove the compensator.

The compensator certificates should be kept at a safe place.

11.3 Disassembling the rest of the parts

- Be careful when disassembling the parts.
- Make sure you know exactly what you disassemble and what weight is coming onto you.
- Try to recycle parts or take them to a specialist recycling company.

- Try to disassemble parts in their different materials as far as possible.
- Remove fluids and greases off all parts.
- Separate all parts in steel, iron, brass and copper, aluminium and plastics.
- Dispose of all different kinds of materials separately.
- Dispose of the cleaning cloths according to local government laws and regulations.

The following list tells you which materials are used for what parts:

Component	Steel/ iron	Copper alloy	Aluminum	Plastics	Wood	Other
Base frame	X					
Guiding frame	X					
Hydraulic cylinders	X			X		
Hydraulic tank	X			X		
Hydraulic lines	X					
Pipe clips	X			X		
Hydraulic components	X	X	X	X		
Hydraulic hoses	X			X		
Junction box	X			X		
Planetary gears	X			X		
Electric motor	X	X	X	X		
Compensator	X			X		

Glossary

- **CPT** means Cone Penetrometer Testing.
- **Static testing** means pushing a rod with a cone shaped end into the soil slowly and continuously in order to measure the resistance to penetration of the testing cone and a part of the CPT rod. Static testing is usually referred to as **testing**.
- **Testing equipment** is the entirety of equipment, devices and tools used for testing.
- The **CPT string** is the complete set of CPT rods which is pushed into the soil at testing.
- The **testing cone** is the part which is mounted to the end of the CPT string.
- The **testing method** determines the type of testing; electric or mechanic or continuous or interrupt testing.
- At **electric testing** soil parameters are directly measured by the electric load cells, mounted inside the cone.
- At **mechanic testing** soil parameters are indirectly measured through the inner rods by load cells, located above the soil.
- At **continuous testing** soil parameters are continuously measured at mechanic or electric testing. The CPT rods are moving at the same speed as the cone.
- At **interrupt testing** soil parameters are measured step-by-step at mechanic testing. The CPT rods and the inner rods do not move simultaneously.
- The **testing speed** is the speed during measuring of the soil parameters and has to be 20 ± 5 mm/s.
- At **automatic testing** the cycle of pre-programmed movements of the static cone penetrometer is continued over and over again. This type of testing is possible at mechanic as well as at electric testing.
- The **cone resistance** is the quotient of the force, required to push the cone tip downwards, and the area of the cone tip.
- The **local friction** is the quotient of the force, required to move the friction jacket downwards, and the exterior cylindrical area of the friction jacket.
- The **total resistance** is the resistance on the CPT rods plus the cone.
- The **total friction** is the difference between the total resistance and the cone resistance at testing without friction reducer.
- In the **testing graph** the measurement results of the soil parameters during testing are plotted to the testing depth.
- The **cone tip** is the cone shaped tip of the testing cone through which the cone resistance is measured.
- The **friction jacket** is the cylindrical part of the testing cone through which the local friction is measured.

- The **data acquisition system** is the system consisting of measuring equipment, data transmitting, data registration and data processing equipment, and software.

- The **return compensator** is a device to compensate measuring results which occur during upward movements of the CPT string with regard to the length-sensor due to a decrease of force in the CPT string.

Appendix A

Technical Details

A.1 Technical information equipment

A.1.1 DW-ROSON-ST 200

Machine type	:	DW-ROSON-ST 200
Order number	:	See identification plate
Year of manufacture	:	See identification plate
Number of operators	:	2
Dimensions and weights	:	See chapter "Technical Details"
Colour	:	Green RAL 6018 (Green) / RAL 5003 (Blue)
Clamping pressure clamping cylinder	:	100-130 bar (ST rods) Maximum clamping pressure: 200 bar
Diameter of wheels	:	ø 580 mm
Speed of pushing/retracting	:	2 cm/s
Maximum water depth	:	4000 m
Maximum umbilical length	:	1500 m
Maximum depth of penetration	:	80 m

A.1.2 Drive motor ST 200, drawing 048366

Gear	:	Brevini EQ 4065 MN i=2186
Motor	:	Cantoni 080-4B 0,75 kW (star)
Brake	:	Cantoni H2SP 8 Nm
Connector	:	EMC BH6M
Oil	:	Shell Tellus 32

A.1.3 Drive motor sprocket / folder, drawing 045154

Gear	:	Brevini ET 3010 MN i=79,29
Motor	:	Kolmer 090L-16 0,25 kW (delta)
Encoder	:	1229000A, SSI+incremental (32.768x4.096)
Connector	:	EMC BH6M
Oil	:	Shell Tellus 32

A.1.4 ST Twister, drawing 023453, 0000285A

Gear	:	Worm gear i=26 + Maxon GP42 i=43
Motor	:	Maxon EC 4-pole 32 HD 480W
Connector	:	Subconn MCBH8M + MCBH8F
Clamp range	:	Ø38-Ø40
Max. clamping pressure	:	140 bar
Oil	:	Shell Tellus 32

A.1.5 SHPU

Brand	:	Seatools
Motor	:	Rotor 112M-8 1,5 kW (star)
Pump	:	4.2 cc
Specified flow	:	1.7-8.4 l/min (400-2000 rpm)
Specified pressure	:	100 bar continues – 320 bar max
Oil	:	Tellus 32

A.1.6 Compensators ROSON system / SHPU

Brand	:	Seatools
Type	:	Advanced 6 liter and 15 liter
Pressure	:	0.3 - 0.68 bar

A.1.7 Hydraulic oil Shell Tellus S2 M 32 (or equivalent)

The compensation system and clamping cylinder is filled with Shell Tellus S2 M 32, with the following specifications:

Type	:	DIN 51524 Part 2 HLP type
ISO viscosity class (ISO 3448)	:	32
Density at 15^{o}C (ISO 3448)	:	875 kg/m^3
ISO Fluid Type	:	HM
Viscosity at 40^{o}C (ASTM D445)	:	32 mm^2/s
Viscosity at 100^{o}C (ASTM D445)	:	5.4 mm^2/s
Viscosity index (ASTM D445)	:	99
Pour point (ISO 3016)	:	-30^{o}C
Flash point (ISO 2592)	:	218^{o}C

Appendix B

Test Certificate

Appendix C

Diagrams

C.1 Hydraulic diagram

Drawing number	Description
049405 REV A	Hydraulic diagram ROSON ST
049405 REV A	Part list Hydraulic diagram ROSON-ST
049405 REV A	Layout hydraulic hoses ROSON-ST

C.2 Electrical diagrams

Description

ROSON-ST 200 winch

ROSON-ST Umbilical and Termination

ROSON-ST Junction boxes

ROSON-ST CPT string

ROSON-ST Sliprings Folder

ROSON-ST Pressure sensors

ROSON-ST Pulse generators

ROSON-ST Position sensors

ROSON-ST Service unit

ROSON-ST Seismic source

Frequency inverter settings winch (on USB drive only)

Frequency inverter settings sprocket (on USB drive only)

Frequency inverter settings folder (on USB drive only)

Frequency inverter settings SHPU (on USB drive only)

Frequency inverter settings DU (on USB drive only)

Appendix D

Technical Drawings

D.1 Main drawings

Drawing number	Description
049482 REV A	(DW-)ROSON-ST 200 + winch 1500m
049855 REV A	Layout DW-ROSON-ST 200 – 1500m
049666 REV A	DW-ROSON-ST 200
027880 REV B	ROSON-ST winch 1500m
000874 REV B	ROSON-ST Control box
021838 REV A	Lifting frame 350 kN
049281 REV A	Ballast ROSON-ST 200
049284 REV A	Ballast plate ROSON-ST 200 100mm

D.2 Drawings ROSON system

Drawing number	Description
048675 REV A	ROSON 75 – 3x ASSEMBLY (200 kNn)
048325 REV B	75 drive unit
048366 REV B	Drive motor
048389 REV A	Drive wheel 75-40
014910 REV -	Clamping cylinder
040325 REV A	Limit switch / Dirt scraper
045037 REV A	Scraper clamp
049364 REV A	Pressure compensated accumulator

D.3 Drawings ST system

Drawing number	Description
048718 REV B	Folder ROSON-ST 80m
048926 REV B	Sprocket assembly ROSON-ST 200
023453 REV A	ST Twister ROSON
045436 REV A	String tension guiding
048725 REV B	Drum carriage 80m
048735 REV B	Drum 80m
045154 REV A	Drive motor Folder/Sprocket
044202 REV A	Sprocket ROSON
045583 REV C	Spring guidance
044608 REV B	Twister suspension

022589 REV A	Collet clamp Twister
045123 REV A	Slip ring unit Folder
045120 REV B	SHPU Hydraulic buffer

D.4 Drawings ST string

Drawing number	Description
049754 REV B	ST start set ROSON-ST 200
043990 REV A	ST CPT string Ø40
046676 REV A	ST end set ROSON-ST

D.5 Drawings Junction boxes

Drawing number	Description
048309 REV A	Junction box Step-down trafo
048238 REV A	Junction box main DW-ROSON-ST
048531 REV A	Junction box drive unit DW-R-ST 200
045779 REV A	Junction box Icontrol-ST
023362 REV A	Junction box Twister ROSON-ST

D.6 Drawings sensors

Drawing number	Description
001426 REV D	Total load cell Icone 400 bar
007029 REV C	Iroson BASE P200 XY
006093 REV B	Proximity switch ROSON Subconn
045689 REV A	Depth encoder ROSON-ST
047584 REV A	Depth encoder ROSON-ST drive unit
045734 REV A	Pressure sensor 1000 bar 4-20mA
046141 REV A	Length gauge assembly
047147 REV A	Altimeter assembly

D.7 Drawings cables

Drawing number	Description
045890 REV A	Cable DIL13M-L-DIL13F
050415 REV A	Cable OMB4M-5-OMB4F-1000 VAC-red locking sleeves
050417 REV A	Cable OMB4M-5-OMB4F-1000 VAC-black locking sleeves
048250 REV A	Cable BH10M-L-BH10F

045660 REV A	Cable BH6M-L-BH6F
045719 REV A	Cable MCBH16M-L-MCBH16F
045683 REV A	Cable MCBH8M-L-MCBH8F
045887 REV A	Cable MCIL8M-L-IL4F
042036 REV A	Cable MCIL8M-L-MCIL8F
006613 REV A	Cable Icone SC4M-2,5-SC4F
007900 REV J	Cable Icone CC4
014876 REV -	DA-Cable Icone Power Line
049714 REV A	Power cable service unit 30m
049718 REV A	Cable IL10M-5-Mennekes 21039 (service unit)
049722 REV A	Cable Mennekse 13520-5-IL10F (service unit)

D.8 Drawings tools

Drawing number	Description
014696 REV -	Compensator pump
014581 REV -	Hand pump clamping cylinder
046347 REV A	Service unit HMI
050329 REV A	Drain hose clamping cylinder
050893 REV A	ST check rod

D.9 Drawings ROSON winch 1500m

Drawing number	Description
048266 REV A	DW-ROSON-ST Termination
005741 REV A	Sheave block ROSON-ST
045485 REV A	Controls ROSON-ST winch
048021 REV A	Transformer cabinet ROSON-ST winch
044087 REV A	Control cabinet ROSON-ST winch

D.10 Drawings Seismic source

Drawing number	Description
049558 REV B	Seismic source ROSON
049769 REV B	Seismic source
013625 REV -	Layout Seismic source ROSON
022090 REV A	Junction box Seismic Source
011670 REV -	Seismic source horizontal/vertical

Appendix E

Technical Documentation

E.1 Technical documentation

This appendix contains the technical specifications of OEM equipment. Consult these documents for questions about maintenance and/or operation of this equipment.

The technical documentation of the OEM equipment is available in digital format on the supplied USB drive.

Appendix F

Spares and consumables

This appendix contains the recommended spares and consumables.