VLT® Refrigeration

Improved efficiency using less energy

VLT®
THE REAL DRIVE

60 years of experience within refrigeration

The Danfoss VLT® Refrigeration Team is dedicated to refrigeration applications. 60 years of experience has made Danfoss the number one provider.

VLT® solutions are always developed according to requirements from our customers, so they are reliable, innovative and easy to use.

With a wide range of powerful standard and optional features, the VLT® drives provide the lowest overall cost of ownership for refrigeration applications.

Suitable for all refrigeration applications: Fans, centrifugal pumps, screw, scroll, reciprocating and centrifugal compressors.

- **Save energy**
  The VLT® drives offer considerable energy savings:
  – VLT® efficiency (98%)
  – Sleep Mode
  – Automatic Energy Optimisation AEO: Typically 3-5% – often up to 15%
  – Flow compensation

- **Save space**
  The compact design of the VLT® drives makes them easy to fit in even small installation spaces.
  – Built-in DC coils for harmonic suppression. No need for external AC-coils
  – Optional, additional built-in RFI filters in the whole power range in most series

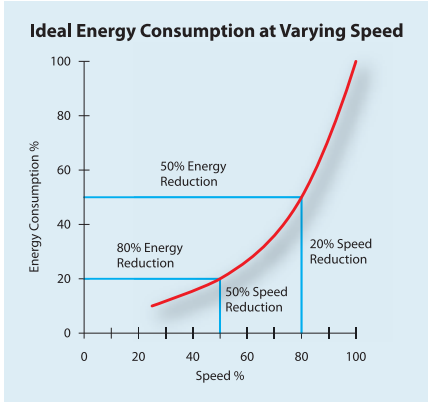
- **Save costs and protect your system**
  – Cascade controller
  – Dry Run Detection
  – End of curve detection
  – Motor alternation
  – 2-step ramps (initial ramp)
  – Safe stop
  – Real-time clock
  – Password protection
  – Overload trip protection
  – Smart logic controller

- **Save cabinet costs**
  VLT® drives are available in all protection classes in the full power range.

- **Save time**
  VLT® drives are designed with the installer and operator in mind to save time on installation, commissioning and maintenance.

  – Intuitive user interface. Award-winning control panel (LCP) in the new series.
  – One drive type for the full power range!
  – Modular VLT® design enables fast installation of options.
  – Auto tuning of PI controllers
  – Robust design and efficient monitoring make VLT® drives maintenance free.

Dedicated to refrigeration
Danfoss Drives' unequalled experience was used to make VLT® drives the perfect match for fans, pumps and compressors of all kinds in modern refrigeration systems. Refrigeration is a global business area for Danfoss Drives, and you will find our dedicated sales and service staff around the world 24 hours a day.

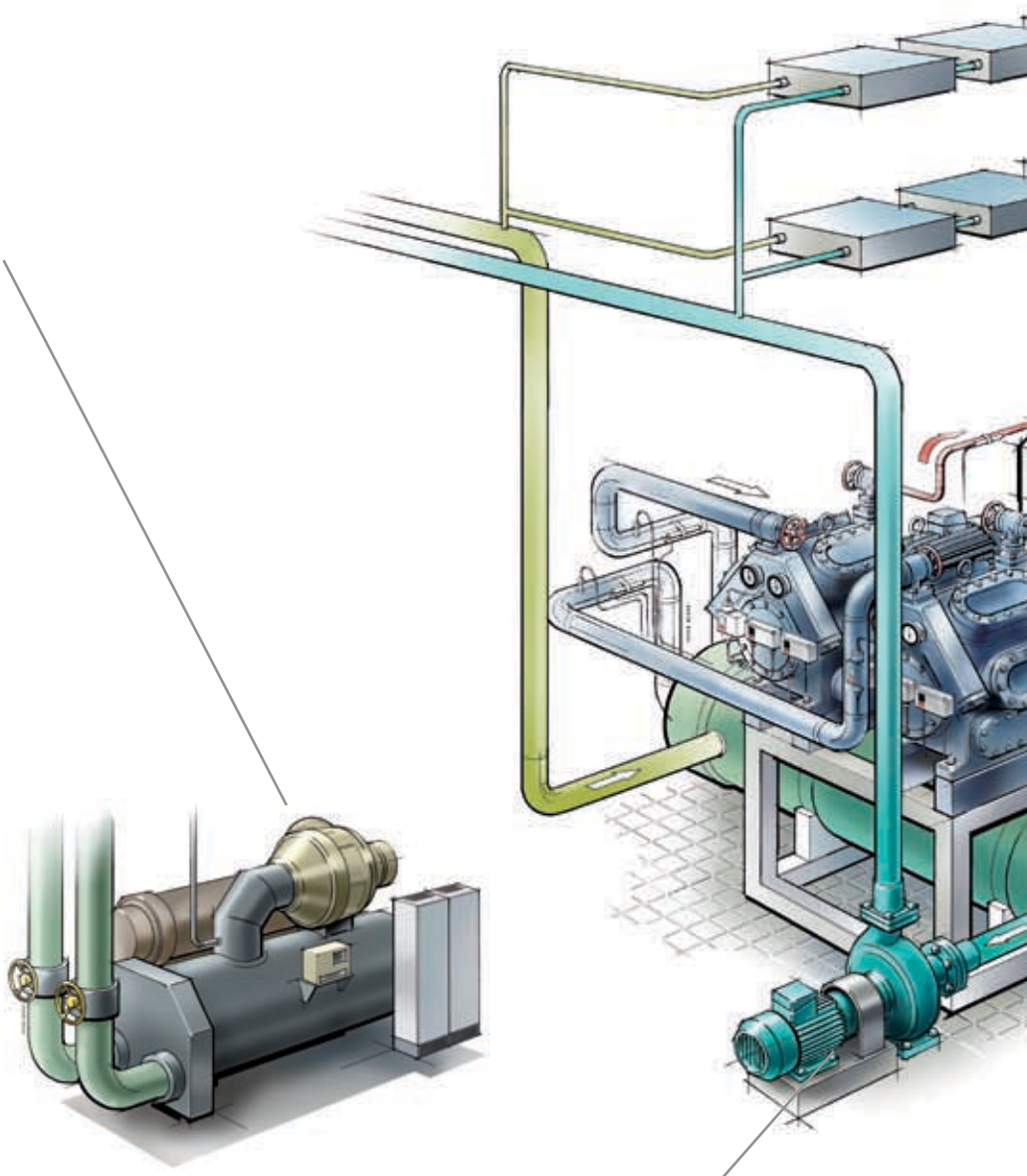


Energy saving using a VLT® drive is achieved even with a modest reduction in speed

Where temperature is critical
Industry facilities for the production of medicine or micro electronics require special precautions. The VLT® drives can meticulously control and maintain the correct temperature in the process under a variety of operating conditions, including continued operation during mains voltage fluctuations.

VLT® solutions optimise cooling systems

District cooling
District cooling is becoming increasingly interesting due to the high demands for energy optimisation. District cooling is made by absorption and adsorption cooling from electricity production, heatpump systems or natural cooling from the sea or underground. VLT® drives can optimise the control of the system and help to increase the total energy saved. The larger the system, the greater power required – and VLT® drives go all the way.

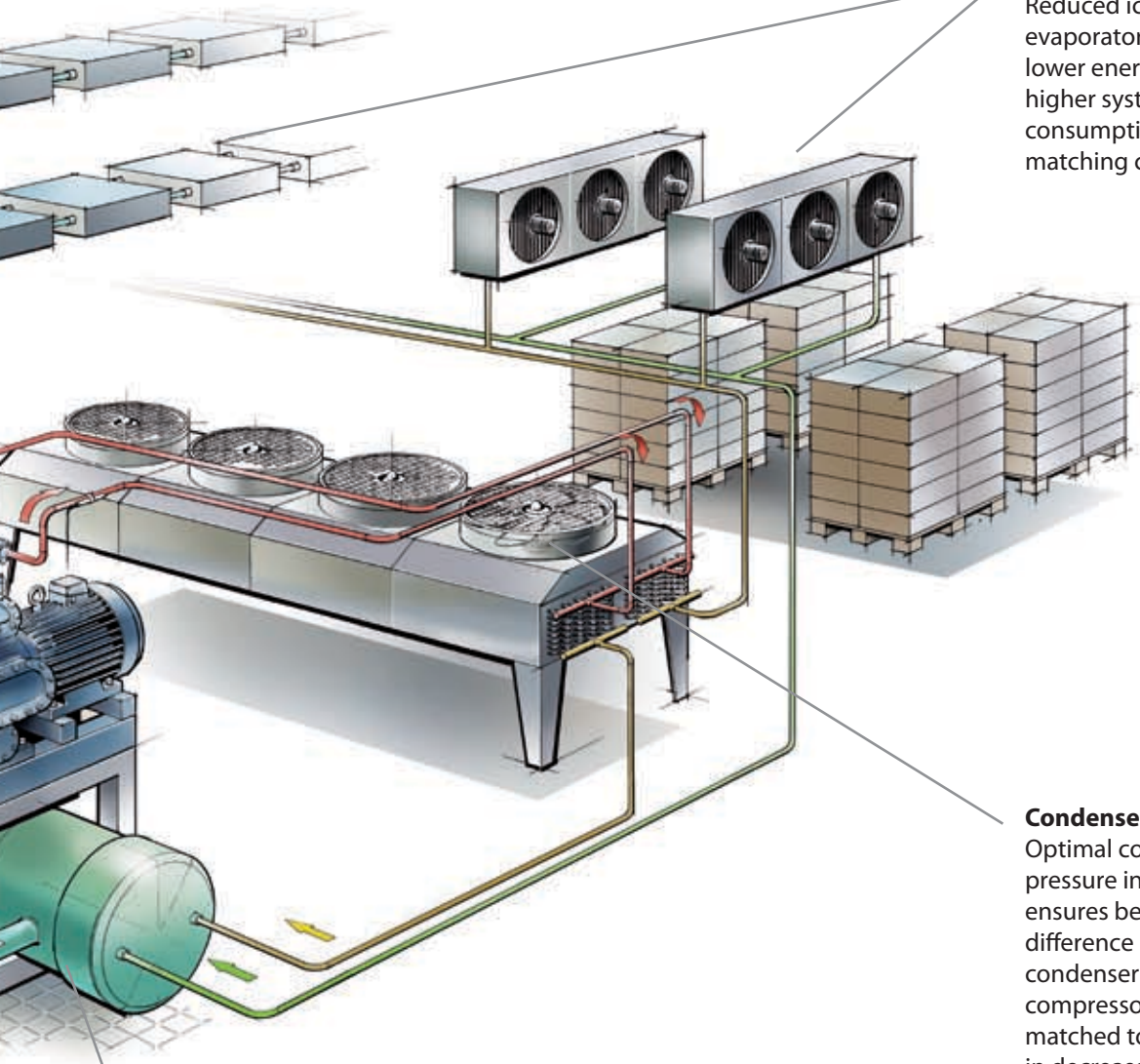


Stable cooling circuit
- Efficiency increase of electronic expansion valves
- Avoiding "flash gaz" due to lack of subcooling when fans are switching
- Stable liquid level

Lower noise level:
- Lower speed at fan extremities
- No switching and changing noise levels

Less dirt in coils:
- Lower Δt and higher compressor efficiency
- Less maintenance costs

Pump
Adding VLT® drives on pump applications in the refrigeration system will reduce the energy comsumption while increasing system performance. The Sleep Mode will prevent pumps running at low or no flow. The Dry Pump Protection and End of Curve Detection will protect the system in case of defective pumps or leaks.



Evaporator fan
Reduced ice build-up and optimised evaporator temperature leads to lower energy consumption and higher system efficiency. The energy consumption is reduced by always matching capacity to the actual load.

Condenser fan
Optimal control leads to stabilised pressure in the condenser. This ensures better control of the pressure difference between evaporator and condenser and a better COP for the compressor. The control of airflow is matched to the actual need resulting in decreased audible noise and energy consumption.

Compressor
Variable speed control of a compressor offers the ability to match the cooling capacity to the actual need based on measurements in the refrigeration system. Costs are reduced both through energy savings when running at lower speed, but also through lower installation costs caused by optimisation of the refrigeration system and the compressor itself. Variable speed controlled also reduce the need for compressor packs because the individual compressor is adjusted to the actual need. The lifetime of the compressor is increased due to few starts and stops which cause mechanical wear and tear.

The modular VLT® technology platform

VLT® AutomationDrive, VLT® HVAC Drive and VLT® AQUA Drive are all built on the same modular platform allowing for highly customised drives mass produced, tested, and delivered from the factory. Upgrades and further options are a matter of plug-and-play. They share features and user interface. Once you know one, you know them all.

Enclosure
The drive meets requirements for enclosure class IP 20/Chassis. Optional IP 21/NEMA 1 or IP 55/NEMA 12.

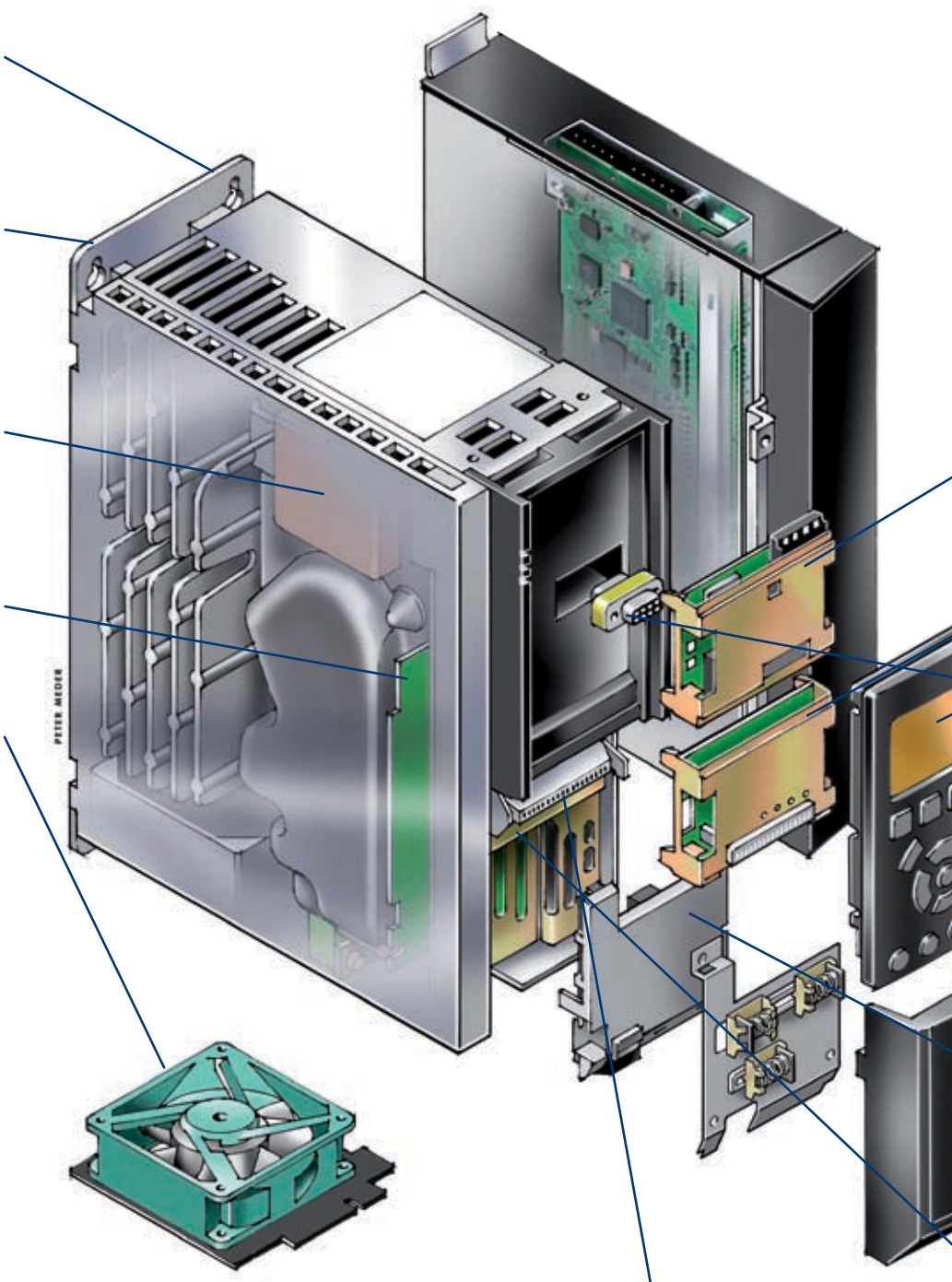
Cold plate technology
The drive is built upon a very stable aluminium base integrated with the back panel. This provides high mechanical stability, efficient cooling and the possibility of cold plate operation.

DC coil
The renowned DC coil is kept to ensure very low harmonic disturbance of the power supply according to IEC-1000-3-2. Compact design: No need for external modules.

Conformal coating
Available with a coated circuit board which makes the drive suited for operation in harsh environments.

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

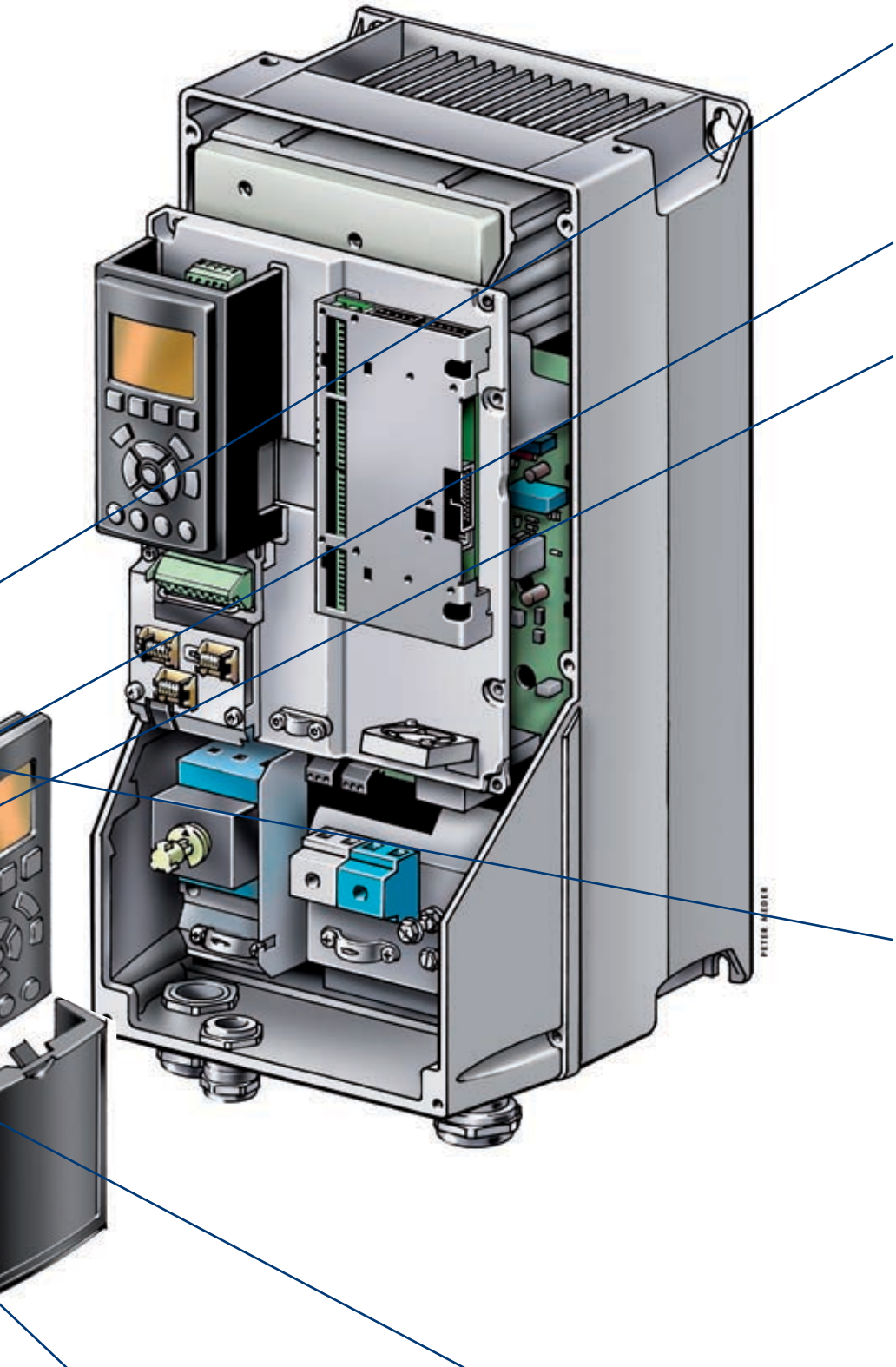
RFI
RFI available in the versions A1/B1 and A2 according to the IEC 61000 and EN 61800 standards.



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

2006 FROST & SULLIVAN Product Innovation Award

Danfoss Drives received the Frost & Sullivan Award for Product Innovation 2006 for the unique VLT® AutomationDrive series.



Fieldbus options
Options for bus communication (Profibus, DeviceNet, CanOpen, LonWorks, BACnet, etc.), synchronisation, user programs, etc., are delivered ready to plug-and-play.

I/O options
General purpose I/O.
Relay.

Display options
Danfoss Drives' renowned removable Local Control Panel has an improved user interface. Choose between six built-in languages (including Chinese) or have it customised with your own. Two of the languages can be changed by the user. 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 design and function of the Local Control Panel. The Automatic Motor Adaptation, the Quick Set-Up menu and the large graphic display make commissioning and operation a breeze. Choose numerical display, graphic display or no control panel.

Hot plugable LCP
The local control panel (LCP) can be plugged in or out during operation. Settings are easily transferred via the control panel from one drive to another or from a PC with MCT10 set-up software.

The VLT® series local control panel was given the international iF design award in 2004. The panel was chosen from a total of 1,003 entries from 34 countries in the category "interface in communication".

Safety
The new VLT® series can be ordered with safe stop functionality suitable for category 3 installations according to EN 954-1. This feature prevents the drive from starting unintentionally. Optional with Profisafe.

24 V supply
24 V supply keeps the VLT® drives' control card "alive" in situations when the AC power supply is removed.

Improved fan and pump operation

User-friendly control, distributed intelligence and reduced power consumption are beneficial for fan applications. The capacity is always matched to the actual load.

Lower installation cost
VLT® drives are fitted with a built-in smart logic controller and auto tune PID controllers. They can control refrigeration system functions with fans, pumps and compressors. Valuable data points are saved.

Extends system's capacity
When integrated into the cooling network, all the drives I/O points are available as remote I/O's to extend the systems capacity. For example, temperature sensors (Pt1000/Ni1000) can be directly connected.

Operational savings
- Less dirt build-up on condenser
- Load dependent capacity control
- No need for separate starting equipment
- No need for separate motor protection

Applied cost benefits
- Eliminate the need for starters, overloads, physical I/O
- Reduce physical I/O by using the VLT® drive's I/O to control fan
- Reduced amount of refrigerant
- Operate single fans as well as multiple parallel operating fans

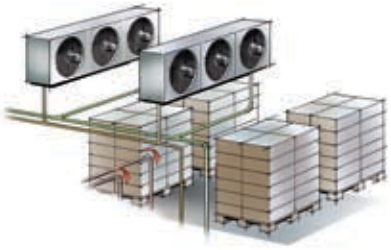
Resonance Monitoring
By pressing a few buttons on the Local Control Panel the drive can be set to avoid frequency bands at which connected fans create resonances in the system.

Intelligent functions
The VLT® drives handle logical rules and input from sensors, real-time functionality, and time-related actions. This enables the drives to control a wide range of functions, including:

- Weekend and working-day operations
- Cascaded P-PI for temperature control
- Multi-zone pressure control
- Flow balancing

Fan features	Benefits
• Smart Logic Controller	– Lower installation cost – Valuable data points are saved
• Auto tune PID controller	– Easier set-up/commissioning
• I/O points are available as remote I/O's	– Extend the system's capacity
• Resonance Monitoring	– Noise reduction – Resonance damping
• Cascaded P-PI for temperature control	– Lower installation costs – Multi-zone control
• Different enclosures available	– IP20. IP 21, IP 55 and IP 66
• Flow balancing	– No external cooling or oversizing necessary
• AEO using Cos phi algorithm	– Upto extra 10% savings
• Flying start	– Can control "free-wheeling" fan in both directions
• Improved Floating Head pressure	– Reduced power consumption
• SW algorithm to detect abnormal overall input power	– Protects the motor(s) from facing the negative effects of over/under voltage and phase unbalance
• VLT® Pre-heat function	– Eliminate anti-condensation heater

Evaporator



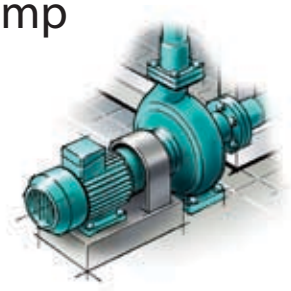
Reduced ice build-up and optimised evaporator temperature leads to lower energy consumption and higher system efficiency. The energy consumption is reduced by always matching capacity to the actual load.

Monitors broken belt, dry pump and "end-of-curve"
From the relation between current and speed, the VLT® drive reliably recognises "effortless" high speed – where the desired pressure is not reached despite of the speed, and indicates a broken belt, a dry pump or a major leak.

The drive sets off an alarm, shuts off the pump, or performs another programmed action.

First cost and down-time is reduced and equipment is protected.

Pump



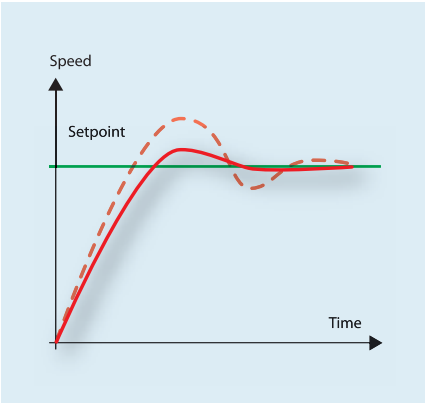
VLT® drives offer a vast number of pump-specific features developed in cooperation with OEMs, contractors and manufacturers around the world.

Sleep Mode
In Sleep Mode the drive detects situations with low or no flow. Instead of continuous operation it boosts the system pressure and then stops to save energy. The drive starts automatically when the pressure falls below the lower set point.

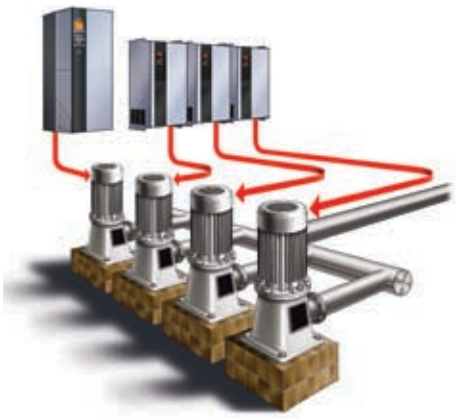
Condenser

Optimal control leads to stabilised pressure in the condenser. This ensures better control of the pressure difference between evaporator and condenser and a better COP for the compressor. The control of airflow is matched to the actual need resulting in decreased audible noise and energy consumption.

Pump features	Benefits
• Pump Cascade Controller	– Keep wear and tear on individual pumps at a minimum
• Sleep Mode	– Save energy
• Dry Pump Protection	– Protect the pump – Save energy
• End of Curve	– Protect the pump – Reduce energy consumption
• Flow compensation	– Save energy



Auto tune PID controllers can control refrigeration system functions with fans, pumps and compressors. Valuable data points are saved.



Pump Cascade Controller
The Pump Cascade Controller is the most sophisticated controller on the market.
It distributes running hours evenly across all pumps, keeps wear and tear on individual pumps to a minimum and ensures that all pumps are in great shape.

Improved compressor operation

VLT® drives are designed to offer flexible, intelligent control of scroll, screw, piston and centrifugal compressors, making it even easier to optimise cooling capacity with constant temperature and pressure levels for typical compressor applications in refrigeration.

Optimised pressure leading
VLT® control leads to better COP (lowest condensing and highest evaporating temperature).

Improved superheat control
VLT® control ensures that all cooling media have evaporated.

Reduced ice build-up
Optimum evaporator temperature is achieved causing lower energy consumption to de-icing.

Stabilised pressure
Stabilised pressure in the condenser reduces the number of starts and increases lifetime.

Replace a cascade with a single compressor
VLT® drives provide same level of flexibility with one large compressor instead of a cascade of 2 or 3 smaller compressors.

The VLT® drive operates all compressors at a far more refined range of speeds than normal. This includes even above nominal speed, meaning that one large compressor is enough.

Set point in temperature
VLT® drives calculate the actual room temperature from the pressure in the cooling media and refines compressor operation accordingly – without the need for additional software, sensors or controllers.

The calculation is also applicable to the set point as well, so the desired temperature is set via the Local Control Panel – and not a pressure value.

Fewer starts and stops
A maximum number of start/stop cycles within a given period of time can be set via the Local Control Panel. Since start-up is the most critical part of compressor operation (all parts of the unit are under mechanical stress before the system is sufficiently lubricated) this extends compressor lifetime.

Quick start-up
To extend life even further, VLT® drives can open a bypass valve and let compressors start quickly without load.

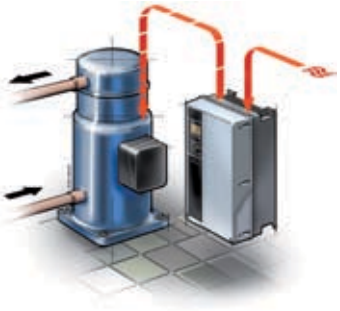
VLT® HVAC drive provides up to 130% break away torque and can give 110% torque for 60 seconds in normal operation. For 160% torque demand, the VLT® AutomationDrive can be applied.

Features	Benefits
• High starting torque	– No need for larger drive
• Reduced current limit	– Ensure functionality of cooling system – Protect the application
• Will run for as long as possible (running at current limit)	– Extend the system's capacity
• Maximum number of starts • Min. time between starts • Min. running time	– Protect compressor – Reduce energy consumption
• Set-point in temperature	– Easy operation
• Quick start-up	– Protect compressor – Reduce energy consumption

Operational savings
- Power savings
- Less wear and tear

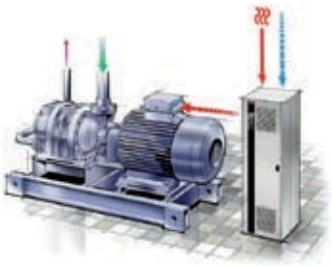
Applied cost benefits
- Flexibility with few compressors
- Less need for software, sensors and controllers

Scroll



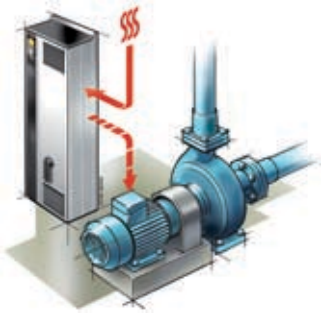
The scroll and screw compressors are gaining market share in the refrigeration applications. The VLT® drives have dedicated refrigeration system functions to control these compressors.

Screw



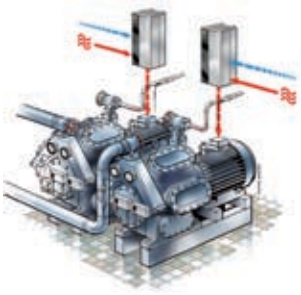
Typically divided in oil-free screw compressors and oil lubricated screw compressors.
Energy savings from adding a variable speed drive on the oil lubricated compressor will be twice the savings on the oil-free compressor. This is caused by the loss at no-load condition, which is much higher on the oil lubricated type. Further savings are achieved by optimised regulation of the pressure.

Centrifugal

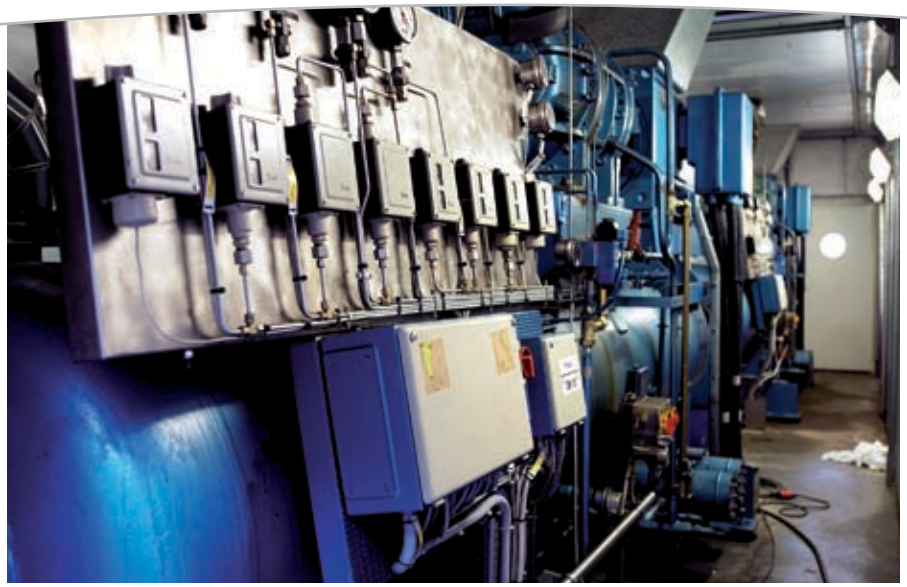


These compressors are used in industrial applications with a large cooling demand. The VLT® drives can control the compressor as well as being integrated in the control system for the plant.

Piston



The piston compressor has the highest market share in refrigeration applications. The VLT® drives can improve performance on piston compressors.



VLT® drives in the biggest indoor ski resort in the world
The biggest indoor ski resort in the world, "Ski Dubai" opened its doors in September last year.
The complex houses 425 shops and 65 restaurants and covers 2.4 million square meters including "Ski Dubai".
The resort, featuring real snow, is part of the "Mall of the Emirates" in Dubai.

Proven refrigeration experience

Maersk Containers, Denmark
VLT® drives are employed to keep correct and constant temperature in Maersk containers. Compact design, high efficiency, extreme reliability and dedicated refrigeration features are necessary for drives to operate cooling containers at sea and in trains and trucks all over the world. The quality of the cargo depends on it.

CUB Yatala brewery, Australia
Carlton & United Breweries' Yatala brewery in Queensland, North Australia, boasts better than world's best practice kWh-per-hectolitre figures after a major revamp of its brine chilling plant. The chiller systems' VLT® drives allow the pumping and compressor capacities to be modulated according to plant demand for chilled brine.

Helsinki Ice Stadium, Finland
Helsinki Ice Stadium opened 1966 and it is the oldest ice stadium in Helsinki. The spectator capacity is 8120. For the opening hockey game in 1967, there were almost 11000 spectators. Besides hockey, there are held exhibitions, concerts and other sport events.

Corman, Belgium
Located a stone's throw from the famous Gileppe dam, Belgium, the Corman public limited company specialises in a broad range of anhydrous dairy fats, concentrated butter and technically adapted butter to the needs of food and agriculture industries throughout the world.
Installing VLT® drives proved to be the best way to reduce operation costs and to cater effectively for the changing needs in the production lines.

Versacold Group, Canada
The Versacold Group operates approximately 24 large cold storage and distribution facilities across Canada and the Pacific Northwest, United States. The warehouses are refrigerated by VLT® drives and provide storage for a variety of pharmaceutical and retail-wholesale grocery chains, contributing to improved quality of life in large metropolitan areas and small villages throughout North America.

Product overview

VLT® AutomationDrive

An extremely flexible and cost-effective drive suitable for all industry applications – from simple speed control to dynamic servo applications.

VLT® AutomationDrive comes in a basic version (FC 301) and an advanced version (FC 302) with additional functionalities.

- 200 – 240 V, 0.25 – 3.7 kW
- 380 – 500 V, 0.37 – 800 kW
- 525 – 690 V, 37 kW – 1.2 MW
- Built-in DC coils and RFI-filter (optional)
- Bookstyle IP 20/IP 21/NEMA 1/ IP4X top and IP 55/NEMA 12
- Compact drive IP 55 and IP 66/NEMA 4
- Integrated Smart Logic Controller, (USB and RS485) as standard
- Integrated optional communication options (Profibus DP/V1, DeviceNet, CanOpen and more)
- Integrated optional additional I/O (digital I/O's, encoders, (incremental, absolute, sin/cos, resolver))
- Integrated Motion Control Option (PLC)

VLT® HVAC Drive

The VLT® HVAC Drive continues Danfoss leadership in dedicated HVAC features and applications for drives.

Advancements in energy monitoring, trending, system maintenance and operation are combined with a modular platform to make the drive "child's play" to operate.

- 200 – 240 V, 1.1 – 45 kW
- 380 – 480 V, 1.1 kW – 1.2 MW
- 525 – 600 V, 1.1 kW – 1.2 MW
- Built-in DC coils and RFI-filter (optional)
- Integrated communication options (Modbus RTU, BACnet, LonWorks and more)
- Multiple PID loops for advanced HVAC control
- Platinum and Nickel temperature sensor inputs
- Application specific menus for quick and easy programming
- Capability for compressor control
- Preventive maintenance scheduling

VLT® AQUA Drive

VLT® AQUA Drive the perfect match for pumps and blowers in modern water and wastewater systems.

Advanced application protective features. Available with cascade control of up to 8 pumps in fixed speed mode or master/-follower mode.

- 200 – 240 V, 0.25 – 45 kW
- 380 – 480 V, 0.37 kW – 1.0 MW
- 525 – 600 V, 0.75 – 90 kW
- 690 V, 11 kW – 1.2 MW
- Built-in DC coils and RFI-filter (optional)
- Integrated communication options (Modbus RTU, Profibus, DeviceNet, EtherNet IP)
- Multiple PID loops for advanced AQUA control
- Platinum and Nickel temperature sensor inputs
- Application specific menus for quick and easy programming
- Capability for constant torque loads
- Preventive maintenance scheduling

VLT® 2800 Series

An extremely compact series of drives prepared for side-by-side mounting and developed specifically for the low power market.

- 200 – 240 V, 0.37 – 3.7 kW
- 380 – 480 V, 0.55 – 18.5 kW
- Multipurpose
- Side-by-side mounting in any direction
- Built-in PID controller, RFI-filter and DC coils
- Bookstyle IP 20
- Integrated RS 485 interface as standard
- Integrated Profibus (optional)

VLT® Micro Drive

A compact general purpose drive for AC motors up to 7.5 kW.

It performs perfectly even in complex application set-ups and optimises energy efficiency and operation.

- 1 phase 200 – 240 V AC: 0.18 – 2.2 kW
- 3 phase 200 – 240 V AC: 0.25 – 3.7 kW
- 3 phase 380 – 480 V AC: 0.37 – 7.5 kW
- Multipurpose
- Process PI-controller
- Automatic Energy Optimiser (AEO)
- Automatic Motor Adaptation (AMA)
- 150% motor torque up to 1 minute
- Smart Logic Controller

Power options

Danfoss Drives offers a wide range of external power options for use together with our drive in critical networks or applications:

- **Advanced Harmonic Filters**: for applications where reducing harmonic distortion is critical (hospitals, airports, etc.)
- **dU/dt filters:** For providing motor isolation protection
- **Sine filters** (LC filters): For noiseless motor and low dU/dt

Complementary products

A broad range of soft starters
Soft starters are usually mounted on the condenser fans in general or as part of a cascade controller.

Application options

A wide range of integrated water application options can be fit into the drive:

General purpose I/O option:
3 digital inputs, 2 digital outputs,
1 analog current output,
2 analog voltage inputs

Relay option/cascade controller option:
3 relay outputs

External 24 VDC supply option:
24 VDC external supply can be connected to supply control and option cards

Brake chopper option:
Connected to an external brake resistor, the brake chopper limits the load on the intermediate circuit in case the motor acts as generator.

PC software

- **MCT 10**
  – ideal for commissioning and servicing the drive including guided programming of cascade controller, real time clock, smart logic controller and preventive maintenance.
- **VLT Energy Box**
  – comprehensive energy analysis tool, shows the drive payback time
- **MCT 31**
  – harmonics calculations tool

Harmonic filters

Soft starters

Decentral drive solutions

Sales and Service Contacts worldwide

Find your local expert team on www.danfoss.com/drives

- 24/7 availability
- Local hotlines, local language and local stock

Danfoss service organisation is present in more than 100 countries – ready to respond whenever and wherever you need, around the clock, 7 days a week.

Pick your dedicated solution from the VLT® service menu:

Keep you running
- Current drives update
- Commissioning and regular adjustments
- Preventive maintenance

Keep you fit:
- Training
- Stock maintenance & consignment
- Harmonic Survey
- Environmental Disposal

Fix your costs
- Fixed Price
- Post warranty agreement
- Transport insurance
- Response time

Protects environment

VLT® products are manufactured with respect for environment, safety and wellbeing.

All activities are planned and performed taking into account the individual employee, the work environment and the external environment. Production takes place with a minimum of noise, smoke or other pollution and environmentally safe disposal of the products is assured.

UN Global Compact
Danfoss has signed the UN Global Compact on social and environmental responsibility and our companies act responsibly towards local societies.

EU Directives
All factories are certified according to ISO 14001 standard. All products fulfil the EU Directives for General Product Safety and the Machinery directive. Danfoss Drives is in all product series implementing the EU Directive concerning Hazardous Substances in Electrical and Electrical Equipment (RoHS) and is designing all new product series according to the EU Directive on Waste Electrical and Electronic Equipment (WEEE).

Products impact
One year's production of VLT® drives will save energy equivalent to the energy production of a power plant. Better process control at the same time improves product quality and reduces waste and wear on equipment.

What VLT® is all about

Danfoss Drives is the world leader among dedicated drives providers – and still gaining market share.

Dedicated to drives
Dedication has been a key word since 1968, when Danfoss introduced the world's first mass produced variable speed drive for AC motors – and named it VLT®.

Two thousand employees develop, manufacture, sell and service drives and softstarters in more than one hundred countries, focused only on drives and softstarters.

Intelligent and innovative
Developers at Danfoss Drives have fully adopted modular principles in development as well as design, production and configuration.

Tomorrow's features are developed in parallel using dedicated technology platforms. This allows the development of all elements to take place in parallel, at the same time reducing time to market and ensuring that customers always enjoy the benefits of the latest features.

Rely on the experts
We take responsibility for every element in our products. The fact that we develop and produce our own features, hardware, software, power modules, printed circuit boards, and accessories is your guarantee for reliable products.

Local backup – globally
VLT® motor controllers are operating in applications all over the world and Danfoss Drives' experts located in more than 100 countries are ready to support our customers with application advice and service wherever they may be.

Danfoss Drives experts don't stop until the customer's drive challenges are solved.

Danfoss Drives, Ulsnaes 1, DK-6300 Graasten, Denmark, Tel. +45 74 88 22 22, Fax +45 74 65 25 80,
www.danfoss.com/drives • E-mail: info@danfoss.com

DKDD.PB.33.C1.02 VLT® is a trademark of Danfoss A/S Produced by KKM 2007.02