

## VariStar 2000 Plus and SWD Drives

### APPLICATIONS

- Variable-speed ESP and surface pumping applications

### BENEFITS

- Reduced downtime
- Prolonged electrical system life
- Reduced operating costs

### FEATURES

- Plug-and-play system that eliminates the need for wellsite adjustment
- Expandable platform to accommodate additional protection and system requirements
- Pulse-width modulation (PWM) output waveform or sine wave output waveform
- Load-side, phase-to-phase, short-circuit protection
- Ability to start an ESP while motor is spinning
- Programmable automatic load reduction (soft-stall function)
- Speed control to maintain constant load and pressure
- Rocking start, used to start wells with stuck pumps resulting from scale or sand problems
- Momentary power failure ride-through
- Air intake filter that prevents entry of blowing rain (at angles greater than 45°)
- Hall-effect high-frequency-response current transformer for current sensing

The VariStar\* variable-speed drive (VSD) is specifically tailored for controlling and protecting ESPs and surface pumps. The VariStar 2000 Plus drive is typically used with surface pumping systems. The VariStar SWD sine wave drive, which has an integral output sine wave filter, is typically used with ESPs. The output voltage wave form is similar to that of a true sine wave and thus results in less voltage stress and a longer life for the motor, cable, and other electrical components. VSDs enable pumps to perform across a wider operating range by varying their speed. A unit's optimum performance can be preset or automatically adjusted to avoid no-flow and cycling conditions. The VariStar VSD reduces the need to change out pump components as operating conditions change, thereby reducing downtime and operating costs and contributing to a longer system run life.

### Enhanced performance

The VariStar VSD provides state-of-the-art motor control incorporating advanced digital PWM flux vector control that ensures constant speed and torque. It also provides for higher torque per amp, less motor heating, and reduced torque pulsation. Current sensing using a Hall-effect high-frequency-response current transformer ensures motor stability. The VariStar VSD increases a system's power factor substantially over one driven using a fixed-speed drive, and it decreases a system's electrical stress at startup to as low as 1.5 times the operating motor current. Each size is heat-run-tested at full load and maximum ambient temperature to ensure proper operation at maximum rating.

### Increased system run life

For submersible motors used at extreme depths, the VariStar VSD offers an automated plug-and-play sine wave drive (SWD) with a harmonic output filter that eliminates problems related to resonance. The patented filter pushes the resonance band of the downhole system below the drive's carrier frequency, eliminating excessive resonance and minimizing voltage overshoots, regardless of variations in cable length, motor type, and transformer taps selected. The output voltage waveform is



A 200-kVA [241-A] VariStar VSD with sine wave harmonic output filter compartment at bottom of cabinet and optional light receptacle package.

similar to a true sine wave and thus results in less voltage stress and longer life for the motor, cable, and other electrical components.

### Modularity and flexibility

Optional modular components can be added to the VariStar VSD to enhance field operations and system protection. They include

- space heater to prevent humidity buildup inside the drive and ensure long-term operation in high-humidity areas
- StarShield\* surge protection device (SPD) to protect the VariStar VSD and connected pump against lightning strikes and voltage surges
- light and utility receptacles to enable the use of additional electrical instruments in the field.

# VariStar 2000 Plus and SWD Drives

## Enhanced operation and protection

The VariStar VSD uses the UniConn\* universal site controller as a single user interface for all wellsite controller and data acquisition requirements. The modular, customizable controller provides for

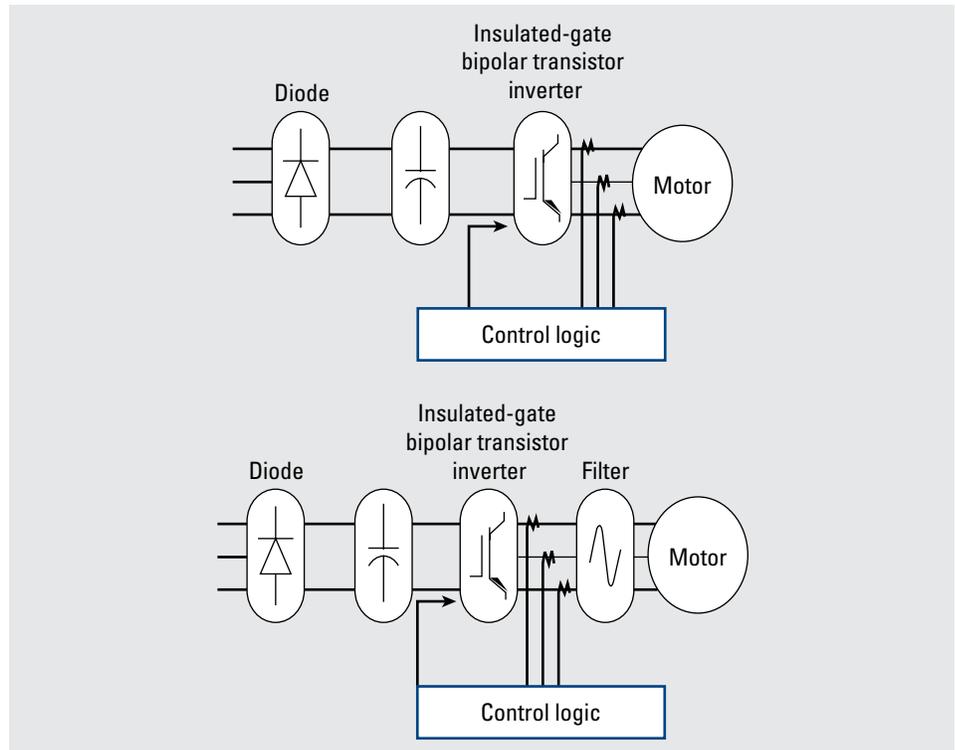
- speed control in frequency, current, and pressure modes
- ability to start an ESP while motor is spinning
- setting of alarms and parameters for automatic restart
- automatic speed reduction
- remote wellsite data gathering, monitoring, surveillance, and control.

## Protection features

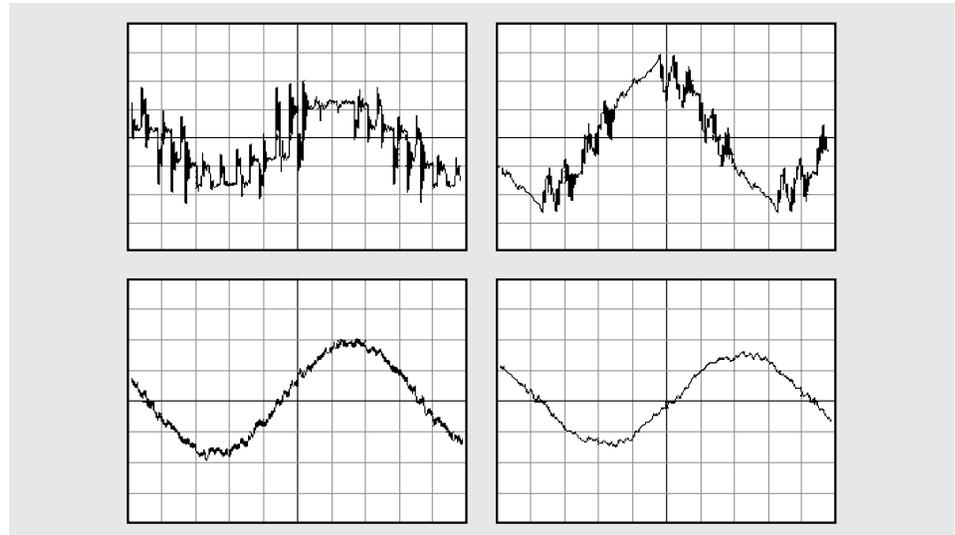
- Main circuit overcurrent at startup
- Load-side phase-to-phase short circuit protection
- Heat-sink and enclosure overtemperature
- Open output phase
- Electronic thermal overload protection
- Soft stall: automatic load reduction during overload with user-adjustable settings
- DC bus overvoltage/undervoltage
- Regeneration power ride-through
- Momentary power failure ride-through

## Standard features

- Input circuit breaker disconnect with 100-kAIC-rated fuses
- Diode front-end converter
- Insulated-gate bipolar transistor inverter
- Heat-sink-mounted power components with forced air cooling
- Hall-effect current transformer sensing device
- UniConn universal site controller
- Weatherproof gasketed door with three-point padlockable latch
- Lifting eyebolts



Basic power system circuitry of VariStar VSD (top) and VariStar VSD with integral sine wave filter (bottom).



VSD output voltage waveform (left column) versus output current waveform (right column), PWM VSD (top), and SWD (bottom).

# VariStar 2000 Plus and SWD Drives

## Optional features

- UniConn three-phase current transformer for three-phase current monitoring
- Potential transformers for three-phase voltage monitoring
- UniConn expansion cards
- Light and 110-/220-V utility receptacle powered by a 1-kVA potential transformer
- Sine wave output harmonic filter

## Monitored parameters

- Current: drive, measured; motor, calculated (three-phase measurement optional)
- Input voltage: drive, calculated, three-phase (optional)
- Output voltage: drive, calculated, three-phase (optional)
- Supply voltage
- Power: drive input and output, running frequency
- Backspin frequency, leg ground (optional)

## Protection set points

- Overload with time-response curve, underload, tracking underload, imbalance (optional)
- Overvoltage, undervoltage with time-response curve, rotation (all optional)
- High/low supply voltage with time-response curve
- Backspin, leg ground (optional)

## VariStar VSD PWM Output

Output rating, kVA at 480/380 V	200/158	390/309	518/410
Output rating, A	241	469	623
Ambient temperature, degC [degF]	-10 to 50 [14 to 122]	-10 to 50 [14 to 122]	-10 to 40 [14 to 104]
Dimensions, H x W x D, in	81.5 x 35.5 x 35	81.5 x 45.5 x 42	81.5 x 45.5 x 42
Approximate weight, kg [lbm]	454 [1,000]	544 [1,200]	544 [1,200]
VariStar VSD Sine Wave Output, kVA at 480/380 V	200/158	390/309	518/410
Output rating, A	241	469	623
Ambient temperature, degC [degF]	-10 to 50 [14 to 122]	-10 to 50 [14 to 122]	-10 to 40 [14 to 104]
Dimensions, H x W x D, in	96 x 35.5 x 35	96 x 45.5 x 42	96 x 45.5 x 42
Approximate weight, kg [lbm]	680 [1,500]	907 [2,000]	907 [2,000]

## VariStar VSD Principal Control Parameters

Control system	PWM flux-vector, V/Hz control
Input power	380/480 V (± 10%), 50/60 Hz (± 5%)
Output voltage regulation	Same as input power
Frequency setting	0.01–120 Hz, 0.01-Hz resolution
PWM carrier frequency	User-adjustable: 0.5–3.0 kHz, sine wave fixed at 2.2 kHz
Input configuration	6-pulse diode only
Efficiency	98% at all loads and speeds
Power factor	96% at all loads and speeds
Overload rating	120% overcurrent for 120 s (100% continuous)

## VariStar VSD Enclosure and Environmental Ratings

Type	NEMA 3R-rated enclosure (outdoor); standard compliance with UL-508
Cooling method	Forced air (internal and external fans)
Maximum altitude	1,000 m [3,300 ft] above sea level (derated above maximum altitude)
Relative humidity	20%–95% maximum (noncondensing)
H <sub>2</sub> S protection	Coated circuit boards, heat sink, and heat exchanger
Material	12-gauge carbon steel enclosure

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