

LOW VOLTAGE AC DRIVES

ACS880 ultra-low harmonic and regenerative drives

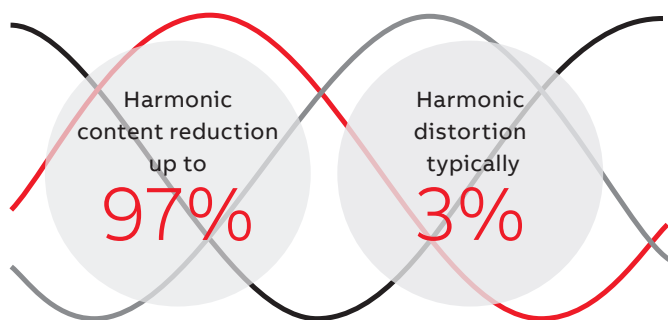
Keeping the network clean while saving energy



- The total harmonic current distortion is typically <3% in nominal situation in an undistorted network
- Possibility to regenerate 100% of the power continuously

Keeping the network clean with ACS880 ultra-low harmonic and regenerative drives

ACS880 ultra-low harmonic drives offer an easy harmonic reduction method which is incorporated in the drive. No additional filters or special transformers are needed. This compact, cost-effective solution meets the strictest harmonic recommendations.



Clean supply network

The drive produces exceptionally low harmonic content and exceeds the requirements of harmonic guidance/standards such as IEEE 519, IEC61000-3-2, IEC61000-3-12, IEC61000-3-4 and G5/4. Compared to a conventional drive, the harmonic content is reduced by up to 97%. The total harmonic current distortion is typically <3% in a nominal situation and an undistorted network.

Minimized downtime

The ACS880 ultra-low harmonic drive offers immunity to network disturbances. The drive will not interrupt the process or affect its quality in unstable supply network conditions. The drive's active supply unit can boost the output voltage to enable full motor voltage, even when the supply voltage is below nominal. This ensures reliable operation in weak networks. This voltage boost capability can also be utilized to overcome voltage drops caused by long supply or motor cables. The possibility to stabilize the output voltage of the drive is an advantage compared to alternative low harmonic solutions where voltage cannot be boosted.

Optimized cost and space

The compact drive features built-in harmonics mitigation. This includes an active supply unit and a low harmonic line filter. As there is no need for external filters, multi-pulse arrangements or special transformers, the simple installation offers significant space, time and cost savings.

As there is less risk of overheating with lower harmonic currents, there is no need to over-dimension equipment such as transformers and cables. The drive's voltage boost capability can be an advantage in motor dimensioning. With a higher motor voltage, the same power is achieved with a lower current, which improves motor efficiency and may allow a smaller motor to be used.

Maximized motor performance and efficiency

The drive can provide full motor voltage even if the supply voltage fluctuates. It features direct torque control (DTC) as standard, making it suitable for very demanding applications as well. DTC provides precise speed and torque control for maximum motor performance and motor efficiency.

Efficient energy utilization

Ultra-low harmonic drives achieve a unity power factor, indicating that electrical energy is being used efficiently. The drive offers the possibility for network power factor correction to compensate for the low power factors of equipment connected to the same network. It can help to avoid penalty charges set by electrical utilities for poor power factors. Lower harmonics and full motor voltage at all times mean reduced system losses and better overall system efficiency.



Increased operation reliability in weak networks

if using ABB's active front end drives with voltage boost feature.



Avoid power factor penalties

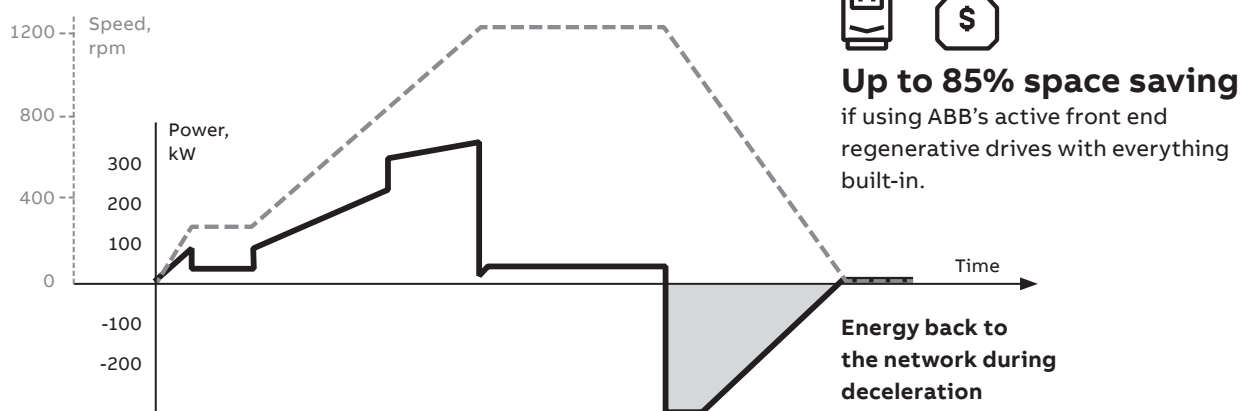
by using ABB's active front end drives.

ACS880 regenerative drives

The best of both worlds

ACS880 regenerative drives are also ultra-low harmonic drives, and they therefore include all the benefits of ABB ULH drives. And they can continuously regenerate 100% of the braking power back to the network.

Speed and power curves in cyclic operation



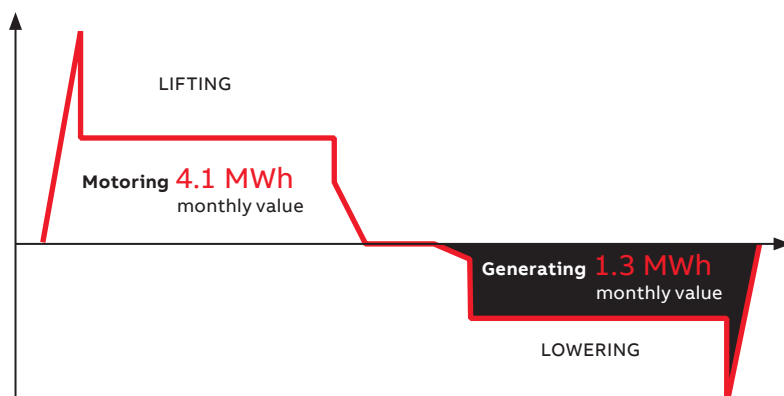
Energy savings

ACS880 regenerative drives are a compact and complete regenerative drive solution, with everything you need for regenerative operation in cyclic or continuous braking applications. Such applications include cranes, elevators, centrifuges, downhill conveyers and test benches. With regenerative functionality, the braking energy of the motor is returned to the drive and distributed to the supply network so that it can be utilized by other equipment. Compared to mechanical or resistor braking, where braking energy is wasted as heat, regenerative drive operation offers significant energy consumption and cooling savings.

Simplified installation and energy savings

By feeding energy back to the network, significant energy savings can be achieved compared to other braking methods. With mechanical or resistor braking, energy dissipates as heat and is wasted. The handling of waste heat may be an issue if the braking power is significant, and additional cooling may be required.

As no external braking devices are needed, the drive installation is simple, and the installation footprint is small. There is no need to add cooling to handle the heat generated by mechanical or resistor braking. Wiring is simple, and fewer spare parts are needed.



A practical example of a waste-handling crane with a 55-kW hoisting motor, 9-kW long travel motor, 4.5-kW trolley motor and a 25-kW grab motor shows that a 32% reduction in annual energy costs, resulting in savings of €2,300, can be made at a power cost of €0.15/kWh when ABB regenerative drives are used.

Ultra-low harmonic drives and their benefits over other solutions

What is an ultra-low harmonic drive?

Instead of a conventional diode bridge, an ultra-low harmonic (ULH) drive has switching IGBT semiconductors on the supply side. The drive can control the line current to a sinusoidal waveform. Additionally, the line filter used

in an ultra-low harmonic drive is designed to attenuate high-order voltage harmonics to achieve very low total distortion of both current and voltage.

Keeping the network clean without costly additional solutions

All this leads to a current harmonic content in the network of below 3% compared to a traditional 6-pulse solution with THDi of about 40%. ABB ultra-low harmonic drives with DC bus capacitors do not produce harmonics in the first place, while other variable speed technologies may require costly additional solutions to decrease harmonics to a minimum.



40% THDi means 16% higher current losses

Avoided if using ABB's active front end drives with THDi < 3%.

Neat installation without oversized power network components

With a THDi of 3%, facilities can avoid massive oversizing of power network components like generators, transformers, switchgear and cables in new projects, while making the projects more sustainable due to their decreased material

usage. ABB's ULH drives can go a step further by compensating for other network reactive loads, potentially allowing end users to save on installing standalone reactive power compensators on their site.



Up to 50% smaller generator
when using ABB's active front end drives.



Up to 20% smaller transformers
when using ABB's active front end drives.

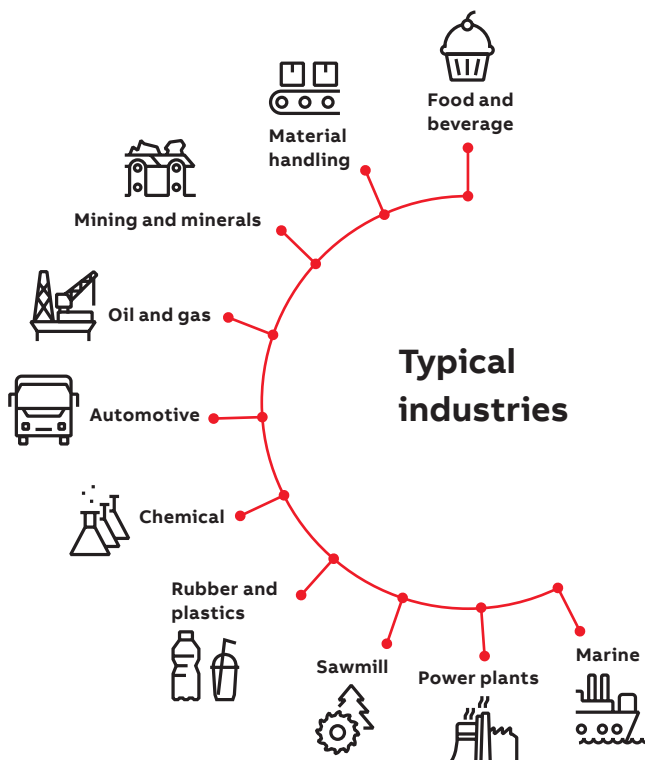
Creating a stable process environment

ULH drives are also beneficial to the reliability of facilities and operations. Because they have a minimal harmonic content, they eliminate process interruptions from network overloads caused by an increased line current. Malfunctions in connected devices due to a distorted current are also eliminated.



Reduction of random disturbances
when using ABB's active front end drives.

Highlights of ACS880 ultra-low harmonic and regenerative drives



Key benefits of ACS880 ultra-low harmonic and regenerative drives

- The total harmonic current distortion is typically <3% in a nominal situation in an undistorted network. In partial loads, the harmonic content is also low.
- Unity power factor. Network power factor correction is also possible.
- The active supply unit in the drive can boost output voltage, which ensures reliable operation and guarantees full motor voltage, even when the supply voltage is below nominal
- No need for external filters, multi-pulse arrangements or special transformers

With ACS880 regenerative drives you'll also get these

- 100% of the power can be regenerated continuously
- Significant energy savings compared to other braking methods
- No need for external braking devices, which makes drive installation simple and requires less cabinet space

Overall system efficiency

Comparing AFE drives to systems with passive or active filters

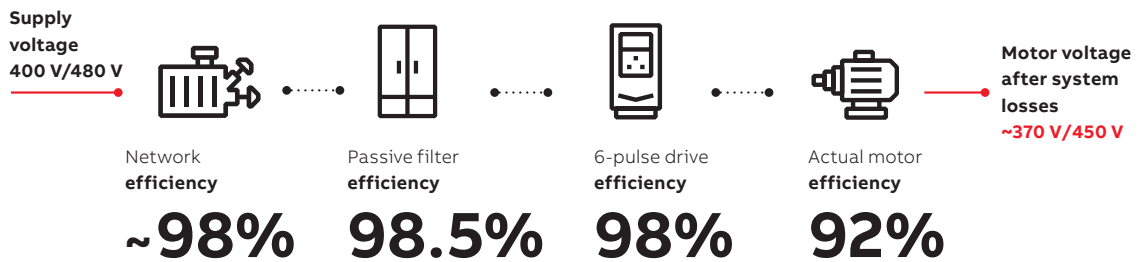
When comparing different harmonic mitigation technologies, it's important to look at how they affect system efficiency. Active front end drives naturally have lower efficiency than traditional 6-pulse solutions due to the additional active supply unit (IGBTs) in their design, but the losses to the system caused by harmonic filters that provide the same

low harmonic performance are often overlooked. Overall losses in systems with ultra-low harmonic drives are the same or lower, and they have the added advantages over standalone harmonic filters of a unity power factor and eliminated voltage drop at the motor terminals.

Harmonics mitigation with passive filter

Harmonics content at nominal load = 10%

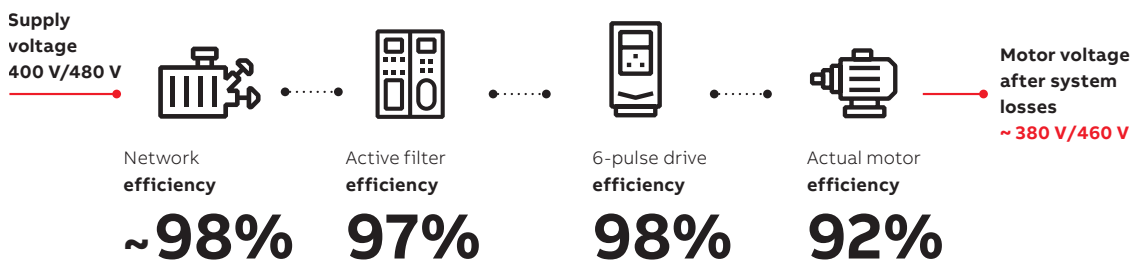
System efficiency = 87%



Harmonics mitigation with active filter

Harmonics content at nominal load = 5%

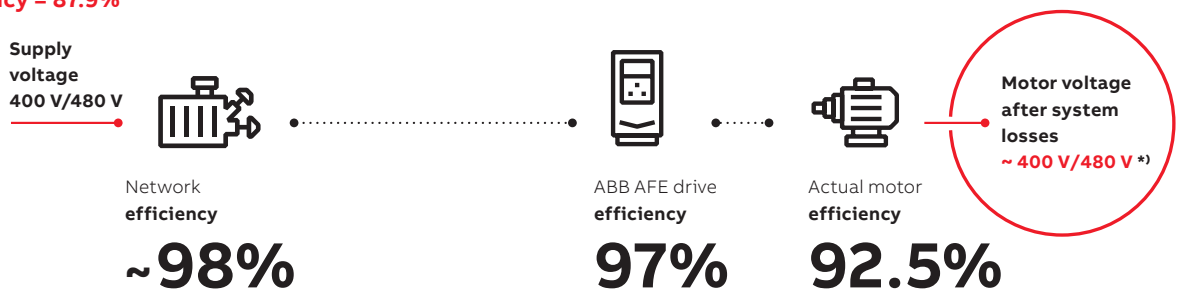
System efficiency = 85.7%



Harmonics mitigation with active front end drives

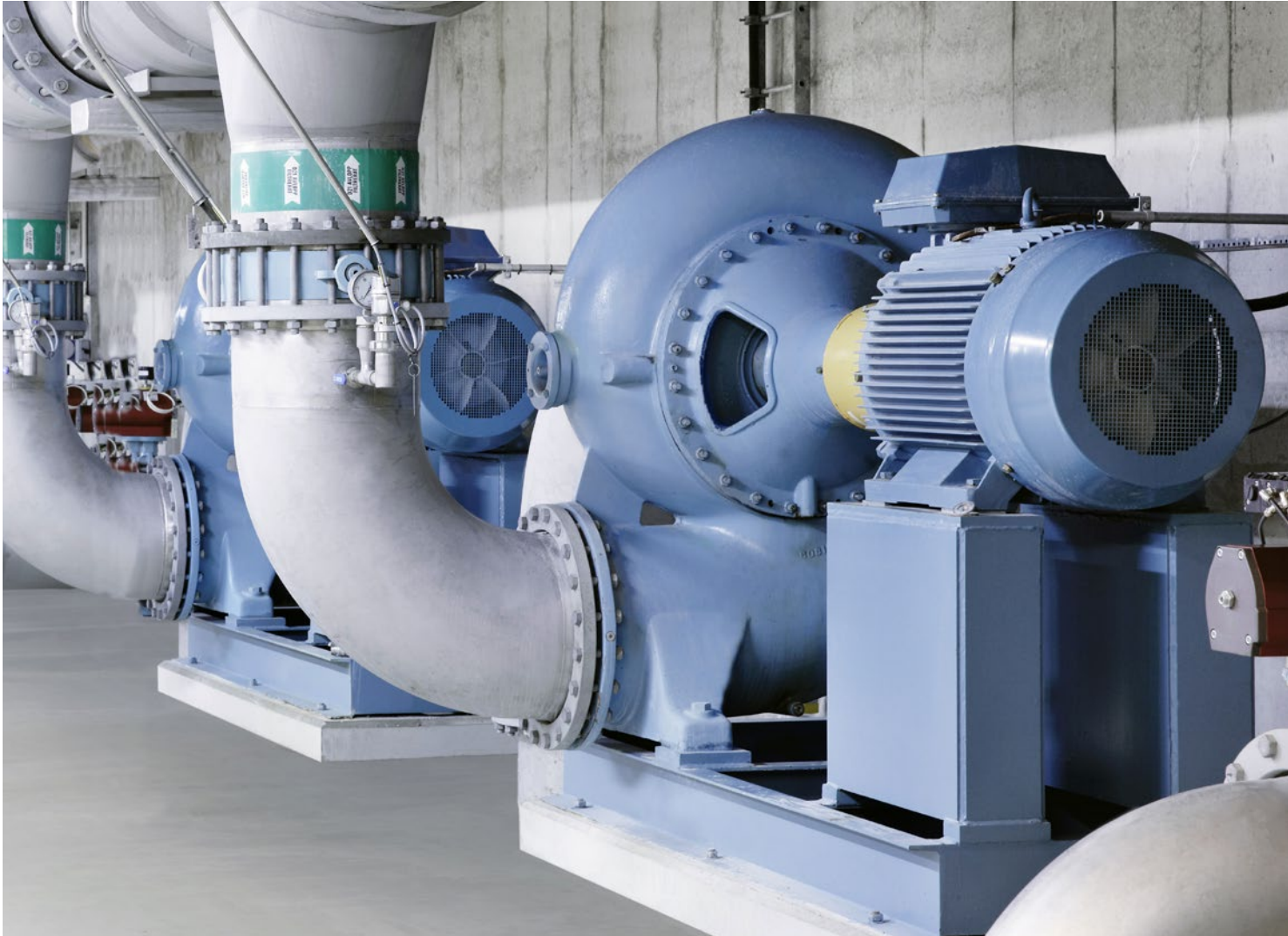
Harmonics content at nominal load = 3%

System efficiency = 87.9%



*) See next page about DC voltage boost feature.

DC voltage boost unleashes the motor's full potential



When a motor's nominal voltage is higher than the input voltage, its nominal rating must be changed to match the input voltage. A voltage drop caused by a long motor cable or an output filter may cause a drop in the motor's operating voltage.

The ACS880 ultra-low harmonic drive's active supply unit controls DC voltage and can boost it to achieve a higher motor output voltage, which enables the motor's full potential to be used, even when the supply voltage is below nominal.

Advantages of using the DC voltage boost

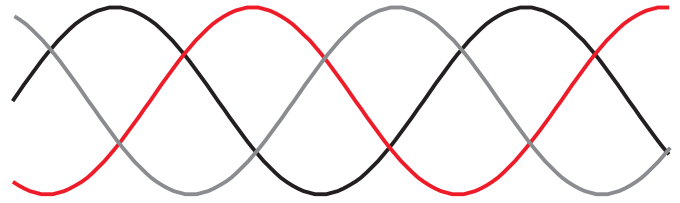
- Nominal voltage can be supplied to the motor, even when the drive's supply voltage is below the motor's nominal voltage level
- A voltage drop caused by an output filter, motor cable or input supply cables is compensated
- Voltage to the motor can be boosted, even when maintaining superior harmonic mitigation
- Motor torque in the field weakening area is increased (i.e. when the drive operates the motor in a speed range above the motor's nominal speed)
- A motor with a higher nominal voltage than the drive's actual supply voltage can be used

Understanding the effects of harmonic distortion

The presence of harmonic content is measured as a percentage value, known as the total harmonic distortion (THD), which is the relationship between all the current or voltage harmonics and the fundamental current or voltage. Where no voltage or current harmonics are present, the THD is 0%.

Harmonics negatively affect power networks and connected equipment. The higher the harmonic content, the higher the line current, which means higher losses in the network, including its components like transformers, switches, circuit breakers and cables. The increased line current also means power network equipment overheats, which leads to premature failure. Furthermore, harmonics with a distorted current mean there is also a risk of connected equipment malfunctioning and failing.

Taking action to deal with harmonic distortion provides many benefits beyond those related to managing risk. Industries with high power consumption like pulp and paper, metals, oil and gas refineries, cement and chemicals processing can optimize the quality of power in the facilities by managing the disturbances and losses caused by harmonics.



—
A pure sinusoidal voltage and current does not contain any harmonics.



—
Voltage and current that deviate from the sine form contain harmonics.

Any distorted voltage and current waveform that deviates from the ideal sinusoidal waveform has the potential to harm electrical components, which can result in costly repairs and equipment downtime. All non-linear loads connected to the electrical supply in industrial and commercial facilities insert waveform distortions called harmonics on the power distribution system. Common non-linear loads include solid-state motor soft starters, standard variable speed drives, computers, LED lighting, welding supplies and uninterruptible power supplies.

Comparison of harmonics mitigation technologies

There are many different approaches to reducing harmonics in power networks with **6-pulse drives**, and all of them have different effects on network power quality, resulting in better or worse energy efficiency, cost-effectiveness and reliability.

Passive harmonic filters are tuned to the specific harmonic frequency that needs to be eliminated. Several passive filters can be installed in parallel to reduce significant distortion caused by multiple harmonic frequencies, but this means a bigger installation footprint and a higher cost.




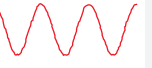
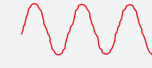
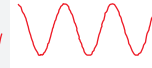
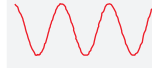
Active harmonic filters offer much better harmonic reduction compared to passive filters, as they detect multiple harmonic frequencies present in the network, and they produce counter-harmonic currents to cancel the harmonics produced by non-linear loads. However, their harmonic reduction performance also changes significantly with the load – at 50%, THDi can easily be 12–14%.

Multi-pulse drives reduce harmonic distortion by using several additional diodes in the rectifier, but the installation complexity, massive footprint and need for phase-shifting transformers are significant drawbacks of the technology.

Active front end drive technology with DC bus capacitors is advantageous for several reasons – the main one being that it doesn't introduce harmonics in the first place, meaning no additional harmonic mitigation methods are needed. One important aspect is harmonic mitigation performance at partial loads, which is where applications with variable speed control operate most of the time. ABB's active front end drives provide low harmonic content even at partial loads.

There are also AFE drives without DC capacitors available, called **matrix drives**. Removing capacitors from a drive may reduce the cost, but it negatively affects its performance, creating significant limitations to drive output voltage, harmonic performance, power factor and power-loss ride-through functionality.

Comparison of harmonic reduction solutions

Harmonic reduction solution	6-pulse rectifier without choke	6-pulse rectifier with large choke	6-pulse drive and passive filter	6-pulse drive and active filter	Multipulse drive	Matrix drive	Active front end drive/ low harmonic drive
Current waveform							
Typical THDI% at nominal load	>100%	40%	<10%	<5%	6 to 10% (12-pulse) <6% (18-pulse)	<5%	<5%
Drive system efficiency (excluding motor and supply), typical value at rated power	~98%	~97%	~96.5% ¹⁾	~96.5% ¹⁾	~96% ²⁾	~96.5%	~96.5% ³⁾
Motor voltage ⁴⁾	~0.96 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.92 × supply voltage ⁵⁾	Full motor voltage
True power factor	~0.7 at nominal load only	~0.98 at nominal load only	~0.98 at nominal load only	~0.99 at nominal load only	~0.98 at nominal load only	~0.98 at nominal load only	1.0 at all load conditions
Simplicity of installation	A single component	A single component or two separate components	Two separate components	Two separate components	Multiple separate components	A single component	A single component
Installation footprint ⁷⁾	100%	110%	250%	250%	300% ⁶⁾	140%	120%
Equipment cost of all required components ⁷⁾	100%	120%	190%	230%	200% ⁶⁾	190%	190%

Data is based on a 100 kW installation. Results may vary depending on equipment types and their dimensioning.

For an IGBT-supplied drive, evaluations are based on ABB ultra-low harmonic drives.

¹⁾ Both filter and drive efficiency must be considered: filter efficiency is ~98.5%, and standard 6-pulse drive efficiency is ~98%. The total combined efficiency is ~96.5%.

²⁾ Transformer and drive efficiency must be considered: the typical total combined efficiency is ~96%.

³⁾ Increased losses through inverter supply unit and filter. The total combined efficiency is ~96.5%.

⁴⁾ To achieve the same mechanical power with lower motor voltage, a higher current is needed which equates to higher losses in the motor.

⁵⁾ Output voltage when operating in low harmonic mode.

⁶⁾ Cost and size comparison includes dedicated multiwinding transformer.

⁷⁾ Footprint and cost are compared to a single drive installation.

ACS880 ultra-low harmonic drives

Technical data

ACS880-31 wall-mounted ultra-low harmonic drives	
Power range	2.2 to 110 kW
Voltage range	3-phase, 380 to 500 V
Enclosure	IP20, IP21 (as standard) and IP55. Flange mounting with IP55 back protection as an option.
ACS880-34 ultra-low harmonic drive modules	
Power range	2.2 to 400 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP20
ACS880-34 ultra-low harmonic drive module packages	
Power range	160 to 2200 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP00
ACS880-37 cabinet-built ultra-low harmonic drives	
Power range	45 to 3200 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP22 (as standard), IP42 and IP54
ACS880-37LC cabinet-built ultra-low harmonic drives	
Power range	250 to 6000 kW
Voltage range	3-phase, 690 V
Enclosure	IP42 (as standard) and IP54

ACS880 regenerative drives

Technical data

ACS880-11 wall-mounted regenerative drives	
Power range	2.2 to 110 kW
Voltage range	3-phase, 380 to 500 V
Enclosure	IP20, IP21 (as standard) and IP55. Flange mounting with IP55 back protection as an option.
ACS880-14 regenerative drive modules	
Power range	2.2 to 400 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP20
ACS880-14 regenerative drive module packages	
Power range	160 to 2200 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP00
ACS880-17 cabinet-built regenerative drives	
Power range	45 to 3200 kW
Voltage range	3-phase, 380 to 690 V
Enclosure	IP22 (as standard), IP42 and IP54
ACS880-17LC cabinet-built regenerative drives	
Power range	250 to 6000 kW
Voltage range	3-phase, 690 V
Enclosure	IP42 (as standard) and IP54





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