Introduction to Drive, Servo, Motors

Many manufacturing processes today require different levels of control of electrical motors. Without any type of “control” an electric motor can only have two states:

- On (motor is spinning at one speed) or
- Off (motor is off)

There are several applications which require more precision than that. What is the basic difference between Drives and Servo Drives? And what types of motors are out there?

Motors as well as Drives are divided into two voltage groups:

- Low voltage drives/motors (up to 690V)
- Medium voltage drives/motors (above 1000V)

Drives can be divided into two groups as well:

- Low voltage VFDs (Variable Frequency Drive) aka VSD (Variable Speed Drive) and Servo Drives (up to 690V)
- Medium voltage VFDs (Variable Frequency Drive) aka VSD (Variable Speed Drive) (1kV and up)

VFDs provide control over speed and torque of the motor. A variable-frequency drive (VFD) is a device designed for alteration of a motor’s rotational speed by changing the frequency and the voltage of the electrical power supplied to it. In this manner, the rotational speed can be adjusted within a wide range from standstill to above the nominal rotation speed at 60 hertz.

The VFD is also able to control the motor’s torque.

VFDs/VSDs are mainly used for industrial applications in which the flow of liquids or gases must be controlled.

Servo Drives add position control to the motor by adding feedback devices such as encoder or resolver units. By installing a feedback device, the exact positioning of the motors rotor can be obtained and therefore the number of revolutions to be made can be controlled. Servo Drives with positioning control are used for example in machine tools. Servo Drives require special servo motors with a higher dynamic response than standard AC motors.

Drives and Servo Drives are available in single phase and three phase versions and in AC and DC Versions.
There are other types of motor control but they don’t offer the benefits of Drives and have some limitations:

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<thead>
<tr>
<th></th>
<th>Direct Starter</th>
<th>Reversing Starter</th>
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<tbody>
<tr>
<td><strong>F</strong></td>
<td><img src="Diagram1.png" alt="Diagram" /></td>
<td><img src="Diagram2.png" alt="Diagram" /></td>
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<tr>
<td><strong>B</strong></td>
<td><img src="Diagram3.png" alt="Diagram" /></td>
<td><img src="Diagram4.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Only one direction at one speed</td>
<td>Forward and backward direction but only at one speed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Soft Starter</th>
<th>VFD/VSD</th>
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<tr>
<td><strong>F</strong></td>
<td><img src="Diagram5.png" alt="Diagram" /></td>
<td><img src="Diagram6.png" alt="Diagram" /></td>
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<td><strong>B</strong></td>
<td><img src="Diagram7.png" alt="Diagram" /></td>
<td><img src="Diagram8.png" alt="Diagram" /></td>
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<tr>
<td><strong>Description</strong></td>
<td>One speed but with ramp up and ramp down</td>
<td>Forward and backward direction, at continuously variable speeds, ramp up, ramp down plus additional control functions based on model and manufacturer</td>
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There are typically two types of motors used in AC Drive applications:

<table>
<thead>
<tr>
<th>Main operation AC motor</th>
<th>Servo motor</th>
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<tbody>
<tr>
<td>For use at normal speeds</td>
<td>Encoder option possible</td>
</tr>
<tr>
<td>Continuous duty</td>
<td>More compact, more efficient</td>
</tr>
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Motors can overheat easily when they are operated at lower speeds but high torque. Therefore, protective devices are of great interest to shut the motor down before failure happens.
Summary of Motor, Drive and Automation systems 2012
Motors, Drive and Motion Control – a global market update (Summary of presentation from Electric Motors Group, Alex Chausovsky)

All Data is categorized for low voltage Motors and drives, and medium voltage motors and drives.

Low voltage motors (definition 690V or below):
44 million units shipped in 2010 (worldwide)

All low voltage motors are classified into efficiency classes:

1. IE1: Standard efficiency
2. IE2: High efficiency
3. IE3: Premium efficiency (AKA NEMA premium, standard in USA since end of 2010 for new sales)
4. IE4: Super Premium efficiency

Total worldwide market size in 2008 was about $13,500,000,000 market size for 2011 was $15,000,000,000. This market shows tremendous growth in particular for more efficient motors with permanent magnets. Estimate for 2015 is $26,000,000,000 which is almost double the size of 2008. The main growth is expected to come from Europe’s transition to IE3 efficiency motors.

China is determined to become the world leader in IE4 efficiency motors as they already control the world’s rare earth supply. Various rare earths are used in permanent magnet type motors required to meet IE4 efficiency.

Source: IMS Research
Top Industry sectors are:

1. Commercial HVAC
2. Industrial

Top Suppliers are

1. Siemens
2. Baldor
3. ABB
4. WEG

ABB has purchased Baldor and once the Baldor sales are assimilated into ABB's P&L, ABB will be the largest supplier of medium voltage motors in the world.

**Medium Voltage Motors (definition: everything above 1KV)**

40,000 units shipped in 2010, moderate growth, max. 45,000 forecasted for 2012. These motors are very efficient and provide efficiency ratings of up to 95%. Therefore, no efficiency regulation is necessary.

Top Industries

1. Oil & Gas 23%
2. Power generation 15%
3. Water/waste water 14%

Top suppliers:

1. Siemens 13.5%
2. ABB

**Drives - Low Voltage**

Separated into 2 groups compact (<25 kW) and standard (<500 kW). The compact low voltage drives are typically found in fan & pump applications of any kind, in any industry. Standard size low voltage Drives are often found in large/heavy material handling applications.

17 million units were shipped in 2010 and growth until 2015 is forecasted to be 13-15% each year. This means about 38 percent (or roughly every third motor) of all low voltage motors sold are controlled by low voltage drives.
2010 Low Voltage Drive Market by Power rating in million $US.

IMS Research

2010 Low Voltage Drives Market by Product Type in million $US

IMS Research
Low Voltage Drives Market by Region in million $US

Top Industries are:
1. HVAC 13%
2. Oil& Gas
3. Utilities

Top Suppliers in terms of $ sales are:
1. ABB
2. Siemens
3. Mitsubishi (selling the highest number of units as they are strong in smaller compact Drives)

Drives – Medium Voltage
Voltage ranges from 1kV to 2.3 kV, 3.3 kV, 4.16kV, 5kV-7.2kV, 10kV-11kV and Drives above 11kV. 8,800 units have been shipped worldwide in 2010. The market is expected to almost double by 2015 from $2.4 billion to $4.2 billion.

Top Industries are:
1. Metals 20.5%
2. Oil& Gas 19%
3. Power & Utilities 16%

Top Suppliers in terms of $ sales are:

1. Siemens 24%
2. ABB 20%

Source: IMS Research

Market trends:

- Higher efficiency motors
- Higher RPM’s
- Permanent Magnet Motors
- More control functions
- New Inverter optimized Motors which allow better control than standard AC motors but are not Servo motors (hybrid function)