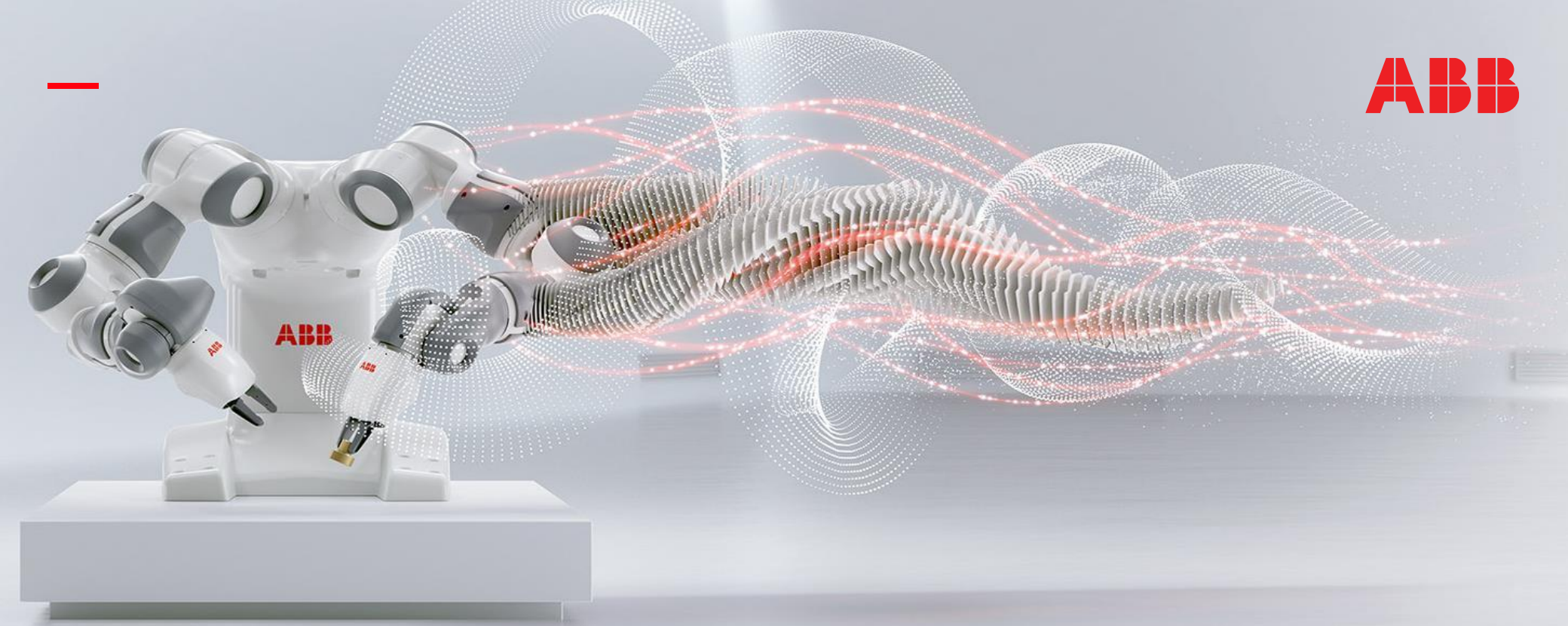


MODR, LV DRIVES

Variable Speed Drives

Ebram Helal

Electricity Distribution Network :

Residential Voltage Levels

Single phase (220 Volt)

Three Phase (380 Volt)

Industrial Voltage Levels

Three Phase

1- 380 Volt

2- 500 Volt

3- 690 Volt

4- 3.3 KV

5- 6.6 KV

6- 11 KV

7- 22 KV

Types of Electrical Loads in Power System

- Domestic load
- Commercial load
- Industrial load (Represent the highest Load on the electrical network.)

Types of Motors

As the motors form a high portion of the industrial load, so we must understand the nature of this significant load.

DC Motors

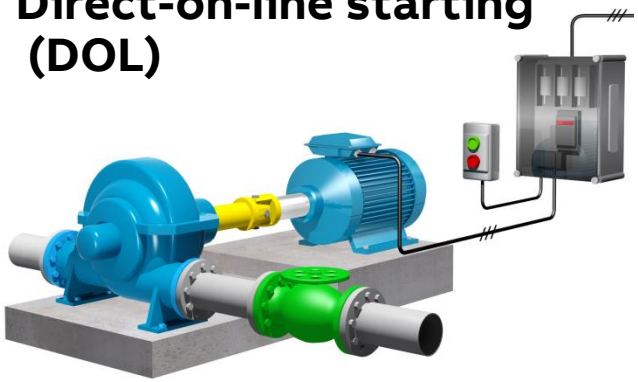
1. **Series Wound**
2. **Shunt Wound**
3. **Compound Wound**
4. **Permanent Magnet**

AC Motor

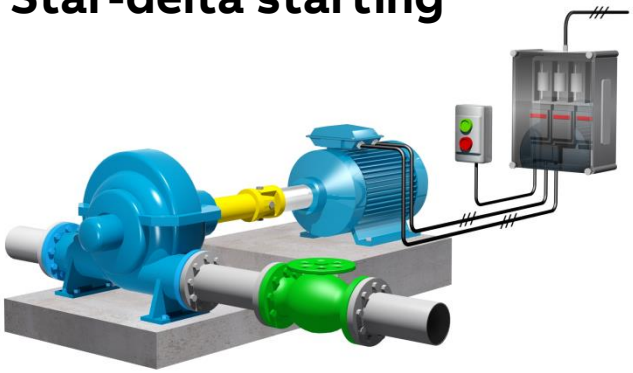
1. **Synchronous**
2. **Asynchronous (induction)**

Common motor starting methods

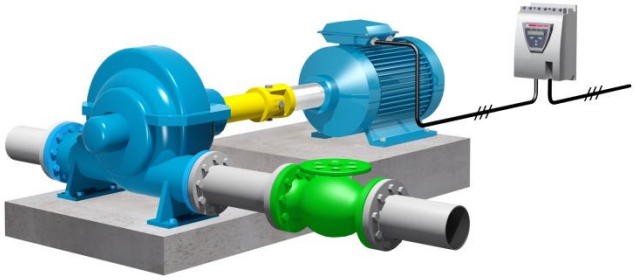
Direct-on-line starting (DOL)



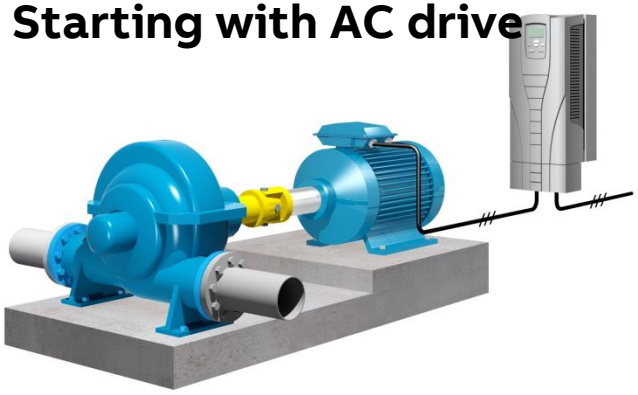
Star-delta starting



Motor soft starter



Starting with AC drive



General benefits of AC drives Reduced maintenance

AC drive enables:

- **soft and controlled starting, stopping and operation of motor**
  - **reduced mechanical resonances/stresses – longer lifetime of conveyors, fans, pumps and other mechanical equipment**
  - **in pump applications, no hammer effect to pipelines – fewer repairs**
  - **lower pressure in the pipeline – reduced leakages**
- **use of squirrel cage induction motors**
  - **Robust and simple construction – minimal need for maintenance**
  - **Good weight-power ratio**
  - **Standardized – motors of different manufacturers have same dimensions**
  - **High protection classes (e.g. IP54)**

Driven machine can be operated in its most efficient operating point or area, meaning that the machine runs cooler and thus its lifetime is extended

Different names and acronyms

VSD = variable speed drive
ASD = adjustable speed drive

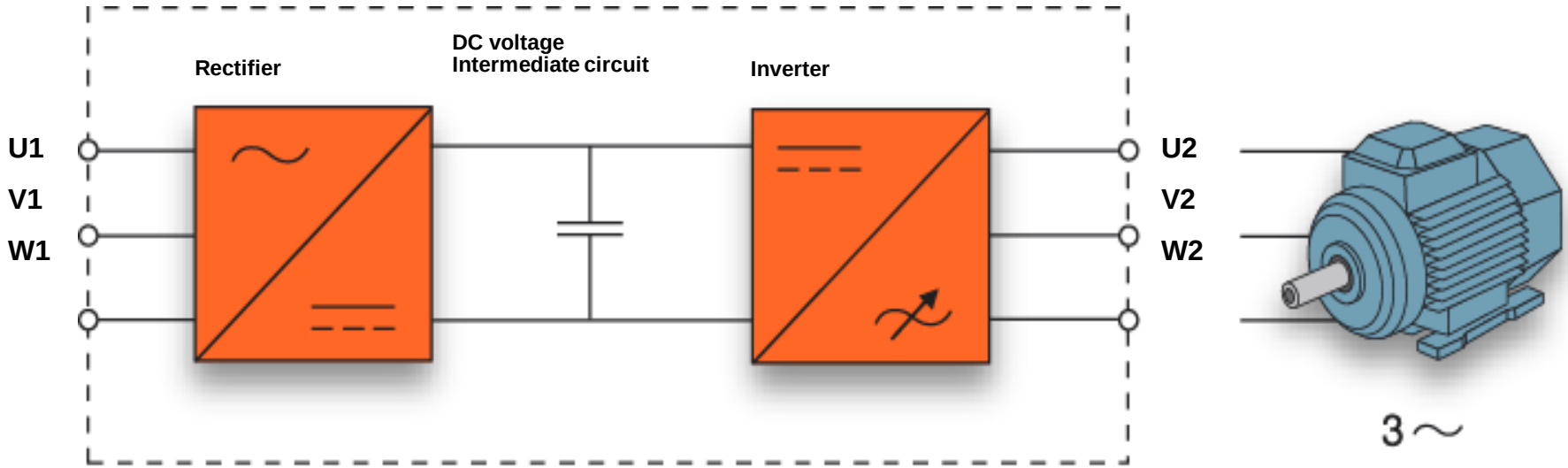
VFD = variable frequency drive
AFD = adjustable frequency drive

VVVF = variable voltage variable frequency

Frequency converter
Inverter
AC drive

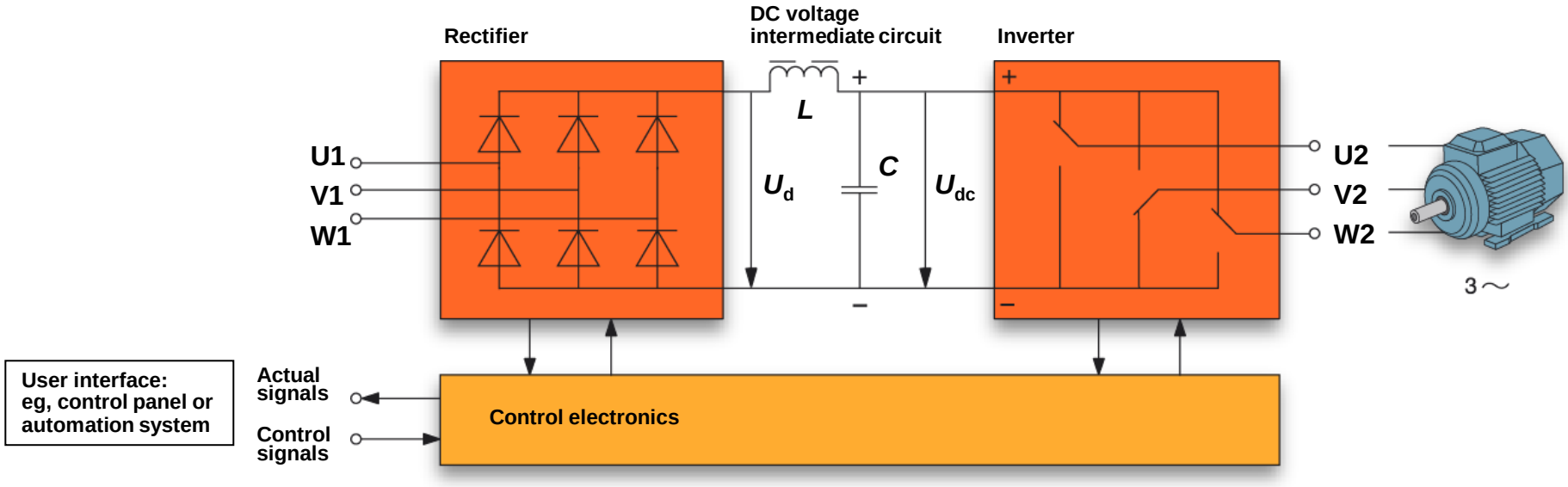
Drives Main construction

Complete AC drive consisting of:
1-Rectifier
2-DC voltage intermediate circuit,
3-Inverter
4-control electronics



Main components of AC drive

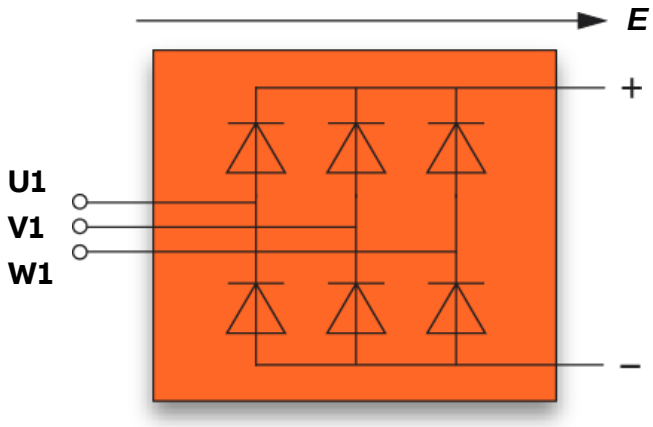
- An AC drive converts mains current and voltage with fixed frequency and amplitude into current and voltage with variable frequency and amplitude
- An AC drive consists of rectifier, DC voltage intermediate circuit, inverter and control electronics
- Control electronics control the operation of an AC drive



Rectifier
Function and types

- A rectifier converts mains voltage (AC) into DC voltage
- Rectifier types include:
  - Diode rectifier
  - Thyristor rectifier
  - IGBT rectifier

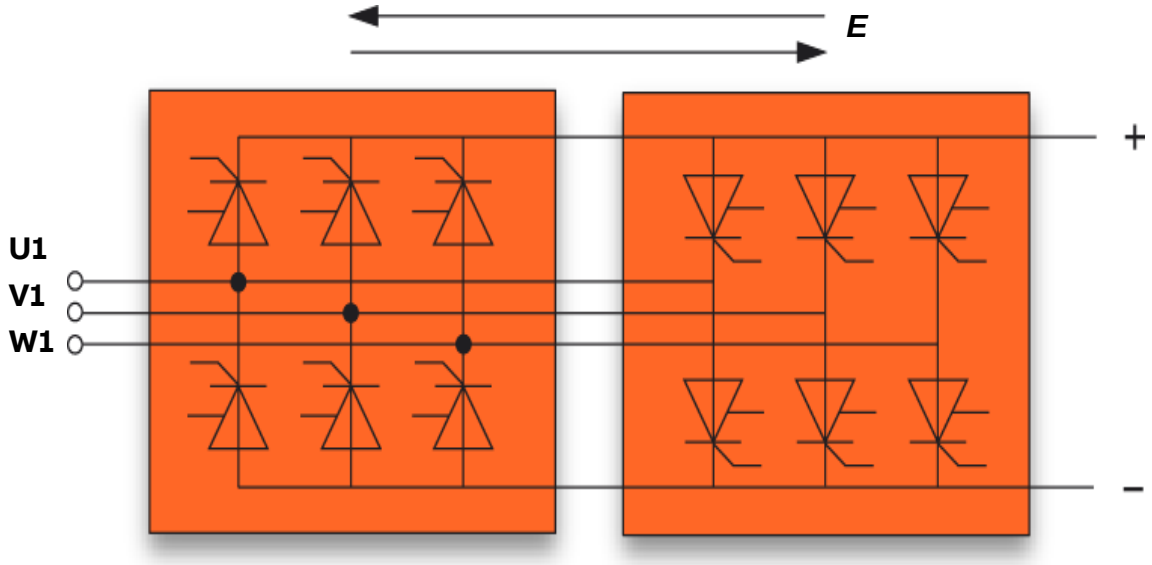
Rectifier Diode rectifier



Most common diode rectifier consists of six diodes (6-pulse diode bridge)

- Energy (*E*) can flow only in one direction, from network to motor
- Diode bridges can be parallel-connected in order to increase power and/or lower harmonics in supply network by using phase shifting transformer
- Power factor close to unity (1)

Rectifier Thyristor rectifier



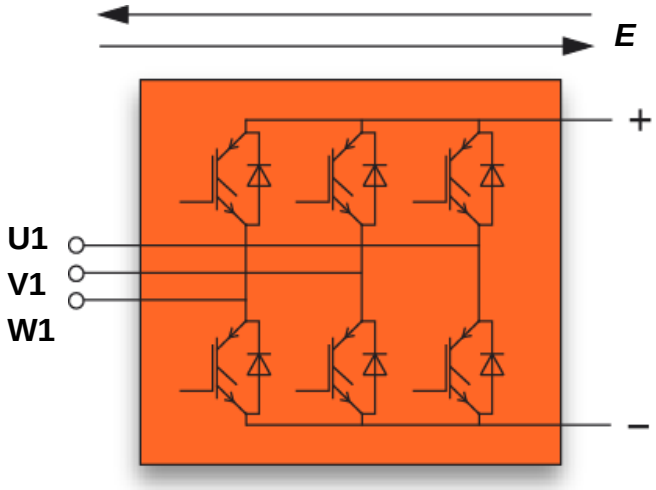
Thyristor bridge has six thyristors

– Typically consists of one motoring and one regenerative thyristor bridge

– Energy can flow in two directions

– Power factor in motoring mode is close to unity and in braking mode typically 0.85

Rectifier IGBT rectifier



Consists of six IGBTs and six diodes

Energy can flow in two directions

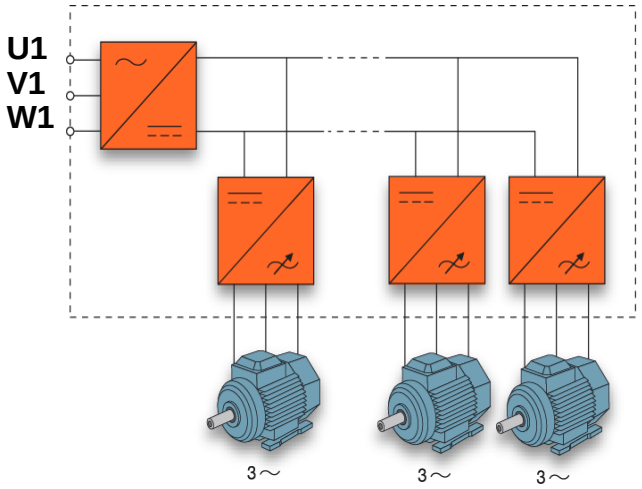
– When braking, energy is fed back to supply network

Switching of IGBT is controlled by an IGBT control program and control electronics

Requires a filter in front of the IGBT rectifier for proper operation

Power factor is unity (1.0)

AC drive types Multidrive



Multidrive is an AC drive that consists of one rectifier (supply unit) and several inverters connected to a common DC voltage intermediate circuit

Each inverter is able to operate independently

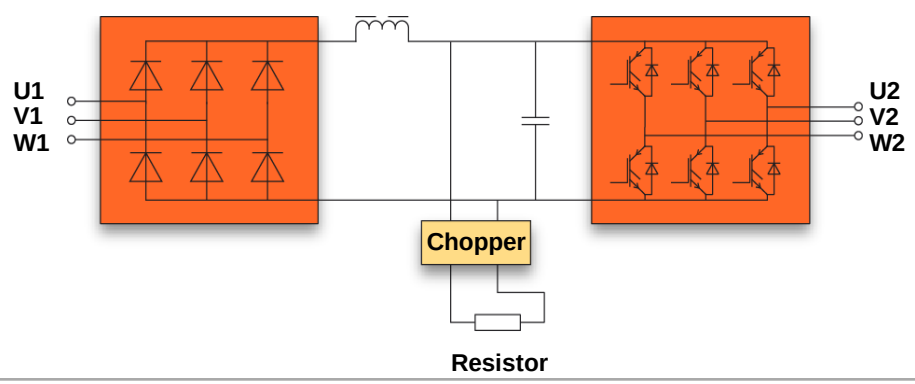
Braking energy from braking motors is fed into common DC bus for use by other motors

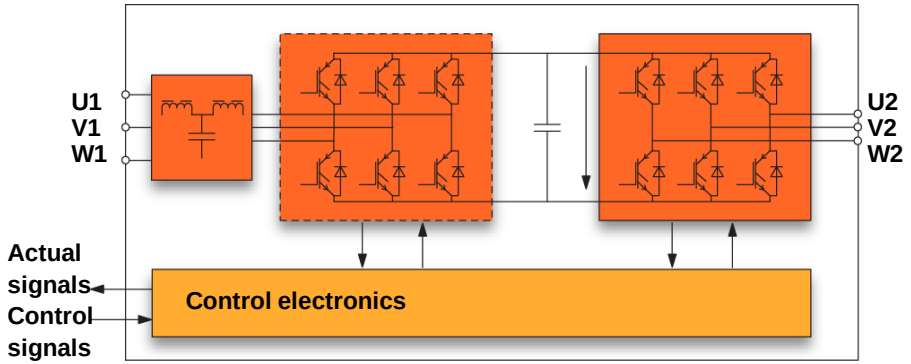
Electrical braking

Braking energy has to be dissipated or fed into supply network

With diode rectifier it is not possible to feed braking energy into supply network. Energy has to be dissipated using braking chopper and braking resistor connected to DC voltage intermediate circuit of AC drive.

With IGBT or thyristor rectifiers the braking energy can be fed to supply network





Drives Structure

ACS800-01 & -11 Wall mounting	ACS800-02, Pedestal mounting	ACS800-04, Modules for Panel builder	ACS800-07, Cabinet mounting with DSU	ACS800-17, Cabinet mounting with regenerative ISU	ACS800-37, Cabinet mounting with low harmonic ISU
					

ABB Drives

Drive Products – At a glance

We are the leading drives manufacturer with focus on domain expertise and reliability

#1 global manufacturer of AC drives

~2,500 employees worldwide

1,7 million drive and PLC products manufactured in a year

80+ countries with local representatives

1. Total R&D workforce includes only internal employees

ABB Values

Courage

At ABB, we:

- **Take action and manage consequences**
- **Speak up and ask for help**
- **Take calculated risks to create success**

Care

At ABB, we:

- **Take care of our customers, our people and the environment**
- **Respect and value differences**
- **Do what is right and act with integrity**

Curiosity

At ABB, we:

- **Believe there is always a better way**
- **Lead with technologies and innovations**
- **Learn from failures and successes**

Collaboration

At ABB, we:

- **Believe smart people collaborate**
- **Build on each other's strengths and successes**
- **Partner with our customers**

Drive Products – Main markets

Who we are

Leading supplier of AC drives and PLC for light and heavy industries, infrastructure, integrators and machine builders.

We are market leader in <600kW drives with history of manufacturing drive for more than 45 years.

Where we play

Light industries **Reducing cost by saving energy**	**Food and beverage, discrete production, plastics, ceramics, etc.**
Heavy industries **Running critical process at best performance**	**Oil and gas, power production metals, mining, chemical, cement, pulp and paper, etc.**
Machine building **Delivering high performance and reliable components**	**Cranes, mixers, compressors, extruders, conveyers, pumps, fans, etc.**
Infrastructure **Reducing cost by saving energy**	**Water and air handling applications in buildings, utilities and industrial applications**

How we do it

Reliability, performance, support

We are the product of choice for our end customers

Geographical coverage, value beyond products and value-added services

We are the supplier of choice for our channels and partners

Domain expertise and application know-how

We are the trusted partner for helping our customers' applications to work optimally

Drive Products – The forerunner of technology

Cornerstones of innovation

Over 45 years of experience

Our offering

Drive Products

Product portfolio by product line

Industrial

- Wall mount Drives
- Drives modules
- Ultra low harmonic drives
- Regenerative drives
- Advanced IEC program
- Advanced Functional safety

Machinery & Micro

- Drives for machine building
- Advanced Position control
- Application ready features
- Connectivity ready

PLC & HMI

- Advanced Functional safety
- Certified Security
- Harsh environment
- Motion Control

Segment specific HVAC and Water and wastewater

- Wall mount Drives
- Drives modules
- Ultra low harmonic drives
- Cabinet Drives
- Segment specific features

General Purpose

- Wall mount Drives
- Drives modules
- Cabinet Drives
- Functional safety

Customer value Beyond products

- Smart Guides (Digital manuals)
- Guided selection tools
- Energy efficiency calculators
- Remote apps

Drive Products

Industrial drives

Uncompromised productivity

- **High performance, safety and configurability with world class services**
- **Our benchmark of performance, expertise and quality**
- **Application ready product for Cranes, Winders, Artificial lifting, Centrifuges and Position control and more**
- **Scalable and flexible programmability**
- **Advanced Functional Safety**

ACS880-04/14/34/…

Drive modules

ACS880-31

Ultra-low harmonic drives

ACS880-11

Regenerative drives

ACS880-01

Wall mount drives

Drive Products

Machinery & Micro

Persistent and adaptable performance

- **Specifically designed to offer high performance, adaptability and reliable operation to machine builders**
- **Customers can configure and optimize the units to match exactly their needs – they get all they need with a great motor control accuracy and performance**
- **Designed specifically for machine builders and system integrators**
- **Part of all-compatible product family**
- **Integrated functional safety**

ACS380-04

Drives for cabinet installation

ACS880-M04

Drives for Machinery applications

Drive Products

Segment specific drives for Water and wastewater

Securing the flow of water and wastewater

- **The most complete offering for water and wastewater**
- **Optimized efficiency even in demanding environments**
- **Effortless commissioning and configuration**
- **Smart embedded functions for uninterrupted operation**
- **Application expertise and life cycle services to keep the water flowing**

ACQ580-07
Cabinet drives

ACQ580-04/34
Drives modules

ACQ580-01
Wall mount drives

ACQ580-31
Ultra low harmonic drives

Drive Products

Segment specific drives for HVACR

Comprehensive climate control

- **The most complete offering for HVACR**
- **Designed for the HVAC market and has all you need built inside**
- **Speak the languages our HVAC customers and their systems do**
- **Quality that has been proved with over 600.000 running installations worldwide**

ACH580-07

Cabinet drives

ACH580-04/34

Drive modules

ACH580-31

Ultra-low harmonic drives

ACS880-01

Wall mount drives

ACH480-04

Drives for cabinet installation

Drive Products

General purpose drives

Effortless energy efficiency

- **One product, many applications – includes the all essential and much more for typical light industry applications**
- **Instant availability from central stocks around the world**
- **Product including all essential components minimizes the commissioning and setup time**

ACS580-07
Cabinet drives

ACS580-04
Drive modules

ACS580-01
Wall mount drives

ACS480-04
Drives for cabinet installation

System Drives

Product portfolio

General Performance

ACS580MV

- 200 kW to 6.3 MW
- Applications: pumps and fans
- Simple to select, order, commission and use
- All-Compatible user interface
- Affordable energy saving solution

ACS5000 / MEGADRIVE LCI

- 2 to 36 MW
- Applications: large compressors, pumps, fans and GT starters
- Flexible to configure for specific needs
- Medium to high power single drives
- High reliability and availability
- Highest level of personal safety

Renewables

ACS880-77/87

- 800 kW to 8 MW
- Application: onshore and offshore wind turbines
- Customer specific designs
- Compact and cost efficient
- Grid code compliance and simulations
- Modular design for high availability and high efficiency

PCS6000

- 3 to 12 MW
- Application: medium voltage wind turbine converter
- Flexible to configure for specific needs
- High performance
- High reliability and availability
- Highest level of personal safety

System Drives

Product portfolio

Industrial Drives

ACS880 cabinets

- 1.5 to 5200 kW
- Applications: paper machines, winders, rolling mills, conveyors, hoists, cranes, propulsion, etc.
- Versatile with full functional safety
- Best in class motor control and high performance
- Built-in reliability

ACS1000/ACS2000

- 315 kW to 5 MW / 250 kW to 3.68 MW
- Applications: pumps, fans, mills, conveyors, extruders, mixers, hoists
- Flexible to configure for specific needs
- Small footprint
- High reliability and availability
- Highest level of personal safety

ACS6080/ACS6000

- 5 to 36 MW
- Applications: mills, propulsion, conveyors, hoists, test stands
- Flexible to configure for specific needs
- **Supporting multiple motors**
- High performance
- High reliability and availability

Drive Modules

ACS880 modules

- 1.5 to 3200 kW
- Designed for OEM's, system integrators and panel builders
- Easy to integrate
- Flexible to configure for specific needs

HES880

- 320 to 900A / 230 to 500Vac
- Applications: working machines, marine, harsh environment industrial
- Small size and weight
- Cyclic load tolerance
- Ultra-low harmonic drive
- 4 g vibration and 30g shocks, IP67

DC Drives

Product portfolio

DC Drives

DCT880 modules/cabinets

- 20-4200 A_{AC}
- Thyristor power controller with power optimization
- Applications: Electrical heating, egannealing, drying, melting or heating in glass, plastic and metal industry
- Better process control and reduced CO2 emission compared to fossil fuel heating
- Power optimizer
- Extended connectivity as 880-platform

DCS880-S modules

- 20-5200 $A_{DC,}$ 1000 V_{AC}
- Applications: cranes, extruders, winders, mill stands, centrifuges, test benches, elevators, electrolysis
- Flexible configuration
- Extended connectivity
- Integrated field exciter
- Easy programming
- Highest level of functional safety

DCS880-A cabinets

- Up to 20 kA_{DC} and 1600 V_{AC}
- Applications: cranes, extruders, winders, mill stands, centrifuges, test benches, elevators, electrolysis
- Enclosed Converter
- Complete pretested
- Short power down time
- Hard parallel configurations up to 20kA
- High power solutions in 6- and 12-pulse

Drives Service – You choose, we respond. Globally

Services to match your every need

Long-term commitment to maintain your assets

Rapid response

Fast and flexible response to maximize your equipment uptime

Lifecycle management

Powerful tools and knowledge to optimize and extend your equipment life

Operational excellence

Manage your assets, operations, and risk to deliver strategic business results

Performance improvement

Optimized connectivity, reliability and efficiency of your assets to increase speed and yield

We are your planning and operations partner for services and solutions

You choose, we respond. Globally

ABB is a reliable service partner

Over **600** **ABB field service engineers**

Services in more than **60** **countries**

500 **service partners**

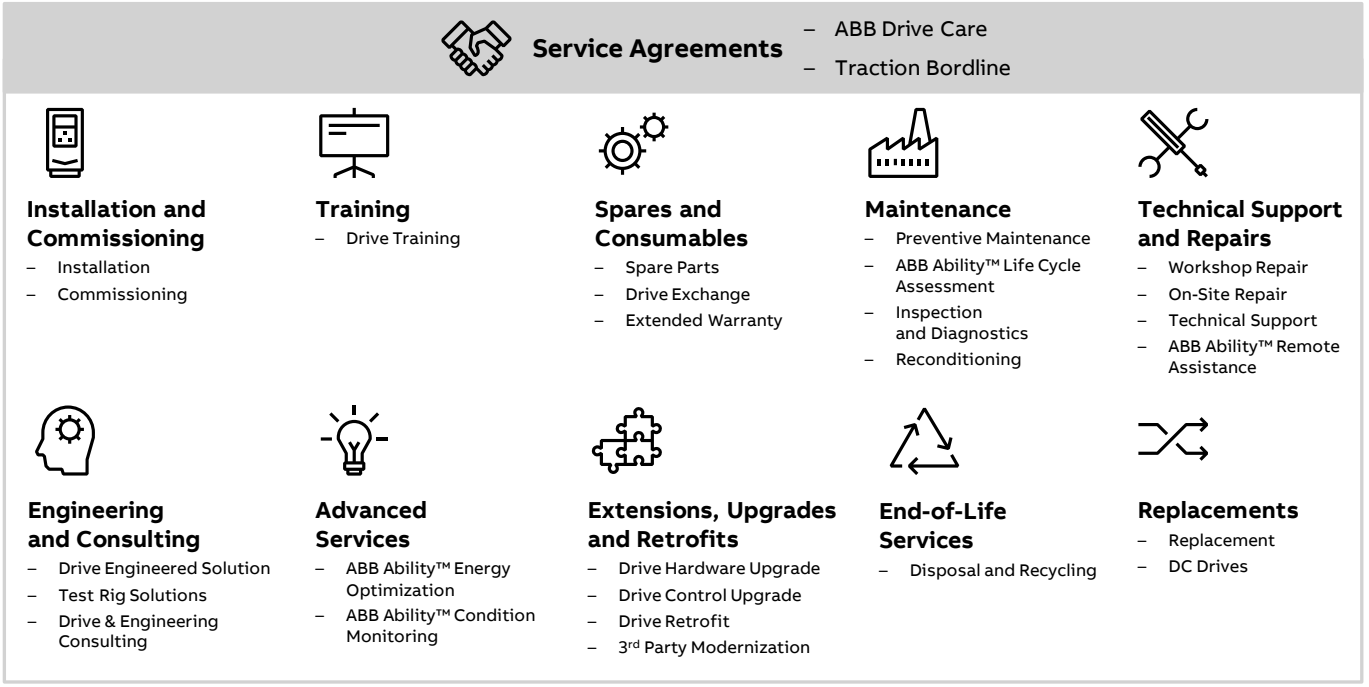
Over **10** **million drives delivered**

Providing **services for drives** for almost **40** **years**

ABB Drives Service Portfolio

From spare parts to cloud-based condition monitoring

- Global ABB service units, complemented by ABB authorized value providers, cover your installation throughout its lifecycle
- Maximize performance, uptime and efficiency throughout the life cycle of your assets
- From spare parts and technical support to cloud-based condition monitoring solutions, ABB offers the most extensive service offering to fit your needs



Power and productivity
for a better world™