Drives and motors

A guide to using variable speed drives and motors in data centres
Meeting your Carbon Reduction Commitment (CRC)

Power and productivity
for a better world™

The power behind the data

Private and public businesses, from banks to supermarkets, to telecommunications companies and internet providers depend on data centres for gathering, storing and managing vast volumes of data in a reliable, efficient and secure way, powering everything from online shopping transactions through to storage and retrieval of hospital records.

Any form of data loss can have a disastrous impact on the business. As such, data centres suffer high operating and maintenance costs.

Not surprisingly, they require massive amounts of power to keep them running smoothly and efficiently. The ever-increasing demand for computing power has a significant impact: with the new technologies, between 20-22 kW of power is required for each single rack, compared to 4-5 kW normally needed in the past. In the future, these environments will become one of the main consumers of power in the world.

With the continued growth of the internet and electronic banking, the need to deliver data storage solutions that also help improve energy efficiency and the levels of power used within such a centre has never been greater.

All of which affects plant costs: the electrical and mechanical aspects of a new office building usually equal to 15 percent of the investment, but with a data centre this value increases to 70 percent.

CRC Energy Efficiency Scheme

Organisations that consume more than 6 GWh/year and use a half-hourly meter, must register for the CRC Energy Efficiency Scheme – a mandatory scheme to promote energy efficiency and reduce carbon emissions. The CRC Energy Efficiency Scheme is a new UK business tax and is the UK government's preferred method when it comes to controlling emissions. The CRC Energy Efficiency Scheme will have cash flow implications for qualifying organisations, as businesses will have to pay for their emissions. An energy saving of 5 to 10 percent will be needed to cover the extra tax burden the scheme will generate.

The CRC treats whole sections of the economy as a single entity and set targets for group rather than individual companies. Each organisation will have to pay the exchequer £12 per t/CO_2, with the cost steadily rising as the UK approaches 2020 - a key date for European climate change. Each year a league table will be produced, highlighting the best and worst performers in the scheme based on total CO_2 reduction.

Variable speed drives
Data centre running costs can be significantly reduced by as much as 50 percent with variable speed drives from ABB. These devices control the flow of pumps and air conditioning fans to eliminate the energy waste that is common with conventional pump and fan control methods.

Typical savings
- Typical data centre may have approx. 70 fixed speed motor applications.
- Average power per motor is 7.5 kW.
- Typical motor power could be > 0.5 MW.
- Typical running costs could be > £450 k per annum
- Typical financial savings could be > 20% i.e £90 k per annum.
- Payback < 2 years.

How variable speed drives work
Many existing pump and fan systems are based on throttling arrangements: the motor is driven at full speed and then the flow of liquid or gas is regulated by valves, vanes or similar throttling mechanisms. Throttling the output in this way wastes energy. An AC drive can increase the system's efficiency by adjusting the motor speed to the correct operation point and eliminating the need for throttling.

A small reduction in speed can make a big difference in energy consumption. A centrifugal pump or fan running at 80% speed consumes only half as much energy as a unit running at full speed. This is because the power required to run a pump or fan changes with the cube of the speed.

Because many pump and fan systems run at less than full capacity for much of the time, variable speed drives can produce huge savings. If a 100 kW fan is throttled by 20%, for example, the investment in a variable speed drive will have a payback of typically six months based on continuous operation.

Benefits of variable speed drives
Commercial
- Reduced energy consumption – from 20 to 50 percent
- Fast payback – from six months
- Reduced CO_2 emissions
- Enhanced Capital Allowance (ECA)
- Interest-free loan from the Carbon Trust
- Contribute to meeting Carbon Reduction Commitment (CRC)

Technical
- Lower maintenance costs
  - Starting, stopping and braking can easily be programmed to reduce stress on mechanical equipment
  - Increases equipment life and reduces maintenance requirements for pumps, motors and pipework
- Easily retrofitted into an installation
- Real time clock
  - Can easily set up programmes with different running speeds at different times or on different days
- Low harmonic solutions available as part of installation design

Who benefits from variable speed drives and motors
Financial controller
- Significantly reduced energy bills
- Rapid return on investment
- Access to Carbon Trust loans
- Qualify for Enhanced Capital Allowance (ECA)
- Contributing to Carbon Reduction Commitment (CRC) obligation
- Lower maintenance costs
- Substantial contribution to environment by lower CO_2 emissions

Facilities manager
- Gain control of air conditioning costs
- Easily retrofit VSD to installation

Maintenance engineer
- Reduced maintenance on pumps and fans, hence lower costs
- Adjusting speed according to demand saves wear and tear on pumps, fans and motors

Data centre applications for variable speed drives

Challenges facing air conditioning

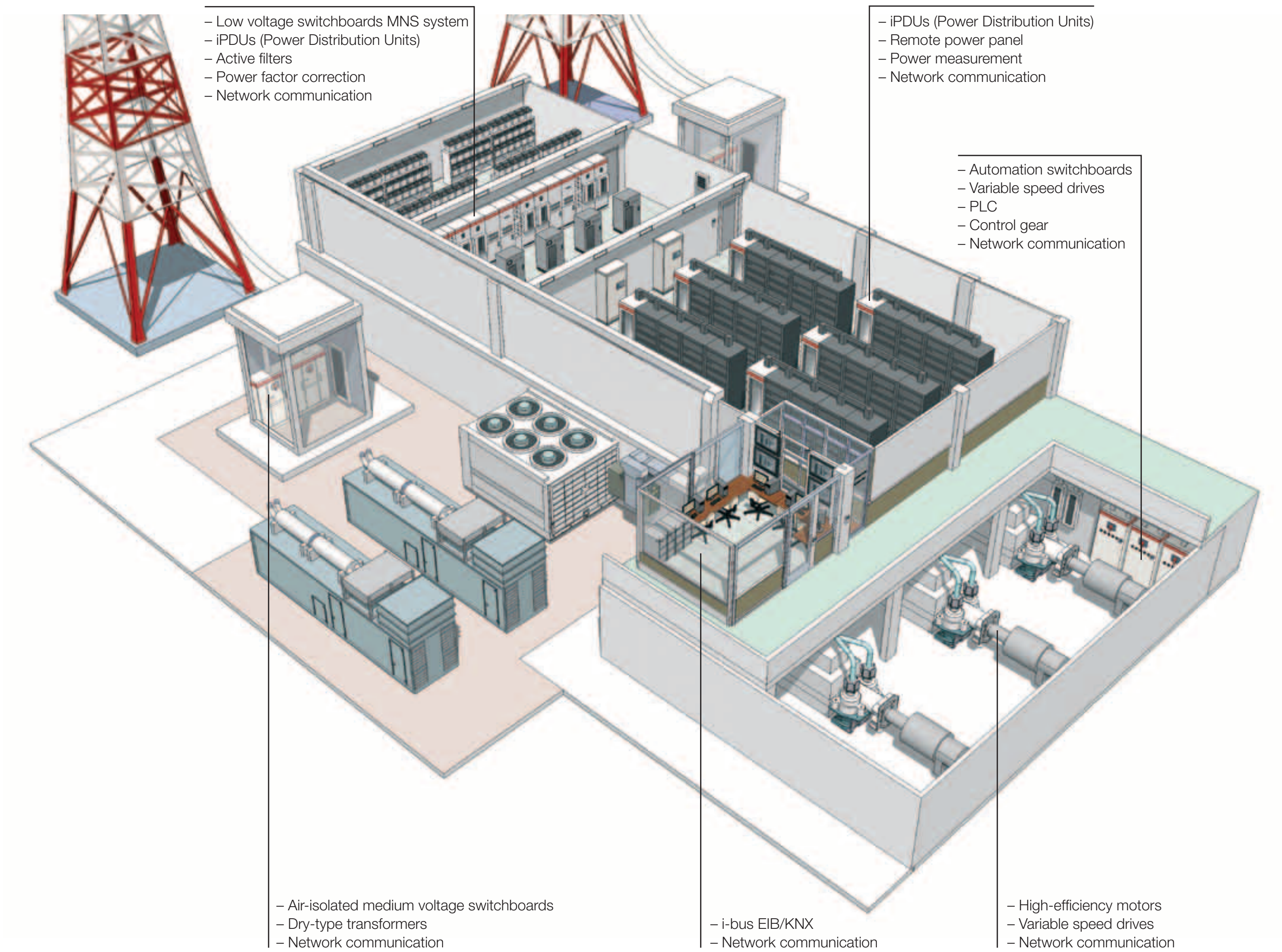
As the servers are always operating around the clock, one of the highest operating costs is the air conditioning, which is normally set to 20°C and requires one watt per watt used in computing functions.

Air conditioning is used to control the temperature and humidity in the data centre. The recommended temperature range is between 20 to 25°C (68 to 75°F) and humidity range of 40 to 55% with a maximum dew point of 17°C as optimal for data centre conditions.

The electrical power consumed by the servers heats the air in the data centre. Unless the heat is removed, the ambient temperature will rise, resulting in electronic equipment malfunction. By controlling the air temperature, the server components at the board level are kept within the manufacturer's specified temperature/humidity range.

Air conditioning systems help control humidity by cooling the return space air below the dew point. Too much humidity, and water may begin to condense on internal components. In case of a dry atmosphere, ancillary humidification systems may add water vapour if the humidity is too low, which can result in static electricity discharge problems which may damage components.

ABB's electrical solutions for data centres

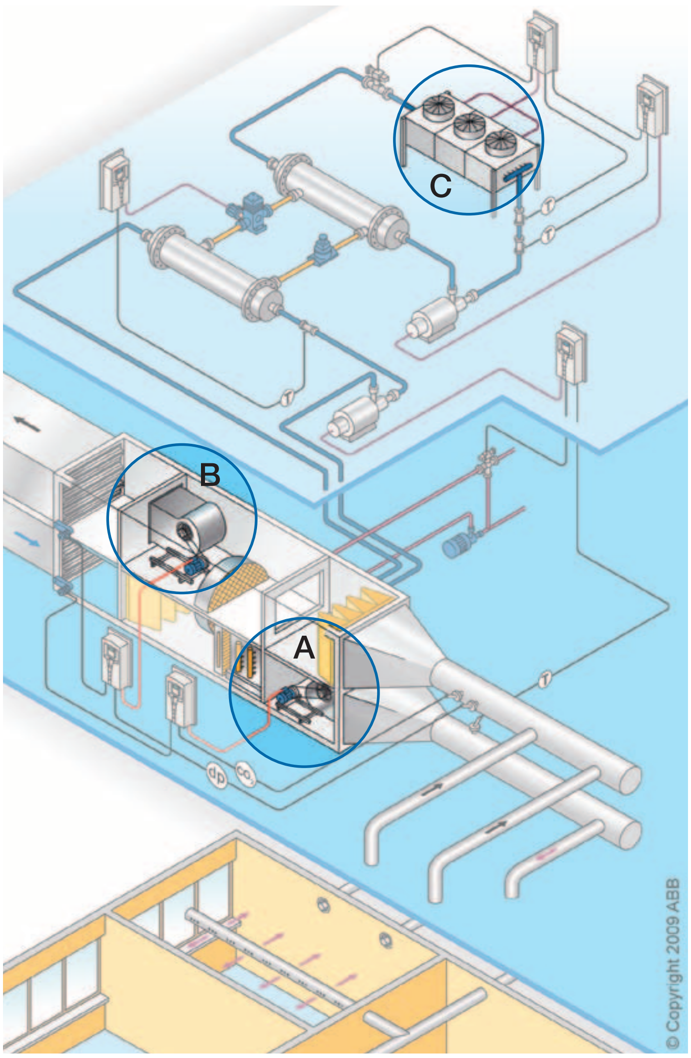


Supply fan (A)

Room air quality is controlled by changing the speed of the supply fan according to the CO_2 content of the exhaust air. The outdoor air damper will be opened when the fan is started. Operation is enabled when the damper is fully open (damper end switch).

Benefits:

- Energy savings
- Accurate control to keep desired air quality/CO_2 content
- Reduced maintenance of mechanical equipment such as belts and bearings due to reduced operating speeds and AC drive soft starting and stopping
- Easier to maintain low noise levels
- Approximately 30% reduction in CO_2 emissions and energy



Return fan (B)

Room pressure is controlled by changing the speed of the return fan according to the exhaust duct pressure. Return fan keeps up constant pressure in the exhaust duct by using PID control. Exhaust air dampers will be opened when the fan is started. Operation is enabled when damper is fully open (damper end switch).

Benefits:

- Energy savings
- Accurate control to keep desired duct pressure
- Reduced maintenance of mechanical equipment such as belts and bearings due to reduced operating speeds and AC drives soft starting and stopping
- Easier to maintain low noise levels
- Approximately 30% reduction in CO_2 emissions and energy

Liquid cooler fans (C)

Liquid cooler fans are controlled according to the temperature of the condenser water outlet. Condenser water temperature is kept constant with PID control. To prevent unnecessary cooling, liquid cooler fans are not started until the condenser water pump exceeds maximum speed. If water temperature falls too low, circulation can be stopped with a solenoid valve. Fans can also be programmed to run fixed speed for a certain time, for example once a week, to avoid condensation in the motors.

Benefits:

- Energy savings
- Easier to maintain low noise levels
- Accurate control to keep desired condenser water temperature
- Approximately 15% reduction in CO_2 emissions and energy

Condenser water pump (D)
Condenser water pump is controlled with a PID controller according to the temperature of the condenser water. Operation is enabled when the chilled water pump and the chiller compressor are running.

Benefits:
- Energy savings
- Accurate control to keep desired condenser water temperature
- Elimination of water hammer due to soft starting and stopping
- Reduced pump and pipe sizes
- Approximately 25% reduction in CO_2 emissions and energy

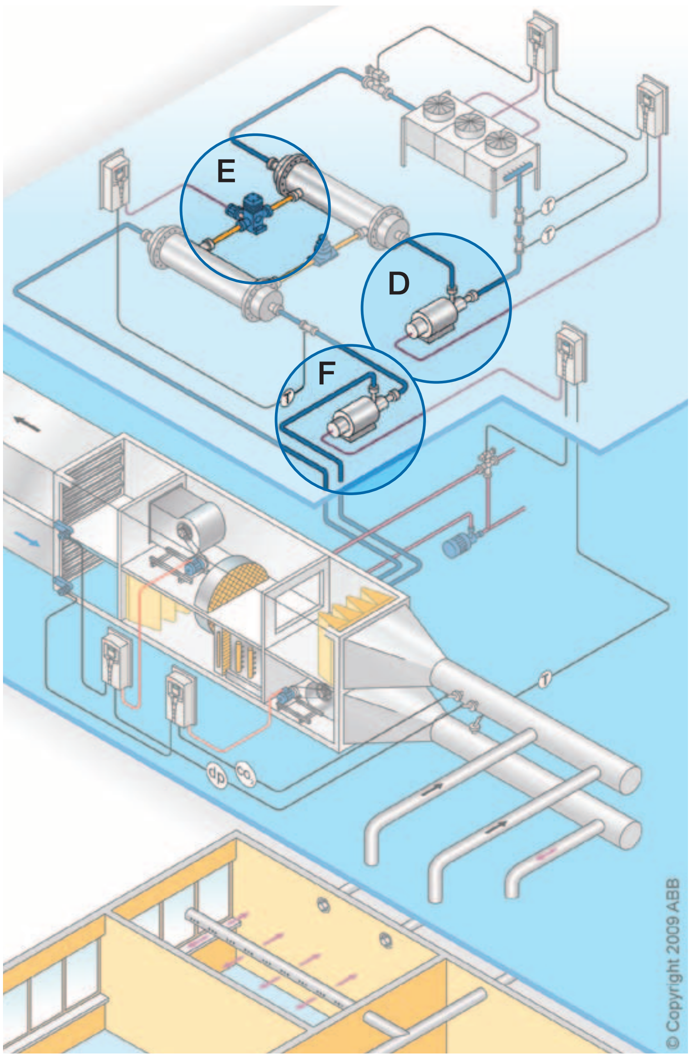
Chiller compressor (E)
The need for chilled water or CO_2 cooled racks can lead to space problems – for one square metre of technical space, one square metre of plant space is required plus two square metres of ancillary and accommodation space. This excludes any main substation(s) that may be required.

An AC drive optimizes compressor motor speed to actual cooling demand. The compressor is controlled according to the temperature of the chilled water. The compressor's minimum speed is 60 per cent of its normal speed. Operation is enabled when chilled water pump and condenser water pump are running.
- Approximately 20% - 50% energy reduction

Benefits:
- Energy savings
- Reduced peak demand charges
- Elimination of water hammer or hydraulic shock due to soft starting and stopping
- Increased chiller life
- Tighter chilled water temperature control
- Reduced maintenance demand
- Approximately 20% reduction in CO_2 emissions and energy

Chilled water pump (F)
Chilled water pump circulates chilled water in a cooling coil according to the temperature of the supply air. Operation is enabled when the duct temperature rises above a preset level and chiller compressor is running.

Benefits:
- Energy savings
- Accurate control to keep desired duct temperature
- Elimination of water hammer due to soft starting and stopping
- Reduced pump and pipe sizes
- Approximately 25% reduction in CO_2 emissions and energy



Life cycle support

The drive for the future

When you choose an ABB drive, you automatically become part of the most comprehensive product life cycle management scheme in the industry.

Product life cycle management model

The life cycle management model divides a product's life cycle into four phases: active, classic, limited and obsolete. Each phase has different implications for the end user in terms of services and support provided.

In the 'active' phase the end user benefits from warranty options and a full range of life cycle services, spare parts and maintenance materials. This phase ends when the volume production of a particular product ends and the 'classic' phase starts. In addition to offerings available in 'active' phase, end users may migrate to new technology by using upgrade and retrofit solutions providing improved performance and extension of the life cycle.

After the 'classic' phase products enter the 'limited' phase and end users are recommended to start planning a transfer to new technology before product support ceases.

Spare part services continue as long as components and materials are available, and throughout the course of time the use of reconditioned parts increases.

A product is transferred to the 'obsolete' phase when it is no longer possible to provide life cycle services within reasonable cost or the old technology is no longer available.

Benefits of product life cycle management

Product life cycle management maximizes the value of equipment and maintenance investments by:
- ensuring spare part and competence availability throughout the life cycle
- enabling efficient product support & maintenance for improved reliability
- adding functionality to the initial product by following the upgrade path
- providing a smooth transition to new technology at the end of a product's life cycle
- helping the end user to decide when an upgrade, retrofit or replacement is required

ABB's life cycle management model ensures that the required product support is always available and paves the way for a smooth transition to a new product at the end of the life cycle. A drive product will remain current for about 5 to 10* years, known as the 'active' phase. After this, service support will remain available for a further 5 to 15 years, the 'classic' phase.

Through contact with ABB you will be kept up to date with the support plans for your drive. At the end of the product life, you will be recommended an appropriate replacement. The old drive will be removed and recycled in accordance with local regulations.

* Dependent on size of drive

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