



## Overview

Unico's Electric Submersible Pump (ESP) Drive provides a number of features specifically designed for operation of electric submersible pumps. The drive combines motor and pump control into a single, compact package that increases production, improves energy efficiency, and enhances the reliability of both new and existing pumping systems.

### Multiple Constraint Optimization

At any instant during the life of a well, there is a single constraint that limits production. Production can be maximized without compromising efficiency or reliability by forcing the system to operate at the constraint limiting production at each instant of time. Determining the applicable limits and moving smoothly between them in real time is a key advantage of the Unico system. Models of all the system elements are run in real time at the wellhead to detect appropriate limits and enforce associated control strategies. At different points in time, the system may be limited by motor voltage, motor current, motor speed, motor torque, motor thermal capacity, power demand, flow line pressure, fluid level, or well inflow. Multiple constraint optimization is particularly beneficial in applications with variable inflow conditions, such as those found in coal-bed methane, high gas/oil ratio, and thermally stimulated wells.

### Sophisticated Modeling

Embedded mathematical models of the drive, transformer, cable, motor, casing, tubing, fluid, and reservoir use component specifications and well completion parameters along with field setup parameters to monitor pumping system operation. Identification routines automatically determine installation-dependent system parameters including those of the transformer, cable, motor, and pump. The models capture the thermal, mechanical, electrical, and hydraulic behavior of the system to control the pumping process with greater precision than ever before.

### Sensorless Operation

The drive uses a number of unique methods for precisely determining performance parameters from models of the pumping system elements without requiring downhole sensors. Sensorless system variables including pump speed, pump torque, fluid flow, fluid level, suction pressure, discharge pressure, and differential pressure can be observed through the drive keypad/display or recorded as circle charts and time-based plots. Fluid level, pump flow, and total production are displayed in selectable engineering units.

**ESP**

*Electric  
Submersible  
Pump Drive*

**Overview**  
*(continued)*

**Pump Speed Control**

The drive provides a number of options for manual, remote, and automatic control of pump speed. Speed commands can be selected from a number of sources including potentiometer adjustments, keypad presets, serial data communications, and internal optimization controllers. The motor can be operated up above base speed and power by supercharging. This helps maximize production during periods of reduced pump loading, such as during gas interference. Speed control includes user-programmable starting and running speeds or frequencies as well as adjustable acceleration and deceleration ramps. The system can be configured for optimization of fluid production, gas production, energy efficiency, and/or power flow.

**Production Optimization**

Level control maximizes fluid production by regulating the downhole pump inlet pressure. A search routine uses an optional gas flow sensor input to automatically select the fluid level that maximizes gas production in coalbed methane pumping applications. Current limit control increases production by raising motor speed during periods of reduced pump load. A power flow optimizer maximizes production from gassy wells by allowing the drive and motor to operate at their maximum thermal capacities.

**Pump-Off Control**

Pump-off control maximizes well production for any given inflow characteristic. Fluid level over the pump intake is precisely controlled by differential sensing of casing gas and pump intake pressure. A pump-off control allows the pump to dwell for a programmable period of time to protect the pump and to control average flow. A dwell period minimum pump speed can be used to prevent sanding in the well.

**Energy Savings**

A power flow optimizer reduces the electric utility cost for any inflow rate. A cyclic energy optimizer provides additional utility cost reduction by pumping at the maximum efficiency point necessary to achieve required flow. Time of use control can be used to minimize on-peak energy demand charges. The drive incorporates an input power meter as well as displays of input power, motor power, pump power, and average efficiency to aid in utility cost control.

**Production Monitors**

A pump flow monitor provides a continuous estimate of flow without the need for additional instrumentation. Pumping speed and pump effective volume are used to estimate the actual production rate. Pump flow is totaled in a resettable production accumulator. Estimated well production is displayed for the operator and is available for remote well monitoring through a serial communication port.

**Fluid Level Monitor**

A fluid level monitor provides a continuous estimate of level from pump head, fluid properties, tubing pressure, and casing pressure. Tubing and casing pressures can be entered as parameters for relatively fixed pressures or input from analog sensors for significantly variable pressures.

**System Protection**

Torque limiting protects the motor and pump from excessive torque loads. Low speed detection protects the system in case of a stall condition, such as a stuck pump or blocked flow-line. Low torque detection indicates a plugged sand screen.

## **Overview** *(continued)*

### **Automatic Restart**

The drive can automatically recover from fault conditions and intermittent power outages to ensure continuous operation of unattended wells. Auto restart control sequences starting of multiple pumps after power outages to eliminate surges in power demand. Start/stop events are automatically logged for subsequent retrieval.

### **Data Capture**

A data sampler option captures real-time information for generation of motor and pump performance charts as well as plots of production information. A data logger collects time-stamped fault, warning, and event logs that can be viewed through the drive keypad/display, uploaded to a personal computer, or retrieved by a network server. Typical events include start, stop, mode change, power up, power loss, overvoltage, overcurrent, low torque, and low speed. A multichannel analog interface option allows data logging of additional well parameters.

### **Data Communications**

Several industry standard serial protocols are available for communicating with popular programmable controllers as well as personal computers or network servers. Available protocols include Modbus RTU, Modbus Plus, ControlNet, Profibus, and Ethernet. Optional software is available for monitoring the pumping system using an iPhone or iPad handheld device, Windows-based personal computer, or network server. A wireless interface option allows remote monitoring of system performance and control of pump operation. User-programmable reports can be generated using software that connects system parameters to Excel spreadsheets.

## Features Control

### Speed References

- Analog potentiometers
- Keypad/display presets
- Serial communications
- Optimization controllers

### Speed Control

- Local speed control
- Remote speed control
- Extended speed control
- Fluid level control
- Pump off control
- Gas flow optimizer

### Protection

- Motor current limiter
- Motor torque limiter
- Motor thermal limiter
- Pump pressure limiter
- Low torque detector
- Low speed detector

### Setups

- Transformer specifications
- Cable specifications
- Motor specifications
- Tubing configuration
- Casing configuration
- Pump characteristics
- Fluid properties
- Reservoir properties

### Displays

#### Motor

- Motor voltage
- Motor current
- Motor frequency

#### Well

- Tubing pressure
- Casing pressure
- Fluid flow
- Fluid level
- Production
- Gas flow
- Gas production

### Graphics

- Pump velocity
- Pump torque
- Motor voltage
- Motor current
- Motor frequency

### Interface

#### Inputs/Outputs

- Three analog inputs
- Two analog outputs
- Twelve logic inputs
- Six logic outputs
- Optional eight analog inputs
- Optional four analog outputs

#### Serial Communications

- Local and remote serial ports
- Standard Modbus RTU
- Optional Modbus Plus, ControlNet, Profibus, Ethernet
- Windows, iPhone, or iPad
- Optional 900 MHz and 2.4 GHz wireless

#### Sensor Options

- Fluid flow sensor
- Gas flow sensor
- Suction pressure sensor
- Discharge pressure sensor
- Tubing pressure sensor
- Casing pressure sensor

### System Models

- Drive
- Transformer
- Cable
- Electric motor
- Downhole pump
- Tubing/casing
- Fluid column
- Reservoir

### Power Control

- Power demand limiter
- Power flow optimizer
- Time of use optimizer
- Cyclic energy optimizer

#### Pump

- Pump velocity
- Pump torque
- Suction pressure
- Discharge pressure
- Differential pressure

#### Power

- Power meter
- Input power
- Motor power
- Lift power
- System efficiency

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