

Danfoss



VLT® AQUA Drive
The ultimate solution for Water, Wastewater & Irrigation



Protects the environment

The growing need for clean water and energy conservation is rapidly increasing the pressure on global fresh water resources, wastewater treatment, recycling and power generation.

VLT® AQUA Drive is designed to enhance system operation, protect equipment, reduce chemical consumption and water loss, whilst providing significant energy savings. VLT® AQUA Drive is the ultimate solution for all water, wastewater and recycling processes



The VLT AQUA Drive is innovative – Reduces system, installation and operating costs

Danfoss VLT® AQUA Drive is dedicated to water and wastewater applications. With a wide range of powerful standard and optional features, the VLT® AQUA Drive provides the lowest overall cost of ownership for water and wastewater applications.

- **Save energy**

The VLT® AQUA Drive offers considerable energy savings:

- VLT® efficiency (98%)
- High true power factor (>0.9)
- Sleep Mode
- Automatic Energy Optimisation AEO: Typically 3-5% – up to 15% not unusual.
- Flow compensation, lowering pressure and thus energy consumption in low flow conditions

- **Save space**

The compact design of the VLT® AQUA Drive makes it easily fit in even small installation spaces.

- Built-in DC coils for harmonic suppression. No need for external AC-coils.
- Built-in RFI filters in the whole power range (Optional)

- **Save cost and protect your system**

with a series of pump-specific features:

- Cascade controller
- Sensorless control
- Dry run detection
- End of curve detection
- Motor alternation
- 2-step ramps (initial and final ramp)
- Check valve protection
- Safe stop
- Low flow detection
- Pipe fill mode
- Real-time clock
- Password protection
- Overload trip protection
- Smart logic controller

Can be set to either variable or constant torque operation in the full speed range.

- **Save cabinet cost**

NEMA/UL Type 12 (IP 54/55) enclosure solution is available in the whole power range. Furthermore Danfoss Drives also introduces a NEMA/UL Type 4X (IP 66) version up to 90 kW.

- **Save time**

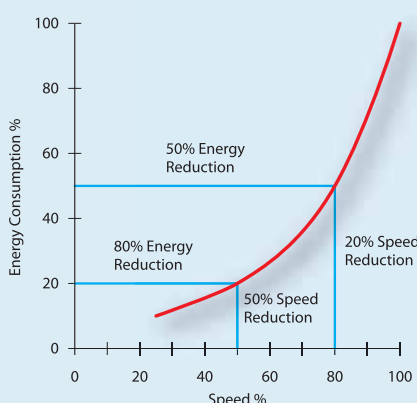
VLT® AQUA Drive is designed with the installer and operator in mind in order to save time in installation, commissioning and maintenance.

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

Dedicated to water and wastewater

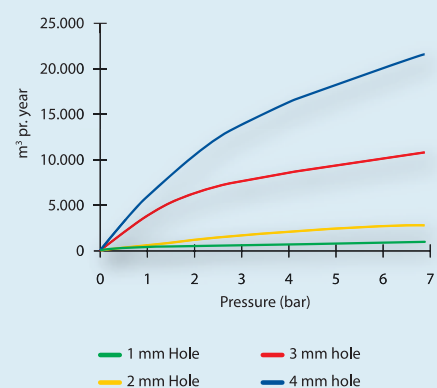
Danfoss Drives' unequalled experience was used to make the VLT® AQUA Drive the perfect match for all AC motor driven applications in modern water and wastewater systems. Water and Wastewater is a global business area for Danfoss Drives and you will find our dedicated sales and service staff all over the world 24 hours a day.

Ideal Energy Consumption at Varying Speed



Energy savings using a VLT® AQUA Drive are achieved even with a modest reduction in speed.

Distribution System Water Losses



Reducing water losses by lowering system pressure becomes increasingly effective as the size of line breaks increase.



Reduces irrigation costs

Climate change and rising energy costs increases the need for more efficient irrigation processes in agriculture and landscaping.

VLT® AQUA Drive is designed to optimise the supply of water, save energy as well as protect pumps and piping in irrigation systems to reduce down time and leakage.

VLT® AQUA Drive is the ultimate solution for irrigation.

The modular VLT® AQUA Drive

Unique cooling concept

- Segregated back channel cooling protects electronics from contamination and enhances service life

Advanced cascade controller option (C-option)

Bus-option (A-option)

- select any of the most common fieldbus protocols

Local control panel (LCP)

- choose numerical, graphical or no display

I/O, Relay or Safety (B-option)

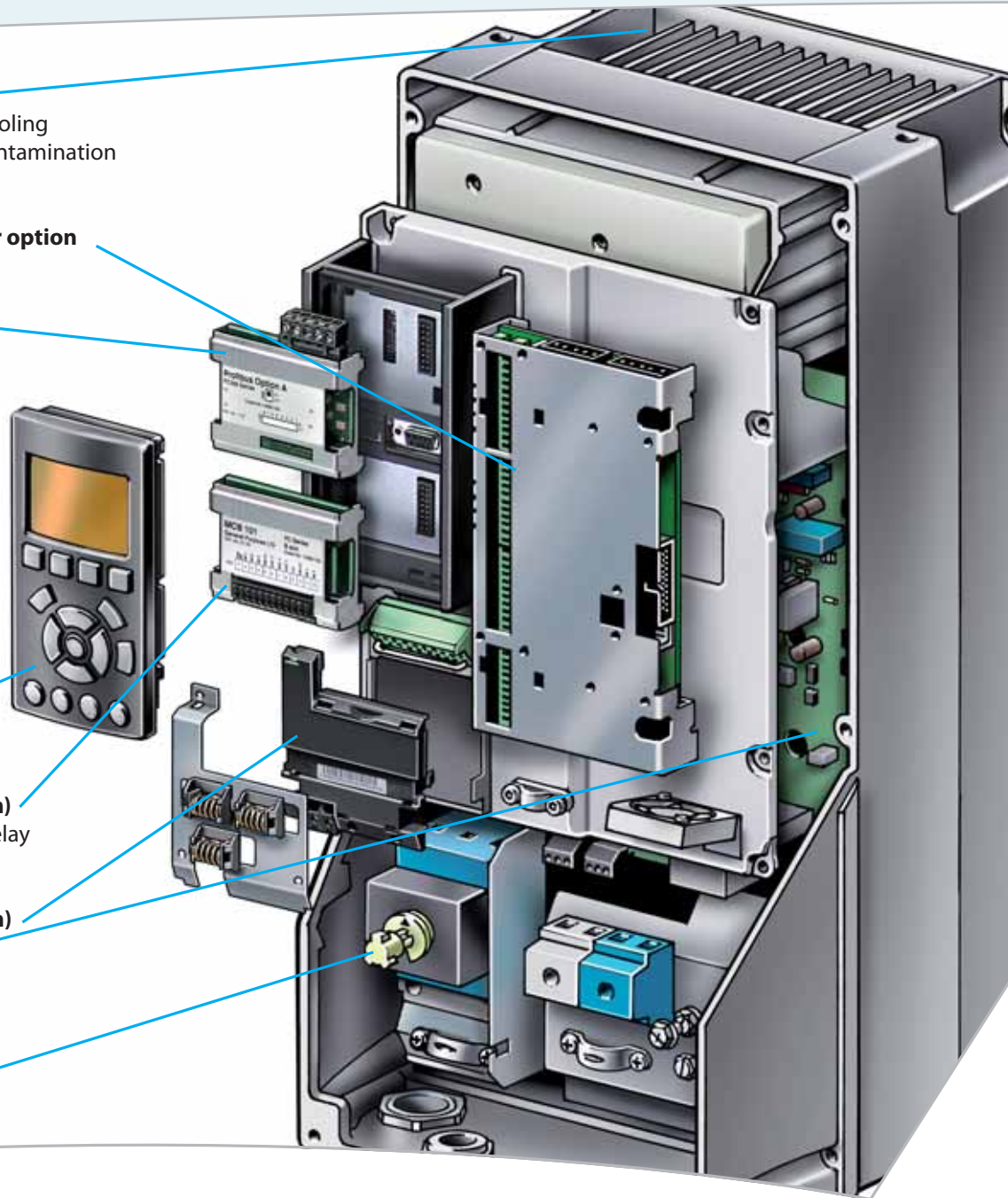
- I/O cascade controller and relay functions

24 V supply option (D-option)

Coated PCB's

- Durable in aggressive environments

AC mains disconnect (Factory option)



The VLT® AQUA Drive shares technology, user interface and basic features with the rest of the new VLT® generation. The modular design of the VLT® AQUA Drive allows even highly customized drives to be mass produced and factory tested.

Plug and play options make upgrading easy.



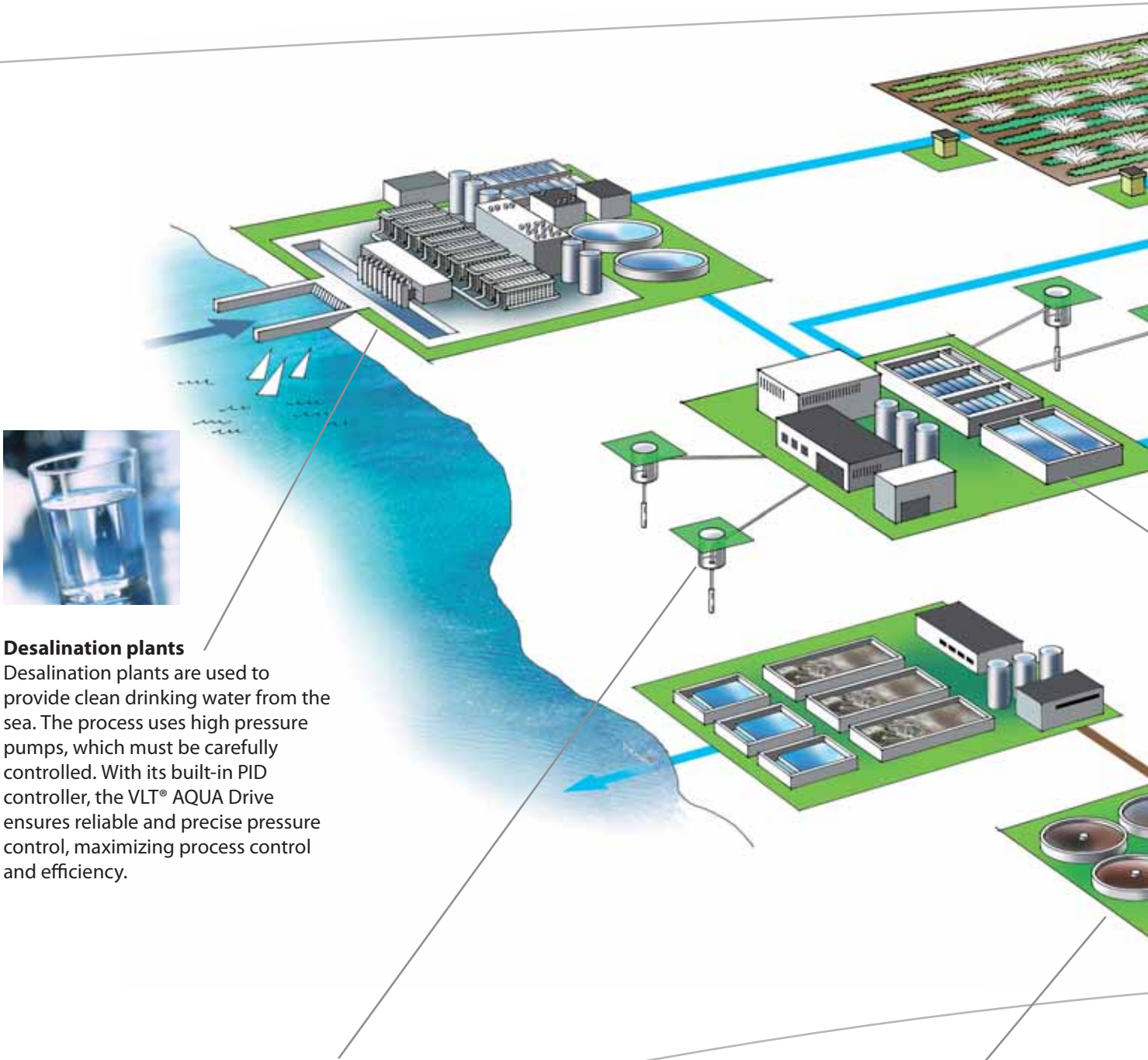
DC coils reduce harmonic noise and protects the drive. Also EMC filters are integrated (meets EN 55011 A2, A1 or B).



The VLT® AQUA Drive can be remote commissioned and monitored through a USB pluggable cable. VLT® Set up Software MCT 10 and Language Changer are special software that can simplify drive setup.

Water and Wastewater processes

– Improved control using less energy



Desalination plants

Desalination plants are used to provide clean drinking water from the sea. The process uses high pressure pumps, which must be carefully controlled. With its built-in PID controller, the VLT® AQUA Drive ensures reliable and precise pressure control, maximizing process control and efficiency.

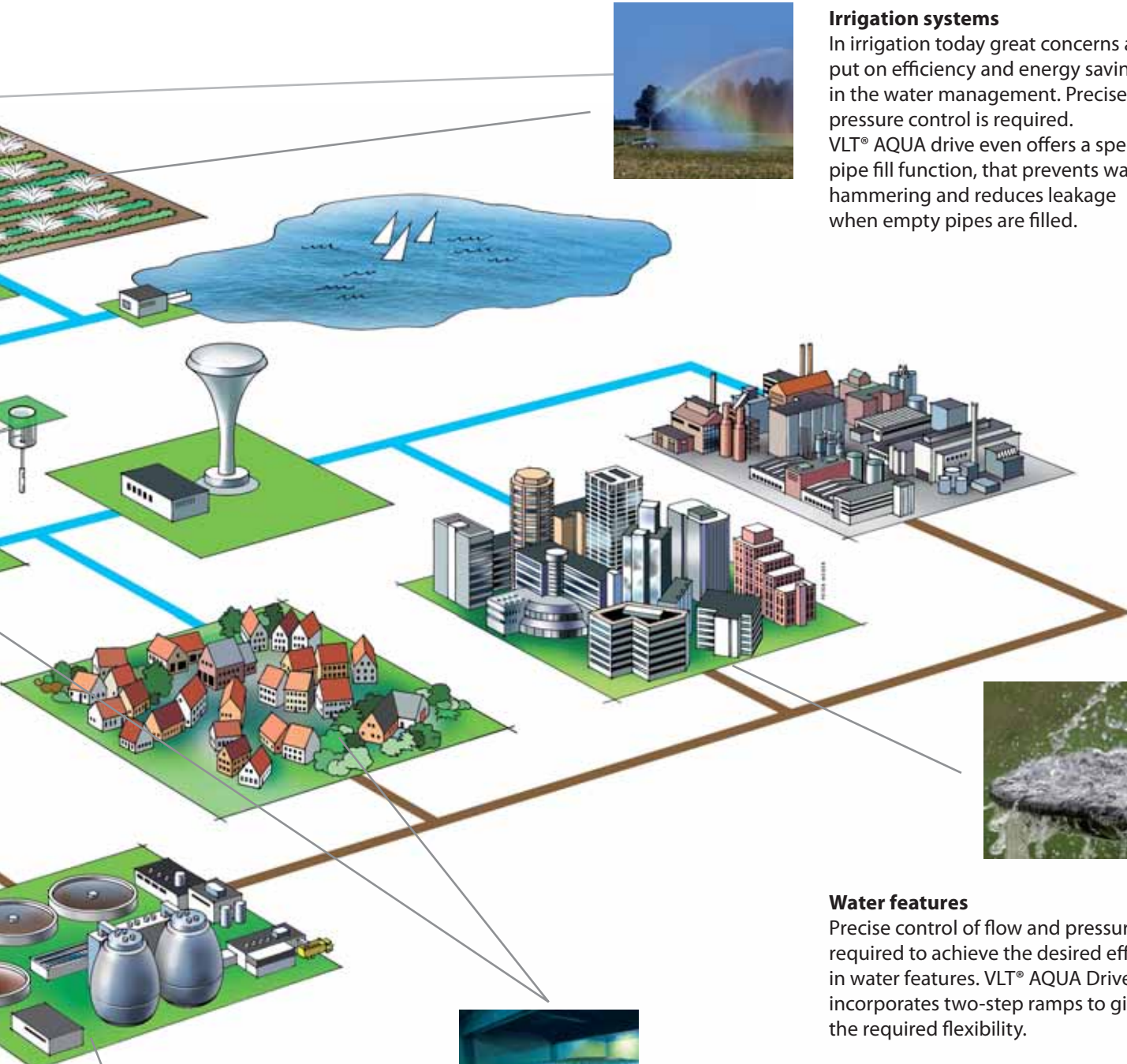


Groundwater pumps

Submersible deep well pumps need fast start capability, precise control and protection against running dry. The built-in dry run detection and the initial ramp-up make the VLT® AQUA Drive handle such applications to perfection.

Wastewater plants

Fluctuations in flow can disturb the process and lead to increased costs, increased wear on machines through higher number of starts and stops and deteriorated effluent quality. Using the VLT® AQUA Drive on pumps, blowers, and other equipment will lead to a balanced process and save considerable amounts of energy.



Irrigation systems

In irrigation today great concerns are put on efficiency and energy savings in the water management. Precise pressure control is required. VLT® AQUA drive even offers a special pipe fill function, that prevents water hammering and reduces leakage when empty pipes are filled.



Water features

Precise control of flow and pressure is required to achieve the desired effect in water features. VLT® AQUA Drive incorporates two-step ramps to give the required flexibility.

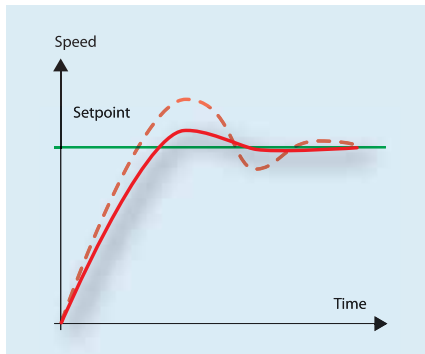


Distribution

Pressure booster pumps with precise pressure control leads to significant reductions in water leakage and energy consumption. Costly and unsightly water towers can be eliminated.

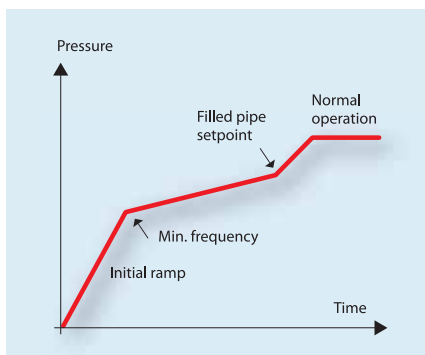


Dedicated water features



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, so that precise and stable operation is achieved quickly.

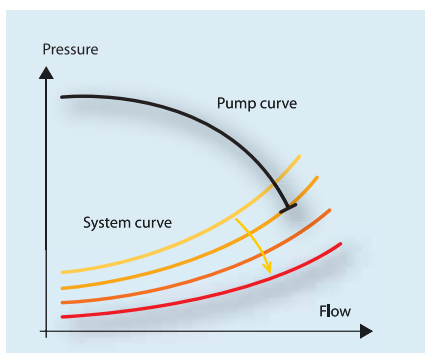
Gain factors for PI are continuously changed to compensate for changing characteristics of the loads. This applies to each PI controller in the 4-menu sets individually. Exact P and I settings at start-up will not be necessary – which lowers the commissioning costs.



Pipe Fill Mode
 Enables controlled (closed loop) filling of pipes.
 Prevents water hammering, bursting water pipes or blowing off sprinkler heads.

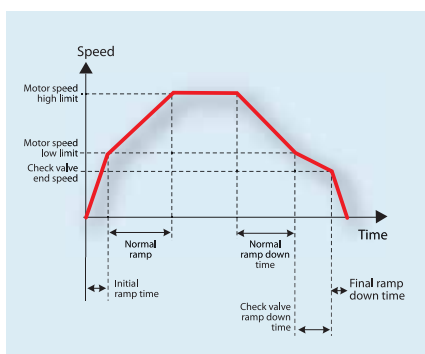
Useful in all applications where controlled pipe filling is demanded, such as irrigation systems, water supply systems, etc.

The new pipe fill mode is useable in both vertical and horizontal pipe systems.



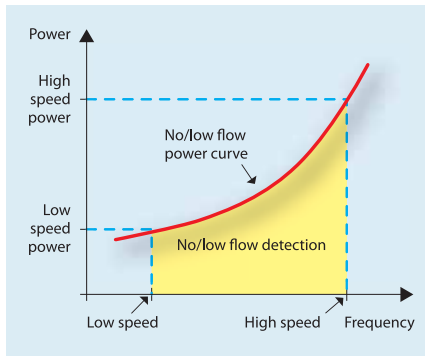
End of Pump Curve detects breaks and leakage
 The feature detects breaks and leakage. End of curve triggers an alarm, shuts off the pump, or performs another programmed action

whenever a pump is found running at full speed without creating the desired pressure – a situation that can arise when a pipe breaks or leakage occurs.



Check Valve Ramp
 The Check Valve Ramp prevent water hammering as the pump stops and the check valve closes.

The Check Valve Ramp slowly ramps down the pump speed around the value where the check valve ball is about to shut.



Dry Pump Protection lowers maintenance costs

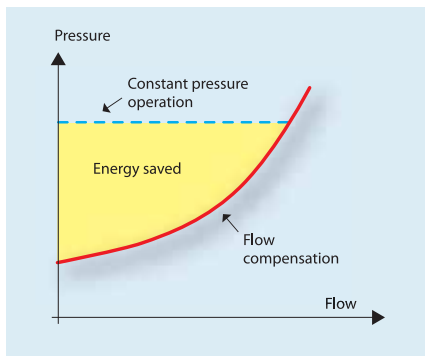
The VLT® AQUA Drive constantly evaluates the condition of the pump, based on internal frequency/power measurements.

In case of a too low power consumption – indicating a no or low flow situation – the VLT® AQUA Drive will stop.

Sleep Mode

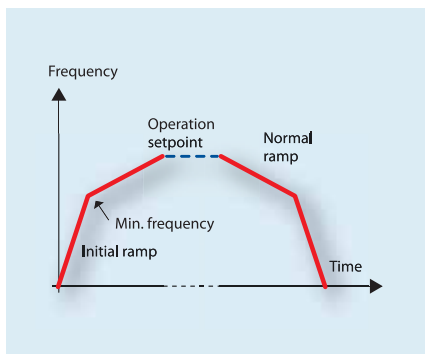
Sleep Mode keeps pump wear and power consumption to an absolute minimum. In low flow situations, the pump will boost the system pressure and then stop.

Monitoring the pressure, the VLT® AQUA Drive will restart when the pressure falls below the required level.



Flow compensation

The flow compensation feature in VLT® AQUA Drive exploits the fact that flow resistance decreases with reduced flow. The pressure set point is accordingly reduced – which saves energy.



Initial/Final Ramp

The initial ramp provides fast acceleration of pumps to minimum speed, from where the normal ramp takes over. This prevents damage to the thrust bearings on the pump.

The final ramp decelerates pumps from min. speed to stop.

Sensorless Pressure or Flow Control

Sensorless pressure or flow control is a patented VLT® feature that allows pump manufacturers to control the constant head (pressure) or flow levels without the use of sensors. The cost and time of installing, cabling and maintaining pressure and flow transducers are eliminated. Reliability is also boosted, as no additional components or connections can cause malfunction.

Payback time indication

One of the major reasons for applying a VLT® drive is the very short payback time due to energy savings. The VLT® AQUA drive comes with a unique feature which continuously shows the remaining payback time for the investment.

Motor Alternation

This built-in logic controls alternation between two pumps in duty/stand-by applications. Motion of the stand-by pump prevents sticking of the pump. An internal timer assures equal usage of the pumps.

With an option card it is possible to control alternations between 8 pumps.

Athens Wastewater Treatment Plant, Greece

*VLT® drives up to 315 kW handle wastewater from a population of 5 million in Athens. VLT® operation save approx. 25% energy.
The Psytalia Wastewater Treatment Plant treats daily 750.000 m³ of sewage and has a nominal daily capacity of 1.000.000 m³.*



Proven AQUA Experience – world wide



Monterrey City, Mexico
 Agua y Drenaje de Monterrey in Mexico is installing Danfoss VLT® drives in wastewater treatment plants, boost pump stations and water wells for both residential and commercial areas in Monterrey - the largest industrial city in Mexico with 3.5 million people. Benefits from VLT® operation of the pumps are energy savings of about 30% and also reduction of water leakage.



Xi'An No.3 Waste Water treatment, China
 Danfoss provided VLT® AQUA drives and MCD soft starters for Xi'An No.3 Wastewater treatment plant. It is one of three bundles of a retrofit project to improve the environment in Xi'An City of Shanxi province, China. The treatment capacity is 100,000 tons of sewage and 50,000 tons of recycled water per day.



Izmir Geothermal District Heating System, Turkey
 VLT® drives operate the deep well and supply pumps in Izmir geothermal district heating. Applying VLT® drives leads to a very low electricity cost.



Vienna's Main Sewage Treatment Plant, Austria
 At Vienna's lowest point, where the Danube Canal meets the Danube, lies Vienna's Main Sewage Treatment Plant. Here around 90% of Vienna's wastewaters is purified. VLT® Drives were chosen to operate the pumps that handle more than 500,000 cubic metres pr. day, which corresponds to a flow of a medium-size river. It takes about five hours for the waste water to pass through the mechanical and biological purification stages before it is purified and discharged into the Danube Canal.



Perth Seawater Desalination Plant, Australia
 VLT® drives and softstarters were chosen to run pumps when The Water Corporation of Western Australia – one of Australia's largest and most successful water service providers – invested \$387 million Australian dollars in Perth Seawater Desalination Plant – the largest of its type in the Southern Hemisphere. The company provides water and wastewater services to the burgeoning city of Perth and hundreds of towns and communities spread over 2.5 million square kilometres.



Changi Water Reclamation Plant, Singapore
 The Changi Water Reclamation plant is the cornerstone of the first phase of the Singapore Deep Tunnel Sewerage System. The plant is to replace six existing water reclamation plants in the long term. Danfoss VLT® drives and AHF filters were supplied for chemical and carbon scrubbers for the odour control, sedimentation tanks, bio-reactors, sedimentation tanks and solids building.

Award winning user friendly interface

Graphical display

- International letters and signs
- Showing bars and graphs
- Easy overview
- Possible to select 27 languages
- iF awarded design

Other benefits

- Removable during operation
- Up- and download functionality
- IP 65 rating when mounted in a panel door
- Up to 5 different variables visible at a time

Illumination

- Important buttons are illuminated when active



design award
winner
2004

The VLT® AQUA Drive has an award-winning Local Control Panel and a well structured menu system that ensures fast commissioning and trouble-free operation of the many powerful functions.



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 setups simultaneously

Quick Menus

- A Danfoss defined Quick Menu
- A Personal defined Quick Menu
- A Changes Made Menu lists the parameters unique for your application
- A Function Setup menu provides quick and easy setup for specific applications
- A Logging menu provides access to operation history

New buttons

- Info ("on board manual")
- Cancel ("undo")
- Alarm log (quick access)

Connection overview

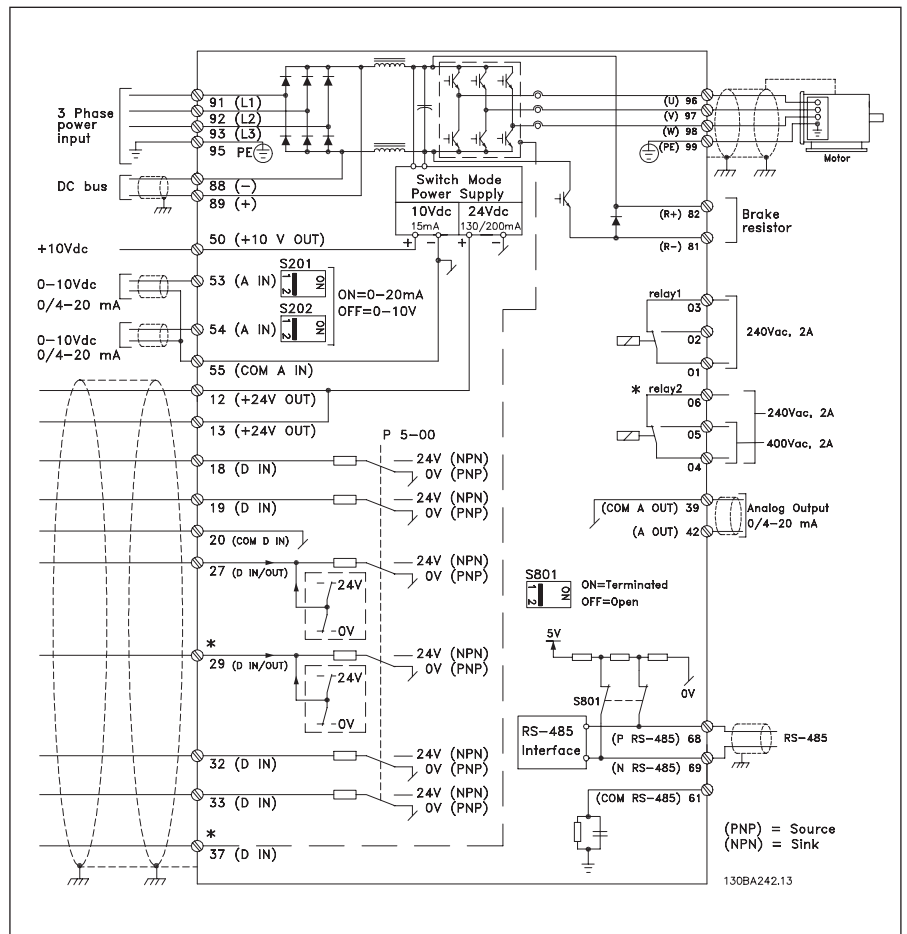
Power is connected to the terminals 91 (L1), 92 (L2) and 93 (L3) and the motor is connected to 96 (U), 97 (V) and 98 (W).

Analog inputs can be connected to the 53 (V or mA), 54 (V or mA) terminals. These inputs can be set up for reference, feedback or thermistor.

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 $0 - I_{max}$.

Modbus RTU interface is standard.



General Specifications

Mains supply (L1, L2, L3)

Supply voltage	200 – 240 V ±10%
Supply voltage	380 – 480 V ±10%
Supply voltage	525 – 600 V ±10%
Supply voltage	525 – 690 V ±10%
Supply frequency	50/60 Hz
True power factor (λ)	≥ 0.9
Switching on input supply L1, L2, L3	1-2 times/min.

Output data (U, V, W)

Output voltage	0 – 100% of supply voltage
Switching on output	Unlimited
Ramp times	1 – 3600 sec
Closed loop	0 – 132 Hz

VLT® AQUA Drive can provide 110% current for 1 minute.
Higher overload rating is achieved by oversizing the drive.

Digital inputs

Programmable digital inputs	6*
Logic	PNP or NPN
Voltage level	0–24 V

*2 can be used as digital outputs

Analog input

Analog inputs	2
Modes	Voltage or current
Voltage level	0 – 10 V (scaleable)
Current level	0/4 – 20 mA (scaleable)

Pulse inputs

Programmable pulse inputs	2
Voltage level	0-24 VDC (PNP positive logic)
Pulse input accuracy	(0.1 – 110 kHz)
Utilize some of the digital inputs	

Analog output

Programmable analog outputs	1
Current range at analog output	0/4 – 20 mA
Max. load (24 V)	130 mA

Relay outputs

Programmable relay outputs (240 VAC, 2 A and 400 VAC, 2 A)	2
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Fieldbus communication

Standard built in	FC Protocol Modbus RTU
Optional	Profibus DeviceNet Ethernet

Temperature

Ambient temperature	up to 55° C
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Application options

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

- **Real time clock with battery back-up**
- **General purpose I/O option:**
3 digital inputs, 2 digital outputs, 1 analog current output, 2 analog voltage inputs
- **Relay option/cascade controller option:**
3 relay outputs
- **External 24 VDC supply option:**
24 VDC external supply can be connected to supply control- and option cards
- **Brake chopper option:**
Connected to an external brake resistor, the brake chopper limits the load on the intermediate circuit in case the motor acts as generator.
- **Extended cascade controller up to a total of 6 pumps**
- **Advanced cascade controller up to a total of 8 pumps**

Power options

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

- **Advanced Harmonic Filters:** for applications where reducing harmonic distortion is critical. (MCT 31 harmonic calculation software can be used to determine the correct filter)
- **dv/dt filters:** For providing motor isolation protection
- **Sine filters (LC filters):** For output similar to mains operation. (IE: low motor noise, low dv/dt and peak voltage and reduced radiated EMI).

Complementary products

- A broad range of soft starters
- Decentral drive solutions
- Local panel solutions (VLT® AQUA Drive + Power Options etc. assembled as one unit)

PC software

- **MCT 10**
– ideal for commissioning and servicing the drive including guided programming of cascade controller, real time clock, smart logic controller and preventive maintenance.
- **VLT Energy Box**
– comprehensive energy analysis tool, shows the drive payback time
- **MCT 31**
– harmonics calculation tool to determine compliance with specific limits/if additional filter options are required.

Sales and Service Contacts worldwide

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

- 24/7 availability
- Local service organisation is present in more than 100 countries – ready to support whenever and wherever you need, around the clock, 7 days a week.

Current and power ratings

3 x 200 – 240 VAC			3 x 380 – 480 VAC				3 x 525 – 690 VAC				
Output current [A] 3 x 200-240 V	Typical shaft output		Output current [A] 3 x 380-440 V	Output current [A] 3 x 441-480 V	Typical shaft output		Output current [A] 3 x 575 V	Output current [A] 3 x 690 V	Typical shaft output		
	kW	HP			kW	HP			kW	HP	
1.8	0.25	0.33									PK25
2.4	0.37	0.5									PK37
3.5	0.55	0.75	1.3	1.2	0.37	0.5					PK55
4.6	0.75	1.0	1.8	1.6	0.55	0.75					PK75
6.6	1.1	1.5	2.4	2.1	0.75	1.0	1.7			1.0	P1K1
7.5	1.5	2	3	3	1.1	1.5	2.4			1.5	P1K5
10.6	2.2	3	4.1	3.4	1.5	2.0	2.7			2.0	P2K2
12.5	3	4	5.6	4.8	2.2	3.0	3.9			3.0	P3K0
16.7	3.7	5	7.2	6.3	3	4.0	4.9			4.0	P3K7
			10	8.2	4	5.5	6.1			5	P4K0
24.2	5.5	7.5	13	11	5.5	7.5	9			7.5	P5K5
30.8	7.5	10	16	14.5	7.5	10	11			10	P7K5
46.2	11	15	24	21	11	15	13	13	11		P11K
59.4	15	20	32	27	15	20	18	18	15	15	P15K
74.8	18.5	25	37.5	34	18.5	25	22	22	18.5	20	P18K
88	22	30	44	40	22	30	27	27	22	25	P22K
115	30	40	61	52	30	40	34	34	30	30	P30K
143	37	50	73	65	37	50	41	41	37	40	P37K
170	45	60	90	77	45	60	52	52	45	50	P45K
			106	96	55	75	62	62	55	60	P55K
			147	130	75	100	83	83	75	75	P75K
			177	160	90	125	100	100	90	100	P90K
			212	190	110	150	125	125	110	125	P110
			260	240	132	200	155	155	132	150	P132
			315	302	160	250	192	192	160	200	P160
			395	361	200	300	242	242	200	250	P200
			480	443	250	350	290	290	250	300	P250
			600	540	315	450	344	344	315	350	P315
			658	590	355	500					P355
			745	678	400	550	400	400	400	400	P400
			800	730	450	600	450	450	450	450	P450
			880	780	500	650	500	500	500	500	P500
			990	890	560	750	570	570	560	600	P560
			1120	1050	630	900	630	630	630	650	P630
			1260	1160	710	1000	730	730	710	750	P710
			1460	1380	800	1200	850	850	800	950	P800
							945	945	900	1050	P900
			1720	1530	1000	1350	1060	1060	1000	1150	P1M0
							1260	1260	1200	1350	P1M2

Note: F1 and F2 power sizes will be introduced in 2007.

Note: VLT® AQUA Drive can provide 110% overload for one minute. Higher overload rating is achieved by over sizing the drive

Cabinet sizes

[mm]

IP 00

Enclosure name		D3	D4	E2
Height		1046	1327	1547
Width		408	408	585
Depth		375	375	498

IP 20/IP 21

Enclosure name	IP 20				IP 21						
	A2	A3	B1	B2	C1	C2	D1	D2	E1	F1	F2
Height	268	268	481	651	680	770	1209	1589	2000	2204	2204
Width	90	130	242	242	308	370	420	420	600	1400	1800
Depth	205	205	261	261	310	335	380	380	494	606	606

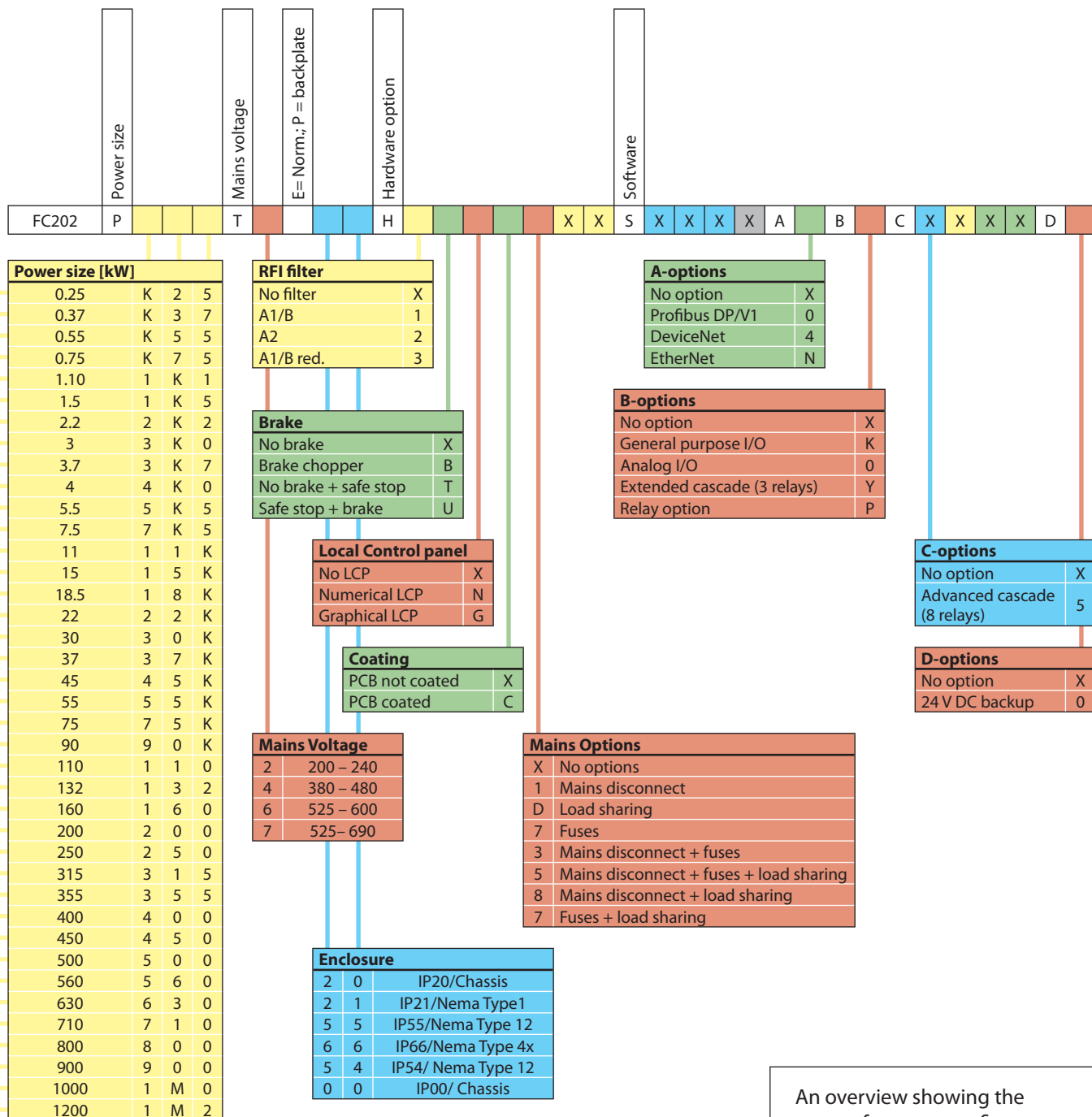
Note: F-Frame options cabinet adds 600 mm to width.

Enclosure name	IP 66						IP 54				
	A5	B1	B2	C1	C2	D1	D2	E1	F1	F2	
Height	420	481	651	680	770	1209	1589	2000	2204	2204	
Width	242	242	242	308	370	420	420	600	1400	1800	
Depth	200	261	261	310	335	380	380	494	606	606	

Note: Smaller IP 20 versions in range B1 to C2 will be introduced mid 2007.

Note: F-Frame options cabinet adds 600 mm to width.

Choose configurations freely



An overview showing the many of ways to configure a VLT® AQUA Drive.

Select the options required for your application to determine the type code for your drive. The factory then uses this type code to build the drive to your exact specifications.

You can configure online at www.danfoss.com/drives – Choose “Online Configurator” or contact your local Danfoss Drives office.

(Note: Some higher power sizes and options to follow in 2007)





Protects environment

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

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

UN Global Compact

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

EU Directives

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

Products impact

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

What VLT® is all about

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

Dedicated to drives

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

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

Intelligent and innovative

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

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

Rely on the experts

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

Local backup – globally

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

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



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