



A guide to selecting variable-speed drives
for use in buildings
Checklist for building services consultants

Re-write the rule book

Today's variable-speed drives (VSDs) bring enormous benefits to buildings, whether commercial, residential or industrial. Yet many of these benefits are not widely recognised. As a result, end-users could be missing out on significant cost and time savings available through:

- **Improved** energy efficiency, leading to lower energy bills
- **Faster** installation and commissioning times
- **Reduced** maintenance routines
- **Greater** adaptability when using drives in buildings
- **Greater** connectivity through automation networks

When specifying VSDs, consultants are urged to review their specification requirements and ensure that the selected drives - and the suppliers from which they are purchased - have, as a minimum, the features contained within these checklists.



Drive features for effective building control

Feature	Description	Benefit	Tick box
Swinging choke	Reduces drives' harmonic signature. Choke varies its impedance as motor load changes, thus optimising the harmonic signature at all loads. Traditional chokes have a fixed impedance and cannot adapt in this way. Patented by ABB.	As motor speed is adjusted to save energy or to optimise air volume, swinging choke ensures lowest harmonic signature. Harmonic signature on a standard choke will increase as motor speed changes.	
Meets EN 61000-3-12; Harmonic Product Standard	EN 61000-3-12 is a European standard limiting current harmonic pollution of a single product. Mandatory for products connected to a 400 V network. In UK, G5/4 takes precedent as a system standard.	Swinging choke technology provides a good start for compliance to EN 6100-3-12. Meets UK site-wide standard G5/4-1 where system harmonics are important. A VSD supplier should be able to assist with site-wide harmonic surveys and offer active closed loop filter solutions to solve potential problems.	
Active power quality closed loop solutions	Systems can include active power quality equipment which actively measures and mitigates harmonics detected on network.	Measures pollution, actively generates solution and measures result to ensure compliance.	
EMC compliance to IEC/EN 61800-3 (2004) (Manufacturer's certification DoC statement available)	IEC/EN 61800-3 (2004) is specific EMC standard for power drive systems (PDS) and requires a motor to be connected to VSD to achieve compliance. In Europe it takes precedence over other generic standards e.g. EN55011 which do not require motor connection. Claiming EN55011 to a PDS system is a mis-application of this standard.	EMC filters built into drive as standard save panel space, avoid additional wiring, earthing and assembly costs. C2 and C3 compliance up to 300m, longer cables are possible with sine filter installation. <i>(Note: C1 is not relevant as the drive requires skilled cable installation, so C1 cannot be claimed).</i>	
Circuit breakers	Protect drive input with installation of standard. MCBs or MCCBs. Supplier should have extensively tested circuit breakers and be able to provide an approved list of tested devices.	Earlier generations of drives were often protected by larger and more expensive semiconductor fuses which were difficult to apply. MCBs or MCCBs are easier to install and use.	
Sinusoidal vibration compliance during operation	Drive is able to withstand following vibration levels: <ul style="list-style-type: none"> – Mechanical conditions: Class 3M4 (IEC60721-3-3) – 2...9 Hz 3.0 mm (0.12 in) – 9...200 Hz 10 m/s² 	Drive will withstand conditions when mounted directly within AHU. It is useful to mount drive within AHU (utilising remote keypad kit) as an additional enclosure is not required and outdoor environments are easily catered for.	

Feature	Description	Benefit	Tick box
50°C ambient temperature (Manufacturer's statement available)	Ensure drive can operate in ambient temperatures up to 50°C whilst still providing typical IEC motor current. Ensure higher currents at lower ambients can be provided.	Drive always has enough current to operate motor in application. Drive does not have lower available currents as ambient conditions increase from typical UK switch-room conditions, thus difficulties during commissioning or operation are avoided. If ambient conditions are accurately known, then more optimal, cost effective, selections can be made. If necessary drive can automatically de-rate if programmed accordingly.	
Coated boards as standard Isolation/safety	Special varnish coated on all printed circuit boards for protection. Drive equipped with an input isolation device, to remove power from drive and can be locked in "off" position.	Improved resistance to environmental factors, withstands contamination levels in IEC 60721-3-3 class 3C2/3S2 Motor isolation is possible without any external equipment and without inconvenience of requiring interlocked isolation in motor cable. Isolating drive internally also removes need to provide an EMC compliant enclosure for motor isolator.	
Tolerance to network dips (Manufacturer's statement available)	Verified tolerance to network interruptions in accordance with Semi F47. Drive is equipped with a suitably rated DC link capacitance and can be programmed to recover energy from load to extend ride-through time.	Reduced spurious trips due to supply interruptions and transients. Critical equipment can be kept operational during power dips, energy recovery from load can increase duration of ride-through.	
BACnet interface built into drive as standard	BACnet is an open serial communication protocol and is fast becoming HVAC industry standard, due to its "open" nature. BACnet does not tie system into a particular manufacturer's hardware. Communication can be via RS485 or Ethernet hardware medium, allowing different communication media.	BACnet over RS485 and BACnet IP over Ethernet is possible. Easy integration to BMS and building controllers, allowing large amounts of data or control signals to be exchanged with minimal cabling (compared to traditional I/O). BACnet allows complete access to drive parameter information, including all information surrounding energy saving and other operational parameters.	
Additional serial communications	HVAC protocols built in as standard. BACnet, Modbus RTU, FLN Apogee, N2 Metasys. Additional fieldbus adapter allows connection of: LonWorks, Profibus-DP, CANopen, DeviceNet, Modbus/TCP, ControlNet, Ethernet IP.	Ensure drive has such a wide range of protocols allowing it to connect easily to any BMS. <i>Note: ABB are not aligned with any single protocol but support all, to allow maximum flexibility. If protocol is not known at beginning of a project, an ABB drive could be best choice.</i>	
Emergency override operation mode (Fireman's override) (Run to destruction) (Smoke extract mode)	Drive programmed to ignore most of its trips and warnings that would normally stop it if application was at fault. Override function is password protected for security and can be programmed to turn motor at a pre-defined speed or direction once mode is enabled. "Trigger" input can be programmed to come from a number of sources so fireman can initiate mode when required.	Feature is designed to allow fire department to use drives to assist with smoke extraction. Input is triggered with a special key and drives operate HVAC motors in reverse to remove smoke from building, assisting with visibility and safety during fire fighting. Drive ignores functions that normally stop it operating, giving priority to its continued operation.	
Range of IP protection ratings	IP ratings define protection levels for ingress from dust and protection against water; they do not define ability of drive to be mounted outdoor. Outdoor mounting requires control of heating and UV effects of direct sunlight and effects of temperature variations across year which will cause condensation to form. These effects cause premature drive failure. z-High IP ratings do not guarantee successful outdoor mounting.	Ensure IP21 and IP54 available as standard, allowing flexible mounting within control rooms or within AHU fan sections without need for additional backplate for cooling purposes. Drives can be mounted side-by-side, reducing required panel size or wall space. Outdoor mounting requires design to control effects of sunlight, UV and condensation.	

Drive features for effective building control

Feature	Description	Benefit	Tick box
Real-time clock / automated building control	<p>Drive should contain a real time clock (RTC) with time and date functionality.</p> <p>Clock can be used in conjunction with extensive timer functionality to automate fan or pump control depending on time of day.</p> <p>Timers can be used to change speed or automatically stop and start motor, thus operating like a simple BMS.</p>	<p>Drive should be able to operate standalone, without need for BMS input.</p> <p>Ensure pre-programmed times and “boosted” times can be employed.</p> <p>Ensure energy can be saved by tailoring drive operating time to occupancy levels and opening times of building or facility.</p> <p>RTC time stamps event, faults and warnings, making diagnostics easier.</p>	
Drive control panel (keypad)	<p>Among control panel features to consider are:</p> <ul style="list-style-type: none"> – multilingual alphanumeric display for easy drive programming. – various assistants and a built-in help function to guide user. – real-time clock for fault logging and for controlling drive, such as start/stop. – ability to copy parameters for backup or for downloading to another drive. – large graphical display and softkeys for easy navigation. – IP54, and ability to mount keypad remotely to drive, on outside of an AHU or cabinet. – IP66 covers. – ability to be removed without tools. – keypad display that is easily customised to display user-specific values. 	<p>Keypad is a familiar interface as it mimics mobile phone operation.</p> <p>Ease of use means set-up times are reduced and reliable installations are produced, thus reducing cost of the overall installation.</p> <p>Ability to copy parameters between drives reduces set up times for a large system.</p> <p>Context sensitive help available at press of “?” key, so user has no reliance on manual.</p> <p>Several remote mounting options so keypad can be mounted anywhere.</p> <p>User can display up to three clear and relevant values on keypad which are appropriate for application to aid diagnostics and running conditions.</p>	
Smart modes of operation	<p>HVAC control panel (operator keypad) should have several different modes for configuring, operating and diagnosing drive:</p> <ul style="list-style-type: none"> – output (standard display) mode – shows drive status information and operates drive. – parameter mode – edits parameter values individually. – assistants mode – guides start-up and configuration. – changed parameter mode – shows changed parameters. – drive parameter backup mode – uploads or downloads parameters between drive and control panel. – time and date mode – sets time and date for drive. – I/O settings mode – checks and edits I/O settings. 	<p>Modes presented to user as menu choices on keypad, which can easily be selected using navigation keys.</p> <p>Some modes give further diagnostic help, like changed parameter mode which just presents parameters that have been edited, making it simple to spot programming mistakes.</p> <p>Other modes report status of I/O, making it easy to see if control signals are arriving at drive.</p> <p>Back-up mode ensures there is always a valid list of “as commissioned” parameters to revert back to in case of editing errors.</p>	
Startup assistant and drive optimisers	<p>Ensure keypad contains an assistant which guides user through basic drive start-up, requesting only motor information and control information to be entered.</p> <p>Help screens should be available with this assistant to find data needed to enter into drive.</p> <p>Optimisers exist to assist with configuration of noise smoothing, energy efficiency, PID, fieldbus set-up and motor control.</p>	<p>Quick and easy setup of drive, which reduces time taken to get system up and running. Because startup is guided, it is more difficult to miss out important steps.</p> <p>Assistant allows user with little drives experience to get drive operating properly and effectively.</p> <p>Optimisers target popular configurations of drive and guide user to make best choices for a number of functions.</p>	

Feature	Description	Benefit	Tick box
Intelligent diagnostics assistant	<p>If a fault occurs drive reports problem then starts diagnostic assistant, which guides user to cause of problem, suggesting reasons why fault has occurred and how to fix it.</p> <p>Drive contains a list of signals which can be used to track a problem, including I/O status and power stage values.</p>	<p>Faults are quickly resolved by saving down time. Most faults associated with drives come from driven application so diagnostic tool guides user to most appropriate reason quickly.</p> <p>Any faults are stored with a time stamp, so time of day can be determined and association with plant issues resolved, again helping to diagnose real root cause more effectively.</p> <p>Assistant allows users with limited drives knowledge to diagnose problems with system.</p>	
Protection features for pumps and fans	<p>Drive should be able to identify any mechanical issues associated with driven load.</p> <p>Fan belt breaks, pump cavitation, end of curve monitoring, dry run protection and blocked filters can be monitored.</p> <p>Drive can be programmed to react in different ways to these triggered events.</p>	<p>Early warning of problems can be generated by drive, allowing preventive maintenance activities to be undertaken.</p> <p>Broken belts on AHU are a common problem which can be easily communicated to building operator.</p> <p>As filter becomes dirty, early warnings can be detected, so filter changes can be performed in time, thereby saving money on changing filters before they are needed, or being reminded to change a filter that has become blocked.</p>	
Mechanical resonance avoidance	<p>Mechanical resonances can be avoided by programming "disallowed" fan or pump speeds.</p> <p>These speeds are specific to mechanics of system, so have to be tuned according to natural system resonant frequencies. Once discovered, drive prevents motor from turning at these speeds and hence avoids resonance build up.</p>	<p>Drive ensures best efficiency - not wasting energy turning motors that are effectively doing no useful work.</p> <p>Resonances can damage mechanics of system, so preventing build ups avoids expensive mechanical damage.</p> <p>Resonances can also generate high levels of audible noise which can affect occupants of a building or premises.</p>	
Audible noise smoothing	<p>VSDs can cause motor to generate audible noise.</p> <p>Audible noise smoothing controls waveform being delivered to motor to ensure lowest possible noise, whilst ensuring drive does not operate outside its own thermal limits.</p>	<p>Building occupants sometimes complain about noise from VSD controlled systems. This mode reduces noise to inaudible levels, and ensures comfort of building's residents.</p>	
Energy optimisation and efficiency	<p>This automatically controls motor magnetisation across speed range to minimise energy being used at all points.</p> <p>Energy optimisation can typically reduce energy being used by 10 – 15 percent (partial loads)</p>	<p>It is essential that motors are controlled using the least possible energy so drive must automatically detect changes in load and control motor magnets to lowest possible level, thus saving energy.</p> <p>Energy savings can be transmitted via system fieldbus to central logging equipment.</p>	
Energy efficiency counters	<p>Energy counter calculates energy savings compared to equivalent direct-on-line, showing savings in kWh, MWh, CO2 emissions and money saved.</p>		
Load analyser	<p>Statistical tool to analyse and interpret drive behaviour and to analyse process energy efficiency and operation.</p>	<p>Provides information on system maintenance needs and can be used to illustrate and control system's energy efficiency.</p> <p>It allows user to identify periods of unexpectedly high (or low) load and can point towards system optimisation improvements.</p>	
Predefined application configurations (Macros)	<p>As default, ensure drive is configured to operate in "BMS control", which suits many applications straight from box.</p> <p>With a single parameter edit, control data and I/O configurations are set up to match the chosen application, e.g. supply fan, return fan, cooling tower etc.</p> <p>Two user-defined blank macros enable custom made configurations to be generated.</p>	<p>Macro selections save time in configuring drive to perform required function and also standardise way a set of applications are configured, reducing errors made during commissioning and reducing time taken to complete work.</p>	

Drive features for effective building control

Feature	Description	Benefit	Tick box
Maintenance assistant	Drive should contain a number of programmable maintenance triggers that can send a real alarm (via I/O or fieldbus) to report when filters, belts or motor maintenance is required.	Used with timer function, this can flag up maintenance intervals. Performing maintenance before a fault occurs is more efficient and saves time and money for end users and building operators. Preventive maintenance can be undertaken.	
PC based commissioning, monitoring and parameter editing tool.	Allows access to all parameter settings and allows drive to be controlled and tuned from a laptop.	Modern drives require a PC tool to allow parameterisation and parameter storage. Ability to edit and tune parameters whilst monitoring signals live in monitor window makes tool an ideal commissioning aid. Offline parameter files can also be generated (and saved), so configurations can be generated before arriving at site. Backups can be made and parameter set-up lists can be generated for client documentation.	
Input/output capacity	Ensure that all I/O is fully programmable for maximum flexibility (the macros can pre-configure them)	Extensive control configuration capabilities, since all I/O points are programmable; they can be connected to internal functions and supervision parameters, so I/O can give indications as well as controls. I/O can be either hardwired, or can be accessed via serial communication network, effectively utilising unused onboard drive I/O as remote I/O across fieldbus.	
Designed for a lifetime	Typically main components should be designed to have long lifetime and to operate in poor environments and elevated temperatures. For example, fans should be designed to operate for 60,000 hours at full 50 degree ambient; doubling at 40 degrees; and doubling again at 30 degrees.	Drives are designed to be a high end quality product. Great care is taken to ensure components and equipment are designed and manufactured to highest standard.	
Every single drive tested on a real motor at full load	Test every single VSD on production line on a real motor at full load and at elevated temperature for at least 2 hours.	Testing VSDs on fixed inductors does not exercise power bridge of a VSD properly and latent failures can be missed. Only true test for a VSD is to run it on a fully functional motor. Motors used in test department are mounted back-to-back with a generator, so load energy being taken from VSD is regenerated back to mains supply of factory, so test department aspires to be energy efficient as well.	
Extensive warranty	Look for at least 30 months from manufacture.	Drives come with extensive warranty coverage to ensure peace of mind with regard to product quality and reliability. Worldwide coverage ensures continued support regardless of location.	

The right drive and advice for your application

Service checklist

There is more to specifying VSDs than the product. As much emphasis should be given to the levels of service and support that a manufacturer offers. Here is a further checklist of key considerations when selecting a drive manufacturer or supplier:

HVAC application and market expertise	Your supplier should have the expertise and support literature to help resolve any technical issues within your project, on complex subjects including: dimensioning, EMC and harmonics.
Harmonics surveys	Ensure extensive harmonic knowledge is available to offer appropriate advice in relation to harmonic mitigation techniques. The company should offer advice and recommendations to ensure adequate measures are chosen to reduce risk of future problems as a result of harmonics. Look out for services such as desktop harmonic analysis and on site harmonic measurement surveys.
Training and product support	A good supplier offers certified training for its drives along with extensive support to ensure users can get the best out of the products. Bespoke training courses should be available according to specific customer requirements.
Energy analysis and free energy appraisals	Does your supplier have an established partner network? Can they offer free site energy appraisals, designed to maximise energy savings and returns on investment for fan and pump applications? Can the same network install new drives and carry out before and after proof of savings? Are loan drives available to prove energy savings?
Technical support and sales support	A dedicated team of technical support engineers should be on hand to help with all your queries. If commissioning assistance or setup help is required, engineers will help guide you through. Your supplier should be able to assist in all aspects of sales process, helping with specification of options, details of deliveries and information regarding purchase and supply of drives.
Nationwide network	A supplier should offer product and application support, commissioning, service, repair and replacement by ensuring a local presence regardless of location of VSD.
Rapid delivery	Drives available at short notice from UK stock.
Complete product offering	Your drive supplier should be able to help you with associated technology such as motor starters, flowmeters, pressure transducers, power quality filters, contactors, relays, fieldbus solutions and switchgear.
Control panel and system design	If your drives are part of a larger control system, you may want your drive supplier to help design complete overall system.
CRC Energy Efficiency Scheme (CRC)	UK Government's mandatory initiative to reduce carbon dioxide (CO ₂) emissions from organisations meeting certain qualification criteria. Make sure your supplier knows and understands what is involved.
Enhanced Capital Allowances (ECA) available	Drives and motors qualify for enhanced capital allowances (ECAs) to assist with the investment costs relating to VSDs and their installation.

Contact us

For more information visit

www.abb.co.uk/hvacdrives

Click on “HVAC Consultants” to locate the AC Drive Technical Specification.

Or call ABB’s BrochureLine on:

0800 783 7491 and ask for the technical specification to be sent to you.

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