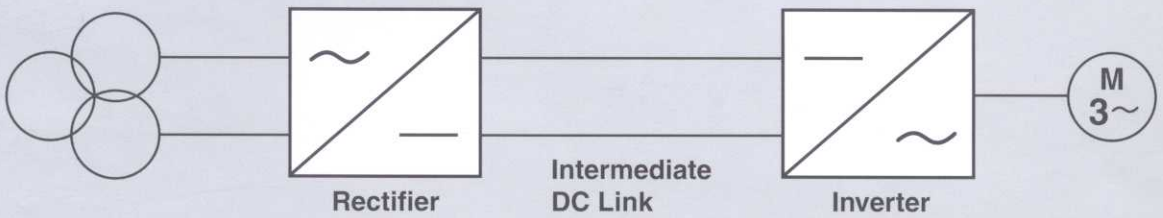


A Guide to Standard Medium Voltage Variable Speed Drives

Part 2:

Choosing a motor control platform and drive system



A guide to medium-voltage standard AC drives

Who should read this guide

This Technical Guide is available in six parts from the ABB address given on the back cover.

It is aimed at the key decision makers engaged in the specification, selection, purchasing, installation and/or commissioning of medium-voltage AC variable speed drives, as a standard solution.

It is therefore aimed at electrical, mechanical and plant engineers as well as managers, consultants and technicians.

There is a new thinking within industry. Standard, 'off-the-shelf' medium-voltage AC drives can often be a more cost effective solution than traditional 'engineered' drive systems, which are tailor made and consequently more costly.

This Technical Guide series, therefore, aims to give a basic understanding of the technologies and practices presently available to those considering purchasing 'standard' medium-voltage AC drives.

However, in a Technical Guide of this nature it is not possible to give an in-depth analysis of all aspects of selecting, purchasing, installing and commissioning medium-voltage AC drives. The reader is advised to consult ABB for more detailed information.

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Introduction

What is a variable speed drive ?

A power electronic device that controls the speed and torque of an electric motor is often called a Variable Speed Drive (VSD)*. It takes energy from the mains and controls the energy flow to the motor creating different motor speeds and torques as required.

In this way, the drive can control the variables of a process, such as flow, by controlling the speed of a pump.

When controlling torque, the load determines motor speed; when controlling speed, the load determines motor torque.

Initially, DC drives and motors were used because speed and torque could be controlled without the need for sophisticated electronics. However, high maintenance requirements of DC motors have led to a decrease in their popularity.

AC drives and motors are the most common in industry as AC motors are inexpensive and need little maintenance. AC drives have been developed to the extent where their torque and speed control performance is as good as DC systems.

* Footnote: Beware of the conflicting jargon that is often used to describe a Variable Speed Drive. A Variable Speed Drive is often referred to as a VSD, an AC drive, a converter, an inverter or quite simply a drive. Other alternatives include VVVF = Variable Voltage Variable Frequency; VFD = Variable Frequency Drive; and ASD = Adjustable Speed Drive

What to consider when selecting a medium-voltage AC drive

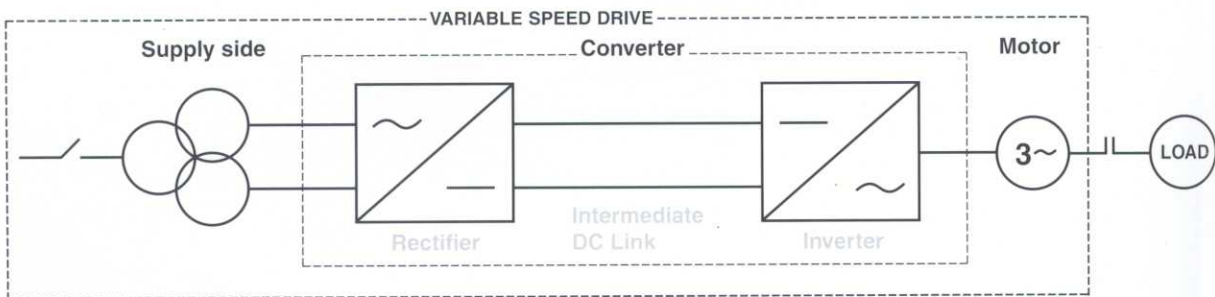
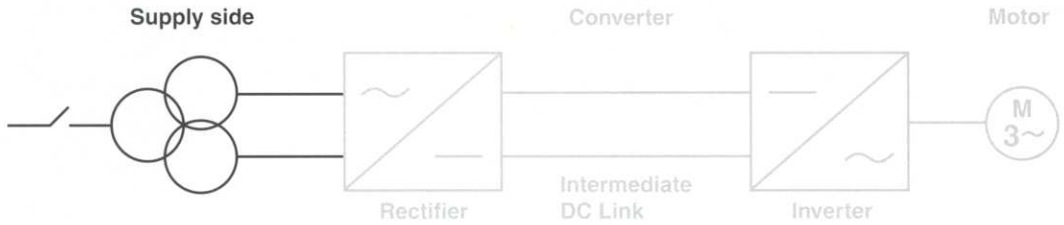


Figure 1: A simple representation of a drive system

When choosing a medium-voltage AC drive, considerations need to be given to each element shown in the above schematic:

- **The supply side**
- **The medium-voltage AC drive** (alternatively called 'converter')
- **The motor**



Harmonics: The main concern on the input side is the presence of harmonics and the need to ensure that the AC drive conforms to harmonic regulations such as IEEE 519.1992 and the UK's G5/3. Furthermore, the drive should comply with these local harmonic regulations without the need for additional harmonic filters.

Harmonics that are the highest in amplitude, and therefore, normally the most problematic in medium-voltage systems, are the 5th and 7th harmonics. These can be removed by using, for example, a 12-pulse uncontrolled diode bridge rectifier. A 24-pulse unit can be used for weaker networks or where more stringent harmonic requirements apply.

Input Power Factor: Ideally, the higher the power factor the greater the cost savings will be as no extra reactive power compensation equipment is needed and cables and transformers can be dimensioned for lower current. This also avoids penalties from utilities.

A fundamental power factor better than 0.97 and a total power factor better than 0.95 should be the goal. Additionally, the power factor should be constant over the entire speed range without the need for additional power factor correction equipment because the goal is to run the drive at other than full speed and so power factor needs to be constant. With some drive topologies, this is not possible (see page 7).

Input isolation transformer: It should be possible to position the transformer both inside the electrical room, or, if conditions dictate, outside the electrical room.

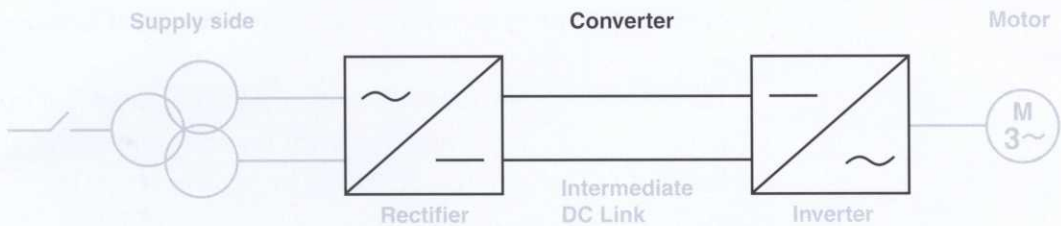
However, the ability to locate a transformer anywhere other than the electrical room, depends on the choice of drive system or topology (see page 7). For example, a three-level Voltage Source Inverter topology, substantially reduces the number of cables between the input isolation transformer and the converter.

Other types of multi-level topology can need anything from

27 to 45 cables, making it problematic to place the transformer away from the converter.

The freedom to choose the transformer location brings cost savings, firstly from a smaller drive size, as the large transformer does not need to be sited in the electrical room. Secondly, the losses from the transformer are not being dissipated into the room. Therefore, the cooling requirements for the electrical room can be greatly reduced. This is especially important in locations that have a high ambient temperature.

Converter



There are many considerations to be taken before purchasing a medium-voltage AC drive, but the principal requirements from any drive should be:

- **Small overall dimensions** - This is especially important in industries such as offshore and the oil and gas sector, where the cost of real estate is high. Today, medium-voltage AC drives can measure as small as 3 - 4.5 metres long, only 900mm deep and 2 metres high.

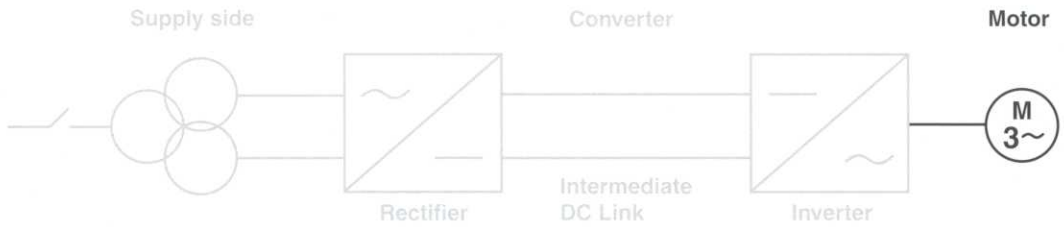
Small size has been mainly achieved by new technological developments, particularly in the field of power semiconductor switching devices.

See Part 3 of this Technical Guide series to discover the secrets to small size.

- **Low audible noise** - Health and Safety legislation in many countries is demanding noise levels that do not subject personnel to harmful or irritating noise.

- **Fully compliant to the necessary EMC regulations** - While drives must not pollute the environment with high levels of electro magnetic radiation, of equal importance is the need to ensure that the installed drive is immune from the effects of radiation being emanated from other equipment.

- **Higher efficiency** - is important if energy costs are to be reduced.



Careful consideration should be given to the following:

- **Compatibility** with standard squirrel cage induction motors. There are three main concerns:

1. **Derating:** Because harmonics cause additional heating in a motor, this leads to the need to derate the motor. When purchasing a motor for use on a medium-voltage drive, enquire, from the drive supplier, as to whether derating is necessary.
2. **Voltage stress:** This can damage motor insulation. Drives which incorporate fast switching power semiconductors can have a high voltage rate of change and it is this which can damage the motor. An output filter which gives a sine wave output can overcome this problem.
3. **Common mode voltages.** These are high frequency voltages that can also damage motor insulation. To be able to retrofit a drive onto an existing motor, it is essential that the converter does not subject the motor to high common mode voltages.

Common mode voltages can be overcome, depending on the drive system (topology) selected (see page 7). For example, a three-level Voltage Source Inverter with an output filter arrangement, can avoid common mode voltages by earthing the star point of the output filter. This simple solution eliminates the dangerous voltages and provides one less concern when carrying out a retrofit installation.

