Welcome to the Applications training module for the ACS800 Single drives.
If you need help navigating this module, please click the Help button in the top right corner. To view the presenter notes as text, please click the Notes button in the bottom right corner.
After completing this module, you will be able to

- Identify and list drive applications
- Find the correct drive SW and macro for an application
- Explain which process application-specific features exist in the product and its software package

After completing this module, you will be able to
- identify and list drive applications,
- find the correct drive software and macro for an application, and
- explain which process and application-specific features exist in the product and its software package.
The ACS800 is a 3-phase frequency converter for electric motors. The ACS800 single drive frequency converter has a supply voltage range from 220 to 690 V and the nominal motor power range is from 0.55 kW to 5600 kW.

The hardware of the ACS800 has to be selected in accordance with power, torque, ambient conditions and other requirements.

The software is selected according to the application. The ACS800 application software meets the latest application requirements for the whole power range.
The type codes of the ACS800 frequency converters consist of 16 characters, which define the basic product with its default features. Options are defined with four digit option codes separated by plus (+) symbols.

For example, a wall-mounted configuration without any options is defined by the code “ACS800-01-0006-5”, where “01” defines the default configuration (IP21, control panel CDP312R, no EMC filter, standard software, cable connection box, and braking chopper for frame sizes R2 and R3).

Options (+xxxx) override the corresponding default parts in cases where the parts are mutually exclusive.
Most low voltage AC drives are delivered with standard software (more than 90% in 2006).
Application software may include two or more macros.
Macros of the Standard application software:

<table>
<thead>
<tr>
<th>Macro</th>
<th>Factory</th>
<th>Hand/Auto</th>
<th>PID Control</th>
<th>Torque C.</th>
<th>Sequential C.</th>
<th>User 1</th>
<th>User 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL SIGNALS</td>
<td>FREQ</td>
<td>FREQ</td>
<td>SPEED</td>
<td>SPEED</td>
<td>FREQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(THREE DEFAULT SIGNALS IN THE CONTROL PANEL)</td>
<td>CURRENT</td>
<td>CURRENT</td>
<td>ACT VAL1</td>
<td>TORQUE</td>
<td>CURRENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters</td>
<td>CTRL LOC</td>
<td>CONT DEV</td>
<td>CTRL LOC</td>
<td>POWER</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>99.02 APPL MACRO</td>
<td>FACTORY</td>
<td>HAND/AUTO</td>
<td>PID-CTRL</td>
<td>T CTRL</td>
<td>SEG CTRL</td>
<td>SAVE 1</td>
<td>SAVE 2</td>
</tr>
<tr>
<td>10.01 EXT1 STRT/STP/DIR</td>
<td>D11,2</td>
<td>D11,2</td>
<td>D11</td>
<td>D11 2</td>
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<td>LOAD 1</td>
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<tr>
<td>10.02 EXT2 STRT/STP/DIR</td>
<td>NOT SEL</td>
<td>D16,5</td>
<td>D16</td>
<td>D11 2</td>
<td>NOT SEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.03 DIRECTION</td>
<td>FORWARD</td>
<td>REQUEST</td>
<td>FORWARD</td>
<td>REQUEST</td>
<td>REQUEST</td>
<td></td>
<td></td>
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<tr>
<td>11.02 EXT1/EXT2 SELECT</td>
<td>EXT1</td>
<td>D13</td>
<td>D13</td>
<td>D13</td>
<td>EXT1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.06 EXT REF2 SELECT</td>
<td>KEYPAD</td>
<td>A12</td>
<td>A11</td>
<td>A12</td>
<td>A11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.01 CONST SPEED SEL</td>
<td>D15,6</td>
<td></td>
<td>D14 (SPEED)</td>
<td>D14 (SPEED)</td>
<td>D14 (SPEED)</td>
<td>D14 (SPEED)</td>
<td>D14 4,5,6</td>
</tr>
</tbody>
</table>

* Each macro has individual default settings for Control panel actual signals and Parameters

Most low voltage AC drives are delivered with standard software (more than 90% in 2006).
Application software may include two or more macros.

The Factory macro is for normal speed-controlled applications, where up to three constant speeds are used. Examples of such applications are conveyors, speed-controlled pumps and fans, and speed-controlled rotation machines.

The Hand/Auto macro is also for speed-controlled applications. With this macro, it is possible to switch control between two external control devices.

The PID Control macro is used in process-controlled applications. These include closed-loop control systems such as pressure control, level control, and flow control. These are, for instance, pressure boost pumps in municipal water supply systems, level-controlling pumps in water reservoirs, pressure boost pumps in district heating systems, and material flow controls of a conveyor line.

It is also possible to switch between process and speed control.

The Torque Control macro is, by definition, used in torque-controlled applications. It is also possible to switch between torque and speed control.

The Sequential Control macro can be used for speed-control applications with a speed reference, seven (max. 15) constant speeds and two acceleration and deceleration ramps.

Each macro has individual default settings for the actual signals and parameters.
A master/follower link is required when two or more drives have to be connected to the same mechanical system.

The Master/Follower function is included in most application software. An RDCO option and optical fibers are necessary for the master/follower link.

The maximum delay of the master follower link with the ACS800 is 4 ms.

The follower does not send any feedback data to the master via the serial master/follower link. Therefore, it is highly recommended to wire the fault information of the follower to the master separately.
The Center Winder/Unwinder software is for center-winder applications. A Center Winder/Unwinder is a section, where rotational force is applied to the axis of a roll that is wound (or unwound).

As the diameter of the roll changes, the speed must change in inverse proportion to the diameter. Therefore, the torque must change proportionally to the diameter in order to maintain constant surface tension in the material being wound (or unwound).
An inline drive section is any process controlling section of a web handling production line that is not a Winder, Unwinder or Extruder and that requires some form of web tension control.
In crane control applications, standard crane safety and performance features are built-in and controlled by the drive.

It includes standard interface modules for joystick, pendant, radio and fieldbus control.
The Slew control application program is used to control the boom of a tower crane accurately.

Normally, a tower crane’s structure is very flexible.

The user wants to control the speed of the load, not the speed of the motor.

In a flexible system, motor speed does not have a linear correspondence to the load speed, since numerous spring constants have an influence on it. When tower cranes are moved from one place to another, the mechanical structure can change.
Extruder

- High starting torque and excellent speed accuracy without encoder
- Adaptive torque limitation feature: set by digital input, analog input or fieldbus
- Two sets of parameterized stall protection functions to detect material jam
- Secure thermal protection for motor through PT-100 and PTC connection
- Control through fieldbus or I/O
- Emergency stop function through digital input
- Digital potentiometer with two different accelerating and decelerating ramp times
- Possibility to change over between four control locations on-line

In extruder applications, material that typically is in granular or pulverized form are driven through a screw to provide continuous material flow processed further.
Decanter control is designed to fulfill the common requirements for two-shaft decanters, where the machinery consists of a bowl and a scroll (screw conveyor). A two-shaft decanter operates on the principle of sedimentation. The slurry (input product) is fed through a fixed central pipe into the distributor located in the scroll. The product is accelerated through the spiral gravity separator into the bowl. This means that solid particles heavier than the liquid will settle out. Centrifugal force speeds up the separation process.

Centrifuges operate on the principle of centrifugal force. The centrifuge accelerates to a predetermined filling speed and the feed input is initiated. As the centrifugal force drives the feed through the filter media and perforated basket wall, a cake builds up on the filter media. The liquids are removed through an outlet. The retained solids are accelerated to spinning speed, after which the centrifuge decelerates to unloading speed and a discharger removes the product from the basket. An alternative unloading method allows top removal of the product in a filter bag.
With motion control software, the movements of a motor shaft can be controlled precisely.

- An encoder is connected to the shaft of the motor or directly to the load.
- The encoder gives feedback to the ACS800 on the position of the load.
- The motion control software in the drive calculates the new position of the load (P0 – Px).
The following slides illustrate some typical motion control applications. These are examples only, there are many other kinds of configurations.

Most of the illustrations include a PLC, which controls the drives.

In a cut-to-length application, a metal cable is fed to a cutting table from a spool. The motion of the shaft in position controlled motor #1 is converted to the horizontal movement of the material. The motion of the shaft in position controlled motor #2 is converted to the vertical movement of the cutting knife.
In a synchronization application, the machine straightens out the plates rolling on the conveyor.

Here, drive #1 is synchronized with the encoder of drive #2. The positions of the front corners of a plate are measured with two sensors. Drive 1 corrects the positions of the plates.

If both sensors and encoders were connected directly to drive 1, the speed of belt 2 could be controlled with a direct online motor or standard drive software.
In a material filling application, the drives run a dosing unit. The motion of the shaft in position controlled motor #1 is converted to the horizontal movement of the boxes. The motion of the shaft in position controlled motor #2 is converted to the vertical movement of the material. The required amount of material is controlled with the rotations of the motor shaft.
In this warehouse automation application, the overriding control system is part of the full factory automation system and knows where the transport pallets need to go. The motions of the shafts in the three position-controlled motors are converted to the three-dimensional movement of the pallet. The horizontal Z axis motion is controlled via motor #1, the horizontal X axis motion via motor #2, and vertical Y axis motion via motor #3.
Most pump and fan applications are designed for stand-alone drives, in which standard application software is used.

If a parallel-controlled pump or fan application system is used, special software can be used to control the drives.

A traditional PFC application is designed for applications where there is one drive-controlled motor and one or more contactor-controlled motors.

In multipump or level-control applications, several drives are parallel-connected via a fiber optic link. In these intelligent pump or fan control applications, the redundancy of the pumps is possible.
So-called Electrical Submersible Pumps are typically used in reservoirs under water flood and also have widespread use in offshore applications. They are generally considered the best choice where high production volumes are required and where gas, for gas lift systems, is not available.

A progressive cavity pump, also known as an eccentric screw pump, is a kind of pump which moves fluid by means of a cavity which progresses along the body of the pump. As the cavity moves, fluid is compressed and forced into the next stage; further rotation of the pump forces the fluid to flow through the various stages through the pump.

However, most wells are not self-flowing and various lifting methods must be employed. Approximately 90% of the wells in the United States using an artificial lift method are equipped with sucker-rod –type pumps. In these the pump is installed at the lower end of the tubing string and is actuated by a string of sucker rods extending from the surface to the subsurface pump. Two common variations are mechanical and hydraulic long-stroke pumps.
The Spinning Control application program is designed to run spinning bobbins in ring frame textile machines. To achieve the best possible form for the doff, the spinning sequence should be ideal for a traverse of the yarn. This is done by giving pre-set values for the speed based on the time or length elapsed. This figure shows the principle of Spinning Control.

There are 4 separate patterns which can be pre-set with parameters in groups 41 to 44 or which can be selected via digital inputs. Any of these patterns can be selected to be the active pattern. The modes for each pattern can be Speed Time Patterns, STP, or Speed Length Patterns, SLP (in meters or percentages). The mode can be selected by a parameter in each pattern group.

**Speed mode.**

An example graph of the Speed Time Pattern is shown, where, when restarting after a pause command, the machine resumes at the same speed as before.

**Length mode.**

There are two different Speed Length Pattern modes: length in meters [m] and percentages [%].

- If the SLP mode in meters is selected, all section values in the x-axis are set in meters. The total yarn delivery length value is shown in parameter 41.28 (42.28, 43.28, 44.28).
- If the SLP mode in percentages is selected, the x-axis values are set in percentages. The total yarn delivery length value set in parameter 41.28 (42.28, 43.28, 44.28) is shared by these values programmatically.

For more details, please see the Spinning Control Application Program firmware manual.
In Traverse Control applications, such as textile machines, the traverse drives are used to guide yarn into a yarn package. This figure shows an overall view of such a system.

- To get an even winding for the yarn, the drive adjusts its speed smoothly depending on the package form and the movement direction of the yarn guide.
- To avoid layering at the reversal points of the yarn guide, the drive performs an instantaneous speed change i.e. "P-jump".

The traverse drive repeats "the saw tooth" speed pattern until the yarn package is built up. The speed pattern is shown here.
ACS800-67 wind turbine drives use components from the ACS800 product family. They are designed for use with induction generators with a wound rotor and slip rings, such as the ABB AMK series. The drive is connected between the rotor of the generator and the supply network.

The following are the advantages of using the ACS800-67.

- The speed of the rotor varies in relation to the wind speed. In order to keep the speed optimal (i.e., somewhat higher than the synchronous speed of the generator), the angle of the rotor blades is adjustable by means of a pitch drive. However, adjusting the pitch is fairly slow.

- To compensate for faster changes in rotor speed, the ACS800-67 quickly accelerates or decelerates the rotation speed of the field in the rotor in order to retain the optimal slip. When the wind decreases, the drive takes energy from the supply and accelerates the rotation of the rotor field so that the stator remains capable of feeding energy into the grid. Conversely, the rotation of the rotor field is decelerated at increasing wind speeds. The energy generated in the rotor above the synchronous speed can also be fed into the grid.

- The drive is also used for synchronizing the stator output with the grid before they are actually connected. On disconnection, the drive adjusts the torque to zero. This also decreases the stator current to zero so that the generator can be disconnected.

- The Cascade Control application program is loaded onto the RMIO board. This program controls the rotor-side and line-side converter modules via fiber optic links, and the main circuit breaker and drive main contactor.
The main features of the test bench application are:

- Fast analogue interfaces for speed and torque reference with an NAIO(-03F) module and for torque feedback utilization;
- Calculation of the actual acceleration of the motor shaft. This can be used for calculation of the compensation to match load inertia and test inertia with each other;
- A motor shaft inertia compensation function;
- Standstill heating;
- Two encoder interfaces for the synchronization of two rotating systems.
Typical system and multidrive applications are industrial machines or systems where several drives are connected to the same system and one upper-level controller. Most system applications are delivered to the paper, metal or marine industry. Winder, Inline, Master/Follower and Pump sections, among others, can be included in system applications.

In most system and multidrive applications, the application-specific control software is located in the upper-level controller. An application controller, such as an AC80 or AC800, is connected via fiber optic link to the drive’s RDCO board channel 0.
Two kinds of software are available for Permanent magnet motor drives: the PMSM standard software and PMSM system software.
Multiblock application software has over 200 function blocks and large extended I/Os. Programs and modifications can be done with DriveAP 2.
Here is a table of the number of I/O signals in multiblock application programmes.

<table>
<thead>
<tr>
<th>I/O Device</th>
<th>Digital Inputs</th>
<th>Digital Outputs</th>
<th>Analogue Inputs</th>
<th>Analogue Outputs</th>
<th>Fast Analogue Inputs</th>
<th>Pulse Encoders</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMIO Basic I/O</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDIO DI/O EXT1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDIO DI/O EXT2</td>
<td>3</td>
<td>2</td>
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<td></td>
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</tr>
<tr>
<td>RDIO DI/O EXT3</td>
<td>3</td>
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<tr>
<td>RDIO DI/O EXT4</td>
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<tr>
<td>RAIO AI/O EXT1</td>
<td>3</td>
<td>2</td>
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</tr>
<tr>
<td>RAIO AI/O EXT2</td>
<td>3</td>
<td>2</td>
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<tr>
<td>RAIO AI/O EXT3</td>
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<tr>
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<tr>
<td>NAIO-03F FAST AI</td>
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<tr>
<td>RTAC Pulse encoder</td>
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<tr>
<td>NTAC-02 Pulse encoder</td>
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<td>ENCODER 2</td>
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<td><strong>Total</strong></td>
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<td><strong>13</strong></td>
<td><strong>13</strong></td>
<td><strong>12</strong></td>
<td><strong>2 Fast Alts</strong></td>
<td><strong>2 Encoders</strong></td>
</tr>
</tbody>
</table>
An application software template has been programmed using the FCB (Function Chart Builder) tool, whose target is the Motor and I/O Control board (RMIO). The trained user can further customize this template by FCB to extend the I/O, add mathematic calculations, application parameters and signals, logic control, communication between the RMIO boards, etc. Parameters are programmed during commissioning by DriveWindow or the CDP 312 Control Panel.
Thank you for your attention. You may now go ahead and move on to the next unit.