Medium voltage AC drive
MEGADRIVE-LCI for control and soft starting of large synchronous motors
MEGADRIVE-LCI — Proven technology for high powers

For more than 35 years ABB’s MEGADRIVE-LCI drives and soft starters have proven their maximum reliability and availability in a wide range of industries and applications where high power and high voltage are required.

Vast operational experience
Since its market introduction in 1974 the MEGADRIVE-LCI has gained an undisputed reputation for reliable operation in the harshest environments.

Unmatched reliability for high powers
The MEGADRIVE-LCI is the preferred choice when it comes to reliable and efficient operation of high-power and high-voltage applications. Standard designs of the MEGADRIVE-LCI are available up to 72 MW; engineered designs to 100 MW and beyond.

In 1997, ABB set a world record by delivering the largest and most powerful electric variable speed drive to NASA. The MEGADRIVE-LCI controls the 135,000 hp (101 MW) synchronous motor of a wind tunnel fan.

Worldwide references
ABB has more than 900 MEGADRIVE-LCI units installed with a total power of 6,500 MW for applications in power plants, the oil, gas and chemical industries, in water pumping stations, marine propulsion systems and in test stands.

Benefits
- More than 35 years operational experience in different applications
- Configurations for variable speed drives and soft starters
- High efficiency
- High reliability and availability
- For motor and generator (braking) operation
- Low maintenance requirements
- Standard designs are available for powers up to 72 MW and voltages up to 10 kV

Fields of application

<table>
<thead>
<tr>
<th>Industries</th>
<th>Applications</th>
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<tr>
<td>Cement, mining and minerals</td>
<td>Fans and pumps</td>
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<tr>
<td>Chemical, oil and gas</td>
<td>Compressors and extruders</td>
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<tr>
<td>Marine</td>
<td>Propulsion systems</td>
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<tr>
<td>Metals</td>
<td>Blast furnace blowers and wire rod mills</td>
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<td>Pulp and paper</td>
<td>Fans and pumps</td>
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<td>Power generation</td>
<td>Starters for gas turbines and hydro pumped-storage power plants, boiler feed-water pumps</td>
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<td>Pumps</td>
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<td>Other applications</td>
<td>Test stands and wind tunnels</td>
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Main components

The MEGADRIVE-LCI uses reliable, well-proven components, which were specially designed for high-power and high-voltage applications.

Thyristors
Thyristor power semiconductors are developed for high powers, highest reliability and low losses. They have low on-state and switching losses, which results in a converter efficiency of 99 percent, including the DC reactor.

Rectifier
The rectifier is line commutated and forms a fully controllable DC-current source in conjunction with the reactor in the DC link.

DC-link reactor
The DC-link reactor smoothes the DC current and limits its rate of change in the event of a fault.

Inverter
Thyristors in the inverter electronically switch the DC current to produce a 3-phase AC system of variable frequency and voltage for supplying the motor. The motor voltages commutate the inverter phase currents. At very low speeds (0 – 10 percent of rated speed), when the motor voltage is too low to guarantee reliable commutation, an artificial commutation is used. 6 or 12-pulse inverter configurations are available for minimized influence of the converter on the ripple of the motor torque.

Benefits
- Thyristor power semiconductors for highest reliability and efficiency
- 6, 12 or 24-pulse converters to minimize the harmonic influence on the supply system and on the motor
- AC or DC-excitation converter for brushless or slip-ring type synchronous motors

Excitation converter
The excitation of the synchronous motor can be of the brushless or slip ring type. The excitation converter provides the motor field current in the entire speed range and at standstill.

Control
The control adjusts the actual torque or speed of the motor to the reference value. It generates the firing impulses for the thyristors in the rectifier, the inverter and the excitation converter to maintain the desired current, cos phi and voltage of the motor.

Examples of MEGADRIVE-LCI converter configurations
Key product features

The MEGADRIVE-LCI offers a number of unique features.

Series connection for higher voltage and redundancy
Increasing the voltage by using thyristors in series connection, scales the MEGADRIVE-LCI up to very high powers. In addition, series connection allows the implementation of thyristor redundancy (n+1).

Fuseless design
The high, non-repetitive surge current capability of today’s thyristors allows the design of fuseless converters, resulting in less spare parts and higher reliability. In case of a failure, a fast overcurrent protection immediately blocks the thyristor firing and initiates the opening of the main breaker.

Motor and generator operation
A synchronous motor, driven by a MEGADRIVE-LCI, can also be operated as a generator without additional power components. If required, the MEGADRIVE-LCI reverses the power flow and feeds the generated power back into the supply network. Regenerative operation is a cost-efficient way to decelerate the motor.

Supply voltage dip ride through
A special design feature of the MEGADRIVE-LCI is its ability to ride through short main and auxiliary supply voltage interruptions so that in most cases the process is not affected.

Encoderless control
Speed and rotor position encoders at the motor shaft are sensitive instruments in a harsh process environment and known to be susceptible to failures. ABB’s MEGADRIVE-LCI operates without encoders, thereby ensuring a high level of availability and reducing maintenance costs.

User-friendly control terminal
The MEGADRIVE-LCI is equipped with a powerful PC with Human Machine Interface (HMI). The LCD touch screen provides the operator with a range of selectable displays showing information on the current status of the system in graphical and numerical form.
MEGADRIVE-LCI air cooled

Air cooling is mainly used for soft starters and applications in the lower power range. It provides short-time overload capability, but requires clean air and dissipates the losses to the converter room.
MEGADRIVE-LCI water cooled

Water cooling is the preferred solution for high-powered drives. It is very efficient as almost all converter losses are dissipated via the heat exchanger to the raw water. It results in a compact layout and is less sensitive to dusty and aggressive atmospheres.
Variable speed control

Many industrial processes can be improved by using variable speed control. The larger the process and the higher the performance demands, the greater the benefits gained from the MEGADRIVE-LCI.

Energy savings
By employing variable speed drives instead of mechanical control methods, energy savings of up to 60 percent can be realized. The power required to run a pump or a compressor is roughly proportional to the cube of speed. In other words, a pump or compressor running at half speed can consume as little as one eighth of the energy compared to one running at full speed. A small reduction in speed can make a big difference in energy consumption. As many pump and compressor systems often run at partial load, the use of a variable speed drive can produce huge savings.

Benefits
- Substantial energy savings as applications run at their optimum operating point
- Smooth and accurate process control at low flow rates
- Less stress and wear reduces maintenance requirements
- Increased reliability because mechanical flow control devices as potential source of failures are eliminated

Productivity increase
Productivity can be considerably increased by employing variable speed drives. Case studies indicate 348 operating days per year using an electric drive, due to less maintenance, compared to 329 days using mechanical speed control.
Starting a large synchronous machine on-line can have a negative impact on the network and the machine itself. These problems can be overcome with the MEGADRIVE-LCI soft starter.

**Starting of motors and generators**
Direct on-line starting of large synchronous machines causes starting currents of up to six times the nominal current and imposes large electrical stress on the supply network, thermal stress on the motor and mechanical stress on the shaft string.

These problems can be overcome with the use of a MEGADRIVE-LCI soft starter. It smoothly accelerates the motor and the load from zero to nominal speed, when the motor is automatically synchronized to the power system and the circuit breaker for fixed-speed operation is closed.

**Benefits**
- Reduced starting impact on network and machinery
- Longer lifetime of equipment
- Starting current limited to rated current or less
- Sequential starting of several machines, even of different power ratings, with a single MEGADRIVE-LCI soft starter
- Flying start allows acceleration or deceleration at any speed
- Generating operation allows decelerating of machine to speed zero
- No speed and no rotor position sensor required
- Various starter configurations available

**Gas turbine starters**
Gas turbines often have to be started and run up quickly at short notice. MEGADRIVE-LCI gas turbine starters use the generator as motor and run it up to a speed which is above the ignition speed of the gas turbine. The gas turbine can then accelerate the generator independently to rated speed and synchronize it to the power system.

**Motor current for various starting methods**

**Examples of MEGADRIVE-LCI gas turbine starter configurations**
- 6/6-pulse configuration
- 12/6-pulse configuration

**Examples of MEGADRIVE-LCI soft starter configurations**
- 6/6-pulse configuration
- 12/12-pulse configuration
**System integration**

To design a drive system, it is important to consider the total solution.

The MEGADRIVE-LCI is designed as a system. It is important to consider not only the process, but the total solution – including the supply network, site conditions, national standards, higher-level control, switchgear, overall efficiency and other plant-specific characteristics.

**Mechanical system interface**
Variable speed drive systems are usually operated over a wide speed control range. They are generally subjected to torque pulsations, which occur in a broad band of frequencies. Aspects which concern the transfer of the torque between motor and driven machine have to be carefully considered when designing the mechanical system interface. A torsional study can clarify whether the shaft design is acceptable.

**Power supply interface**
The power system interface has to be designed to ensure that the converter withstands disturbances from the power system and that the current harmonics from the converter do not cause voltage drops in the network.

Network-friendly converter configurations minimize harmonics. A design with a 12-pulse or even 24-pulse rectifier is usually sufficient to reduce the harmonic content to an acceptable level. In weak networks, additional filtering might be needed. As the filters are capacitive at line frequency, they also provide a power factor correction according to customers’ specifications.

**Automation and operator interface**
The automation and operator interface is the integration of the drive system controls at the plant control level. The communication with the control room can be designed with conventional wiring using analog and binary input/output modules or with communication interfaces for serial data exchange.

**Environment**
Country and plant-specific characteristics have to be taken into account when designing a drive system. Equipment dimensions and weight, installation restrictions, conveyance of the cooling medium and of electric power have to be clarified. In addition, demands on environmental compliance, protection classes, electromagnetic compatibility (EMC) and noise emission have to be considered.
Monitoring and diagnostics

The MEGADRIVE-LCI is available with an intelligent remote monitoring and diagnostics system, which allows secure access to the drive from any location in the world.

DriveMonitor\textsuperscript{TM} allows real-time access to the drive. It supports monitoring and diagnostics of ABB drives for new and existing installations.

The optional tool consists of a hardware module, as well as a software layer that automatically collects and analyzes selected drive signals and parameters.

Long-term monitoring functions deliver important information on equipment status, maintenance tasks needed and possible performance improvements. As experts can gain access to the drive remotely, DriveMonitor\textsuperscript{TM} also helps cut maintenance costs by reducing on-site work.

With extra diagnostic packages, DriveMonitor\textsuperscript{TM} can also monitor other drive system components, such as main circuit breaker, transformer and the driven machine. Special packages related to the application, such as rolling mills, water pumps and compressors, can be integrated into the system.

**Benefits**

- Early detection to avoid costly repairs
- Reduction of process-critical faults
- Optimization of maintenance cost and schedule over the product life cycle
- Long-term statistics for optimization of process performance
- Easier root cause analysis – reduced Mean Time To Repair (MTTR)
Designing a drive system involves selecting and matching the motor and the drive to satisfy requirements determined by the load, the supply system, the ambient conditions and the process.

**Synchronous motors**
Synchronous motors are typically considered for high power ratings (above 8 MW to more than 100 MW). In addition to their high power capabilities, synchronous motors offer the benefits of high efficiency and high performance through the utilization of different rotor designs. They are available air or water cooled, self or forced ventilated, for harsh environmental conditions or hazardous areas and – with different pole pair numbers – for different maximal speeds. Specially designed high-speed 2-pole motors can be operated up to 6,400 rpm with a MEGADRIVE-LCI output frequency of 107 Hz. Depending on the rotor and exciter design, the maximum speed of these motors varies with the power rating.

In order to guarantee the specified output and reliable operation of a large variable-speed synchronous motor designed to operate with a MEGADRIVE-LCI, ABB’s design engineers pay special attention to ensure that
- motor cooling system remains fully effective throughout the specified speed range at the specified load,
- full account is taken of the additional losses resulting from the harmonic content in voltage and current,
- motor insulation withstands the voltage waveforms that may occur,
- motor and converter voltages ensure highest drive efficiency and lowest cable cost,
- motor reactances match converter operation,
- clarification if torsional analysis of the shaft train is necessary,
- excitation system excites the machine at any speed including standstill.

ABB’s AMS 4 and 6-pole motors up to 20 MW
ABB’s WMT 2-pole motors up to 12 MW / 6,400 rpm or 20 MW / 5,000 rpm
Testing

Thorough testing ensures proven functionality and performance and reduces commissioning time.

To verify that quality standards and customer requirements are fully met, every component of a drive is subjected to thorough testing in ABB’s modern test facilities.

**Routine test**
Routine tests and functional tests form an integral part of the scope of supply of a MEGADRIVE-LCI system. They are performed in accordance with international standards (e.g. IEC) and ABB quality assurance procedures (ISO 9001).

**Combined test**
ABB offers the possibility to perform a combined test with the complete drive system, including transformer, converter and motor, to verify the performance and to confirm the design data.

If two identical MEGADRIVE-LCI drives are ordered at the same time, they can be tested “back-to-back”. One complete MEGADRIVE-LCI drive system works in motor mode and is loaded with a second complete MEGADRIVE-LCI drive system working in generator mode.

Such tests are executed to verify performance values such as power output, motor and transformer temperature rise, efficiency, noise level and shaft vibrations at different load points under defined cooling conditions. This reduces commissioning time on site.
Service and support

The MEGADRIVE-LCI is backed by unrivalled service and support from the customer’s initial inquiry throughout the entire life cycle of the drive system.

Technical advice
As originators of AC drives technology in the late 1960s, ABB has over 40 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.

Installation and commissioning
Proper installation and commissioning of the equipment, done by qualified and certified commissioning engineers, reduces start-up time, increases safety and reliability and decreases life-cycle costs. In addition, operators can be given practical training by experienced specialists on site.

Training
ABB provides extensive training for its medium voltage drives. A range of training programs is offered from basic tutorials to programs tailored to the customer’s specific needs.

Life-cycle management
ABB’s drive life-cycle management model maximizes the value of the equipment and maintenance investment by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive.

Life-cycle management includes:
- providing spare parts and expertise throughout the life cycle
- providing efficient product support and maintenance for improved reliability
- adding functionality to the initial product
- providing a smooth transition to a new technology at the end of the life cycle

Global network, local presence
Aftersales service is an integral part of providing the customer with a reliable and efficient drive system. The ABB Group of companies operates in more than 100 countries and has a worldwide network of service operations.

Services for ABB’s medium voltage drives
- Supervision of installation and commissioning
- Training
- Remote diagnostics
- Customized maintenance contracts
- Local support
- 24 x 365 support line
- Spare parts and logistics network
- Worldwide service network
## MEGADRIVE-LCI data sheet

### Motors
Synchronous motors

### Standards
IEC, EN, CE

### Input (line side)
6, 12 or 24-pulse thyristor rectifier

#### Variation:
- ±5% of nominal voltage: rated power down to -15%: safe operation with derated output power below -15%: voltage dip ride through ≤ 4 sec

#### Frequency:
50 or 60 Hz

#### Power factor:
approx. 0.95 in. at rated speed/load

### Output (motor side)
6 or 12-pulse thyristor inverter

#### Voltage range:
0 ... rated output voltage

#### Frequency:
0 ... 60 Hz (higher optional with derating)

#### Power factor:
approx. 0.90

### Auxiliary voltages
For fans, pumps, excitation:
- 3 ~ 400 ... 500 Vac, ±15%

For converter control:
- (approx. 1.5 kVA)
  - from UPS: 1 ~ 120 ... 240 Vac, ±10%
  - from battery: 110 ... 220 Vdc, ±10%

### Excitation
AC controller for motors with brushless excitation or 6-pulse rectifier for motors with slip rings

### Efficiency
Typical converter efficiency > 99% at rated speed/load

### Temperature
Ambient air: +5°C to 40°C (higher with derating)
Raw water: +2°C to 32°C (higher with derating)

### Noise level at 1 meter distance
- Air cooled: ≤ 80 dB(A)
- Water cooled: ≤ 75 dB(A)

### Enclosure classes
- Air cooled: standard IP30, optional IP31 – IP41
- Water cooled: standard IP30, optional IP31 – IP54

### Control interface
- Standard: Parallel galvanically isolated analog and digital I/O
- Optional: Bus interface including Modbus, Profinet (others on request)

### Protective functions
- Overcurrent, line over- and undervoltage, earth fault, output overfrequency, overvoltage and overflux, air or water cooling monitoring, motor stall and many others

### Type code examples MEGADRIVE-LCI

<table>
<thead>
<tr>
<th>Thyristor cooling</th>
<th>Converter line side</th>
<th>Converter motor side</th>
<th>MEGADRIVE-LCI types (no redundancy)</th>
<th>Input voltage (kV)</th>
<th>No. of thyristors/branch (no redundancy)</th>
<th>Output voltage (kV)</th>
<th>Output current (kA)</th>
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Examples of power parts for MEGADRIVE-LCI drives and starters

* data for specified conditions regarding
- input voltage variations
- motor frequency and commutation reactance
- cooling conditions
* other configurations and ratings on request