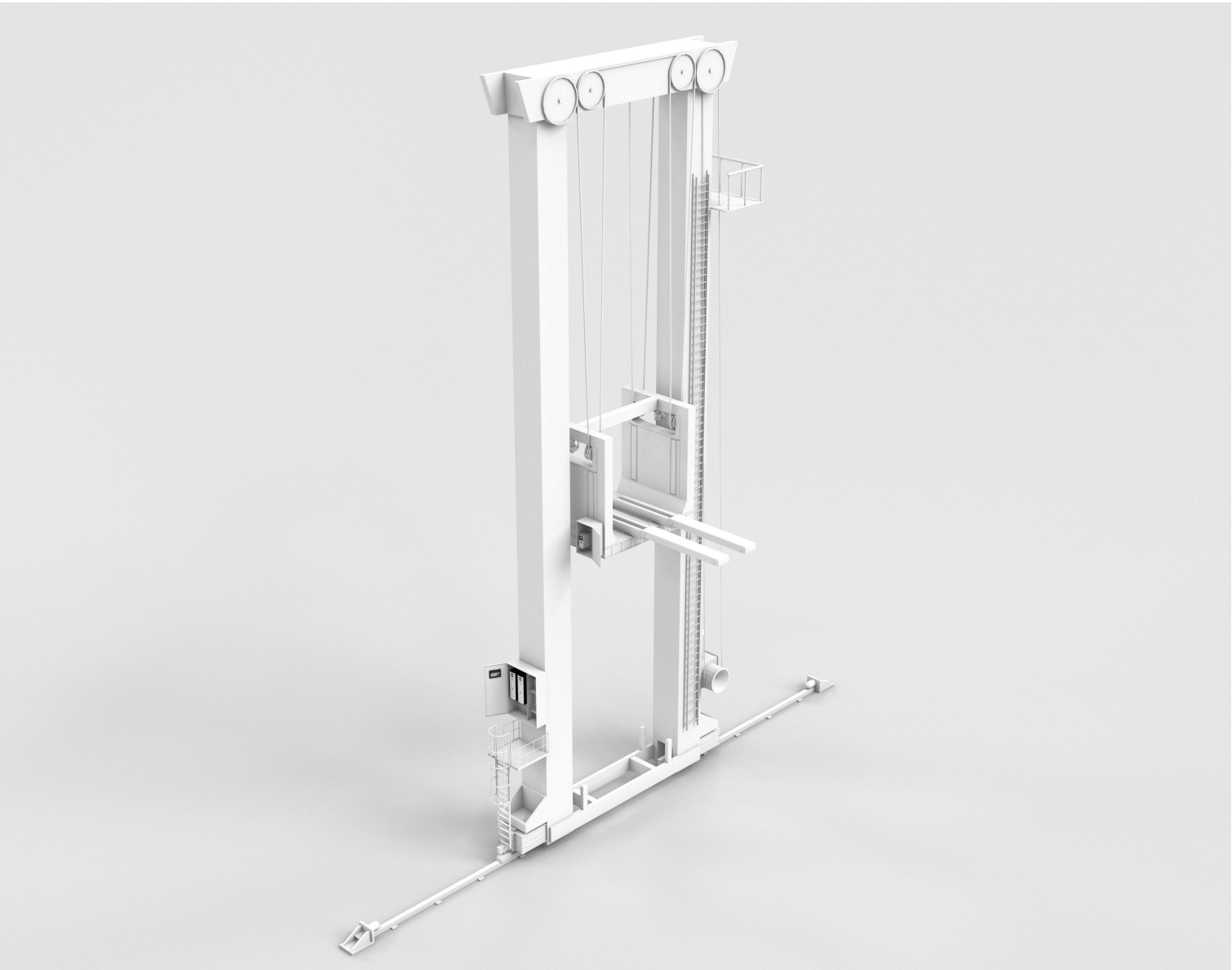
LOW VOLTAGE AC DRIVES

Dynamic and reliable stacker crane operations with ACS880 drives



- Smooth and precise travel, hoist and fork movements
- Includes built-in sensorless anti-pendulum control

ACS880 drives for stacker cranes

Smooth and precise travel, hoist and fork operation

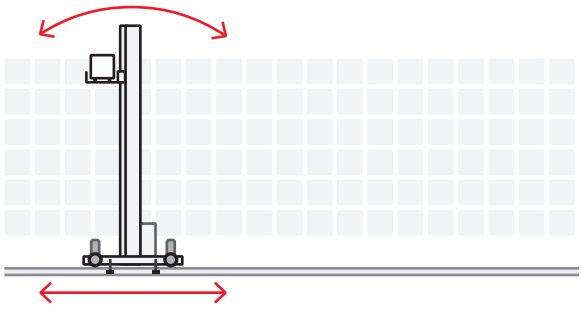
Our ACS880 range of drives includes a large variety of options for ensuring efficient and safe stacker crane operation.

ACS880-01 and -M04 products are available with a power range from 0.55 to 250 kW and voltages of 230, 400, 500 and 690 V. Enclosure class options are IP20, IP21 and IP55.

Premium performance

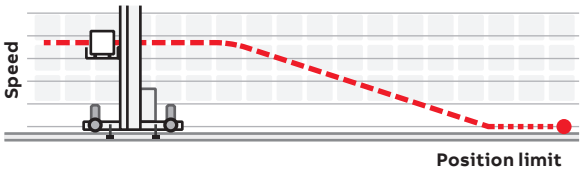
ANTI-PENDULUM

Minimize mast oscillation by controlling travel operation.



POSITION CONTROL HIGHLIGHTS

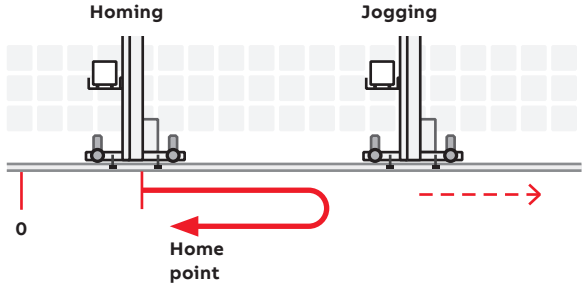
Axis speed and position are supervised during operation. If the axis is approaching a limit, the axis will begin stopping before the limit and stop close to the limit.



Profiled positioning (target position, velocity, acc./dec., jerk)

- Adjustment by additive and superimposed movement
- Change target and adjust velocity on the fly

Homing and jogging



Flexible programming with integrated safety

- ABB offers a comprehensive range of scalable PLCs and robust HMI control panels
- Integrated safety from single to complex safety applications
- Combined Condition Monitoring for predictable operations

Certified Drive-based safety solution

Plug-in safety functions modules provide an easy way to extend safety functions with SIL 3/PL e capability.

Energy savings with regenerative drives

Braking energy fed back to the network
The ACS880-11 regenerative drive includes an active supply unit (ISU), a line filter (LCL) and a motor inverter (INU), all in one compact integrated unit.

- 100% regeneration capacity
- THDi below 3% at nominal load
- Unity power factor at nominal load
- 97% system efficiency with a line filter

Ease of integration and use

User-friendly PC Tool
- All functions are parameterized and can be commissioned and monitored via a user-friendly PC tool
- Single wire PC tool connection over Ethernet

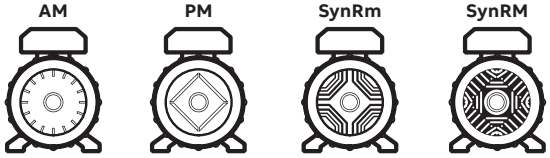
Removable memory unit for fast drive replacement
- Plug-in module with the firmware, application program and all the settings
- Quick and easy onsite drive replacement
- Enables fast firmware and application software update without special skills

Support for almost all encoder types
- HTL, TTL, Resolver, Sin/cos, EnDat, SSI, HIPERFACE, Tamagawa
- Also supports open loop positioning
- Supports two encoder modules at the same time

Connectivity with all major industrial automation networks
- PROFIsafe for functional safety
- Support for media redundancy (ring topology)
- Support for two fieldbus adapters

Support for almost any motor type
Induction motors, permanent magnet synchronous motors, including third party servo and high torque motors, and synchronous reluctance motors (SynRM).

- **Synchronous motors**
- **IEC motors**
- **SynRM motors**
- **NEMA motors**
- **High-speed motors**



Premium performance

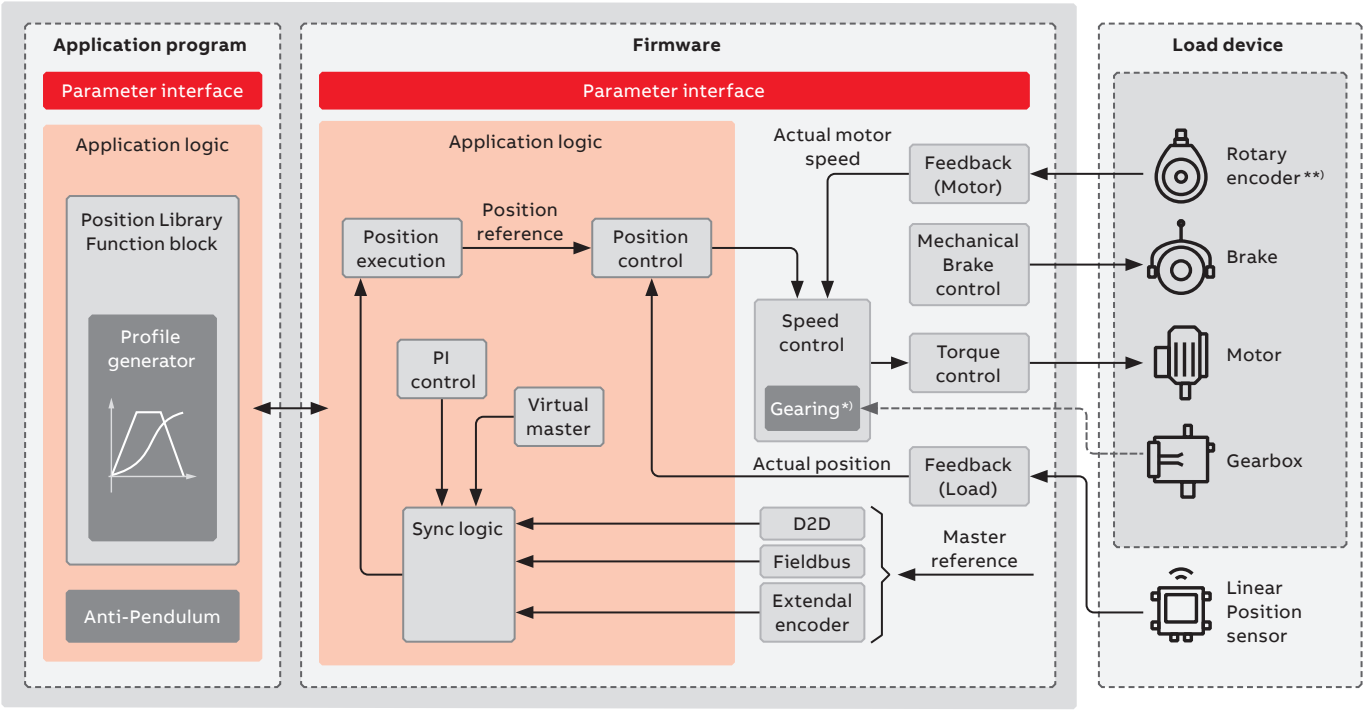
Motor control – Direct torque control (DTC)
ABB's state-of-the-art motor control technology provides precise speed and torque control, with or without a motor encoder, even at close to zero speed. DTC provides reliable starts and rapid reactions to load or network changes and ensures smooth and continuous operation.

Benefits of using DTC motor control
- Works with or without speed feedback
- Works with induction, permanent magnet and synchronous reluctance (SynRM) motors
- Excellent torque linearity
- High static and dynamic speed accuracy
- Optimal switching frequency for driven load requirements

Application control – Decentralized position control
The ACS880 product family offers a wide power range for speed, torque and position control. The position control places less of a load on the PLC while retaining a fast control loop cycle and is easily integrated into the system. It is a perfect solution for decentralized position control in all intralogistics machinery, especially in stacker cranes. All the features are parameterized, including homing, gearing, fast position latching, indexing, and even the anti-pendulum*) function for high-rise stacker cranes. The drives take the load position feedback from a laser distance sensor to enable precise position synchronization and from a motor rotary encoder for even more accurate motor control.

*) Limited offering. Available on special request.

Operation principle of ACS880 Stacker crane control (Position control platform)



*) The firmware utilizes the gearing configuration for a transition of position control into speed control.
**) Option for better motor control. The rotary encoder may not be in use, in which case the estimated speed is used for motor and brake control.

Built-in sensorless anti-pendulum*) prevents mast oscillation

*) Limited offering. Available on special request.

Tall stacker cranes are particularly vulnerable to the oscillation of the mast during travel movement. The anti-pendulum control function in the ACS880 drives is designed to suppress this oscillation. The function creates a mathematical model of the crane's mechanical oscillation. It calculates oscillation time by constantly measuring the position and weight of the load. The load's target height and mass are used to calculate a damping ratio that affects the behavior of the suppression. When the target height changes during movement, the function automatically recalculates the required speed and torque reference to compensate for the change in the crane's center of gravity and prevents the mast from oscillating.

Hoist and travel movement can run at the same time. Tall stacker cranes are particularly vulnerable to oscillation of the mast during travel movement. The anti-pendulum function is designed to avoid and compensate for unwanted vibration and oscillation on the mast of the crane during the movement. Damping is done by modifying the speed according to the calculated vibration frequency, which is highly dependent on the mass and position of the load. The system automatically recalculates the required speed and torque reference when the target height changes during the movement.

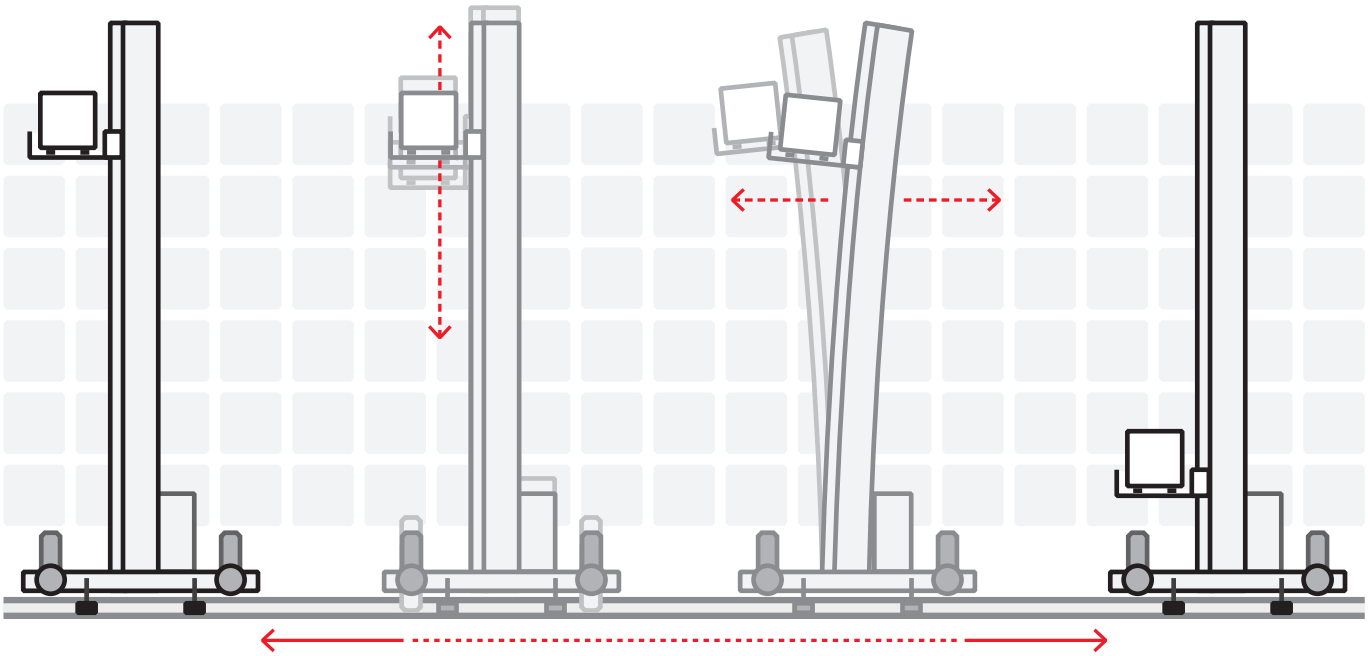
Key benefits of the anti-pendulum function

Minimize waiting time
- No need to wait for the vibration to be stabilized to store or retrieve the load from the bay
- Waiting time usually takes from a few seconds to more than ten seconds

Controlled oscillation
- As the vibration of the crane is anticipated, and the remaining oscillation is damped in a controlled manner, there is no torque surprise for the drive

Increased warehouse maximum height
- The height of the warehouse is not limited by sway on the high stacker cranes
- Designers can design the crane structure to have a lower damping ability, which means less cost on the structure

Built-in functionality
- The function is programmed inside the drives and does not require any additional sensors or controllers



Certified drive-based safety solutions

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01 Safety functions modules FSO-12, FSO-21 and safety pulse encoder module FSE-31

ACS880 drives come with the safe torque off (STO) safety function already integrated. Optional safety functions modules (FSO-12 and -21) provide an easy way to extend safety functions. This plug-in module is installed and cabled inside the drive, enabling safety functions and diagnostics in one compact and reliable module.

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Both safety functions modules have SIL 3/PL e capability and conform to the European Union Machinery Directive 2006/42/EC. The safety functions modules are certified by TÜV Nord.

You can enable PROFIsafe over PROFINET connectivity between your ACS880 drive and the safety PLC by adding a PROFIsafe fieldbus adapter module to your drive.

Inside the FSO-12/FSO-21:
- Safe stop 1 (SS1)
- Safe stop emergency (SSE)
- Safe brake control (SBC)
- Safely limited speed (SLS)
- Safe maximum speed (SMS)
- Prevention of unexpected startup (POUS)

Additional safety functions inside the FSO-21:
- Safe direction (SDI); requires a safety pulse encoder interface module FSE-31
- Safe speed monitor (SSM)

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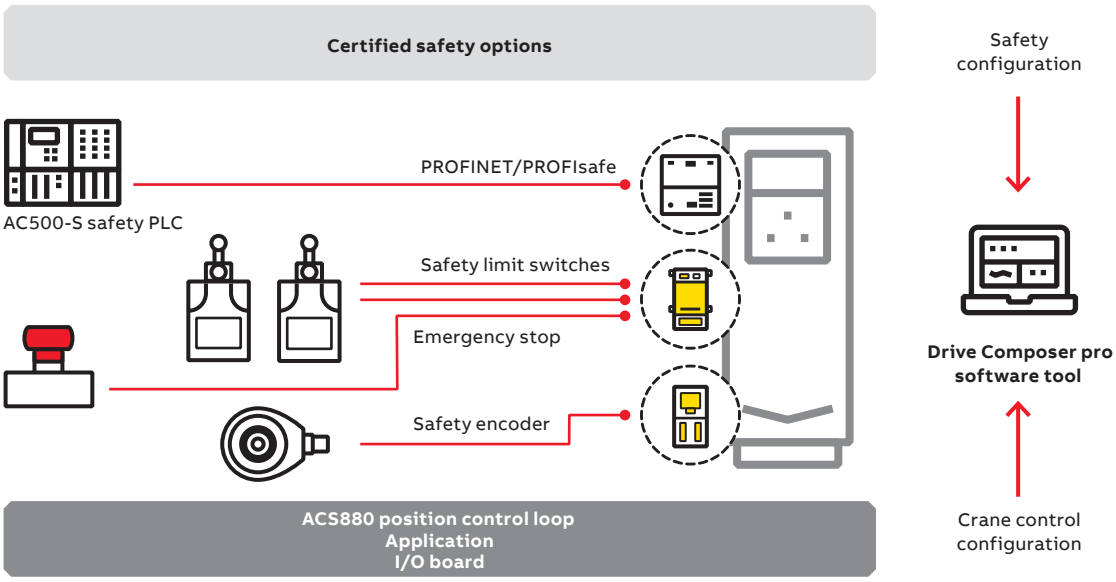
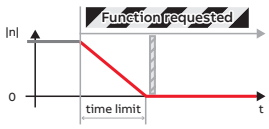
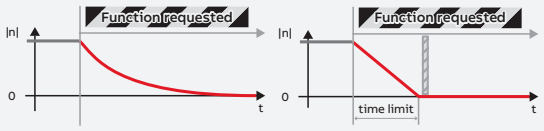
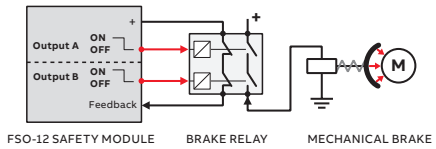
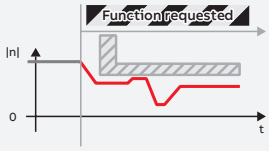
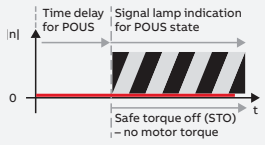
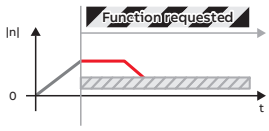
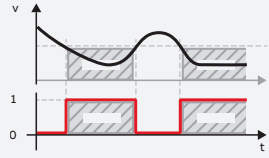
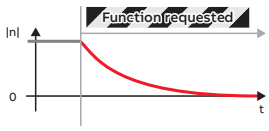
How all is connected

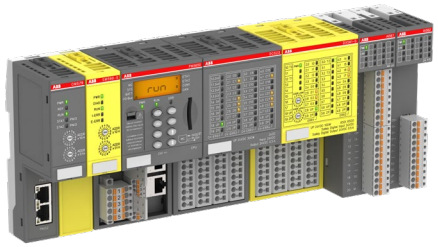


Drive-based functional safety features

Safety function	Description	Supported functions			
		FSPS-21	FSO-12 without encoder	FSO-21 + FSE-31 + HTL encoder	
Safe stop 1 **SS1-t** **SS1-r**	Brings the machine to a stop using a monitored deceleration ramp. It is typically used in applications where the machinery motion needs to be brought to a stop (stop category 1) in a controlled way before switching over to the no-torque (STO) state.	x (SS1-t)	x (SS1-t) (SS1-r)	x (SS1-t) (SS1-r)	
Safe stop emergency **SSE**	On request, can be configured to either activate STO instantly (category 0 stop) or first initiate motor deceleration and then, once the motor has stopped, activate the STO (category 1 stop).		x	x	
Safe brake control **SBC**	Provides a safe output to control the motor's external (mechanical) brakes, together with STO.		x	x	
Safely limited speed **SLS**	Ensures that the specified speed limit of the motor is not exceeded. This allows machine interaction to be performed at slow speed without stopping the drive. The safety functions module comes with four individual SLS settings for speed monitoring.		x	x	
Safe maximum speed **SMS**	Monitors the speed of the motor and ensures that it does not exceed the configured maximum speed limit.		x	x	
Prevention of unexpected startup **POUS**	Ensures that the machine remains stopped when people are in the danger area.		x	x	
Safe direction **SDI**	Ensures that rotation is allowed only in the selected direction (available only with FSO-21 and FSE-31).			x	
Safe speed monitor **SSM**	Provides a safe output signal to indicate whether the motor speed is within user-defined limits (available only with FSO-21).			x	
Safe torque off **STO**	Brings the drive safely to a no-torque state, i.e., switches off the drive output to the motor, motor speed then coasts to a stop. ACS880 has safe torque off as standard.	x	x	x	

AC500-S safety PLC for increased productivity and reduced downtime

Fully automated stacker cranes collaborating with other machines demand advanced safety protections. Combining the ACS880 with the AC500-S safety PLC a series of unique safety functions are released where the AC500-S in real-time can trigger safety functions on the ABB drive via PROFINET/PROFIsafe. Once such a system is in operation it will increase the flexibility, reliability, and the number of handlings over the day.



AC500 Engineering for indoor and outdoor applications
A single engineering tool throughout the AC500 development process between the controller configuring and programing of standard and safety applications, including safe communication.

The AC500-S safety is an integrated safety solution. In combination with a PLCopen safety function block library, the package provides advanced features for effective development.

Safety programming in Structured Text alongside FBD and LD is essential in advanced safety applications such as safe positioning.

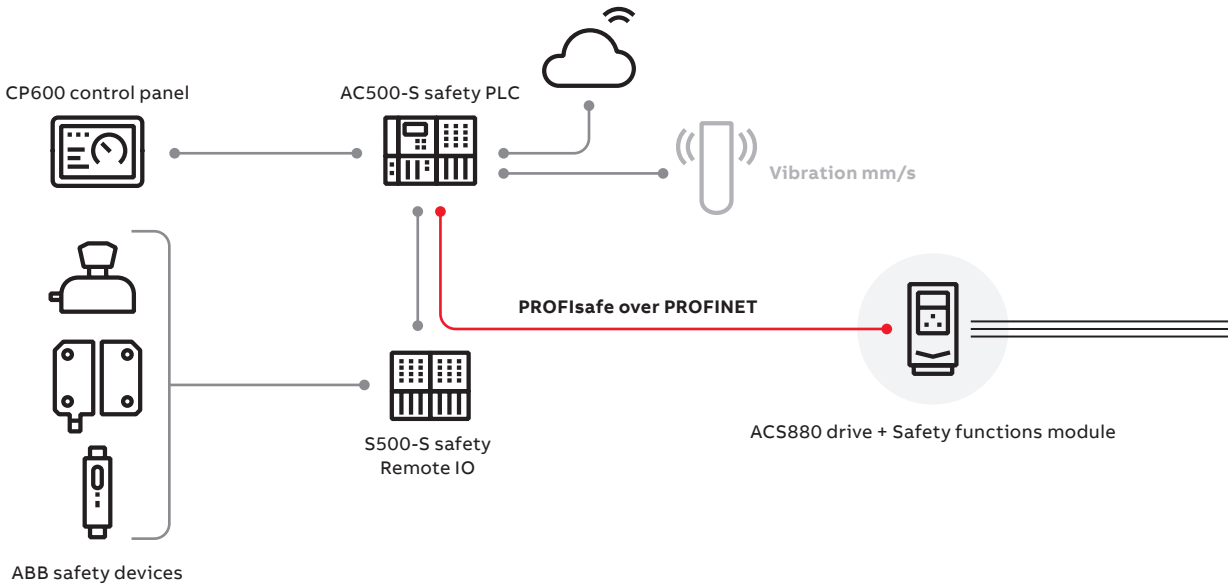
Safety floating-point and safety trigonometric calculation
Provides faster and more precise calculations, which improves machine precision in safety applications such as restricted safety areas.

Enhanced flexibility with PROFINET/PROFIsafe
Facilitates high-volume, real-time safety data exchange between the controller and device, as well as the controller and controller over wired and open 5G and Wi-Fi technologies. This is a prerequisite when developing safety collision avoidance in automated vehicles.

Furthermore, engineering efficiency is provided via AC500-S safety PLC to implement such functional safety functions as:

- Safely limited acceleration
- Safely limited deceleration
- Safely limited force
- Safely limited orientation
- Safely limited position
- Safely limited speed
- Safely limited torque

and, on demand, to trigger Safety stop 1 or Safe torque off functional safety functions on ABB drives via PROFINET/PROFIsafe protocol.



Integrated condition monitoring and analytics for predictable operations

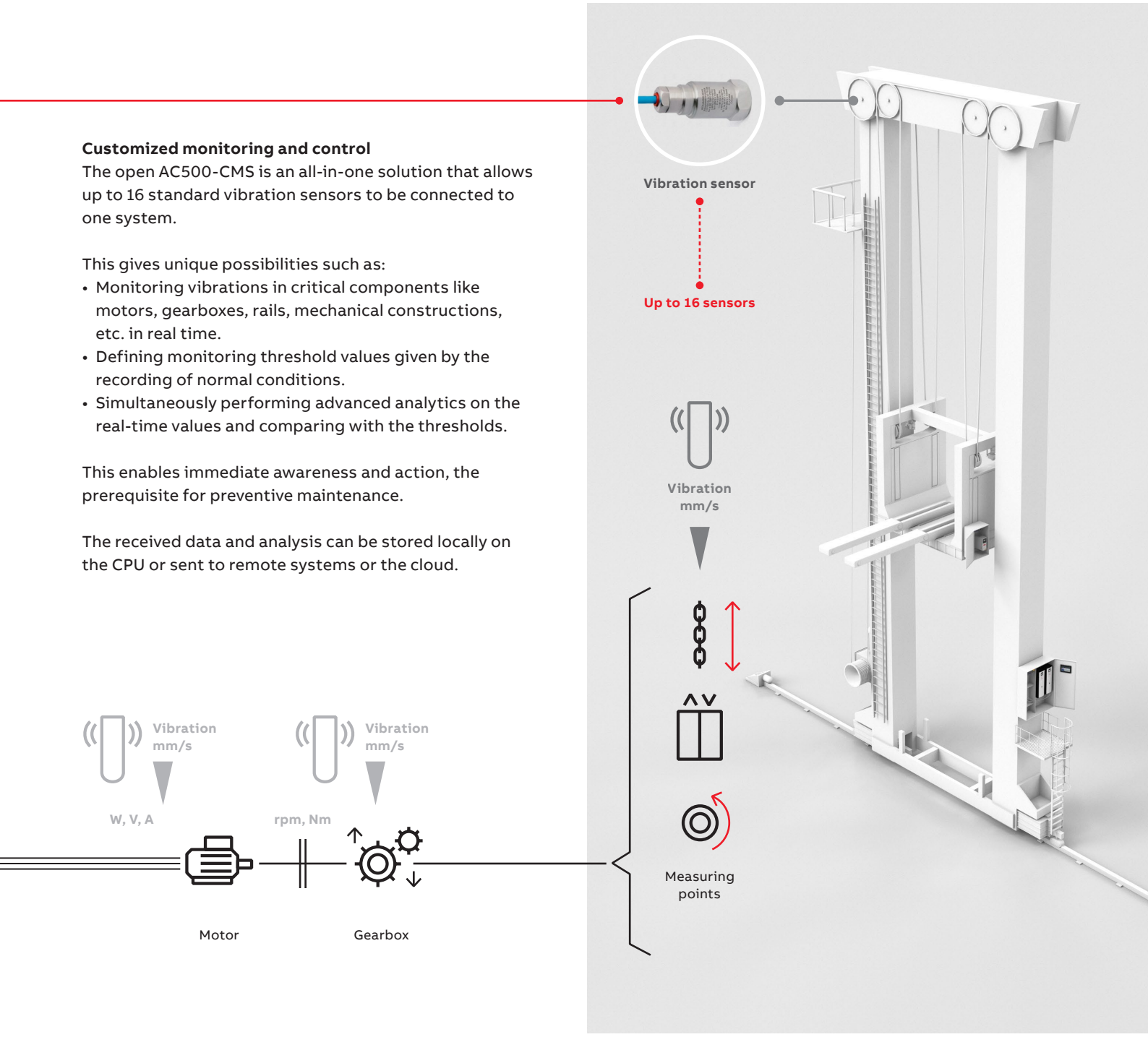
An integrated CMS (condition monitoring system) is the key for the early detection of mechanical damage and deformation. Utilizing an integrated monitoring system provides the opportunity for an immediate reaction for fast protection from spontaneous failures because the CMS is an integrated part of the whole PLC application.

Customized monitoring and control
The open AC500-CMS is an all-in-one solution that allows up to 16 standard vibration sensors to be connected to one system.

This gives unique possibilities such as:
- Monitoring vibrations in critical components like motors, gearboxes, rails, mechanical constructions, etc. in real time.
- Defining monitoring threshold values given by the recording of normal conditions.
- Simultaneously performing advanced analytics on the real-time values and comparing with the thresholds.

This enables immediate awareness and action, the prerequisite for preventive maintenance.

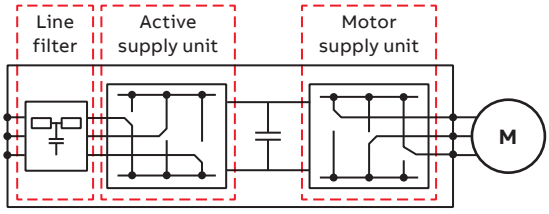
The received data and analysis can be stored locally on the CPU or sent to remote systems or the cloud.



Big savings on energy and installation costs with regenerative ACS880-11 drives

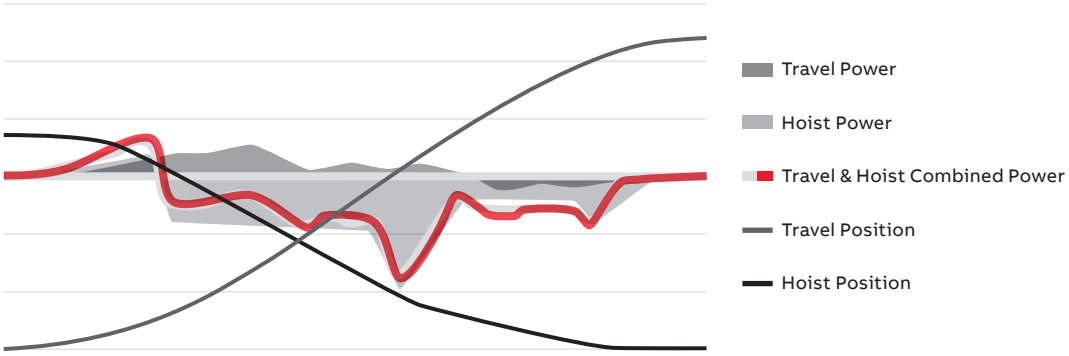
Regenerative drive feeds braking energy back to the network

“Eliminate braking resistor”
It is essential to control braking energy or regenerative power in stacker cranes. Power is regenerated not only in hoisting that works against gravity but also in stopping traveling. The heavier the load and the faster it moves, it becomes more important than ever. ACS880-11 regenerative drives can recover this braking energy and feed it back to the network.



The drive includes an active supply unit (ISU), a line filter (LCL) and a motor inverter (INU) – all in one compact integrated unit.

Significant energy cost savings can be achieved by feeding energy back to the network without additional components because it supports full power regeneration. An additional benefit of utilizing heat or wasted energy is an easier ambient temperature control. For example, eliminating heat dissipation from braking resistors makes temperature control easier in areas such as cold chains.



Graph showing the typical combined power flow of two drives as a stacker crane retrieves the load from the bay.

System cost saving

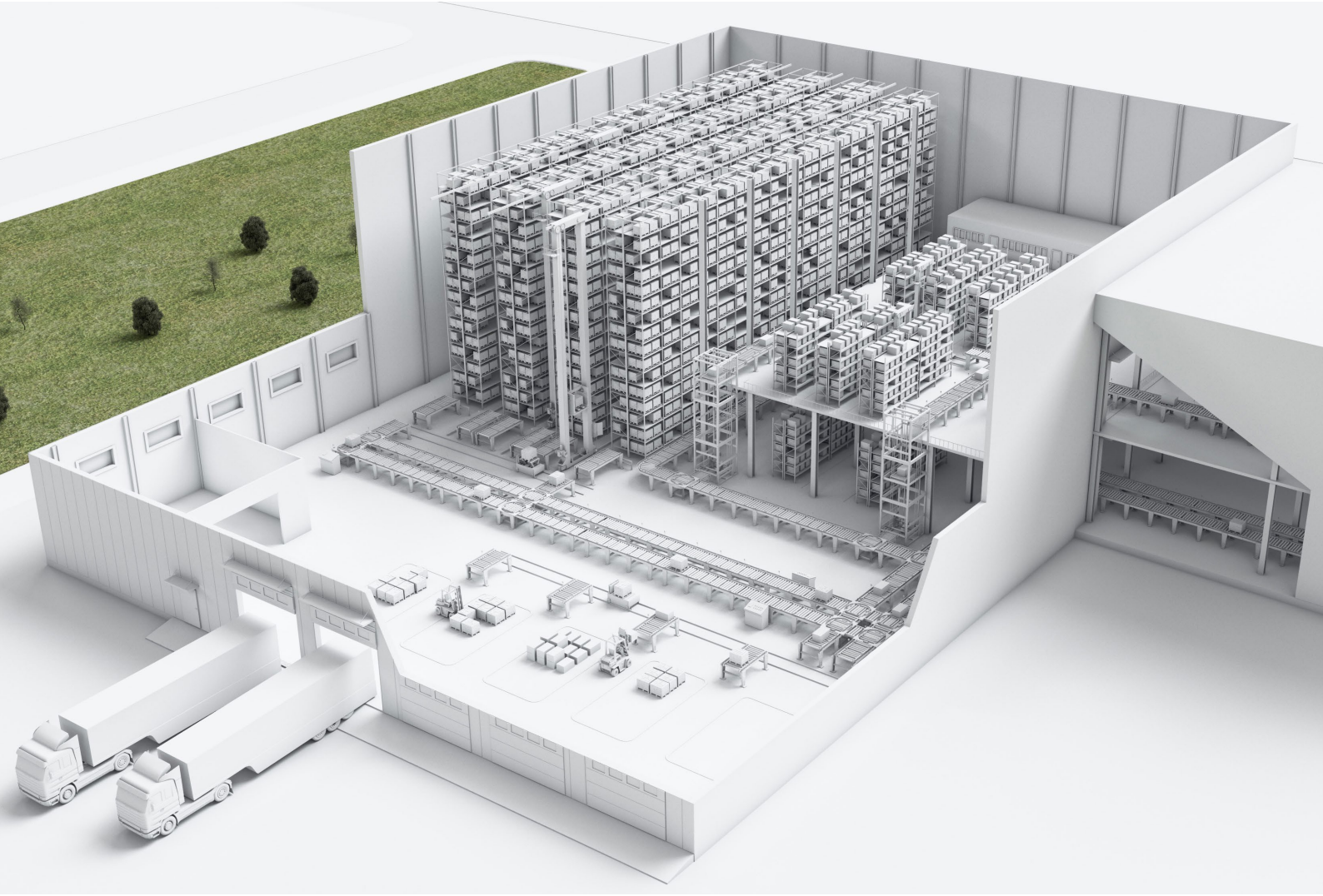
The nature of drives that generate harmonics and lower the power factor leads the system integrators to increase the system cost. When the network is unstable, and if multiple electric devices are connected to the same transformer, power quality control becomes more critical.

Harmonic and reactive current increases will lead to a higher current, higher losses, overheating, and disturbance to other devices.

The ACS880-11 regenerative drive is integrated with an active supply unit and LCL filter that offers 3% THDi and a power factor of 1 at a nominal load and speed. The drive also offers the possibility of the power factor correction of the network, meaning that it reduces the need for additional power factor correction equipment such as filters and large capacitor banks.

Low harmonic content and power factor unity help reduce the need to oversize the following equipment/components: transformer, mains cable, switchgear, circuit breaker, fuse, motor, …

System Integrators can minimize oversizing by simply using the ACS880-11, resulting in system cost savings besides the drives.



Energy cost saving

When **THDi must meet the requirement**, using ACS880-11/14 drives can offer best **energy efficiency.**

10%
harmonic content
Supply voltage 400 V/480 V

Network efficiency	Passive filter efficiency	6-pulse drive efficiency	Actual motor efficiency due to drive waveform and lower motor voltage	
~98%	98.5%	98%	92%	**87.0%**

5%
harmonic content
Supply voltage 400 V/480 V

Network efficiency	Active filter rated efficiency	6-pulse drive efficiency	Actual motor efficiency at nominal motor voltage	
~98%	97%	98%	92%	**85.7%**

3%
harmonic content
Supply voltage 400 V/480 V

Network efficiency	ABB AFE drive efficiency	Actual motor efficiency at nominal motor voltage	
~98%	97%	92%	**87.5%**

Ease of integration and use

User-friendly PC tool and connectivity

— 01 Single wire connection over EtherNet for PC tool connection or PLC control.
— 02 Easy software customization with Adaptive programming.

- The Drive Composer PC tool offers fast and harmonized setup, commissioning and monitoring of the drive. Drive Composer allows users to easily set up all the functions in a user-friendly interface without any programming.
- The ACS880 drive includes the possibility for a single-wire PC tool connection over the Ehternet. This Ethernet-based fieldbus connection also allows PLC control.
- Adaptive programming enables the customization of the drive software, using sequential and function block programming. It may allow the reduction of system costs by replacing the need for a PLC.
- When using safety functions modules (FSO-12/21), functional safety configuration can be done with parameters or in a graphical view.

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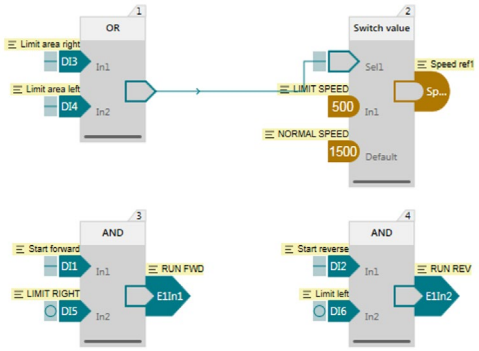
— 02



Removable memory unit for fast updates and drive replacement

— 03 Removable memory unit for quick and easy software updates or drive replacement.

- The drive's firmware, application software and all its settings are stored in a removable memory unit. This allows quick and easy firmware and application software updates and the fast onsite replacement of the drive.

— 03

Support for almost any motor type, encoder and fieldbus

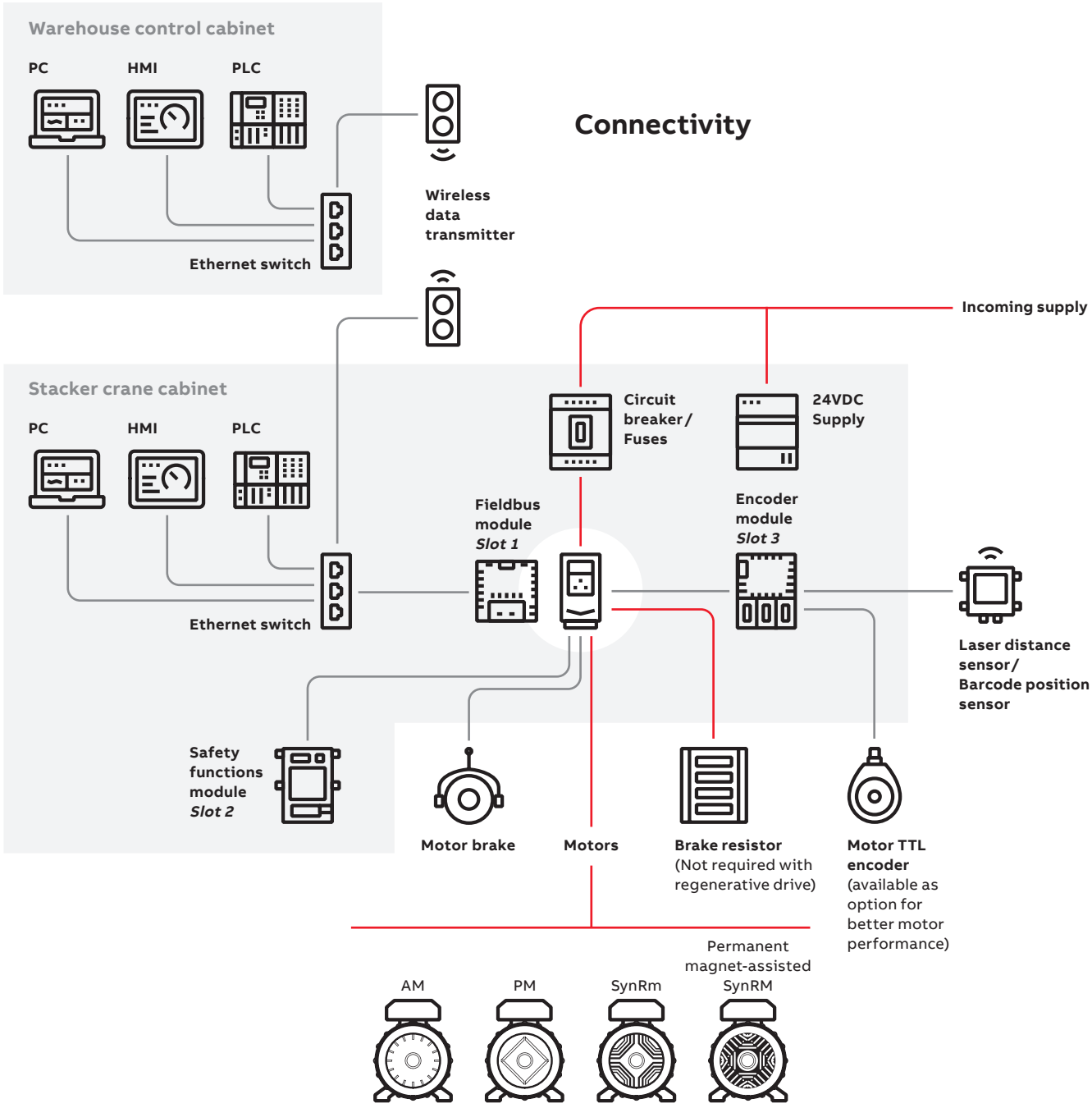
— 04 Connectivity with all major fieldbus protocols.

- ACS880 drives support almost any motor type, including induction motors, permanent magnet synchronous motors and synchronous reluctance motors (SynRM). Third-party servo and high-torque motors are also supported.
- Encoder support for HTL, TTL, Resolver, Sin/cos, EnDat, SSI, HIPERFACE, Tamagawa.
- An extensive selection of fieldbus adapters enables connectivity with all major industrial automation networks.

— 04

Communication protocol	Adapter
DeviceNet™	FDNA-01
PROFIBUS DP. DPV0/DPV1	FPBA-01
CANopen®	FCAN-01
Modbus RTU	FSCA-01
ControlNet	FCNA-01
EtherCAT®	FECA-01
POWERLINK	FEPL-02
Modbus/TCP	FMBT-21
PROFINET IO	FPNO-21
EtherNet/IP	FEIP-21
PROFIsafe safety functions module	FSPS-21

ACS880 drives connect to various components for optimal stacker crane control



All necessary control I/O connections are embedded and can also be controlled over fieldbus

All necessary control I/O connections are built into the drive and can be controlled over fieldbus

- Stacker crane position reference via fieldbus
- Jog operation
- Position limits and hardware limit switch
- Mechanical brake control and acknowledgement
- Motor temperature (FEN-x1)
- Motor encoder (FEN-x1)
- Distance/position sensor (FEN-11)
- Brake resistor for dynamic brake with temperature input
- Safety input (FSO-12/21)
- Emergency stop
- Fieldbus connection to PLC
- Reset fault
- Homing and preset positioning

Additional information
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

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3AXD50000736843 REV B EN 30.11.2023