ACS 5000

Medium Voltage AC Drive for Control of Motors up to 6.9 kV
The evolution of ABB’s ACS drives platform for motors up to 6.9 kV has led to a drive with unbeatable efficiency, reliability and footprint.

**Leading the way**
As the originator of AC drives technology, ABB has over 35 years of application know-how in all industrial sectors. ABB has always known how to convert customer requirements into reliable world-class products, which fulfill customer’s future needs.

The ACS 5000, the latest member of the world’s most successful drives family, confirms ABB’s market leadership.

**Revolution by evolution**
The ACS 5000 is based on ABB’s renowned ACS platform, that has been used in thousands of drives worldwide. It uses well proven and highly reliable components, thus eliminating risks typically associated with new developments. The ACS 5000 was developed to specifically meet the requirements of the growing number of applications driven by standard motors up to 6.9 kV.

The combination of well-proven building blocks from existing ABB medium voltage drive products with the Voltage Source Inverter Multilevel-Fuseless (VSI-MF) topology, has revolutionized the drives industry – it simplifies the drive, increases its reliability and efficiency and results in the most application-friendly high-powered drive available on the market.

**Benefits:**
- Highest reliability due to lowest parts count
- Highest system efficiency due to multilevel-fuseless topology, IGCTs and DTC
- Smallest footprint due to highest power density
- Optimal network friendliness due to 36-pulse configuration
- Lowest cost of ownership due to high efficiency and simplified installation, commissioning and maintenance
- Ultimate control performance due to DTC
- Suitable for standard motors

**Fields of application**

<table>
<thead>
<tr>
<th>Industries</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, Mining and Minerals</td>
<td>Grinding mills, conveyors, fans and pumps</td>
</tr>
<tr>
<td>Chemical, Oil and Gas</td>
<td>Compressors, extruders and pumps</td>
</tr>
<tr>
<td>Marine</td>
<td>Propulsion</td>
</tr>
<tr>
<td>Metals</td>
<td>Bar and rod mills, blast furnace blowers, fans and pumps</td>
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<tr>
<td>Pulp and Paper</td>
<td>Fans and pumps</td>
</tr>
<tr>
<td>Power Generation</td>
<td>Gas turbine starters, ID/FD fans and pumps</td>
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<tr>
<td>Water and Waste Water</td>
<td>Pumps</td>
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<tr>
<td>Other Applications</td>
<td>Test stands and wind tunnels</td>
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</table>
ABB engineers developed a drive that provides advantages over other medium voltage drives in reliability, efficiency and power density - features that have a direct impact on the customer’s cost of ownership.

**Highest reliability and efficiency**
Thanks to the combination of well-proven components and an innovative topology, the ACS 5000 has a reliability and efficiency unmatched on the market.

**IGCT semiconductors**
Like other drives of the ABB medium voltage AC drives family, the ACS 5000 uses an advanced and proven power semiconductor switching device known as IGCT. It combines the best of two traditional semiconductor technologies: the fast switching of the IGBT/IEGT with the proven reliability and low losses of the GTO.

The use of IGCTs results in a low parts count, providing an intrinsically less complex, more efficient and reliable drive.

**Fuseless**
The converter design does not require any medium voltage power fuses, which are known to be unreliable, costly and subject to aging. Instead of fuses the ACS 5000 uses IGCTs, which provide much faster and more reliable protection for the power components. The ACS 5000 protection scheme responds in less than 25 µsec, about one hundred times faster than fuses.

**Long-life DC-link capacitors**
Advanced, self-healing, environmental friendly foil capacitors, designed for a long lifetime, are used in the DC-link. ABB has clearly distinguished itself with this technology compared to unreliable and maintenance-intensive designs based on electrolytic DC-link capacitors.
**Powerful and application-friendly**
During development of the ACS 5000, special attention was given to the entire drive system to ensure powerful and application-friendly performance at lowest possible cost of ownership.

**Smallest footprint**
The ACS 5000 is based on a unique concept which enables operation of motors up to 6.9 kV without making the drive more complex. Thanks to the Voltage Source Inverter Multilevel-Fuseless (VSI-MF) topology the high motor voltage is achieved without series connection of semiconductors. This reduces the parts count to a minimum resulting in a power density up to 1 MVA/m³ for the complete drive, including control, cooling and auxiliaries, which is unmatched in the medium voltage drives market.

**Network friendly**
The ACS 5000 is equipped with a 36-pulse diode rectifier to minimize harmonics. It meets the most stringent requirements for current and voltage harmonic distortion as defined by IEEE, IEC and EN. This eliminates the need for costly harmonics analysis or installation of network filters when applying a new drive.

**Powerful performance**
Fast and accurate process control in combination with low energy consumption results in top performance. The ACS drive control platform is ABB’s award-winning Direct Torque Control (DTC), resulting in the highest torque and speed performance as well as the lowest losses ever achieved in medium voltage drives. Control of the drive is immediate and smooth under all conditions and the audible noise in the motor is considerably reduced compared to other control methods.

**Motor friendly**
The ACS 5000 topology has an optimum number of switching levels, which provides a multilevel output waveform. This allows the use of standard motors up to 6.9 kV without compromising reliability.

![Graphs showing line current and voltage](image1)

![Graphs showing motor current and voltage](image2)
ABB has been driving the evolution of state-of-the-art medium voltage drive technologies for more than 35 years.

VSI
In general, today’s state-of-the-art medium voltage drive products are based on one of two basic inverter topologies: Voltage Source Inverter (VSI), employing a DC-link capacitor and providing a switched voltage waveform, and Current Source Inverter (CSI), employing a DC-link inductor and providing a switched current waveform.

For more than two decades, ABB has been pioneering the development of VSI-based medium voltage drives. Today, the VSI is the preferred topology on the market.

Advantages of VSI
A VSI can be implemented without the need for additional input or output filters, which are a must in a CSI topology with self-commutated semiconductors.

A VSI allows a very reliable and highly efficient input rectifier topology by means of a simple diode bridge. Besides excellent efficiency and reliability, diode bridges feature a high power factor (typically >0.95), which is constant over the whole speed range. The CSI topology either uses a thyristor rectifier or an active rectifier unit with self-commutated components, which are inherently less reliable and efficient. In addition, a thyristor rectifier has a worse power factor on the supply side and typically needs additional compensation equipment.

Furthermore, the VSI topology has a more superior dynamic control performance than the CSI topology.

IGCT
In 1996 ABB introduced IGCT (Integrated Gate Commutated Thyristor) semiconductors, fast switching power switches that have inherently low losses. Until then the power switches for medium voltage drives had been either GTOs or IGBTs. For medium voltage applications such devices led to compromises in design that increase cost and complexity of high-powered drives.

IGCT-based medium voltage drives are more reliable than medium voltage drives using IGBTs as they require fewer power semiconductors.
ACS 5000 data sheet

Motors
Induction & synchronous motors up to 24000 kVA

Standards
All common standards including EN, IEC, CE

Inverter type
Voltage Source Inverter Multi-level-Fuseless (VSI-MF), 9 levels line-to-line, with fast-switching power semiconductors – Integrated Gate Commutated Thyristors (IGCTs), without parallel or series connected devices

Input
Medium voltage input transformer for 36-pulse diode rectifier

Variation: ±10% of nominal voltage, down to -25% safe operation with derated output

Auxiliary voltage
Common 3...400 VDC, 690 VAC ±10%, 50 Hz/60 Hz, 12-17 kW

Rated power voltage
Standard: 6.0 to 6.9 kV
Optional: 4.16 kV

Output frequency
0 to ±75 Hz (higher optional)

Efficiency
Typically >98.5% (incl. auxiliaries)

Input power factor
Fundamental: >0.95 (Total: >0.95)

Ambient temperature
+1°C to 40°C (higher with derating)
34°F-104°F (higher with derating)

Enclosure classes
Standard: IP23
Optional: up to IP54

Control interface
All common fieldbuses including Profibus, Modbus, Interbus S, DeviceNet, ABB AF100, others

Industrial® Compatible (Level 1)

Protective functions
Converter: Overcurrent, short circuit, earth fault, phase loss, overvoltage, undervoltage, overtemperature, output frequency, network disturbance, water cooling supervision
Motor: Overload, underload, stall protection

Optional
- Motor supervision I/Os
  - Fault/alarm: overtemperature, vibration of bearings
  - PT 100: winding & bearing temperatures
  - Transformer supervision I/Os
    - Fault/alarm: overtemperature, overcurrent
    - PT 100: winding temperatures
  - Hardwired signals: drive control and drive status indication
  - References: start/stop, speed/torque etc.
  - Actual feedbacks: ready/running, current/voltage/power etc.
- Synchronous bypass functionality
- Braking chopper

ACS 5000 type codes for induction motors

<table>
<thead>
<tr>
<th>Motor Voltage</th>
<th>Voltage Supply</th>
<th>Inverter</th>
<th>WCU</th>
<th>Motor Power * (kW)</th>
<th>Motor Power * (hp)</th>
<th>Converter Power (kW)</th>
<th>Converter Current (A)</th>
<th>Converter Length (m)</th>
<th>Converter Weight (Kg)</th>
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<tbody>
<tr>
<td>6.0</td>
<td>ACS 56-03L 121-1s23-1W2</td>
<td>34600</td>
<td>1600</td>
<td>8000</td>
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<td>6.6</td>
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<td>6.9</td>
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<td>3000</td>
<td>16500</td>
<td>22000</td>
<td>9500</td>
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Notes
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** Indicative information (eff. 97.5%, pf 1.0)

ACS 5000 type codes for synchronous motors

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ACS 5000
ABB
The ACS 5000 medium voltage AC drive

Understanding the constraints of limited space has inspired ABB to increase the power density up to 1 MVA/m³ for the complete drive, including control, cooling and auxiliaries, thus saving valuable space.

The picture above shows an ACS 5000, 12 MVA, 6.9 kV.
Transformer cable connection section for top and bottom entry

36-pulse diode rectifier

DC-link capacitors

Power Electronic Building Block (PEBB)
Inverter unit

Control unit

Motor cable connection section for top and bottom entry

Water cooling unit with stainless steel piping

Auxiliary power for control hardware
PEBB
The heart of the inverter is the Power Electronic Building Block (PEBB). It replaces complex power electronics circuits with a single, multifunction device.

The very high power density of the PEBB is based on the use of snubberless IGCTs, enabling reduced parts count and a compact mechanical arrangement. As a result, the size for a complete system for a given power rating has been reduced by 50% compared to other available solutions.

In 1999 ABB launched the ACS 6000, the first PEBB-based variable speed drive for single and multi-motor applications. Since its introduction, the ACS 6000 has gained an excellent reputation for high quality and reliability. As a result, ABB has the largest installed base of medium voltage multidrives worldwide.

VSI-MF topology
Based on the successes of the IGCT and PEBB technologies, ABB developed the Voltage Source Inverter Multilevel-Fuseless (VSI-MF) topology.

By combining power electronic building blocks higher voltages can be reached, enabling reliable and efficient operation of motors up to 6.9 kV.

Motor-friendly with low parts count
In order to get a sinusoidal voltage to the motor, the number of switching levels would have to approach infinity. However, too many switching levels decrease reliability and efficiency because the number of components increases.

The ACS 5000 topology provides the optimal solution because it has enough switching levels to enable the use of standard motors while at the same time keeping the parts count to a minimum.

Compared to other available solutions, the VSI-MF topology provides a number of advantages:
- Higher power density and smaller footprint
- Smooth output waveform suitable for standard motors
- Increased reliability
- Higher efficiency
ACS 5000 - features and benefits

The ACS 5000 is designed to deliver value through reliable process control and low cost of ownership.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest reliability for minimum downtime</td>
<td>ABB’s revolutionary IGCT power switching device results in lowest parts count, providing a less complex, more reliable converter.</td>
</tr>
<tr>
<td>Highest efficiency</td>
<td>The ACS 5000 multilevel-fuseless topology results in a drive with unmatched efficiency.</td>
</tr>
<tr>
<td>Cost savings due to smaller electrical room and easier layout</td>
<td>Smallest footprint</td>
</tr>
<tr>
<td>Suitable for standard motors</td>
<td>The ACS 5000 provides a multilevel output waveform for increased motor friendliness.</td>
</tr>
<tr>
<td>Elimination of network harmonics to avoid penalties and system interferences. Costly harmonic analysis or network filters are not required.</td>
<td>The ACS 5000 36-pulse rectifier meets the most stringent requirements of international standards for current and voltage harmonic distortion.</td>
</tr>
<tr>
<td>Faster and easier maintenance</td>
<td>The ACS 5000 has a modular design simplifying maintenance. The inverter phase modules are mounted on sliding rails for easier and faster access. The cooling equipment is designed with redundant pumps to allow maintenance during operating hours.</td>
</tr>
<tr>
<td>There is a minimal need for air-conditioning as the losses from the transformer are not going into the electrical room.</td>
<td>Flexible input transformer configuration. The transformer can be placed outside the electrical room.</td>
</tr>
<tr>
<td>Fast, accurate and robust process control for constant product quality, minimum raw material waste and minimum machinery wear.</td>
<td>The fast control provided by Direct Torque Control (DTC) allows optimum process control and exact motor performance with minimum torque ripple and lowest energy consumption.</td>
</tr>
<tr>
<td>User-friendly drive monitoring and remote diagnostics</td>
<td>A Windows®-based software package provides monitoring and control access to the drive even from remote locations.</td>
</tr>
<tr>
<td>Round the clock access to drive specialists and spare parts</td>
<td>ABB, the largest drives supplier worldwide, has a global support network, which provides assistance and spare parts 24 hours/day, 365 days/year.</td>
</tr>
</tbody>
</table>
Simple system integration

The ACS 5000 allows smooth and simple system integration into the customer's industrial environment.

Open control system
ABB offers an open communication strategy, enabling connection to higher-level process controllers. The ACS 5000 can be installed with all major fieldbus adapters for smooth integration, monitoring and controlling of different processes, according to customer requirements.

DriveOPC
DriveOPC is a software package, which allows communication between ABB drives and the customer’s Windows®-based applications.

Benefits
• Standard interface
• Remote connection via LAN (Local Area Network)
• Access to: • drive control • signals and parameters • data and fault loggers

IndustrialIT
ABB’s IndustrialIT means increased standardization and seamless interaction of different ABB products. The ACS 5000 is certified to bear the IndustrialIT Enabled symbol, a special mark indicating that the drive can be easily integrated into the IndustrialIT architecture in a ‘plug & produce’ manner.

Benefits
• Easy integration of the drive into customer’s industrial environment
• All drive information readily available in electronic form
• Drive communication with the environment through control panels, standardized fieldbus adapters and interfaces (OPC, OLE for Process Control)
• Easy to use start-up and maintenance tools

Principle of IndustrialIT

Customer support systems for product training, help desk, service
Business systems for sourcing, ordering, spare parts

Process Controllers
Control Network
Application Controller
Fieldbus
Variable Speed Drives
Electrical machinery in the process

Software for dimensioning, configuration, start-up, monitoring, documents
Software tools for energy calculations, efficiency analysis, new drive selection
Monitoring and control

The ACS 5000 is equipped with an intelligent monitoring and control system, which allows secure access to the drive from any location in the world.

The Ethernet Adapter module (ETA) allows remote real-time access to the drive. It supports monitoring, configuration, diagnostics and control of ABB drives independent of the implemented control method, thus also enabling the connection of already existing installations.

Event-triggered e-mail messages will be sent to predefined addresses, allowing customers to quickly react to deviations. As ETA is compatible with any computer platform with a standard Web browser and Java support, the customer does not have to set up a PC with customized software.

In addition, the ACS 5000 incorporates the same suite of user-friendly tools as other drives of the ACS product family. These tools, DriveWindow and DriveOPC, enable communication between Windows®-based applications and ABB drives and simplify commissioning, maintenance, remote diagnostics and monitoring of the drive system.

Maintenance

Simple and efficient maintainability is an important factor in keeping operating costs down. The modular concept of the ACS 5000 implies minimal maintenance.

Reliable components
ABB drive technologies, such as IGCT power semiconductors and the multilevel-fuseless topology, provide a low parts count, which increases reliability, extends Mean Time Between Failures (MTBF) and improves availability.

Easy access
The ACS 5000 has been designed to allow easy front access to the drive's components. The inverter phase modules can be withdrawn quickly as they are mounted on sliding rails and are connected via fast connectors.

Redundant cooling
The cooling equipment is designed with redundant pumps to allow maintenance during operating hours, which minimizes downtime.
Service and support

The ACS 5000 is backed by unrivalled service and support from the customer’s initial inquiry throughout the entire lifecycle of the drive system.

Technical advice
As originators of AC drives technology in the late 1960s, ABB has over 35 years of application know-how in all industrial sectors, in virtually every country. ABB’s specialists are located around the world to offer advice that ensures trouble-free operation of ABB drives.

Commissioning
The ACS 5000 allows a fast and efficient commissioning routine which minimizes start-up delays and costs.

Testing
ABB knows how important reliability is to its customer’s success. ABB is committed to ensuring the reliability of every drive it delivers. To this end, every ACS 5000 is tested before being delivered to the customer. This ensures a smooth and trouble-free integration into the customer’s facility.

DriveWindow
DriveWindow is an advanced, easy-to-use tool for commissioning, maintenance, remote diagnostics and monitoring of ABB drive systems.

Benefits
- Access to all drives connected to the same network
- Graphical presentation of signal values
- Monitoring and editing of drive signals and parameters off-line and on-line
- Back-up of drive parameters – file can be easily re-loaded
- Fault diagnosis with indication of drive status and fault history

Training
Extensive training for ABB’s medium voltage drives can be provided at the ABB University. A range of training is offered from basic tutorials to programs tailored to the customer’s specific needs.

www.abb.com/abbuniversity

ABB has the largest drives service organization worldwide offering:

- Technical advice
- Installation and commissioning
- On-board diagnostics
- Remote diagnostics
- Customized service programs
- Local technical support
- Local service support
- Spare parts and logistics network
- 24 x 365 support line
- Training