



Drives and controls

# Using variable-speed drives in the water industry

## A checklist for consultants, contractors and designers

# Latest technology is being used

Advances in variable-speed drive technology could mean that specifications used by water industry consultants, contractors or designers are out of date.

Among the many features included within today's drives are a host of built-in intelligent pump functions, designed to ensure smooth, disturbance-free operation of water and wastewater processes, maximising energy efficiency while reducing unnecessary downtime. These pump-specific functions decrease the life cycle cost of the pumping system, helping to save time and money.

But it is not just the variable-speed drive that needs to be considered. The service and support of the supplier is equally as important.

The following pages offer advice on features that will enhance the user experience of variable-speed drives. The features are colour-coded as indicated below and cover products and services as well as technical advice that your supplier should be able to offer.

**Product features**

**Service features**

**Technical advice**



# Product features

This checklist highlights many of the latest features that are available in today's variable-speed drives (VSDs). To ensure that your application operates at optimum performance, make sure that you specify the following.

Drive type		Check ✓
6-pulse, 12-pulse (or 24-pulse), low harmonic VSDs and active filters	With different space and cost constraints multiple options are available to optimise an installation.	<input type="checkbox"/>
Module or cabinet	All drives should be available as module or cabinet to meet space and investment cost needs.	<input type="checkbox"/>
Withdrawable modules	Reduces time to maintain or repair/ replace modules.	<input type="checkbox"/>
<b>Control panel</b>		
Drive control panel (keypad)	<ul style="list-style-type: none"> <li>– For ease of drive programming, a detachable, multilingual alphanumeric control panel is preferred.</li> <li>– Include interactive start-up, maintenance and diagnostics support.</li> <li>– Suitable for copying parameters for back-up or for downloading to another drive.</li> <li>– Removable, without tools, for remote panel mounting.</li> <li>– Ensure if panel is removed, information is stored.</li> </ul>	<input type="checkbox"/>
Real-time clock and calendar	– A real-time clock, (including a battery back up) which can be used during fault logging.	<input type="checkbox"/>
In-built timers	<ul style="list-style-type: none"> <li>– External timer circuits are no longer required.</li> <li>– Built-in timers allow the drive to be started, stopped and the speed to be changed.</li> <li>– Relay outputs can be operated with timers to control any auxiliary equipment on site.</li> </ul>	<input type="checkbox"/>
<b>Communications</b>		
Serial communications	<ul style="list-style-type: none"> <li>– Modbus protocols built in as standard.</li> <li>– Fieldbus adapters for connection of Profibus-DPV1, DeviceNet, Ethernet (EtherNet/IP, Modbus/TCP, PROFINET IO).</li> <li>– Ensure it can connect to any PLC or HMI system.</li> </ul>	<input type="checkbox"/>
Input / Output	<ul style="list-style-type: none"> <li>– Multiple I/O points available as standard with expansion capabilities using standard plug-in modules.</li> <li>– Extensive control configuration capabilities, either hardwired or accessible via serial communication network.</li> </ul>	<input type="checkbox"/>
<b>Cooling</b>		
Water-cooled drives	The installed footprint of a water-cooled drive is small. Initial costs can be higher than air-cooled but provide lower TOTEX site costs when considering building cooling needs and 5, 10 or 15 year operation.	<input type="checkbox"/>
<b>Supply</b>		
Supply voltages	<ul style="list-style-type: none"> <li>– Provide standard solutions for 200, 400, 500, 690, 3300, 6600 V.</li> <li>– Standard pre-engineered and tested solutions should be available in modular and cabinet offerings.</li> </ul>	<input type="checkbox"/>
<b>Energy</b>		
Energy efficiency counters	<ul style="list-style-type: none"> <li>– Works out energy savings in kWh and MWh, cost of energy saved, carbon dioxide (CO<sub>2</sub>) emissions equivalent of energy saved.</li> <li>– Allows verification of energy savings before making investments in capital equipment.</li> </ul>	<input type="checkbox"/>
Energy optimisation	<p>A dynamic control technique that adapts to VSD output waveform to control the motor flux created at partial loads.</p> <p>A dynamic solution further reduces energy consumption across the speed range rather than basic look-up table solutions.</p>	<input type="checkbox"/>
Load analyser	<ul style="list-style-type: none"> <li>– Statistical tool to analyse and interpret drive behaviour, process energy efficiency and operation.</li> <li>– Provides information on system maintenance needs and can be used to illustrate and control energy efficiency.</li> </ul>	<input type="checkbox"/>
<b>Harmonics &amp; EMC</b>		
Low harmonics	A low harmonic drive ensures harmonics are mitigated at source in all operating scenarios when connected to a mains or generator supply.	<input type="checkbox"/>
Swinging "Chokes"	<ul style="list-style-type: none"> <li>– Delivers up to 25 percent fewer harmonics at partial loads compared to a conventional choke of equal size.</li> <li>– AC and/or DC chokes are required to ensure realistic 6-pulse harmonic levels are achieved.</li> </ul>	<input type="checkbox"/>
Integrated 2nd environment EMC filters (category C3)	EMC filters suitable for 400 V network connection built-in as standard. This saves panel space, avoids additional wiring, earthing and assembly costs required by default.	<input type="checkbox"/>
Tolerance to network dips	<ul style="list-style-type: none"> <li>– Verified tolerance to network interruptions in accordance with Semi F47.</li> <li>– Reduces spurious trips due to supply interruptions and transients.</li> </ul>	<input type="checkbox"/>
Closed loop active filters	<ul style="list-style-type: none"> <li>– Ensure specific spectrums on application are reduced to necessary minimum levels.</li> <li>– Reduced filter ratings can be selected with closed loop and these can be used on mains or generator supplies.</li> </ul>	<input type="checkbox"/>

# Product features

Intelligent Pump Control function (IPC)		Check ✓
Level control	Prevent sediment build up by randomly varying surface level within a preset range. Keeps tank and pipes clean by using a “flush effect” which rapidly pumps water through tank and pipes. <ul style="list-style-type: none"> <li>– Provide default macros for emptying, filling or constant level applications</li> <li>– Reduced tank maintenance costs</li> <li>– Control over pumps keeping systems operational at all times</li> </ul>	<input type="checkbox"/>
Pump cleaning	Runs pump backward and forward, or just backward rapidly to clean impeller, preventing build-up of solids on pump or inlet screens. Removes debris from around pump volute, preventing it from entering the pump and blocking it. <ul style="list-style-type: none"> <li>– Reduces the possibility of pump blockages</li> <li>– A regularly used pump cleaning function lowers weekly electricity consumption</li> <li>– Pump cleaning cycles can be customised to the pump OEM guidelines</li> </ul>	<input type="checkbox"/>
Multi-pump control	Controls flow rate of pumps running in parallel. Shares information between connected drives so operating time of pumps can be balanced. <ul style="list-style-type: none"> <li>– In-built energy saving function automatically selects best pumping routine</li> <li>– Dynamically controls the starting and stopping of multiple pumps to reduce surging</li> </ul>	<input type="checkbox"/>
Sleep and boost	Rather than keep pumps running to maintain pressure, the function slightly boosts pressure in pipeline before shutting pumps down, this allows pumps to sleep for long periods whilst pipe pressure is monitored within limits. <ul style="list-style-type: none"> <li>– Saves energy by extending sleep time and avoiding having pumps run continuously during low demand periods</li> </ul>	<input type="checkbox"/>
Soft pipe filling	Protects pipe networks from pressure peaks when starting the pump system. Allows a pipeline to fill smoothly before PID control is activated. <ul style="list-style-type: none"> <li>– Helps to reduce overpressure and reduce water hammer</li> <li>– Reduces burst pipes and seal damage during pump start</li> <li>– This functionality can help improve turbidity control</li> </ul>	<input type="checkbox"/>
Flow calculations	Reduces the need for external flow meters and is suitable for applications where flow data is not needed for invoicing purposes. <ul style="list-style-type: none"> <li>– Sensorless flow calculation (power curve) is easily configured and does not require pressure feedback</li> <li>– Alternatively use pressure transmitters to define the flow by using the pump head curve performance</li> </ul>	<input type="checkbox"/>
Pump protection	Increase time between maintenance intervals by avoiding mechanical damage. Uses data from pump curves and pressure transmitters to detect any abnormalities. <ul style="list-style-type: none"> <li>– Reduces failures</li> <li>– Increases maintenance intervals</li> <li>– High plant reliability</li> </ul>	<input type="checkbox"/>
<b>Maintenance</b>		
System diagnostics	The diagnostic assistant provides on-board fault history with the actual time of when the fault occurred, covering voltage, current, DC link level etc. Instant fault tracking and date stamping, gives the status of the drive to enable rapid drive diagnostics.	<input type="checkbox"/>
Run time accumulator	Counts the number of hours the drive is passing current to motor. Used with timer function, this can flag maintenance intervals.	<input type="checkbox"/>
<b>Macros</b>		
Macros	Multiple application set-up macros ensure a consistent set-up of drive parameters for identical applications.	<input type="checkbox"/>
<b>Protection</b>		
IP21 & IP54 protection rating options	Both versions can be wall or frame mounted with no requirement for enclosure or an additional backplate for heatsink cooling.	<input type="checkbox"/>
Coated printed circuit boards as standard	Improved resistance to environmental factors, withstands contamination levels in accordance with IEC 60721-3-3 class 3C2/3S2.	<input type="checkbox"/>
<b>Safety</b>		
Isolation/ safety	Safe torque-off (STO) and other functions can be used to stop/prevent the output of the VSD from modulating. Improves safety performance in an emergency situation	<input type="checkbox"/>
Safe torque-off	TÜV certified safety to SIL3/2 levels. Can be used to comply with safety PL levels without using an input contactor.	<input type="checkbox"/>
<b>Components</b>		
Fans and capacitors	Ensure there is an operating life of at least 7 years for fans and 10 years for capacitors, based on permanent operation on permanent operation at full load in 40°C ambient temperature.	<input type="checkbox"/>

# Service features

It is important to ensure that the variable-speed drive (VSD) supplier is capable of supporting the product throughout its life cycle. Below are some considerations.

Pre-purchase		Check ✓
Energy appraisal	In just half-a-day the energy saving potential of motor-driven applications could be known and an automated report generated.	<input type="checkbox"/>
Life cycle audits	A full life cycle analysis of the installed drives is carried out. A report with an action plan and recommendations is then created.	<input type="checkbox"/>
Harmonics survey	Identifies potentially damaging harmonics quickly. A report details recommendations and costs (TOTEX).	<input type="checkbox"/>
Harmonic selection tool	Provide optimised programs to calculate harmonics for G5/4-1 compliance. Provides detailed loss data to use in TOTEX calculations.	<input type="checkbox"/>
Control panel and system design	If drives are part of a larger control system, ensure supplier can help design complete system. Involving the drives supplier at outset saves time and assists in TOTEX considerations.	<input type="checkbox"/>
Applications support	Ensure the supplier has an extensive team of application and service engineers to ensure correct selection and set-up of the VSD systems.	<input type="checkbox"/>
<b>Order &amp; delivery</b>		
On-line ordering	Enables drives to be ordered instantly. Reduces paperwork and ensures fast delivery.	<input type="checkbox"/>
Rapid delivery	Drives are available at short notice from UK stock. Ensures that a plant is up and running the same day. Local authorised value providers carry considerable UK stock levels up to of drives up to 400 kW	<input type="checkbox"/>
Warranty (VSD's)	Typically 54 months from commissioning or 60 months from manufacture.	<input type="checkbox"/>
<b>Installation &amp; commissioning</b>		
Start-up service	Check installation, power up system and configure parameters. Ensures drive start-up is quick and efficient on first run.	<input type="checkbox"/>
<b>Operation &amp; maintenance</b>		
Preventive maintenance plan	Preventive maintenance consists of regular inspections and component replacements according to a product-specific maintenance schedule. Onsite preventive maintenance is carried out by certified field service engineers. This gives maximised drive system availability, quality of operation and life time, predictable maintenance budgeting and drive life time cost management.	<input type="checkbox"/>
Exchange units	ABB provides re-manufactured drives and drive modules in exchange for failed, repairable units. Known as exchange units, the drives and drive modules are re-manufactured to the original specification at ABB drive service workshops. Standard exchange units are available for dispatch from stock 24/7. Made-to-order units are dispatched the next working day.	<input type="checkbox"/>
Scheduled maintenance	For a complete fit-and-forget service, consider using a supplier who also offers scheduled maintenance. Scheduled maintenance programs should cover 0-20 year operation.	<input type="checkbox"/>
Spares	Ensure spares are readily available in the UK. Online ordering facilities provide 24-hour access. Spares delivery is typically 2-3 working days.	<input type="checkbox"/>
PC tools	Optimal commissioning and monitoring software. Storage of drive parameter sets and production of operation and maintenance manual documentation. Allows customisation of drive reducing operation need for a PLC to control small systems	<input type="checkbox"/>
Service agreements	Service agreements are available to ensure an ABB engineer or an authorised value provider (AVP) is available to respond in the event of any unplanned outages. The level of response ranges from a next working day site attendance, up to a 6 hour response to site. All service agreements can also contain maintenance resource and spares, both proactive and reactive if required. ABB can also offer combined service agreements that look after other ABB assets on site.	<input type="checkbox"/>
Withdrawable IGBT's	For high power VSD's consider the need for withdrawable IGBT's (or wheeled complete modules) to improve system redundancy and reduce time to repair.	<input type="checkbox"/>
Life cycle	A life cycle assessment provides a clear understanding of the drive installed base of a particular facility. It provides a management view for defining critical maintenance actions and planning maintenance for years to come.	<input type="checkbox"/>
Remote support	Remote support automatically and continuously collects performance data from drives. The data collected allows faster reactions in failure cases. Service engineers from the local ABB team can utilise this data to provide support.	<input type="checkbox"/>

# Technical features

While variable-speed drives are easy to select, install and commission, a supplier should be able to offer detailed technical advice. Some topics to consider are highlighted below.

Energy		Check ✓
Enhanced Capital Allowances (ECAs)	Motors (IE3 motors from 0.75 to 5.5 kW and IE4 motors from 7.5 to 355 kW) and drives qualify for ECAs. A variable-speed drive supplier with ECA know-how can help lower purchase costs.	<input type="checkbox"/>
IE4 and IE5 motor packages	Consider SynRM motor & VSD technology for easy compliance with IE4 efficiency performance levels (& future IE5)	<input type="checkbox"/>
<b>Supply network</b>		
Circuit breakers	Protection of low voltage drive inputs by standard MCBs or MCCBs avoids the use of larger and more expensive semiconductor fuses that can be difficult to apply. Tables of suitable circuit breakers should be available from the drive manufacturer.	<input type="checkbox"/>
EN 61000-3-12	Since February 2008, you need to meet the standard, EN61000-3-12. Compliant products make it easier to fulfill G5/4-1. Mandatory for products on a 400 V network.  Ensure your supplier has the necessary expertise on harmonics and is able to advise best practice. Also, ensure that your chosen drive has a suitable choke that suppresses harmonics effectively across the speed range and not just at full speed.	<input type="checkbox"/>
EMC compliance	Variable-speed drives needs to co-exist with other electric and electronic systems in any installation. A powerful current with a strong electromagnetic field can affect the performance of nearby devices with lower current levels. – Use three-core symmetrical shielded (armoured) cable – Use separate external earth (potential equalising) cable between motor and drive – Route power and control cables separately – Apply 360°C earthing at each end of the cable	<input type="checkbox"/>
<b>Drive selection</b>		
Medium voltage (MV) drive or low voltage (LV) drive selections in terms of kW steps	Between 800 kW and 1300 kW the project specific installation could favour either a LV or MV solution. Over 1300 kW MV packages are typically the default offering based on commercial and technical considerations. In single low voltage VSD applications (>400kW) with a dedicated MV connection, the solution is typically low harmonic or 12-pulse Low voltage (and low power) multiple VSD packages should consider active filtering where possible as a potential solution. Ask your supplier to prepare sound technical and commercial arguments for the most cost-efficient solution.	<input type="checkbox"/>
Matched drive and motor packages	Ensures correct dimensioning of the drive and motor. When purchased as a unit, the entire motor and drive installation qualifies for ECA.	<input type="checkbox"/>
Open network standards	Fieldbus offers greater flexibility than point-to-point hardwiring. It can give as many as 70 points of information and frees up the drive's I/Os, which can then be used to control your plant.	<input type="checkbox"/>
5-level switching	On MV VSD's ensure multi-level switching technology is used to ensure optimum output waveform.	<input type="checkbox"/>
Sine filtering	On MV applications, sine filtering should be available for ease of retrofitting VSD's into existing DOL applications.	<input type="checkbox"/>
Fuse-less designs	On MV applications consider a fuse-less design, this improves the reliability of the VSD.	<input type="checkbox"/>
Cooling redundancy	For high power dedicated VSD's (LV or MV) consider the need for cooling fan redundancy.	<input type="checkbox"/>
<b>Installation</b>		
Long cable runs	Typical applications involve motor cable length of between 30 and 100m. Without additional output chokes motor cable length restriction should be 100m. The supplier should be able to provide du/dt or sine filters to suit very long cable runs or weak motor insulation applications.	<input type="checkbox"/>
<b>Maintenance</b>		
Remote monitoring	Remote monitoring and diagnostic for pumping stations can be easily implemented with an optional adapter. Remote interface modules can send process data, logs and event messages independently without additional on-site devices. Easy access to pumping system in remote locations is possible to avoid unnecessary site visits.	<input type="checkbox"/>
<b>Motor selection</b>		
Motor insulation	Always ensure the motor insulation is designed for VSD operation at 400 V without the need for the VSD to be fitted with du/dt or sine filters.	<input type="checkbox"/>
ATEX	In ATEX applications, ensure the motor supplier can provide pre-certified VSD and motor packages.	<input type="checkbox"/>
Slow speed motors	To reduce VSD rating selection for slow speed motors consider using 690 V (star)/400 V (delta) designed motors supplied with 400 V (star), to improve the overall string efficiency.	<input type="checkbox"/>

# Training

## Target audience

C&I, maintenance, electrical engineers, asset managers or those responsible for the upkeep, maintenance or the electrical designs of variable-speed drives.

## Previous knowledge

There are no prerequisites for this training however it would be helpful if the student had a basic understanding of electrical installations and some experience of an industrial environment.

## Objectives

To alert engineers and management of the merits of using variable-speed drives to improve process efficiency, reduce energy and lower carbon dioxide emissions.

## Location

The courses can be presented at your premises or an ABB facility. Online content can be accessed from any web-enabled PC with an up-to-date browser.

To enroll on any instructor-led or e-learning course contact ABB:

call **07000 DRIVES (07000 374837)**

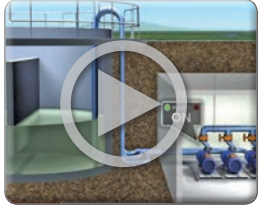
or email: [energy@gb.abb.com](mailto:energy@gb.abb.com)

Lunch and learn subjects	Duration	Tick
Harmonics and mitigation methods - Pros and cons of different technologies	45 mins	<input type="checkbox"/>
IPC (Intelligent Pump Control) software - what are the benefits? Which product ranges?	45 mins	<input type="checkbox"/>
Selection and operation rules for borehole & submersible pumps	45 mins	<input type="checkbox"/>
How to use the power factor correction facility when using low harmonic VSD's	20 mins	<input type="checkbox"/>
When to choose between a low voltage or medium voltage drive systems? A discussion of the pros and cons	30 mins	<input type="checkbox"/>
Overview and demonstration of programming and remote diagnostic software available	45-60 mins	<input type="checkbox"/>
Co-ordinating motor-driven systems for best efficiency - consideration of parallel pumping and best efficiency point. (BEP)	60 mins	<input type="checkbox"/>
SynRM technology - the new motor platform for achieving IE4 and IE5 efficiency performance	20 mins	<input type="checkbox"/>
How does a VSD affect the performance of a pump and offer alternative system curves	25 mins	<input type="checkbox"/>
How a VSD works and is constructed. A run through of the key hardware components and how these influence the correct design of a power drive system	45 mins	<input type="checkbox"/>

e-learning subjects			
Theme	Course Title	Course Reference	Tick ✓
Application and installation training	Basics of AC drives - Process control and various control methods	G101e_a	<input type="checkbox"/>
	Basics of AC drives - Hardware construction	G101e_b	<input type="checkbox"/>
	LV AC drives general installation practices	G020e	<input type="checkbox"/>
	LV AC drives general cabinet engineering principles	G089e	<input type="checkbox"/>
	Basics of active filters	S600e	<input type="checkbox"/>
	MV drives fundamentals	G790e	<input type="checkbox"/>
	AC drive dimensioning	G102e	<input type="checkbox"/>
	DriveSize fundamentals	G066e	<input type="checkbox"/>
	ATEX directives, ABB low voltage AC drives and motors	S021e	<input type="checkbox"/>
	Functional safety in ABB drives	G111e	<input type="checkbox"/>
Fieldbus training	Fieldbus basics for ABB drives	G107e	<input type="checkbox"/>
	Profibus basics	G113e	<input type="checkbox"/>
	Remote monitoring portal	G205e	<input type="checkbox"/>
Product specific training	Low voltage AC drives product portfolio	G060e	<input type="checkbox"/>
	ABB MV drives product overview	G791e	<input type="checkbox"/>
	Overview of drives PC tools	G061e	<input type="checkbox"/>
	ACS800 single drive fundamentals	G152e	<input type="checkbox"/>
	ACS800 multidrives fundamentals	G160e	<input type="checkbox"/>
	ACS800 liquid-cooled drives	G163e	<input type="checkbox"/>
	ACQ810 industrial drive fundamentals	G653e	<input type="checkbox"/>
ACQ810 product Introduction	G653e_a	<input type="checkbox"/>	
Life cycle and service training	Low voltage drives life cycle services	G062e	<input type="checkbox"/>

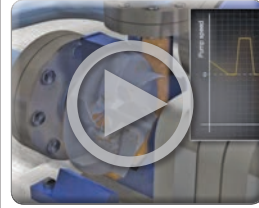
### Level control

Prevents sediment build-up by randomly varying the surface level



### Pump cleaning

Runs the pump back and forward rapidly to clean the impeller



### Soft pipe filling

Allows a pipeline to fill smoothly without pressure build up





### Multi-pump control

Controls the flow rate within pumps running in parallel



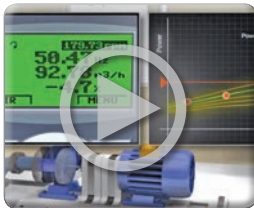
### Sleep and boost

Detects pressure drops in the pipes and runs the pump to boost it.



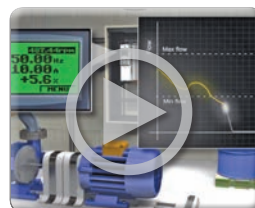
### Flow calculation

Determines the flow rate within a process



### Pump protection

Prevents damage to pumping systems by identifying abnormalities



## Learning



### Basic features of AC drives.

Learn about controlling motor speeds and energy savings, as well as control strategies.



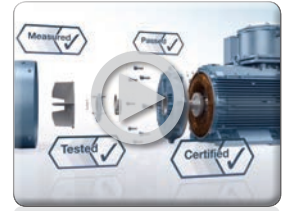
### Harmonic solutions

This video gives you an overview on how to tackle harmonics with the use of variable-speed drives.



### Low voltage motors for explosive atmospheres - reliability

This video about low voltage motors for explosive atmospheres focuses on reliability.



### Low voltage motors for explosive atmospheres - safety

In this first part of the series of videos we are showcasing the importance of safety.



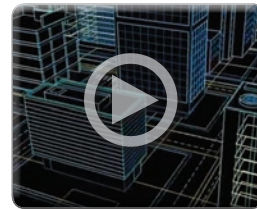
## Learning

## Services



### Soft starters versus variable-speed drives

This video explains the differences between soft starters and drives, and the applications where to use them.



### Low voltage AC drives preventive maintenance and reconditioning service

Learn about regular preventive maintenance of low voltage AC drives to ensure maximum availability.



### ABB energy appraisal

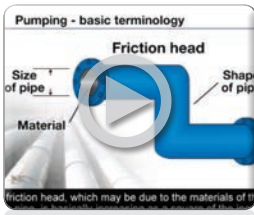
This video explains ABB's half-day energy appraisal, that can reduce energy consumption and lower costs.



### Low voltage motors for explosive atmospheres - service

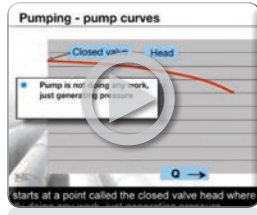
This video about ABB low voltage motors for explosive atmospheres focuses on service.





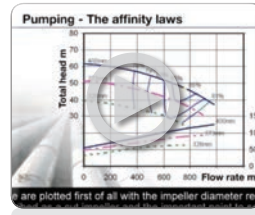
### Basics of pumps and pump curves - Part 1

This video introduces the basic terms and principles you need to know about to understand a basic pumping system.



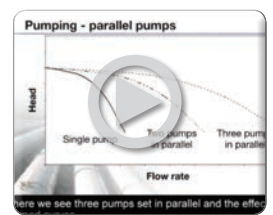
### Basics of pumps and pump curves - Part 2

This video explains the different pump curves provided by pump manufacturers and how to interpret them to understand the operation of a pumping system.



### Basics of pumps and pump curves - Part 3

This video explains affinity laws and how they affect a pump in terms of power, flow rates and efficiency.

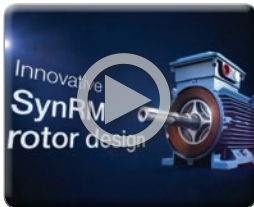


### Basics of pumps and pump curves - Part 4

This video explains how running pumps in parallel can affect the flow rate of the pumping system, and how to optimise these pump configurations with variable-speed control.



## Products



### ABB synchronous reluctance motor-drive package

Learn about combining totally new motor technology with a best-in-class industrial drive loaded with new, purpose-designed software.



### ABB drives - simple and reliable motor control with ACS200

Medium voltage drives are available for direct-to-line connection, for connection to an external transformer or with an integrated transformer.



### ABB regenerative drives

The ACS800 regenerative drives are equipped with an active supply unit. It allows full power flow both in motoring and generating modes.



### Low harmonic drive for outdoor use

The ACS800-38 low harmonic drive for outdoor use boosts productivity without compromise in the harshest of environments.



# Contact us

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