Lower lifecycle costs
Increase efficiency with speed control of compressors, fans and pumps

Energy savings can be achieved by using VLT® drives to control refrigeration compressors
VLT® Refrigeration Drive FC 103 reduces lifecycle costs

For over 60 years the Danfoss Refrigeration team has specialized in the development of innovative and effective refrigeration technology solutions.

Out of this wealth of experience over so many decades, Danfoss has now developed the ideal drive for the fans, pumps and compressors used in these applications: the VLT® Refrigeration Drive FC 103.

All-inclusive
- Top efficiency (98%)
- Automatic Energy Optimization (AEO)
- Mains chokes
- Refrigerant tables
- Large performance range
- Neutral zone controller
- Open for all kind of controllers including Danfoss ADAP-KOOL®

Integrated functions save money
- Cascade controller
- Dry-running protection
- Overload protection
- Safe stop
- Sleep mode
- Flow compensation

Easy installation
- Quick Menu
- Commissioning Wizard menu is friendly to engineers
- Speaks “refrigeration language”
- Small frame size
- IP20–IP66 enclosure rating

To help dramatically reduce lifecycle costs of your refrigeration systems, the VLT® Refrigeration Drive FC 103 offers a control and commissioning environment specifically designed to meet the needs of refrigeration compressor, fan, and pump applications.
Reducing the operating costs of refrigeration systems with quick payback is becoming increasingly important. Speed control of the electric drives used in these systems is a pragmatic and effective approach. Load-dependent speed control reduces power consumption and therefore saves money.

When you consider that energy costs amount to 90% or more of total operating costs over the total product lifetime, it’s easy to see that there is plenty of potential for savings in this area. Speed control also lowers mechanical stress in the system, which reduces service and maintenance costs.

**VLT® Refrigeration Drive FC 103 – simply uncomplicated**

Danfoss developed the VLT® Refrigeration Drive FC 103 to allow all users in the refrigeration world to benefit from the advantages of speed control in a simple, uncomplicated manner. With its functions specifically tailored for refrigeration technology, it reduces total life cycle costs in the application.

The drive cuts the external component count, integrates easily into existing refrigeration systems, and makes motors energy efficient thanks to its high performance. In this way it improves the energy balance of the overall refrigeration system and reduces its environmental footprint.

**Proven reliability**

Starting with the first VLT® Drive – the VLT® 5 from 1968 – every drive series from Danfoss has proven the reliability of VLT® drives.
The VLT® Refrigeration Drive FC 103 benefits from Danfoss’ many years of experience in both refrigeration and drive technology. It combines an energy-efficient power stage with advanced software algorithms. This is the only way to effectively realize potential energy savings.

**VVC+ vector control**
The FC 103 uses proven VVC+ vector control, which automatically adapts to all load conditions and supplies exactly the right voltage to the motor.

**Fan and pump applications**
Due to their nonlinear load characteristics, the power consumption of fans and pumps can be radically reduced by using intelligent speed control. Power consumption decreases with the cube of the reduction in speed.

**Higher system efficiency reduces power dissipation**
With efficiency ratings up to 98% and a power factor greater than 0.9, VLT® frequency converters are distinctly better than comparable devices. Losses for chokes and filters are already allowed for in the rating.

This reduces not only direct energy costs for the drive itself, but also the costs for air conditioning or removing additional heat.

**Low power consumption in standby mode**
Speed-controlled cooling fans with control electronics designed for low current draw can ensure low power consumption even in standby mode. Thanks to its short start-up period when switched on, the power stage can be completely disconnected from the mains during short breaks in operation.

**AEO control for automatic load balancing**
Automatic Energy Optimizing (AEO) provides additional energy savings of up to 5%. This feature matches the input current to the actual motor speed and load, and draws only the amount of power necessary for motor excitation and operation with this load. This avoids additional thermal losses in the motor.

On fan and pumps, up to 50% energy can be saved by reducing the speed from 100% to 80%.
Optimize the compressor’s performance coefficient
Achieve system-wide energy efficiency

The performance of a refrigeration system is expressed using the energy efficiency ratio (EER) or the coefficient of performance (COP). This is the ratio of the generated cooling or heating capacity to the power actually consumed, and is usually based on full-load operation.

However, it is not enough to rate a refrigeration unit at just one load level, since most refrigeration systems operate under partial load conditions. This means that significant energy savings can be obtained using speed control.

**Refrigeration system without speed control**
In a refrigeration system without speed control, the refrigerant compressor always runs at full speed, regardless of the cooling capacity actually required. The cooling output is regulated by the evaporator, which is filled by the expansion device. Since the expansion valve constantly tries to fill the evaporator optimally, this adjustment causes the evaporation pressure to change and therefore creates oscillation in the system. With the compressor operating at full output capacity, this oscillation can persist for a very long time. As a result, the evaporator is never properly filled and operates ineffectively, and the cooling capacity of the refrigerant is not optimal.

**Refrigeration system with speed control**
The continuous variable speed control by VLT® Refrigeration Drive FC 103 makes intelligent capacity control possible. By creating stability while balancing the capacity to the actual load, system-wide COP improves providing significant energy savings. Intelligent compressor and condenser fan control is a “must” in any optimized refrigeration system.

The following positive effects can be achieved in a refrigeration system with variable-speed compressor operation:

**Compressor**
- Stable suction pressure
- Increased capacity using a smaller compressor
- Built-in soft starter function
- Reduced mechanical load
- Fewer start and stops extends the lifetime
- No mechanical capacity control

**Condenser fan control**
- Load dependent capacity control
- Operate single fans/multiple parallel operating fans
- Stable condensing pressure
- Reduced charge of refrigerant
- Less dirt build-up on condenser
- Stand-alone control using VLT® Refrigeration Drive FC 103

**Pumps in A/C or indirect cooling systems**
- Coolant pump capacity according to demand
- Stable coolant flow and pressure
- Stand-alone control using VLT® Refrigeration Drive FC 103
- Operate from direct signal (0/4-20 mA or 0-10 V DC)

**Fans in air-conditioning systems**
- Optimized operation of air handling units
- High efficiency
- Airflow according to demand
- Stand-alone control using VLT® Refrigeration Drive FC 103
- Operate from direct signal (0/4-20 mA or 0-10 V DC)

Depending on the concrete application, speed control can result in energy savings ranging from 10% to as much as 70%.

The figure on the left shows the condensation temperature curve (red) and the evaporation temperature curve (blue). The effect of on/off operational behavior compared to a stable temperature (straight line) is clearly visible.

The right-hand figure shows a log (p) h diagram. The standard condensation or evaporation processes are shown as dark red and dark blue lines.
To protect people and equipment, in practically all refrigeration applications, the system operator must ensure that compressors are actually stopped and cannot start up again. This is important in order to avoid HP tripping or vacuum formation in the suction line or the evaporator.

The Safe Torque Off function (compliant with EN 61800-5-2) of the VLT® Refrigeration Drive FC 103 provides a cost-effective way to implement this with high reliability. Unlike software functions that trigger a stop command using the digital inputs, here the control voltage of the output module is enabled or disabled directly via the safe terminal of the frequency converter. This reduces cabling cost, and the functionality integrated in the Refrigeration Drive eliminates the need for costly and bulky external components, such as contactors and relays, that are used for this purpose in conventional solutions.

Easy commissioning
Another significant advantage of the integrated safety function in the VLT® Refrigeration Drive FC 103 is that it can be activated without special software or complicated set-up procedures. This considerably simplifies commissioning, servicing, and the replacement of individual components.

Simplified installation
VLT® Refrigeration Drive FC 103 eliminates the need for special start equipment due to built-in current reduction. It offers motor protection against overload and high temperature conditions and has built-in crank case heater functionality.

Start up compressors gently and reduce wear and tear
There is often insufficient lubrication when compressors are started or operated at excessively low speeds. This is not a problem when compressors are started directly from the mains, since they pass through the critical area quickly. However, in theory the situation is different with variable speed operation: long ramp times mean slow acceleration, resulting in extended operation in the critical region.

To effectively avoid this potential source of wear, the FC 103 provides a separate start ramp for the start-up process when working with a compressor. Once the compressor has passed through the critical region and adequate lubrication is assured, it automatically switches to a slower and gentler starting ramp. Naturally, the fast ramp is also active during the stop process.
Pack Controller
Energy savings thanks to optimal control

There is a speed range in the interaction between the compressor and frequency converter that allows the system to save energy. The compressor should function within this range most of the time. If the difference between the maximum required performance and the average performance under partial load is too great, it is a good idea to use a cascade configuration. The efficiency of the drive, and especially the motor, drops significantly under partial load conditions. In many cases the required capital investment, including the conversion of an existing system, will be amortized quickly.

Easy commissioning
The VLT® Refrigeration FC 103 drive offers a setup wizard, using common refrigeration terms rather than computer language. During field testing, programming ease made installers and service technicians more comfortable and confident, and made their jobs easier and quicker.

The wizard menu also supports the commissioning engineers if they encounter any problems. The menu will help the engineer troubleshoot and offer ‘quick fixes’ to get the drive up and running if there is a problem.

Commissioning is fast and easy using the drive display panel. The wizard that appears the first time the device is switched on guides the user through the necessary settings.

The user only has to switch from external to internal control. If necessary, the wizard can be called up again from the Quick Menu. Configuring the necessary parameters is even easier with the wizard in the VLT® Motion Control Tool MCT 10 software. During operations, the VLT® Refrigeration Drive FC 103 can show the compressor status on the drive display panel and log the compressor’s operating time and number of starts.

Reduced service costs
Mechanical wear is automatically reduced by the fact that only as many compressors are running as are actually needed. This allows service intervals to be extended. The user can configure rotation of mains-powered compressors to ensure that they all end up with a similar number of operating hours.
The modular VLT® Refrigeration Drive – adapted to your requirements

The VLT® Refrigeration Drive is built on Danfoss’ modular concept. Real plug-and-play adding and exchanging of options. Just upgrade instead of buying a new drive.

1 Fieldbus
   - Option: VLT® AK-LonWorks MCA 107
   - Built-in: Modbus RTU as standard
     VLT® PROFIBUS DP MCA 101
     VLT® PROFINET MCA 120

2 Local Control Panel (LCP)
   Choose graphical or no display

3 I/O option
   - General Purpose I/O
     (3DI + 2AI + 2DO + 1AO)
   - Analog I/O option
     (3AI (0 – 10 V / PT1000 / NI 1000) + 3AO (0 – 10 V))
   - Relay output (3 x relays)

4 24 V supply option

5 RFI Filter
   Built-in RFI filter for long motor cables compliant with the IEC 61800-3 and EN 55011 standards.

6 AC mains disconnect
   No need for an external switch when you want to disconnect the drive from the mains.

7 Input mains option
   Various input configurations are available including mains switch (disconnect) or RFI filter. Input plates are field adaptable.

8 Unique cooling concept
   - No ambient air flow over the electronics up to 125 HP
   - Above 125 HP, designed with back channel cooling (85% heat dissipated via back channel)

9 Durable in aggressive environments
   In some refrigeration applications, it is recommended to protect the drive with coated PCB’s. VLT® Refrigeration Drive is designed for level 3C2 according to IEC 60721-3-3. Protection level 3C3 is optionally delivered from factory.

This option offers significantly improved protection against chlorine, hydrogen sulphide, ammonia and other corrosive environments.

VLT® quality up to 350 HP
   The VLT® Refrigeration Drive FC 103 is available from 1.5 HP to 350 HP.

Danfoss’ drive experience since 1968 lies behind the intelligent design of VLT® drives.

All enclosures are mechanically designed with focus on:
   - Robustness
   - Easy access and installation
   - Intelligent cooling
   - High ambient temperatures
High Ambient Temperatures
VLT® Refrigeration Drive FC 103 is designed to operate in ambient temperatures up to 50°C with an autoderate capability. This derating enables reduced operation for a period of time at higher ambient temperatures to maintain operation of the VLT® Refrigeration Drive FC 103 system in extreme climate conditions.

Robust to Mains issues
In most cases, the VLT® Refrigeration Drive will handle abnormal situations without needing attention.

VLT® Refrigeration Drive will manage the loss of a mains phase or a high mains imbalance by autoderating speed and load to maintain a period of reduced operation, enabling technicians to respond to the situation.

Maintenance free
Due to a series of self-protecting and monitoring features and a highly durable mechanical design, the VLT® Refrigeration Drive is maintenance free, except for general cleaning. No replacement of internal fans or capacitors is required.

Save space
Due to its compact dimensions, the VLT® Refrigeration Drive is easily mounted inside a panel, reducing overall enclosure costs and freeing up panel backspace for other devices.

Save energy
The energy consumption from fans and pumps rises with the cube of the flow. That’s the reason why VLT® control of such applications typically saves up to 48% or more energy compared to on-off operation. The energy saving potential from compressors and entire refrigerating appliances depends on compressor type and system setup.

Save money
We offer a standard & integrated NEMA 12/IP55 protection class equal to that of the motor.

This eliminates the cost of a separate enclosure and saves on the additional installation costs associated with installation in a remote location.

NEMA 4X/IP 66 Indoor for harsh environments
The NEMA 4X/IP 66 enclosure option for harsh environments can eliminate the cost of a separate enclosure and reduce the installation costs associated with remote installations.

Protection mode
As soon as the system detects a critical status, (e.g. over-current or overvoltage) the frequency of the VLT® Refrigeration Drive will automatically be reduced and the modulation process adjusted.

Due to its ability to limit its switching operations, the VLT® Refrigeration Drive is extremely reliable and robust. The protection mode will – if allowable – end after 10 seconds and the frequency will be restored under control.

Minimum 98% efficiency
The VLT® Refrigeration Drive provides 98% efficiency at full load. This reduces initial costs and operating costs due to the smaller heat load/air conditioning requirement in the switch room/plant room, thereby maximizing energy efficiency. Every kW of losses requires another ~0.5 kW of energy to remove the heat.

Installed in an air conditioned switch room, lower losses can easily result in operating cost savings from >5% – 10% of the cost of the drive every year (based on a typical load profile, with the drive operating 24/7). Also system energy consumption and CO2 emissions are reduced.
The common approach to drive programming

1. Graphical display
   - International letters and signs
   - Graphical display with bar-charts
   - Easy overview
   - 8 language selections

2. Menu structure
   - Based on the well known matrix system in today’s VLT® Drives
   - Easy shortcuts for the experienced user
   - Edit and operate in different set-ups simultaneously
   - Speaks refrigeration language

3. Other benefits
   - Demountable during operation
   - Upload and download functionality
   - IP 65/NEMA 4 rating when panel door mounted.
     (A remote mounting kit is available)
   - Up to 5 different variables visible at a time
   - Manual speed/torque setting
   - 100% user defined information and size

4. Illumination
   - Relevant buttons are illuminated when active
   - LEDs indicate the status of the drive

5. Quick Menus
   - A Danfoss-defined Quick Menu
   - A user-defined Quick Menu
   - A Changes Made menu lists the parameters unique to your application
   - A Wizard set up menu
   - A Logging menu provides access to operation history

6. Intuitive functions
   - Info (on board manual)
   - Cancel (undo)
   - Alarm log (quick access)

The user interface may be mounted remotely on a control panel fascia, eliminating the need for additional switches and instrumentation.

The VLT® Refrigeration Drive can be remote-commissioned and monitored via a USB cable or RS-485 communication.

Panel options: Graphical and blind cover.
Efficient setup wizard speaks refrigeration language

The setup wizard uses the language of the refrigeration trade, rather than technical jargon, to guide users through setup to create a logical easy-to-follow process for engineers and installers.

For making installation even more efficient, the built in wizard set up menu guides the user through the set up of the drive in a clear and structured manner. The following applications are supported:

- Multi compressor control
- Multi condenser fan, cooling tower / evaporative condensing
- Single fan and pump
- Pump system

The feature is activated at the first power up, after a factory reset, or from the quick menu. When activating the wizard, the drive will ask for the information it needs to run the application.

You will be guided through the programming of all important parameters like motor data and used control signal (including instructions for connection). At every single step help is easily available by pressing the info button on the display.

Finally, you can also choose to start the Automatic Motor Adaptation (AMA). This functionality will determine the exact motor data and thereby ensure robust and energy efficient operation of your appliance.

VLT® Motion Control Tool
The real effect is money saved

Free VLT® Motion Control Tool MCT 10 set-up software provides easy control of details as well as a general overview of drive systems, large or small. The tool handles all drives-related data.

Explorer-like interface
The MCT 10 software features explorer-like interface design and functionality to ease both use and learning of the facilities.

More efficient service organization
- Scope & logging: analyze problems easily
- Read out alarms, warnings and error log in one view
- Compare a saved project with an on-line drive

More efficient commissioning
- Offline commissioning off-site
- Save/send/mail projects anywhere
- Easy fieldbus handling, multiple drives in project file. Enables the service organization to be more efficient

Basic
- Scope & Graph
- Alarm history in saved projects
- Graphical Timebased Actions, Preventive Maintenance and Basic Cascade Controller
- Multiple fieldbus support

Advanced
- No limitation in the number of drives
- Motor database
- Real-time logging from the drive

Online and offline mode
In the online mode, you work with the actual setup of the drives in question. Your actions will have immediate effect on the performance of the drive(s).

Connections
- USB
- RS485

Project oriented
In project mode you work with the drive parameters as a 'virtual' set-up. This allows you to adjust the whole system before you implement it into the drives and put it in action. In project mode you can set the system up even before the drives are installed. A single command will update the whole system. In case a drive is exchanged, it is easily set up to perform exactly as its predecessor.
Dedicated pump features

The VLT® Refrigeration Drive FC 103 offers a vast number of pump-specific features developed in cooperation with OEMs, contractors and manufacturers around the world.

**Embedded Pump Cascade Controller**
The Pump Cascade Controller 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.

**Leakage or broken pipe**
Continuous liquid supply can be assured in the event of leakage or a broken pipe. For example, overload is prevented by reducing drive speed – and supply is secured at lower flow.

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

1. **Dry Pump Protection and End of Curve**
   Dry Pump Protection and End of Curve relate to situations where the pump runs without creating the desired pressure – as when a well runs dry or a pipe leaks. In this situation the drive sets off an alarm, shuts off the pump, or performs another pre-programmed action.

2. **Auto tuning of the PI controllers**
   With auto tuning of the PI controllers, the drive monitors how the system reacts to corrections made by the drive, learns from it, and calculates the ‘P’ and ‘I’ values so that precise and stable operation is achieved quickly.

   This applies to each PI controller in the 4-menu sets individually. Exact P and I settings at start-up will not be necessary – which lowers commissioning costs.

3. **Flow compensation**
   Significant energy savings and reduced installation costs are provided by flow compensation in both fan and pump systems. A pressure sensor mounted close to the fan or pump provides a reference enabling pressure to be kept constant at the discharge end of the system. The drive constantly adjusts the pressure reference to follow the system curve.

4. **No/low flow**
   An operating pump will normally consume more power the faster it runs – according to a curve determined by the pump and application design. The FC 103 will detect situations where the pump runs fast but is not fully loaded – and thereby not consuming adequate power. This is the case when water circulation stops, the pump runs dry, or when pipes leak.
The VLT® Refrigeration Drive FC 103 is designed for operating piston, scroll, screw compressors and centrifugal compressors. Variable speed control allows the refrigeration capacity of a compressor to be adapted to exactly match the demand.

**Dedicated compressor features**

**Pressure level control using connected temperature sensors.** Speed is reduced before the high pressure reaches a critical value.

**Single compressor or pack**

The user has the choice of operating the system with a single large compressor or using the pack controller to operate the system with several smaller compressors which are activated as necessary.

**Direct entry of evaporation pressure temperature**

The user can enter the desired evaporation pressure temperature directly in the control panel of the VLT® Refrigeration Drive. The frequency converter also takes the properties of the refrigerant into account. Tables for the most commonly used refrigerants are preloaded in the frequency converter. User-defined entry of the refrigerant used in the system is also possible.

**Inject ON**

When all connected compressors on the FC 103 are stopped due to a missing safety circuit, this will be registered by the system unit which will close all valves connected to the case controllers. This prevents a flow of liquid going to the compressor when the FC 103 starts again. As soon as a compressor starts running again, the valves are allowed to reopen.

**Fewer starts and stops**

Start-up is the critical phase of compressor operation. The VLT® Refrigeration Drive minimizes the number of required starts and stops by varying the speed of the compressor to tune its capacity during operation. In addition, the maximum number of start/stop cycles in a given period can be configured using the control panel.

**Unloaded start**

To further extend the lifetime of the VLT® Refrigeration Drive a pressure relief valve can be opened to allow the compressor to start up quickly with no load.

**135% Starting torque**

The VLT® Refrigeration Drive delivers 135% of the rated starting torque for a period of half a second. In normal operation, 110% of the rated torque is available for 60 seconds.

**Smaller compressors with the same peak load**

The operator can configure the system with a smaller compressor for a given peak load. Provided the compressor is designed for over-speed operation, the VLT® Refrigeration Drive can run it at up to 90 Hz. This may allow brief peak loads to be handled in this way without necessarily requiring a larger compressor for this purpose.

**Day/night control**

Compressors usually operate with different setpoints depending on the time of day. This in turn results in different evaporator fan speeds, resulting in reduced energy consumption. This function can be easily programmed with day/night control.

**P0 optimization**

The VLT® Refrigeration Drive FC 103 supports connection of an ADAP-KOOL® LonWorks control for P0 optimization.

**Neutral Zone**

The VLT® Refrigeration FC 103 drive continues to control fixed speed compressors in situations where the variable speed compressor fails. Neutral zone is in a fail situation set by a special parameter “Fixed speed neutral zone”, which gives the opportunity to have fewer starts by expanding the neutral zone.

**Condensation final temperature monitoring**

The frequency converter can monitor the Floating Head Pressure high pressure level control using connected temperature sensors. Speed is reduced before the high pressure reaches a critical value.
Dedicated fan features

User-friendly, distributed intelligence and reduced power consumption are beneficial for fan applications.

Velocity-to-flow conversion
The VLT® Refrigeration Drive FC 103 is able to convert velocity pressure sensor values into flow values. Operators can configure the drive to provide a fixed flow or differential flow, which optimizes both comfort and energy consumption. Using a pressure sensor instead of a flow sensor saves money.

Intelligent functions
The FC 103 handles logical rules and inputs from sensors, real time functionality, and time-related actions. This enables the FC 103 to control a wide range of functions, including:
- Weekend and working-day operations
- Cascaded P-PI for temperature control
- Flow balancing between fresh and outlet air
- Belt monitoring

Extended I/O capacity
When operated by an external controller, all the Refrigeration Drive I/O points are available as remote I/O to extend the capacity of the controller. For example, room temperature sensors (Pt1000/Ni1000) can be directly connected.

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 ventilation system. This reduces vibration noise and wear and tear on equipment.

Auto tuning of the PI controllers
With auto tuning of the PI controllers, the drive monitors how the system reacts on corrections made by the drive – and learns from it.

4 x PID controller
(Individual set-points/feed-backs)
- 1 PID for closed loop control of the motor connected to the drive
- 3 PIDs for external closed loop control of refrigeration equipment
- Auto-tuning of all 4 PID loops
- Eliminates the need for other controllers
- Provides flexibility for the controller and reduces the load

The drive controller uses an input sensor that measures pressure, temperature or other variables to change the speed of the motor connected to the VLT® Refrigeration Drive FC 103, by adjusting its output frequency to match the varying load.

The additional 3 PID controllers can be used for external sensors (i.e. pressure, temperature, flow) to control components.
Keeps EMC on the safe side

Optimum EMC protection coupled with integrated harmonic filters ensure that the optimum EMC environment and cleanest power supplies are maintained throughout the operational lifetime of the system, negating any reduction in lifecycle costs.

VLT® Refrigeration Drive FC 103 meets the EMC product standard EN 61800-3 without additional external components, even when using long motor cables. The drive corresponds to the EMC guidelines 2004/108/EC, and offers performance superior to other drives.

Critical for practical use is compliance with the environment standard.

<table>
<thead>
<tr>
<th>Categories according to EN 61800-3</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limits according to EN 55011</td>
<td>Class B</td>
<td>Class A1</td>
<td>Class A2</td>
<td>Exceeding class A2</td>
</tr>
</tbody>
</table>

Comparison of limits EN 55011/61800-3

Clean power supply

VLT® Refrigeration Drive FC 103 introduces a minimum of RFI or harmonic pollution into the building and avoids problematic performance.

FC 103 is a reliable and cost effective investment.

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Keep your power supply clean

Harmonic distortion on the supply grid is an increasing problem, mainly caused by electronic power devices, including frequency converters, drawing non-sinusoidal current from the mains supply. This creates harmonic distortion on the supply depending on the supply impedance.

Danfoss’ VLT® Motion Control Tool MCT 31 makes it possible to calculate the extent of these harmonics at the planning stage and can suggest mitigation countermeasures.

Harmonic mitigation can be particularly valuable when the power supply is backed up with emergency generators, which have poorer tolerance to non-sinusoidal currents.

Data can be entered, stored and recalled project by project. At a click the software presents a clear overview of each project with data presented in both tabular and bar-chart formats.

Current standards (EN 50106) are included in the software analysis tool, which can quickly and easily be downloaded from www.danfossdrives.com.
All VLT® Refrigeration Drive FC 103 versions have manganese phosphor rear bodies.

IP66/NEMA 4X enclosed drives are suitable for installation in demanding environments.

Cooling air is kept outside the device to prevent any pollution of the electronics. The surfaces are smooth and easily cleaned.

The IP55/66, NEMA 4X series are designed for easy accessibility and time-saving installation.

Furthermore, all components such as EMC filters for compliance with EN 55011, class A1/B, as well as the DC coils, are protected inside the drive.

Because of the high-density integration, the tight housings of the VLT® Refrigeration Drive are significantly smaller when compared to other drives of the same performance.

Motor and power cables are mounted securely through glands in the base plate.
VLT® Refrigeration Drive FC 103 – optimized for installation in panels

IP 20/NEMA 1 enclosures

The functionality fulfills the highest requirements even for applications with high overload, long motor cables and ambient temperatures up to 50°C (55°C with derating).

**Optimized design**
Optimized efficiency and intelligent cooling technology make for a compact and service-friendly design. Supplementary equipment such as EMC filters, harmonics suppression and brake modules are integrated into the enclosure.

**Save installation time**
The IP20/NEMA 1 series is designed for easy accessibility and time-saving installation.

Mechanical fastening points are easy to access from the front even with automatic tools.

All terminals are sufficiently dimensioned and clearly marked. One need only loosen a few screws to get to the terminals.

Accessories for bonding screened cables are included. The compact enclosures are easier to install. This is important especially within existing installations with limited accessibility. An extensive range of options and accessories are available, optimizing the drive for the respective application.

Intelligent heat management – cooling methods for additional benefits

Total separation between cooling air and electronics protects the electronics and allows for installation where heat is removed from outside of the cabinets.

With the VLT® Refrigeration Drive FC 103, a flanged heat sink kit is available for mounting the drive in the backplate of a cabinet, separating the heatsink airflow from the electronics.

Eliminating airflow over the electronics increases drive lifetime as contaminants are excluded from the drive.

Back channel cooling minimizes heat loss while increasing energy efficiency, a significant benefit for high power drives.
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, the stadium hosts exhibitions, concerts and other sport events.

**Corman, Belgium**

Located a stone’s throw from the famous Gileppe dam, Belgium, the Corman public limited company specializes 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.

**Crowne Plaza Copenhagen Towers Hotel, Denmark**

The climate-friendly hotel deploys an innovative ground water cooling system with a COP up to 40. VLT® drives-controlled screw compressors enable the heat pumps to adjust the heat capacity continuously from low to full performance with the same efficiency.
## Specifications

(Basic unit without extensions)

### Main supply (L1, L2, L3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>200 – 240 V ±10%</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>380 – 480 V ±10%</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>525 – 600 V ±10%</td>
</tr>
<tr>
<td>Supply frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Displacement power factor (cos Φ)</td>
<td>near unity &gt; 0.98</td>
</tr>
<tr>
<td>Switching on input supply L1, L2, L3</td>
<td>1–2 times/min.</td>
</tr>
<tr>
<td>Harmonic disturbance</td>
<td>Meets EN 61000-3-12</td>
</tr>
</tbody>
</table>

### Output data (U, V, W)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output voltage</td>
<td>0 – 100% of supply voltage</td>
</tr>
<tr>
<td>Output frequency</td>
<td>0–590 Hz</td>
</tr>
<tr>
<td>Switching on output</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Ramp times</td>
<td>1 – 3600 sec.</td>
</tr>
</tbody>
</table>

### Digital inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable digital inputs</td>
<td>6*</td>
</tr>
<tr>
<td>Changeable to digital output</td>
<td>2 (terminal 27, 29)</td>
</tr>
<tr>
<td>Logic</td>
<td>PNP or NPN</td>
</tr>
<tr>
<td>Voltage level</td>
<td>0 – 24 V DC</td>
</tr>
<tr>
<td>Maximum voltage on input</td>
<td>28 V DC</td>
</tr>
<tr>
<td>Input resistance, Ri</td>
<td>Approx. 4 kΩ</td>
</tr>
<tr>
<td>Scan interval</td>
<td>5 ms</td>
</tr>
</tbody>
</table>

* 2 can be used as digital outputs

### Analog inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog inputs</td>
<td>2</td>
</tr>
<tr>
<td>Modes</td>
<td>Voltage or current</td>
</tr>
<tr>
<td>Voltage level</td>
<td>0 to +10 V (scaleable)</td>
</tr>
<tr>
<td>Current level</td>
<td>0/4 to 20 mA (scaleable)</td>
</tr>
<tr>
<td>Accuracy of analog inputs</td>
<td>Max. error: 0.5% of full scale</td>
</tr>
</tbody>
</table>

### Pulse inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable pulse inputs</td>
<td>2*</td>
</tr>
<tr>
<td>Voltage level</td>
<td>0 – 24 V DC (PNP positive logic)</td>
</tr>
<tr>
<td>Pulse input accuracy</td>
<td>(0.1 – 1 kHz) Max. error: 0.1% of full scale</td>
</tr>
</tbody>
</table>

* Utilize some of the digital inputs

### Analog output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable analog outputs</td>
<td>1</td>
</tr>
<tr>
<td>Current range at analog output</td>
<td>0/4 – 20 mA</td>
</tr>
<tr>
<td>Max. load to common at analog output (clamp 30)</td>
<td>500 Ω</td>
</tr>
<tr>
<td>Accuracy on analog output</td>
<td>Max. error: 1% of full scale</td>
</tr>
</tbody>
</table>

### Control card

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB interface</td>
<td>1.1 (Full Speed)</td>
</tr>
<tr>
<td>USB plug</td>
<td>Type “B”</td>
</tr>
<tr>
<td>RS485 interface</td>
<td>Up to 115 kBaud</td>
</tr>
<tr>
<td>Max. load (10 V)</td>
<td>15 mA</td>
</tr>
<tr>
<td>Max. load (24 V)</td>
<td>200 mA</td>
</tr>
</tbody>
</table>

### Relay output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Programmable relay outputs</td>
<td>2</td>
</tr>
<tr>
<td>Max. terminal load (AC) on 1-3 (break), 1-2 (make), 4-6 (break) power card</td>
<td>240 V AC, 2 A</td>
</tr>
<tr>
<td>Max. terminal load (AC) on 4-5 (make) power card</td>
<td>400 V AC, 2 A</td>
</tr>
<tr>
<td>Min. terminal load on 1-3 (break), 1-2 (make), 4-6 (break), 4-5 (make) power card</td>
<td>24 V DC 10 mA, 24 V AC 20 mA</td>
</tr>
</tbody>
</table>

### Surroundings/external

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>IP: 20/21/54/55/66</td>
</tr>
<tr>
<td></td>
<td>UL Type: Chassis/1/12/</td>
</tr>
<tr>
<td></td>
<td>NEMA 4x Outdoor</td>
</tr>
<tr>
<td>Vibration test</td>
<td>1.0 g (D, E &amp; F-enclosures: 0.7 g)</td>
</tr>
<tr>
<td>Max. relative humidity</td>
<td>5% – 95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>Max. 50° C w/o derating</td>
</tr>
<tr>
<td>Galvanic isolation of all</td>
<td>I/O supplies according to PELV</td>
</tr>
<tr>
<td>Aggressive environment</td>
<td>Designed for coated/uncoated 3C3/3C2 (IEC 60721-3-3)</td>
</tr>
</tbody>
</table>

### Fieldbus communication

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard built-in</td>
<td>FC Protocol</td>
</tr>
<tr>
<td></td>
<td>N2 Metasys</td>
</tr>
<tr>
<td></td>
<td>Modbus RTU</td>
</tr>
<tr>
<td>Optional:</td>
<td>LonWorks for ADAP-KOOL® (MCA 107)</td>
</tr>
</tbody>
</table>

### Protection mode for longest possible up-time

- Electronic thermal motor protection against overload
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches 95° C ± 5° C.
- The frequency converter is protected against short-circuits on motor terminals U, V, W.
- The frequency converter is protected against earth faults on motor terminals U, V, W.
- Protection against mains phase loss
# Power, currents and enclosures

## Dimensions

<table>
<thead>
<tr>
<th>Inches</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C1h</th>
<th>C2h</th>
<th>D1h</th>
<th>D2h</th>
<th>D3h</th>
<th>D4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>10.6</td>
<td>15.4</td>
<td>16.5</td>
<td>18.9</td>
<td>25.6</td>
<td>15.7</td>
<td>20.5</td>
<td>26.8</td>
<td>30.3</td>
<td>21.7</td>
<td>26</td>
<td>35.5</td>
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<td>44.2</td>
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</tr>
<tr>
<td>W</td>
<td>3.5</td>
<td>5.1</td>
<td>7.9</td>
<td>9.5</td>
<td>6.5</td>
<td>9.1</td>
<td>12.1</td>
<td>14.6</td>
<td>12.1</td>
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<td>16.5</td>
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<td>13.8</td>
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<tr>
<td>D</td>
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<td>13.2</td>
<td>13.1</td>
<td>14.9</td>
<td>14.8</td>
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</tr>
<tr>
<td>H+</td>
<td>14.8</td>
<td>18.7</td>
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<td>37.4</td>
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</tr>
<tr>
<td>W+</td>
<td>3.5</td>
<td>5.1</td>
<td>6.5</td>
<td>10</td>
<td>13</td>
<td>15.4</td>
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<table>
<thead>
<tr>
<th>Millimeters</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C1h</th>
<th>C2h</th>
<th>D1h</th>
<th>D2h</th>
<th>D3h</th>
<th>D4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>268</td>
<td>390</td>
<td>420</td>
<td>480</td>
<td>650</td>
<td>399</td>
<td>520</td>
<td>680</td>
<td>770</td>
<td>550</td>
<td>660</td>
<td>901</td>
<td>1107</td>
<td>909</td>
<td>1122</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>90</td>
<td>130</td>
<td>200</td>
<td>242</td>
<td>165</td>
<td>231</td>
<td>308</td>
<td>370</td>
<td>308</td>
<td>370</td>
<td>325</td>
<td>420</td>
<td>250</td>
<td>350</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>D</td>
<td>205</td>
<td>175</td>
<td>200</td>
<td>260</td>
<td>248</td>
<td>242</td>
<td>310</td>
<td>335</td>
<td>333</td>
<td>333</td>
<td>738</td>
<td>375</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H+</td>
<td>375</td>
<td>475</td>
<td>670</td>
<td>755</td>
<td>950</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>W+</td>
<td>90</td>
<td>130</td>
<td>165</td>
<td>255</td>
<td>329</td>
<td>391</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Note:** H and W dimensions are with back-plate. H+ and W+ are with IP upgrade kit. D dimensions are without option. A or B for A2 and A3.
Based on your selection, Danfoss manufactures the desired VLT® Refrigeration Drive FC 103 to your specification. You will receive a fully assembled frequency converter, tested under full load conditions.
Connection examples
The numbers represent the terminals on the drive

This diagram shows a typical installation of the VLT® Refrigeration Drive FC 103. Power is connected to the terminals 91 (L1), 92 (L2) and 93 (L3) and the motor is connected to 96 (U), 97 (V) and 98 (W).

Terminals 88 and 89 are used for load sharing between drives.

Analog inputs can be connected to the 53 (V or mA), and for 54 (V or mA) terminals. These inputs can be set up as either reference, feedback or thermistor inputs. There are 6 digital inputs to be connected to terminals 18, 19, 27, 29, 32, and 33. Two digital input/output terminals (27 and 29) can be set up as digital outputs to show an actual status or warning. The terminal 42 analog output can show process values such as 0 - I\text{max}.

On the 68 (P+) and 69 (N-) terminals’ RS 485 interface, the drive can be controlled and monitored via serial communication.

* Safe Stop optional
### Enclosure

<table>
<thead>
<tr>
<th>Enclosure</th>
<th>IP 20 (IP 21*)/Chassis(NEMA 1)</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP 55/NEMA 12, IP 66/NEMA 4X</td>
<td>A4 + A5</td>
<td>A5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>P1K1</th>
<th>P1K5</th>
<th>P2K2</th>
<th>P3K0</th>
<th>P3K7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Shaft Output</td>
<td>[kW]</td>
<td>1.1</td>
<td>1.5</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>Typical Shaft Output at 208 V</td>
<td>[HP]</td>
<td>1.5</td>
<td>2.0</td>
<td>2.9</td>
<td>4.0</td>
</tr>
<tr>
<td>Output Current (3 x 200 – 240 V)</td>
<td>Continuous</td>
<td>[A]</td>
<td>6.6</td>
<td>7.5</td>
<td>10.6</td>
</tr>
<tr>
<td></td>
<td>Intermittent</td>
<td>[A]</td>
<td>7.3</td>
<td>8.3</td>
<td>11.7</td>
</tr>
<tr>
<td>Output Power (208 V AC)</td>
<td>Continuous</td>
<td>[kVA]</td>
<td>2.38</td>
<td>2.70</td>
<td>3.82</td>
</tr>
<tr>
<td>Max. cable size</td>
<td>(Mains, motor, brake)</td>
<td>[mm²] (AWG)</td>
<td>4 (12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Input Current (3 x 200 – 240 V)</td>
<td>Continuous</td>
<td>[A]</td>
<td>5.9</td>
<td>6.8</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>Intermittent</td>
<td>[A]</td>
<td>6.5</td>
<td>7.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Max. pre-fuses</td>
<td>[A]</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>32</td>
</tr>
</tbody>
</table>

### Environment

| | Estimated power loss at rated max. load | [W] | 63 | 82 | 116 | 155 | 185 |

### Weight

<table>
<thead>
<tr>
<th></th>
<th>IP 20</th>
<th>IP 21</th>
<th>IP 55, IP 66</th>
<th>[lbs (kg)]</th>
<th>10.8 (4.9)</th>
<th>12.1 (5.5)</th>
<th>29.7 (13.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP 20</td>
<td>[lbs (kg)]</td>
<td>10.8 (4.9)</td>
<td>12.1 (5.5)</td>
<td>29.7 (13.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP 21</td>
<td>[lbs (kg)]</td>
<td>10.8 (4.9)</td>
<td>12.1 (5.5)</td>
<td>29.7 (13.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP 55, IP 66</td>
<td>[lbs (kg)]</td>
<td>10.8 (4.9)</td>
<td>12.1 (5.5)</td>
<td>29.7 (13.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| | Efficiency | 0.96 | 0.96 | 0.96 | 0.96 |

---

* (A2, A3, B3, B4, C3 and C4 may be converted to IP21/NEMA 1 using a conversion kit.
(Please also see items Mechanical mounting in Operating Instructions and IP 21/ NEMA 1 Enclosure kit in the Design Guide.)
### Enclosure Specifications for 380 – 480 VAC

<table>
<thead>
<tr>
<th>Enclosure</th>
<th><em><em>IP 20 (IP 21</em>)/Chassis (NEMA 1)</em>*</th>
<th><strong>IP 55/NEMA 12, IP 66 NEMA 4X</strong></th>
<th><strong>A2</strong></th>
<th><strong>A3</strong></th>
<th><strong>A4 + A5</strong></th>
<th><strong>A5</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>P1K1</td>
<td>P1K5</td>
<td>P2K2</td>
<td>P3K0</td>
</tr>
<tr>
<td><strong>Typical Shaft Output</strong></td>
<td>[kW]</td>
<td>1.1</td>
<td>1.5</td>
<td>2.2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Typical Shaft Output at 460 V</strong></td>
<td>[HP]</td>
<td>1.5</td>
<td>2.0</td>
<td>2.9</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Output Current (3 x 380 – 440 V)</strong></td>
<td>[A]</td>
<td>Continuous</td>
<td>3</td>
<td>4.1</td>
<td>5.6</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermittent</td>
<td>3.3</td>
<td>4.5</td>
<td>6.2</td>
<td>7.9</td>
</tr>
<tr>
<td><strong>Output Current (3 x 441 – 480 V)</strong></td>
<td>[A]</td>
<td>Continuous</td>
<td>2.7</td>
<td>3.4</td>
<td>4.8</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermittent</td>
<td>3.0</td>
<td>3.7</td>
<td>5.3</td>
<td>6.9</td>
</tr>
<tr>
<td><strong>Output Power (400 V AC)</strong></td>
<td>[kVA]</td>
<td>Continuous</td>
<td>2.1</td>
<td>2.8</td>
<td>3.9</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Output Power (460 V AC)</strong></td>
<td>[kVA]</td>
<td>Continuous</td>
<td>2.4</td>
<td>2.7</td>
<td>3.8</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Max. cable size</strong></td>
<td>[mm²]</td>
<td>Continuous</td>
<td>2.7</td>
<td>3.7</td>
<td>5.0</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermittent</td>
<td>3.0</td>
<td>4.1</td>
<td>5.5</td>
<td>7.2</td>
</tr>
<tr>
<td><strong>Max. Input Current (3 x 380 – 440 V)</strong></td>
<td>[A]</td>
<td>Continuous</td>
<td>2.7</td>
<td>3.1</td>
<td>4.3</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermittent</td>
<td>3.0</td>
<td>3.4</td>
<td>4.7</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>Max. pre-fuses</strong></td>
<td>[A]</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

#### Environment

- **Estimated power loss at rated max. load**
- **Weight**
- **Efficiency**

- **(A2, A3, B3, B4, C3 and C4 may be converted to IP21 using a conversion kit. Please contact Danfoss. (Please see also items Mechanical mounting in Operating Instructions and IP 21/ NEMA 1 Enclosure kit in the Design Guide.))**

1) With brake and load sharing 95 (4/0)
## 525 – 600 VAC

### Enclosure

<table>
<thead>
<tr>
<th>Enclosure</th>
<th>IP 20 Chassis</th>
<th>IP 21/NEMA 1</th>
<th>IP 55/NEMA 12, IP 66/NEMA 4X</th>
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<tbody>
<tr>
<td></td>
<td>A3</td>
<td>A3</td>
<td>B3</td>
</tr>
<tr>
<td></td>
<td>P1K1</td>
<td>P1K5</td>
<td>P2K2</td>
</tr>
</tbody>
</table>

#### Typical Shaft Output

|         | kW  | 1.1 | 1.5 | 2.2 | 3   | 4   | 5.5 | 7.5 | 11  | 15  | 18.5 | 22  | 30  | 37  | 45  | 55  | 75  | 90  |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

#### Output Current

|         | A   | 2.6 | 2.9 | 4.1 | 5.2 | 6.4 | 9.5 | 11.5 | 19  | 23  | 28   | 36  | 43  | 54  | 65  | 87  | 105 | 137 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

|         | [A] | 2.9 | 3.2 | 4.5 | 5.7 | 7.0 | 10.5| 12.7 | 21  | 25  | 31   | 40  | 47  | 59  | 72  | 96  | 116 | 151 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

|         | [A] | 2.4 | 2.7 | 3.9 | 4.9 | 6.1 | 9.0 | 11.0 | 18  | 22  | 27   | 34  | 41  | 52  | 62  | 83  | 100 | 131 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

|         | [A] | 2.6 | 3.0 | 4.3 | 5.4 | 6.7 | 9.9 | 12.1 | 20  | 24  | 30   | 37  | 45  | 57  | 68  | 91  | 110 | 144 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

#### Output Power

|         | kW  | 2.5 | 2.8 | 3.9 | 5.0 | 6.1 | 9.0 | 11.0 | 18.1 | 21.9 | 26.7 | 34.3 | 41  | 51.4 | 61.9 | 82.9 | 100 | 130.5 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|-----|-----|------|------|-----|-----|------|

|         | [kVA]| 2.4 | 2.7 | 3.9 | 4.9 | 6.1 | 9.0 | 11.0 | 17.9 | 21.9 | 26.9 | 33.9 | 40.8 | 51.8 | 61.7 | 82.7 | 99.6 | 130.5 |
|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|-----|-----|------|------|-----|-----|------|

#### Max. cable size

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<tr>
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<th>[mm²]</th>
<th>(AWG)</th>
<th>4 (12)</th>
<th>10 (8)</th>
<th>35 (2)</th>
<th>50 (1)</th>
<th>150 (300 MCM)</th>
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</table>

<table>
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<tr>
<th></th>
<th>[mm²]</th>
<th>(AWG)</th>
<th>4 (12)</th>
<th>10 (8)</th>
<th>35, 25 (2, 4)</th>
<th>35 (2)</th>
<th>50 (1)</th>
<th>150 (300 MCM)</th>
<th>95 (4/0)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>[mm²]</th>
<th>(AWG)</th>
<th>4 (12)</th>
<th>16, 10 (6, 8)</th>
<th>50, 35 (1, 2)</th>
<th>95, 70 (3/0, 2/0)</th>
<th>185, 150, 120 (350 MCM, 300 MCM 4/0)</th>
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</thead>
</table>

#### Max. Input Current

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<thead>
<tr>
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<th>[A]</th>
<th>2.4</th>
<th>2.7</th>
<th>4.1</th>
<th>5.2</th>
<th>5.8</th>
<th>8.6</th>
<th>10.4</th>
<th>17.2</th>
<th>20.9</th>
<th>25.4</th>
<th>32.7</th>
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<th>49</th>
<th>59</th>
<th>78.9</th>
<th>95.3</th>
<th>124.3</th>
</tr>
</thead>
</table>

|         | [A]  | 2.7 | 3.0 | 4.5 | 5.7 | 6.4 | 9.5 | 11.5 | 19  | 23  | 28   | 36  | 43  | 54  | 65  | 87  | 105 | 137 |
|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|

|         | [A]  | 10  | 10  | 20  | 20  | 20  | 32 | 32  | 63  | 63  | 63   | 80  | 100 | 125 | 160 | 250 | 250 |
|---------|------|-----|-----|-----|-----|-----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

#### Max. pre-fuses

|         | [A]  | 10  | 10  | 20  | 20  | 20  | 32 | 32  | 63  | 63  | 63   | 80  | 100 | 125 | 160 | 250 | 250 |
|---------|------|-----|-----|-----|-----|-----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

#### Environment

|         | [W]  | 50  | 65  | 92  | 122 | 145 | 195 | 261 | 300 | 400 | 475 | 525 | 700 | 750 | 850 | 1100 | 1400 | 1500 |
|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

#### Estimated power loss at rated max. load

<table>
<thead>
<tr>
<th></th>
<th>[W]</th>
<th>14.3 (6.5)</th>
<th>14.5 (6.6)</th>
<th>26.4 (12)</th>
<th>51.8 (23.5)</th>
<th>77.1 (35)</th>
<th>110.2 (50)</th>
</tr>
</thead>
</table>

#### Weight

<table>
<thead>
<tr>
<th></th>
<th>[lbs (kg)]</th>
<th>29.7 (13.5)</th>
<th>31.3 (14.2)</th>
<th>50.7 (23)</th>
<th>59.5 (27)</th>
<th>99.2 (45)</th>
<th>143.3 (65)</th>
</tr>
</thead>
</table>

#### Efficiency

|         | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
|---------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|

---

1) With brake and load sharing 95 (4/0)
### Constant-torque applications

#### Low starting torque (110% overload)
- Scroll compressor: [0.6 to 0.9 nominal]
- Screw compressor: [0.4 to 0.7 nominal]
- Piston compressor: [0.6 to 0.9 nominal]

#### Normal starting torque [overtorque]
- Scroll compressor: [1.2 to 1.6 nominal]
- Screw compressor: [1.0 to 1.6 nominal]
- 2-cylinder compressor: [up to 1.6 nominal]
- 4-cylinder compressor: [up to 1.2 nominal]
- 6-cylinder compressor: [up to 1.2 nominal]

#### High starting torque [overtorque]
- 2-cylinder compressor: [up to 2.2 nominal]
- 4-cylinder compressor: [up to 1.8 nominal]
- 6-cylinder compressor: [up to 1.6 nominal]
Dimensions VLT® Refrigeration Drive

In inches (mm)

### A2 enclosures

**Rear View**
- Exhaust: Min. 3.9 (100) inches
- Inlet: 8.1, 8.7 (205, 220) inches
- Depth: 13.4 (341) inches

**Exhaust Inlet**
- Min. 3.9 (100) inches
- Depth: 8.1, 8.7 (205, 220) inches

### A3 enclosures

**Rear View**
- Exhaust: Min. 3.9 (100) inches
- Inlet: 8.1, 8.7 (205, 220) inches
- Depth: 13.4 (341) inches

**Exhaust Inlet**
- Min. 3.9 (100) inches
- Depth: 8.1, 8.7 (205, 220) inches

### A4 enclosures

**Rear View**
- Exhaust: Min. 3.9 (100) inches
- Inlet: 16.5 inches
- Depth: 6.9 (176) inches

**Exhaust Inlet**
- Min. 3.9 (100) inches
- Depth: 6.9 (176) inches
Dimensions VLT® Refrigeration Drive

In inches (mm)

**A5 enclosures**

<table>
<thead>
<tr>
<th>IP 55/NEMA 12</th>
<th>IP 66/NEMA 4X</th>
</tr>
</thead>
<tbody>
<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
</tr>
<tr>
<td>(525-600V)</td>
<td></td>
</tr>
<tr>
<td>110%</td>
<td>110%</td>
</tr>
<tr>
<td>IP 55/NEMA 12</td>
<td>IP 66/NEMA 4X</td>
</tr>
<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
</tr>
<tr>
<td>(525-600V)</td>
<td></td>
</tr>
<tr>
<td>110%</td>
<td>110%</td>
</tr>
<tr>
<td>IP 55/NEMA 12</td>
<td>IP 66/NEMA 4X</td>
</tr>
<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
</tr>
<tr>
<td>(525-600V)</td>
<td></td>
</tr>
<tr>
<td>110%</td>
<td>110%</td>
</tr>
</tbody>
</table>

**B1 enclosures**

<table>
<thead>
<tr>
<th>IP 55/NEMA 12</th>
<th>IP 66/NEMA 4X</th>
</tr>
</thead>
<tbody>
<tr>
<td>(200-240V)</td>
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<tr>
<td>(525-600V)</td>
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</tr>
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<td>110%</td>
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<tr>
<td>110%</td>
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<tr>
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<tr>
<td>(200-240V)</td>
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<td>(525-600V)</td>
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<tr>
<td>110%</td>
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</table>

**B2 enclosures**

<table>
<thead>
<tr>
<th>IP 55/NEMA 12</th>
<th>IP 66/NEMA 4X</th>
</tr>
</thead>
<tbody>
<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
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<tr>
<td>(525-600V)</td>
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<td>IP 55/NEMA 12</td>
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<td>IP 55/NEMA 12</td>
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<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
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<td>(525-600V)</td>
<td></td>
</tr>
<tr>
<td>110%</td>
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</tbody>
</table>

**Power Ratings**

- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
- IP 55/NEMA 12: 110% 1.1 – 7.5 kW 1.5 – 10 HP
## Dimensions VLT® Refrigeration Drive

**In inches (mm)**

### C2 enclosures

<table>
<thead>
<tr>
<th>IP/21/</th>
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<th>IP 66/NEMA 4X</th>
<th>IP 55/NEMA 12</th>
<th>IP 66/NEMA 4X</th>
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</thead>
<tbody>
<tr>
<td>(200-240V)</td>
<td>(380-480V)</td>
<td>(525-600V)</td>
<td>(380-480V)</td>
<td>(525-600V)</td>
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<tr>
<td>37 – 45 kW</td>
<td>37 – 45 kW</td>
<td>37 – 45 kW</td>
<td>37 – 45 kW</td>
<td>37 – 45 kW</td>
<td>37 – 45 kW</td>
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<tr>
<td>50 – 60 HP</td>
<td>50 – 60 HP</td>
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### C3 enclosures

<table>
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<th>(525-600V)</th>
<th>(200-240V)</th>
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<tr>
<td>50 – 60 HP</td>
<td>50 – 60 HP</td>
<td>50 – 60 HP</td>
<td>50 – 60 HP</td>
<td>50 – 60 HP</td>
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### C4 enclosures

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</tr>
</tbody>
</table>
**D1h enclosures (floor- or cabinet mount)**

**D2h enclosures (floor- or cabinet mount)**
Dimensions VLT® Refrigeration Drive

In inches (mm)

D3h enclosures (cabinet mount)

D4h enclosures (cabinet mount)
Installation of options is a simple matter of plug-and-play.

VLT® Refrigeration Drive
A & B Options

VLT® AK-LonWorks MCA 107
VLT® AK-LonWorks MCA 107 is a complete electronic refrigeration and control system for monitoring and controlling refrigeration plants. Connecting this drive to ADAP-KOOL® Lon network is really simple. After entering a network address, pressing a service pin starts the automatic configuration procedure.

Ordering number 130B1169 uncoated – 130B1269 coated (Class 3C3/IEC 60721-3-3)

VLT® General Purpose I/O MCB 101
The I/O option offers an extended number of control inputs and outputs.

- 3 digital inputs 0-24 V:
  - Logic ‘0’ < 5 V; Logic ‘1’ > 10 V
- 2 analog inputs 0-10 V:
  - Resolution 10 bit plus sign
- 2 digital outputs NPN/PNP push pull

1 analog output 0/4-20 mA
Spring loaded connection
Separate parameter settings

Ordering number 130B1125 uncoated – 130B1212 coated (Class 3C3/IEC 60721-3-3)

VLT® Relay Card MCB 105
Enables you extend relay functions with 3 additional relay outputs.

Max. terminal load:
AC-1 Resistive load ..................................................240 V AC 2 A
AC-15 Inductive load @cos φ 0.4 ..................................240 V AC 0.2 A
DC-1 Resistive load .....................................................24 V DC 1 A
DC-13 Inductive load @cos φ 0.4 .................................24 V DC 0.1 A

Min. terminal load:
DC 5 V ..............................................................................10 mA
Max switch rate at rated load/min. load ................................ 6 min⁻¹/20 sec⁻¹

Ordering number 130B1110 uncoated – 130B1210 coated (Class 3C3/IEC 60721-3-3)

VLT® Analog I/O Option MCB 109
This analog input/output option is easily fitted in the frequency converter for upgrading to advanced performance and control using the additional in/outputs. The option also upgrades the frequency converter with a battery back-up supply for the clock built into the frequency converter. This provides stable use of all frequency converter clock functions as timed actions etc.

- 3 analog inputs, each configurable as both voltage and temperature input
- Connection of 0-10 V analog signals as well as PT1000 and NI1000 temperature inputs
- 3 analog outputs each configurable as 0-10 V outputs
- Incl. back-up supply for the standard clock function in the frequency converter

The back-up battery typically lasts for 10 years, depending on environment.

Ordering number 130B1143 uncoated – 130B1243 coated (Class 3C3/IEC 60721-3-3)
Installation of options is a simple matter of plug-and-play

**VLT® 24 V Supply MCB 107**
The option is used to connect an external DC supply to keep the control section and any installed option active when mains power is down.
- **Input voltage**
  - Range: 24 V DC +/- 15% (max. 37 V in 10 sec.)
  - Max. input current: 2.2 A
  - Max. cable length: 75 m
  - Input capacitance load: < 10 μF
- **Power-up delay**: < 0.6 s
- **Easy to install in drives in existing machines**
- **Keeps the control board and options active during power cuts**
- **Keeps fieldbuses active during power cuts**

**Ordering number** 130B1108 uncoated – 130B1208 coated (Class 3C3/IEC 60721-3-3)

**VLT® Control Panel LCP 102**
- **Multi-language display**
- **Status messages**
- **Quick Menu for easy commissioning**
- **Parameter setting and explanation of parameter function**
- **Adjustment of parameters**
- **Full parameter backup and copy function**
- **Alarm logging**
- **Info button** – explains the function of the selected item on display
- **Hand-operated start/stop or automatic mode selection**
- **Reset function**
- **Trend graph**

**Ordering number** 130B1107

**LCP Panel Mounting Kit**
For easy installation of the LCP 101 and LCP 102 in e.g. a cabinet:
- **IP 65/NEMA 12 (front)**
- **Thumb screws for tool-free installation**
- **Incl. 3 meters of cables of industrial quality (also available separately)**
- **With or without LCP operating unit**
- **Each time easy to install**

**Ordering number** 130B1117 (Mounting kit for all LCP’s including fasteners, 3 m cable and gasket).

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*Installation of options is a simple matter of plug-and-play*
**VLT® Refrigeration Drive Accessories**

**IP 21/NEMA 1 Kit**
The NEMA 1 kit is used for installation of VLT® drives in dry environments. The enclosure kits are available for frame sizes A1, A2, A3, B3, B4, C3 and C4.
- Supports VLT® drives from 1.5 HP to 125 HP
- Used on standard VLT® drives with or without mounted option modules
- IP 41 on top side
- PG 16 and PG 21 holes for glands
- 130B1122 for frame size A2, 130B1123 for frame size A3, 130B1187 for frame size B3, 130B1189 for frame size B4, 130B1191 for frame size C3, 130B1193 for frame size C4

**VLT® Brake Resistors**
Energy generated during braking is absorbed by the resistors, protecting electrical components from heating up.
- Quick braking of heavy loads
- Braking energy is only absorbed into the brake resistor
- External mounting makes it possible to use the generated heat
- All necessary approvals are available

**USB Extension**
USB extension for IP 55/NEMA 12 and IP 66/NEMA 4X enclosures. Makes the USB connector available outside the drive. The USB extension is designed for mounting in a cable gland in the bottom of the drive, which makes PC communication very easy, even in drives with high IP ratings.
- USB extension for A5-B1 enclosures, 13.78” cable, ordering number 130B1155
- USB extension for B2-C enclosures, 25.59” cable, ordering number 130B1156

**VLT® Advanced Harmonic Filter AHF 005/010**
Easy, effective harmonic distortion reduction by connecting the VLT® Advanced Harmonic Filter AHF 005/010 harmonic filter in front of a Danfoss drive.
- AHF 005 reduces total harmonic current distortion to 5%
- AHF 010 reduces total harmonic current distortion to 10%
- Small compact housing that can be fitted into a panel
- Easy to use in retrofit applications
- User-friendly start-up – no adjustment necessary
- No routine maintenance required

**VLT® Sine-Wave Filters**
VLT® sine-wave filters are placed between the drive and the motor to optimize the motor power current.
- Reduces motor insulation stress
- Reduces acoustic noise from the motor
- Reduces bearing currents (especially in large motors)
- Enables use of longer motor cables
- Reduces losses in the motor
- Prolongs service lifetime
- IP 20/Chassis; IP 21/NEMA 1

**VLT® dV/dt Filters**
VLT® dV/dt Filters are placed between the drive and the motor to eliminate very fast voltage changes.
- These filters reduce stress on the motor’s insulation and are recommended in applications with older motors, aggressive environments or frequent braking which cause increased DC link voltage.
- IP 20/Chassis; IP21/NEMA 1

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Please refer to the product and design manuals for selection and dimensioning

**Note:** Missing numbers can be found in the design manual or can be delivered on request
What VLT® is all about

Danfoss VLT 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®.

Twenty five hundred employees develop, manufacture, sell and service drives and soft starters in more than one hundred countries, focused only on drives and soft starters.

Environmentally responsible
VLT® products are manufactured with respect for the safety and well-being of people and the environment.

All frequency converter factories are certified according to ISO 14001 and ISO 9001 standards.

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 pre-prepared.

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

Impact on energy savings
One year’s energy savings from our annual production of VLT® drives will save the energy equivalent to the energy production from a major power plant. Better process control at the same time improves product quality and reduces waste and wear on equipment.

Intelligent and innovative
Developers at Danfoss VLT 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 of our products. The fact that we develop and produce our own features, hardware, software, power modules, printed circuit boards, and accessories is your guarantee of reliable products.

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

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

Danfoss VLT Drives, 4401 N. Bell School Rd., Loves Park, IL 61111, Tel. +1 (815) 639-8600 (main), Tel. +1 (800) 432-6367 (24 Hour Service for Drives), Fax +1 (815) 639-8000, www.danfossdrives.com, Email: salesinformation@danfoss.com

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