

ENGINEERING  
TOMORROW



Selection Guide | VACON® 3000 Drive Kit

**Transform** your **toughest applications**  
with a unique **modular** approach

**Medium-  
voltage**  
definite-purpose  
drives



# When a **standard cabinet** drive is **just not enough**

Heavy duty industries face some of the most complex and competitive engineering environments on the planet.

That is where the VACON® 3000 Drive Kit can give you a head start with this strategic combination: unique modular medium-voltage (MV) drive technology, supported by the application knowledge of experts – the Danfoss Medium Voltage Partners.

## You are a **serious player** in **your industry**

You are an expert in your field in some of the toughest applications imaginable:

A specialist who is used to working in heavy duty engineering, facing some of the most complex challenges on the planet. You know how vital AC drives are to your business, where reliability, robustness, space and weight are crucial – and downtime is a disaster.

## Danfoss **Medium Voltage Partners** complete the team

Danfoss Drives works with selected, qualified partners to push the boundaries of the medium-voltage drives market. Together we deliver a unique modular approach, which gives you the ultimate solution for your project with the flexibility and choice to take your business to the next level.

## Danfoss Drives is the **drives expert**

We are experts in drives. We know drives like nobody else and we've always pushed innovation to the limit in our quest to deliver the best drives in the world. Combining innovation and high durability for the sustainable industries of tomorrow, VACON® 3000 achieves its unique benefits based on the powerhouse of engineering expertise at Danfoss Drives. Always at the forefront of development, we give you tomorrow's technology today.





# Integrate high-performance MV drives to suit your **application needs**

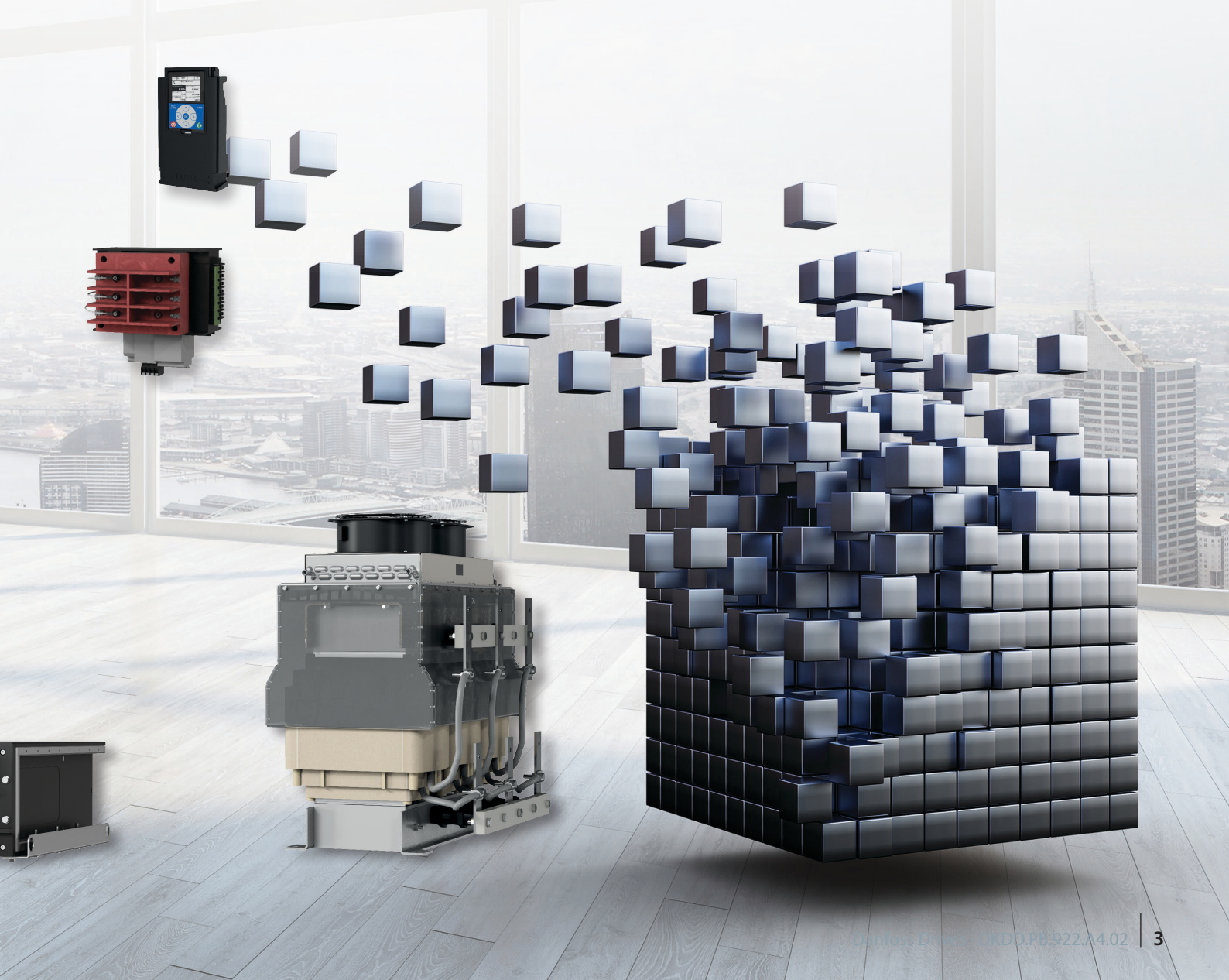
Your industry and your applications demand adaptability in MV drives, and this is where Danfoss Drives opens up valuable new opportunities. The VACON® 3000 Drive Kit accommodates flexible arrangements, straightforward system integration and easy maintenance. Use the flexibility of these modules to optimize the drive, meeting your individual requirements.

## Owner or operator?

When owning or running a system with medium-voltage drives installed, you can discuss your needs in depth with Danfoss Medium Voltage Partners, to define a design encompassing the ultimate and exact characteristics you expect of an MV drive.

## Operating benefits:

- Fit-for-purpose MV products, both in functionality and physical dimensions
- Low total cost of ownership (TCO) due to reliable and robust operation
- Less downtime, thanks to
  - fast and easy serviceability
  - robust design
  - uncompromising quality
  - premium operating performance





# A myriad of **ways to maximize ROI**

## **Save energy, reduce wear, save lifetime cost**

Now you have a new opportunity to use medium-voltage (MV) drives where it was perhaps not possible before. You might previously have been obliged to use low-voltage (LV) drives or not been able to get the benefits of using a drive at all.

Achieve significant savings using MV drives by variably adjusting the motor voltage and frequency compared with constant speeds with throttle valves and other regulators.

Slash maintenance costs by fully exploiting the ability of this drive to prevent peaks and extreme loads. These loads occur during rapid start-up of the motor and are a primary cause of wear, if not controlled.

## **Versatile design for optimal use of space**

The modules facilitate a structure tailored entirely to meet the requirements of individual applications. As well as conventional solutions in standardized cabinets, unique space-saving solutions can be developed:

- To meet special requirements in construction shapes and sizes
- To comply with stringent ingress protection classes as demanded by marine and mining applications
- The liquid-cooling concept facilitates easy IP54 cabinet design

## **Win flexibility through modularity**

- Simple and elegant concept
- Only a few basic modules throughout the whole power range
- Combine the modules like building blocks, to build up the complete offering
- Wide application coverage, including low harmonics, regenerative and braking applications
- Saves cost on service and redundancy
- Common spares
  - Modular, low inventory
  - Same phase module used in inverter unit (INU), active front-end unit (AFE) and brake chopper unit (BCU)





## Easy to build

### Easy to handle

- Compact component size with high power density
- Manageable component weight
- All components allow cabinet integration with front access only
- Easy to handle, to lift, move, and repair

### Easy to integrate

- Full harmonization, supports open solutions
- Customer-specific interface configuration of cabinet
- Customer-specific enclosure class

## Easy to operate

- Easy to connect, program and monitor
- The same user interface and fieldbus option cards as VACON® 100 low-voltage drives

## High performance

- High power density provides maximum power for minimal volume
- Efficient heat management using liquid-cooled power modules and hybrid-cooled chokes
- Very good speed and torque control, sensorless vector control
- AFE configurations connect to the grid without inrush current

## Robust and reliable in harsh conditions

### Designed for stability

- Long lifetime design of power modules with no cooling fans
- Rugged module enclosure provides good protection
- Reliable insulation
- Hybrid cooling of the chokes









# Exceptional **MV** performance in **demanding applications**

Individually tailored to meet the toughest requirements

Heavy industry requires high performance of drives sized into the high megawatt power range. The oil and gas, chemical and petrochemical, mining, ship building, and cement industries all have diverse individual demands depending on local regulations. Use the flexibility of VACON® 3000 Drive Kit to meet these industry requirements in a wide range of applications, including:

- Pumps
- Fans
- Compressors
- Mixers
- Mills
- Conveyor systems
- Extruders
- Steel mills
- Test benches
- Marine propulsion
- Marine pumps
- Dredger cutter
- Dredge pumps

All these applications regularly push AC drives to their limits. Customers in these sectors are working in adverse environmental conditions, including dust, humidity and aggressive gases, but their equipment must remain reliable nevertheless. Rugged, water-cooled modules, with no internal fans, provide the devices with high protection. In addition, the depth of expertise of Danfoss and its partners guarantees safe operations in the long term.

## **When 'standard' is not good enough – go for definite-purpose!**

### ***Highly compact solutions for special installation requirements***

In most cases, standard enclosed MV drives solutions currently available on the market are sufficient for standard applications, such as where the drive is installed in a clean, standard electrical room. In these applications, the medium-voltage drives are integrated into standard cabinets of fixed height.

However, the application often demands a specialized solution optimized for installation in an existing space, such as on ships, in oil and gas, or mining operations, where space is at a premium. Here the highly compact, high-performance VACON® 3000 modules are ideal.

The active front-end (AFE) and inverter units are based on the same water-cooled power modules, and can be arranged in a flexible manner, thus making it possible to change the height, width and depth and even the shape of the cabinet.

Similar to low-voltage drive modules, you can position the power modules optimally to achieve the most compact configuration possible, in this way saving precious space.









# Single port of call

No matter what your motor control question, you can find the answer at Danfoss Drives. Obtain the optimum AC drive for the job, whatever the low- or medium-voltage application is on board the ship.

## Main propulsion

Electric propulsion provides a great deal of freedom in ship design, and ships can be designed much more efficiently without the traditional limits on equipment layout, due to mechanical restrictions (for example, the main engines having to be aligned to and in the vicinity of the propeller shafts). Due to its inflexibility, a fixed power transmission produces excessive mechanical stress. When the propeller is controlled by a drive, the power available to rotate the propeller can be contained with lighter and less robust mechanical constructions than would otherwise be needed with a fixed power transmission. This in turn means the vessel is cheaper to construct. The structure is also lighter.

With electric propulsion:

- The power can be supplied by any number of generators, which enables high redundancy.
- The motor + drive combination consumes energy only when the azimuth thruster is actively turned
- The environment benefits from lower fuel consumption and exhaust emission

Electric propulsion is a good platform for the next phase of development – hybridization.

## Refrigeration compressors

Screw compressors controlled by a drive typically use 15% less energy than traditional screw compressors with slide valve control only.

Optimized start/stop cycles reduce wear and tear on the compressor. Drive-controlled reciprocating and scroll compressors have higher COP at part loads.

## Pumps

AC drives control the pump to match actual process need, leading to reduced energy consumption. Reducing the speed by 20% reduces the power consumption by 50%.

As well as saving energy, these AC drives also protect the pump in many different marine applications.

Due to increasingly stringent exhaust emission limits, scrubbers are frequently installed. They act as SO<sub>x</sub> abatement devices on the main and auxiliary engines

and boilers, using water as a medium for sulfur absorption. Optimization of water pumps for these scrubbers is the ideal task for VLT® and VACON® drives. Other typical application areas: ballast water, bilge water, circulation, cargo, firefighting, feeding pumps, lubrication, and sea water pumps.

## Thrusters

VLT® and VACON® drives' high torque capabilities and their fast and accurate performance provide precise maneuverability in all seas.

AC drive-controlled variable speed propellers with fixed pitch are typically 20-30% more energy efficient than fixed-speed variable-pitch propellers – which waste approximately 20% of the power at zero thrust.

Frequency-controlled variable-speed propellers use 50% less energy than hydraulic variable-speed propellers.

Electrically-steered thrusters provide more accurate control and respond more quickly than hydraulic steering systems. A minimum of two parallel motors and drives are always

in use. If one combination stops, the steering system continues to operate.

## Cutter suction dredgers

A cutter suction dredger consists of two main elements: the rotary cutter head and dredge pump. The rotating cutter head is used for cutting and fragmenting hard soil, while the dredge pump sucks up the soil and discharges it on shore, by means of a floating pipeline or a barge.

Depending on the size and design, there can be several pumps discharging the soil. The high powers required for cutting and pumping makes it the perfect application for electric motors controlled by drives, ensuring high efficiency and minimum downtime.



# Why choose Danfoss drives for mine and mineral processing environments?

With our wide range of AC drives and a broad choice of supporting options we can match your specific requirements. The compact enclosures and robust design of our drives with built-in long motor cable capability, innovative heat management and other mine-site-relevant features can help you optimize your panel, switchboard, switchroom or substation design, saving costs and improving your competitive position.

## Intelligent heat management for significantly lower switchroom costs

With the increasing use of AC drives to efficiently control equipment on mine sites, the heat loads in switchrooms from those drives are demanding larger and more expensive air-conditioning systems. However, the availability of VACON® liquid-cooled drives can result in significantly reduced heat loads in switchrooms, enabling the use of smaller, lower-cost air-conditioning systems.





# Robust mine ventilation

Ensuring reliable ventilation of the mine is paramount for the health and safety of workers in the underground mine. This is necessary to ensure particulates from diesel engines are adequately diluted, for example. Ventilation operating costs are often a significant proportion of the total electrical energy costs on site, and being able to ventilate in the most efficient manner saves significant operating costs.

AC drives are well recognized to be the most flexible, energy-efficient, low-maintenance method for controlling mine ventilation fans. They are used to control the air flow of main ventilation fans on the surface as well as auxiliary ventilation and booster fans underground, and can be easily integrated into Ventilation on Demand (VOD) control systems.

VACON® drives incorporate a number of features that make them especially suitable for mine ventilation fan applications. These ensure reliable operation of the fan even in abnormal operating conditions and the optimum use of energy.

## Long conveyor capability

Smoothly controlling the acceleration and deceleration of long conveyors reduces mechanical stress through all drive-train components and within the conveyor belt itself. This leads to longer lifetime for the belt and other drive components, increasing asset availability and lowering maintenance and operating costs. Having the flexibility to control the speed of long conveyors can help optimize the complete system, reduce bottlenecks and maximize the efficiency of a material flow process, resulting in operating cost savings.

### Maximize belt life

It's common practice to install multiple motors on long conveyors and the drives need to ensure load sharing between each motor for reliable operation and to maximize belt life.

Selection of the control solution depends on the configuration of the conveyor drives on the conveyor (for example, all drives at the head end or drives at both the head and tail end).

They are both easy to implement and have proven to be robust, reliable solutions for long conveyors.

### Bulk handling

For downhill conveyors, where continuous regenerative braking operation is typically required, an Active Front End (AFE) drive is the best solution.

VACON® drives are used extensively on many long conveyors in excess of 1-km length, which are common on bulk material applications on mine sites, processing plants and port facilities such as:

- Run-of-mine (ROM) bin feeder conveyors
- Stockyards
- Train loadout conveyors
- Pipe conveyors
- Long overland conveyors







# Applications



- 1** Long conveyors
- 2** Stacker
- 3** Conveyors
- 4** Dewatering pump skids
- 5** Ball mills; flotation cells; apron feeders, conveyors, slurry pumps (e.g. transfer pumps, feed pumps, concentrate pumps, tailings pumps); process water pumps
- 6** Excavator
- 7** Slurry pumps; process water feed pumps
- 8** Primary ventilation fans
- 9** Underground conveyors
- 10** Booster fans
- 11** Crushers
- 12** River water pumps

## **13 Underground mines**

Mine ventilation fans  
Conveyors  
Pumps  
Hoists



# Royal IHC Scheldt River pioneers **new environmental standards** in dredging

The role of dredging in the maintenance of safe riverside occupations has become more vital as heavy rain events become more common. As more dredging is undertaken around the world - often in heavily populated areas, the need for energy efficiency and adherence to environmental regulations also assumes more significance.

The Scheldt River is a 7950 m<sup>3</sup> dual-fuel (diesel and LNG) hopper dredger designed and built by Royal IHC in the Netherlands for DEME. It represents the latest in hybrid dredging technology with its "flex fuel" main engine capable of running on natural gas, light fuel oil (LFO) or heavy fuel oil (HFO).

With its 'Green Passport' and a 'Clean Design' notation, the vessel complies with the strictest international emission requirements. To help achieve these high standards, Danfoss delivered a drive solution that could boost an inboard dredge pump and increase energy efficiency with a small footprint,

minimum weight and low volume - while being robust enough to withstand the harsh marine environment.

## Performance and flexibility

The modular VACON® 3000 Drive Kit met green performance requirements and enabled IHC to make their own customized, integrated solution, the IHC MV drive.

Based on a modular approach, the compact IHC MV drive helps to save space and weight, optimizing the overall design of the vessel and its equipment.

## A partnership of experts

When configuring and installing the VACON® 3000 drive, IHC was able to draw upon the experience of application experts in Danfoss Drives' Marine Application Development Centre in the Netherlands. The center is equipped with a range of testing and demo units, which were used to facilitate complete panel testing on load and customer FAT, together with IHC.

## The keys to energy efficiency

The boosting of the vessel's 8000 kW dredge pump with an AC drive was made possible through power take-in (PTI) technology, which allowed load sharing between the VACON® 3000 and the main dual-fuel engine. This resulted in significantly higher energy efficiency. Using transformer-less AFE technology employing normal water-cooling, the VACON® 3000 drive can run on lower supply frequency and voltage, for constant output power. Energy is saved in the auxiliaries by reducing the engine speed.

VACON® NXP LV drive modules are employed for other applications on board, including pumps, thrusters and active filters. The switching of drive control between the inboard dredge pump and the submersible dredge pump of 1700 kW is performed by a medium voltage switchboard, where also the required sinus filter is located.



# 2018

KNVTS Ship of the  
Year award for  
achievements in  
cleaner dredging



# You're covered

## with DrivePro® Life Cycle service products

Every AC drive application is different. DrivePro® Life Cycle Services is a collection of tailor-made products designed around your needs.

From optimized spare part packages to condition-monitoring solutions, customize our products to support your business through the different stages in the life cycle of your AC drive.



### DrivePro® Site Assessment

**Optimize planning based on a site-wide survey**

Optimize your maintenance strategy with a complete onsite survey and risk analysis of all your AC drives collected in one detailed report. Together with a Danfoss expert, you can build a tailored plan for future maintenance, retrofits, and upgrades based on your exact needs.



### DrivePro® Spare Parts

**Plan ahead with your spare part package**

Maintain maximum uptime with a spare parts package that covers you in any AC drive breakdown. Choose from three customized packages to get your AC drive back up and running with minimal impact to operations.



### DrivePro® Start-up

**Fine-tune your drive for optimal performance today**

Take the complexity out of commissioning with DrivePro® Start-up's full range of health checks and adjustments. Our DrivePro® experts inspect and test your AC drive and motor performance to ensure the best configuration of your AC drives.



### DrivePro® Exchange

**The fast, most cost-efficient alternative to repair**

Maintain uptime with a fast alternative to repair when there is no time to waste. If an AC drive fails, the DrivePro® Exchange service can quickly exchange any drive to ensure as little production delay as possible.



### DrivePro® Extended Warranty

**Long-term peace of mind**

Even the best performing AC drives need protection. DrivePro® Extended Warranty offers a wide range of warranty options and provides the longest coverage in the industry. Enjoy better uptime, repairs, replacements, and spare-part support for up to six years.



### DrivePro® Preventive Maintenance

**Take preventive action**

Take the guesswork out of your maintenance plan. With a structured maintenance program tailored to your needs, you can boost operational efficiency and reduce the effects of wear and tear.



To learn which products are available in your region, please reach out to your local Danfoss Drives sales office or **visit our website**



Discover more about DrivePro® services **here**

## DrivePro® Life Cycle Services

Delivering a customized service experience



DrivePro® Site Assessment



DrivePro® Start-up



DrivePro® Extended Warranty



DrivePro® Spare Parts



DrivePro® Exchange



DrivePro® Preventive Maintenance







# A winning combination of modular components...

**Firstly**, this drive comes as a unique modular concept. The **VACON® 3000 modules** offer you new opportunities to easily and reliably create purpose-built MV drives. These power modules can be engineered deeper than ever before into system solutions, allowing for designs that better suit the needs of your application.

- Well-thought-out concept of modular, adaptable components
- Reliability in harsh conditions
- Optimal use of space

## ..and a partner with proven track record

**Secondly**, you get market-leading professional guidance from Danfoss Medium Voltage Partners who can support your project from cradle to completion. These partners integrate the individual drive modules, and filter technology in one compact, fully assembled and tested unit; and provide their support onsite during installation and start-up.

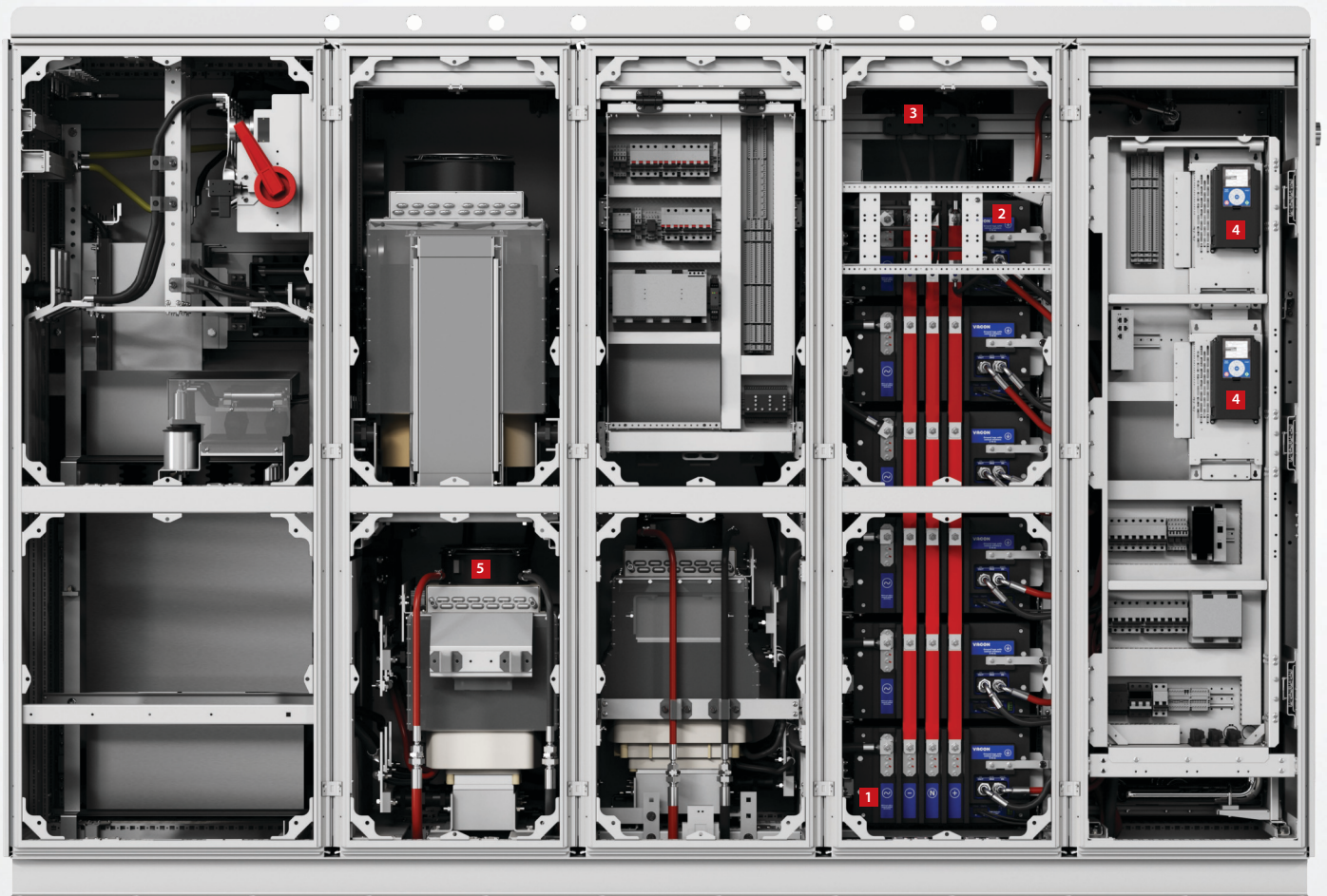
Our partners continuously receive support via the MVP Program®, adding value by being able to create their own system and cabinet offering – tailored perfectly to your applications.

- Expert support all the way through the system lifecycle
- Adaptable integration capabilities





# VACON® 3000 Drive Kit **units**







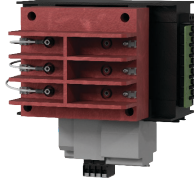
### 1 Inverter unit

Robust, compact and water-cooled – state-of-the-art technology for latest system design. The small dimensions make single-phase modules easy to handle and facilitate quick maintenance. Robust electronics guarantee high performance, reliability, and durability of the modules.



### 2 Front-end unit

Various modules are available for the VACON® 3000 front end. In addition to 12-pulse standard rectifier modules, the medium-voltage drive can also be fitted with an active front end, which feeds the braking energy generated directly back into the network, for regenerative applications. AFE utilizes the same power modules as in Inverter units.



### 3 Pre-charge unit

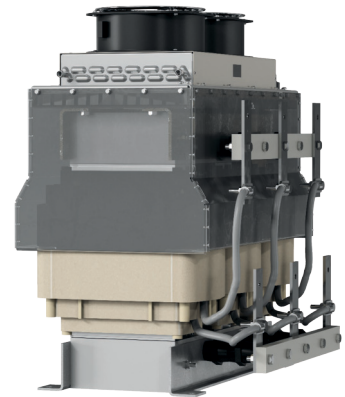
The pre-charge unit for the DC-link features the latest design. It is extremely compact and requires no pre-charge resistors. It also limits the load current and facilitates the safe start-up of the drive. It requires no fans or other special cooling and provides its own thermal protection. The power supply is a single-phase low-voltage source.



### 4 Control unit

Based on the VACON® 100 controller, the control unit comprises integrated Ethernet interfaces and a graphical display. State-of-the-art control algorithms are available for the comprehensive control of frequency, speed and torque:

- U/f control
- Open loop control (sensorless vector control) – speed and torque control
- Closed loop control (field oriented) – full control of torque and speed (requires an encoder)



### 5 Filters

Filters are key systems components. These filter units comprise both L, C and common mode filters for the AFE version. The L filters are optimized for the VACON® 3000, have hybrid cooling, forced air-to-liquid heat exchanger, and provide outstanding power density and easy integration for the entire system.







# Reference designs for **reduced engineering**

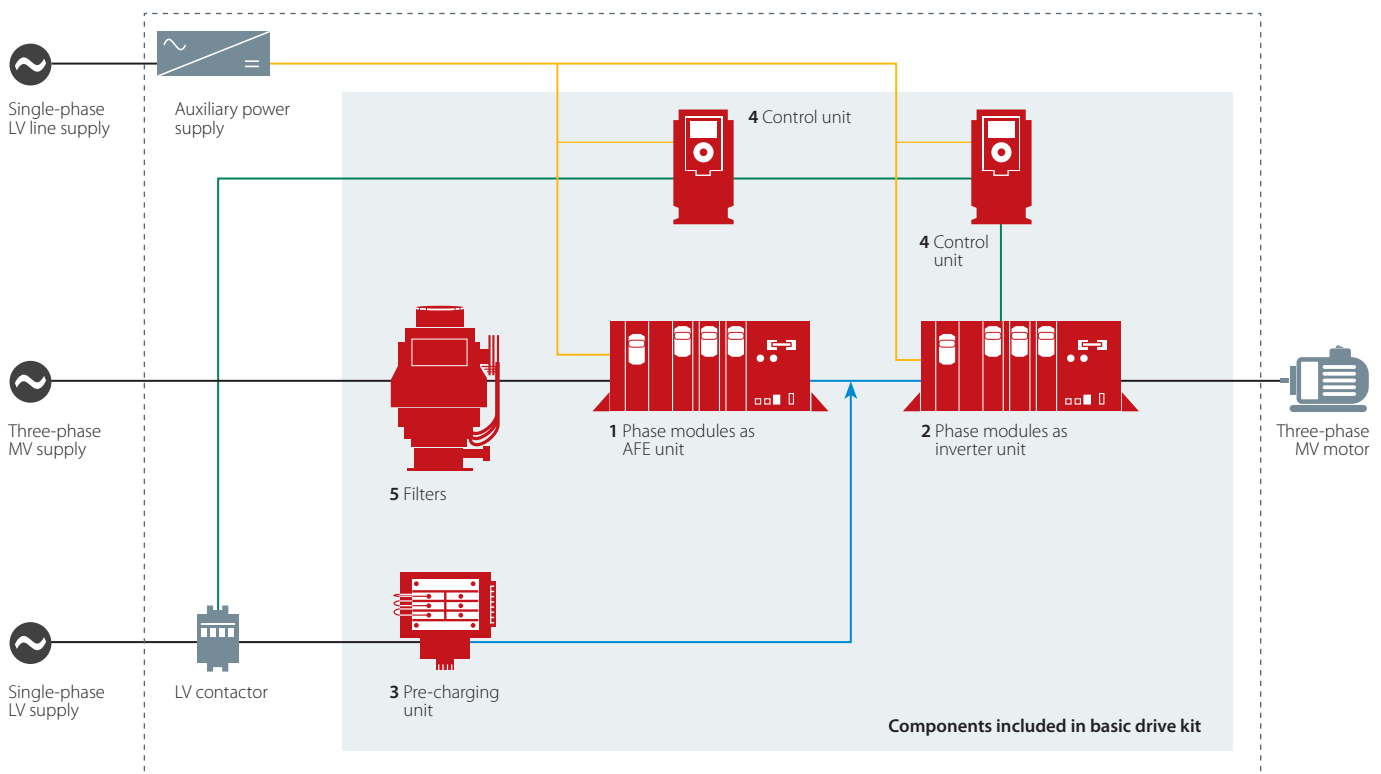
## New way of doing business

Not only is the VACON® 3000 Drive Kit totally original, but the business model is also unique, offering you commercial advantages, no matter whether you are a system integrator, an OEM or the equipment owner. Due to close collaboration between Danfoss Drives and its authorized Medium Voltage Partners in the Danfoss MVP Program®, the engineers and the owners benefit from a high level of knowledge transfer and application engineering assistance from Danfoss. This collaboration

ensures strong system performance combined with state-of-the-art system energy efficiency – as well as the most compact power dense MV drives solutions available anywhere. Danfoss Drives can promise this based on its global and decades-long market leadership as specialists purely focused on AC drives.

Authorized Medium Voltage Partners, members of the MVP Program®, have access to reference designs for definite-purpose drives.

- To create a reference design: Obtain the reference design from the Danfoss MVP Portal. Order the modules as a kit. Add commercially available standard parts. Build the drive according to the instructions.
- To create an original design: When creating an original design, you can use a reference design as a starting point, or start from scratch.



Example of VACON® 3000 Drive Kit: single line diagram for an AFE configuration.

The reference design package includes a design guide, circuit diagrams, 3D models, parts list and mechanical drawings.







# Partner focus

## A partner **you can trust**

### **The Danfoss Drives Medium Voltage Partner Program (MVP Program®)**

Danfoss Drives cooperates with a special network of partner companies with long-standing experience in the medium-voltage sector. They integrate the individual drive modules, feed-in and filter technology in one compact, fully assembled and tested device and provide their support on-site during installation, start up and optimization.

### **Authorized and fully supported by Danfoss**

The Danfoss Drives MVP Program® provides our partners with the necessary tools, training and support needed to create custom dedicated Medium Voltage Drives for your project. We supply the MV drives modules, while they engineer and assemble the cabinets for you.

### **Partner programs for individual solutions**

The partners, who are OEMs, system integrators or switchgear manufacturers, have full knowledge of the requirements in the medium-voltage sector, in most cases know the applications and are able to compile systems tailored to customers' requirements using the robust and compact VACON® 3000 modules, individually fit them into the space provided and optimize them to meet requirements.

### **Center of Excellence for Danfoss Drives high-power and medium-voltage drives**

We have established Centers of Excellence in various locations around the world to provide our partners and end customers with even better engineering solutions and optimized processes. They give both customers

and partners access to experienced staff, to develop new systems or further optimize and improve existing systems.

The centers are home to MV and LV drive specialists as well as comprehensive test stations and laboratories where applications can be tested or simulated. Machines and their correct drives can be optimized to meet the requirements of the respective application. OEMs and other customers can request the integration of tailored software solutions.



# VACON® 3000 Drive Kit

## – functional units and kits

### Kits

The VACON® 3000 Drive Kit includes all the main parts for the drive.

Two different drive configurations are available: regenerative, with active front-end (AFE) or non-regenerative, with diode front-end (DFE). The two kit types are therefore:

- AFE
- 12-pulse DFE
- 24-pulse DFE

Use the basic AFE kit for installations supplied by a dedicated transformer. When the system is not supplied via a dedicated transformer, then use the basic AFE kit plus the common mode filter option.

### 12 or 24-pulse DFE

Use the **12 or 24-pulse DFE kit** when regeneration or low harmonic capability is not needed.

Each VACON® 3000 Drive Kit comprises the following functional units:

- Control unit (CNU)
- Inverter unit (INU)
- Active Front End unit (AFE) or Diode Front End unit (DFE)
- Pre-charge unit (PRC)
- Brake chopper unit (BCU)\*
- Output filters\*
- Other filters\*

*\*optional*

### Functional units

#### Control unit (CNU)

For drives with AFE, one control unit controls the inverter units; and another control unit controls the AFE and pre-charge units.

For DFE drives, the control unit controls all inverter units, and the pre-charge unit.

There are three separate control units, one for the active front-end unit, (AFE), one for the inverter unit (INU), and one for the brake chopper unit (BCU).

#### Inverter unit (INU)

The inverter unit includes either 3 or 6 liquid-cooled single-phase phase modules, also known as power conversion units (PCU).

#### Active front-end unit (AFE)

The VACON® 3000 Drive Kit with AFE is a fully regenerative low-harmonic power converter kit. The AFE converts the supply AC voltage to DC voltage. When the motor is braking, the AFE supplies power back to the supply side. The AFE includes 3 or 6 phase modules (PCU) and an LC or LCL filter (a choke plus capacitor), as well as a control unit for the AFE. This AFE control unit has two functions: to control the AFE phase modules and the pre-charge unit, and to ensure the AFE voltage synchronizes smoothly to the supply-side voltage.

#### Diode front-end unit (DFE)

The 12-pulse DFE is a power converter, which changes the AC supply voltage to DC voltage. A VACON 3000 DFE kit includes additional DC capacitors and an integrated liquid-cooled 12-pulse rectifier with DC crowbar for fastest arc elimination in the event of a fault.

The DFE includes two 6-pulse rectifiers and one or two DC capacitors, supplied through a dedicated transformer with two secondary windings.

#### Brake chopper unit (BCU)

For certain DFE configurations demanding dynamic braking, a brake chopper is required. The brake chopper is a DC/AC converter, which transfers the energy during braking to a brake resistor supplied by an external partner.

The brake chopper consists of up to three L20 or L30 phase modules. It also includes its own control unit.

The brake chopper switches between the DC link neutral point and DC+/DC-.

#### Pre-charge unit (PRC)

The pre-charge unit charges the DC link capacitors before start-up of the drive. The low-voltage adaptability ranges from 230 V up to 480 V.

### Modules which are components of the functional units

#### L20 and L30 phase modules

The VACON® 3000 phase modules are liquid-cooled single-phase power conversion units. In sets of three, the phase modules make a full 3-phase DC/AC or AC/DC converter. The same phase modules are used in AFE and INU units and as brake choppers.

The phase modules monitor the phase current and DC voltages, and if there is a fault, stop automatically and independently. The fault signal is then sent to the control unit to stop the other phase modules. The phase modules also have an earth fault detection circuit, which monitors the DC voltages and ground. If there is an earth fault, the circuit causes an alarm and stops the AC drive.

The phase modules are available in 2 different voltage and 2 different current classes. The size and number of the used phase modules is specified by the nominal voltage and current of the AC drive.

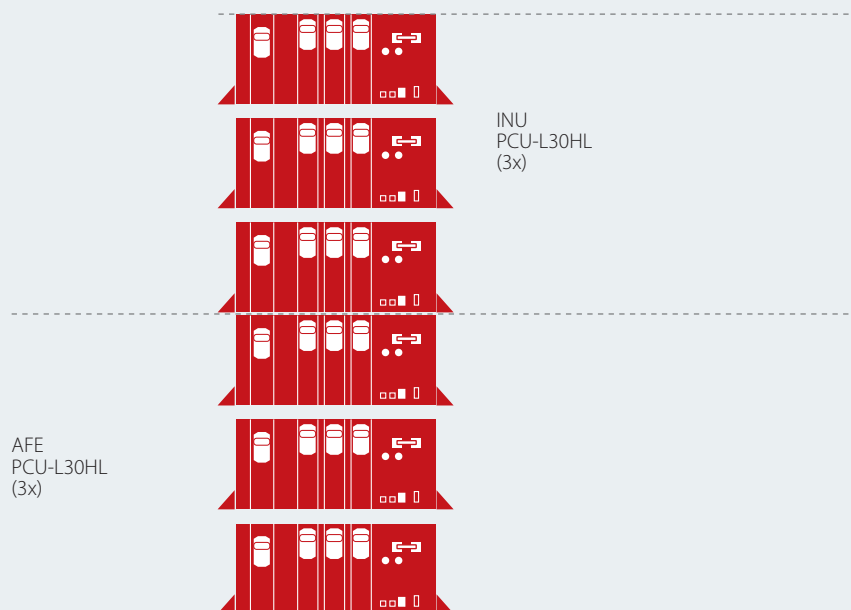


## Form factor

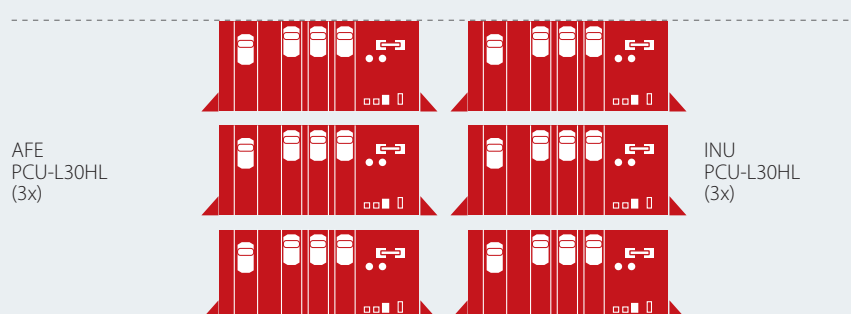
You are free to arrange the modules to use the form factor that fits your application best. This flexibility gives you the opportunity to design AC drives suitable for MV applications where it was previously impossible due to space restrictions.

Examples of assemblies with different form factors:

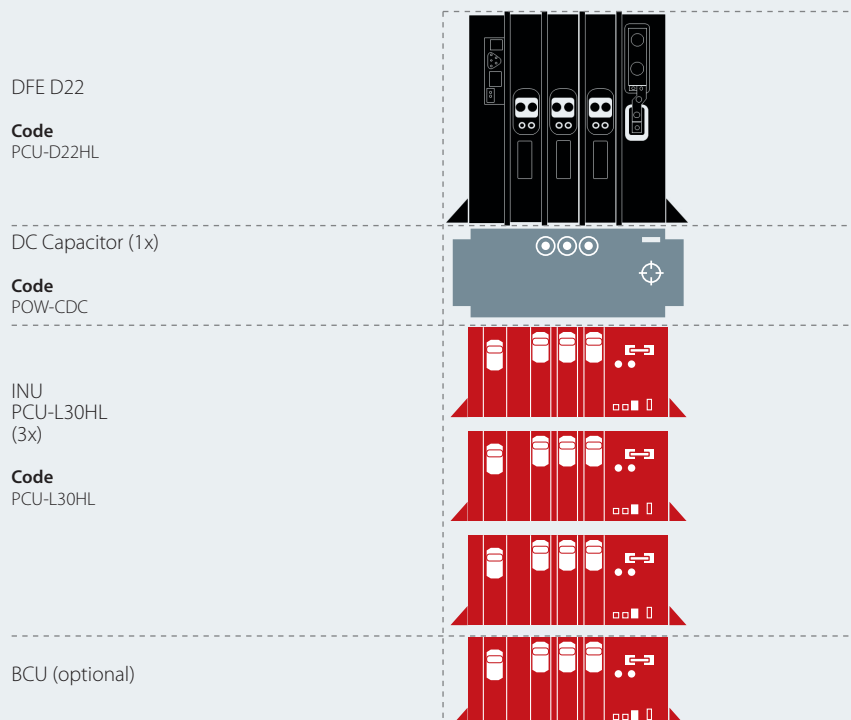
### AFE single-stack assembly



### AFE two-stack assembly



### DFE single-stack assembly with brake chopper unit





# Technical data

<b>Topology</b>	3-level neutral point clamped (NPC)	HV-IGBT
<b>Inverter (INU) capacity</b>	L20HLx3	425 A, 3300 V, 2.4 MVA <sup>1)</sup> 340 A, 4160 V, 2.4 MVA <sup>1)</sup>
	L30HLx3	640 A, 3300 V, 3.7 MVA <sup>1)</sup> 510 A, 4160 V, 3.7 MVA <sup>1)</sup>
<b>Diode front-end (DFE) capacity</b>	D22HL	1700 A, 1850 V 1700 A, 2360 V
<b>Input operating voltage</b>	Active Front End	3300 V, 3 phases $\pm 10\%$   4160 V, 3 phases $\pm 10\%$
	12-pulse DFE <sup>2)</sup>	2x 1850 V AC $\pm 10\%$   2x 2360 V AC $\pm 10\%$
<b>Input frequency</b>		50 Hz $\pm 5\%$ (3300 V) or 60 Hz $\pm 5\%$ (4160 V)
<b>Rectifier</b>	Active Front End	AFE
	Diode Front End	12 and 24-pulse DFE
<b>Input current THD</b>	AFE	< 5%
	12-pulse DFE	Typically <<15%
	24-pulse DFE	Typically <<8%
<b>Power factor</b>		>0.95
<b>Output voltage levels</b>		3 (5 phase-to-phase)
<b>Output frequency</b>		0-120 Hz
<b>Acceleration/deceleration time</b>		0.1-3600 s
<b>Grounding</b>		Isolated neutral, resonant earthing, high resistive earthing or solid earthing (IEC61936-1) For operation in unearthed neutral systems without a dedicated transformer, contact Danfoss Drives
<b>Switching frequency</b>	AFE	1050 Hz (50 Hz) and 1260 Hz (60 Hz)
	INU	900 Hz synchronous PWM
<b>Motor control method</b>	Asynchronous (induction) motor	U/f control Sensorless vector control (open loop) Vector control (closed loop, with fallback to sensorless operation available if encoder fails)
	SoftSync® functionality	Integrated SoftSync® functionality protects and enhances motor performance The SoftSync® function reduces typical motor current transients and lowers the current harmonic distortion during motor acceleration and deceleration, preventing pulsation or reduced motor shaft torque
<b>Communication</b>		AI/O, DI/O, fieldbuses (e.g. PROFIBUS DPV1, DeviceNet), industrial Ethernet protocols (PROFINET IO and EtherNet IP™), VACON® PC tool
<b>Main protective functions</b>		Torque and power limit, current limit, overcurrent, overvoltage, undervoltage, loss of auxiliary power, loss of communication, ground fault detection.
<b>Efficiency at rated load</b>	12 - 24-pulse DFE	$\geq 98.8\%$ , excluding the input transformer
	AFE for dedicated transformer	$\geq 97.8\%$ , excluding the input transformer
	AFE with input common mode filter (+PICM)	$\geq 97.4\%$
<b>Protection rating</b>		IP00
<b>Temperature</b>	Operational ( <i>ambient</i> )	0 °C to +45 °C (+30 °F to +113 °F)
	Storage ( <i>ambient</i> )	-40 °C to +70 °C (-40 °F to +158 °F); No liquid in heat sink under 0 °C (+32 °F)
	Power module inlet cooling liquid	0 °C to +43 °C (+32 °F to +109 °F) Lowest allowed cooling liquid temperature 2 °C (36 °F) above the dew point
<b>Relative humidity</b>		< 95 % RH, non-condensation, non-corrosive
<b>Cooling</b>	Power and phase modules ( <i>Rectifier, inverter, and brake chopper units</i> )	Closed-loop liquid cooling with grounded heatsink using ethylene glycol-based heat transfer fluid with corrosion inhibitors No need to use de-ionised water, less complexity and less maintenance.
	Chokes	Hybrid cooling ( <i>forced air cooled with air-to-liquid heat exchanger</i> )
<b>Standards<sup>3)</sup></b>		IEC, cUL, marine standards

1) Higher power capacities achieved by paralleling inverters

2) For lower voltage operation, please contact Danfoss Drives

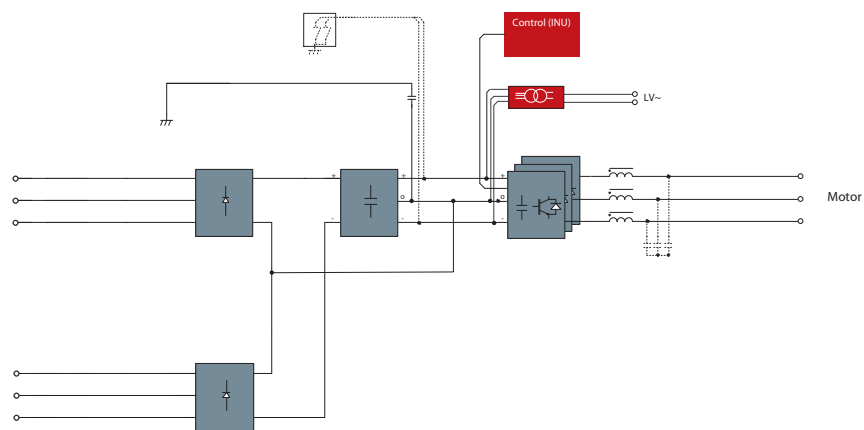
3) Certification pending



# Power rating

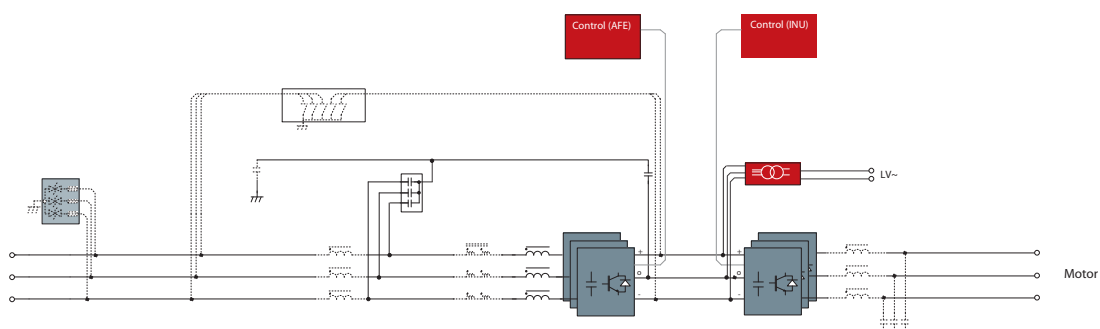
## 12-pulse DFE drives

AC drive type	Continuous rating (variable torque)		Low overload rating 110% (constant torque)		High overload rating 150% (constant torque)		Output frame size
	Continuous current I <sub>th</sub> [A]	Continuous power [kVA]	Continuous current I <sub>L</sub> [A]	Continuous power [kVA]	Continuous current I <sub>H</sub> [A]	Continuous power [kVA]	
Nominal voltage 3300 V							
VACON3000-12-0425-03	425	2430	386	2209	283	1620	L20HLx3 (425-03)
VACON3000-12-0640-03	640	3660	582	3327	427	2440	L30HLx3 (640-03)
VACON3000-12-0820-03	820	4690	745	4264	547	3127	L20HLx6 (425-03)
VACON3000-12-1230-03	1230	7030	1118	6391	650	4680	L30HLx6 (640-03)
Nominal voltage 4160 V							
VACON3000-12-0340-04	340	2450	309	2227	227	1633	L20HLx3 (340-04)
VACON3000-12-0510-04	510	3670	464	3336	340	2447	L30HLx3 (510-04)
VACON3000-12-0650-04	650	4680	591	4255	433	3120	L20HLx6 (340-04)
VACON3000-12-0980-04	980	7060	891	6418	650	4680	L30HLx6 (510-04)



## Active Front End drives

AC drive type	Continuous rating (variable torque)		Low overload rating 110% (constant torque)		High overload rating 150% (constant torque)		Output frame size
	Continuous current I <sub>th</sub> [A]	Continuous power [kVA]	Continuous current I <sub>L</sub> [A]	Continuous power [kVA]	Continuous current I <sub>H</sub> [A]	Continuous power [kVA]	
Nominal voltage 3300 V							
VACON3000-4Q-0425-03	425	2430	386	2209	283	1620	L20HLx3 (425-03)
VACON3000-4Q-0640-03	640	3660	582	3327	427	2440	L30HLx3 (640-03)
VACON3000-4Q-0820-03	820	4690	745	4264	547	3127	L20HLx6 (425-03)
VACON3000-4Q-1230-03	1230	7030	1118	6391	650	4680	L30HLx6 (640-03)
Nominal voltage 4160 V							
VACON3000-4Q-0340-04	340	2450	309	2227	227	1633	L20HLx3 (340-04)
VACON3000-4Q-0510-04	510	3670	464	3336	340	2447	L30HLx3 (510-04)
VACON3000-4Q-0650-04	650	4680	591	4255	433	3120	L20HLx6 (340-04)
VACON3000-4Q-0980-04	980	7060	891	6418	650	4680	L30HLx6 (510-04)





# Options

## VACON® 3000 Drive Kit

Factory option	Description	Option slot			
		B	C	D	E
I/O options					
+S_B1	6 x DI / DO, programmable	■			
+S_B2	1RO(NO/NC),1RO(NO), Thermistor		■	■	■
+S_B4	1 x A1, 2 x AO (isolated)		■	■	■
+S_B5	3 x RO		■	■	■
+S_B9	1 x RO, 5 x DI (42-240 V AC)		■	■	■
+S_BF	1 x AO, 1 x DO, 1 x RO		■	■	■
+S_BH	3 x Temp sensor inputs (PT100, PT1000, KTY84-130, KTY84-150, KTY84-131, NI1000)		■	■	■
Communications					
+S_E3	PROFIBUS DPV1			■	■
+S_E5	PROFIBUS DPV1 (D9)			■	■
+S_E6	CANopen			■	■
+S_E7	DeviceNet			■	■
+S_EC	EtherCAT			■	■
+S_E9	Dual Port Ethernet			■	■
+S_EA	Dual port Ethernet			■	■
Power dependent options					
+PICM	Input common mode filter <i>(for AFE variants only)</i>				
+PODU	Output dU/dt filter <sup>1)</sup>				
+POSI	Output sine filter <sup>1)</sup>				
+PHSI	High source impedance <i>(for AFE variants only)</i>				
+DBCU	Brake chopper for dynamic braking <i>(excl. resistor)</i> <sup>2)</sup>				
+POCM	Output common-mode filter				
+PFC1	Without HEX, without fan				
+PGC0	No common-mode capacitor to ground				
Auxiliary units options					
+QAIT	Isolated auxiliary transformer for power section				
+QGSW	Grounding switch				
+QPTR	Potential transformer				
+QSPD	Surge protection device (for AFE variants only)				
+PMRK	Mounting rack				
+SAXB	Additional auxiliary I/O board				
+HGAS	Phase module gasket sealing				
+PGDN	DC neutral-to-ground resistor not connected				
Precharge input voltage					
+QP24	240 VAC				
+QP40	400 VAC				
+QP48	480 VAC				
Control and fan voltage					
+QFV1	115 V				
+QFV2	230 V				

<sup>1)</sup> Contact Danfoss Drives for +PODU and +POSI options

<sup>2)</sup> The +DBCU option is for DFE variants only. For AFE variants contact Danfoss Drives

## VACON® 3000 Drive Kit

Standard factory option	Description
<b>Default for all VACON® 3000 drives</b>	
+HMGR	Graphical keypad



L20HL



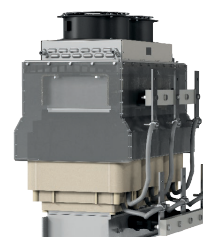
L30HL



Control unit



Pre-charge unit



Choke



## VACON® 3000

Option board	Description	Option slot code			AC drive
		C	D	E	VACON® 3000
OPTB1	I/O: 6 x digital input/digital output, programmable	+SCB1	+SDB1	+SEB1	■
OPTB2	I/O: 2 x relay output + thermistor	+SCB2	+SDB2	+SEB2	■
OPTB4	I/O: 1 x analogue input, 2 x analogue output ( <i>isolated</i> )	+SCB4	+SDB4	+SEB4	■
OPTB5	I/O: 3 x relay output	+SCB5	+SDB5	+SEB5	■
OPTB9	I/O: 1 x relay output, 5 x digital input (42-240 V AC)	+SCB9	+SDB9	+SEB9	■
OPTBF	I/O: 1 x analogue output, 1 x digital output, 1 x relay output	+SCBF	+SDBF	+SEBF	■
OPTBH	I/O: 3 x temperature sensor inputs (PT100, PT1000, KTY84-130, KTY84-150, KTY84-131, NI1000)	+SCBH	+SDBH	+SEBH	■
OPTE3	Fieldbus: PROFIBUS® DP V1 (screw connector) <sup>1)</sup>		+SDE3	+SEE3	■
OPTE5	Fieldbus: PROFIBUS® DP V1 (D9 connector) <sup>1)</sup>		+SDE5	+SEE5	■
OPTE6	Fieldbus: CANopen <sup>1)</sup>		+SDE6	+SEE6	■
OPTE7, OPTEC, OPTEA OPTE9	Fieldbus: DeviceNet <sup>1)</sup>		+SDE7	+SEE7	■

In the option code, the characters B and E indicate the compatible option slot.

<sup>1)</sup> For an AFE drive kit the option includes two boards, one for the AFE control unit and one for the INU control unit.

# Liquid to liquid heat exchangers

We have a range of cooling units based on liquid-to-liquid heat exchangers, which improve the availability and usability of AC drive systems. The heat exchanger is a pre-designed, pre-tested and fully functional package that ensures safety and reliability.

## Intelligent system interfaces for heavy industries

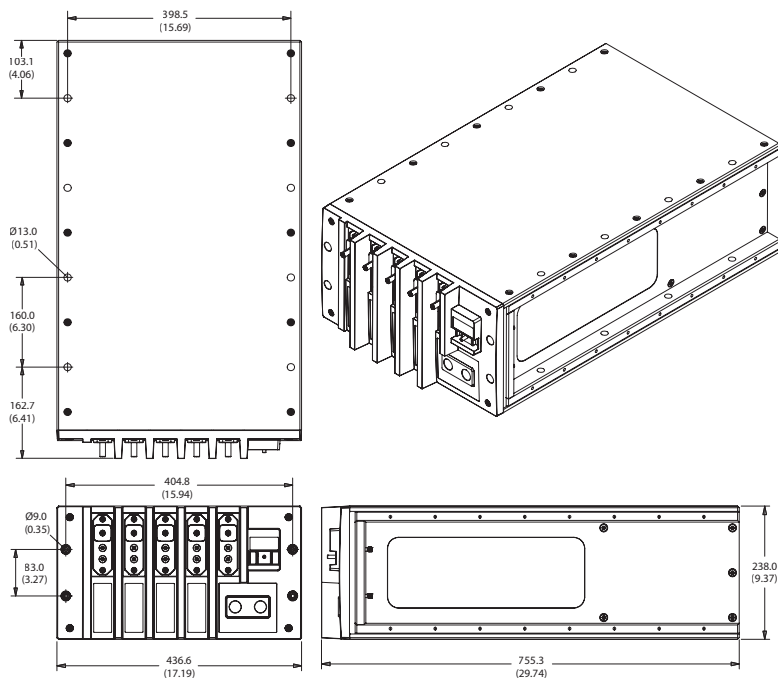
- Self-supporting module rack construction
- Cooling circuit equipped with threaded joints or flanges
- Heavy industry, stainless steel
- Industrial water heat exchanger, three-way-valve, pump
- Flow and pressure sensors
- Stainless steel AISI piping
- Two-way-valve
- Double pumps for marine class requirements

## Liquid to liquid heat exchanger specifications

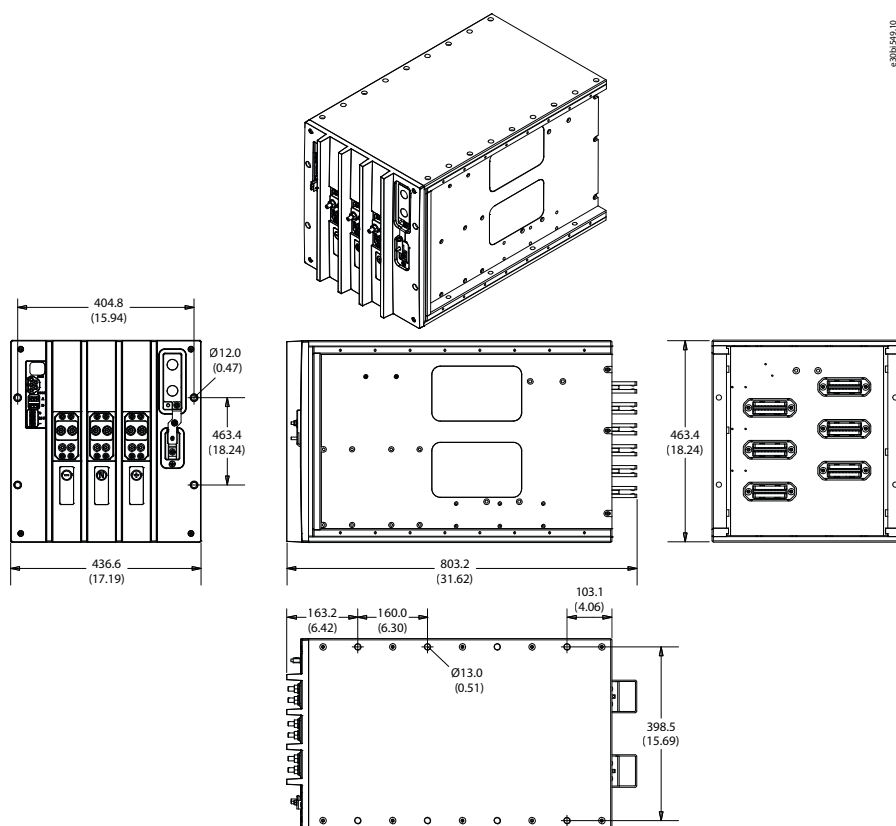
Cooling capacity	up to 200 kW
Coolant flow	up to 450 l/min
Expansion tank	12 liters, stainless steel
Instrumentation	Temperature sensors (2 pcs)
	Pressure sensors (2 pcs)
	Coolant level indicator
	Coolant level alarms (2 pcs)
Materials	Stainless steel and aluminum
	All materials are copper free
	No surface coatings
Coolant	Water-glycol mixture
Interfaces for water lines	Water to water heat exchanger
	Cooling manifolds
Option	Electrical heater



# Phase module dimensions and weight



Type designation code	PCU-L20HL-425-3	PCU-L30HL-640-3	PCU-L20HL-340-4	PCU-L30HL-510-4
Module size	L20	L30	L20	L30
Nominal voltage [VAC]	3300	3300	4160	4160
Nominal current [A]	425	640	340	510
Weight [kg (lb)]	69 (152)	96 (212)	69 (152)	96 (212)



Type designation code	PCU-D22HL-1700-5	PCU-D22HL-1700-7
Module size	D22	D22
Nominal AC voltage [VAC]	1850	2360
Nominal current [A]	1700	1700
Weight [kg (lb)]	150 (331)	150 (331)



# Typecode key example

## VACON® 3000 Drive Kit

VACON3000	4Q	0425	03	+PICM	+PMRK
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VACON3000	Product range VACON® 3000
4Q	Front end 12 = 12-pulse 24 = 24-pulse 4Q = AFE
0425	Drive rating e.g. 0425 = 425 A
03	Motor voltage/output voltage (Same terminology as for LV) 03 = 3300 V 04 = 4160 V
+PICM	Options e.g. +PICM = Input common mode filter
+PMRK	Options e.g. +PMRK = Mechanical Rack for the AFE phase modules

## Optimize your configuration using our expertise

When configuring and installing the VACON® 3000 Drive Kit, you can draw upon the experience of experts in Danfoss Drives' Application Development Centres (ADCs). Consulting and testing services provided by application experts are available to you as a customer from anywhere in the world. Simply contact your local Danfoss Drives sales office.

### Medium Voltage

Services offered at the Medium Voltage Application Development Center (ADC) include production and testing of medium-voltage AC drives. Full testing of configurations up to 4.5 MW is available.

The Medium Voltage ADC is located in Research Triangle Park (RTP), Raleigh-Durham area, North Carolina. Close

to research centers, universities and existing power electronic clusters, this is an ideal location, where our customers benefit from the knowledge density in the local power electronics environment.

### Marine and Offshore

The focus at the Marine Application Development Center (ADC) is on hybridization, including storage, and medium-voltage drives. Danfoss is renowned for long-term stability in product quality, and the ADC combines that with short-term agility to be able to act as an early adapter of Megatrends. Through its partners, the ADC has test facilities available to build, test and validate new solutions at full scale, with a direct interaction between key partner engineers and Danfoss R&D engineers.

The Marine ADC is located in the Netherlands, and is equipped with a range of testing and demo units. These include a full-scale medium-voltage test setup with loads up to 2 MW, and a second LV motor load test bench for regenerative applications, and multiple VACON® drives for drive sync applications, generator synchronizing and load sharing.

A power-conversion-technology test bench with battery system is available for testing and demonstrating energy storage and grid converter applications for hybrid propulsion systems, and ship-to-shore power supply.



# A better tomorrow is **driven by drives**

## **Danfoss Drives is a world leader in variable speed control of electric motors.**

We offer you unparalleled competitive edge through quality, application-optimized products and a comprehensive range of product lifecycle services.

You can rely on us to share your goals. Striving for the best possible performance in your applications is our focus. We achieve this by providing the innovative products and application know-how required to optimize efficiency, enhance usability, and reduce complexity.

From supplying individual drive components to planning and delivering complete drive systems; our experts are ready to support you all the way.

You will find it easy to do business with us. Online, and locally in more than 50 countries, our experts are never far away, reacting fast when you need them.

You gain the benefit of decades of experience, since 1968. Our low voltage and medium-voltage AC drives are used with all major motor brands and technologies in power sizes from small to large.

**For more information visit our website**



**VLT® | VAGON®**

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