



**VACON AC DRIVES
FOR MARINE AND OFFSHORE**

VACON
DRIVEN BY DRIVES

VACON AC DRIVES SAVE FUEL AT SEA

The fuel economy and smooth control of various processes onboard speak for the use of variable speed AC drives in the highly competitive marine and offshore sector. For years, Vacon has been establishing strong partnerships with leading system integrators in the field. Therefore we can offer robust AC drive solutions to all your needs, from simple ventilation to the most demanding load sharing in high-power propeller and steering gear systems. The Vacon AC product line ranges from 0.25 kW to 5 MW, at voltages up to 690 V.

Hydraulic vs. electric in winch systems

Electrical winches provide substantially lower levels of noise than traditional hydraulic winches and, consequently, more comfort onboard. This is one of the reasons why luxury ships such as Queen Mary 2, Voyager and Freedom-class cruise ships – and many others – are equipped with electrical winches. With electrical drives the motors can be run up to three times faster than with hydraulic systems, e.g. in slack rope handling.

However, the advantages of the electrical winch system are most imminent in energy consumption. As the hydraulic system has to provide full torque at all speeds, the supply operates at full power at all times. In contrast, the electrical system only requires the power that is needed for the work. The formula on the right is applicable to the electrical system: when either the torque or speed decreases, the power required decreases accordingly.

Hydraulic vs. electric in dynamic positioning

Traditionally, dynamic positioning is done by a variable pitch propeller and a fixed rotational speed. However, a solution with a fixed pitch propeller and a variable speed is more beneficial. For most of the time in dynamic positioning, the thrust needed is minimal so the shaft speed can be reduced. This means less energy consumption. In contrast, the energy consumption of the variable pitch propeller at zero thrust is still approximately 20% of the full torque.

$$P = T * \omega$$



Why use speed control?

- energy savings up to 40%
- less electromechanical stress for electrical system
- process control according to demand
- flexibility in power generation and distribution
- flexibility in ship design, providing more freedom in layout

Winches onboard a luxury cruise ship

LESS NOISE IN ENVIRONMENT

In general, electric drives and systems generate less noise than hydraulic systems. Therefore, there are less restrictions on machinery placement onboard. Machinery can, for instance, be installed close to accommodation areas without any inconvenience to the crew or passengers.

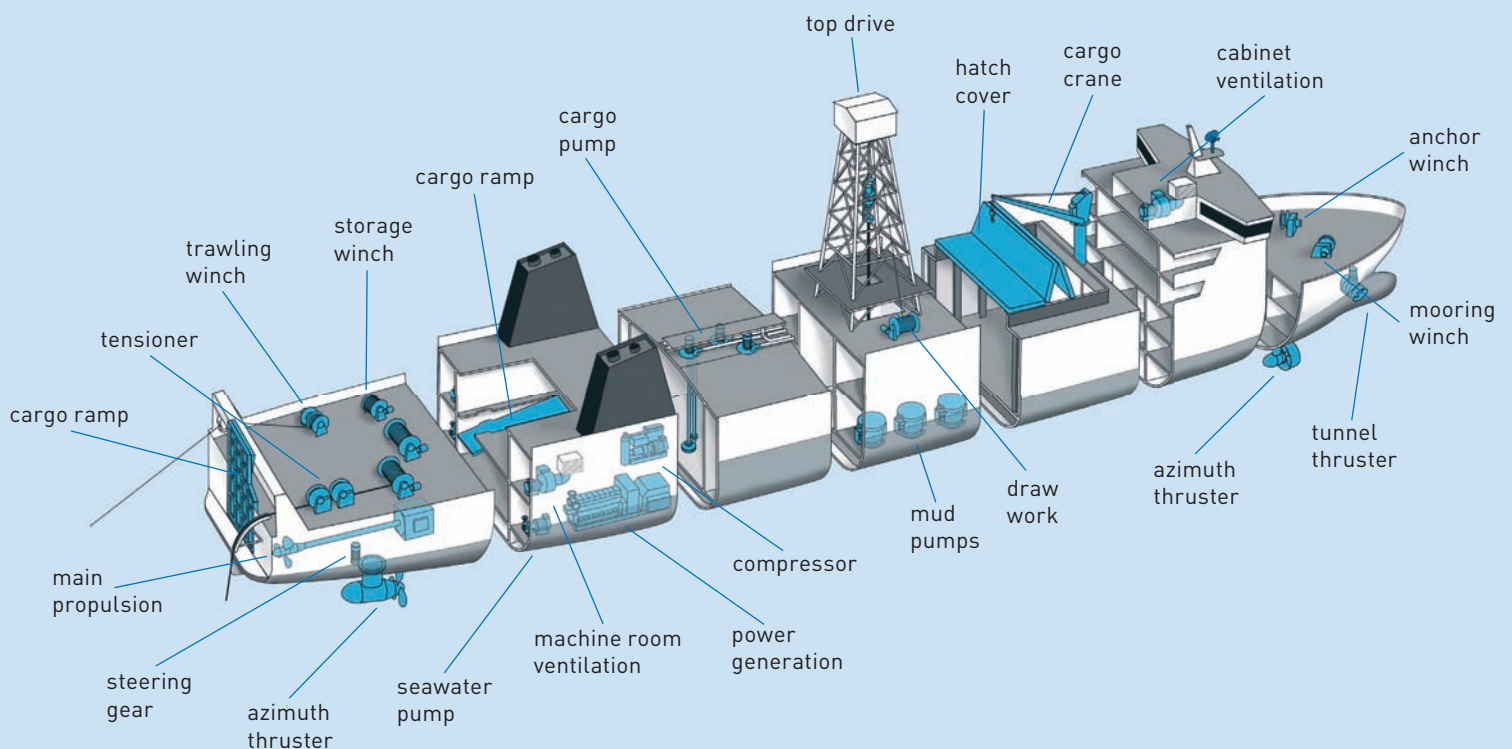
The use of electric propulsion allows the use of several smaller generator sets. They can individually be shut down when the need for power decreases, e.g. while operating the vessel at low speeds in coastal areas. This also contributes to considerably less audible noise in the environment than using a slow-running large marine diesel engine. Additionally using frequency converters for bow thrusters, fire pumps and other large power consumers eliminates the need to reserve power for the startup current peak. Consequently, the use of the starting auxiliary generators just for the startup can often be avoided.



M/S Speciality, an all-electric tanker

APPLICATIONS

Requirements in marine and offshore rise from the ambient conditions and also from the supply network of vessel and space and fuel save requirements. Tens of thousands of Vacon AC drives are already running onboard vessels of every kind. They vary from the smallest helper drives to the megawatt's propulsion and from simple ventilation to the most complicated winch systems. And all of them are made to last. Vacon AC drives fully comply with the rules of the marine approval societies.



MAKE THE PERFECT CHOICE

The choice of electrical equipment onboard is one of the most important and most costly decisions the shipowner or shipmaker needs to make. Among the critical choices are the use of a low or medium voltage system, the choice of a transformer, and the choice between diesel-electric and mechanical system.

The choice and use of an AC drive

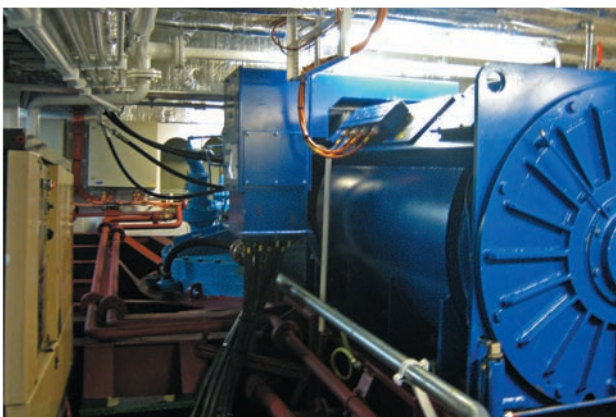
1. AC drives should be located in dry heated places such as control rooms, electrical rooms, engine rooms or accommodation areas.
2. AC drives must not be installed on deck, in masts, inside or on the surface of machinery because the ambient conditions exceed the drive's tolerance.
3. In choosing Vacon AC drives, be sure that the EMC type is suitable for IT networks, indicated by the typecode letter "T" for the EMC class.
4. Dimensioning AC drives for propulsion is like dimensioning for pumps and fans. Special care should be taken when planning ice-going ships and winch drives.
5. Brake choppers and resistors are necessary for bow thrusters when the changes in rotational speed are rapid.
6. An Active Front-End (AFE) solution allows numerous advantages with regards to harmonic distortion and for dimensioning components on the supply side because of the following reasons:
 - the power factor is almost 1
 - THD is as low as below 4%
 - heat losses are minimal
 - less steelwork, foundation, termination and cabling work because there are no phase-shift transformers
 - the weight and space needed by transformers are saved
 - improved fuel economy and generator power utilization



The choice of the motor

Large-size (over 2 MW) motors can be built using several sets of windings that have a zero-degree phase shift. These sets require galvanic isolation so that each winding can have a separate AC drive. The drive topology can consist of 1, 2, 3 or 4 drives running the same motor, i.e. sharing the same load. There are redundancy benefits as the motor can be partially loaded with one or several drives disconnected.

Permanent magnet motors are about to penetrate the motor market. Cargo cranes and offshore drills in particular are often equipped with these motors. Vacon has proven technology for these markets as well.



Marelli 2200 kW water-cooled double jacked main propulsion motor for an ice breaker

ROBUST TECHNOLOGY FOR MARINE AND OFFSHORE

The Vacon NX product family is designed to fulfill the requirements of all marine applications with a single product family.

Robust and reliable

- Each drive is tested at maximum operating temperature at full motor load prior to shipment
- All drives are made of high-quality components for long lifetime
- Comprehensive run-time self-supervision and alarm system for enhanced reliability and safety

Versatile control and integration

- Single-drive and complex load sharing possible
- Flexibility in communication via multiple fieldbuses
- Expandable I/O connections with quick terminals
- Control logic can be externally powered – secured communication possible
- Wide selection of application software available
- RS232 terminal for PC connection

Innovative and modern

- Quick and easy installation
- Start-up wizard for easy commissioning
- Compact size
- Motor parameter identification capability
- Engineering tool that complies with the IEC61131-3 standard
- Parameters and applications can be copied between drives and panels



MAKING HARMONIC DISTORTION A NON-ISSUE

Total harmonic distortion (THD) is regulated by standards such as IEEE 519. The standards specify the voltage distortion which is generated in the inductance of the network, transformer and generator. The current distortion is typically generated by chopping current sources such as frequency converters.

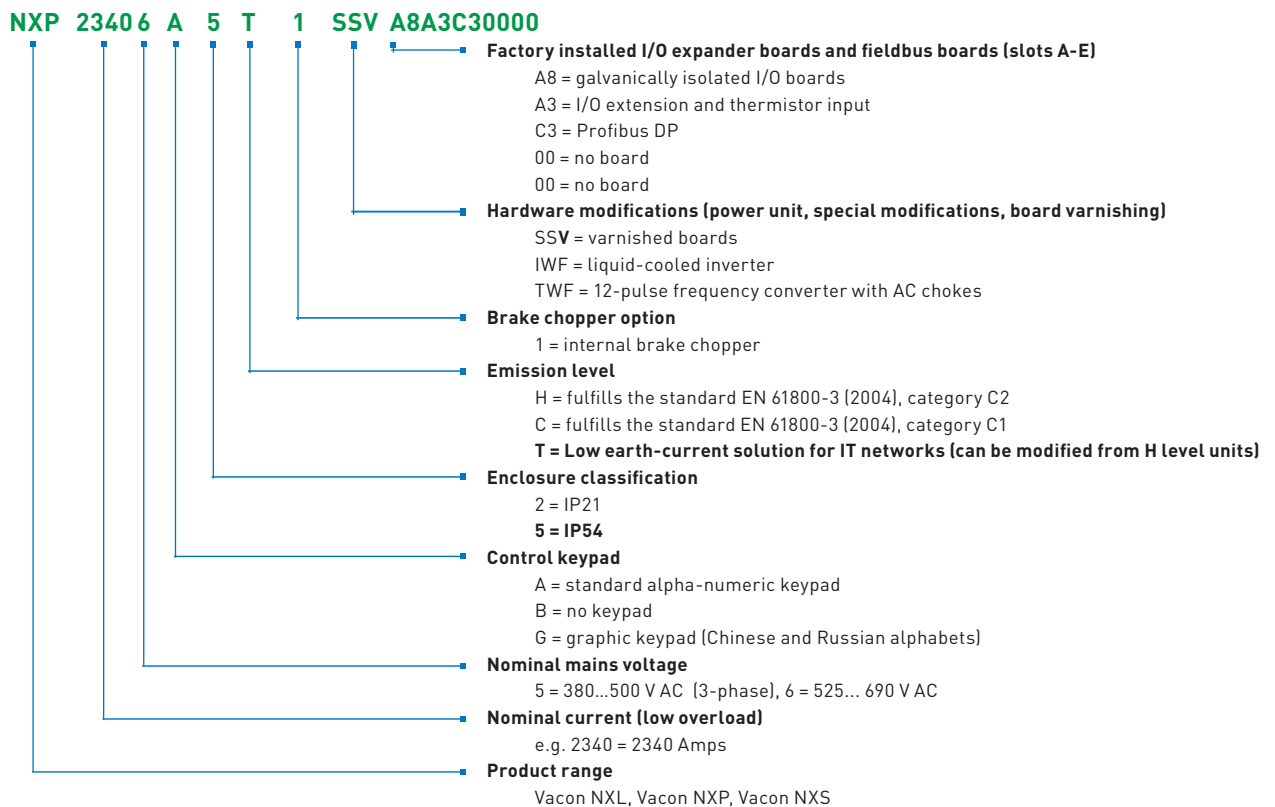
The transformers and generators onboard have to tolerate the harmonic distortion caused by frequency converters. This is specifically of note in systems where the frequency converters are the major consumer.

Vacon has reduced the harmonic distortion to a non-issue by introduction of its Active Front-End (AFE) solution. The drive actively connects the internal DC bus to the network when appropriate and efficient filtering limits the level of the voltage THD below 4%.

The network frequency of 60 Hz usually may cause malfunctions in the components intended for use at 50 Hz (externally powered fans, contactors and pumps).

The IT networks with no grounding require earth-leakage supervision. This supervision system will trip if the drives used are not suitable for insulated networks. Vacon AC drives for marine and offshore are specifically designed for use in the IT networks as they have a galvanic isolation between the live parts and the frame.

TYPE DESIGNATION CODE

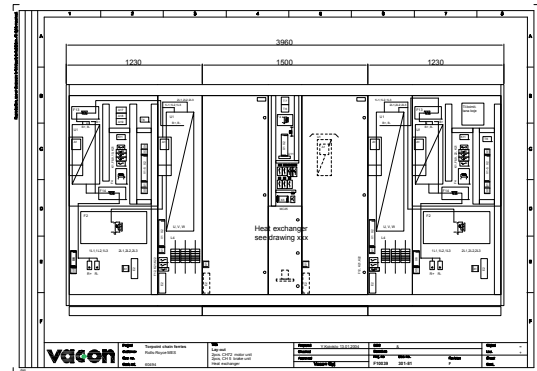


SYSTEM INTEGRATOR MAKES COMPLETE SYSTEMS

The system integrator takes the total responsibility of the complete system. Vacon's professionals and their know-how are at the system integrator's disposal from beginning to end.

Total responsibility of the system integrator

- Perform harmonic calculations
- Ensure success in EMC issues
- Perform short circuit calculations
- Succeed in black-out prevention
- Co-operation with automation system
- Control of power management system
- Ensure good engineering
- Provide documentation and training



CASE: ALL-ELECTRIC TANKER SPECIALITY

The design goal: to build silent coastal tankers that can discharge the cargo in the middle of residential areas at night. The solution: an electrical main propulsion system which provides extremely low noise levels as there are no large low-speed diesel engines that can be heard at long distance. The same technology was applied to four similar vessels belonging to the same series.

M/S Speciality

- 2 x 900 kW main propulsion drives
- 350 kW bow thruster drive
- 6 x 150 kW cargo pump drives
- 3 x 52 kW drives for slop/ballast pumps



Characteristic of these oil product tankers is the requirement of the lowest possible noise level. Electric motors are quiet compared to their hydraulic alternative. The usefulness and efficiency of the variable speed control of a fixed blade propeller is clearly better than the fixed speed with a variable angle. Additionally, the fixed speed propeller always runs at the maximum speed, which causes more mechanical noise even at partial loads. In these tankers, all propellers are equipped with a fixed space angle (CP) to ensure a sufficient noise performance. The main goal is to avoid noise from hydraulic machinery when discharging the cargo. This is a clear advantage for the neighbourhood, especially at night time.

An electrical main propulsion drive offers numerous important benefits over a diesel-engine direct-driven propeller. For example, the power generation plant can be optimized, consisting of several smaller units, thus reducing the emissions of environmentally harmful gases. The motor speed of the tankers' main propulsion will be controlled by two 900 kW liquid-cooled Vacon NX drives. Speed control also decreases the electromechanical stress for the electrical system and provides flexibility in power generation and distribution. All together four similar vessels belong to the same series.

REFERENCES



EVA 316

TypeIce breaker
 OwnerEstonian State
 System integratorSES, Norway

Vacon AC drives
 2 x 2200 kW main propulsion AFE
 Star-coupler, 2 winding motors
 Acc. to DNV rules



Atlantic Enterprise

TypeTrawler
 OwnerOcean Prawns
 System integratorSES, Norway

Vacon AC drives
 3 x 315 kW trawling winches AFE
 Class DNV



Seili

TypeFairway maint. vessel
 OwnerFinstaship
 System integratorAsle Metals, Finland

Vacon AC drives
 2 x 1100 kW main propulsion AFE
 Acc. to DNV rules



Limitless

TypeSuper yacht
 OwnerPrivate
 System integratorImtech, the Netherlands

Vacon AC drives
 2 x 1800 kW main propulsion
 Star-coupler and load sharing
 Class ABS



Safe Concordia

TypeAccommodation rig
 OwnerConcordia
 System integratorOffshore & Marine, Norway

Vacon AC drives
 4 x 2500 kW main propulsion
 Star-coupler, 2 winding motors
 Class ABS



Speciality, first of four vessels

TypeCoastal tanker
 OwnerF.T. Everard & Sons Ltd
 System integratorImtech, the Netherlands

Vacon AC drives
 2 x 900 kW main propulsion, 35 thruster
 6 x 150 kW cargo pump, 3 x 52 kW slop/ballast pumps
 Class ABS



Voyager and Freedom Class Cruise Ships, five vessels

TypeCruiser
 OwnerRoyal Caribbean Cruise Line
 System integratorAker Finnyards, Finland

Vacon AC drives
 250 ventilation drives
 14 winches
 Class DNV



Stena Paris, first of six vessels

TypeP-Max class tanker
 OwnerConcordia Maritime
 System integratorHamworthy Svanehøj, Denmark

Vacon AC drives
 10 x 250 kW drives and 6 x 250 kW AFE units for cargo pumps
 3 x 100 kW slop/ballast pumps
 Class DNV



Nahlin

TypeMotor yacht
 OwnerPrivate
 System integratorImtech, the Netherlands

Vacon AC drives
 2 x 2200 kW AFE main propulsion
 150 kW bow thruster, 40 kW sea water pump
 Class LRS



Deep Driller 2, first of four rigs

TypeJack-up drilling rig
 OwnerSinvest
 System integratorOffshore & Marine, Norway

Vacon AC drives
 6 x 1300 kW mud pumps
 4 x 1500 kW draw works
 2 x 1500 kW top drive
 Class ABS

Vacon Partner

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