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- Welcome to Danfoss Drives
- Crane types and applications
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- Applications: Control Performance Software Tools
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- Crane Products: Feature trend Hybridization
- Cranes: Alternative Products
- Crane features offering
- Danfoss Value proposition
Welcome to
Danfoss Drives
Danfoss Drives (DDS) **Product Portfolio**

**Frequency Converters**
- **IP20/21/54/55/66, NEMA1/12/3R/4X**
- **0.18 – 710 kW**
- **200 – 690 V**
- Central & De-central drives

**Enclosed Drives**
- **IP21, IP54**
- **11kW – 6 MW**
- **380 – 690V**
- Power Regeneration
- Low Harmonic Drive
- Multi Pulse 12, 18, 24

**System Modules**
- **IP00 / IP20**
- **4kW – 6 MW**
- **INU**
- Supply Unit
- Grid Converter
- BCU
- Active Filter Module

Stand alone Drives, central or decentral installed in applications
**Segments**: AQUA, HVAC/R, General Purpose
**Focus Customers**: OEMs, Project Sales, Integrators, Distributors

Singe Enclosed Drives and System Drives, utilizing modules and optional HW power options.
**Segments**: AQUA, HVAC/R, General Purpose
**Focus Customers**: Project Sales, OEMs

System modules (components) that Integrators build into cabinets and into systems.
**Segments**: General Purpose
**Focus Customers**: Integrators, OEMs
Danfoss Drives (DDS) **Product Portfolio**

**Medium Voltage Drives**
- Power sizes: 1-11MW (2 & 3MW inverters)
- Liquid cooled
- Voltage: 3.3kV & 4.16kV
- Modules & kits

Modular MV AC drive solutions
**Segments:** Marine & Offshore, Oil & Gas, Mining, Metals, others
**Focus Customers:** System Integrators and OEMs

**Motion Drives**
- IP20
- Integrated Servo Drives
- Multi-Axis Central Unit
- Motor Near-by

Easy Motion Portfolio
**Segments:** F&B, Material Handling, Packaging, Pharma
**Focus Customers:** OEM, Machine Builders
DrivePro® Services and IoT Portfolio

Stay calm. You’re covered

Installation/Start-up

Use/Maintain

Retrofit/Disposal

DrivePro® Retrofit

DrivePro® Spare Parts

DrivePro® Exchange

DrivePro® Upgrade

DrivePro® Start-up

DrivePro® Extended Warranty

DrivePro® Remote Expert Support

DrivePro® Preventive Maintenance

DrivePro® Life Cycle

Pre-sales support

Training

DrivePro® Services

Higher performance

More uptime

Healthier budget

Stay calm. You’re covered.
## Ready proven applications

<table>
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<tr>
<th>INDUSTRIES</th>
<th>HVAC</th>
<th>Food &amp; Beverage, Packaging</th>
<th>Water &amp; Wastewater</th>
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<th>Cranes &amp; Hoists</th>
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<td>APPLICATIONS</td>
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<td>Propulsion, thrusters</td>
<td>Winches</td>
<td>Vertical &amp; horizontal movement</td>
<td>Power conversion, smart grids</td>
<td>Positioning, Synchronization</td>
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Danfoss Drives business

AC DRIVES
1.2 BN EUR NET SALES
89% SHARE OF DANFOSS DRIVES BUSINESS

SILICON POWER
0.1 BN EUR NET SALES
8% SHARE OF DANFOSS DRIVES BUSINESS

SOLAR INVERTERS (SMA)
38.8 M EUR NET SALES
3% SHARE OF DANFOSS DRIVES BUSINESS

2016 figures
Crane types and applications
Crane Types

The cranes industry is covering all applications related to hoisting, lowering and horizontal movement of material, equipment and parts. Cranes are used in all industries offering the speed and reach for moving the items.
Cranes Applications

Main applications:

- **Hoist**
  - Lifting and lowering of the load.

- **Bridge/Gantry/long travel**
  - That part of an overhead crane consisting of girders, trucks, end ties, walkway and drive mechanism which carries the trolley and travels in a direction parallel to the runway.

- **Trolley/Cross travel**
  - The unit carrying the hoisting mechanism which travels on the bridge rails. Trolley will have either single motor or two motor coupled with common shaft.

- **Jib/Boom**
  - A type of crane, which has a horizontal member (known as jib or boom) that supports a moveable hoist fixed to a wall or to a floor-mounted pillar is known as jib crane. Used mostly in industrial premises.

- **Slewing**
  - In crane terminology, slewing is the angular movement of a crane boom or crane jib in horizontal plane. e.g. tower cranes.
Crane Types: **Tower Cranes**

**Trolley:**
- Closed loop OR sensorless Vector control
- Master/follower – torque sharing operation.

**Hoist:**
- Closed loop OR sensorless Vector control
- Mechanical brake control & Monitoring
- Single/Tandem Hoist operation
- Dynamic field weakening
- Catch dropping load

**Slew/Boom/Jig:**
- Closed loop control
- Torque limit control for slew motion

**Electrical Motors**

**Counter Weights**

**Moving parts**

**Electrical Panels**
Crane Types: **Tower Cranes**

There are two types of Tower Cranes:

1. **Top Slewer tower crane**
   - Power range of Hoist: 5.5-200kw
   - Load: 8 – 100t
   - Vertical (Hoist)
   - Horizontal (Trolley)
   - Rotation (Slewing)
   **Typical drive setup:**
   - Single drives with brake resistors
   - Common DC Bus system with NFE, INU and BCU
   - Common DC Bus system with AFE, INU (and BCU for emergency case).
   - **Future potential for energy storage systems**

2. **Bottom Slewer tower crane**
   - Power range of Hoist: 5.5-30kw
   - Load: 1.5 – 10t
   - Vertical (Hoist)
   - Horizontal (Trolley)
   - Rotation (Slewing)
   **Typical drive setup:**
   - Single drives with brake resistors
   - Common DC Bus system with NFE, INU and BCU
Crane Types: **Overhead (EOT) cranes**

**Travel /Bridge:**
- Closed loop or sensorless vector control
- Antisway
- Programmable limit switch
- Master/follower – torque sharing operation

**Hoist:**
- Closed loop OR sensorless Vector control
- Mechanical brake control and monitoring
- Single /Tandem Hoist operation
- Dynamic field weakening
- Catch dropping load

**Trolley:**
- Closed loop OR sensorless Vector control
- Master/follower – torque sharing operation.
- Anti-sway
- Safe speed limit switch
Crane Types: EOT/Gantry Cranes

EOT/Gantry cranes are integral parts of the construction and manufacturing process. They are most common and useful types of material handling equipments, coming in a wide range of loads, from 4 to 400 tons (sometimes higher).

- Power range of hoist: 5.5 – 400KW (sometimes higher)
- Load: 4-400t
- Main Hoist
- Auxiliary hoist
- Trolley
- Travel

**Typical drive setup:**

- Single drives with brake resistors.
- Common DC Bus system with NFE, INU and BCU.
- Common DC Bus system with AFE, INU (and BCU for emergency case)
- Future Potential for energy storage systems.
In each harbour, a high number of cranes are employed to deliver the job of loading/unloading and transporting various goods. STS/Harbour crane required high power ratings and regenerative system like AFE.

There are two important “working areas” for the cranes:

1. Loading/unloading from the ship to the shore
2. Transportation from the shore to the container terminals.

- Power range of hoist: 250 – 800KW
- Load: 40-100t
- AFE: 0.8 - 1.6MW
- Hoist
- Trolley
- Travel
- Boom

**Typical drive setup:**
Common DC Bus system with AFE, INU (and BCU for emergency case).
Crane: Product Portfolio
Danfoss Drives products – **VACON®**

### Low-voltage drives up to 6.0 MW

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tr>
<td>VACON® 20</td>
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<td>VACON® 20 Cold Plate</td>
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<td>VACON® 100 INDUSTRIAL</td>
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<td>VACON® 100 FLOW</td>
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<tr>
<td>VACON® NXP Air Cooled</td>
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<tr>
<td>VACON® NXC Air Cooled Enclosed Drives</td>
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<td>VACON® NXP Common DC Bus</td>
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<td>VACON® NXP System Drive</td>
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<td>VACON® NXP Liquid Cooled Drive</td>
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<tr>
<td>VACON® NXP Liquid Cooled Enclosed Drive</td>
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</tbody>
</table>

### Decentral drives up to 37 kW

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>VACON® NXP Liquid Cooled Common DC Bus</td>
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<tr>
<td>VACON® NXP Grid Converter</td>
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<tr>
<td>VACON® 20 X</td>
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<td>VACON® 100 X</td>
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<tr>
<td>VACON® 3000</td>
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</table>

### Medium-voltage drives

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tr>
<td>VACON® Software</td>
<td></td>
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<tr>
<td>DrivePro® Services and Support</td>
<td></td>
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</tbody>
</table>

**Software**

**Services**
VACON® NXP Air Cooled
Wide power range of air-cooled drives for industrial drive applications.

**Power range**

- 3 x 208-240 V ................. 0.55-90 kW
- 3 x 380-500 V ................. 1.5-1200 kW
- 3 x 525-690 V ................. 2.0-2000 kW

*with DriveSynch 1.5-4000 kW
*with DriveSynch 2.0-4500 kW

**Protection ratings**

- IP00
- IP21/Type 1*
- IP54/Type 12*

*dependent upon enclosure size

0.55 to 4500 kW

Full power and voltage range for both IM and PM motors
## VACON® NXP Air Cooled

Wide power range of air-cooled drives for industrial drive applications.

### Feature | Benefit
--- | ---
Reliable | Maximum uptime
Available in IP00, IP21, IP54 enclosures | Enclosures for all environments both as wall mounted and cabinets
Built in AC-chokes | Reduced harmonics and increased disturbance immunity
All metal power structures (wall-mounted and standalone drives) | Maximum mechanical robustness
Drive protection and monitoring | Early warning alarms ensures maximum uptime
Segregated cooling air flow | Increased reliability in demanding conditions

### Easy and Safe | Saves installation cost
--- | ---
Space saving design | Minimized space need
Same size of IP21 and IP54 drives | System planning easy
Through panel / Flange mounting | Effective cooling of enclosure
EMC filters for C1/C2 class built-in (wall mounted sizes) | No extra components need for connection to public networks
Marine Type Approvals available | Perfect choice for marine applications

### High Power Modules | Easy to integrate
--- | ---
IP00 modules for mounting in customers enclosure | Ideal for system integrators and panel builders
Full power LV range covered | Complete offering enable full scope supply of drives products
AC Chokes external | Reduces weight of power unit
12-pulse solutions available | The complete high power range is available also in 12-pulse version for reduced harmonics
Separate mounting possibility for control unit | Control unit can be mounted in a different cabinet section for maximum safety
Cabinet assembly kits available | Easy and tested cabinet solutions

### Feature | Benefit
--- | ---
VACON® NXP control flexibility | Best control solutions
High performance control and flexibility in one control unit | Same interfaces and functionality in all VACON® NXP based products
Removable keypad with parameter backup and copy function | Latest parameters always in keypad, copy for fast cloning of drives
All I/O modular – 5 interface card slots | I/O and fieldbus interface can be configured for any need
Built-in PLC functionality | Enables custom made software functionality
Open and Closed Loop motor control | Maximum motor control performance
Fast drive-to-drive communication and Drive-synch functionality | For load sharing and paralleling of power units
Separate automation control bus and separate monitor bus for PC tool | Using of PC software for drive configuration and monitoring
Safe Torque Off (STO), Safe Stop 1 (SS1) Advanced safety option | Safe and compliant machine operation
ATEX certified thermistor input | No need for external ATEX approved thermistor relay
VACON® NXP Common DC Bus
Efficient and flexible solutions for demanding industrial drive systems

**Power range**
- 3 x 380-500 V .................. 1.5-1850 kW
- 3 x 525-690 V .................. 3-2000 kW

**Protection ratings**
- IP00

380 to 690 V
Full voltage range of common DC bus products for IM and PM motors
VACON® NXP Common DC Bus

Efficient and flexible solutions for demanding industrial drive systems

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
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<tbody>
<tr>
<td><strong>Complete portfolio</strong></td>
<td>Efficient System Design</td>
</tr>
<tr>
<td>Complete package of INU, BCU, AFE and NFEs</td>
<td>Complete product portfolio for Common DC systems</td>
</tr>
<tr>
<td>Common HW platform for INU, BCU and AFE</td>
<td>Minimized amount of spare part needed</td>
</tr>
<tr>
<td>Full power LV range covered</td>
<td>Complete offering enable full scope supply of drives products</td>
</tr>
<tr>
<td><strong>Reliable</strong></td>
<td><strong>Maximum uptime</strong></td>
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<tr>
<td>Common DC package designed for demanding use</td>
<td>Ensures maximum availability of the system</td>
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<tr>
<td>Easy to service and maintain</td>
<td>Easy fan replacement and easy servicing for maximum availability</td>
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<tr>
<td>Segregated cooling air flow</td>
<td>Increased reliability in demanding conditions</td>
</tr>
<tr>
<td>Drive protection and monitoring</td>
<td>Early warning alarms ensures maximum uptime</td>
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<tr>
<td><strong>Easy and Safe</strong></td>
<td><strong>Saves installation cost</strong></td>
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<tr>
<td>Width optimized large inverter units</td>
<td>Minimized cabinet space need</td>
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<tr>
<td>Through panel / Flange mouting of sizes FR4-FR8</td>
<td>Effective cooling of enclosure</td>
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<tr>
<td>Separate mounting possibility for control unit (high power drivers)</td>
<td>Control unit can be mounted in a different cabinet section for maximum safety</td>
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<tr>
<td>Paralelling of AFE and NFE possible</td>
<td>Cover wide power range with DC supply redundancy</td>
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<td>High performance control and flexibility in one control unit</td>
<td>Same interfaces and functionality in all VACON® NXP based products</td>
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<td>Removable keypad with parameter backup and copy function</td>
<td>Latest parameters always in keypad, copy for fast cloning of drives</td>
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<td>All I/O modular – 5 interface card slots</td>
<td>I/O and fieldbus interface can be configured for any need</td>
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<td>Built-in PLC functionality</td>
<td>Enables custom made software functionality</td>
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<td>Open and Closed Loop motor control</td>
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<td>Separate automation control bus and separate monitor bus for PC tool</td>
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Applications:
Control Performance
Software Tools
Application focus to **boost your business**

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Vacon® NXP High Performance Control Platform

- One control for whole liquid and air cooled drive range
- Induction, permanent magnet, motors
- Accurate speed & torque control both in open & closed loop
- Fast drive to drive communication for load or speed sharing shaft synchronization with master follower configuration.
- Wide range of extended I/O & speed feedback options.
- Wide range of fieldbus options (RS485, Ethernet based)
  - Profibus DP, Profinet IO
  - DeviceNet,
  - Modbus RTU, Modbus/TCP
  - CANopen, Ethernet I/P, EtherCAT
- STO and SS1: SIL 2 approved according to IEC 61800-5-2
- Advanced Safety Functions: SLS, SSM, SMS, SDI, SAR & SBC with Profisafe over profibus and profinet.
- Easy configuration of safety functions with VACON® Safe tool.
- Fast data loggers for debugging

Improved Redundancy with Drive Synch

Extend I/O with CanOpen IO

Wide range of I/O expansion, fieldbus & Encoder Options
Applications Programming Environment

- Programming is a IEC61131-3 standard based.
- Programming languages supported:
  - FBD (Function Block Diagram)
  - ST (Structured Text)
  - SFC (Sequential Function Chart)
  - LD (Ladder)
- Customers can build own applications & protect own IPR. Licensing for the IPR based features, handles “read & write” access through own access codes.
- Capability from Simulation models to IEC61131-3 code generation.
- Customise UI to the application.
- On-Line debugging.
VACON® Software
**Configure and monitor drives**

Set up drives to function according to your requirements, and monitor drive performance throughout the entire lifecycle.

<table>
<thead>
<tr>
<th>VACON® Software</th>
<th>Supported drives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VACON® Live</strong></td>
<td>VACON® 10</td>
</tr>
<tr>
<td>Commissioning,</td>
<td>VACON® 20</td>
</tr>
<tr>
<td>maintenance,</td>
<td>VACON® 20 X</td>
</tr>
<tr>
<td>parameterization and</td>
<td>VACON® 100 X</td>
</tr>
<tr>
<td>monitoring of multiple</td>
<td>VACON® 100 family</td>
</tr>
<tr>
<td>drives.</td>
<td></td>
</tr>
<tr>
<td><strong>VACON® Loader</strong></td>
<td>VACON® 10</td>
</tr>
<tr>
<td>Updating AC drive</td>
<td>VACON® 20</td>
</tr>
<tr>
<td>firmware and installing</td>
<td>VACON® 20 X</td>
</tr>
<tr>
<td>application software.</td>
<td>VACON® 100 X</td>
</tr>
<tr>
<td></td>
<td>VACON® 100 family</td>
</tr>
<tr>
<td><strong>VACON® NDrive</strong></td>
<td>VACON® NXP</td>
</tr>
<tr>
<td>Commissioning,</td>
<td>VACON® NXS</td>
</tr>
<tr>
<td>maintenance,</td>
<td>VACON® NXL</td>
</tr>
<tr>
<td>parameterization and</td>
<td></td>
</tr>
<tr>
<td>monitoring of drives.</td>
<td></td>
</tr>
<tr>
<td><strong>VACON® NLoad</strong></td>
<td>VACON® NXL</td>
</tr>
<tr>
<td>Updating AC drive</td>
<td>VACON® NXS</td>
</tr>
<tr>
<td>firmware and installing</td>
<td>VACON® NXP</td>
</tr>
<tr>
<td>application software.</td>
<td></td>
</tr>
</tbody>
</table>
# Customize behavior of drives
A range of tools that allows you to optimize drive performance.

<table>
<thead>
<tr>
<th>VACON® Software</th>
<th>Supported drives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VACON® Customizer</strong></td>
<td>VACON® INDUSTRIAL&lt;br&gt;VACON® 100 FLOW&lt;br&gt;VACON® 100 X</td>
</tr>
<tr>
<td><strong>VACON® Programming</strong></td>
<td>VACON® 20&lt;br&gt;VACON® 20 X&lt;br&gt;VACON® 100 family&lt;br&gt;VACON® 100 X&lt;br&gt;VACON® NXS&lt;br&gt;VACON® NXP</td>
</tr>
<tr>
<td><strong>VACON® Key</strong></td>
<td>VACON® NXP Grid Converter&lt;br&gt;VACON® NXP Anti-Sway</td>
</tr>
</tbody>
</table>
# Dimension and document drives

A set of tools that provides you with dimensioning and documentation information.

<table>
<thead>
<tr>
<th>VACON® Software</th>
<th>Supported drives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VACON® Layout</strong></td>
<td>VACON® NXP System Drive</td>
</tr>
<tr>
<td>Configure and obtain documentation.</td>
<td></td>
</tr>
<tr>
<td><strong>VACON® Documentation Wizard</strong></td>
<td>VACON® NXC</td>
</tr>
<tr>
<td>Diagrams and drawings.</td>
<td></td>
</tr>
</tbody>
</table>
**Analyze performance of drives**

These tools allow you to analyze the performance of drives in relation to harmonics, and to calculate the energy savings that can be achieved when using drives with various applications.

<table>
<thead>
<tr>
<th>VACON® Software</th>
<th>Supported drives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VACON® Harmonics</strong></td>
<td>VACON® NXS</td>
</tr>
<tr>
<td></td>
<td>VACON® NXP</td>
</tr>
<tr>
<td></td>
<td>VACON® 10</td>
</tr>
<tr>
<td></td>
<td>VACON® 20</td>
</tr>
<tr>
<td></td>
<td>VACON® 20 X</td>
</tr>
<tr>
<td></td>
<td>VACON® 100 family</td>
</tr>
<tr>
<td><strong>Danfoss HCS</strong></td>
<td>VACON® NXS</td>
</tr>
<tr>
<td></td>
<td>VACON® NXP</td>
</tr>
<tr>
<td></td>
<td>VACON® 10</td>
</tr>
<tr>
<td></td>
<td>VACON® 20</td>
</tr>
<tr>
<td></td>
<td>VACON® 20 X</td>
</tr>
<tr>
<td></td>
<td>VACON® 100 family</td>
</tr>
<tr>
<td><strong>VACON® Save</strong></td>
<td>VACON® NXS</td>
</tr>
<tr>
<td></td>
<td>VACON® NXP</td>
</tr>
<tr>
<td></td>
<td>VACON® 10</td>
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<tr>
<td></td>
<td>VACON® 20</td>
</tr>
<tr>
<td></td>
<td>VACON® 20 X</td>
</tr>
<tr>
<td></td>
<td>VACON® 100 family</td>
</tr>
</tbody>
</table>
Crane Products
Feature trend Hybridization
Why is **Hybridization** in focus today

- The world is steadily, and quite quickly, **diversifying its primary sources of energy**.

- A simple and broad **definition of hybridization** is any system with **two or more sources** of energy acting together to accomplish a task.

- In the world according to **Danfoss Drives**, the definition of hybridization can be summed up by **introducing a means of energy storage** into a system.
World of **Hybridization** opportunities

- **Energy production**
  - Commercial buildings
  - Transportation
  - Land construction & mining
  - Harbors
- **Solar**
  - Windmill
  - Marine & offshore
- **Process ind., OEM**
  - Grid & substation
- **Transportation**
  - Propulsion
  - Thrusters
  - Winches
  - Power conversion
  - Power generation
  - Smart Grid
Applications for System **Hybridization**

Typical applications are:

- **Time shift of production**
- **Peak load shaving for incoming power**
- **Back-up power or black-out start**
Energy Storage: Topologies

1. DC/DC solution, DC/DC-chopper, filter and battery / Capacitor
2. AC/DC solution, Transformer, LC-filter, AFE and battery / Capacitor
3. Direct DC solution, LCL-filter, AFE, INU and battery / Capacitor connected to DC-link

Market development still in progress
VLT® AutomationDrive FC 301 and FC 302
Control of all motor-driven applications

**Power range**
- 3 x 200-240 V....................0.25-37 kW
- 3 x 380-500 V....................0.37-1100 kW
- 3 x 525-600 V....................0.75-75 kW
- 3 x 525-690 V....................1.1–1400 kW

**Protection ratings**
- IP00
- IP20
- IP21/Type 1
- IP54/Type 12
- IP55/Type 12
- IP66/Type 4X

**Power range – Low harmonic drive**
- 3 x 380-480 V....................132-710 kW

**Power range – 12-pulse drive**
- 3 x 380-500 V....................250-1000 kW
- 3 x 525-690 V....................250-1400 kW

85% average lower switchroom heat load resulting from high efficiency and innovative back-channel cooling.

40% Integrated DC chokes reduce mains interference to a THDi of
## VLT® AutomationDrive FC 301 and FC 302
Control of all motor-driven applications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable</td>
<td>Maximum uptime</td>
</tr>
<tr>
<td>Ambient temperature 50° C without derating</td>
<td>Reduced need for cooling or over-dimensioning</td>
</tr>
<tr>
<td>Available in IP00, IP20, IP21, IP54, IP55 and IP66 enclosures</td>
<td>Enclosures for all environments</td>
</tr>
<tr>
<td>Resistant to wear and tear</td>
<td>Low lifetime cost</td>
</tr>
<tr>
<td>Back-channel cooling for D, E and F enclosure sizes</td>
<td>Prolonged lifetime of electronics</td>
</tr>
<tr>
<td>Mains disconnect switch</td>
<td>85-90% of heat losses are exhausted directly outside of the enclosure</td>
</tr>
<tr>
<td>User-friendly</td>
<td>Saves commissioning and operating cost</td>
</tr>
<tr>
<td>Plug-and-play technology</td>
<td>Easy upgrade and changeover</td>
</tr>
<tr>
<td>Award-winning control panel</td>
<td>User-friendly</td>
</tr>
<tr>
<td>Intuitive VLT® interface</td>
<td>Saves time</td>
</tr>
<tr>
<td>Pluggable cage clamp connectors</td>
<td>Easy connection</td>
</tr>
<tr>
<td>Exchangeable languages</td>
<td>User-friendly</td>
</tr>
<tr>
<td>VLT® drive software customizer</td>
<td>Adapt parameter names and splash screen</td>
</tr>
<tr>
<td>Operates in range -25°C to +50°C with no extra enclosure</td>
<td>Lower installation cost</td>
</tr>
<tr>
<td>Remote LCP mounting kit</td>
<td>Save time in installation &amp; startup</td>
</tr>
<tr>
<td>Wireless LCP for remote access from any device</td>
<td>Faster, easier startup and operation</td>
</tr>
<tr>
<td>Web server - customizable</td>
<td>Remote monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General features</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive maintenance scheduling</td>
<td>Optimizes planned system maintenance</td>
</tr>
<tr>
<td>Data logging extension</td>
<td>Ensures logging and readout of the drive running history, which are vital data in the event of a trip</td>
</tr>
</tbody>
</table>

### Intelligent
- Intelligent warning systems
- Warning before controlled stop
- Smart Logic Control
- Reduces need for PLC capacity
- Advanced plug-in features
- Easy commissioning
- Extended safety functions which deliver full safety monitoring whilst enabling the machine to remain active
- STO: Safe Torque Off (IEC 61800-5-2)
- SIL 2 (IEC 61508)
- SIL CL 2 (IEC 62061)
- PL d (ISO 13849-1)
- Intelligent heat management
- Reduced heat load saves on cooling costs and switchroom size

### Energy saving
- Automatic Energy Optimization (AEO)
- Saves 5-10% energy
- VLT® drive 98% efficiency
- Saves energy
- PM, IPM and PMaSynRM support
- High efficiency due to motor adaptability

VLT® 3000 converter
VLT® 5000 converter
VLT® Midi Drive FC 280
Flexible. Communicative. Easy to use.

**Power range**
1 x 200-240 V ..................... 0.37-2.2 kW
3 x 200-240 V ..................... 0.37-3.7 kW
3 x 380-480 V ..................... 0.37-22 kW

**Protection ratings**
IP20
IP21/NEMA Type 1

---

**Easy retrofit**
VLT® Midi Drive is compatible with the VLT® 2800, for a fast, streamlined retrofit.

---

**The right mix**
of features gives you freedom to achieve your system goals.
### Feature | Benefit
--- | ---
**Integrated harmonics and EMC design** |  
Integrated DC choke | Saves installation time and cabinet space requirements  
Improve power supply quality and helps extend DC capacitor lifetime  
**Integrated EMC filter** | Avoids malfunction and improves reliability of surrounding components  
**RFI switch** | Operates safely on IT mains  
Trouble-free operation of insulation monitoring relay  
**Easy to install and set up** |  
Pluggable terminals | Fast installation and unit exchange  
**USB port** | Easy PC connection for troubleshooting or commissioning  
**Application set-up wizards** | No need for adapter or PC-USB driver  
**Memory module (option)** | Convenient transfer of parameter set-up  
**Easy firmware updates** | Easy and fast commissioning  
**Memory module programmer (option)** | Convenient transfer of files to and from the VLT® Memory Module MCM 102 via PC  
**Enhanced numerical LCP (option)** | Cost effective user interface  
**Adapter for graphical LCP supporting many languages (option)** | Easy set-up in one of seven main languages  
Fast troubleshooting  
**Strategic design for applications, safety, and motor control** |  
Integrated Safe Torque Off (STO), dual channel | Eliminates external components  
Control algorithm runs both induction and PM motors | Enables reliable functional safety  
**Integrated brake chopper for 3-phase drives in power sizes up to 22 kW** | Freedom to choose the best high-efficiency motor for the task  
Side-by-side or horizontal mounting, without derating | No cost for external braking chopper  
**Operates at up to 45 °C without derating** | Saves panel space and cost  
**Fits your application.** | Saves cost for external cooling and reduces downtime for overtemperature failures
VACON® 20
Possibilities and performance in a low power drive.

**Power range**
- 1 x 115 V .......................... 0.25-1.1 kW
- 1 x 208-240 V ...................... 0.25-2.2 kW
- 3 x 208-240 V ...................... 0.25-11 kW
- 3 x 380-480 V ..................... 0.37-18.5 kW

**Protection ratings**
- IP20
- IP21/Type 1

**Fast**
Installation and set-up
**VACON® 20**
Possibilities and performance in a low power drive.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to integrate and operate</td>
<td></td>
</tr>
<tr>
<td>Quick menu</td>
<td>Easy start-up for most common setup</td>
</tr>
<tr>
<td>Easy to use keypad</td>
<td>Intuitive user interface saves time and effort</td>
</tr>
<tr>
<td>Parameter copy without main power in the drive (with MCA)</td>
<td>Enables configuration of the drive without main power connected</td>
</tr>
<tr>
<td>Connects to all main fieldbus systems</td>
<td>Effective drive integration independently system setup</td>
</tr>
</tbody>
</table>

- **Application dedication** |
- Wide integrated functionality as standard | Drive suitable for a wide variety of applications |
- Built-in PLC functionality | Enables custom made software functionality |
- PID-controller built-in | Cost efficient optimized process control |
- Support for permanent magnet motors | Support the use of high efficiency motors |

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible and robust</td>
<td></td>
</tr>
<tr>
<td>Max. ambient temperature 50 °C without derating</td>
<td>No external cooling or oversizing required</td>
</tr>
<tr>
<td>DIN-rail mounting as standard (sizes MI1-MI3)</td>
<td>Fast mounting</td>
</tr>
<tr>
<td>Through panel mounting (sizes MI4-MI5)</td>
<td>Effective cooling of enclosure</td>
</tr>
<tr>
<td>Side by side mounting</td>
<td>Saves space in installations</td>
</tr>
<tr>
<td>Built-in EMC filters for C2 class</td>
<td>No extra components need for connection to public networks</td>
</tr>
<tr>
<td>Harmonics compliant with IEC/EN61000-3-12 (&gt;=16A)</td>
<td>Can be connected to public networks in Europe without extra chokes</td>
</tr>
</tbody>
</table>
VACON® NXP Liquid Cooled Drive
World's first dedicated liquid-cooled drive for demanding environments

Power range
3 x 400-500 V ..................132-4100 kW
3 x 525-690 V ..................110-5300 kW

Protection ratings
IP00

Up to 25% savings in total lifecycle costs compared to air-cooled solutions
VACON® NXP Liquid Cooled Drive
World's first dedicated liquid-cooled drive for demanding environments

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Cooling</td>
<td>Easy to transport heat losses in liquid</td>
</tr>
<tr>
<td>Moves 95% of heat losses to liquid</td>
<td></td>
</tr>
<tr>
<td>No large fans</td>
<td>Liquid cooled drives are more quiet</td>
</tr>
<tr>
<td>Optimized liquid cooled drive</td>
<td>Maximum space saving by optimizing design</td>
</tr>
<tr>
<td>Reliable &amp; Service friendly</td>
<td>Maximum uptime</td>
</tr>
<tr>
<td>Robust drives module design</td>
<td>Reliable operation also in demanding situations</td>
</tr>
<tr>
<td>Marine Type Approvals available</td>
<td>Perfect choice for marine applications</td>
</tr>
<tr>
<td>No need for vast amount of filtered air</td>
<td>Filtering of air not efficient if there is a lot of dust in the air</td>
</tr>
<tr>
<td>Pre designed Water-Water heat exchangers</td>
<td>Ready made pre-designed and tested solutions for reliable operation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy and Safe</td>
<td>Saves installation cost</td>
</tr>
<tr>
<td>IP00 modules for mounting in customers enclosure</td>
<td>Ideal for system integrators and panel builders</td>
</tr>
<tr>
<td>Full power LV range covered</td>
<td>Complete offering enable full scope supply of drives products</td>
</tr>
<tr>
<td>Separate mounting possibility for control unit</td>
<td>Control unit can be mounted in a different cabinet section for maximum safety</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VACON® NXP control flexibility</td>
<td>High performance control and flexibility in one control unit</td>
</tr>
<tr>
<td>Best control solutions</td>
<td>Same interfaces and functionality in all VACON® NXP based products</td>
</tr>
<tr>
<td>Removable keypad with parameter backup and copy function</td>
<td>Latest parameters always in keypad, copy for fast cloning of drives</td>
</tr>
<tr>
<td>All I/O modular – 5 interface card slots</td>
<td>I/O and fieldbus interface can be configured for any need</td>
</tr>
<tr>
<td>Built-in PLC functionality</td>
<td>Enables custom made software functionality</td>
</tr>
<tr>
<td>Open and Closed Loop motor control</td>
<td>Maximum motor control performance</td>
</tr>
<tr>
<td>Fast drive-to-drive communicaaton and Drive-synch functionality</td>
<td>For load sharing and paralleling of power units</td>
</tr>
<tr>
<td>Separate automation control bus and separate monitor bus for PC tool</td>
<td>Using of PC software for drive configuration and monitoring</td>
</tr>
<tr>
<td>Safe Torque Off (STO), Safe Stop 1 (SS1)</td>
<td>Safe and compliant machine operation</td>
</tr>
<tr>
<td>ATEX certified thermistor input</td>
<td>No need for external ATEX approved thermistor relay</td>
</tr>
</tbody>
</table>
Crane: Features offering
Application software: APFIFF20
## Crane Application: **Features offering (APFIFF20)**

<table>
<thead>
<tr>
<th>Application Functions</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical brake control</strong></td>
<td>The mechanical brake control function in drive support to build up torque smoothly against the closed brake before releasing the mechanical brake for smooth start up and drive will continue to deliver the torque until mechanical brake control take over the command.</td>
</tr>
<tr>
<td><strong>Catch dropping load</strong></td>
<td>In case of mech. brake failure the drive automatically detects, takes over(starts) and can bring the load down to the ground controlled way</td>
</tr>
<tr>
<td><strong>Bump less transfer from CL to OL &amp; performance at low speed in OL</strong></td>
<td>Drive should switch control mode from closed loop to open loop in case of encoder failure/encoder error detected by drive. Output speed should remain at last closed loop before encoder failure detection</td>
</tr>
<tr>
<td><strong>Functional Safety with VSE board (SBC, SLS, SMS)</strong></td>
<td>Functional safety defines protection against hazards caused by incorrect functioning of components or systems</td>
</tr>
<tr>
<td><strong>Load dependent speed control (Power Optimization)</strong></td>
<td>Speed limits based on actual load, when low load drive can increase speed up to max speed. Improve cycle time</td>
</tr>
<tr>
<td><strong>Master follower (Torque sharing) - Tandem Trolley</strong></td>
<td>When the motor shafts are coupled to each other for running a common load. In this case, Master will be in speed control mode and follower will be in torque control mode.</td>
</tr>
</tbody>
</table>
## Crane Application: Features offering (APFIFF20)

<table>
<thead>
<tr>
<th>Application Functions</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tandem hoist (Shaft sync)</strong></td>
<td>Tandem operation is used where loads have to be transported with more than one lifting-gear unit at the same time and delivered to an exact spot. Up to four units can be controlled by the crane operator in tandem operation at the same time.</td>
</tr>
<tr>
<td><strong>Safe speed limit switch (without functional safety option)</strong></td>
<td>Horizontal trolley movement with left and right limit end position and left and right pre-limit switch. If the trolley hit the limit switch, then speed has to be reduced automatically to the pre limit speed (defined by a parameter). Trolley can move with reduced speed, or slower (if reference is smaller), till it reaches the end limit switch.</td>
</tr>
<tr>
<td><strong>Anti-Sway (under piloting phase)</strong></td>
<td>With an overhead travelling crane or a gantry crane the load is suspended from a gripping device by cables and becomes a pendulum device. With Anti-sway enabled, customer get advantage of protection of load and thus lower risk of accidents, lower operator fatigue. Cycle time improved (up to 25%).</td>
</tr>
</tbody>
</table>
Crane Application: **Features offering**

### Crane features v/s Product matrix

<table>
<thead>
<tr>
<th>Features</th>
<th>VACON® NXP</th>
<th>VLT® FC 302</th>
<th>VLT® FC 280</th>
<th>VACON® 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Control (OL &amp; CL - Voltage Vector control, Flux sensor-less, Flux with sensor feedback)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor independence technology (ASM, PM)</td>
<td></td>
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</tr>
<tr>
<td>Bump-less transfer from CL to OL in case of encoder failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fieldbus – In-built Modbus, Optional (Profibus, Profinet, Ethernet, etc..)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application programming flexibility (IEC61131-3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical brake control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical brake control monitoring in standstill and in running with feedback, Auto brake timing calculation in CL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catch dropping load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-sway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power optimization (Load dependents speed control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tandem Operation (shaft sync)</td>
<td></td>
<td></td>
<td></td>
<td>With IMC</td>
</tr>
<tr>
<td>Master/follower (Torque sharing &amp; droop control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe limit speed (Programmable limit switch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated functional safety (SBC, STO, SLS, SSM, SMS)</td>
<td></td>
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* Function limitation while running in flux mode

With VSE board

*(STO, SS1, SLS with MCB15x)*
Crane Application: **Features offering**

**Mechanical brake control**

**Need**
- In the vertical motion, the key point is that the load must be held, stopped, controlled (raised, lowered) in a perfectly safe mode all the time.

**Danfoss solution**
- Open loop and closed loop control
- Brake ID run to calculate brake opening and closing delay timings.
- Brake acknowledge feedback to ensure brake open/closed physically.
- Exclusive brake control status word for easy diagnosis and troubleshooting.

**Value to customer**
- Safe reliable operation.

**Example:** OPTA2 board RO1:
- **Brake Control Closed:** Terminals 22-23 are normally open (NO) -(Relay is not energized)
- **Brake Control Open:** Terminals 22-23 are normally closed (NC) -(Relay is energized)
Crane Application: **Features offering**

Monitoring and feedback parameters to control the brake is different in closed loop and open loop.

**Mechanical brake timing diagram in closed loop**

**Mechanical brake timing diagram in open loop**
Crane Application: **Features offering**

**Bump less transfer - Switch control from Closed loop to Open loop**

**Need**
- For closed loop operation, in case of encoder failure, there is requirement to have smooth changeover from closed loop to open loop with “Encoder loss” warning for operator to act.

**Danfoss solution**
- User friendly operation - Auto changeover on fly, activate through parameter.
- “Warning” can generate for OL operation.
- High accuracy in bump-less transfer above 10% of rated speed.

**Value to customer**
- No stoppage during process /operation.
- Minimize shutdown in case of encoder (hardware) failure.
- High degree safety for machine – No uncontrolled speed, no load drop.

![Fig.1: Motor speed and torque response/behavior captured with “NC drive tool” at the event of encoder lost.](image)
Crane Application: **Features offering**

**Tandem Hoist (Speed Sync) Operation**

**Need**
- Optimize Crane design to carry higher capacity load with tandem operation.
- Loads have to be transported with more than one lifting-gear unit at the same time and delivered to an exact spot.

**Danfoss solution**
- **Shaft synchronization** between master-slave axes through system bus.
- Maximum four slaves can be synchronized.
- Independent operation of axes with disable tandem operation.

**Value to customer**
- Able to lift higher capacity load with helps of two axes in same time thus improve productivity.
- Mechanical design can be optimized.
- Tandem operation helps to monitors and controls the position difference of the hooks and synchronize the movement of each hoist/trolley.
Crane Application: Features offering

Anti-sway (Under piloting phase)

**Need**
- Overhead travelling crane or a gantry crane, the load is suspended from a gripping device by cables and becomes a pendulum device.

**Danfoss solution**
- Sensor-less control, No feedback device or encoder required.
- No Drive to Drive communication required.
- Independent of hoist, load.
- Software to be programmed only in trolley and travel motion.

**Value to customer**
- User friendliness - No skilled operator required for commissioning and operation.
- Improve productivity by reducing cycle time indirectly, lower energy costs.
- Reduce structural stress and lower risk of accidents.
- Protection of the load and the machinery and less maintenance.
Crane Application: **Features offering**

**Tandem (Master – Follower, Torque sharing)**

### Need
- When the motor shafts are coupled to each other for running a common load. Mostly use for trolley or travel motion.

### Danfoss solution
- For closed loop operation, the master drive is speed controlled and transmits torque reference to the follower drives via analog output or fieldbus. The follower drive works in torque control mode and master drive works in speed control mode.
- For open loop operation, droop control to equalize torque between two different motor.

### Value to customer
- Mechanically optimize design.
- Smooth operation, No jerk, oscillation during start-up, ramping.
- Easy commissioning
Crane Application: **Features offering**

**Tandem (Master – Follower, Torque sharing)**

**Need**
- When the motor shafts are coupled to each other for running a common load for trolley or travel application.
- The master drive is speed controlled and transmits torque reference to the follower drives via analog output or fieldbus. So the follower drive as torque control, for example, a trolley or travel with two drives and motors run a common drum.
- Control either with speed-torque sharing or load drop control.

**Danfoss solution**
- Drop control
- Master–follower (Speed-torque sharing).

**Value to customer**
- Balancing the load when motors are “on the same shaft” and both motors are speed controlled
- Closed loop control
- No master-follower arrangement
- Easy commissioning, no extra components
Crane Application: Features offering

Integrated functional Safety

Need

- Functional safety defines protection against hazards caused by incorrect functioning of components or systems

Danfoss solution

- With VACON® Advanced Safety Options, will be able to fulfill safety requirements according to Safety levels: SIL2, PLd, Cat. 3 (TÜV SÜD certified).
- Wide range of safety functions which is required in crane application STOP functions: STO + (SBC), SS1, SS2, SQS
- Speed functions: SLS, SSR, SMS, SSM.

Value to customer

- Safety functions are used to protect people, equipment.
- A certified level of reliability.
- Optimal realisation using the safety function.
Crane Application: **Features offering**

**Integrated functional Safety – STOP Function**

- **Safe Torque Off (STO)**
  - Power, that can cause rotation is not applied to the motor. The PDS will not provide energy to the motor which can generate torque.

- **Safe Stop 1 (SS1)**
  - Initiates and monitors the motor deceleration rate within set limits to stop the motor and initiates the STO function when the motor speed is below a specified limit; or after specified time.

- **Safe Stop 2 (SS2)**
  - Initiates and monitors the motor deceleration rate within set limits to stop the motor and initiates the Safe Operating Stop function when the motor speed is below a specified limit or after specified time.

- **Safe Quick Stop (SQS)**
  - Independent set of functions in combination with STO, SS1 or SS2 functions. The functions utilize independent ramp definitions from the standard SS1 and SS2 functions.

- **Safe Brake Control (SBC)**
  - Provides a safe output signal(s) to control an external brake(s). Integrated to STO function.

*STO requires external safety relay or OPT-AF along with OPT-BL/BM/BN
Crane Application: **Features offering**

**Integrated functional Safety – SPEED Monitoring Function**

- **Safely-limited Speed (SLS)**
  Prevents the motor from exceeding the specified speed limit.

- **Safe Speed Monitor (SSM)**
  Provides a safe output signal to indicate whether the motor speed is below a specified limit.

- **Safe Speed Range (SSR)**
  Keeps the motor speed within specified limits.

- **Safe Maximum Speed (SMS)**
  Prevents the motor exceeding the maximum specified limit.
Crane Application: **Features offering**

**Integrated functional Safety**

- A PC tool “**VACON® Safe**” used to set up the functions of the VACON® Advanced Safety Options.
- Can be used to validate the setup and generate reports.
- Monitoring functionality allows the user to see the status of the options.
Crane Application: **Features offering**

**Upcoming features**

- Load Estimation
- Shock load prevention
- Slack rope prevention
- Slew Control
Danfoss Value Proposition
Innovating your industry

TO STAY ONE STEP AHEAD, YOU NEED

APPLICATION FOCUS
We offer you application-optimized products with flexibility and independence to suit your system, and meet your needs exactly. Not just good, but ideal
- Application engineering
- Centres of Excellence
- Dedicated AC drives

COMPETITIVE EDGE
We innovate to provide a continuously-expanding product offering which is right at the forefront of industry trends:
- Broadening the product portfolio
- Pursuing a greater degree of specialization
- Continuous standard and quality

RELIABILITY
We share our wealth of quality experience and application knowledge with you to find lasting solutions that suit your needs and maximize your uptime. Individual and optimized
- Strong logistics for reliable, fast delivering
- ISO 9001 and ISO 14001 certified, TS 16949 compliant
Empowering via expertise

PROFIT FROM

Deep applications knowledge

Understanding of your industry

Local presence

Broad range of DrivePro® services

Dedicated contact team

5000 PASSIONATE PEOPLE serve your needs and deliver focused guidance.

Their word-class expertise means you get not only the right products, but can apply them in the optimal manner.

Enhanced product variety

Enhanced application variety

Enhanced compatibility and functionality
Focus on **success of our partners**

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<th><strong>We promise</strong></th>
<th><strong>We expect</strong></th>
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<tr>
<td>Long-term strategic partnership based on trust</td>
<td>Investment to build a strong drives organization that generates year-on-year growth</td>
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<td>Access to the best product portfolio in the industry</td>
<td>Strong proactive sales and service effort to win new business</td>
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<tr>
<td>Generation of new revenue streams for partner’s business</td>
<td>Full ownership and accountability for customers</td>
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<td>Business development support</td>
<td>Support of the Danfoss strategy and alignment of mutual business objectives</td>
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<td>Easy access to technical support</td>
<td>Competent technical advice provided to customers in pre-sales, sales and post-sales phases</td>
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<td>Training and competence-building programs</td>
<td>Strong partner organization that is able to create value for customers with Danfoss products and solutions</td>
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<td>Easy to do business with – through user-friendly online ordering and registration systems</td>
<td>Order handling with webshop, EDI, warranty cases registration, linkage of website with Danfoss</td>
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A better tomorrow is driven by drives
Questions?