

LOW VOLTAGE AC DRIVES

# ACS880 ultra-low harmonic and regenerative drives

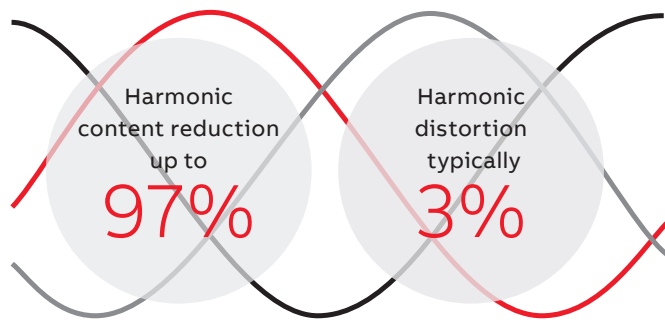
Keeping the network clean while saving energy



- 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 used to overcome voltage drops caused by long supply or motor cables. The ability to stabilize the drive's output voltage is a big advantage over alternative low harmonic solutions where voltage cannot be boosted.



## Increased operation reliability in weak networks

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

## 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.

With lower harmonic currents there is less power distribution overheating reducing the need to oversize transformers, cables, and protective gear. The drive's voltage boost capability can be an advantage in motor sizing. With a higher motor voltage, the same power is achieved at 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. DTC provides precise speed and torque control for maximum motor performance and motor efficiency making it suitable for very demanding applications.

## Efficient energy utilization

Ultra-low harmonic drives achieve a unity power factor, a direct indication that electrical energy is being used efficiently. The drive offers network power factor correction to compensate for the low power factor of equipment connected to the same network. This can help 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.



## Avoid power factor penalties

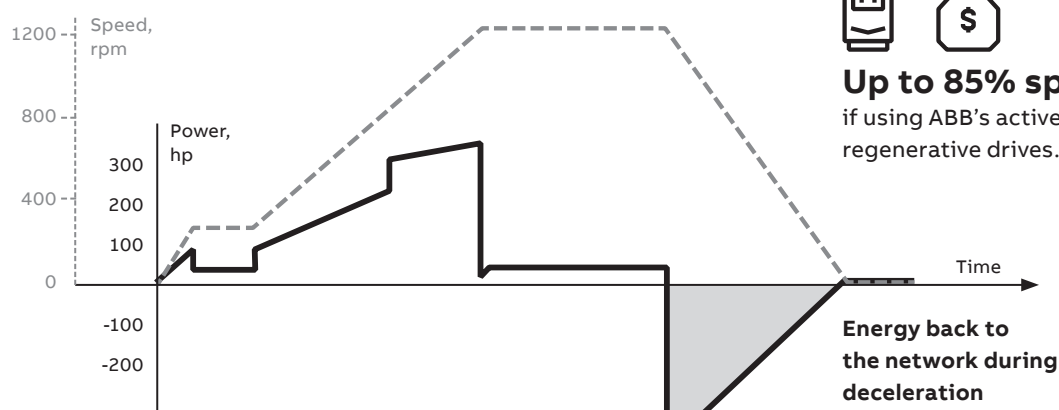
by using ABB's active front end drives.

# ACS880 regenerative drives

## The best of both worlds

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

### Speed and power curves in cyclic operation



### Up to 85% space saving

if using ABB's active front end regenerative drives.

**Energy back to the network during deceleration**

### 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, hoists, 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, a regenerative drive offers significant energy savings and lower heat dissipation.

### Simplified installation and energy savings

By redirecting generated power 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 74hp hoisting motor, 12hp travel motor, 6hp trolley motor and a 34hp grab motor shows that a 32% reduction in annual energy costs, resulting in savings of \$2,422, can be achieved at a power cost of \$0.16/hph when ABB regenerative drives are used.

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# Ultra-low harmonic drives and their benefits over other solutions

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## 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 voltage and current distortion.

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## Keeping the network clean without costly additional solutions

All this leads to a network's current harmonic content below 3% compared to other traditional 6-pulse solutions (with THDi of about 40%). ABB ultra-low harmonic drives with DC bus capacitors produce extremely low harmonics, 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%.

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## Clean installation without oversized power distribution components

With a THDi of 3%, facilities can avoid equipment oversizing that can include 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.

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## Creating a stable process environment

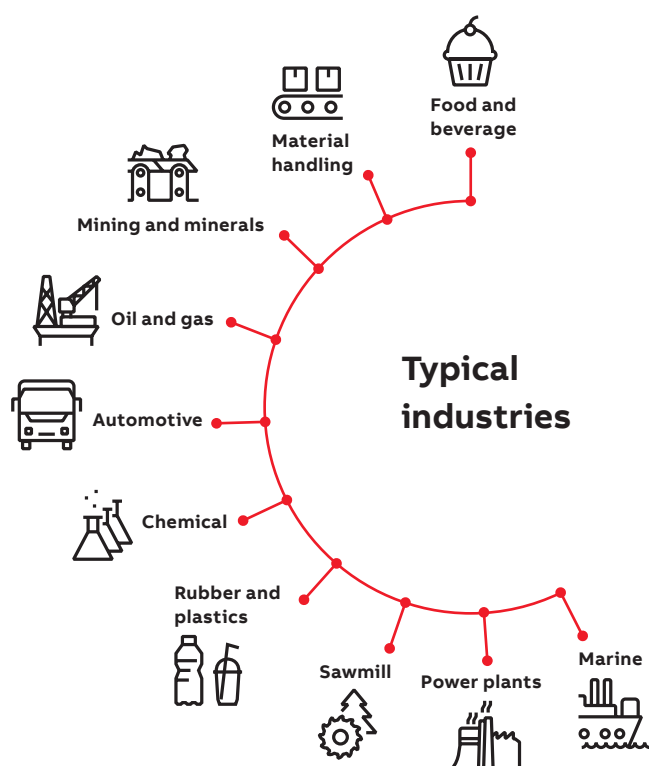
ULH drives are also beneficial to the reliability of facilities and operations. Because they have minimal harmonic content, they eliminate process interruptions from network overloads caused by an increased line current. Malfunctions in connected devices due to a distorted current are also eliminated.



### **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 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

- 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

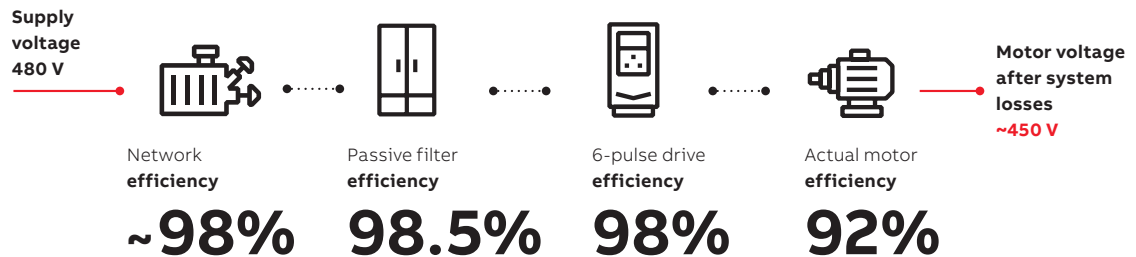
### Comparing AFE drives to systems with passive or active filters

When comparing different harmonic mitigation technologies, it's important to examine how they affect system efficiency. Active front-end (AFE) drives have lower efficiency than traditional 6-pulse solutions due to the additional active supply unit (IGBTs) in their design, but often the system losses for harmonic filters are 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 unity power factor and no voltage drop at the motor terminals.

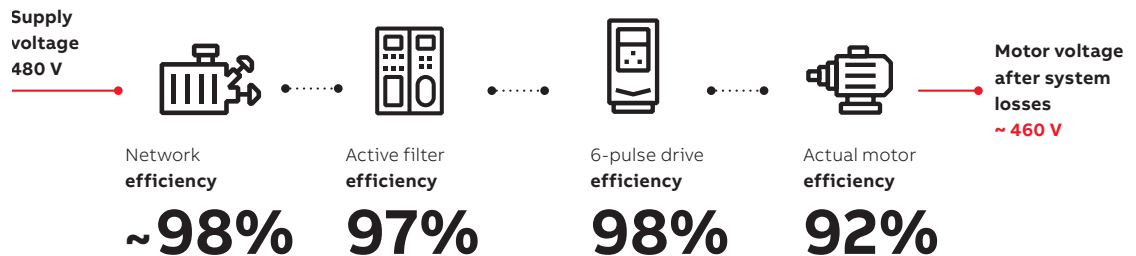
#### Harmonics mitigation with passive filter

Harmonics content at nominal load = 10%  
System efficiency = 87%



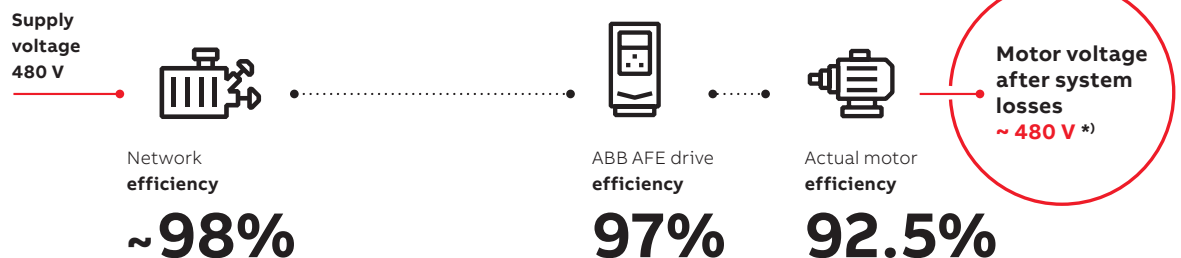
#### Harmonics mitigation with active filter

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 network voltage, its nominal rating must be changed to match the network 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 network voltage is below nominal.

### Advantages of using the DC voltage boost

- Nominal voltage can be supplied to the motor, even when the drive's network voltage is below the motor's nominal voltage level
- A voltage drop caused by an output filter, motor cable, or input supply cable 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 network voltage can be used

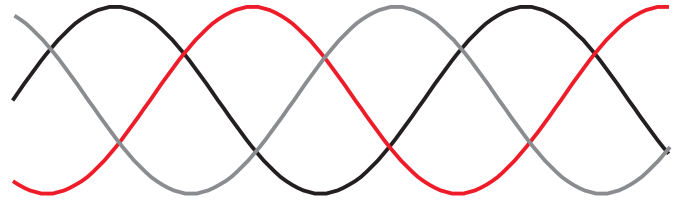
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# Understanding the effects of harmonic distortion

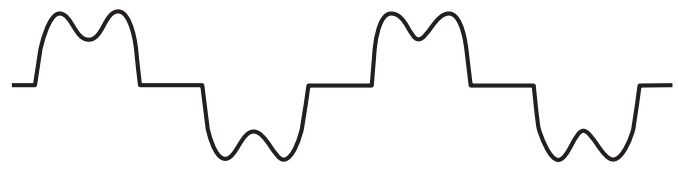
The presence of harmonic content is measured as a percentage, known as the total harmonic distortion (THD), which is the relationship between all the current or voltage harmonics and the fundamental current or voltage. Where no voltage or current harmonics are present, the THD is 0%.

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 means 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.



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



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

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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, energy efficiency, cost-effectiveness, and reliability.

**Passive harmonic filters** are tuned to eliminate specific harmonic frequencies. Several passive filters can be installed in parallel to reduce significant distortion caused by multiple harmonic frequencies but this often results in a bigger installation footprint and a higher cost.




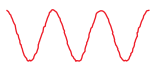
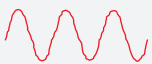
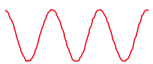
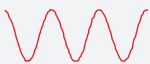
**Active harmonic filters** offer much better harmonic reduction compared to passive filters, as they detect multiple harmonic frequencies present in the network, and they produce counter-harmonic currents to cancel the harmonics produced by non-linear loads. However, their harmonic reduction performance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

**Multi-pulse drives** reduce harmonic distortion by using several rectifiers, and a phase-shifting transformer resulting in a larger footprint and tends to generate high heat loss. Installation is complex and there are significant drawbacks in this technology.

**Active front-end drive technology with DC bus capacitors** is advantageous for several reasons – the main one is 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% <sup>1)</sup>	~96.5% <sup>1)</sup>	~96% <sup>2)</sup>	~96.5%	~96.5% <sup>3)</sup>
Motor voltage <sup>4)</sup>	~0.96 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.95 × supply voltage	~0.92 × supply voltage <sup>5)</sup>	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 <sup>7)</sup>	100%	110%	250%	250%	300% <sup>6)</sup>	140%	120%
Equipment cost of all required components <sup>7)</sup>	100%	120%	190%	230%	200% <sup>6)</sup>	190%	190%

Data is based on a 134 hp 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.

<sup>1)</sup> 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%.

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

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

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

<sup>5)</sup> Output voltage when operating in low harmonic mode.

<sup>6)</sup> Cost and size comparison includes dedicated multiwinding transformer.

<sup>7)</sup> Footprint and cost are compared to a single drive installation.

# ACS880 ultra-low harmonic drives

## Technical data

<b>ACS880-31 wall-mounted ultra-low harmonic drives</b>	
Power range	3 to 150Hp (2.2 to 110kW)
Voltage range	3-phase, 380 to 500 V
Enclosure	UL Type 1 (IP21) , UL Type Open (IP20), and UL Type 12 (IP55) as standard. Optional flange mounting with Type 12 (IP55) back protection
<b>ACS880-34 ultra-low harmonic drive modules</b>	
Power range	150 to 450Hp (2.2 to 400 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type Open (IP20)
<b>ACS880-34 ultra-low harmonic drive module packages</b>	
Power range	215 to 3000Hp (160 to 2200 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type Open (IP00)
<b>ACS880-37 cabinet-built ultra-low harmonic drives</b>	
Power range	60 to 3300Hp (45 to 3200 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type 1 (IP21), UL Type 1-Filtered (IP42) and UL Type 12 (IP54) as standard
<b>ACS880-37LC cabinet-built ultra-low harmonic drives</b>	
Power range	335 to 8046Hp (250 to 6000 kW)
Voltage range	3-phase, 690 V
Enclosure	UL Type 1-Filtered (IP42) and UL Type 12 (IP54) as standard

# ACS880 regenerative drives

## Technical data

<b>ACS880-11 wall-mounted regenerative drives</b>	
Power range	3 to 150Hp (2.2 to 110kW)
Voltage range	3-phase, 380 to 500 V
Enclosure	UL Type 1 (IP21), UL Type Open (IP20) and Type 12 (IP55) as standard. Optional flange mounting with Type 12 (IP55) back protection
<b>ACS880-14 regenerative drive modules</b>	
Power range	150 to 450Hp (2.2 to 400 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type Open (IP20)
<b>ACS880-14 regenerative drive module packages</b>	
Power range	215 to 2950Hp (160 to 2200 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type Open (IP00)
<b>ACS880-17 cabinet-built regenerative drives</b>	
Power range	60 to 3300Hp (45 to 3200 kW)
Voltage range	3-phase, 380 to 690 V
Enclosure	UL Type 1 (IP21), UL Type 1-Filtered (IP42) and UL Type 12 (IP54) as standard
<b>ACS880-17LC cabinet-built regenerative drives</b>	
Power range	335 to 8046Hp (250 to 6000 kW)
Voltage range	3-phase, 690 V
Enclosure	UL Type 1-Filtered (IP42) and UL Type 12 (IP54) as standard





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For more information, please contact  
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