MARINE SOLUTIONS

Proven solutions for Marine applications
Propulsion & Power Grid

LEROY-SOMER™

Nidec
All for dreams

Introduction

Nidec Leroy-Somer has long been a key player providing products, solutions and services for a wide range of applications in the marine industry, covering navy, merchant and pleasure vessels. We provide expertise and leading technologies for a large number of partners including vessel owners, shipyards and **OEMs/system integrators**, with the aim of helping them maximizing the performance and efficiency in their marine operations. Our products and systems are designed to fit naval standards and comply to specific marine certification regulations.

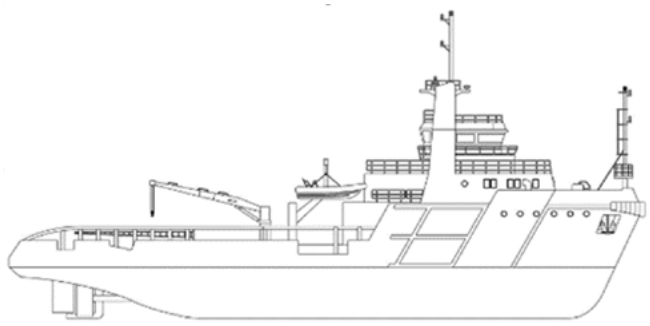
With vast experience in marine project management, engineering design, commissioning and training, we are a single source supplier of all electrical components and project services related to:

- Energy saving and low-to-zero emission electric and hybrid propulsion systems
- High performance and safe deck machinery, including anchor and mooring winches, as well as pipe laying equipment including tensioners and various winches (traction, storage and umbilical)
- Efficient onboard grid, pump, compressor, and fan systems. Covering both new and retrofit applications, project timescales and costs are minimized, with easy integration with ship wheelhouse control systems performed by our multiple Ethernet and fieldbus communication protocols.

Nidec Leroy-Somer marine systems are **flexible** and **customized** to the exact requirements of your vessel, ensuring maximum performance and functionalities from our core drive, motor and alternator technologies. Reliability is guaranteed by a load testing on propulsion systems prior to installation. Products can be adapted to specific marine requirements such as high shock resistance and EMC protection to military levels, while noise and vibration are minimized, ensuring occupants and ride comfort.

The aim of this document is to provide our customers an overview of our **onboard energy conversion systems**.
At first the various possibilities of Nidec Leroy-Somer equipment will be introduced. We provide turnkey integrated variable frequency drives (VFDs) for marine. OEMs or system integrators will most appreciate the modularity of our new Powerdrive MD Smart, presented in the second part. Our motor ranges suitable for marine applications will be specified in the third part. The last part will explain the strengths of Nidec Leroy-Somer to answer your project.

All information is compiled with our experiences. This document will be revised and completed.



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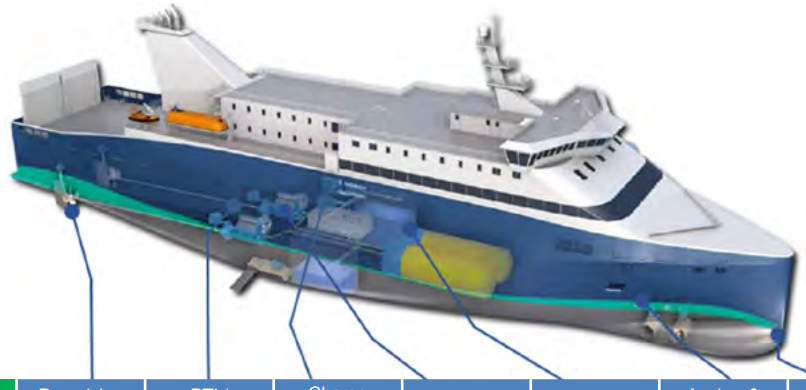
Propulsion & Power grid solutions

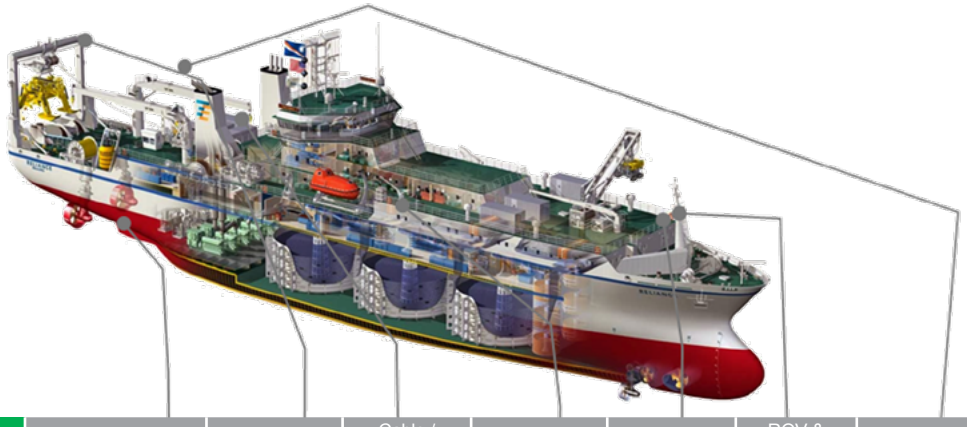
Our equipment can cover various integrated energy conversion functions.

MARINE PRODUCT PORTFOLIO
Underway



CIMD-E Products	Propulsion and Control	PTI / PTO / PTH	Charge discharge battery storage	Machinery Ventilation	Pumps Compressors	Anchor & Mooring Winches	Bow Thrusters
MD Smart	•	•	•	•	•	•	•
FLSHR	•	•					
LC	•	•			•	•	•
PLSES	•	•			•		•

Handling



CIMD-E Products	Stern Thrusters	Plough Deployment	Cable / Pipe Handling	Davit Actuation	Deck Winches	ROV & Umbilical Winches	Cranes
MD Smart	•		•		•		•
FLSHR							
LC	•		•		•	•	•
PLSES	•						

Propulsion & Power grid solutions

The scheme below introduces a standard propulsion structure of a ship.

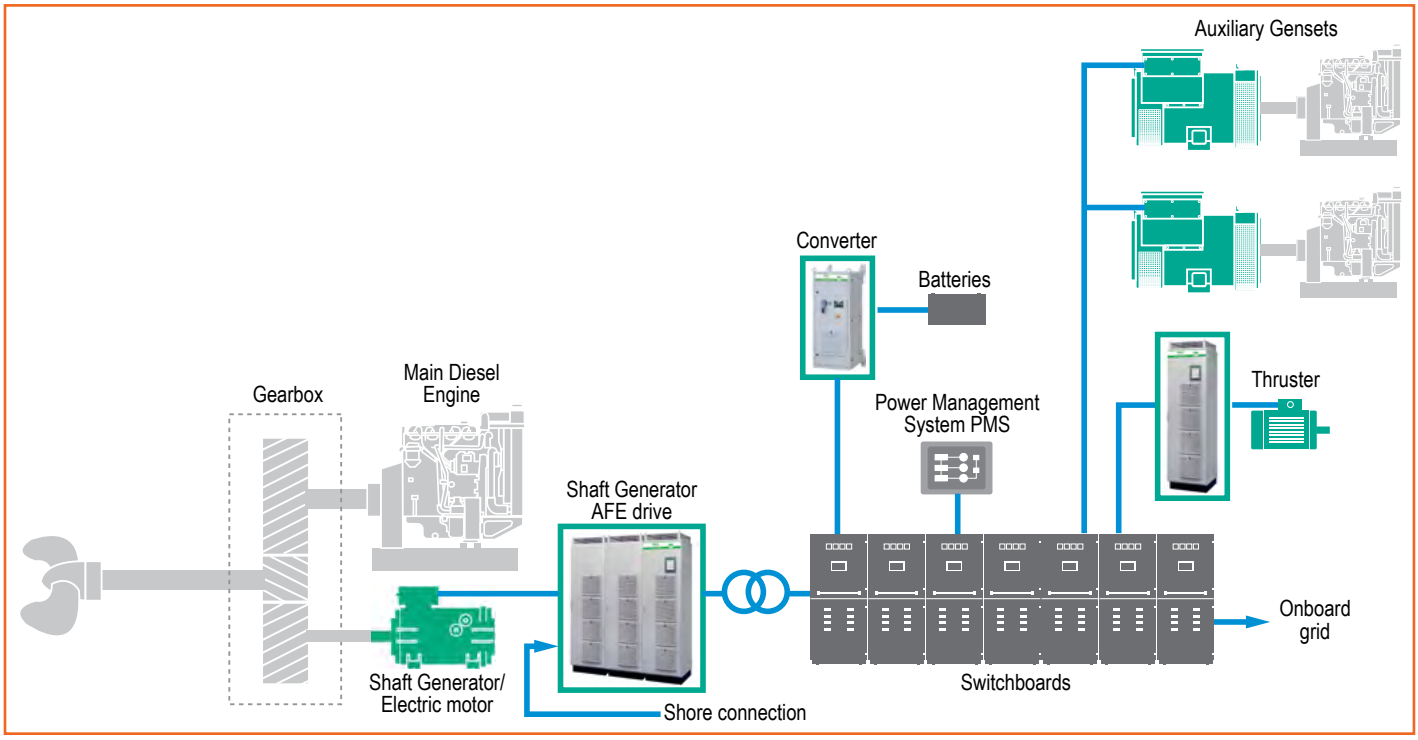


Figure 1: Standard propulsion structure

The following materials are part of the Nidec Leroy-Somer offering:

- Shaft Generator / Electric Motor
- AFE (Active Front End) Drive
- Thrusters or other auxiliaries
- Thrusters or other auxiliaries Drives

DC/AC included DC/DC stage for Battery converter

Nidec Leroy-Somer can also provide the DC and AC Power Grid onboard, the following chart illustrates its working principle.

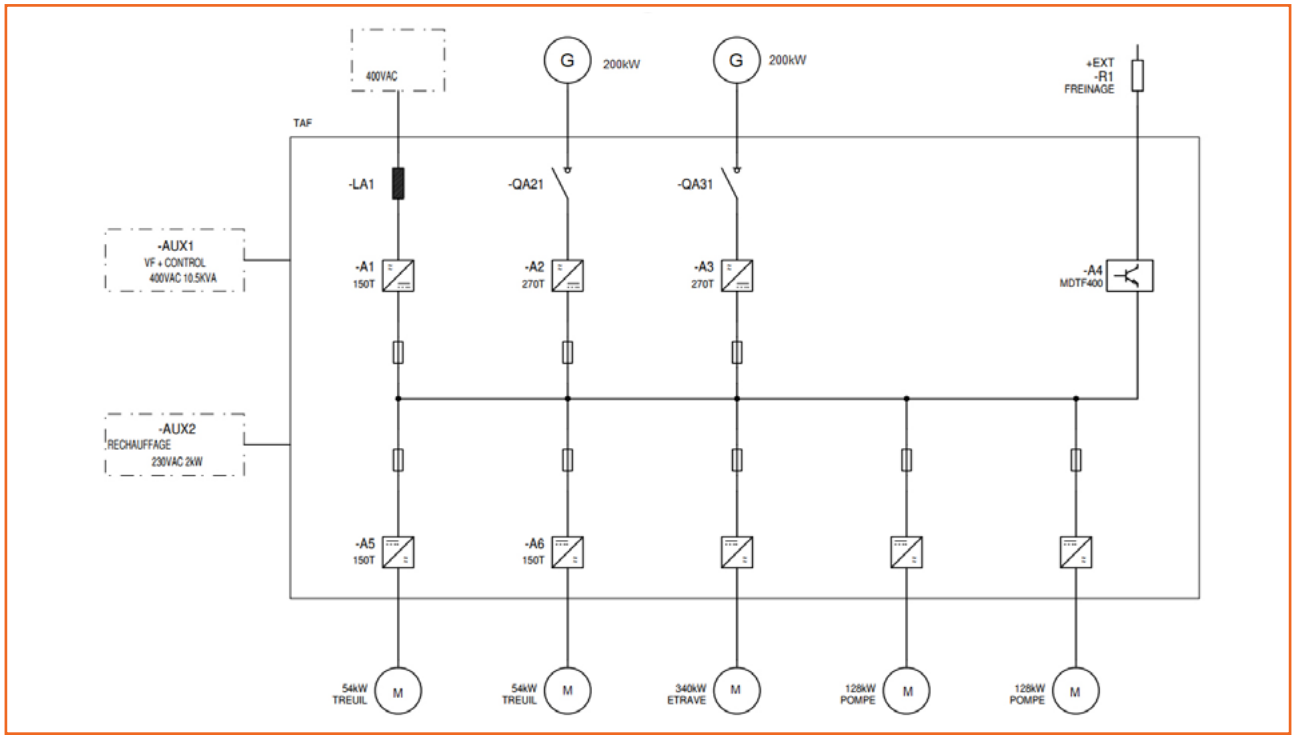


Figure 2: DC Grid structure example

In this case, Nidec Leroy-Somer can propose the DC Grid and the DC/DC battery charger.

The **Powerdrive MD Smart** is commanded by the Power Management System (PMS) of the ship, which is not included in the solution. The VFDs however is equipped with advanced functions such as PTI/ PTH, PTO (island or parallel) with short-circuit management, power limitations, load sharing through voltage and frequency droop or external active and reactive power setpoints. It also manages the various alarms, exchange functional data and receive commands such as the functional mode which will be detailed next page.

The ships can be designed with various propulsion structures, depending on the source(s) of energy and the propulsion means.

Propulsion & Power grid solutions

OPERATING MODES

The operating modes described underneath are covered by the Nidec Leroy-Somer **Powerdrive MD Smart ETO** offer:

- Electric propulsion PTI (electric motor at low speed or high speed)
- Electric propulsion PTH (electric generator used as electric motor at low speed)
- Diesel propulsion alone
- Electric propulsion PTI booster (electric motor and diesel)
- Electric generator PTO (electric machine used as a generator and coupled to diesel alternators)
- Electric propulsion IPTO (electric machine used as a generator alone to create the network power)

To illustrate those principles onboard here is a useful generic diagram, followed by an explanation of each mode.

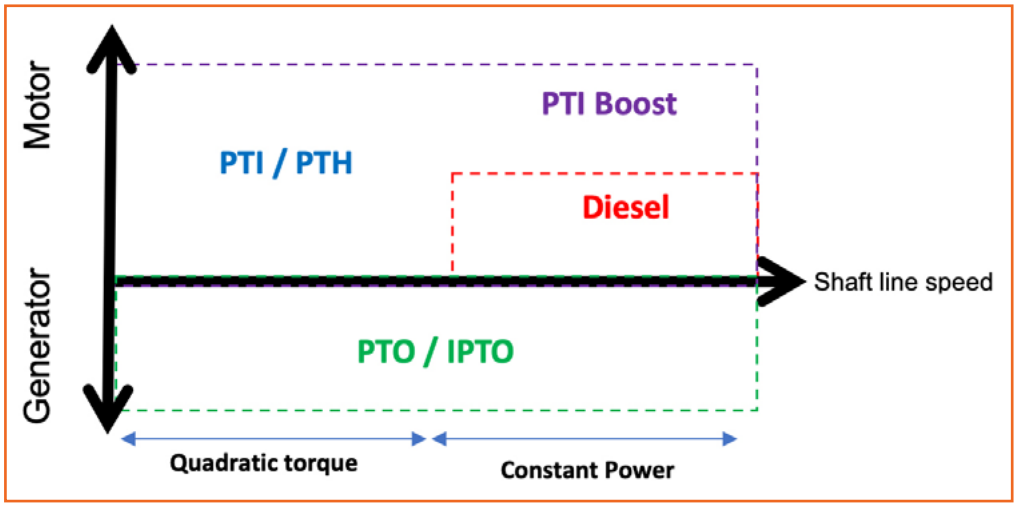


Figure 3: Operating modes diagram

Electric propulsion PTI

In this mode, the propulsion is ensured by the electric motor **driven at low speed or high speed** by the **Powerdrive MD Smart** in open or closed loop. A speed feedback sensor can be mounted on the electric motor.

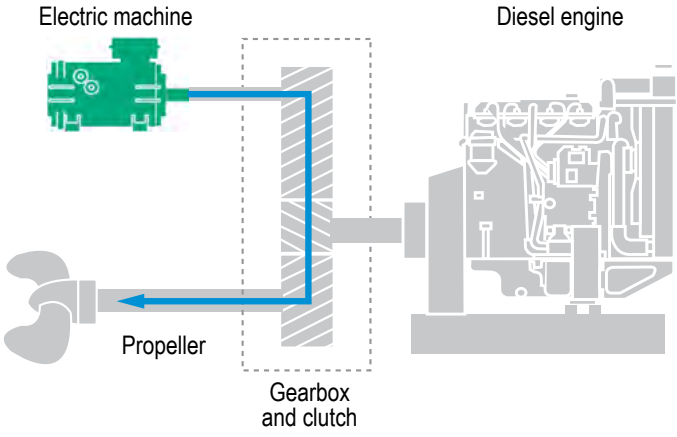


Figure 4: Power Take In (PTI)

The speed reference as to be limited according to the electric motor definition. Regarding the torque, it must be limited to the **Powerdrive MD Smart** reference. This is operated either by an intern setting or through an analog reference, or through the Ethernet fieldbus.

Exchanges between PMS and **Powerdrive MD Smart**: In this mode the **Powerdrive MD Smart** needs a speed reference restricted between 0 and the nominal speed, a torque reference equals to the maximum torque allowed and a run command.

- Case of a resistant torque higher than the torque reference. The **Powerdrive MD Smart** won't be able to drive the motor at the speed and will be limited to the maximum torque reference. A thermal protection may trigger if the drive remains on its limitation too long.
- Case of a resistant torque too low (propeller out of water). The **Powerdrive MD Smart** will follow its speed reference and won't run away. When the resistant torque comes back, the drive will supply the torque needed to maintain the speed to the reference.

If, on a run command, the speed propeller is not null, the converter performs a catch on speed identifying the motor speed and adapting the Pulse Width Modulation (PWM) consequently to catch the motor.

Propulsion & Power grid solutions

Electric propulsion PTH

This mode can either way be full electric for a port exit maneuver of a diesel breakdown, or full electric mode to bring back safely the ship to the shore. The **shaft generator** is used as an electric motor **at low speed**.

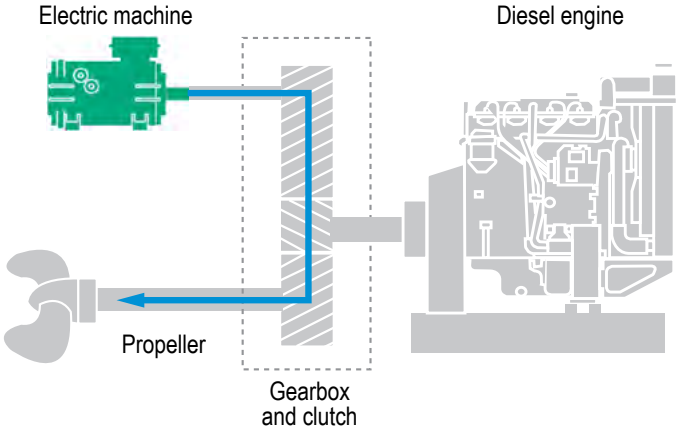


Figure 5: Power Take Home (PTH) mode

The propulsion is ensured by the electric generator (alternator) driven by the **Powerdrive MD Smart** in closed loop. The Powerdrive MD Smart has specific algorithms to start Nidec Leroy-Somer alternator managing torque:

- **Using the saliency torque**
- Without loading the damper cage
- Without pony motor

After, the speed reference as to be limited according to the electric generator specification. Regarding the torque, it has to be limited to the **Powerdrive MD Smart** reference. This can be operated either by an internal setting, through an analog reference, or through the Ethernet fieldbus.

Exchanges between the PMS and the **Powerdrive MD Smart**: In this mode, the **Powerdrive MD Smart** needs a speed reference restricted between 0 and the nominal speed, a torque reference equals to the maximum torque allowed and a run command.

- Case of a resistant torque higher than the torque reference. The **Powerdrive MD Smart** won't be able to drive the motor at the speed and will be limited to the maximum torque reference. A thermal protection may trigger if the drive remains on its limitation too long.
- Case of a resistant torque too low (propeller out of water). The **Powerdrive MD Smart** will follow its speed reference and won't run away. When the resistant torque will come back, the drive will supply the torque needed to maintain the speed to the reference.

If, on a run command, the speed propeller is not null, the converter performs a catch on speed identifying the electric machine speed and adapting the PWM consequently to catch the motor.

Diesel engine mode

In this mode, the Electric Power System do not drive the propeller. The diesel engine provides all the energy to move the ship.

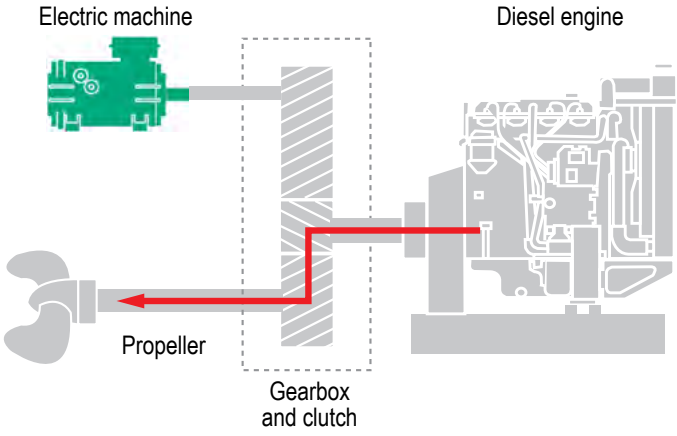


Figure 6: Diesel mode

The **Powerdrive MD Smart** is locked. The induction motor is no longer magnetized, and the voltage generated by the motor driving through the gearbox is low. No energy can flow up to the **Powerdrive MD Smart** DC Bus as the Insulated Gate Bipolar Transistors (IGBT) are not commanded. In this mode, the **Powerdrive MD Smart** waits an unlock command from the power management system.

Propulsion & Power grid solutions

Electric propulsion PTI Booster

In this mode, both **electric motor** and **diesel engine** take part to drive the propeller.

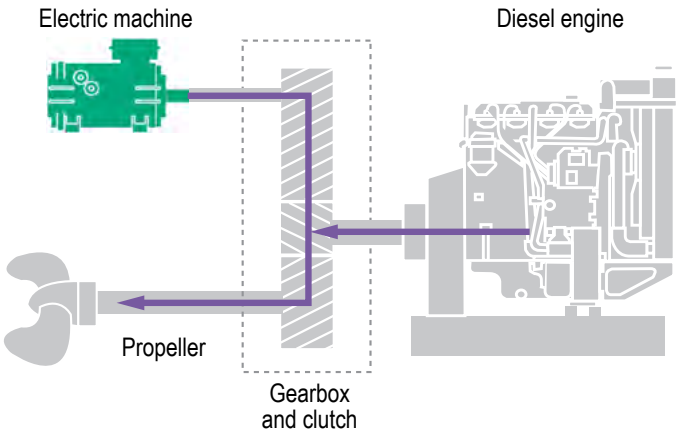


Figure 7: Booster mode

The electric motor is driven by the **Powerdrive MD Smart** in closed loop mode. The converter is functioning on a torque regulation mode. It undergoes the propeller speed but do not control it. The converter only brings the demanded torque independently to the speed. If, for any reason the load on the shaft disappears (propeller out of water), the speed will change to respect this simplified equation:

JdW/dt = Torque Diesel Engine + Torque Motor - Torque Propeller

The motor torque is constant then, in the case of a propeller torque decreasing, the speed drive will increase. The Power Management System, helped by the motor speed feedback, can quickly identify this situation, and lock the converter.

This mode is interesting as the PMS controls the commands. If, nevertheless, the speed keeps increasing and reach the maximum speed threshold, the converter trips, locking the IGBT and displaying a user trip. Then the motor is no longer magnetized, and the dangerous voltages are reduced. To implement this protection, the motor speed feedback must be returned to the PMS, either via fieldbus or analog signal.

As the speed will decrease to the authorized range, a sequence (trip reset command on PMS or automatic reset) restarts the converter to catch the motor on speed and apply the torque again.

If, at the opposite, the diesel engine torque decreases suddenly or even disappear, the shaft line speed decreases and, in some case, gets null. The converter however keeps applying the demanded torque, which can be applied at zero speed as the thermal protection is not active. The converter accepts its nominal current at zero speed.

In this mode, the converter needs this information:

- Torque reference
- Speed reference equals to the maximum speed accepted
- A run order command

Shaft generator PTO

The electric machine is used as a generator and coupled to diesel alternators. The electric machine could be either an asynchronous motor or a synchronous permanent magnet motor or an alternator.

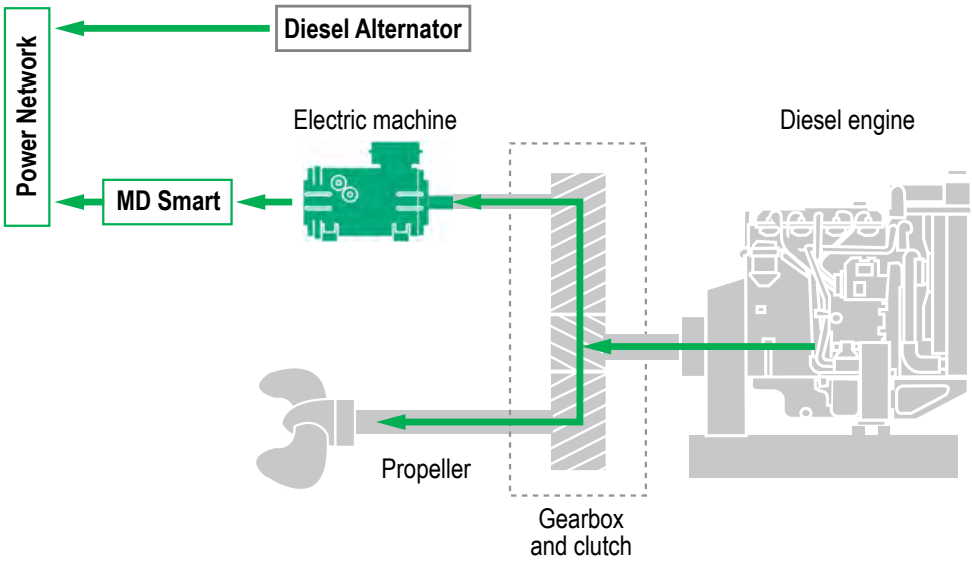


Figure 8: PTO mode

The electric motor is used as a generator. It is controlled in closed loop. The **Powerdrive MD Smart** provides constant voltage and frequency to the grid. It is considered as one of the generators of the system, and works in parallel with gensets.

The **Powerdrive MD Smart** embeds specific algorithms, set by parameters for this mode.

In this mode of operation the **Powerdrive MD Smart** is an AIC (Active Infeed Converter), forming a three-phase voltage system.

It generates the voltage system in parallel with other voltage sources according to the voltage and frequency droop characteristics set in the drive parameters or by active and reactive power control (slave mode).

At the start of the AIC in grid forming mode, the voltage measurement at the drive terminals is analyzed:

- If the voltage RMS value is above half of the AIC rated voltage, a synchronization phase of approximatively one second will be performed. After this phase, the AIC will operate in voltage and frequency droop control.
- If the voltage RMS value is below half of the AIC rated voltage, the AIC will generate the three-phase voltage system at its output terminals as soon as a run order is given.

The active and reactive powers are either balanced with the other sources according to the voltage and frequency droop levels, or regulated via instructions given to the AIC.

Propulsion & Power grid solutions

Shaft generator IPTO

The electric machine is used as a generator alone to create an **«island» grid**. The electric machine could be either an asynchronous motor or a synchronous permanent magnet motor or an alternator.

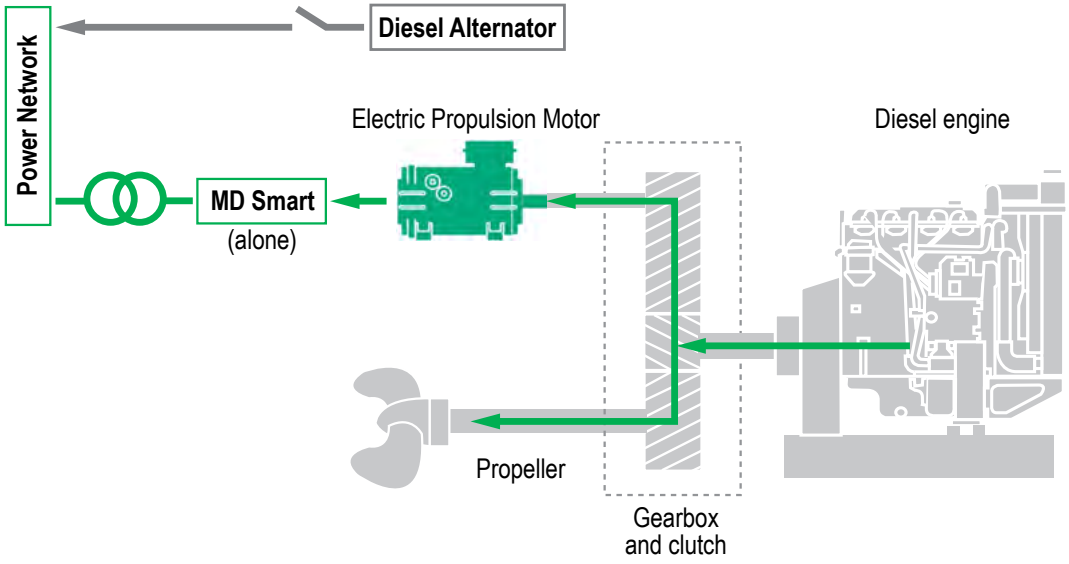


Figure 9: IPTO mode

The electric motor is used as a generator. It is controlled in closed loop. The Variable Speed Drive (VSD) generates alone an AC voltage grid providing constant voltage and frequency. The **Powerdrive MD Smart** can compensate the unbalanced load on the grid and provides reactive power compensation.

An insulation transformer is needed between the **Powerdrive MD Smart** and the grid for galvanic isolation avoiding transmission of common mode currents. The input power bridge is oversized to regulate the short-circuit current, equally to approximately 3 times the current normally consumed.

In this mode of operation the **Powerdrive MD Smart** is an AIC (Active Infeed Converter), forming a three-phase voltage system. **Powerdrive MD Smart** has integrated dedicated algorithms and parameters for this mode.

At the start of the AIC in grid forming mode, the voltage measurement at the drive terminals is analyzed:

- If the voltage RMS value is above half of the AIC rated voltage, a synchronization phase of approximatively one second will be performed. After this phase, the AIC will operate in voltage and frequency droop control.
- If the voltage RMS value is below half of the AIC rated voltage, the AIC will generate the three-phase voltage system at its output terminals as soon as a run order is given.

The AIC can be set-up to generate alone a voltage grid with a defined voltage level and frequency value.

TRANSITIONING BETWEEN DIFFERENT PROPULSION MODES

From Electric Propulsion to Diesel Engine Propulsion

When there is a diesel engine clutch demand, the electric motor is unclutched, then the diesel engine clutches to maintain the speed of the ship.

The **Powerdrive MD Smart** has to stop the speed regulation mode regarding the power ratio Diesel engine / Electric motor. Indeed, it would not be able to control the speed and would go straight on current limitation.

Consequently, meanwhile clutching the diesel engine, the PMS must give an information to the converter to leave the speed mode.

From Diesel Engine Propulsion to Electric Propulsion

For the same reasons, the converter must receive an information when the diesel engine in unclutched and the PMS allows this mode.

The converter waits for an unlock command from the PMS. A timer might be added to consider the diesel engine unclutching time.

From Diesel Engine Propulsion mode to Booster Propulsion

The converter only waits for a run command, a torque reference, and a max speed. A catch on speed will occur to ensure the torque control.

From Propulsion Booster to Diesel Engine Propulsion : only a lock command is needed.

RECAPITULATIVE TABLE

Operation mode	Operation mode	Electric machine
Electric mode	OFF	ON
Diesel mode	ON	OFF
Booster mode	ON	ON

POWER LIMIT MODE

This is a degraded mode. The PMS sends a power limit command expressed in percentage of the electric propulsion power. The **Powerdrive MD Smart** receives it from the PMS as an analog or digital signal via fieldbus.

Powerdrive MD Smart

In addition to its compacity and reliability, the **Powerdrive MD Smart** offers modularity to OEMs and system integrators. It can either be integrated by our teams or by yours.

Figure 10: Integration example performed by a system integrator

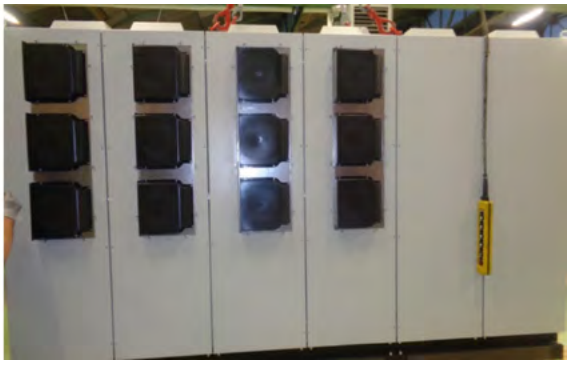


Figure 11: Integration example performed by Nidec Leroy-Somer

MAIN CHARACTERISTICS AVAILABLE

- **Powerdrive MD Smart** is a modular Power Electronic converter compound of rectifiers, inverters and control module
- Range is based on IP00 open standard sub-assemblies to be integrated in an electrical enclosure
- Chassis are available for Air (AC) or Liquid cooling (LC)
- Designed for an easy integration worldwide with the possibility of any kind of architectures (6p, 12p, 18p, 24p, AFE, DC Bus, DC/DC converters)
- Single chassis from 132 kW to 500 kW (AC) with easy paralleling without balancing chokes (maximum of 8) up to 3.8 MW
- **Powerdrive MD Smart** is available in AC 380V -10% to 480V +10% and 500V -10% to 690V +10%
- DC Bus available up to 1,100V
- UL61800-5-1 certification (UL/cUL) and Marine Type approval (BV first, and depending on projects DNV-GL, ABS, RINA, LR, CCS) of full range of chassis

COMPONENTS AND OPTIONS

The following components can be selected on demand to fit your functional requirements.

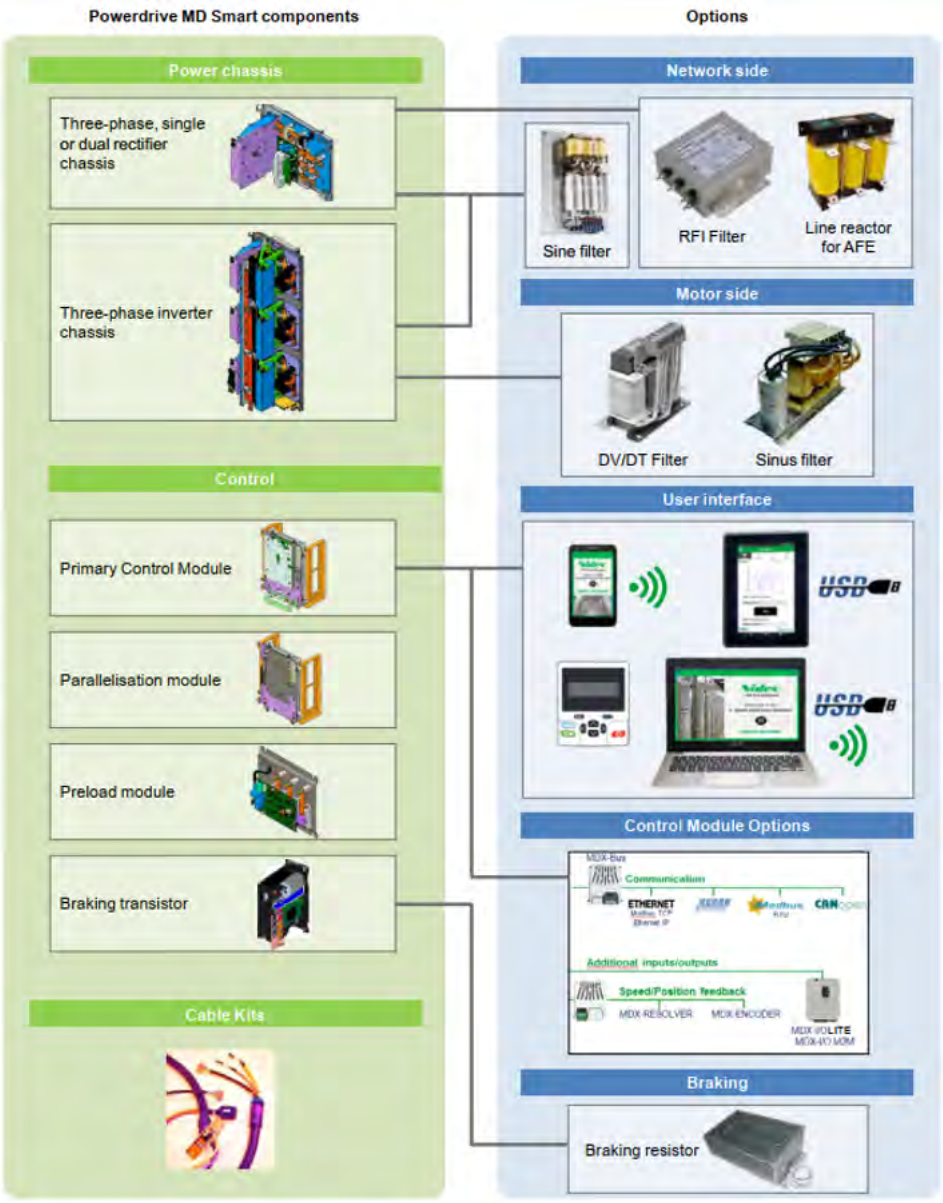


Figure 12: Components and options

Figure 13: Examples of IP00 modules

Powerdrive MD Smart

MODULAR ARCHITECTURE

Thanks to its modularity, the following architectures can be implemented, depending on your technical specifications.

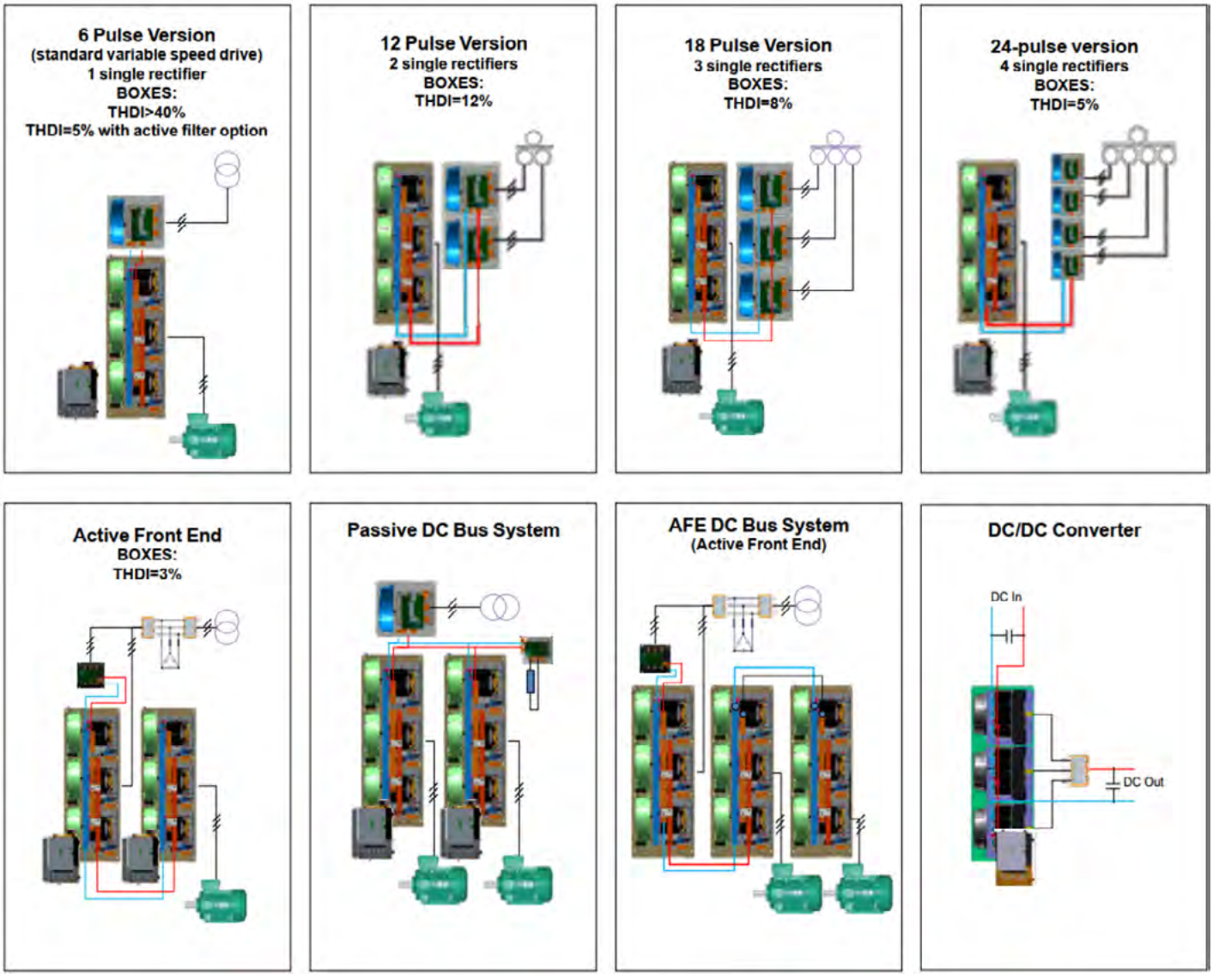


Figure 14: Various architectures available

OPERATING PRINCIPLE OF ELECTRONIC DRIVES

The **Powerdrive MD Smart** is an electronic drive or frequency inverter providing power supply to an electric motor at variable voltage and frequency by taking power from the electrical power supply of fixed voltage and frequency. Illustration 1 represents the 2 (two-stage) frequency inverter structures commonly used in industry.

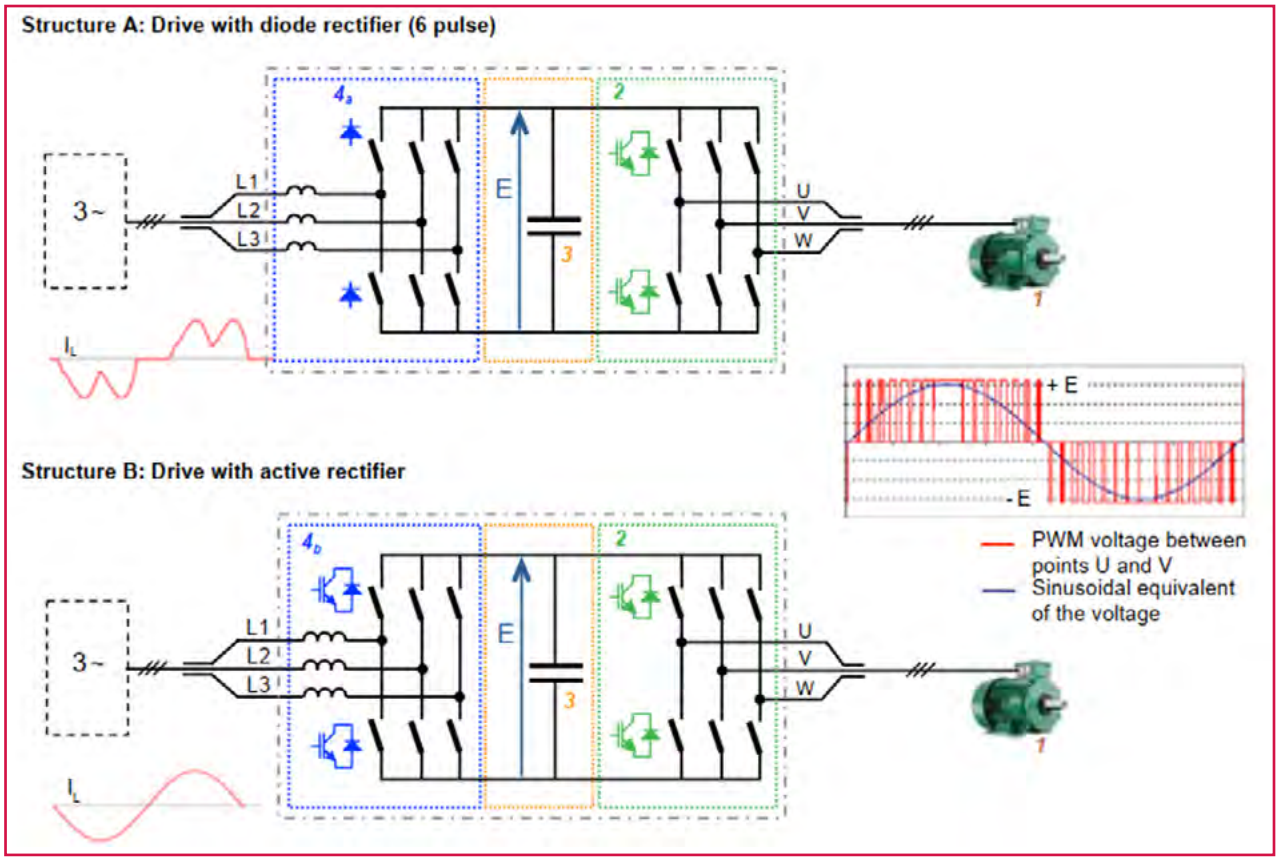


Figure 15: Frequency inverter structures

1. *Motor which can be based on asynchronous, synchronous, reluctance or hybrid technology.*
2. *Inverter: AC/DC inverter for which the components of the output stage (IGBT) behave as electronic switches that pass a continuous voltage E at a frequency of several kHz, in order to generate an alternating voltage between phases equivalent to a sine wave of variable amplitude and frequency. This mode of operation by voltage switching, commonly called PWM (Pulse Width Modulation), provides a huge advantage of limiting inverter losses to about 2% of the transmitted power. This leads to several side-effects on the motor-inverter installation.*
3. *DC Bus: Filtering stage made up of several capacitors connected in a series-parallel assembly. The DC Bus voltage value (E) is linked to the value of the mains voltage and the rectifier technology.*
4. *Rectifier: AC/DC power supply inverter. It consists of a simple passive diode rectifier for the most recent drives (4a). The power can then pass only from the power supply to the motor. The line current of the power supply is not sinusoidal and its harmonic distortion level is high. For applications that require a low level of harmonic distortion in the power supply or for applications where the power must be returned to the power supply, the AC/DC converter is designed with IGBT (4b).*

The command of the **Powerdrive MD Smart** is entirely digitalized via a microprocessor and a dedicated software, developed by Nidec Leroy-Somer Engineering and Development teams.

The Active Front End architecture allows a reversibility in braking mode. This kind of rectifier, associated to a filtering system, allows a global harmonic current close to 5% and an individual harmonic current close to 3%. The Total Harmonic Distorsion (THD) is thus lower than Navy Rules specifications.

Thanks to the sinus filter and the self, the equipment consumes on the network a sinusoidal current. The input bridge is connected to an EMC filter, composed by a set of capacitors and common mode inductances to limit high frequency currents feedbacks to the source.

A DC Bus with electrolytics capacitors supplies the power components. A preload system limits the current in the Bus capacitors at power-on of the equipment.

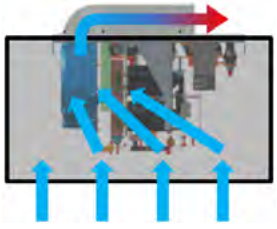
Powerdrive MD Smart

COOLING PROCESS

The **Powerdrive MD Smart** offers flexibility for the cooling method.

Indoor Enclosures - AF VERSION

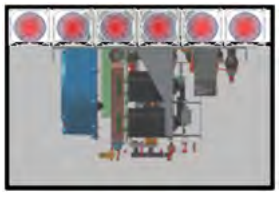
Chassis with indoor fan



Power module fans located in panel enclosure with **easy front access for service**

- 100% of air flows entering the panel through the front door
- Hot air exhausting through the heatsinks

Through wall mounting



- Hot air could be collected in tunnel for top extraction

Outdoor Enclosures - AO VERSION

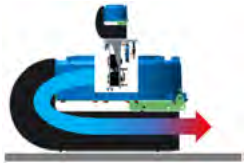
Chassis with no indoor fan

IP54

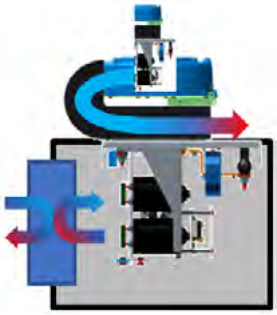
Narrower chassis with no internal fan. Outdoor fan is mounted on heatsink

- When space is available at the back of the panel for fan service, IP66 outdoor fan kit can be used with direct mounting on heatsink
- Space saving in cabinet
- Significantly simplified cabinet arrangement
- Panel enclosure can be fully tight with suitable heat management

Through wall mounting



Nema 4 Using a heat exchanger



- Hot air could be collected in tunnel for top extraction

Liquid Cooled		
Power modules fitted on flat plate	Complete module fitted on liquid cooled heatsink	• Compact and less noise high-power drives • Standard Powerdrive power components fitted on flat plain plate • Modules are assembled on a liquid cooled heatsink making on-site module replacement simple and easy without interrupting liquid circuit • Heatsink is mounted outside enclosure preventing from potential leakages inside panel • Innovative Patented design • Available as a Teady-To-Use solution fitted in IP23 or IP54 enclosures in various front-end arrangements

Example: 1 x 1,100 kW AFE + 1 x 500 kW output inverter on DC Bus

Powerdrive MD Smart

SETTING THE DRIVE

The main physical and electrical dimensions of the drive are adjustable through the digital parameters, organized in several menus.

There are two access levels:

- User : reading access
- Maintenance (locking pass code): reading/writing access to parameters

Access to settings and modifications can be done through the keyboard or the specific set-up software installed on Windows PC. Different sets of parameters can be stored for each configuration and transferred by the program.

Drive Converter

- Intern trips
- Main supply short-circuit
- Output short-circuit between phases
- Output short-circuit between phases and neutral
- Thermal trips
- Supply over and under voltage

Motor Protection

- Rotor blocked
- Monophase run
- Over current
- Overpower by computing i^2t
- Over and under speed
- Temperature management

The trips are logged in parameters into the drive.

POWERDRIVE MD SMART REFERENCES MODES

The **Powerdrive MD Smart** can be driven remotely by the PMS via fieldbus, analog reference or directly on the control panel of the cabinet.

REMOTE:

Usually, the **Powerdrive MD Smart** is commanded remotely by the PMS or rescue PMS.

Remote commands are:

- Run / Stop
- Mode Selection
- Control mode (Speed/Torque)
- Speed reference
- Torque reference

The **Powerdrive MD Smart** does not manage global machine security. It is locked until the security loop (Safe Torque Off) is open and the unlock command is missing.

The exchange table between PMS and EPS has to be defined.

LOCAL:

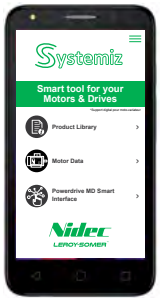
The local mode consists in driving the **Powerdrive MD Smart** directly in front of the cabinet. Run/Start commands are given directly on the HMI or via command organs as buttons in front of the cabinet. The global security management system must allow the unlocking of the **Powerdrive MD Smart**.

Maintain of operation in case of minor trip.

In case of cooling fan fail on the converter, the equipment remains operational but adapts the performances to restrain the temperature of the power components.

CYBER SECURITY

Cyber security has become of a primary concern. At each project, our Engineering and Development teams improve our products.



Regarding the **Powerdrive MD Smart**, a local Ethernet based fieldbus allows the exchange of information and commands between the HMI and both rectifier and inverter. First, this network is physically inside the cabinet, locked by keys. Different locking options are possible. Then, each unused access port to the network is disabled, thanks to our managing switch. A whitelist system makes the security even stronger, allowing only a defined list of Media Access Control (MAC) addresses to communicate on the network.

Several user accesses are defined in the HMI, respecting the ANSSI (Agence Nationale de la Sécurité des Systèmes d'Information) recommendations in terms of authentication secrets.

SOFTWARE

Systemiz is a software developed by our teams. It allows the user to perform a full control of the drive, by setting, monitoring, managing set of parameters and much more. The software can be downloaded and used for free.

If required by the application a PLC can be integrated in the **Powerdrive MD Smart**. In this case, control/command functions are implemented on a Siemens PLC. This PLC is programmed at our factory and after acceptance test, the software used for programming is no more required as there will not be onboard or ashore software updates.

Electric motors

Nidec Leroy-Somer manufactures a large range of industrial electric motors. We focus here on three motor ranges specifically adapted to marine applications.

Individual datasheet and drawing can be provided upon request, on a case by case basis.

Main characteristics available:

- Power: 150 to 2,000 kW
- Frame sizes: 315 to 560 mm
- Voltage: 400V up to 690V
- Number of poles: 2, 4 & 6
- Frequency: 50 or 60 Hz. Capability to build the machine at the specific frequency required by the system.
- Class of insulation: F or H
- Mounting: B20, B3, B35 and V1
- Degree of protection: IP23, IP55 (IP56 or IP65 on request)
- Fasteners and nameplates in stainless steel material
- Double nameplates: grid + variable speed characteristics
- Water leakage detector. Only for liquid cooled motors (LC and FLSHR).
- Drain plugs
- Breather plug with waterproof membrane
- Grounding studs on the frame and inside main terminal box
- 1 auxiliary terminal box
- Insulated DE & NDE bearings
- Winding & Endshields thermal protections: as PT100, CTP, KTY or others...
- Encoder
- Space heaters
- Water cooled bearings
- Anti corrosive finish (Corrobloc)
- 2nd auxiliary terminal box or more if required
- If VFD supplied: one or two insulated bearings, reinforced winding insulation system, grounding bar for terminal box.
- Motor VPI method (Vacuum Pressure Impregnation)
- Possibility to add spacers to ease wiring
- Possibility to custom position and wire connection in main terminal box on request
- A brake can be added on request

FLSHR (Sea Water liquid cooled with air exchanger)

Figure 16: FLSHR range

This motor is BV/NR compliant. It is an asynchronous machine with an hydro cooling system. It consists in a double tube exchanger in cupronickel (IC8A6W7) mounted on the top of the motor.

The air flow inside the motor and the hydro are generated by two independent auxiliary fans. The hydro is connected to the external refrigeration circuit by DN flange, this circuit is tested at 8 bars minimum. The air/water exchanger is equipped with a leak detector connected in the terminal box.

The exchanger is designed to receive sea water or pure water. The stator winding is made of insulated and coated copper wires, the assembly is impregnated under vacuum and pressure, the insulation system is class H. The winding is designed with reinforced insulation allowing optimum operation on a frequency converter.

The rotor is made from an assembly of low losses magnetic laminations, and copper bars inserted into closed slots and brazed with copper short-circuit rings.

The shaft made of casted steel keyed, the rotor and shaft assembly are dynamically balanced. The motor is subject to a quality plan traceability of the shaft steel from casting, to steel cutting, to machining. Material obtained Approval Marine Certificates from Marine Class Societies.

Inspection and obtaining associated Marine certificates are provided for in the supply.

The coupling is made by means of a keyed cylindrical shaft end with a tapped center hole. The fluid connections, terminal boxes, motor fans, motor shafts and motor coolers can be positioned according to requirements.

The endshields are made of steel or cast iron, they are ribbed for better dissipation. For VSD supply, motors are fitted with insulated bearing associated with a grounding rind on one side. One of the bearings is fitted with a preload system to allow expansion of the shaft.

The motor can be fitted with an isolated incremental encoder with its protective cover. The bearings are lubricated by grease nipples, the lubrication chamber has an evacuation door.

The electrical connections are made inside a closed terminal box. The terminal box is fitted with a removal gland plate. There is an auxiliary terminal box dedicated to the connection of instrumentation.

Thanks to its speed-independent cooling system, this motor is particularly well suited to variable speed operation

Electric motors

LC (freshwater Liquid Cooled), very low noise emission

Figure 17: LC Liquid Cooled motor range

This motor has a BV/NR type approval (Bureau Veritas Type Approval for Marine: n° 02040_K1_BV). It is an induction machine with a liquid cooling system (IC71W).

The stator winding is made of insulated and coated copper wires, the assembly is impregnated under vacuum and pressure, the insulation system is in class F or H. The winding is designed with reinforced insulation allowing optimum operation on a frequency converter.

The rotor is made from an assembly of low loss magnetic laminations, copper bars inserted into closed slots and brazed with copper short-circuit rings.

The shaft made of casted steel keyed, the rotor and shaft assembly are dynamically balanced. The motor is subject to a quality plan traceability of the shaft steel from casting, to steel cutting, and machining. Material obtained Approval Marine Certificates from Marine Class Societies.

The coupling is made by means of a keyed cylindrical shaft end with a tapped center hole.

The endshields are made of steel or cast iron, they are ribbed for better dissipation. For VSD supply, motors are fitted with insulated bearings associated with a grounding ring on one side windings renforced insulation. One of the bearings is fitted with a preload ring system to allow expansion of the shaft.

The motor can be fitted with an isolated incremental encoder with its protective cover.

The bearings are lubricated by grease nipples, the lubrication chamber has an evacuation door.

The electrical connections are made inside a closed terminal box. The terminal box is fitted with a removal gland plate. There is an auxiliary terminal box dedicated to the connection of instrumentation.

Thanks to its speed-independent cooling system, this motor is particularly well suited to variable speed operation.

Cooling system characteristics:

- Drain plugs to facilitate condensate evacuation
- Breather Plug (breathable waterproof membrane) reducing considerably the condensates to facilitate the maintenance
- Water leakage detector to control the water circuit integrity
- No more pollution associated with the airflow maintaining a clean surrounding environment
- Low impact on ambient temperature (waste heat from the motor is carried away by the cooling circulation)
- Improved modularity

PLSES

Figure 18: PLSES

This motor has a BV/NR type approval (Bureau Veritas Type Approval for Marine: n° 02040_K1_BV). It is an asynchronous machine with an air-cooling system (IC411).

This motor is particularly suited for auxiliary propellers such as bow thrusters with its IP23.

Its ratio power / weight is the highest of our ranges.

The stator winding is made of insulated and coated copper wires (or bars for our powerful motors), the assembly is impregnated under vacuum and pressure, the insulation system is in class F or H. The winding is designed with reinforced insulation allowing optimum operation on a frequency converter.

The rotor is made from an assembly of low loss magnetic laminations, copper bars inserted into closed slots and brazed with copper short circuit rings.

The rotor body can be made of copper or aluminium.

The shaft made of casted steel keyed, the rotor and shaft assembly are dynamically balanced. The motor is subject to a quality plan traceability of the shaft steel from casting, to steel cutting, to machining. Material obtained Approval Marine Certificates from Marine Class Societies.

The coupling is made by means of a keyed cylindrical shaft end with a tapped center hole.

The end shields are made of steel or cast iron, they are ribbed for better dissipation. For VSD supply, motors are fitted with insulated bearing associated with a grounding ring on one side. One of the bearings is fitted with a preload system to allow expansion of the shaft.

The motor can be fitted with most encoders of the market with their protective cover.

The bearings are lubricated by grease nipples, the lubrication chamber has an evacuation door.

The electrical connections are made inside a closed terminal box. The terminal box is fitted with a removal gland plate.

There is an auxiliary terminal box dedicated to the connection of instrumentation.

Nidec Leroy-Somer capabilities

PROJECT MANAGEMENT

If Project Management is required, during the kick-off meeting, the project will be handled by a project manager for both drive and motor:

- Planification
- Coordination between several Business Units
- Production follow-up
- Deliverable follow-up
- Marine certification follow-up
- Factory Acceptance Test (FAT)

ENGINEERING

ELECTRIC MOTORS: Studies and production of the definition file

- Electric definition
- Mechanical definition

POWERDRIVE MD SMART: Studies and production of the definition file

- Electrical definition
- Mechanical definition
- Design Approval file
- Definition of Automation and Control Command Requirements

MARINE CERTIFICATION

Drives and Motors can be subject to separate FATs with Marine Certification Societies at the respective Manufacturing plants with site testing facilities.

OUR USUAL PROCESS FOR 2 VFDs CABINET & ELECTRIC MOTOR PER SHIP

VFD n°1 and Electric Motor n°1: trials at full load until thermal stabilization

VFD n°2 and Electric Motor n°1: standard no load tests

STW / HAT / SAT

Breakdown of the number of days planned for each assistance offered, for the example of electric propulsion.

Assist.	Setting to Work	Harbour Acceptance Tests	Sea Acceptance Tests
FOC	1 technician for 1 x 4 worked days	1 technician for 2 x 5 worked days	1 technician for 1 x 5 worked days
FOS	1 technician for 1 x 4 worked days	1 technician for 1 x 5 worked days	1 technician for 1 x 3 worked days

Breakdown of a working day:

- 1 day worked at the quay = 7 working hours
- 1 day worked at sea = 10 hours of work

TRAINING

We believe that training is as valuable as the products themselves and should be a key factor in your budget. Training has a positive impact on the lifetime of the equipment you have invested in, especially in Marine industry.

For this reason, our training team consists of qualified trainers having many years of experience in selection, installation and maintenance of our products. Training without an objective has no value, we believe in defining the training objective by asking the question “what should the trainee be capable of doing after completing the course”.

Training center statistics:

- More than 380 days of training provided each year to our customers
- 30% of training takes place in the Training Centre
- 70% of training is customized to meet the defined objectives of our customers

Our engineering teams design your equipment based on your specifications; our service teams can create a specific training four your equipment. The training sessions can take place at our Training Center at your facilities or even on the shipboard.

INTEGRATED LOGISTICS SUPPORT

Nidec Leroy-Somer benefits from a long experience providing logistics support in Marine. An ILS (Integrated Logistics Support) file can be **engineered on request**.

- ILS (Integrated Logistics Support) Plan
- FMECA (Failure Mode, Effects & Criticality Analysis) Analysis
- RAM (Reliability, Availability and Maintainability) Analysis
- LSA (Life Saving Appliance) Studies

OBSOLESCENCE

There is long term continuity in our ranges, Nidec Leroy-Somer can provide equivalent motors and drive during the whole lifetime of your marine projects.

For more information:
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https://acim.nidec.com/fr-fr/motors/leroy-somer/industries/marine

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Nidec

All for dreams

Moteurs Leroy-Somer SAS. Headquarters: Bd Marcellin Leroy, CS 10015, 16915 Angoulême Cedex 9, France. Share Capital: 38,679,664 €, RCS Angoulême 338 567 258.

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