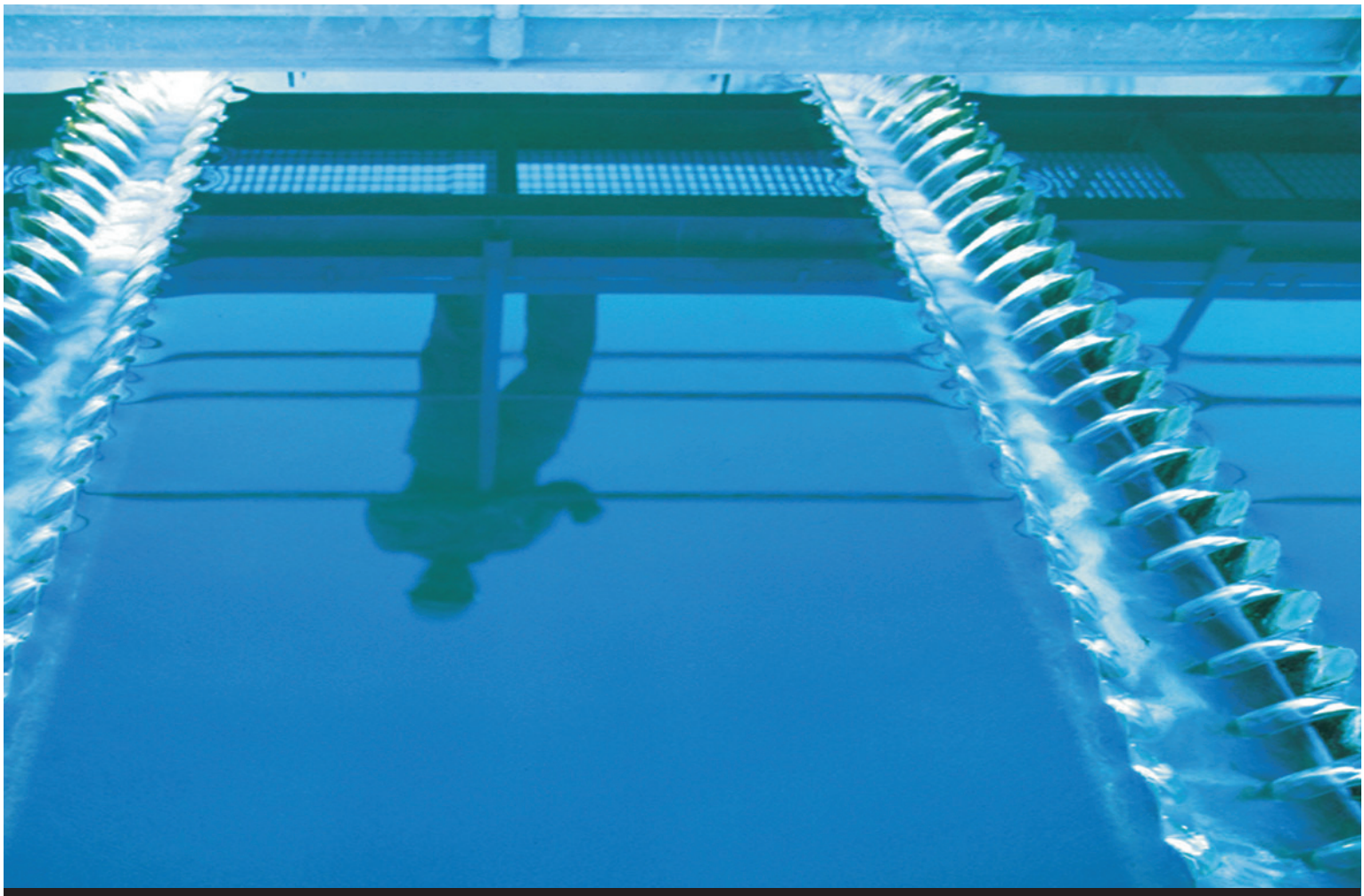


# Harmonic Solutions

## Solving harmonic challenges in water and waste water

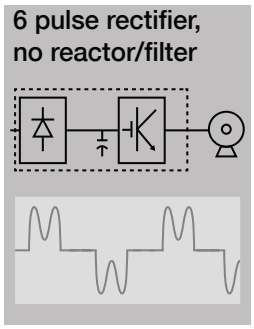
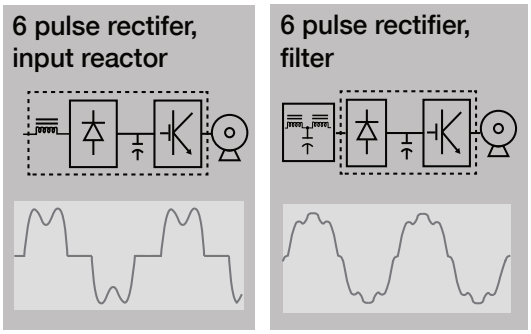
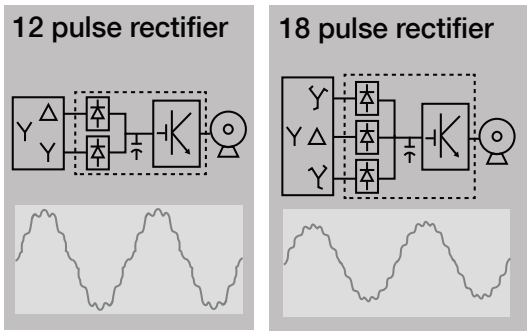
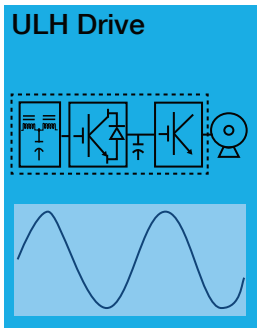
## Who you choose matters

Power and productivity
for a better world™

# Solution comparison

**Many options; one real solution**

Each of the popular methods of harmonic-reducing variable speed drive packages is described below. All harmonic levels indicated are input current distortion measured at the input terminals at full load, the line impedance is 0.5%. A drive without a line reactor or DC link choke will have a current distortion of about 35-40%.

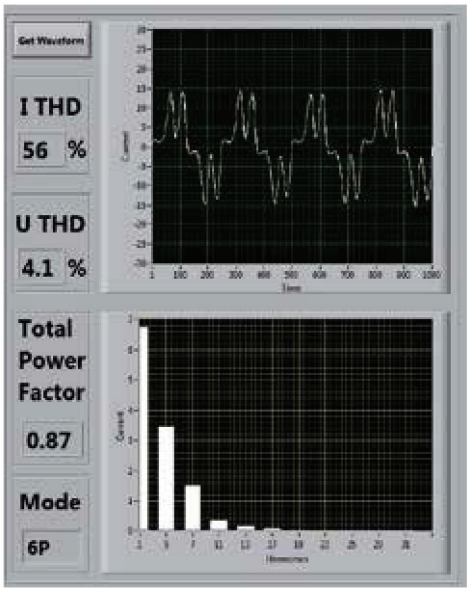
| | | |
|---|---|---|
| **6 pulse rectifier, no harmonic reduction** |  | A 6-pulse drive without any harmonic reduction such as line reactors, dc link choke or passive filter is the least expensive and simplest drive configuration; typical input current distortion is 40 - 120%. |
| **6 pulse rectifier, input reactor or filter** |  | 6-pulse drive with reactors – Reactors may be located either at AC line, or in DC link of the drive; typical input current distortion is 25 – 35%.<br><br>6-pulse drives with passive filter – This solution adds a low-pass filter in series with the drive. This solution can cause load-dependent voltage issues and potential power factor issues; typical input current distortion is 7-12%. |
| **Multi-pulse rectifiers** |  | 18-pulse drive – Same operation principle as the 12-pulse drive. This design has three rectifiers resulting in a higher part count and greater complexity. Harmonic performance is better than an 12-pulse drive but still sensitive to network voltage imbalance. |
| **Active rectifier (ULH drive)** |  | Ultra-low Harmonic drive (ULH) – This solution is configured to enable the drive to control the line current to near sinusoidal waveform quality. The active front end used in the ULH drive is designed to reach very low total distortion of both current and voltage. Simply, the drive package meets the IEEE 519 standard at the input terminals, and is not susceptible to unbalanced supply voltages.<br><br>Typical input current distortion is 3 – 5%. |

# Measurement results

## Technical Performance Comparison

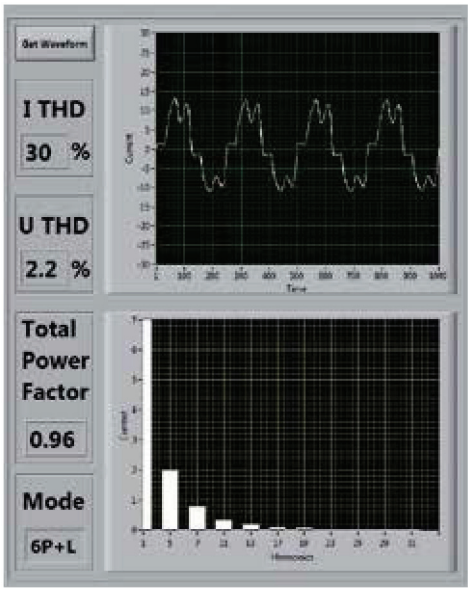
The following graphics indicate the actual level of harmonic distortion produced by the variable speed drive types mentioned. The results confirm that the ULH produces the least harmonic distortion of all solutions tested. Note that the actual level of harmonic distortion will vary from installation to installation due to the site conditions. The relative comparison and results between each of these variable speed drive types on the same system will be the same.

### 6-pulse drive, no harmonic reduction



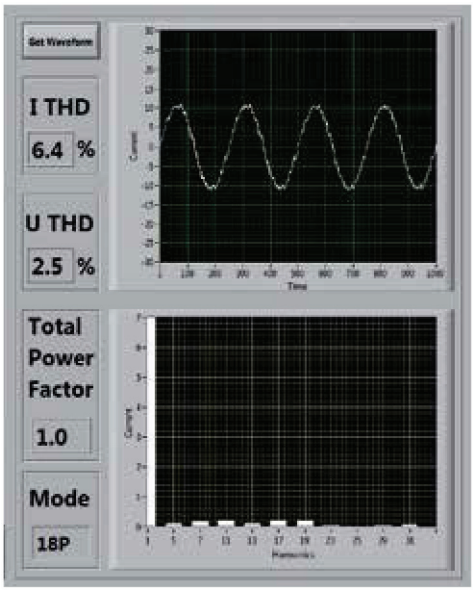

6-pulse drives without any harmonic reduction have a dramatic impact on the power distribution system – in this case the level of input current distortion is 56% and reduces the power factor to .87.

### 6-pulse drive with reactors




The level of harmonic distortion is reduced when reactors are added to 6-pulse drives, but is still significant. Total power factor is also improved.

### 18-pulse drive

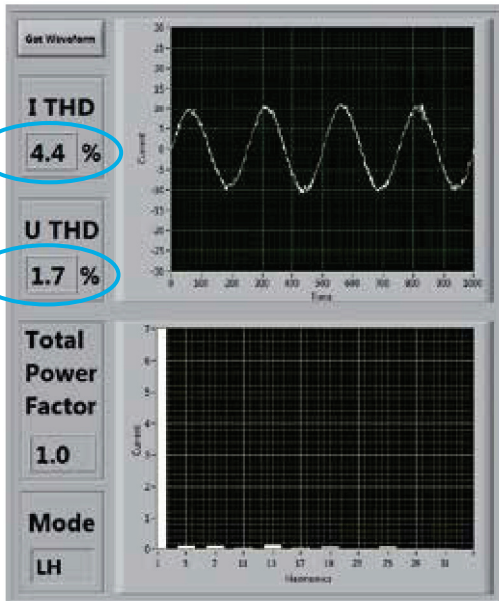



An 18-pulse solution offers very good reduction of harmonic distortion. However, this solution has considerable size and weight disadvantages due to the special phase-shifting transformers that are used.

## Ultra-low Harmonic drive

The Ultra-low Harmonic drive solution provides the best overall management of harmonic distortion of all solutions tested. Not only are the current and voltage distortions minimized, but the power factor is controlled to operate at unity (1.0), minimizing the total current used by the drive.

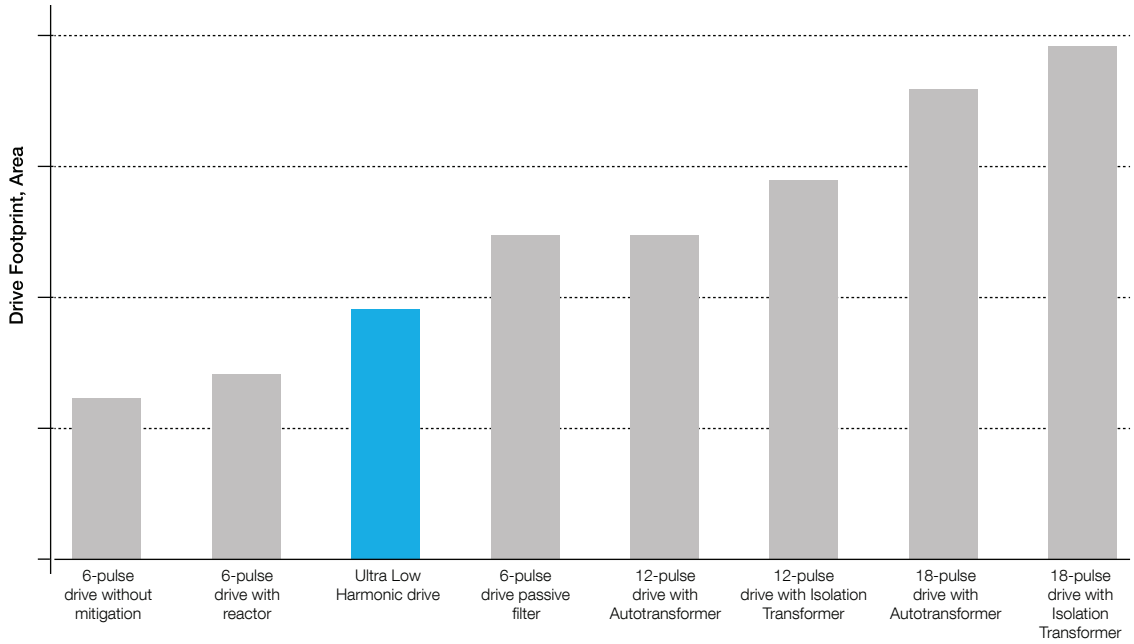
The ULH drive is the ideal solution for those drive installations where low harmonic content is desired or mandated. Its footprint is generally smaller than comparable stand-alone installations that use additional bolt-on harmonic reduction means. Its performance and simplicity of installation make it suitable for the water and wastewater industry, which includes applications such as: pumps, blowers, and compressors.



# Ultra Low Harmonic Drives

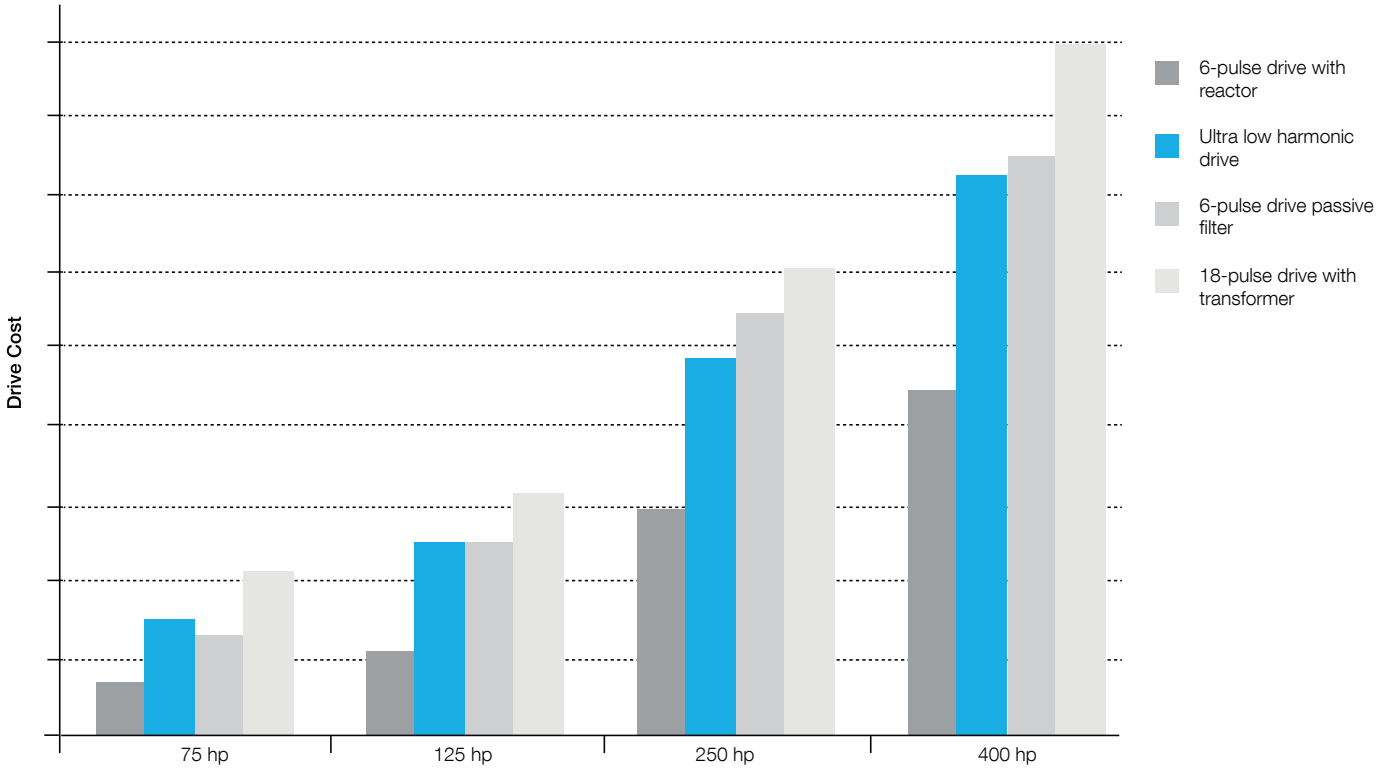
### Solution vs Physical Footprint Comparison

Comparison of the overall footprint of the ULH drive vs. other available harmonic reduction solutions. Comparisons in the chart below are at 125 Hp.




### Solution vs Overall Cost Comparison

Comparison of the overall cost of the ULH drive vs. other avaialble harmonic reduction solutions.



# Understanding harmonics

### Why worry about harmonics?

Any distorted voltage and current waveform that deviates from an ideal sinusoidal waveform presents potential harm to electrical components. The distortion can result in costly repairs and equipment downtime. Non-linear loads connected to the electrical supply in facilities cause harmonics (waveform distortions) on the power distribution system. Common non-linear loads include solid state motor soft starters, variable speed drives, computers, electronic lighting, welding supplies and uninterruptible power supplies.

Harmonic distortion can impact a system in many ways: it can cause distribution transformers to overheat, resulting in insulation breakdown and failure; electronic displays and lighting may flicker; nuisance tripping of circuit breakers is possible; and damage can occur to electronic equipment.

Harmonic distortion effects are not limited to the facilities where electrical equipment is installed. This potentially impacts any residential and commercial areas, where electrical equipment is installed such as: pumping stations, waste water treatment plants, cooling towers and HVAC systems. The Institute of Electrical and Electronics Engineers (IEEE) has established a recommended practice - IEEE 519-2014- which sets limits for harmonic current and voltage distortion for electrical power systems. This recommended practice provides the foundation for evaluating the level of harmonic distortion in a power distribution system, and the level of action required to mitigate the risks.

Industries such as water and waste water treatment, and HVAC, must meet local requirements to achieve low harmonic levels; this prevents disturbances to equipment in nearby residential properties and commercial buildings.

### Drives with Harmonic Reduction Solutions Built-In

Professionals responsible for designing and maintaining electrical systems must be aware of the potential issues related to harmonic distortion of their power distribution systems -- and know how to manage them in the most efficient and cost effective manner.

Many factors and components impact the overall quality of a power distribution system. Variable speed drives are among the many electrical devices included in that group. Manufacturers of variable speed drives offer a variety of answers to the question of how to reduce the level of distortion these devices produce. Most of these solutions involve adding large, costly components like specialty transformers to the variable speed drive installation to reduce the level of harmonic distortion.

ABB offers a broad range of harmonic reduction solutions. These include the Ultra-low Harmonic variable speed drives, which provide the best combination of harmonic reduction, package size, weight and range of features.

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