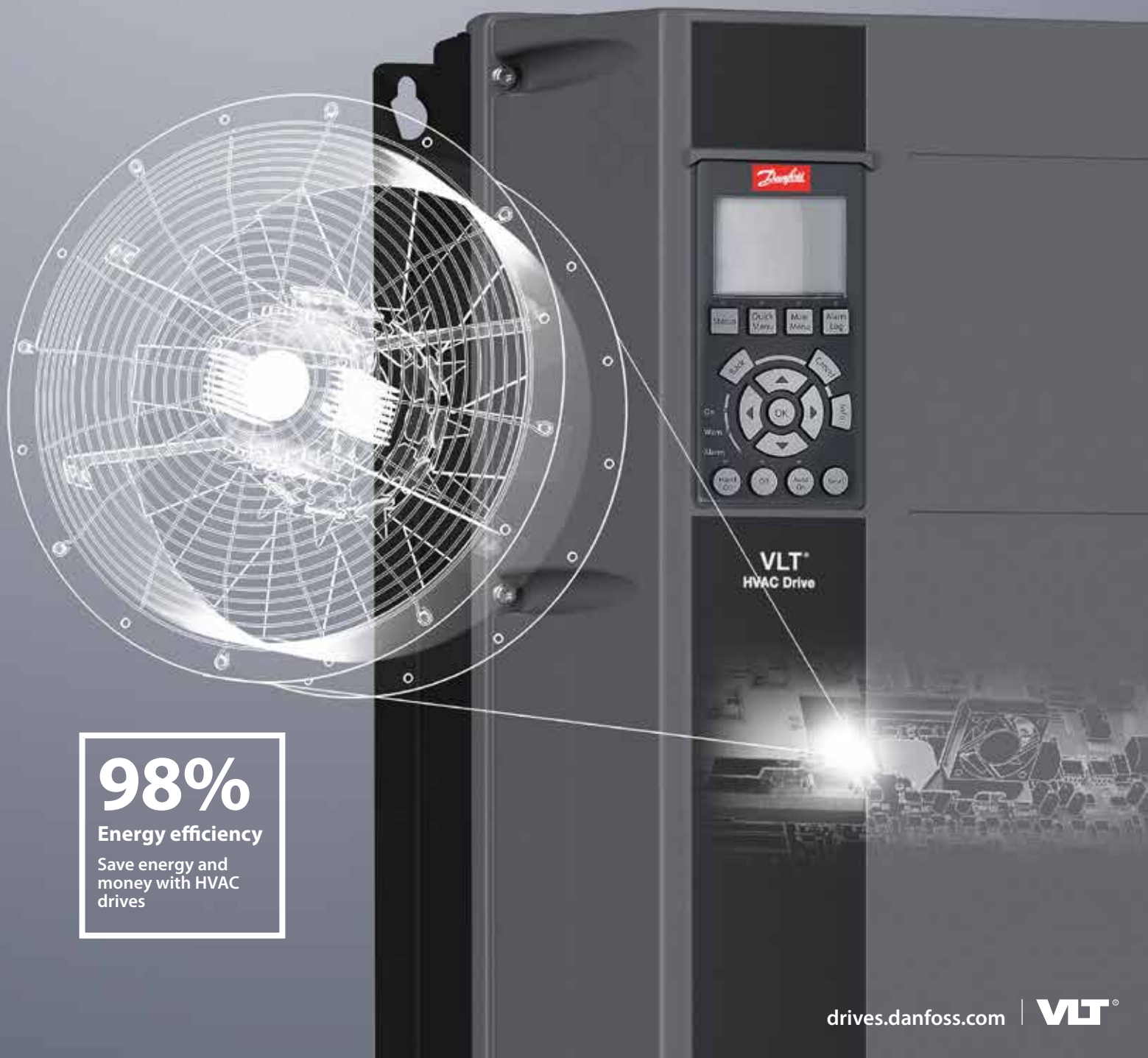


Selection Guide | VLT® HVAC Drive FC 102

# Drive down operating costs with the HVAC efficiency leader



**98%**  
Energy efficiency  
Save energy and  
money with HVAC  
drives



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# Dedicated drive for highest **energy efficiency** and **reliability**

The VLT® HVAC Drive FC 102 is a dedicated, globally supported drive that combines flexibility and efficiency in a package designed to minimize total system and lifecycle costs in HVAC applications.

The VLT® HVAC Drive is the preferred AC drive for heating, ventilation and air conditioning systems throughout the world. Designed to be installed in any fan or pump system and efficiently operate induction, permanent magnet, and high-efficiency synchronous reluctance motors, you can count on the VLT® HVAC Drive to provide years of reliable, maintenance-free operation.

The Danfoss EC+ concept pairs the VLT® HVAC Drive with high-efficiency motor technologies, with efficiency classes of IE3 and above. EC+ provides building owners with a flexible and future-proof system that is able to meet and exceed increasingly stringent environmental and efficiency-focused legislation in a cost effective way.

Every VLT® HVAC Drive is based on 30 years of experience and innovation. Easy to use, all models follow the same basic design and operating principle. The portfolio of drives offers enormous breadth and depth, but no matter which drive you choose, once you know one, you know them all. This selection guide helps you to choose and configure your perfect drive for applications in the range 1.1-1400 kW.

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**IM**  
Three-phase  
induction motor  
with copper rotor



**IPM**  
PM motor with  
buried magnets

**LSPM**  
Line-start PM motor  
with buried magnets  
and rotor cage



**SPM**  
PM motor with  
surface-mounted  
magnets

**SynRM**  
Synchronous  
reluctance motor



# The **best** in HVAC is now **better than ever**

As the world's population continues to increase, energy-optimized HVAC systems are the key to providing comfort and safety without increasing energy consumption. Even extreme climates and isolated outposts have a need for efficient HVAC operation. To give you the flexibility you need with the reliability you expect, the VLT® HVAC Drive has been enhanced to meet your needs – and more.

## Enhanced efficiency

New motor technologies are driving an increase in operating efficiency, especially in HVAC applications. To get the most out of these permanent magnet (PM) and synchronous reluctance (SynRM) motors, you need an AC drive equipped with the algorithms to most optimally control these motors.

## Enhanced connectivity

HVAC applications can be found everywhere, with installations in isolated areas of the world or in difficult-to-access locations. This requires new ways of thinking in order to efficiently communicate to these drives.

Integrate the VLT® HVAC Drive seamlessly to practically any building automation control network. Web servers provide even more ways to connect to your drive, securely and remotely. Web servers integrated in the Ethernet™ options provide for even more ways to securely and remotely connect to your drive.

## Built to last

The VLT® HVAC Drive series is designed with ruggedized enclosures to resist harsh ambient conditions with temperature and humidity extremes. Furthermore its high-quality components provide at least 10 years reliable operation under normal operating conditions, with no component replacement.

## Comprehensive portfolio

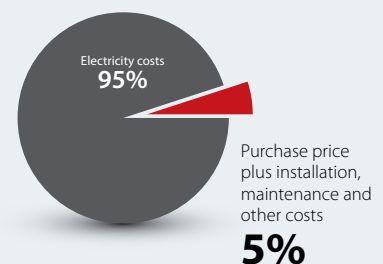
- Standalone drives
  - Low-power range: 1.1-90 kW
  - High-power range: 110-1.4 MW
- Enclosed drives: cabinet-mounted drives with harmonic & EMC filters

## Small investment – big returns

New energy efficiency regulations focus on ways to reduce energy consumption and CO<sub>2</sub> emissions. To meet these new standards, adding an AC drive is a necessity. Over the lifetime of an AC drive, energy cost is the dominating economical factor, but savings can be found in other associated costs.

Selecting the VLT® HVAC Drive provides the lowest total cost of ownership. Installation and commissioning take less time, and operating efficiency is higher than for other comparable drives.

Total cost of ownership is mainly defined by the operational cost. Therefore operational costs are the most important factor in selecting a new drive.



Go outdoors with  
extreme-climate  
performance from  
+55 °C down to

**-25°C**

# Efficient climate solutions for commercial buildings and infrastructure

## - Driving performance to the next level

Commercial buildings and infrastructure, where people work and travel, and where costly technology is installed, must provide a safe and healthy indoor climate that allows occupants - as well as equipment - to perform at their best.

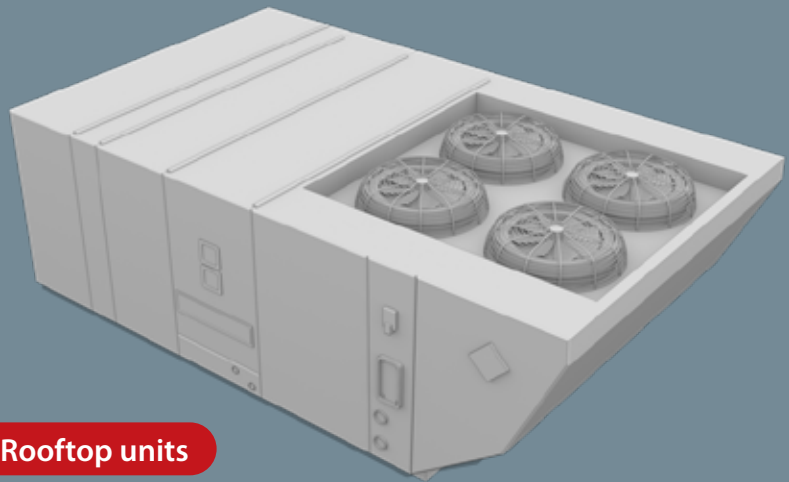
Offering the lowest total cost of ownership in the market, a Danfoss Drives solution will continue to pay itself back multi-fold throughout its entire lifecycle. Virtually maintenance-free, optimized operation of the HVAC installations in your building

means that, for many years, you can simply keep counting your wins on all parameters; from user-friendly operation to system reliability, carbon footprint, energy savings and productivity.



# A breath of fresh air for productive environments

Offices, schools, sports arenas – facilities occupied by people must provide a safe and healthy indoor climate for its occupants. VLT® HVAC Drive ensure that buildings are supplied with fresh air and at the optimal temperature for everybody to focus and perform at their very best.



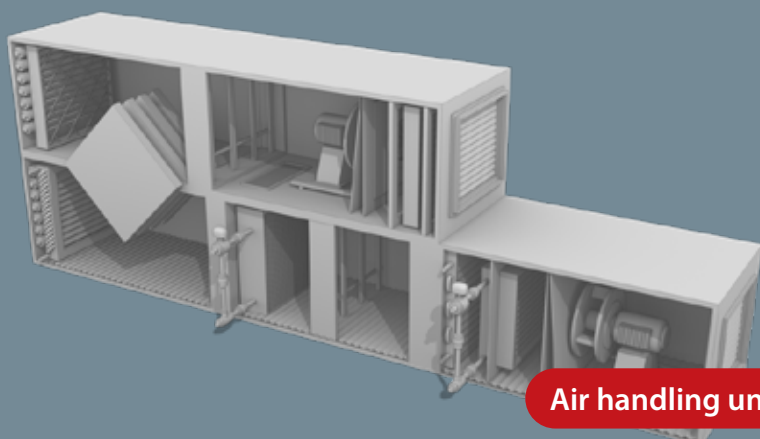
Rooftop units

## Cool tech for optimal performance

Danfoss AC drives applied to air recirculation fans in the data center control the air flow between the racks. Removing excessive heat around the IT installations, they ensure optimal thermal conditions to protect electronic components and enable optimal performance of the servers.

Maximize uptime

- Maintain optimal temperature around IT installations
- Extend the life span of your equipment
- Keep energy costs down



Air handling units

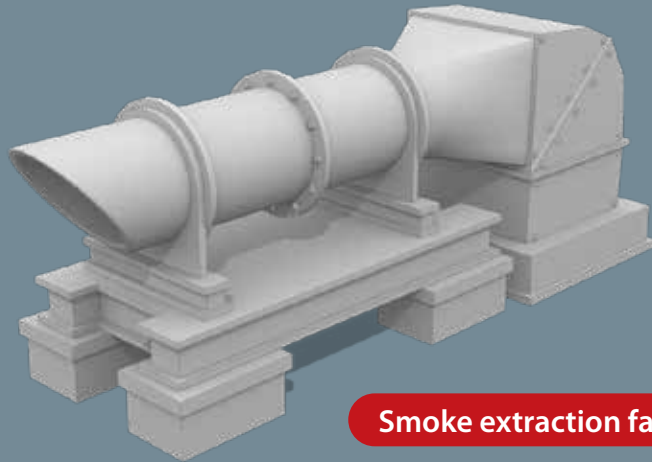
## Energy-lean performance

Danfoss AC drives enable you to optimize energy efficiency, never compromising on the safety and comfort for the occupants of your building.

The lowest Total Cost of Ownership (TCO) in the market

- Adapt capacity to actual demand
- Reduce operating costs
- Reduce wear and tear on your installations

# Evacuate safely from buildings and tunnels



Smoke extraction fans

## Safeguard transport hubs

Fire safety is a top priority when ensuring the comfort and safety of staff and passengers in transport hubs. As well as increasing precision, saving energy and extending application lifetime of the entire HVAC system, VLT® HVAC Drive is designed to keep smoke extraction fans running, no matter what.



## Underground health and safety

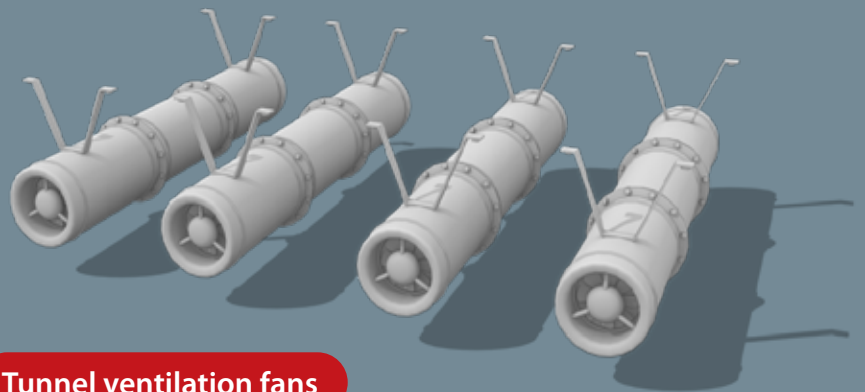
Danfoss AC drives work with the complex HVAC systems in underground subway and train services as well as road tunnels. Providing reliable operation of cooling, ventilation and safety systems, our solutions ensure pollution-free and safe environments for millions of passengers the world over.

## Protect commuters and staff

Our drives provide a reliable smoke extraction system that reacts independently to multiple zones as needed, to support the safe evacuation of commuters and staff in the event of a fire.

A less complex and more reliable system

- Ensures continued operation of smoke extraction fans in the event of a fire
- Multi-zone feature allows for independent speed controls



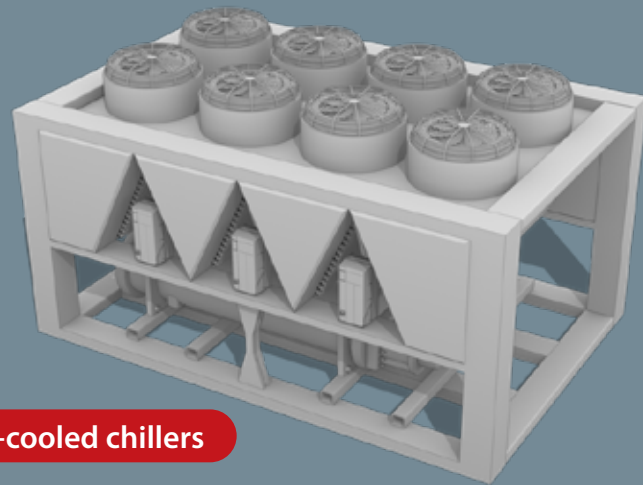
Tunnel ventilation fans

# Take the heat off your air conditioning budget

Optimizing energy efficiency, speed control enables tremendous savings - without compromising on occupants' well-being - and minimizes Total Cost of Ownership (TCO).

Ultimate cost efficiency

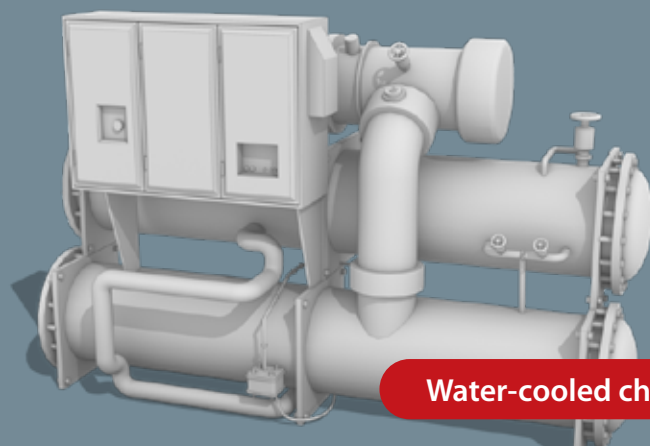
- Adapt capacity to actual demand
- Reduce wear and tear
- Reduce maintenance costs



Air-cooled chillers

## When drives are operation critical

Danfoss AC drives enhance and support the operation and reliability of complex hospital HVAC systems. Regulating air flow, humidity and temperature, they ensure patient and staff comfort and safety – also in the event of fire – while optimizing conditions in operation rooms and wards.



Water-cooled chillers

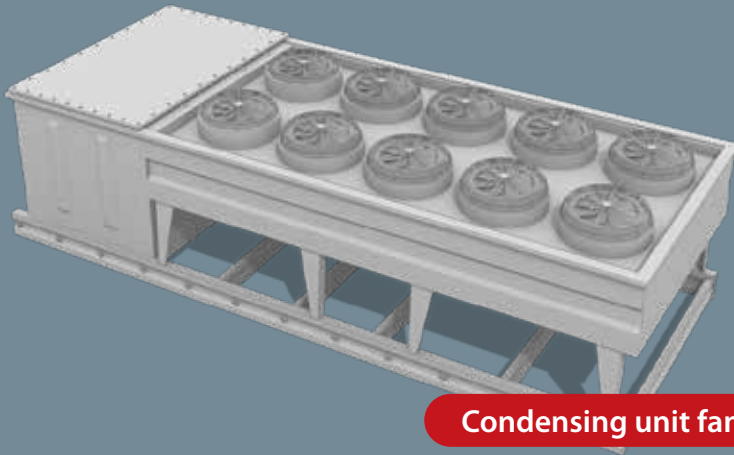
## Stay in your comfort zone

Danfoss AC drives enable tremendous savings, without compromising the comfort or the well-being of staff and shoppers spending their day in the mall.

Ultimate cost efficiency

- Adapt capacity to actual demand
- Reduce wear and tear on the system
- Reduce maintenance costs





Condensing unit fans

### Stay cool!

You can rest assured that Danfoss AC drives will keep your operation running smoothly, while contributing to considerable savings on your energy bill, and never compromising on indoor comfort.

Reliable and efficient operation

- State-of-the-art multi-motor control and monitoring feature
- Optimal energy efficiency
- Outdoor enclosure ensures full reliability with temperature extremes from -25 °C to +55 °C



### Top flight performance

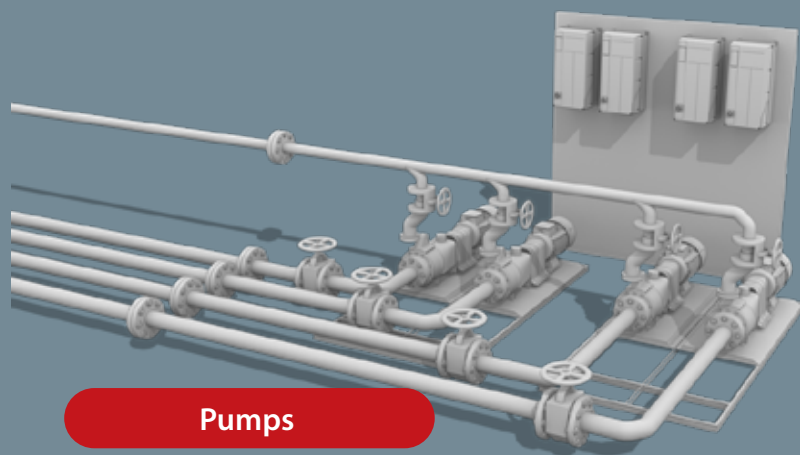
Ventilation and air conditioning are top priority when ensuring the comfort and safety of airport passengers and staff - including fire safety. Danfoss AC drives increase precision, save energy and extend application lifetime of the entire HVAC system.

### Dedicated to precision and protection

Reliable operation of the building infrastructure is key to providing a consistently healthy indoor climate to keep customers and staff happy and safe.

Pump-dedicated control features

- Optimize your operation
- Maintain perfect thermal conditions
- Keep your energy bill at an absolute minimum



Pumps



*Nothing beats know how and experience*  
VLT® HVAC Drive is built to **deliver**  
the **ultimate cost efficiency**

#### **Total cost of ownership**

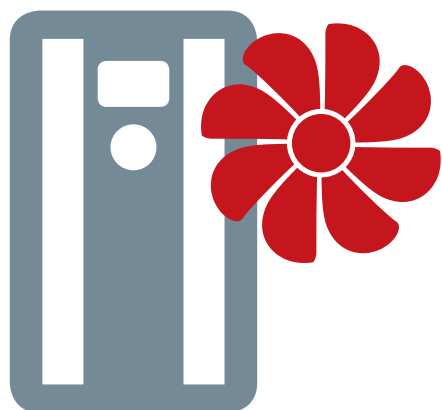
A variety of costs come into play when looking at the total lifecycle of your AC drive. From time spent gathering specifications and engineering the solution, to the purchase price, to installation, commissioning, operation and maintenance costs, the VLT® HVAC Drive has the perfect mix of quality and features to ensure these costs are minimized over the life of the AC drive.

#### **Reliability**

AC drives in HVAC applications see some of the most extreme aspects of the environment. From the frozen tundras to the scorching deserts, VLT® HVAC Drives are exposed to a wide range of operating temperatures. Additionally, AC drives are often used in areas of the world where seismic activity is common or where they are exposed to potentially corrosive atmospheres. You can count on the VLT® HVAC Drive to continuously operate in all of these conditions.

#### **HVAC expertise**

Applications in HVAC are extremely well positioned for energy savings, resulting in reduced energy costs and lowering a building's carbon footprint. New, more efficient motors being used in these applications require unique motor control algorithms in order to optimize their operation. Enabling the user to program their VLT® HVAC Drive in terms commonly used in the HVAC industry ensures that the AC drive is quickly commissioned and always operating with optimal efficiency.



**Total  
cost of  
ownership**

**Reliability**

**HVAC  
expertise**

**Know-how and experience**

**Proven quality**

**DrivePro® Services**

# Savings throughout your entire lifecycle

When you partner with Danfoss, your savings start from the moment you consider installing a VLT® HVAC Drive in your application. Access to electrical and mechanical drawings, early in the design phase. Easy installation, commissioning, and operation of the drive.

An AC drive that efficiently operates your motor. And 24/7 service and support to ensure trouble-free operation of your application.

## Energy efficiency

Energy efficiency of the AC drive includes more than the drive itself. Through a combination of minimizing thermal losses, low standby power consumption and a demand-based cooling fan, the VLT® HVAC Drive operates at 98 % efficiency.

## Optimal motor control

Efficiency is very much based on which motor is best suited for your application. Whether you use an induction motor (IM), a permanent magnet motor (PM) or a synchronous reluctance motor (SynRM), you can be certain that your VLT® HVAC Drive will provide reliable, accurate motor control. Using Automatic Motor Adaptation (AMA) and Automatic Energy Optimization (AEO) functions further ensures that your motor is always operating as efficiently as possible.

## User friendliness

Installation, commissioning and maintenance can be some of the most time and cost-intensive steps in the life cycle of an AC drive. To minimize the impacts of these steps, the VLT® HVAC Drive features a common control panel that includes SmartStart application guides, HVAC-specific parameter names, spring loaded I/O terminals, easy-to-access power and motor terminals. Smart wireless connection alternatives using app or web server make it easy to connect via the device of your choice.

## Fieldbus availability

The ability to easily integrate your AC drive into your building automation system is a key to optimal control. The VLT® HVAC Drive features a number of HVAC-specific communication protocols, such as BACnet/IP, that allow for a great level of flexibility of installation in both new and existing building automation systems.

## Personalize your drive

The VLT® Software Customizer optimizes drive personalization, allowing you to customize parameter names, alarms and warnings, configurable application-specific SmartStart guides, and even a custom display screen for the control panel to brand your company or improve customer information.

Additionally, where there's a high level of commonality in the application and parameter settings, a unique set of customer specific initial values (CSIV) can be defined. This CSIV can then be loaded in the drive, replacing the factory default values with the customer specified default values.

## Total cost of ownership

# 5

## reasons to choose the VLT® HVAC Drive

1. Energy efficiency
2. Optimal motor control
3. User friendliness
4. Fieldbus availability
5. Personalize your drive



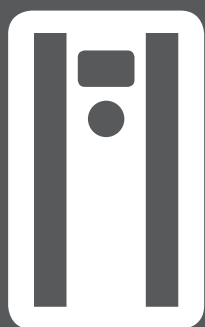
Total  
cost of  
ownership

## Reliability

# 5

### reasons to choose the VLT® HVAC Drive

1. Quality
2. Environment
3. Uptime
4. Electrical immunity and EMC
5. Global 24/7 support



Reliability

## Guaranteed operation in your application

These days, your HVAC applications are often challenged by temperature fluctuations, seismic activity, areas with high levels of atmospheric pollutants, unstable grid quality or a mixture of these conditions. Knowing this, the VLT® HVAC Drive has been equipped to give you the tools to meet these challenges and more. Day in and day out, wherever you face them, you'll have an AC drive that you can always rely on.

### Quality

Our goal has always been to provide you with products and systems of the best possible quality, functionality and efficiency. To improve our service to you even further, we have implemented the ISO/TS 16949 standard. This standard builds on the previous ISO 9001 guidelines but is far more ambitious in scope, addressing not just what we should do but how we should do it. The TS 16949 standard is about understanding your needs and meeting them with products, solutions and services that match your expectations.

### Environment

With a wide operating temperature down to -25 °C and up to 55 °C and an availability of enclosure classes up to IP66/UL Type 4X, the VLT® HVAC Drive can operate almost anywhere even outdoors. The addition of seismic resistance, the ability to install to altitudes of 2000 m/6500 ft without derating and options for conformal, harsh environment coating to 3C3, further improves the VLT® HVAC Drive's ability to work in the most demanding environments.

### Uptime

The drive is an important part of air-handling and rooftop units. With billions of people all around the world relying on these HVAC systems for comfort and safety, one of the key focuses is selecting an AC drive that can withstand unforeseen grid fluctuations that would otherwise interrupt operations. To improve ride-through, the VLT® HVAC Drive relies on a robust

overvoltage controller, kinetic backup and flying start which ensures reliable operation when it's needed most.

### Electrical immunity and EMC

Electrical events occurring in the grid can cause serious issues for AC drives and systems. SEMI 47 certification is your documentation for reliable drive performance, despite voltage spikes and dips. The VLT® Advanced Harmonic Filter program deals with harmonics challenges in the grid and guarantees mitigation below 5 % THDi.

The drive is also short-circuit proof, with a 100 kA prospective short circuit current capability to protect it against damage.

Integrated EMC filters meet the requirements of Residential Categories C1 and C2 with up to 150 m screened motor cable. These filters also minimize radio-frequency interference (RFI) to even further protect sensitive equipment from radiated emissions.

### Global 24/7 support

Expect minimum 10 years' reliable drive operation with no scheduled component replacement, under normal operating conditions. Should you need any kind of support, any time, at any location, we will be there for you. We understand that your uptime is critical, and we react fast.



Learn more about  
DrivePro® Life Cycle service offerings

# Integrated **intelligence**

When searching for the best AC drive for your application, you want to find a partner that understands your needs and challenges. With over 30 years dedicated to HVAC applications, we've heard your comments and continually added the most requested features. As a result of your close cooperation, the VLT® HVAC Drive is a drive that speaks your language, is reliable enough to be installed where you need it, and saves you time and money throughout its lifetime.

## Safety

HVAC applications require a wide and varying consideration for safety in order to protect both the people around the equipment and the equipment itself. To aid this, the VLT® HVAC Drive features the integrated Fire Mode function and a series of options for basic and advanced functional safety, ATEX certified inputs and a lockable mains disconnect as part of the enclosure.

## Drive as a controller

Unleash the intelligence of your drive. Via its Smart Logic Controller, the drive offers a multitude of sophisticated control functionalities you can put to work to reduce complexity, optimize cost and achieve next-level performance in your HVAC applications. Customize the process control exactly to your application. VLT® Pressure Transmitter PTU 025 and a wide range of control options extend control functionality where required.



*Learn more about intelligent control*

## Condition-based monitoring

Use the intelligent VLT® HVAC Drive to monitor the condition of your motor and application in real time, detect when current operation status is drifting away from the defined limits, and alert the operator to changes before they impact your process.



*Learn more about condition-based monitoring*

## Digital design tools

Almost all owners and operators of AC drives aim to reduce the amount of energy used in their applications. That's why understanding and documenting energy savings and energy efficiency are vital steps in engineering a system - and in measuring its performance once up and running. Use the Danfoss digital tools and intelligence built into the drive, to support your engineering and document performance:

**VLT® EnergyBox tool** calculates the potential energy savings of the system in the design phase, based on logged real-life operation data.

**MyDrive® ecoSmart tool** calculates and documents the efficiency class of both the drive and system according to IEC/EN 61800-9.

A built-in energy meter measures the energy consumed by each drive in your application.



*Learn more about digital tools*

## Resource library

Design your system faster with access to diverse resources including 3D BIM files.

## HVAC expertise

# 5

## reasons to choose the VLT® HVAC Drive

1. Safety
2. Drive as a controller
3. Condition-based monitoring
4. Digital design tools
5. Dedicated HVAC functionality



HVAC  
expertise

# Intelligence for Air Handling Units & Rooftop Units

## Master control for AHU or RTU

VLT® HVAC Drive includes intelligent features enabling you to program the drive to control a complete Air Handling Unit (AHU) or Rooftop Unit (RTU). The Smart Logic Controller (SLC) with 4 parallel control loops makes it easy to program monitoring and control loops in a simple way without additional cost. For more advanced control, let the VLT® Programmable Controller option take over the controls. Program the LCP for specific user dialogue. Use external I/Os to extend and match the required number of I/Os in an advanced AHU or RTU controlled by the drive.

## Pressure to flow conversion

A flow controller integrated into the drive ensures a defined flow or pressure level in the air supply system. Using the built-in VLT® Pressure Transmitter PTU 025 you achieve a cost-optimal intelligent AHU control system, with optimized energy consumption, reduced system complexity, and improved comfort.

## Air Filter Monitoring

Intelligent filter monitoring maintains the perfect indoor climate at a low operating cost. The operator can define his own warning levels for clogged filter replacement, and the monitoring level is adjusted according to the fan speed. The intelligent VLT® Pressure Transmitter is factory-calibrated and monitors up to 4 filters simultaneously. This option features 3 pressure ranges from 500 Pa to 2500 Pa. Attach it easily and directly to the VLT® HVAC Drive with no need for additional external equipment.

## Extended BMS capacity

Easy integration into building management systems (BMS) provides managers with detailed information about the current state and operation of the infrastructure in the building. All the I/O points in the drive are available as remote I/O to extend the capacity of the BMS. Pressure signals from the PTU 025 function as external I/O modules connected via the communication interface.



### VLT® HVAC Drive equipped with VLT® Pressure Transmitter PTU 025

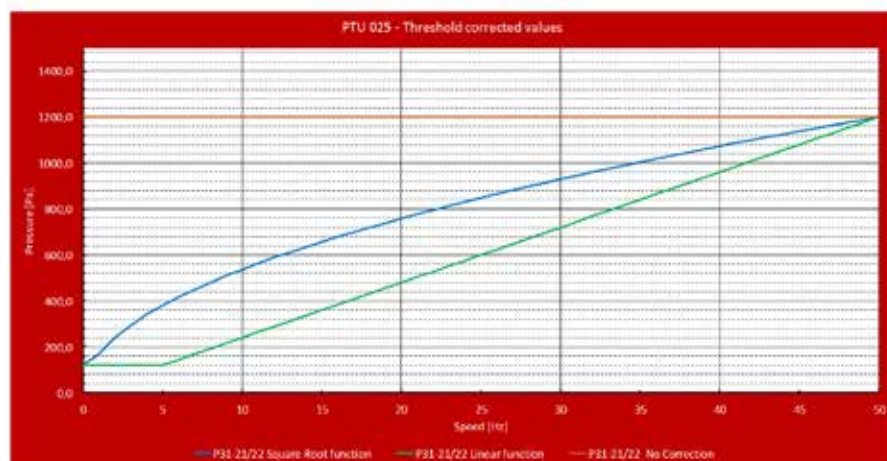
*This innovative solution fulfils the Ecodesign Directive ErP, EC Regulation 1253/2014/EG to improve AHU/RTU energy consumption.*



Read the fact sheet



Pressure/Speed curve settings



## Intelligent HVAC features

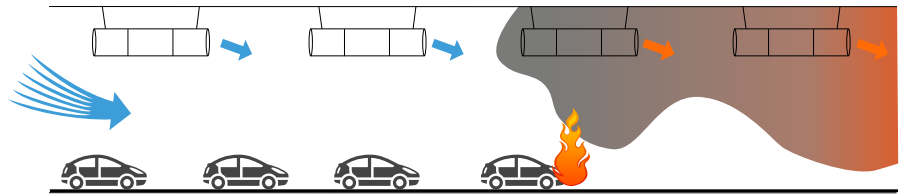
- Controls AHU or RTU air flow from inlet to outlet
- Flow control based on pressure level or air volume
- Smart Logic Controller with 4 loops in parallel
- Optional programmable controller
- Extended I/O for BMS integration, internal & external
- Integrated VLT® Pressure Transmitter PTU 025 with filter monitoring

# Intelligence for Fire & emergency operation

## Fire and emergency

In the event of fire in a building, the Fire Emergency Mode safety feature prevents the drive from stopping to protect itself. Instead it will continue vital fan operation to secure optimal smoke extraction or over-pressure in the stairwell to ensure occupants can more safely evacuate buildings via staircases.

Continual monitoring of the fire system installation, including the motor, also ensures optimal operating conditions when a critical situation arises. This eliminates potential interruptions to starting the fire system, such as a motor service switch or a broken cable installation. This kind of continual monitoring may also reduce the frequency of service checks required. Run the drive on normal operation settings, where Fire Emergency Mode will suppress alarms. Alternatively change to special Fire Emergency Mode settings, with up to 32 different operation settings in 4 setup groups.



## Smoke extraction and Multi-zone Fire-mode

The VLT® HVAC Drive also features a multi-zone fire-mode function that allows for adjustable speed controls depending on the zone(s) where the fire is active. Utilizing the logic within the drive allows for a less complex and more reliable smoke extraction system that can respond to multiple zones according to need.

Multi-zone Fire-mode is based on 8 setpoints in 4 setup menus to support forward and reverse directions, and open-loop or closed-loop control. Activate Multi-zone Fire-mode via digital input or via fieldbus.

Use it confidently in buildings as well as carpark and tunnel systems, where the multi-zone control and change of operation condition support secure and coordinated control of ventilation and smoke extraction systems for heightened safety of occupants.



## Intelligent HVAC features

- Special operation condition for best protection of human life: “Run to dead” suppresses drive self-protection alarms
- Reduce fire development via standard ventilation systems or by controlling special smoke extraction systems
- PID control maintains “over pressure” in stairwells to keep them smoke-free, and to ensure people can enter the stairwell from the different floors
- Use normal operation condition or switch to special operation setting with up to 32 different zones in 4 setups
- Control via fieldbus or standard I/O to adapt to different fire system solutions
- Continue operating at full load\* for minimum 1 hour at 70 °C ambient temperature. \*80 % load for high-power drives
- Continuous monitoring of the installation to ensure reliable operation when a critical situation arises
- Operation log documents Fire Emergency Mode operation and alarms, including service guidelines for any critical alarm activated
- Supports EN 12101 standard for smoke and heat control systems



# Intelligence for **fan applications**

## **Embedded fan function**

The VLT® HVAC Drive FC 102 includes more features than any other drive, to increase efficiency and deliver a trouble-free operation with high performance in all HVAC applications.

## **Speed bypass to avoid resonance**

The drive avoids resonance problems using a built-in function to bypass speed ranges where the application may generate resonance. The bypass speed range is defined by a start and stop speed for bypass activation. It supports up to 4 speed ranges, based on a RPM or Hz selection.

## **No load / Broken Belt warning**

Many fan applications are still operated by a belt. This function monitors whether the belt is still in use, has ceased operation due to wear and tear. The built-in maintenance program helps you to ensure belt inspection at regular intervals.

## **Multi-Motor**

One drive can handle a number of induction motors in a multi-motor configuration, often defined as a “fan wall”. This means that one VLT® HVAC Drive operates all of the connected motors at the same frequency and with the same voltage. Special selection and configuration is required to ensure safe operation of the motors and the application.

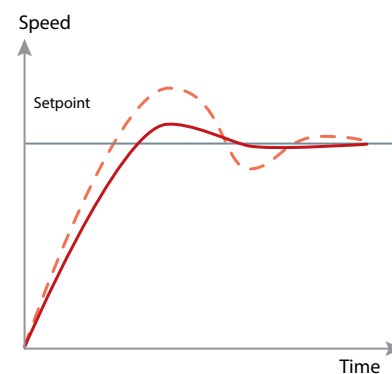
## **Drive bypass<sup>1)</sup>**

If a drive bypass is available the VLT® HVAC Drive will not only sacrifice itself; it will also bypass itself and connect the motor directly to mains. As a result fan functionality will be maintained after the drive stops operating, as long as there is still power and the motor is functioning.

<sup>1)</sup>Only available in the USA

## **Auto tuning of PI controllers**

Auto tuning enables the drive to monitor how the system reacts to corrections made by the drive constantly. The drive learns from it and calculates the P and I values, so precise and stable operation is restored quickly.







# Intelligence for pumps

## Embedded pump controller

The Pump Cascade Controller distributes operation hours evenly across all pumps. Uneven wear and tear on individual pumps is therefore reduced to a minimum, extending their lifetime expectancy and reliability considerably.

## Vital water supply

If a pipe leaks or breaks, the VLT® HVAC Drive can reduce the motor speed to prevent overload, while continuing to supply water at lower volume.

## Sleep mode

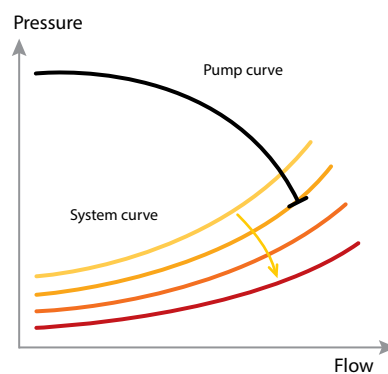
In situations with low or no flow, the drive enters sleep mode to conserve energy. When the pressure falls below the pre-defined setpoint, the drive starts automatically. Compared to continuous operation this method reduces energy costs and equipment wear and tear, extending the lifetime of the application.

## Auto tuning of PI controllers

For details, refer to page 16

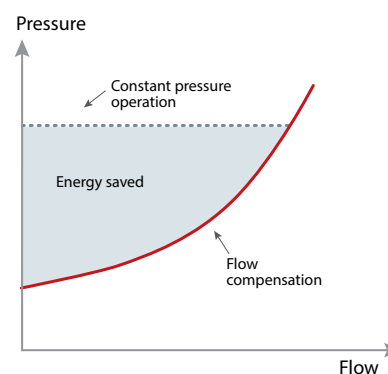
## Dry pump protection and end of curve

If the pump runs without creating the desired pressure, the drive sets off an alarm or performs another pre-programmed action. This happens for example when a well runs dry or a pipe leaks.



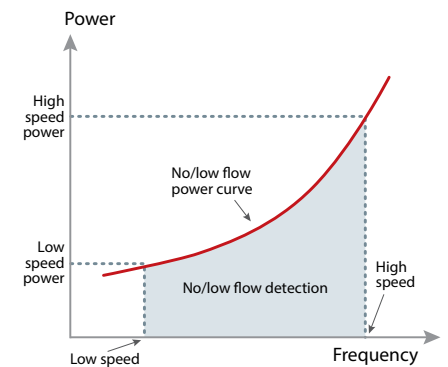
## Flow compensation

A pressure sensor mounted close to the fan or pump provides a reference point maintaining constant pressure at the discharge end of the system. The drive constantly adjusts the pressure reference to follow the system curve.



## No/low flow

During operation, a pump normally consumes more power the faster it runs. In situations where the pump runs fast, but is not fully loaded, and does not consume adequate power, the drive compensates accordingly. This is a particular advantage when water circulation stops, the pump runs dry or when pipes leak.



## Sensorless Pump control

Sensorless Pump Control enables the drive to generate the pressure or flow based on a defined or measured pump curve inside the drive.

This process works with non-compressible liquid and no additional sensors are required.

The drive can communicate its sensorless data to an external process controller, when relevant.



**Intelligent**  
 monitoring and  
 maintenance  
 functions embedded  
 in the drive

# Achieve maximum availability of your system – with **condition-based monitoring**

Equipped with intelligent monitoring functionality, the VLT® HVAC Drive enables you to use the drive as a smart sensor. It can monitor the condition of your motor and application in real time, detect when current operation status is drifting away from the defined limits, and alert the operator to changes before they impact your process.

## Condition-based monitoring

During installation, the condition-based monitoring (CBM) function establishes a baseline defining the recorded operation conditions for each monitoring element of the system, and threshold values are defined. During operation, CBM monitors motor stator windings, sensors and load-envelope conditions, all adjusted according to the actual speed of the system. When actual operation conditions exceed the defined limits, CBM sends alerts to notify personnel to take action.

The CBM function complies with relevant standards and guidelines, such as

- ISO 13373 standard for Condition Monitoring and Diagnostics of Machines
- VDMA 24582 guideline for condition monitoring
- ISO 10816/20186 standards for measurement and evaluation of mechanical vibration.

The unique embedded functionality means that the VLT® HVAC Drive performs CBM monitoring inside the drive. When required, activate cloud or PLC connectivity to enable monitoring of numerous conditions or to send alerts when required.

Feature	Benefit
Condition-based monitoring functionality embedded in the drive	<ul style="list-style-type: none"> <li>- No cloud connection required: high security level and no subscription fee</li> <li>- Reduced installation costs, since no external controller or PLC required to generate the CBM observation and notification</li> <li>- Documentation of system stability</li> </ul>
Motor-stator-winding monitoring	<ul style="list-style-type: none"> <li>- More uptime due to early detection and action on faults in the motor stator winding, before the fault develops into a crippling failure and unscheduled operational stop</li> </ul>
Load-envelope monitoring Application baseline (run / online)	<ul style="list-style-type: none"> <li>- Process optimization/maximized efficiency thanks to ability to compare actual system performance with baseline data and trigger maintenance actions</li> </ul>
Sensor application monitoring (external) Application baseline (run / online)	<ul style="list-style-type: none"> <li>- More uptime due to early detection and action on signs of mechanical misalignment, wear-out and looseness</li> <li>- Higher precision since sensor monitoring relates to motor speed</li> </ul>



Read the white paper here

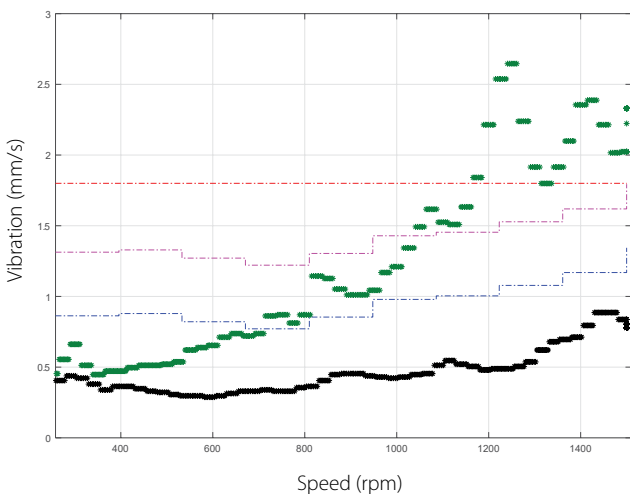
## Motor-stator-winding condition monitoring

Motor-winding failures do not occur suddenly; they develop over time. They start with a small single-turn shortcircuit fault which causes additional heating. The damage then spreads to a level where the overcurrent protection activates, and the operation stops, causing unwanted downtime.

The unique winding condition monitoring function allows you to shift from reactively performing corrective maintenance of faulty motors, to proactively detecting motor isolation faults at an early stage and dealing with them during scheduled maintenance. In this way, you can avoid unwanted and potentially costly machine downtime caused by 'burned' motors.

## Sensor selection

Four condition-based monitoring sensor inputs are defined by the analogue inputs. Using condition-based monitoring parameterization, you can scale the inputs to monitor the sensor signals where the vibration sensor is the most commonly used sensor type. Pressure and flow sensors could also be selected, provided that sensor selection is related to the drive speed of the system.



Application example showing changes in vibration signal

- Baseline data
- Faulty data
- - - Alarm Level
- - - Warning Stage 2 Level
- - - Warning Stage 1 Level

## Mechanical-vibration monitoring

Avoid accelerated wear of the mechanical parts of a drive system by using CBM together with an external vibration transducer, to monitor the vibration level in a motor or application, related to the actual speed or rotation of the system.

Vibration monitoring is performed using standardized methods and threshold levels given in standards such as ISO13373 for Condition Monitoring and Diagnostics of Machines or ISO10816/20816 for Measurement and Classification of Mechanical Vibration.

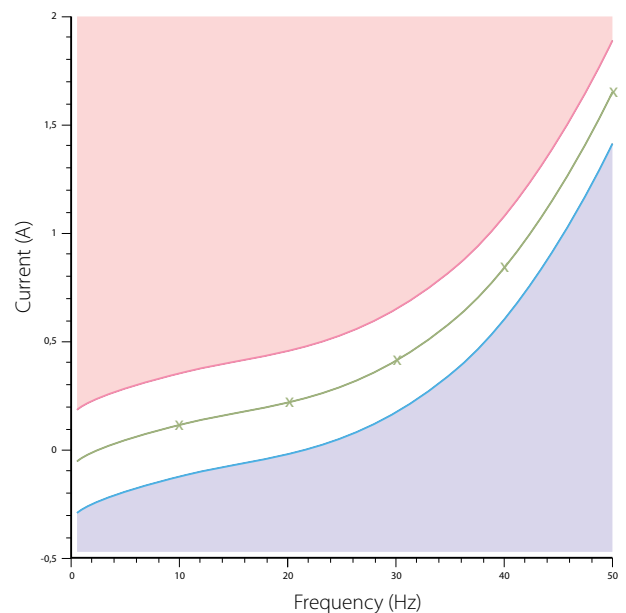
Baseline measurement of min/max and average values indicate the stability of a system at different speeds and are very useful as a hand-over test from contractor to end-user.

## Load-envelope monitoring

Use the VLT® HVAC Drive to compare the actual load curve to the initial values determined during commissioning. This empowers you to detect unexpected operating conditions, such as

- leakage in an HVAC system. Inadequate or excessive power consumption indicates a problem, defined at individual speeds.
- pumps which have become fouled or sanded
- clogged air filters in ventilation systems

When a part has worn out, the load curve changes compared to the initial baseline, and a maintenance warning is triggered allowing you to quickly and effectively remedy the issue. Load-envelope monitoring can also help you to save energy by ensuring the equipment always runs in optimal conditions.



Baseline - Load envelope monitoring of energy consumption.

- Energy consumption above the limit
- Energy consumption below the limit



## Drive as a **controller**

### **Customize with SLC**

Use the built-in Smart Logic Controller (SLC) to customize drive functionality, and optimize how the drive, motor and application work together. The VLT® HVAC Drive features 4 different SLC loops which operate independently. Create new functions via simple, intuitive drop-down selections that give you numerous options for setting the drive to specific application needs. Most logic functions run independently of the sequence control, meaning the drive monitors variables or signal-defined events in an easy and flexible way, independently of the motor control.

Use freely programmable options and I/O modules to increase the control area of the drive even more.

Use these programmable options to control air handling functions with fans, valves and dampers to reduce and free up valuable control capacity for the building management system. Advanced local programmability and programming of the LCP for user interaction reduces the overall complexity of an AHU/RTU installation, and future-proofs it, ready for IoT and cloud integration.

### **Time-based functionality and real-time clock**

Integrated date, day and time-based functionality means you can easily program the drive to change operation mode, start functions or even make specific actions, right on time. The real-time clock option ensures you are always in control of the time and date - even after power cycling of the drive.

### **Functional safety**

The VLT® HVAC Drive is able to provide the STO (Safe Torque Off) function in compliance with ISO 13849-1 PL d and SIL 2, according to IEC 61508 / IEC 62061. Optional integrated lockable mains disconnect protects staff working inside the HVAC installation.

### **Extended I/O**

Extend the I/O interfaces using a wide variety of options to match application needs, such as standard digital I/O and relays; analog I/O, and special interfaces for temperature sensors. Connect the extensions inside the drive enclosure or via a bus system to external I/O modules, with protection ratings IP20 to IP66.

### **Drive as I/O interface in remote installations**

The ruggedized enclosure of the VLT® HVAC Drive makes it possible to install the drive fully exposed to a harsh environment: close to the motors, sensors, and other control components. The drive I/O interface and control functions reduce installation complexity. The drive connects directly to all the local components in the installation, and connects via fieldbus to the BMS system or other SCADA systems which control the complete application.

Local I/O connection covers a variety of interfaces: the built-in I/O functions, and optional internal and external I/O modules via BACnet or Modbus. These installations are often used in tunnel projects or in renovation projects where standalone systems are integrated into a larger BMS which monitors the application.

### **PID controllers & autotuning**

Four proportional-integral-derivative (PID) controllers are built into the drive to ensure optimal internal and external control and to eliminate the need for auxiliary control devices.

The PID controllers maintain constant control of closed loop systems enabling the drive to adjust motor speed to regulate pressure, flow, temperature or other system requirements.



## Installed efficiency – **Enjoy ongoing returns** on your drive investment each year

VLT® HVAC Drive delivers superior energy savings using a unique combination of strategies which include intelligent control algorithms, heat management, and harmonic mitigation.

These valuable energy savings are a result of our tight focus on energy efficiency, including the highly economical solution for harmonic mitigation and an outstanding cooling concept that considerably reduces or completely eliminates the need for air conditioning. Compared to traditional drive solutions, the savings made possible with the VLT® HVAC Drive exceed the energy savings gained by choosing an IE3 motor instead of an IE2.

### **Energy saving heat management**

A unique back-channel cooling concept transfers up to 90% of heat away from the room, using a fan-less design that exploits heat differentials in materials and air temperature and the latest developments in heat piping technology. This results in large energy savings on air conditioning.


 *Learn more about back-channel cooling*

### **Energy efficient harmonic mitigation**

The unique VLT® Low Harmonic Drive with integrated Advanced Active Filter delivers energy efficiency that is 2-3% better than traditional AC drives with Active Front End technology. Sleep function at low load ensures further energy savings.

### **Advanced Automatic Motor Adaption**

The VLT® HVAC Drive will automatically adapt to the motor to ensure supremely efficient motor performance, no matter which brand or type of motor technology you choose for your facility. The VVC+ control automatically performs advanced motor data analysis for optimum and highest efficiency control.

 *Learn more about intelligent control*




AHRI - directory of Certified Product Performance

### **Automatic adaption to application**

Around 90% of all motors are oversized by more than 10%. Automatic Energy Optimizing functionality can deliver energy savings of 2-5% over the whole load range.

### **Validate performance of your drives using digital tools**

- **MyDrive® ecoSmart™** calculates IE and IES classes according to EN 61800-9-2
- **MyDrive® Harmonics** calculates harmonics mitigation requirements and recommends solutions
- **VLT® EnergyBox** calculates and monitors the energy savings achievable by using VLT® drives

 *Learn more about digital tools*



EC+

concept for superior  
system efficiency

## Ecodesign and EC+ concept

### Ecodesign and generation of power efficient systems

The Ecodesign is based on international IEC standards (IEC/EN 61800-9) to document the efficiency of a power drive systems and thereby reduce the energy consumption of systems. Save energy by combining a high-efficiency Danfoss drive with a high-efficiency PM motor.

Use the MyDrive® ecoSmart tool for guidance and documentation of the optimal drive selection for any motor type in a power drive system application.



[ecosmart.danfoss.com](https://ecosmart.danfoss.com)



*Ten things you need to know about Ecodesign*



*Learn more about digital tools*

### EC+ concept

Motors with permanent-magnet rotors are increasingly popular due to their high efficiency. In the HVAC sector, this technology is primarily known as an "EC motor". EC motors operate on the basis of the brushless DC motor (BLDC) principle and they are typically used in external-rotor fans with low air throughput.

However Danfoss offers a more efficient control concept, named EC+. EC+ concept is based on high-efficiency PM motors combined with drives running the VVC+ control algorithm for optimal system efficiency.

An EC+ concept system normally offers higher efficiency, since axial fans consume much less energy, and generate a higher air throughput than EC fans. Furthermore, the design of these PM motors is based on the IEC standard for motor mechanical construction – making it easier to upgrade an existing system.



*Learn more about EC+ concept*

### Advantages of the EC+ concept

- Free choice of motor technology: control a SynRM, PM or induction motor with the same AC drive
- Device installation and operation remain unchanged
- Manufacturer independence in the choice of all components
- Superior system efficiency thanks to a combination of individual components with optimum efficiency
- Retrofitting of existing systems is possible
- Wide range of rated powers for SynRM, PM and induction motors.



**85%**  
system efficiency

### System efficiency increase:

- Axial fans with up to 92 % efficiency
- Highly-efficient PM motor with efficiency up to 95 %
- VLT® HVAC Drive with up to 98 % efficiency



*Read how Volkswagen uses EC+ concept*

# Back-channel cooling: Efficient and economic heat management

The Danfoss back-channel cooling system is a masterclass in thermodynamics that delivers efficient cooling using a minimal amount of energy.

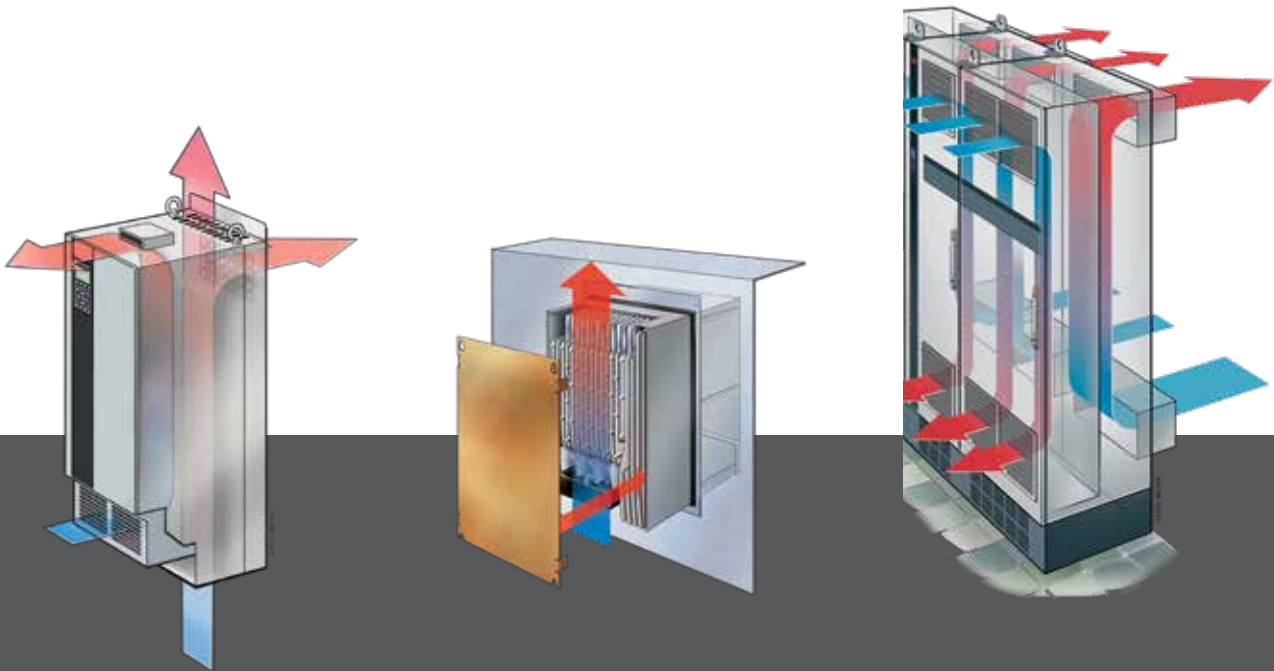
## Cost-saving heat management

A compact design that exhausts 90% of system heat outside the building makes it possible to reduce the size of your cooling system in the panel or switch room. These remarkable savings are achieved with Danfoss' panel-through cooling system or the extremely efficient back-channel cooling concept. Both methods considerably reduce the installation costs of the panel or

switch room, as designers can shrink the size of the air conditioning system, or even eliminate it entirely. In daily operation, the benefits are equally clear as the energy consumption related to cooling is brought down to an absolute minimum. Combined installation and energy savings result in up to 30 % cost savings in the first year of your drive investment.

## Revolutionary design

The proprietary back-channel cooling concept available for the VLT® HVAC Drive is based on a unique heatsink design, with heat pipes that conduct heat 20,000 times more efficiently than traditional solutions. Using a minimal amount of energy, the concept exploits the heat differentials in materials and air temperature to effectively cool high performing electronics.



**90% reduction** in air conditioning system investment  
**90% reduction** in energy use for air conditioning

### 1 Reduced dust over electronics

Complete separation between cooling air and internal electronics, ensures trouble-free operation and longer intervals between service.

### 2 Panel-through cooling

An accessory mounting kit for small and mid-range drives enables heat losses to be directed directly outside the panel room and into designated air ducts.

### 3 Back-channel cooling

By directing air through a rear cooling channel up to 90 % of the drive's heat loss is removed directly outside the installation room.

# A master of all motor technologies

Save commissioning time and fine-tune for optimal system control. The choice of motor is all yours - use VLT® HVAC Drive with the motor technology you prefer.

## Free choice of motor

Danfoss gives you a free choice of motor supplier and supports all commonly used motor types. The VLT® HVAC Drive offers control algorithms for high efficiency and trouble-free operation with standard induction motors, permanent magnet (PM) motors, induction and synchronous reluctance motors. This means you can combine a VLT® HVAC Drive with your favorite motor technology to achieve a masterclass performance.

## Straight into action with Automatic Motor Adaption

Allowing you to access optimal, dynamic motor performance with just a few clicks, the AMA function saves you a lot of time and effort when setting up the system. Guided by the SmartStart start-up wizard, just enter the basic motor data, such as currency and voltage, which are found on the motor name plate, and you are straight into action.

## Motor control for general & advanced applications

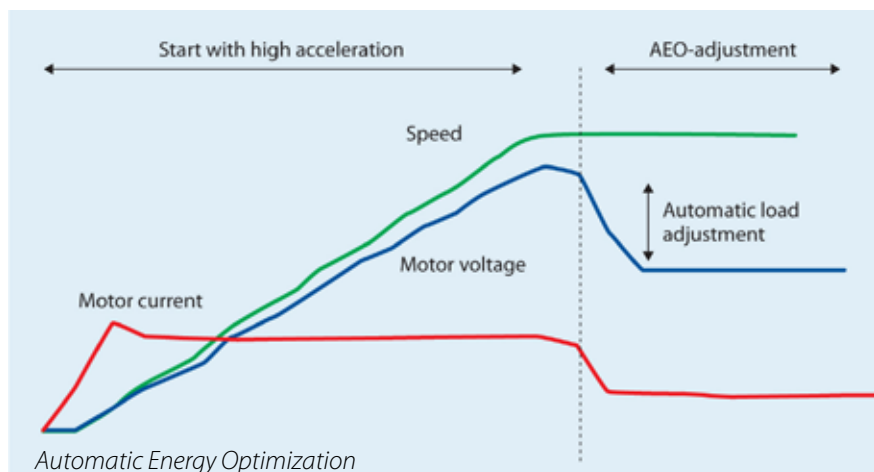
The drive uses standard VVC+ motor control, an easy and perfect choice for most variable torque HVAC applications. However in some circumstances, the more advanced Flux mode motor control is required to gain faster motor control of the application and to handle unstable mains power supply. Advanced Flux control also demands a higher degree of alignment of the motor parameters for optimal control, where the AMA function helps to create the best operation platform.

## Automatic Energy Optimization

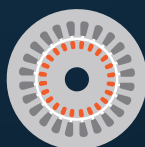
With the AEO feature we have made a complex task easy and available with only a few clicks. The integrated AEO function ensures optimal energy-efficient speed control of the pump, while adapting the voltage exactly to the current load situation to reduce energy consumption.

## Super-easy commissioning with Auto Tuning

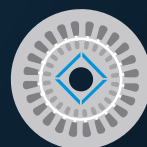
Auto tuning fine-tunes your system to optimal performance, while cutting down on programming. The auto tuning function measures a series of system characteristics and automatically finds the settings of the process controller for stable and precise system control.



**IM**  
Three-phase induction motor with copper rotor



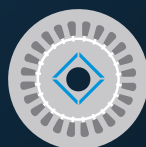
**LSPM**  
Line-start PM motor with buried magnets and rotor cage



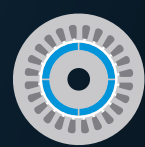
**SynRM**  
Synchronous reluctance motor



**IPM**  
PM motor with buried magnets



**SPM**  
PM motor with surface-mounted magnets





# Installation made simple

## – Save mounting time and cost

The VLT® HVAC Drive is built on a flexible, modular design to provide an adaptable compact solution which is also simple to install. Reduced complexity and clever practical details save installation costs and time.

### **Reduce costs with compact drives. Danfoss offers the highest power density in the market.**

Compact design and efficient heat management enable the drive to take up less space in control rooms and panels in various environments. Combined with side-by-side installation capability, the VLT® HVAC Drive delivers superior space-saving drives solutions. Especially impressive is the 400 V version, which is among the smallest in its power class on the market today, and is available in an IP54 and IP66 enclosure.

### **Direct from factory for outdoor installation**

VLT® HVAC Drive is ready in any protection class that you require for your HVAC operation, from IP20 for panel mounted solution to IP66/NEMA 4X for outdoor installation, for example where drives are installed on a rooftop unit (RTU).

### **Extended temperature range**

Tolerance of a wide operating temperature range, from -25 °C to +55 °C, means you can install the drive locally in outdoor HVAC operations. This decentral installation capability reduces cable costs and eliminates the need for air conditioning, lowering cost of electrical rooms.

### **Long cable capability**

With no need for additional components, the VLT® Drive provides flexible installation with cable lengths up to 150 m screened and 300 m unscreened to reduce installation costs. An with an All-Mode filter up to 1000 m with standard unscreened cables.

### **Built-in EMC filters**

VLT® HVAC Drive units are equipped with integrated DC link chokes and EMC filters as standard features. This enables them to reduce grid pollution and eliminate the cost and effort of fitting external EMC components and related wiring. A regular electrician can install the drive easily in residential areas, with no need for a professional installer.

### **Space-saving harmonic mitigation**

The Danfoss enclosed drives or a central Advanced Active Filter (AAF) solution for harmonic mitigation keeps installation costs down, while reducing the size of the drive cabinet to save space in the electrical control room.

### **Easy commissioning**

Whether it's a 1.1 kW or a 1.4 MW drive, you get the same control panel with local language, the new SmartStart function and many other time-saving features, all wirelessly accessible from your mobile device to save you installation time and hassle.





# Optimize performance and grid protection

## Built-in protection

The AC drive contains all the modules necessary for compliance with EMC standards.

A built-in, scalable RFI filter minimizes electromagnetic interference, and the integrated DC link chokes reduce the harmonic distortion in the mains network, in accordance with IEC 61000-3-12. Furthermore, they increase the

lifetime of the DC link capacitors and therefore the overall efficiency of the drive.

These built-in components save cabinet space, as they are integrated in the drive from the factory. Efficient EMC mitigation also enables the use of cables with smaller cross-sections, which reduces installation costs..

## Expand grid and motor protection with filter solutions

Danfoss' wide range of solutions for harmonic mitigation ensures a clean power supply and optimal equipment protection, and includes:

- VLT® Advanced Harmonic Filter AHF
- VLT® Advanced Active Filter AAF
- VLT® Low Harmonic Drives
- VLT® 12-pulse Drives

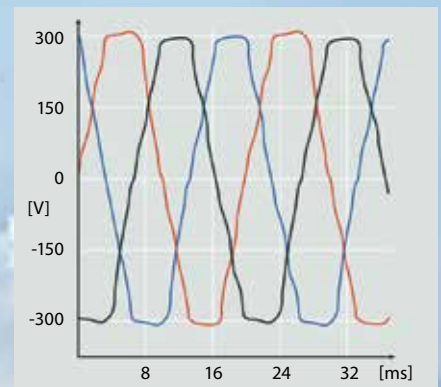
Provide extra motor protection with:

- VLT® Sine-wave Filter
- VLT® dU/dt Filter
- VLT® Common Mode Filters
- All-Mode filters

Achieve optimum performance for your application, even where the grid is weak or unstable.

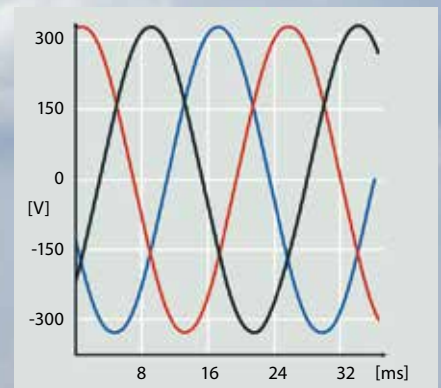
## Use motor cables up to 1000 m

The design of the AC drive makes it a perfect choice in applications that require long motor cables. Without needing additional components, the drive provides trouble-free operation with cable lengths of up to 150 m shielded or 300 m unshielded. Extend the cable length to 1000 m with unshielded motor cables by using a All-mode filter solution. This allows the drive to be installed in a central control room, away from the application without affecting motor performance.



### Harmonic distortion

Electrical interference reduces efficiency and risks harming equipment.



### Optimized harmonic performance

Efficient harmonic mitigation protects electronics and increases efficiency.

EMC Standards		Conducted emission		
Standards and requirements	EN 55011 <i>Facility operators must comply with EN 55011</i>	Class B Housing and light industries	Class A Group 1 Industrial environment	Class A Group 2 Industrial environment
	EN/IEC 61800-3 <i>Converter manufacturers must conform to EN 61800-3</i>	Category C1 First environment, home and office	Category C2 First environment, home and office	Category C3 Second environment
Compliance <sup>1)</sup>		■	■	■

<sup>1)</sup> Compliance to mentioned EMC classes depends on the selected filter. For further details see the design guides.

# Installation made simple

## – Save commissioning time with SmartStart



SmartStart is a setup wizard that is activated at the first power up of the drive, or after a factory reset. Using easy-to-understand language, SmartStart guides you through a series of simple steps to ensure correct and efficient motor control and alignment for the application operation.

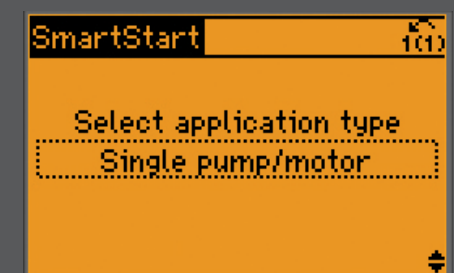
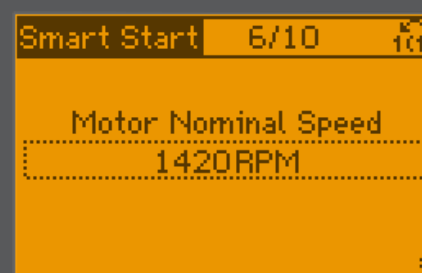
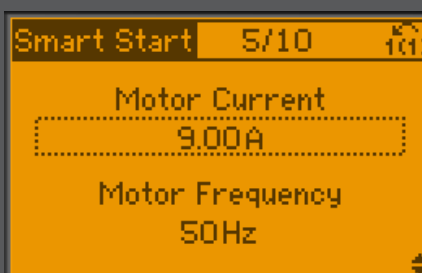
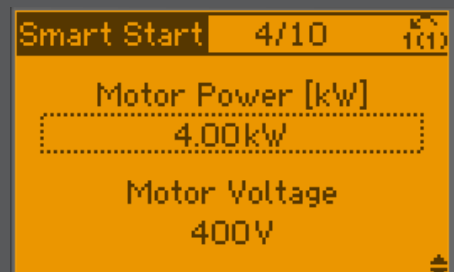
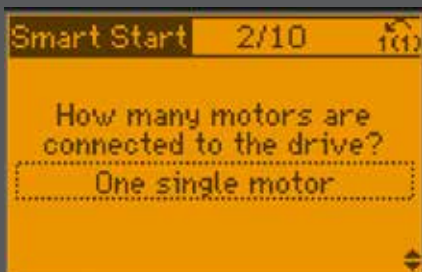
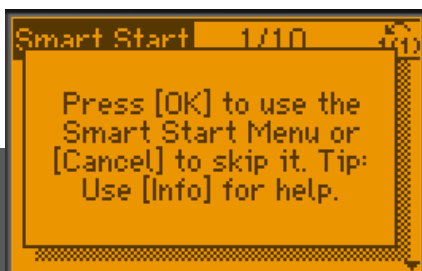
Start the wizard directly via the Quick Menu on the graphical control panel, and choose your preference amongst 27 languages.

Additionally, the ability to save up to 50 user-selectable parameters further simplifies interactions with key parameter settings for your unique application. The graphical local control panel (GLCP) featured in VLT® drives is hot-pluggable and can be mounted remotely when your application requires.

### Remote LCP Mounting

The VLT® HVAC Drive is often mounted inside the AHU housing. Therefore it is convenient to install a remote LCP for easy operation and programming of the drive. The LCP Remote Mounting Kit is specially developed for easy installation in isolated AHU units with up to 90mm wall thickness.

Additionally, the cover on the kit will hold itself up, blocking the sun while you program the LCP, or you can close and lock it while keeping the On/Alarm/Warning LEDs visible. Read more under 'Accessories'.



# Installation made simple

## – Wireless connectivity to the drive

Wireless connection to the drive via your smartphone makes commissioning and troubleshooting easier and faster when drives are outdoor protected and located in hard-to-access spots.

The VLT® Wireless Communication Panel LCP 103 communicates with MyDrive® Connect – an app which you can download to iOS and Android-based smart devices. MyDrive® Connect gives you full access to the drive, making it easier to perform commissioning, operation, monitoring and maintenance tasks.

### Instant access to vital information

The VLT® Wireless Communication Panel LCP 103 displays the current drive status (On, Warning, Alarm, Wi-Fi Connectivity) through built-in LEDs. Via MCT 10 on a laptop or via the MyDrive® Connect app you can then use your smart device to access detailed information, such as status messages, start-up menus and alarm/warning events. This means you can configure your drive wirelessly on IP55 and IP66 without compromising the tight enclosure for USB connection.

The app will also visualize various data with graphs to document the behavior of a drive over time. Utilizing the active point-to-point wireless connection or via an access point and local network, maintenance personnel can receive real-time error messages via the app to enable quick response to potential issues and reduce downtime.

### Sharing data

The advanced LCP copy function allows you to store copies of the drive parameters, either to the internal memory of the VLT® Wireless Communication Panel LCP 103 or to your smart device. Log details can be shared from MyDrive® Connect, so that the service team can provide relevant support for troubleshooting. The safe control parameter allows the user to decide the drive behavior in case of crash/connection-loss from app to drive.



## Free to connect

Real time information is becoming increasingly important in building management systems (BMS) as well as industrial applications with Industry 4.0. Immediate access to data increases transparency in production facilities, while making it possible to optimize system performance, collect and analyze system data and provide remote support around the clock from anywhere in the world.

Today, drives are more than simple power processors. With the ability to act as sensors and sensor hubs, to process, store and analyze data, along with connectivity capabilities, drives are vital elements in modern BMS and

automation systems using Industrial IoT. This means Danfoss drives are valuable tools in **condition monitoring**.

Regardless of your application or your preferred communication protocol, Danfoss drives have an extremely wide variety of communication protocols to select from. In this way you can ensure that the AC drive integrates seamlessly into your chosen system providing you the freedom to communicate however you see fit.

### Increase productivity

Fieldbus communication reduces capital costs in production plants. In addition to the initial savings achieved

through the significant reduction in wiring and control boxes, fieldbus networks are easier to maintain, while providing improved systems performance.

### User friendly and fast set-up

Danfoss fieldbuses can be configured via the drive's local control panel, which features a user friendly interface with support for many user languages. The drive and fieldbus can also be configured using the software tools that support each drive family. Danfoss Drives offers fieldbus drivers and PLC examples for free from the Danfoss Drives website to make integration to your system even easier.



# Customize to improve user experience

## Make the VLT® HVAC Drive your own

The VLT® HVAC Drive masters all the world's most commonly-used languages and you can easily make it speak the language of your own specific installation. The VLT® HVAC Drive gives you a wealth of options for setting your drive up to serve your specific application or customer needs.

## Customizer - plain language communication

Whether you are an end user or an OEM, our customization options allow you to make the drive your own for easy commissioning and trouble-free operation. The Customize feature tailors your solution precisely to your users' language, to inform and guide them optimally for the best operation of the application:

- Choose the parameters that are most important to show in the display for your operation.
- **Reduce commissioning time.**
  - We have carefully selected the initial values with the typical user in mind. But it is also possible to enter your own values\* and save them as factory settings for a particular application segment.

- Set up your own start-up wizard to customize the drive for your users. No programming required, you simply and intuitively drag and drop to select your parameters.
- Splash-Screen; import your logo from a jpg or any other commonly used file type to have your own name featured on the display.
- Make the drive speak your application's language by naming terminals according to functions.
- **Manage access.**
  - The VLT® HVAC Drive allows for several password functions with various ways of locking access and allocating user rights.
  - Simulate the LCP

## Hassle-free trouble-shooting with user-defined alerts

Make error codes a thing of the past with user-defined alerts that make any system warning understandable to any user. When the drive speaks application language, rather than drives language, service technicians can get guidelines straight from the display and immediately take the action required.

*\*CSIV - customer-specific initialization values*

## Communication interfaces

The VLT® HVAC Drive offers you a diverse range of communication interfaces:


- The integrated LCP, which is still the most common way to interact with the drive
- Fieldbus communication to a Building Management System (BMS) is a major trend. However user interaction for optimizing the drives in the application is often forgotten, and here the VLT® HVAC Drive can fulfill the need well
- Wireless communication using LCP 103 for commissioning and service purposes
- Access management. A BMS will often limit the options for unauthorized change of operation settings, however the VLT® HVAC Drive has a built-in password management system which can serve this function



## Digital tools

Danfoss offers a range of digital tools you can use to customize, communicate with, or monitor the drive.

- **VLT® Software Customizer**
- **MyDrive® Connect**
- **VLT® Motion Control Tool MCT 10**

 Learn more about digital tools

# Access the drive remotely

Commission and operate the drive either locally via the LCP or remotely using the MyDrive® Connect tool. Today it is common to connect drives via a fieldbus system or a wireless network connection, for convenient access from a remote location.

## Connect via wireless network

Use the VLT® Wireless Control Panel LCP 103 to create a Wi-Fi network for direct access between a smart device and the drive, or via an access point where multiple smart devices can access the drive, one at a time.

The MyDrive® Connect app shows the drives that are accessible on the network, each displayed with a user-defined name created in the parameter settings.

Both LCP 103 and MyDrive® Connect give you full access to all information inside the drive. You can change parameter settings and control the drive to start and stop remotely.

## Integrated webserver in Ethernet-based fieldbuses

A webserver interface is available in all Ethernet-based VLT® fieldbus options. Using a standard browser, you can access the drive after entering the correct IP address and password. This interface is perfect for smartphone, tablet and desktop screens, where the webserver supports a variety of different browser interfaces.

Which information you can access is pre-defined in menus and widgets to improve the user experience.

These data include the normal status information of the drive (readout, I/O, Alarm Log, Trend charts, statistics), and maintenance and energy efficiency information and trends.

You can also subscribe to e-mail notifications from the drive, when an e-mail server is connected to the same network.

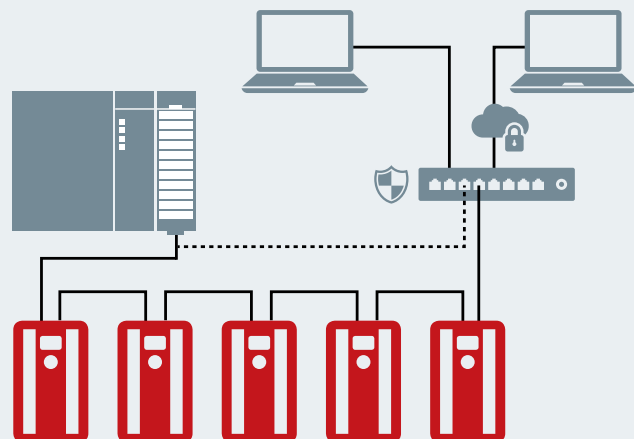
## Cloud-based solution for smart buildings

Generate IoT and smart cloud solutions to suit your needs. In the HVAC industry a “smart building” trend with MQTT connection is gradually replacing conventional BMS systems, where a master BMS controller is in control of all the building applications. The new approach is towards a multitude of “sub-master” systems, each of which controls the operation of a smaller application.

A good example of the sub-master approach is to use VLT® HVAC Drive to control a complete AHU. Then different control systems can access the drive

directly to incorporate the complete AHU into the new generation of BMS solutions. One of the expert systems may focus on comfort in the building, a second system on the energy consumption, and a third system deal with maintenance and filter replacement.

Danfoss offers drives solutions with the ability to support these different cloud solutions, with built-in security at a very high level to secure the connection between the drive and the “broker” and cloud- servers; all depending on the internet-cloud concept that the user has selected.



## Web server dashboard



# Built to last

## – in the toughest environments

Danfoss designs and develops product for real-life applications, meeting tough challenges to ensure trouble-free operation. VLT® HVAC Drive components are selected to guarantee a long operating lifetime. Internal sensors and integrated maintenance software support many years' straightforward operation.

### Design for 10+ years operation between part replacements

High quality components are selected for use in the design of the VLT® HVAC Drive, in order to ensure minimum 10 years normal operation before first replacement of service components. A built-in maintenance program helps you to monitor the drive installation, to ensure the drive operates within its specification. A service plan covers the maintenance and service of vital elements essential to the safe operation of the application. After the first 10 years, replace only a few components before commencing the next 10+ years of reliable operation.

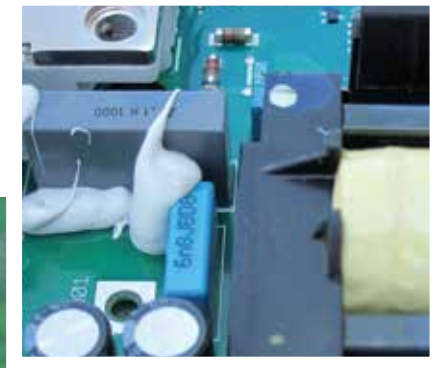
### Built for the environment

The VLT® HVAC Drive can operate almost anywhere, even outdoors. Enclosure protection ratings from IP 20 up to IP66/UL Type 4X mean the drive resists the most demanding of installation conditions with a standard enclosure. Its wide operating temperature specification from -25 °C to +55 °C reflects the extreme strength of this product design.

The VLT® HVAC Drive conforms as standard to class 3C2 (IEC 60721-3-3), and options for conformal, harsh environment coating to 3C3 are available. The drive is available in a 'ruggedized' version to ensure that components remain firmly in place in applications characterized by high vibration levels, such as marine and mobile equipment. All these factors work together to ensure the ability of this drive to run reliably in the most demanding environments.

### Smart software increases uptime

The drive is an important part of AHU/RTU systems for comfort and safety. One of the key priorities in drive selection is high resistance to unforeseen grid fluctuations that would otherwise interrupt operations. To improve ride-through, the VLT® HVAC Drive relies on a robust overvoltage controller, kinetic backup and an improved flying start which ensures reliable operation when it's needed most.



# 3C3

Coated PCBs as standard in all high-power drives



## Manufacturing matches the highest standard in automotive

Intelligent product design is key to ensuring long and trouble-free operation of the drive in the application. The manufacturing process must meet the highest of standards to ensure reliability and strong product performance.

To improve our service to you even further, we have implemented the ISO/TS 16949 standard in our factory. This standard builds on the previous ISO 9001 guidelines but is far more ambitious in scope, addressing not just what we should do, but the processes behind how we should do it. The ISO/TS 16949 standard is about understanding your needs and meeting them with products, solutions and services that match your expectations. Danfoss factories follow the highest manufacturing standards and many processes are managed by robots, to fulfill our aim of a zero-failure production.

## Designed to protect

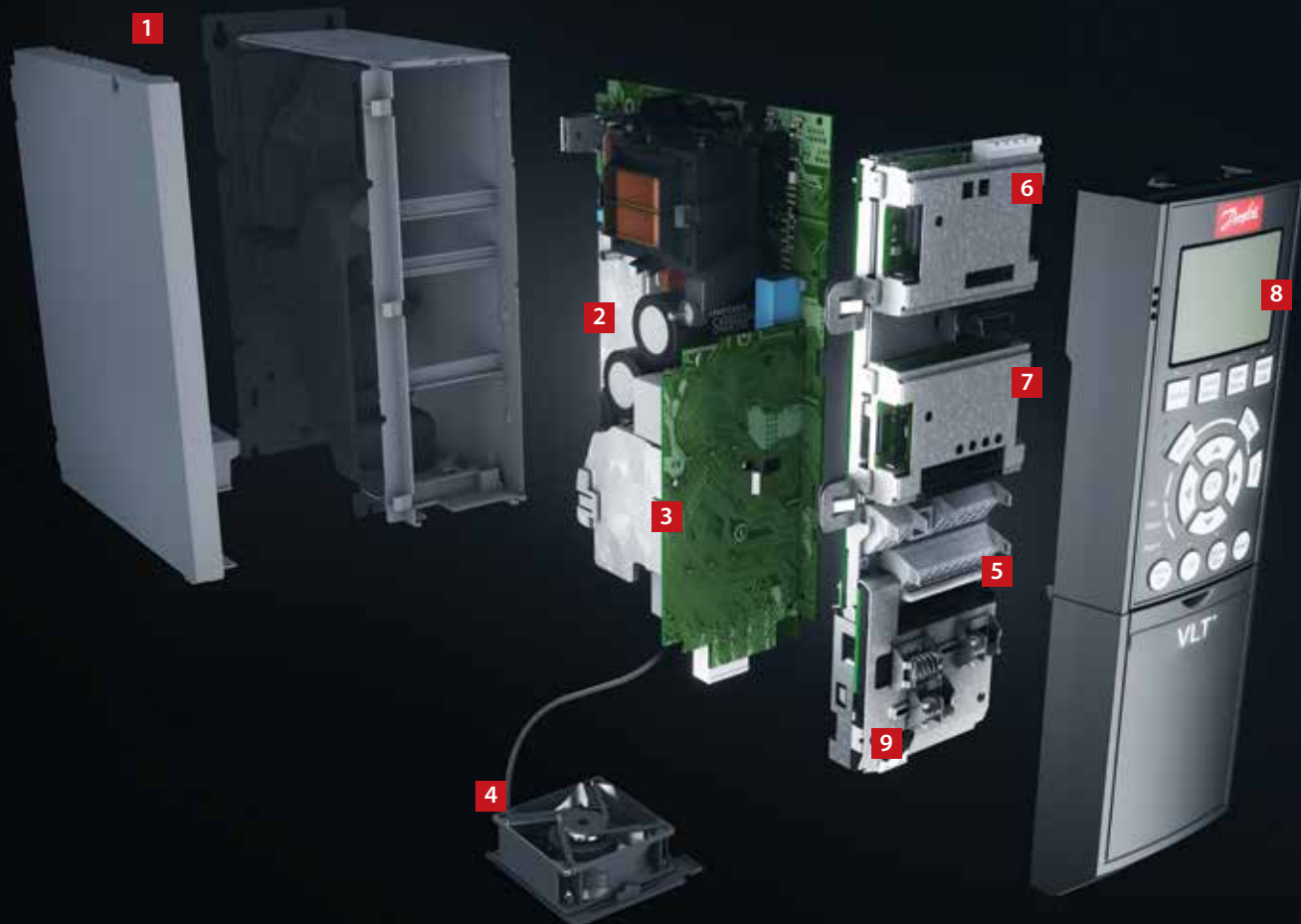
Intelligent algorithms ensure that the drive continues to operate as expected, despite spikes and dips in voltage. The drive is SEMI F47-certified to document its performance. The drive is SEMI F47-certified to document its performance.

Because the drive may be connected to a system that experiences a short circuit which could potentially destroy the connected drive, the VLT® HVAC Drive is designed to be short-

circuit-proof with a 100 kA prospective short circuit current capability for reliable operation, no matter what the challenge.

The drive enclosure completely separates cooling air and the internal electronics to protect them from dust-borne contaminants. Efficient heat removal helps prolong product life, increases the overall availability of the system and reduces faults related to high temperatures.





# Modular simplicity – A, B and C enclosures

Delivered fully assembled and tested to meet your specific requirements

## 1. Enclosure

The drive meets requirements for enclosure class IP20/Chassis. IP21/UL Type 1, IP54/UL Type 12, IP55/UL Type 12 or IP66/UL Type 4X.

## 2. EMC and Network effects

All versions of VLT® HVAC Drive comply as standard with EMC category C1, C2 and C3 after IEC 61800-3 (A1, A2 and B after EN 55011) limits B, A1 or A2 according to the EN 55011 norm and IEC61800-3 Category C1, C2 and C3. The standard integrated DC coils ensure low harmonic load on the network according to EN 61000-3-12 and increase the lifetime of the DC link capacitors.

## 3. Protective coating

The electronic components are, as standard, coated as per IEC 60721-3-3, class 3C2. For harsh and aggressive environments, coating as per IEC60721-3-3, class 3C3 is available.

## 4. Removable fan

Like most of the elements, the fan can be quickly removed and remounted for easy cleaning.

## 5. Control terminals

Specially developed removable spring-loaded cage clamps add to reliability and facilitate easy commissioning and service.

## 6. Fieldbus option

See complete list of available fieldbus options on page 41.

## 7. I/O options

The general purpose I/O, relay and thermistor expands the flexibility of the drives.

## 8. Display option

The removable VLT® Local Control Panel LCP 102 or the VLT® Wireless Communication Panel LCP 103 provide highly intuitive user interfaces. Choose between 27 built-in languages (including Chinese) or have it customized with your own. Languages can be changed by the user.

Alternatively the drive can be commissioned via the built-in USB/RS485 connection or through fieldbus options with the VLT® Motion Control Tool MCT 10 PC tool.



### 9. 24 V supply

A 24 V supply keeps the VLT® drives logically “alive” in situations when the AC power supply is removed.

### 10. Mains switch

This switch interrupts the mains supply and has a free useable auxiliary contact.

### Safety

Please see chapter “Integrate Safely”.



*The VLT® Real-time Clock MCB 117 option provides accurate time control functions and time stamp of logging data.*

# High-power modularity – D, E and F enclosures

The high-power VLT® HVAC Drive modules are all built on a modular platform allowing for highly customized drives which are mass produced, tested, and delivered from the factory.

Upgrades and further options dedicated to your industry are a matter of plug-and-play. Once you know one, you know them all.

## 1. Display options

Danfoss drives' renowned removable Local Control Panel (LCP) has an improved user interface. Choose between 27 built-in languages (including Chinese) or have it customized with your own. Languages can be changed by the user.

## 2. Hot pluggable LCP

The LCP can be plugged in or unplugged during operation. Settings are easily transferred via the control panel from one drive to another or from a PC with MCT 10 set-up software.

## 3. Integrated manual

The info button makes the printed manual virtually redundant. Users have been involved throughout development to ensure optimum overall functionality of the drive. The user group has significantly influenced the design and functionality of the LCP.

The Automatic Motor Adaptation (AMA), the Quick Set-Up menu and the large graphic display make commissioning and operation a breeze.

## 4. Fieldbus options

See complete list of available fieldbus options on page 41.

## 5. I/O options

The general purpose I/O, relay and thermistor expands the flexibility of the drives.

## 6. Control terminals

Specially developed removable spring-loaded cage clamps add to reliability and facilitate easy commissioning and service.

## 7. 24 V supply

A 24 V supply keeps the VLT® drives logically "alive" in situations when the AC power supply is removed.

## 8. RFI filter suitable for IT-grids

All high-power drives come standard with RFI filtering according to EN 61800-3 Cat. C3/EN 55011 class A2. A1/C2 RFI filters according to IEC 61000 and EN 61800 standards as integrated options.

## 9. Modular construction and ease of maintenance

All components are easily accessible from the front of the drive, allowing for ease of maintenance and side-by-side mounting of drives. The drives are constructed using a modular design that allows for the easy replacement of modular sub-assemblies.

## 10. Programmable options

A freely-programmable motion control option for user-specific control algorithms and programs allows the integration of PLC programs.

## 11. Conformally coated and ruggedized circuit boards

All high power drive circuit boards are conformal coated to withstand the salt mist test. Meets IEC 60721-3-3 Class 3C3. The conformal coating complies with ISA (International Society of Automation) standard S71.04 1985, class G3. Additionally, drives in D- and E-enclosures can be further ruggedized to withstand the higher vibration needs of certain applications.

## 12. Back-channel cooling

The unique design uses a back channel to pass cooling air over heat sinks. This design allows up to 90 % of the heat losses to be exhausted directly outside of the enclosure with minimal air passing through the electronics area. This reduces temperature rise and contamination of the electronic components for improved reliability and increased functional life.

As an option, the back-channel cooling duct can be supplied in stainless steel to provide a degree of corrosion resistance against conditions such as those found in salt-air environments near the ocean.

## 13. Enclosure

The drive meets relevant requirements for all possible installation conditions. Enclosure class chassis, IP20/chassis, IP21/UL Type 1, and IP54/UL Type 12. A kit is available to increase the enclosure class on enclosure size D drives to UL Type 3R.

## 14. DC-link reactor

The built-in DC-link reactor ensures low harmonic disturbance of the power supply in accordance with IEC-61000-3-12. The result is a more compact design with higher efficiencies than competitive systems with external mounted AC chokes.

## 15. Input mains option

Various input configurations are available, including fuses, mains disconnect switch, or RFI filter.

## 16. Front USB connector

gives IP54 access to the drive data with no impact on drive operation. Open the front door to access the internal USB port.



## Efficiency is vital for high-power drives

Efficiency is essential in the design of the high-power VLT® drive series. Innovative design and exceptionally high-quality components have resulted in unsurpassed energy efficiency.

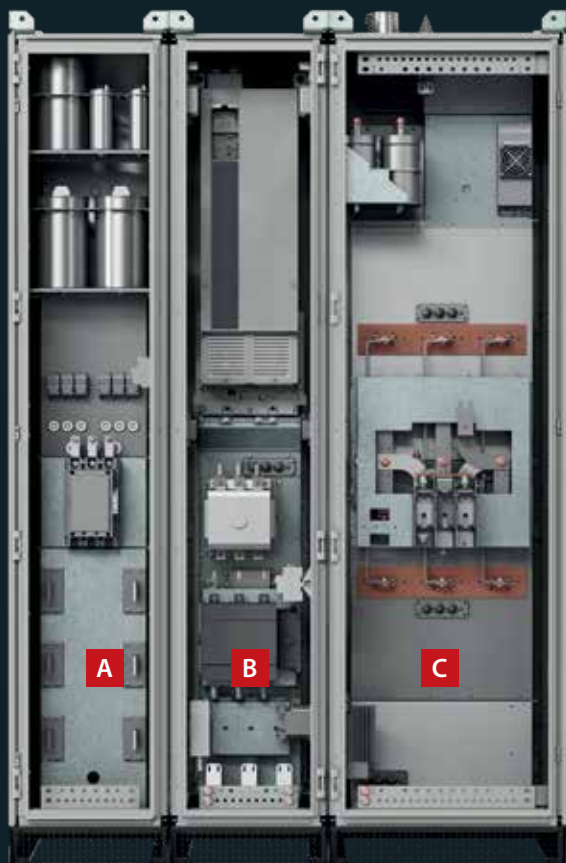
VLT® drives pass more than 98 % of the supplied electrical energy on to the motor. Only 2 % or less is left in the power electronics as heat to be removed.

Energy is saved and electronics last longer because they are not exposed to high temperatures within the enclosure.

### Safety

Please see chapter "Integrate Safely".





- A** Input filter cabinet
- B** Drive cabinet
- C** Output filter cabinet

## Extended functionality for **high-performance operation – Enclosed Drives**

The high-power VLT® HVAC Enclosed Drives have been designed to meet the most demanding requirements for flexibility, robustness, compactness and ease of service. Each enclosed drive is precisely configured in flexible mass production, then individually tested and delivered from the Danfoss factory.

### **1. Door-mounted control compartment**

separate from the main power terminals ensures safe accessibility to control terminals, also during operation of the drive.

### **2. VLT® HVAC**

high-power drive in enclosure size D or E, with selectable control options.

### **3. Back-channel cooling assembly for power options**

ensures utilization of the drive's back-channel cooling concept in the cabinet and efficient cooling of the integrated selectable power options.

### **4. Mains contactor**

is a selectable mains power option.

### **5. Mains switch disconnect**

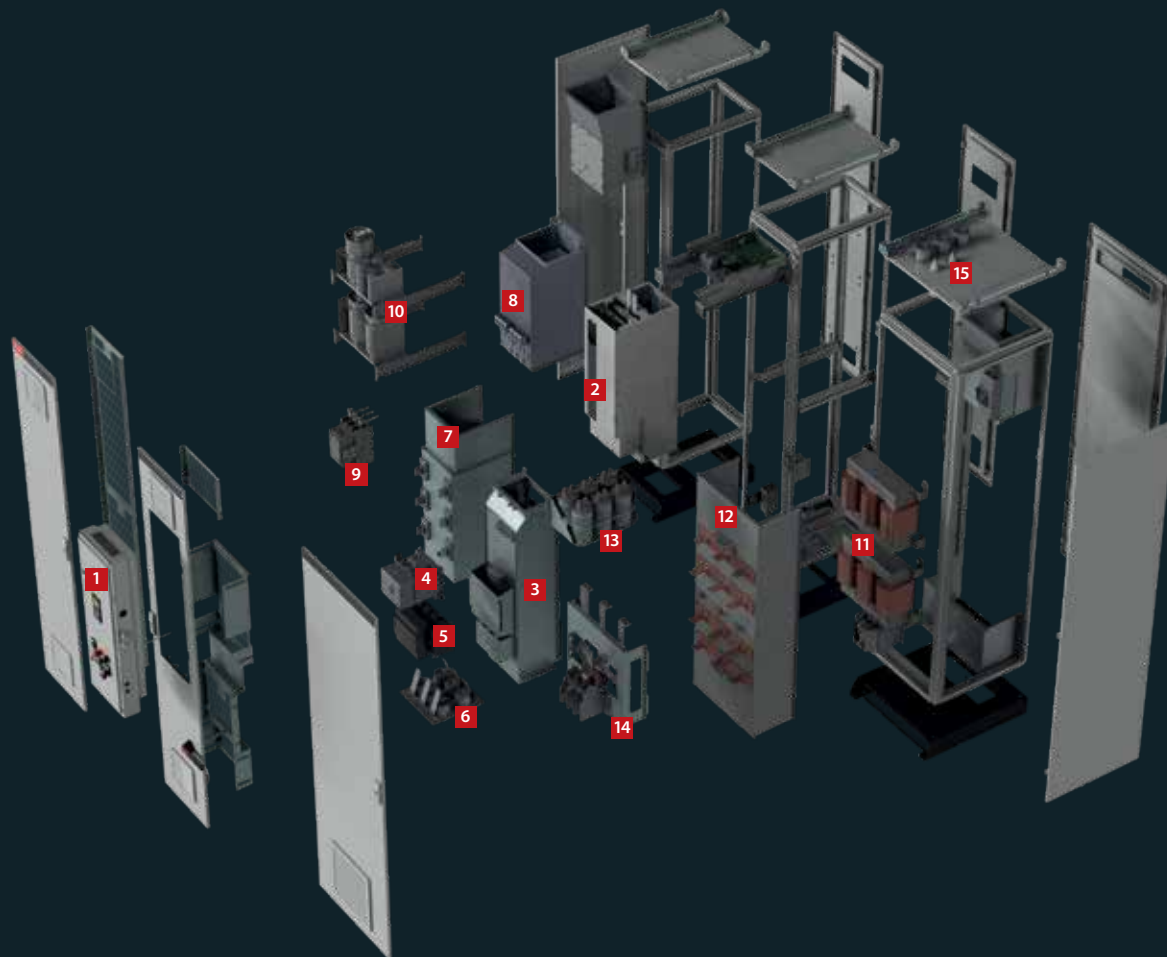
is a selectable mains power option.

### **6. Bottom entry establishment**

ensures IP54/UL type 12 connections of the enclosed drive mains terminals to the power supply.

### **7. Mains reactor assembly**

of the selectable passive harmonic filter ensures absolute minimum harmonics content of the mains currents: **THDi <5 %**.



**8. Passive filter magnetics**  
and the mains reactor of the passive filter are integrated into the back-channel cooling assembly of the cabinet.

**9. Contactor**  
to control the passive harmonic filter of the drive.

**10. Capacitor assembly**  
for the mains current passive harmonics filter.

**11. Sine-wave filter magnetics**  
of the output filter, as a selectable power option.

**12. Back-channel cooling assembly**  
for magnetics of the output sine-wave filter.

**13. Capacitor assembly**  
for the sine-wave filter.

**14. Motor connection terminals**  
are located in the sine-wave filter cabinet.

**15. Top exit establishment**  
ensures IP54/UL type 12 connections of motor cables from the top.



# Harmonic mitigation

## – invest less and save more

The Danfoss solution for harmonic mitigation is a simple space and cost-saving design that increases system efficiency, to provide long-term energy savings and trouble-free operation.

### Certified solutions to control harmonics

- Advanced active filters
- Advanced harmonic filters
- Low harmonic drives
- 12-pulse drives
- Active front end drives

#### Meet new standards

Efficient harmonic mitigation protects electronics and increases system efficiency. The prescribed standard for harmonics mitigation is specified as limits for the harmonic voltage distortion and current waveforms that may exist in the system to minimize interference between electrical equipment. The Danfoss harmonic mitigation solution is developed to meet the standards specified in the IEEE-519 2014 Guide.

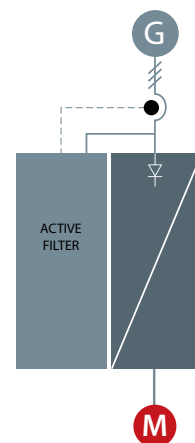
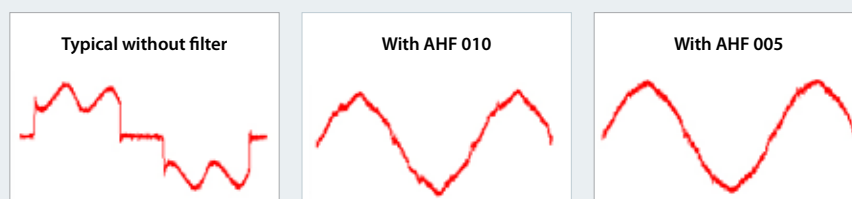
#### Minimize costs using advanced active filters

Danfoss offers solutions for harmonics mitigation based on active front end, passive filter and advanced active filter (AAF) technology. Most applications will benefit from our central solution using AAF, minimizing cost and energy consumption to achieve the ambition of excellence in harmonic mitigation.

#### Low harmonic drives

The VLT® low harmonic drives continuously regulate the network and load conditions without affecting the connected motor. The drives combine the well-known performance and reliability of standard VLT® drives with an Advanced Active Filter. The result is a powerful, motor-friendly solution that provides the highest possible harmonic mitigation with total harmonic current distortion (THDi) of maximum 5 %.

#### Current and Distortion Spectrum at Full Load

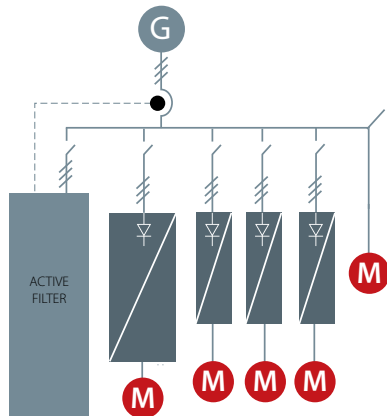




## Advanced active filters

Advanced active filters identify harmonic distortion from non-linear loads and inject counter-phase harmonic and reactive currents into the AC line to cancel out the distortion. The result is distortion levels of no more than 5 % THDi. The optimal sinusoidal waveform of the AC power is restored and the power factor of the system is re-established at 1.

Advanced active filters follow the same design principles as all our other drives. The modular platform provides high energy efficiency, user-friendly operation, efficient cooling and high enclosure ratings.

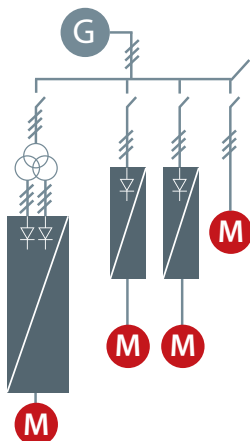


## 12-pulse drives

A robust and cost-effective harmonic solution for the higher power range, the Danfoss 12-pulse drive variants offer reduced harmonics for demanding industry applications above 250 kW.

VLT® 12-pulse drives are high efficiency AC drives which are built with the same modular design as the popular 6-pulse drives. The 12-pulse variant is available with similar drive options and accessories and can be configured according to your specific needs.

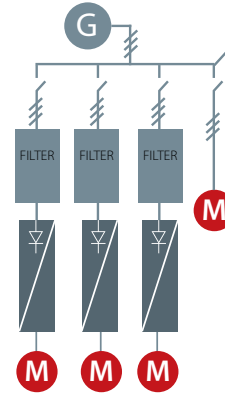
The VLT® 12-pulse drives provide harmonic reduction without adding capacitive or inductive components which often require network analysis to avoid potential system resonance problems.



## Advanced harmonic filters

The Danfoss harmonic filters are specially designed to be connected in front of a VLT® drive, and ensure that the harmonic current distortion generated back to the mains is reduced to a minimum.

Easy commissioning saves installation costs, and due to the maintenance-free design, running expenses for the units are eliminated.



## Active front-end drives

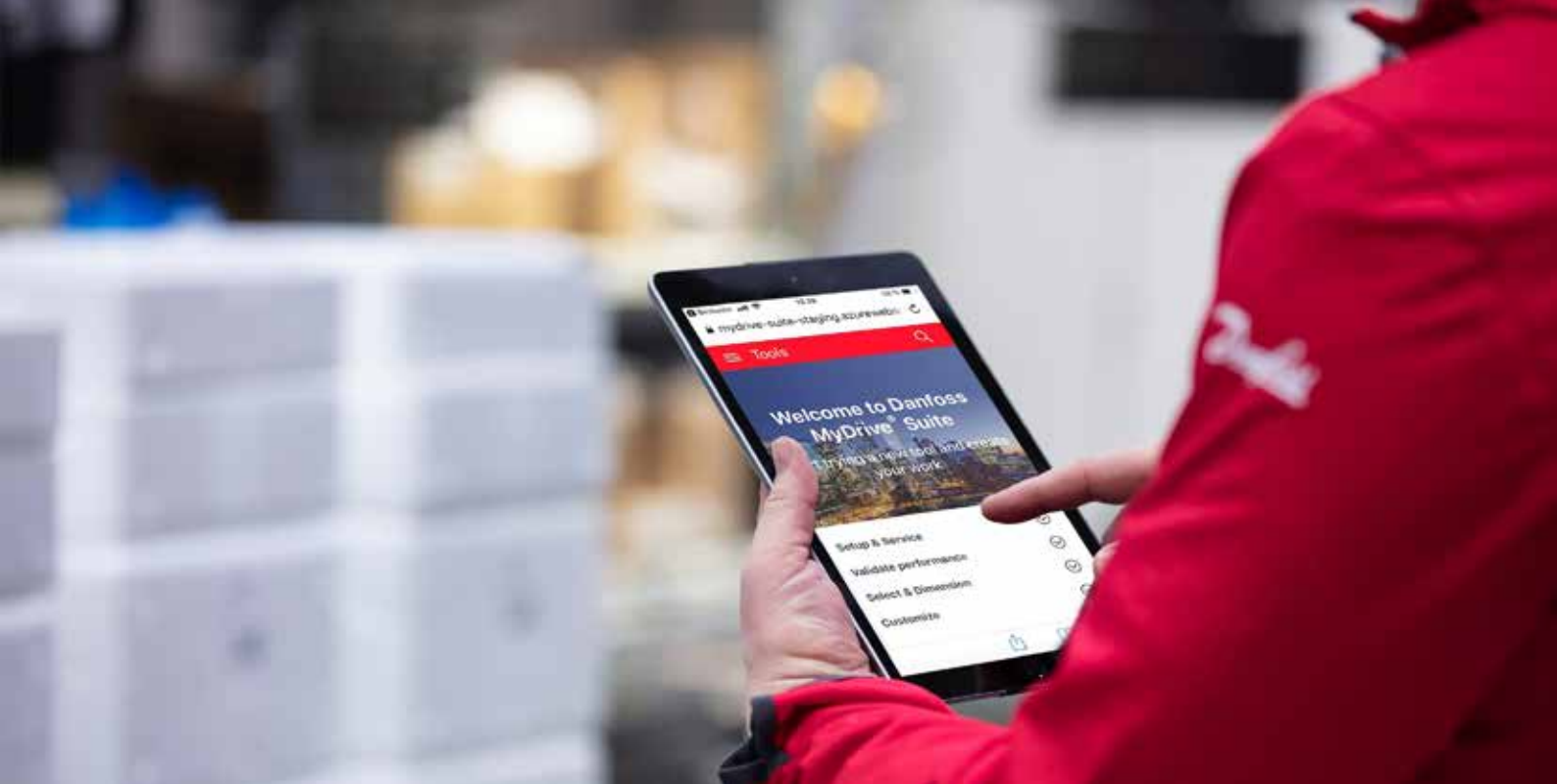
An AFE system is a regenerative power converter located at the front end of a common DC bus drive line-up, and is suitable in applications where:

- Regenerative power generation is the goal
- Low harmonics are required
- The frequency inverter load is up to 100 % of the total generator capacity

An active front-end (AFE) system comprises two identical inverters with a common DC bus. There is one motor inverter and one supply inverter. The supply inverter works together with a tuned sinus filter, and the current distortion (THDi) at the supply is about 3-4 %.

When an AFE system is installed, then the motor voltage can be increased above that of the network, because adjustment of the DC link voltage is enabled. Any excessive energy can be returned to the network as clean (active) power, rather than reactive power, which only produces heat.





# MyDrive® Suite ensures your digital tools are only one click away

**MyDrive® Suite** brings all your tools together to support you during engineering, operation and service. What is MyDrive® Suite? It's a tool providing a single point of access for the other digital tools supporting you during engineering, operation and service, thereby covering the whole life cycle of the drive.

Based on your needs, the tools are accessible via different platforms. They can be integrated into your system and business processes to enable a world-class end-to-end experience with full flexibility. Your data is synchronized between the tools, and by sharing the same data backend, information is always correct and up to date.

Our suite of software tools is designed to ensure you easy operation and the highest level of customization of your

AC drives. Whether you're a beginner or a pro, you have everything you need to go from selecting to programmability of a drive.

Try MyDrive® Suite today:  
<https://suite.mydrive.danfoss.com/content/tools>

## Easy to use

- One tool suite
- One common look and feel
- Single login to all tools
- Seamless usage across devices and touchpoints
- Platform enables coherent workflows
- Data synchronization between tools. There is no need to enter information twice, which means your information is always correct and up to date
- Search and smart filtering
- Tutorials and documentation

## Keeps your data safe

- Data security through user levels and authentication
- End-to-end secure communication

## Fits your needs

- Data integration into your tools and systems
- APIs and open interfaces facilitate third-party applications or branded versions
- The tools are available as web app, desktop application, dedicated tablet and smartphone app, all with offline functionality. No internet connection is required once the tool is installed to your device

# Convenient and fast – Digital tools empower you

Need help to design your application, or select, set up, and maintain your drive? Danfoss provides a palette of digital tools to give you the information you need, at your fingertips. No matter which stage of the project you are at.

## Select and configure your drives

- Select the right AC drive based on motor and load characteristics
- Find general product, segment and application information of VLT® and VACON® drives

### Available tools:

- **MyDrive® Select**  
Select and dimension your drive based on calculated motor load currents as well as current, temperature and ambient limitations. MyDrive® Select matches your business needs with Danfoss Drives products.

- **MyDrive® Portfolio**

This smart device app gives you a full overview of all Danfoss Drives products and their documentation.

## Set up and service your drives

- Set up your drives to operate according to your requirements
- Monitor drive performance throughout the entire lifecycle of your drive

### Available tools:

- **MyDrive® Connect**  
Connect to one or more drives over a secure Wi-Fi connection. Provides a simple and intuitive interface for easy commissioning.

- **VLT® Motion Control Tool MCT 10**

Configure the drive from a PC. With functionality for drive firmware update and configuration of functional safety using the safe plugin.

## Customize your drives

- Optimize performance & behavior
- Emphasize your brand by defining own parameter names
- Get PLC-based functionality based on IEC61131-3
- Enable license-based functions

### Available tools:

- **VLT® Software Customizer**  
Emphasize your brand by modifying the splash screen and create your own smart start wizard.

## Validate performance of your drives

- Analyze the performance of your drives in relation to harmonics content
- Calculate the energy savings to be achieved when using drives
- Validate compliance to norms and standards

### Available tools:

- **MyDrive® ecoSmart™**  
Now it's easy to determine IE and IES classes according to IEC/EN 61800-9, for VLT® and VACON® drives alone and in combination with a motor. MyDrive® ecoSmart™ uses nameplate data to perform the efficiency calculations, and produces a pdf report for documentation.

- **MyDrive® Harmonics**

Estimate the benefits of adding harmonic mitigation solutions from the Danfoss product portfolio and calculate predicted system harmonic distortion. This tool provides a quick indication of installation compliance with the most recognized harmonic norms, and mitigation recommendations.

- **VLT® EnergyBox**

This advanced energy calculation tool captures actual energy data from the drives, to document It also monitors energy consumption and overall system efficiency.



Online tool:  
[ecosmart.danfoss.com](https://ecosmart.danfoss.com)  
App: MyDrive® ecoSmart™



# DrivePro® Life Cycle services

## Delivering a customized service experience!

We understand that every application is different. Having the ability to build a customized service package to suit your specific needs is essential.

DrivePro® Life Cycle Services is a collection of tailor-made products designed around you. Each one engineered to support your business through the different stages of your AC drive's life cycle.

From optimized spare-part packages to condition-monitoring solutions, our products can be customized to help you achieve your business goals.

With the help of these products, we add value to your application by ensuring you get the most out of your AC drive.

When you deal with us, we also offer you access to training, as well as the application knowledge to help you in planning and preparation. Our experts are at your service.

[drivepro.danfoss.com](http://drivepro.danfoss.com)

