MEGADRIVE-LCI

Medium voltage AC drive for control and soft starting of large synchronous motors







MEGADRIVE-LCI - Proven technology for high powers

For more than 30 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

During its 30 years of production 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 750 MEGADRIVE-LCI units installed with a total power of 4300 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 30 years operational experience in different applications
- Configurations for variable speed drives and soft starters
- Highest efficiency
- Highest reliability and availability
- For motor and generator (braking) operation
- Lowest maintenance requirements
- Standard designs are available for powers up to 72 MW and voltages up to 10 kV

Industries	Applications							
Cement, Mining and Minerals	Fans and pumps							
Chemical, Oil and Gas	ompressors and extruders							
Marine	Propulsion systems							
Metals	Blast furnace blowers and wire rod mills							
Pulp and Paper	Fans and pumps							
Power Generation	Starters for gas turbines and hydro pumped-storage power plants, boiler feed-water pumps							
Water and Waste Water	Pumps							
Other Applications	Test stands and wind tunnels							

Fields of application

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%, 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.

6, 12 or 24-pulse rectifier configurations are available for minimized harmonic influence of the converter on the supply system. The MEGADRIVE-LCI meets the most stringent requirements for current and voltage harmonic distortion as defined by IEEE, IEC and EN.

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%) of rated speed), when the

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

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.

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

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.

Key product features

- Series connection of thyristors for the scalability of voltage and power as well as for the implementation of n+1 thyristor redundancy
- Fuseless design for high reliability
- Motor and generator (braking) operation for more operational flexibility
- Encoderless control for higher availability and reduced maintenance costs
- Supply voltage dip ride through to keep the process running in case of short voltage dips
- Air- and water- cooled converters for optimal plant integration
- Modular design for optimal configuration and highest reliability



Series connection of thyristors in a water-cooled MEGADRIVE-LCI for higher voltage and redundancy. A Thyristor B Heat sink

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.





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% 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.



Power consumption for various pump control methods



Examples of MEGADRIVE-LCI variable speed drive configurations

Soft starting of large synchronous machines

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.

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.

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



Examples of MEGADRIVE-LCI gas turbine starter configurations



Examples of MEGADRIVE-LCI soft starter configurations

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 customer's 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.

Control

The MEGADRIVE-LCI 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 MEGADRIVE-LCI can be installed with all major fieldbus adapters for smooth integration, monitoring and controlling of different processes, according to customer requirements.

Industrial^{IT}

ABB's Industrial^{IT} means increased standardization and seamless interaction of different ABB products. The MEGADRIVE-LCI bears the Industrial^{IT} Enabled symbol, a special mark indicating that the drive can be easily integrated into the Industrial^{IT} architecture in a 'plug & produce' manner.



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 allows 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 existing installations.

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

Long-term monitoring functions deliver important information on equipment status, tasks needed and possible performance improvements. Diagnostic procedures and trending can cover not only the converter itself but other parts of the shaft train as well - everything according to customer needs and preferences.

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 6400 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 / 6400 rpm or 20MW / 5000 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 tests

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 tests

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.



Illustration of extended test layouts

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.



Back-to-back test 8 MW / 3600 rpm



Back-to-back test 48 MW / 3500 rpm

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 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.

Installation and commissioning

Substantial benefits can be gained from proper installation and commissioning of the equipment. Predictive testing and inspection, in addition to traditional operational parameter setting, done by ABB's qualified and certified commissioning engineers, will reduce start-up time, increase safety and reliability and decrease life-cycle costs. In addition, operators can be given practical training by experienced specialists on site.

Training

Extensive training for ABB's medium voltage drives can be provided at the ABB University. A range of training programs is offered from basic tutorials to programs tailored to the customer's specific needs. -> www.abb.com/abbuniversity

Life-cycle management

ABB's drive life-cycle management model provides customers with the maximum profit for their purchased assets by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive. Lifecycle management maximizes the value of the equipment and maintenance investment by:

- providing spare parts and technical expertise throughout the life cycle
- providing efficient product support and maintenance for improved reliability
- adding functionality to the initial product by following the upgrade path
- providing a smooth transition to a new technology at the end of the life cycle

Global network, local presence

After sales 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. Wherever you are, ABB is there for you.

Service 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

Standards IEC. EN. CE

Synchronous motors

Input (line aide)

input (line side)									
6, 12 or 24-pulse thyristor rectifier									
Variation:	±5% of nominal voltage: rated power								
	down to -15%:	safe operation with							
	below -15%:	derated output power voltage dip ride through ≥4sec							
Frequency:	50 or 60Hz	at rated speed/load							

Output (motor side)

6 or 12-pulse thyristor inverter Voltage range: 0 ... rated output voltage Frequency: 0 ... 60Hz (higher optional with derating) Power factor: approx. 0.90

Auxillary voltages

For fans, pumps, excitation: $3\!\sim\!400$... 500Vac, $\pm15\,\%$ For converter control: (approx. 1.5kVA) from UPS: 1~120 ... 240Vac, ±10% or from battery: 110 ... 220Vdc, ±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 m 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, IP41, IP54

Control interface

Protective functions

Type codes MEGADRIVE-LCI air cooled

MEGADRIVE-LCI types No redundancy	Thyristor cooling	Converter line side	Converter motor side	Input voltage (kV)	No. of thyristors/branch (No redundancy)	Output voltage (kV)	Output current (kA)	Shaft power (MW)
A0606-211N A0606-302N A0606-453N A0606-604N		6-pulse	6-pulse	2.1 3.0 4.5 6.0	1 2 3 4	2.0 2.7 4.1 5.5	1.6 2.0 2.0 2.0	4.5 8.0 12.0 16.0
A1206-101/1N A1206-151/2N A1206-232/3N	Air	12-pulse	6-pulse	2* 1.0 2* 1.5 2* 2.3	1/1 1/2 2/3	2.0 2.7 4.1	1.6 2.0 2.0	4.5 8.0 12.0
A1212-211N A1212-302N A1212-453N A1212-604N		12-pulse	12-pulse	2* 2.1 2* 3.0 2* 4.5 2* 6.0	1 2 3 4	2* 2.0 2* 2.7 2* 4.1 2* 5.5	1.6 2.0 2.0 2.0	9.0 16.0 24.0 32.0

Type codes MEGADRIVE-LCI water cooled

Raw water:	+2°C to 32°C (higher with derating)	es					Ich			
Noise level at	1 m distance	é.			de		au	~	_	
Air cooled:	≤80 dB(A)	<u>5</u>	_	de	<u>.</u>	5	ą	2	₹	S
Water cooled:	≤75 dB(A)	or LC در	oling	e si	otor	(kV	ors/	ge (l	t	M)
Enclosure cla	sses	dan	00	i	Ĕ	age	rrist Idaı	oltaç	Irre	ver
Air cooled:	standard IP30, optional IP31, IP41		٦ ک	te	te	5	<u>é</u> n	2	ರ	ð
Water cooled:	standard IP30, optional IP31, IP41, IP54	3AL edu	risto	ver	ver	rt T	of t red	put	put	ц р
Control interfa Standard:	ace Parallel galvanically isolated analog and	MEG	Thy	Con	Con	Inpu	°N°.	Out	Out	Sha
Optional:	digital I/O Bus interface including Modbus, Profibus	W0606-211N		6-pulse	6-pulse	2.1	1	2.0	2.3	7.0
	(others on request)	W0606-372N				3.7	2	3.4	2.3	12.0
		W0606-563N				5.6	3	5.0	2.3	18.0
Protective fur	nctions	W0606-714N				7.1	4	6.6	2.3	23.0
Overcurrent, li	ne over- and undervoltage, earth fault,	W0606-855N				8.5	5	7.8	2.3	27.5
output overfre water cooling	quency, overvoltage and overflux, air or monitoring, motor stall and many others	W0606-986N				9.8	6	9.0	2.3	32.0
trator cooming	montoning, motor otali and many othero	W0606-1107N				11.0	7	10.2	2.3	36.0
				_						
		W1212-211N	er	12-pulse	12-pulse	2* 2.1	1	2*2.0	2.3	14.0
		W1212-372N	at			2* 3.7	2	2*3.4	2.3	24.0
		W1212-563N	\geq			2* 5.6	3	2* 5.0	2.3	36.0
		W1212-714N				2* 7.1	4	2* 6.6	2.3	46.0
		W1212-855N				2* 8.5	5	2* 7.8	2.3	55.0
		W1212-986N				2* 9.8	6	2* 9.0	2.3	64.0
		W1212-1107N				2*11.0	7	2* 10.2	2.3	72.0
Examples of p	power parts for MEGADRIVE-LCI drives									
* data for sper	cified conditions regarding	W2412-101/1N		24-pulse	12-pulse	4* 1.0	1/1	2* 2.0	2.3	14.0
- input volta	ge variations	W2412-181/2N		_ paido	.2 paico	4* 1.8	1/2	2*34	2.3	24.0
- motor freq	uency and commutation reactance	\N/2/12-101/2N				/* 2.7	2/3	2*50	2.0	36.0
- cooling co	nditions	VVZ41Z-Z1Z/SIN				4 2.1	2/3	2 3.0	2.3	30.0
other configu	urations and ratings on request									

and starters * data for specified conditions regarding

- input voltage variations - motor frequency and commutation rea

ABB

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