Life Is On | Schneider Electric

Reliable power onboard and offshore

AccuSine PCS+ Active Harmonic Filters

For electrical network reliability
and quality in Marine

schneider-electric.com/marine

What causes harmonics in Marine applications?

Power electronics with rapid and frequent variations of loads provide many process-related control and energy savings benefits, leading to the growing abundance of these types of devices on board vessels and in offshore Marine applications.

However, these non-linear loads – including variable speed drives (VSD), uninterrupted power supplies (UPS), and more – create harmonic currents, a major drawback for an electrical distribution system. These harmonic currents result in voltage harmonic distortion that affects all the devices connected to the system, leading to both instantaneous and long term effects on the electronic and electrical devices, and the system.

What are the effects of harmonics?

Harmonics cause excess heating that can damage equipment. For example, as cables overheat, the insulation is damaged. Motors are at risk of overheating and becoming noisy, and torque oscillations in the rotor can result in mechanical resonance and vibration. If a capacitor overheats, in the most severe cases, the breaking down of the dielectric creates an explosion risk. Additionally, the impacts of harmonics can cause electronic displays and lighting to flicker, circuit breakers to trip, computers to fail, and meters to give false readings.

Harmonics reduce reliability and equipment quality, while increasing operation and investment costs.

- Premature equipment replacement caused by excessive current and voltage distortion can add up to 15% in capital expenditures (CAPEX) and 10% in operational costs (OPEX).
- Marine classification societies define limits for harmonics levels in their rules to try to minimize the negative effects on vessels and offshore application operations.

Schneider Electric Harmonics Solutions

Schneider Electric specializes in harmonic mitigation, offering a broad range of solutions for every demand. The right choice depends on various factors, and Schneider Electric is ready to provide a convenient and optimized solution, tailored to your unique needs. Solutions range from the variable speed drive level (Individual), the electrical system level (Global), or a combination of both.

Individual Solutions: Variable Speed Drive Level

AC Line or DC Link Chokes for Drives

Both AC line reactor and DC link chokes help to smooth out the flow of current to variable speed drives (VSDs), reducing the level of harmonics. AC line reactors are placed in series with the incoming AC power line. DC link chokes are connected after the input diodes in the power circuit (see Figure 1). When the choke or reactor (or both) is added, the current flow is expanded and the amplitude is reduced. This helps to partially mitigate the level of harmonics. These devices are commonly used up to a range of about 500 KW unit power.

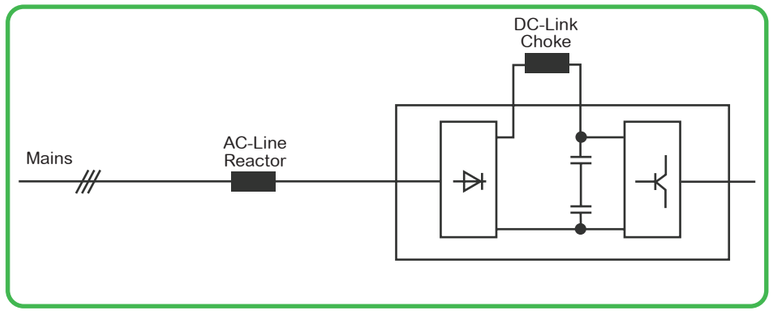


Figure 1: Simplified diagram of an inverter with AC line reactor and DC link choke

Multi-Pulse Transformer Arrangements (12, 18, 24 pulses)

For larger drives, another option for reducing harmonics is to configure VSDs with 12 diodes in the rectifier section. This is known as a 12-pulse drive. In order to make the 12-pulse option work correctly, a 30 ° phase shift transformer must be included (see Figure 2). With multi-winding transformers in different variations, configurations can be created for industrial users of up to 18-pulse and 24-pulse.

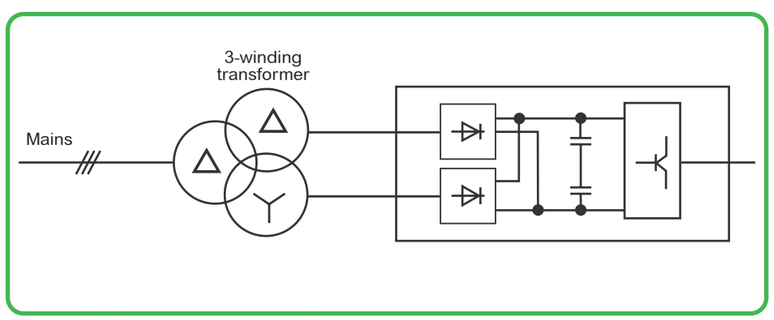


Figure 2: Simplified diagram of a 12-pulse inverter

Low Harmonic and Active Front End (AFE) Drives

Within a VSD, if the diode rectifier (device which allows current to flow in one direction, converting alternating current to direct current) is replaced by an active insulated gate bipolar transistor (IGBT) converter, it is possible to consume energy with very low harmonics and near unity power factor, converting DC power to AC power. This configuration, called a low harmonic drive, allows the system to adjust the waveform of the mains current (see Figure 3). Usually the nominal waveform of the line current is sinusoidal. In the case of the low harmonic drive, the impact on the mains due to harmonics and poor power factor can be avoided.

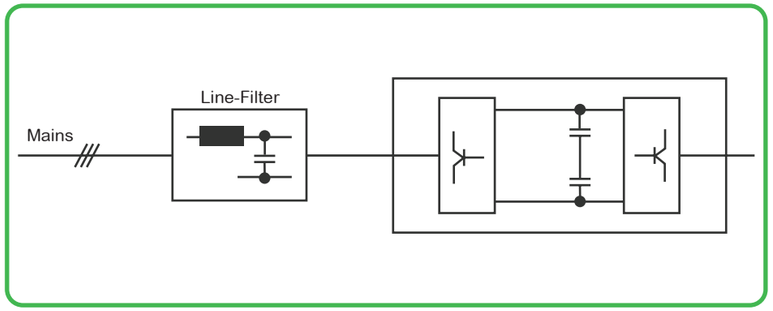


Figure 3: Simplified illustration of a low harmonic drive

Individual Solutions Comparison: Variable Speed Drive Level

Solution	Advantages	Disadvantages
AC Line or DC Link Chokes	• Simple • Low added cost	• Harmonics mitigation may not be enough • Not efficient enough for large drives • Reduction dependant on system impedance
12 Pulse Rectifier	• Good harmonics mitigation (5th and 7th eliminated*) • Reliable • Energy efficient	• Large footprint/heavy • Cabling more difficult • Special transformers • Costly • Applicable for large drives • Not applicable for retrofit
18/24 Pulse Rectifier	• Very good harmonics mitigation* • Reliable • Energy efficient	• Large footprint/heavy • Cabling more difficult • Special transformers • Costly • Applicable for large drives • Not applicable for retrofit
Low Harmonics Drives/ AFE Drives	• Very good harmonics mitigation • AFE drives allows regenerative power	• Large footprint/heavy • High cost per unit • Heat losses • May generate harmonics > 50th

*The 18/24 Pulse Rectifier provides more effective harmonics mitigation than the 12 Pulse Rectifier. The remaining harmonics (or characteristic harmonics) are determined by Hn = np +/-1, where p is the number of pulses and n any integer.

Global Solution: Electrical System Level

Active Filter

The active filter monitors the mains current to determine the amount of harmonic current correction that must be injected to create a sinusoidal AC current and minimize the harmonic current (see Figure 4). An active filter is installed parallel to the inverters with the CT on the mains feeder to effectively compensate for harmonics to the 50th order.

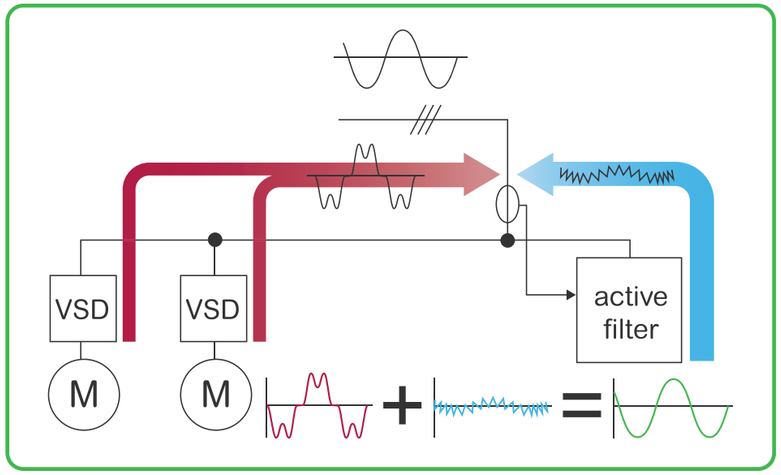


Figure 4: Simplified illustration of an active filter

Active Filter Advantages

- Highly effective
  - 2nd to 50th orders canceled
- Parallel connected
  - Not critical for equipment operation
- Scalable
  - Parallel units as needed
- Best cost universal soltution
  - Handles many loads
  - Many types of loads at the same time
- Can be installed as convenient
  - Install or add anytime in a vessel life cycle
- Smallest footprint with standard VSD/UPS
- Lowest system heat losses
- Injects to capacity even if demand exceeds installed capacity
- Fast response to dynamic loads - effectively per cycle

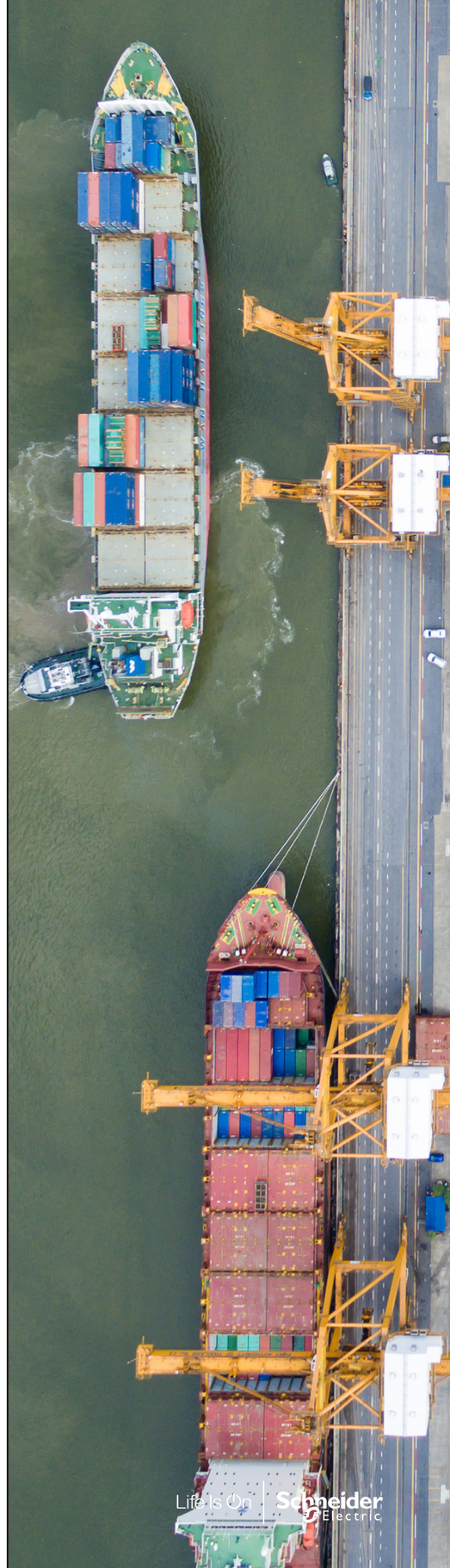
AccuSine PCS+ Active Harmonic Filter

- Harmonics mitigation, displacement power factor correction, and mains current balancing
  - When applied fully, AccuSine PCS+ provides optimized fuel usage for the prime mover of a generator.
- Flexible equipment installation and optimized space utilization
  - Modular AccuSine PCS+ (IP20, IP31 or IP54) can be installed parallel to the generator and the loads.
- Load share or cascade operation of paralleled units
  - Operate up to 10 units in parallel and up to 3000 amperes correction at any one bus location. Cascading provides time equalization of the paralleled units for longer unit life.
- Remote status, performance reports, and compliance reporting
  - Communications capability through Power Monitoring Expert (PME), Power Quality Advisor, and StruxureWare software. AccuSine PCS+ is also compatible with Com'X 510 energy servers for data collection that can be transmitted to reporting systems. WiFi capability is included with the Com'X 510.
- Modbus RTU or Modbus TCP/IP ports
  - Additional communications to other types of devices through Modbus RTU or Modbus TCP/IP provides complete control including run/stop, parameter review and adjustments, and diagnostics.
- On-board commissioning program
  - Improves commissioning time and helps to automatically align current transformers (CT) to the proper phase with the correct polarity.
- Service USB port
  - A service technician with a laptop computer can fully diagnose unit status without power being activated to the unit. View historical data up to the time of power disruption, accessing fast and accurate details while maintaining superior technician safety.
- Best-in-class harmonic mitigation to 3% THDi
  - Assures transformers, cables, and busways operate at or below designed temperatures for a longer life. Very low harmonic current distortion levels also ensure voltage distortion (THDv) has no harmful effects on any other critical equipment.

AccuSine PCS+: Part of Schneider Electric Marine Expertise

Whether on board vessels or in offshore Marine applications, Schneider Electric has deep experience and a long history of providing a comprehensive line of electrical distribution products for the marine industry. Accusine PCS+ has been thoroughly tested on ungrounded networks (the on board standard) and been proven compatible with Vigilohm Insulation Monitors.

Schneider Electric offers a unique set of engineering expertise and can perform harmonics studies to help select the best harmonic mitigation solution to fit your needs.



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