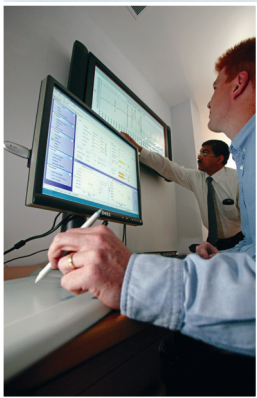


# Variable Speed Drives

## Quality support

Whether you need a brief consultation or the most comprehensive solution, our experts are available anywhere and anytime. Since 1976, our power systems team, based at the Edmonton Technology Center in Canada, has provided innovative and advanced solutions for the control, automation, remote monitoring, and electrical protection of ESP and surface pumping installations. These experts help ensure the efficient and economical use of power through field measurements and computer modeling, by analyzing power system components including VSDs, and by delivering customized solutions.



# Variable Speed Drives

Optimize production potential

[www.slb.com/vsd](http://www.slb.com/vsd)



# Variable Speed Drives

### APPLICATIONS

- Wells with high water cut or high GOR
- Wells with viscous or abrasive fluids
- CO<sub>2</sub> floods
- Wells with unstable flow
- Coalbed methane dewatering
- Gas well deliquification
- Offshore, subsea, and deepwater installations
- Remote locations

### BENEFITS

- Reduce costs and enhance productivity with increased efficiency, reliability, and run life
- Eliminate costs of resizing pumps with varying downhole conditions
- Minimize risks with multiple safety features
- Lower manpower requirements with facility to preset, automatically control, and remotely adjust parameters

### FEATURES

- Surface pumping system and ESP compatibility
- Speed control to maintain constant load
- Low- and high-voltage drives for different power requirements
- Sinusoidal output with minimal harmonic distortion for downstream devices
- Indoor and outdoor models
- ‘Rocking’ start feature for freeing stuck pumps
- Optional lightning protection

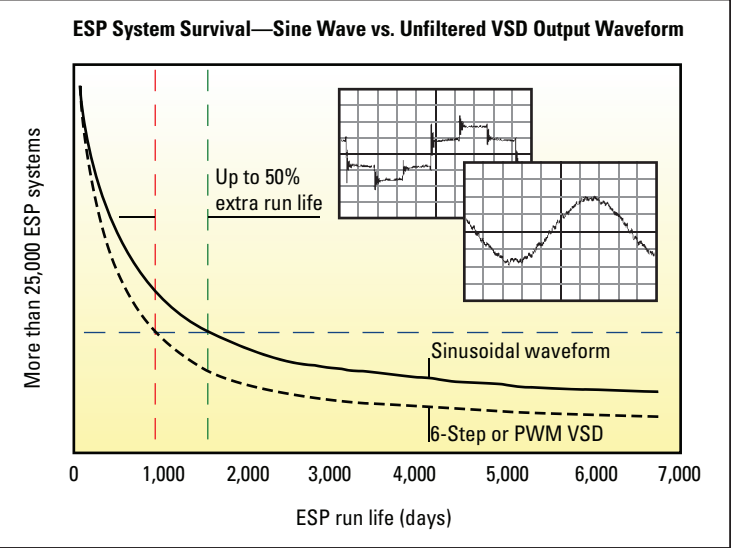
**Well conditions often change over time—reservoir pressures drop, GORs and watercuts vary, pressure maintenance and flood patterns change, abrasives impact flow rates, and power supplies fluctuate. Such events inevitably affect the performance of the ESP system and the well.**

### Optimize production, minimize downtime

Schlumberger variable speed drives (VSDs) help ESPs and surface pumping systems adapt to changing conditions in your well by adjusting production rates, thereby improving performance and optimizing productivity. Parameters to maximize performance can be preset, automatically controlled, and remotely adjusted as required.

By varying speeds, VSDs enable pumps to operate across a wider range than possible with fixed speed drives. This feature reduces the need to change out pumps as conditions change, decreasing downtime and operating costs, contributing to a longer system life, and enhancing production.

SpeedStar SWD VSD can increase ESP system run life up to 50% more than a PWM or other nonfiltered VSD



## Application-specific solutions

Our suite of VSDs includes models for a range of applications, from routine conditions to high-power, high-voltage, technically challenging situations, including

- high-volume onshore developments
- offshore platforms
- deepwater subsea installations.

The right VSD for the job, combined with expert electrical and pump system design, field operation, and monitoring throughout the life cycle of the well can significantly improve the profitability of your operations and maximize production.



### Robust outdoor system protects the Amazon

Large amounts of formation water produced by oil and gas operations in the Amazon basin need to be disposed of without damaging the pristine environment. A major operator in Peru decided to reinject produced water into the reservoir to prevent contamination of the Amazon river and its tributaries. The operator chose REDA HPS\* horizontal multistage surface pumps because of their proven robustness, efficiency, and long run life.

Reduced electrical system impact, and remote control and operation, shaped the operator’s choice of the SpeedStar MVD\* VSD. The only outdoor, NEMA 3R–rated, medium-voltage VSD, it is ideally suited to the harsh Amazonian environment. This fit-for-purpose solution has reduced pollution of the Amazon river.



### Outdoor drives suit indoor space constraints, offshore Middle East

Harsh environments have driven the historical use of indoor medium-voltage drives (MVDs) on offshore installations. In the Middle East, one major operator created a new demand for VSDs suitable for use in nonhazardous but hostile outdoor environments because of a lack of indoor climate-controlled space.

The NEMA 3R–rated SpeedStar MVD addressed the challenge with specialized outdoor packaging, using multiple heat exchangers to separate the outside air from the electronics inside the MVD. Moreover, the elimination of climate control and the typical losses associated with heating, ventilation, and air-conditioning (HVAC) systems offers considerable energy savings. These specialized MVDs saved the customer infrastructure costs, and also lowered operating costs over the life of the wells because of higher efficiency and reliability.



### Adaptive VSDs respond to changing conditions

In gaseous applications, downhole conditions change constantly and gas can cause the pump to lock, resulting in the loss of valuable production time. As these applications have become more prevalent, VSDs combining downhole gauge and surface electrical data have evolved that can quickly and automatically adjust to such changes.

Our VSDs enable operators to track a specific pressure reading or motor current (load), and adjust the VSD speed to maintain constant downhole pressure or load, respectively. When gas production changes bottomhole conditions, the VSD can compensate and maintain the performance of the pump. If water breaks through, the VSD can adjust the speed to keep the production rate unchanged. This feature has saved our clients substantial amounts in deferred production and operating costs.



### Durability and remote control meet North Sea requirements

We can help you access the latest technology even in the most challenging locations. Remote and mature fields, like the North Sea, need solutions that are both cost-effective and reliable. When an operator needed a VSD for an unmanned power buoy installation, a minimum ESP system run life of four years was the top priority.

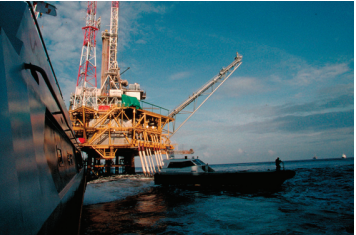
The SpeedStar MVD VSD met the operator’s requirements, providing a long run life with the minimum footprint for transportation. Today, remotely controlled VSDs installed on this buoy provide power for up to nine subsea ESP systems.



### Lightning protection delivers 362% returns

With thousands operating globally under different environmental conditions, VSDs are constantly exposed to potentially damaging power disturbances caused by man-made and natural occurrences. The most severe disturbances result from lightning strikes, which can create spikes in the voltage and superimpose short-duration electrical transients on the input waveforms. Uncontrolled, such disturbances can cause VSDs to fail and may even render equipment repair uneconomical. StarShield\* surge protection devices (SPDs) can be connected to the drive input to ground potentially crippling transient voltages.

In one year, a field in North Africa suffered seven failures among 29 drives because of lightning strikes, resulting in downtime and costly repairs. The failed drives were retrofitted with StarShield SPDs and experienced no failures the following year, leading the customer to equip all the VSDs with surge protectors. The demonstrated 362% rate of return in a single year is typical of the economic value provided by this innovative solution.



### ‘Rocking’ start saves nearly USD 10 million

One of the greatest challenges for an ESP system is starting the motor when solids fallback—caused by natural formation production, workovers, or drilling operations—plug the ESP and causes the pump to become stuck. The rocking-start feature electrically switches the direction of rotation of the motor back and forth, freeing the pump and allowing production to continue without costly downtime and intervention.

In an offshore field with sand production from an unconsolidated formation, a power brownout caused 105 wells to shut down. When production was restarted with a fixed speed drive, 36 wells could not be brought back online because of stuck pumps. Subsequently, a VSD with the rocking-motor feature was used, reestablishing production from 33 of those wells and saving the project nearly USD 10 million in workover costs.



# Variable Speed Drives

## System integrity

Because early system failure can be financially catastrophic, we provide solutions that maintain overall system integrity. Expert services and software packages can help predict the harmonic content and determine the mitigation requirements for your installation.

We offer a complete range of solutions for harmonic control. Conversion of the supply frequency to the desired operating frequency gives rise to harmonic reflections into the input power supply.

- For 6-pulse low-voltage drives (LVDs), the electric current is typically distorted 25%, depending on the power system impedance.
- 12-pulse LVDs halve the distortion to 11% by a process of phase multiplication, from three phases to six.
- The 18-pulse SpeedStar 519 SWD\* VSD effectively reduces the current distortion by 80% compared to a 6-pulse VSD. With just 5% current dis-

tortion, subject to power system impedances, it is an economical method of conforming to IEEE 519–1992 guidelines.

- For a smaller footprint and system efficiency gains in high-power applications, MVDs are the solution. With current distortion typically under 5%, harmonics concerns are practically eliminated and the efficient use of electric power is enhanced.

Our extensive database shows that ESP system run life can be increased by up to 50% when a 6-step or pulse-width-modulated (PWM) VSD is replaced with one that produces a sinusoidal output. Consequently, our VSDs are designed to output a smooth sine wave with minimal harmonics, which lessens system stress. In the Gulf of Mexico, the average run life of numerous ESP systems more than doubled because of this technology and related changes to surface electrical systems.

## Current demands

The emphasis on VSDs is on system optimization, and to some extent auto adaptive systems using intelligent controllers and increasing efficiency gains, including adherence to clean line or supply power according to recommended guidelines on voltage and current harmonic distortion levels. We offer technologies that include high voltage direct to MVD applications using integral input isolation type transformers. The input transformer is designed to match customer specified supply voltage and frequency, eliminating the need for additional transformers, thereby raising efficiency and lowering your operating costs.



SpeedStar 519 SWD 18-pulse, low-voltage package is designed to minimize supply power harmonic current and voltage distortion, while providing clean power to the downstream device.



With thousands sold globally, SpeedStar VSD is widely used and suitable in the majority of mature production situations, including brownfields.



MVDs are suitable for offshore installations where reliability really counts. They are also suitable for high horsepower, medium voltage applications in sub-sea or high intervention environments.



The outdoor MVD, the first of its type in the industry, is designed standard with a visible disconnect switch, precharge circuitry, 36-pulse input and sine wave drive output filter specifically tailored for controlling and protecting high-horsepower ESPs and surface pumps. The outdoor MVD does not require installation in a climate-controlled environment.

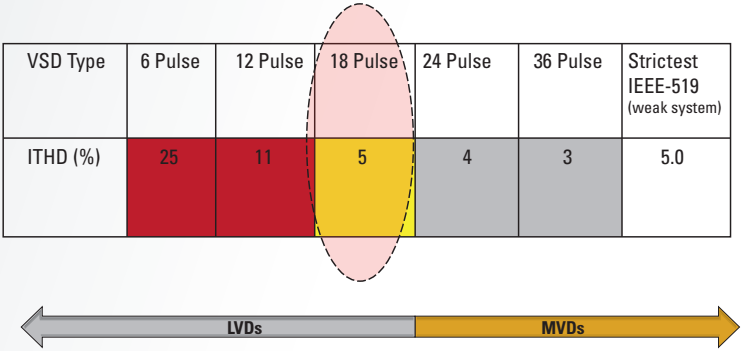


# Variable Speed Drives

## Reliability and safety

Our VSDs are among the most reliable in the industry, with a mean time between failures (MTBF) design philosophy of 5 to 10 years for LVDs and MVDs respectively.

Because medium voltage can be lethal, SpeedStar MVDs have a high level of inbuilt safety. Features include a visible disconnect switch interlocked with Kirk keys to protect personnel and assets, input fuses that provide a current limit, and vacuum contactors that will interrupt a fault and possibly prevent fire and explosion. In addition, a precharge circuit limits the inrush current to a maximum of 150% full load amperage, thereby limiting any mechanical and electrical stresses during startup and ensuring longer term reliability. The SpeedStar MVD also generates its own internal control power for microprocessors and cooling fans, ensuring a single source of power into the MVD and consequently, a single lockout and tagout safety procedure.



VSD portfolio line harmonic solutions for a weak power system (typical outdoor remote land applications) where the percent absolute values will vary with different types of power systems, but the ratios mostly apply and are typical.

