ENGINEERING
TOMORROW

Case story

VLT® drives deliver **fast and accurate control** from the ship to the sea floor

<3%

THDi ensures high quality voltage at full load

drives.danfoss.com

VLT®

Distributing sustainable energy from the North Sea

Laying high voltage AC subsea cables is simpler, safer and more accurate than ever, with the remote operated vehicle (ROV) trencher from CT Offshore A/S. Danfoss VLT® drives are on board the mother ship, controlling high and low pressure ROV seawater pumps on the sea bed via an umbilical cable, which powers and controls the ROV at underwater depths up to 100 m. In the demanding offshore wind industry where the stakes are high, the investment in high power drives pays off in just days – but the benefits are lasting, delivering safe and sustainable power from the high seas, for decades ahead.

Laying the subsea cables safely

With a six-month timeframe, CT Offshore had the task of developing and building a new generation ROV trencher. Ambitions were high despite the short time frame, and targets included 820 kW (1100 HP) capacity for propulsion and pumping and a new DOBI (Depth Of Burial Indication) tool, PLC control with a range of finesses, ergonomic work environment.

A new technical challenge was to relocate the pumps from ship deck to sea floor to reduce losses and increase operation behavior of the ROV. With the pumps mounted on the ROV, high-precision variable speed pump control is crucial for success.

The solution: the ROV is fitted with a high and low-pressure system delivering jetting and back wash water through an advanced hydraulic operated manifold. This provides the unique opportunity to always maintain the optimum jetting pressure, combined with a controllable backwash system.

Senior Manager, Head of Subsea at CT Offshore, Mads Carstens, explains the pump function: "The high pressure pump supplies a water jet to the sword, which undercuts the cable, creating a trench into which the cable gently settles under gravity. At the same time the low-pressure pumpblows the trenched material out backwards, to bury the cable just settled. It is important for us to keep the sea bed material flowing so the cable can be laid down unhindered".

Steps to a solution – engineering support all the way

Variable speed control of high and low pressure seawater pumps mounted at the ROV, requires a special solution. Mads Carstens therefore calls on Danfoss along with competing suppliers to find a good solution for controlling the sea floor pumps.

Danfoss VLT Drives performs a system analysis of:

- The elements required for optimal pump control
- Harmonic distortion of the electric network onboard the ship.

Effective harmonic mitigation and marine compliance are also vital considerations.

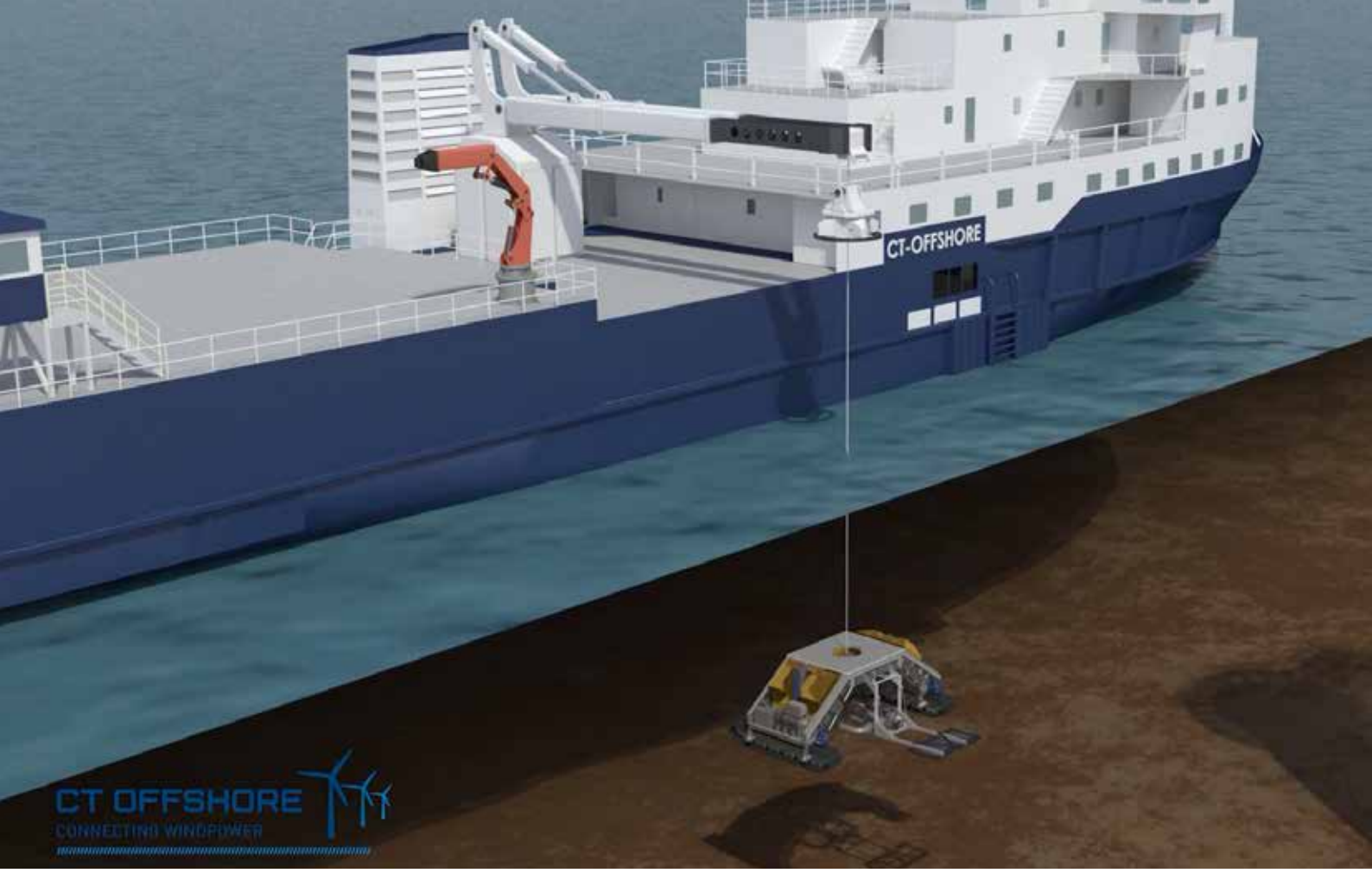
Based on comparison of these analyses, CTO chooses the solution delivered by Danfoss VLT Drives team, a low harmonic drive solution consisting of:

- VLT® AutomationDrive FC 302 Low Harmonic Drive to control high and low pressure pumps. This VLT® drive ensures less than 3% THDi, ensuring high quality voltage at full load.
  By using a low harmonic drive, the THDi and THDv remain low, reducing the generator dimensioning accordingly. Lowering the THDv extends component lifetime, by avoiding the risk of errors and instability of other components normally associated with harmonic disturbance and elevated THDv
- VLT® Sine-wave Filter MCC 101
- Step up transformer to 3300 VAC
- VLT® Soft Starter MCD 500 – for control of oil pump hydraulics: traction belt, sword hydraulics controlling depth and angle of sword, and the thrusters which control the orientation of the ROV when landing on the sea bed.

Danfoss helps in commissioning the low harmonic drives with PROFINET, and trained the PLC engineer in operation. Finally the Danfoss engineer performs test and connection of the drives together with CTO staff, in two phases.

1. Dry test in workshop:
   The team uses a generator to create a typical ship voltage of 440 V at 60 Hz. The pumps are tested under no load conditions, with 50 m umbilical cable. Pump control is good, and on/off control, frequency and pump direction confirmed.

Left: The high pressure pump is mounted directly on the ROV, controlled by a VLT® drive on board the ship. This pump delivers jetting water to the sword.
Right: This motor for the hydraulic system controls the traction belt, sword hydraulics and the thrusters, and is controlled by a VLT® Soft Starter MCD 500.



How the ROV is lowered to the sea floor

"Subcontractors like Danfoss have helped us to meet our deadlines ... We reach payback on the VLT® drives already in the course of a few days."
Senior Manager, Head of Subsea at CT Offshore, Mads Carstens

2. Wet test and commissioning on board the ship, with ROV pumps running at full load underwater:
   - Fine tuning of the LHD drive power parameters
   - Correct pump operation
   - Control of the voltage supplied to the pumps, to avoid overheating of the umbilical cable.

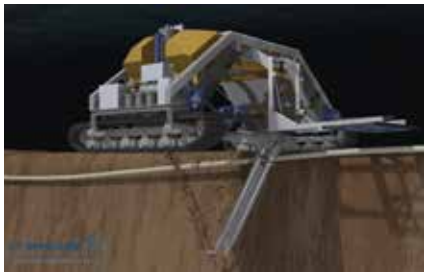
"We can observe the electrical pump performance at the ROV but cannot measure it. So we determine the correct settings by a process of informed trial and error", explains Anders Eriksen, Application Engineer at Danfoss Drives.

Mission accomplished

After the wet test, the ROV is ready for commercial tasks. The ROV and its power and control containers are commissioned on board the Mærsk Recorder, then put into duty at DONG's Gode Wind offshore wind farm in the German sector of the North Sea.
CT Offshore COO Hans Schneider explains "We achieved a good result due to strong subcontractors able to help us and follow the ideas coming from Mads and his team – thank you for that".

High-precision variable speed control of the seawater pumps ensures unhindered burial of the subsea cable:
- The subsea cables, usually connecting two wind turbines, is laid out in its correct position on the sea floor.
- The ROV is carefully lowered and positioned so it straddles the cable.
- On the ROV, the high pressure pump powers a sword, jetting a trench under the subsea cable.
- The low pressure pump on the ROV blows the trenched material out backwards. It is important to keep the sea bed material flowing so the cable can settle down into the trench unhindered.

All handling, lifting, and forcing the cable includes potential risks of cable fatigue damages. Therefore the meticulous control of the ROV pumps by VLT® drives is vital to ensure precision cable undercutting and burial, for elevated safety and stability throughout the subsea cable lifecycle.



How cables are buried under the sea floor

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Details of the CTO 107-1100 ROV trencher

- Model: Trencher ROV
- Serial no.: CTO107-1100
- Built: May 2015
- Weight 9000 kg
- Dimensions
  3940 x 6340 x 2670 mm
- Rating: 820 kW (1100 HP)
- Designed by CT Offshore

What's in the container

The control room and power drive system are each mounted in a standard container for fast and convenient transfer to the deck of the ship.

During testing, a total of 1 MW power was sourced from a generator located in its own container. However during normal operation the ROV draws upon the motor of the ship, which has 1.8 MW surplus capacity available.

What's in the power container

- VLT® AutomationDrive FC 302 Low Harmonic Drive
- Transformer 400 V – 3.3 kV for subsea pumps (economically maintenance- free)
- Transformers for hydraulic pumps
- VLT® Sine-wave Filter MCC 101
- Small telemetric transformer 2.4 kV
- VLT® Soft Starter MCD 500 for hydraulic pumps

What's in the control container

- Control room with two work stations and multiple screens
- Cameras mounted on the ROV show images on the control room screens, enabling the operators to follow the progress of the trenching operation

Mads Carstens, Senior Manager, Head of Subsea at CT Offshore with Jens-Christian Strate and Anders Eriksen from Danfoss Drives, Denmark

ROV operator

CT Offshore A/S

When it comes to connecting wind power offshore

CT Offshore is a Danish subsea cable installation company specialising in installing and maintaining subsea cables for the many new offshore wind farms delivering environmentally friendly energy in the years to come.
CT Offshore is expert in cable-laying for offshore wind farms, fibre optic cables, deep-sea repairs and High Voltage DC/AC cables in diverse environments – and in consultancy before, during and after installation of cables offshore.

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