Pioneering for you

Drainage & Sewage
Consulting guide

FC Operation for Sewage Pumps

Frequency converter operation

The listed Wilo sewage pumps can be operated with 'pulse-width modulated' frequency converters:

- Wilo-Rexa PRO
- Wilo-Rexa PRO-S
- Wilo-Rexa SUPRA with FK ..., FKT ..., HC ... and T motor
- Wilo-Rexa NORM
- Wilo-Rexa BLOC
- Wilo-EMU FA with FK ..., FKT ..., HC ... and T motor
- Wilo-EMU KPR with T motor

Pulse-width modulated frequency converter

The incoming mains voltage is converted into direct current (DC) and stored in a capacitor. An inverter operates at the output of the frequency converter. This inverter has fast-reacting semiconductors. These semiconductors are triggered one after the other to connect the capacitor to the motor windings. This connection occurs at a pulse frequency of approximately 4–16 kHz.

In most frequency converters, the pulse frequency can be adjusted. The duty cycle and the pauses of the square wave can also be modified. These settings permit the output voltage at the motor to be adjusted (see diagram).

Setpoint: The desired output voltage that aligns with the sinusoidal profile of the mains supply.

Pulse: Pulse-width modulated output voltage of the frequency converter.

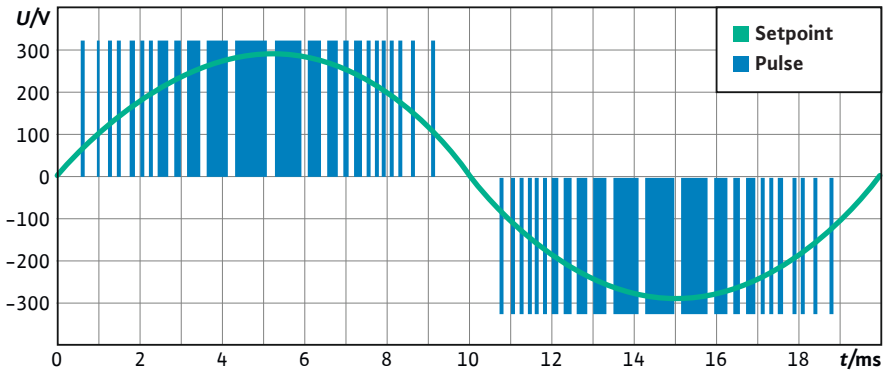

Fig. 1: Output voltage of the frequency converter

Furthermore, output filters can also be connected downstream. These filters soften the outgoing square wave voltage and reduce voltage peaks.

Electromagnetic interference (EMI)

Frequency converters generate electromagnetic interference (EMI) that can cause other electronic devices to malfunction. This interference can affect both the input side (the mains power supply) and the output side (the pump power supply). For example, electromagnetic radiation can disrupt the monitoring of the thermal motor winding. Follow the measures listed for the planning stage to keep potential issues to a minimum:

- Use divided connection cables for the power and the control cables.
- Make sure that there is a sufficient distance between the power and control cables.
- Order the control cables as shielded cables. Also, use shielded cables for level measurement and monitoring devices.
- Install EMC filters on the output side of the frequency converter.
- Do not cross cables.

Thermal motor winding monitoring

All Wilo sewage pumps are fitted with thermal motor winding monitoring. Depending on the motor type, one of the listed sensors is used:

- Bimetallic sensor
- Thermistor temperature sensor (PTC)
- Resistance temperature sensor (PT100)

Note: Connect the thermal motor winding monitor to the frequency converter. Make sure that the frequency converter has the correct inputs.

Potentially explosive atmosphere: The frequency converter must have a hardware-based shutdown (also known as Safe Torque Off) for the thermal motor winding monitor.

Additional motor monitoring devices

Depending on the motor type, the pump can be optionally fitted with:

- A moisture probe for detecting leakage in the motor compartment and/or terminal box
- An internal or external moisture probe for detecting leakage in the sealing chamber.
  For motors with an internal moisture probe, it is recommended to use the external double-rod moisture probe for the sealing chamber monitoring.
- A thermal monitor for the motor bearings.

Note:

- Obey the motor data sheet for details of the fitted monitoring devices.
- Connect all monitoring devices in one of two methods: directly to the frequency converter, or through a designated switchgear.

Potentially explosive atmosphere: Connect all monitoring devices to ex-approved evaluation relays.

Frequency converter selection

Wilo motors in standard design (in compliance with IEC 60034-17) can operate with a frequency converter at voltages of up to 415 V/50 Hz or 480 V/60 Hz. For rated voltages above 415 V/50 Hz or 480 V/60 Hz, contact customer services.

The minimum requirements for selecting and using a frequency converter are as follows:

- The frequency converter and the pump must be compatible. Compatibility is particularly important for permanent magnet motors. Always examine compatibility with the manufacturer before installation.
- Size the frequency converter according to the motor's rated current. Do not select the converter based solely on the motor's power rating. An incorrect converter can lead to operational problems.
- Motor control through vector control (also known as field-oriented control).
  Vector control allows accurate speed and torque control by adjusting the voltage, frequency, and phase angle between the stator current and rotor position.
  For easier applications, control can be applied using U/f control. This type of control keeps a constant ratio between voltage and frequency. Thus, U/f control is not as powerful as vector control.
- Automatic Motor Adaptation (AMA) function
  This function automatically adjusts the drive's settings to optimise performance with the connected motor, without the necessary manual tuning or load decoupling. It simplifies installation and commissioning by identifying the motor's parameters and adapting the drive accordingly.
- Due to the increased heating caused by harmonics, the motor's rated power must be approximately 10 % higher than the hydraulics' power requirement. For frequency converters with low-harmonic output, the power reserve can be decreased to 7 %.

- Examine compliance with all specified limits for voltage peaks, speed, power consumption, and other relevant parameters.
- Connections must be available for bimetallic sensors, PTC sensors or PT100 sensors, depending on the motor type, to monitor the thermal motor winding. Note: If you use the pump in a potentially explosive atmosphere, the frequency converter must have a hardware-based shutdown (Safe Torque Off) for the thermal motor winding monitor.

Output filters

Output filters are usually recommended to decrease high-frequency components in the output signal. These filters prevent damage to motor insulation, decrease motor noise, and make sure that EMC regulations are met.

Install output filters (sine or dU/dt) downstream to keep the maximum values at the windings in their specified limits:

- The maximum rate of voltage rise at the connection between the connection cable and the motor's winding.
- The maximum voltage peak at the connection between the connection cable and the motor's winding.

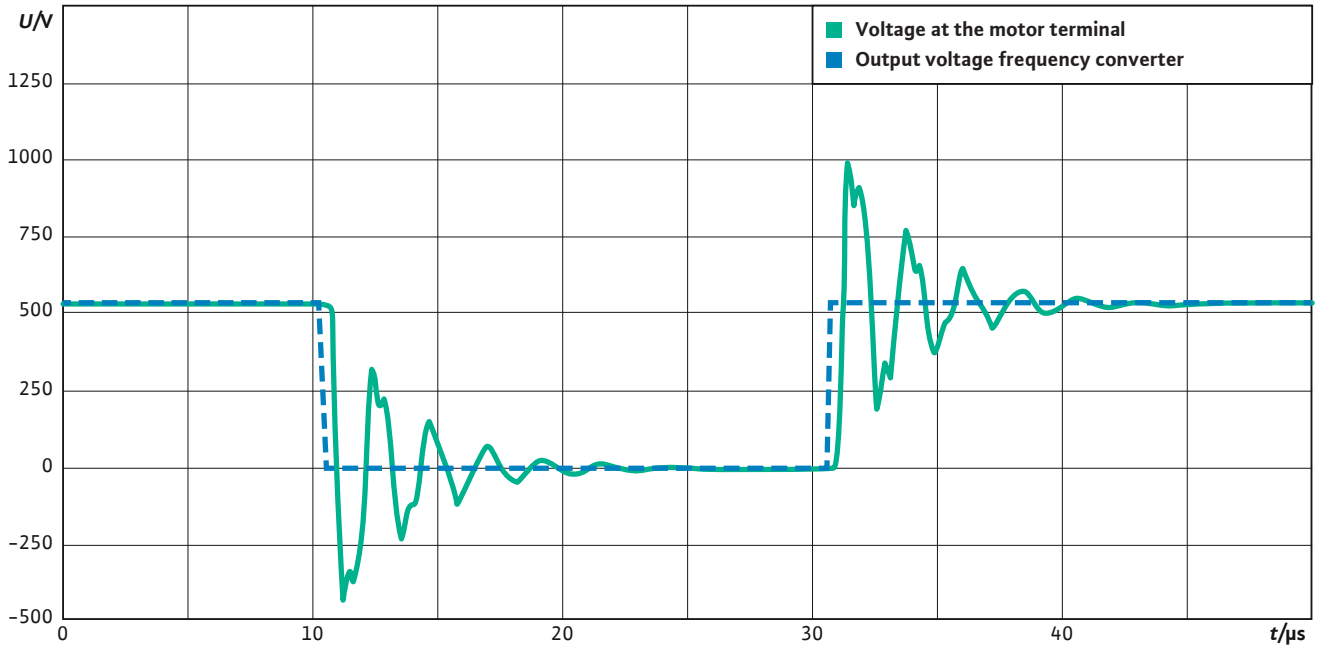

Fig. 2: Output voltage from the frequency converter vs. the voltage at the motor terminal

The 'rate of voltage rise' and 'voltage peak' values are phase-to-phase. Obey the listed points:

- Not all filters are compatible with all frequency converters. Make sure that the filter and frequency converter are compatible with each other.
- Output filters cause an increased voltage drop. Thus, this voltage drop must be kept in mind when designing the system.
- As the semiconductors in frequency converters are constantly becoming faster, phase-to-earth peaks are also increasing to critical heights. Thus, all-pole filters are installed.

Operating parameters

- Increased motor noise due to harmonics in the power supply is normal.

- Make sure that the pump operates without jerks and vibrations (without oscillations, resonances, pendulum torques) in the entire control range. Otherwise, the mechanical seal can leak or be damaged.
- Make sure that the pump operates in the permitted control range shown on the nameplate.
- Minimum pulse frequency
  The pulse frequency is set according to the output filter requirements. For initial commissioning, the recommended setting is 4 kHz unless stated otherwise.
- The maximum rate of voltage rise at the connection between the connection cable and the winding in the motor: 500 V/µs
- The maximum voltage peak at the connection between the connection cable and the winding in the motor: 1350 V
- Maximum output current at the frequency converter: 1.5 times rated current
- Maximum overload time: 60 seconds
- Minimum flow rate in the pipeline: 0.7 m/s (2.3 ft/s)
  If the flow rate is too low, the risk of deposits in the connected pipeline increases.

Operation above rated motor frequency

Depending on the motor load, the pump can operate at a frequency higher than its 'rated motor frequency'. The motor must be permitted to handle the higher power requirements of the hydraulics.

Note: The pump's power requirement must not be larger than the motor's rated power minus the specified reserves. For more details, please contact customer service.

Keep the limits listed for operation above the rated motor frequency:

- Pumps with asynchronous motors with a rated motor frequency of 50 Hz can be controlled up to 60 Hz.
- Pumps with asynchronous motors with a rated motor frequency of 60 Hz cannot be controlled at a higher frequency.
- Pumps with permanent magnet motors: the maximum permitted frequency is shown on the nameplate.

Bearing currents

Bearing currents are voltages caused by a conductor loop that includes the motor shaft, bearings, bearing shields, and housing. These currents occur when the variable AC voltage from the frequency converter generates a magnetic field. Bearing currents flow through the motor bearings and can damage them.

There are three types of high-frequency bearing currents:

- Circulation currents
- Earth currents through the shaft
- EDM currents

To decrease bearing currents, obey the listed points:

- Use short motor cables.
  Shorter cables lower induction and decreasing bearing currents.
- Implement correct earthing.
  Make sure that the earthing is effective to dissipate voltages.
- Route cables properly.
  Prevent crossing control cables with power cables.
- Use shielded cables.
  Shielded cables decrease interference.
- Install suitable residual current circuit breakers (RCDs).
  When using frequency converters, fit RCDs sensitive to all currents, such as types B or B+. These devices detect high-frequency leakage currents.

Further information and recommendations can be found in DIN CLC/TS 60034-25.

Pioneering for you

6100850 • Ed.01/2025-11 • EN

Local contact at
www.wilo.com/contact

WILO SE
Wilopark 1
44263 Dortmund

www.wilo.com