PRODUCTION

WellPilot® Controllers for Rod Pump Optimization

Maximizing performance, efficiency, and cost savings over the life of your rod-pumped wells

Weatherford®

Take control of continually changing well conditions.

Thanks to significant advances in drilling and completions technology, wells today are being drilled deeper, are increasingly horizontal, and are more complex than ever. As a result, production from these wells is becoming less predictable and more problematic. For your rod-pumped wells, these challenges can make it more difficult to manage production efficiently while protecting your valuable downhole equipment.

And though traditional control methods can help safeguard the pump against the damaging effects of fluid pound and excessive friction, they don't have the advanced functionality to optimize production in dynamic conditions. In fact, many controllers stop or slow the pump more than necessary, which can reduce your production levels far below the potential of the well. The Weatherford WellPilot® family of rod-pump controllers (RPCs) takes a more advanced approach—giving you precise, automated control and exceptional reliability to optimize and extend the productive life of your wells.

Our Modified Everitt-Jennings calculation engine will transform the way you look at rod-pump control.

At Weatherford, we take pump control a step further than conventional controllers. Every fixed- and variable-speed WellPilot RPC unit is equipped with our proprietary Modified Everitt-Jennings[1] calculation engine (MEJ).

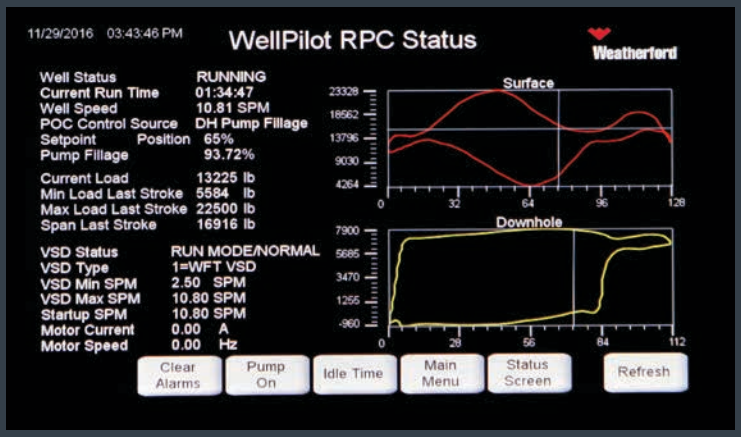
Using an algorithm to solve the wave equation via finite differences, the MEJ enables accurate load computations at multiple points along the rod string. And to further optimize your rod-pump performance, this comprehensive calculation engine performs additional computations that enable WellPilot controllers to deliver the most thorough and accurate control data in the industry.

[1]Everitt, T.A. and Jennings, J.W., SPE 18189, An Improved Finite-Difference Calculation of Downhole Dynamometer Cards for Sucker-Rod Pumps, February 1992.

Every WellPilot RPC delivers advanced control capabilities:

- Performs enhanced pump-fillage calculations via a combination of four algorithms that use calculated downhole data to compute percentage of pump fill for each stroke, regardless of downhole conditions
- Uses pattern recognition to identify atypical downhole conditions and further enhance the accuracy of pump-fillage calculations
- Calculates downhole data with dual-iteration damping to accommodate differences in the upstroke and downstroke
- Uses the MEJ algorithms to correctly compute the upstroke and downstroke fluid-load lines within the dynamometer card to provide
  - Accurate fluid-level calculation for every stroke
  - Accurate calculation of pump intake pressure
  - Enhanced calculation of inferred production, which provides better production data
  - Improved system-efficiency calculation

More historical data. Better pumping performance.



120 days of history: WellPilot RPCs give you immediate access to 120 days of runtime and production history, so you can easily track trends and make appropriate manual adjustments.

256 events in memory: You can view card buffers from the last 256 controller events, including startups, shutdowns, and alarms. Plus, each event buffer gives you access to five surface and five downhole cards.

WellPilot RPCs enable you to access a total of 1,280 historical dynamometer buffers, each showing both surface and downhole cards.

WellPilot Fixed-Speed RPC

The brains behind every WellPilot rod-pump control system.

The powerful WellPilot RPC gathers data from the well through surface load and position sensors and uses the MEJ calculation engine to calculate downhole data to determine pump fillage and fluid level for each stroke. In fixed-speed applications, this information is used to detect pump-off and minimize fluid pound by stopping the unit for a user-configured time, which helps to maintain the desired pump fillage for optimum production.

This unparalleled combination of features and capabilities provides real-time well control with exceptional accuracy across a variety of well conditions. No other RPC on the market can deliver such comprehensive control. And with the intuitive interface and Quick Guided Setup menu function, it takes only a few minutes to get a well running and to start optimizing. The WellPilot RPC is also available in a base model that does not include a local display. This model enables you to view the interface using a portable display, laptop software, or a direct link to a SCADA system.

Feature-rich packaging.

The customized metal enclosure protects the WellPilot RPC for years of reliable service in all environments. The inner-door design isolates the user interfaces from all voltages and wiring for safe, onsite data collecting and monitoring. An easy-to-read, enhanced graphics display and keypad make it simple to set up, optimize, and troubleshoot your well. And when it's time to upgrade, the enclosure provides you with ample space to add or modify equipment, such as expansion boards, power supplies, and other communication and interface components.

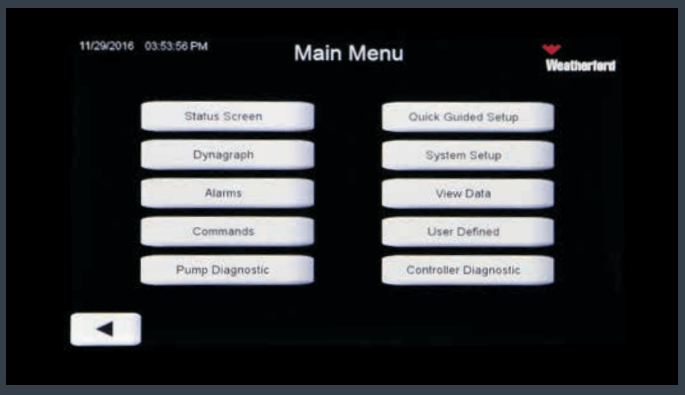
Built to keep pace as your production evolves.

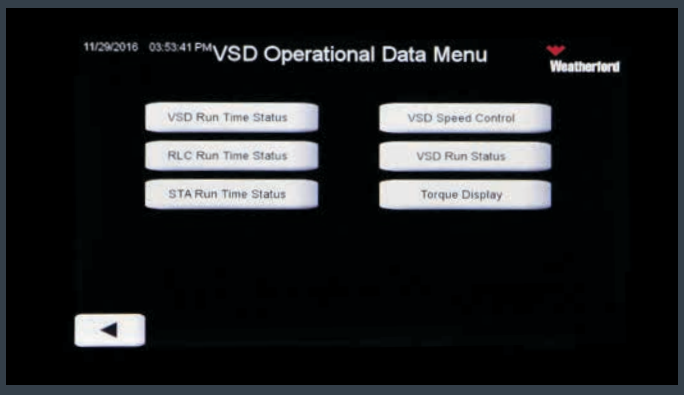
The flexible design of the WellPilot RPC makes it easy to upgrade, so you can add capabilities as you need them:

- Fluid-level measurements from a portable or permanent acoustic-sounding device to provide real-time data that can be logged and used to analyze pressure buildup and add precision to the calculated fluid level
- Real-time electronic flow measurement and water cut at the wellsite
- An interface with tank level sensors for monitoring and well control
- Integration of Weatherford intelligent rod rotator—to validate proper rotator operation
- Easy expansion

Up and running. Fast and intuitive.

Since the WellPilot RPC is an open system and is both backward and forward compatible, you can implement it in existing automated fields without sacrificing your initial investment. The WellPilot RPC uses the 8500 communication protocol for standard host communications. It can also communicate via Modbus RTU protocols, for data gathering and retrieval of surface dynamometer cards. Using our standard high-accuracy load and position sensors, it can even be retrofitted into existing M2000 and ePIC™ controller housings. When you're implementing a new system, the open and extendable design enables compatibility with current and future components and applications. The interactive menu provides simple steps to configure, run, and troubleshoot the system.





Specifications

Area Classification

Temperature rating	-40 to 131°F (-40 to 55°C)
Dimensions (H × W × D)	17.12 × 15.8 × 7.8 in. (43.4 × 40.1 × 19.8 cm)

Power Options

Main processor board	10 to 15 Vdc
Assembly power supply	100 to 240 Vac

Display

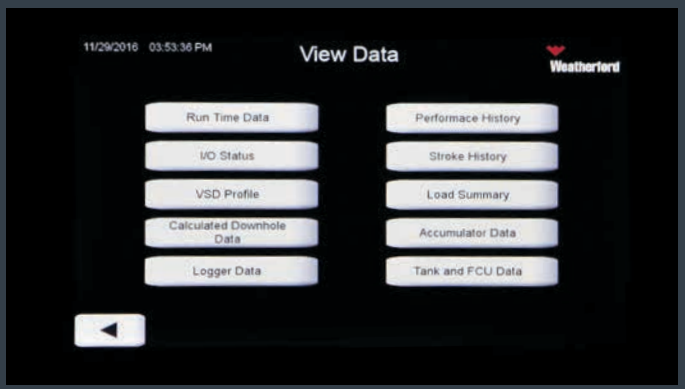
Backlit, heated LED
(optional touchscreen color HMI with data-logging feature also available)

I/O

- One Ethernet port
- Three serial ports
- One CAN port
- Two analog inputs
- One analog output
- Two digital inputs
- Two relay outputs
- One turbine meter input
- One RTD input
- Expandability for additional 6 analog inputs, 6 digital inputs, and 6 digital outputs (optional)

Connectivity and Control Features

- Serial and Ethernet interface to communicate with remote systems
- Three additional ports for scanning external Modbus devices
- Capability of scanning installed flow computers for easier data acquisition
- Advanced controls for gas-engine applications
- Direct connection to monitor Weatherford intelligent rod rotator, which provides intelligent alarming for failed rotation
- SD memory card slot to upgrade operating system and applications in flash file system
- Direct add-on to most variable-speed drives for enhanced pump-fillage calculation and pumping-unit control
- Capability of interfacing with production tanks for overflow monitoring and alarming
- Easy interface between water-cut meters, such as the Red Eye® optical meter, and the field-office host system



Interactive setup and configuration screens make it easy to customize your RPC and make adjustments to optimize performance.

WellPilot Variable-Speed RPC

The ideal balance between production supply and pump speed.

For wells with inconsistent reservoir flow, high gas content, sand infiltration, or the potential for liquids to freeze, repeatedly stopping the well to control pump-off may not be an effective option. In conditions like these, WellPilot variable-speed RPCs not only keep your rod-pump system running more efficiently and with less mechanical stress, but they do it with a level of performance you can't get from conventional variable-speed drives (VSDs). The difference is the unique capability of integrating the MEJ pump-fillage and fluid-level calculations. This gives you added certainty that your surface unit and downhole pump are communicating, coordinated, and operating at optimal performance and reliability.

Choose from two powerful variable-speed options.

Whether you need standard variable-speed control functionality or a controller that offers power regeneration and low harmonics, we're committed to providing the right controller, based on your specific operational needs. Both versions of the WellPilot variable-speed RPC are powered by Yaskawa ac drives, which are trusted for their reliability, control accuracy, load-control flexibility, and capability of providing custom programming for rod-pump control. In addition, because WellPilot variable-speed RPCs deliver maximum torque even when starting from zero speed, they eliminate a common problem of conventional VSDs—having to oversize your drive to achieve adequate torque at startup.

WellPilot standard variable-speed RPC

Reliable, upgradable controller performance for dynamic well conditions

Combining the Yaskawa A1000 drive with exclusive Weatherford MEJ calculations, our standard variable-speed RPC constantly monitors well performance against operator presets and then adjusts pumping speed at multiple points within the pump stroke. This improves pumping efficiency and protects against damaging conditions, such as rod compression during the downstroke. The unit controls the motor by performing dc/ac conversion with pulse-width modulation (PWM). Then, as the motor decelerates, regenerated power is routed to a braking resistor and dissipated as heat.

If your needs change, we can help you upgrade this flexible controller to include power-regenerative, low-harmonics capabilities.

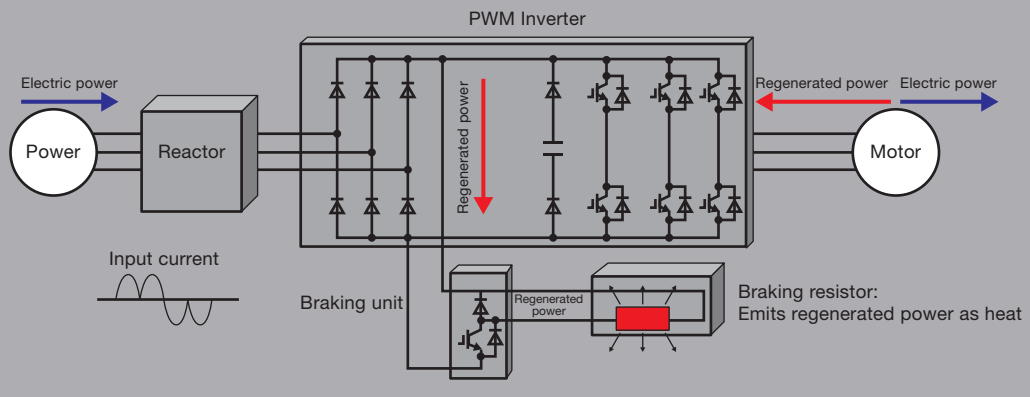
WellPilot regenerative variable-speed RPC

Built-in power regeneration and outstanding harmonics suppression

At the heart of our regenerative, low-harmonic controller is the Yaskawa U1000 drive. This ac/ac drive enables current to flow both ways through a matrix of nine bidirectional switches—so power generated by the motor during deceleration is sent back to the power supply to be reused. Because there is no ac/dc conversion, harmonics are exceptionally low and overall efficiency is very high. Without the need for harmonic filters, the drive performs in accordance with IEEE 519 standards, and generates total harmonic distortion of less than 5 percent at full load. The result is exceptional rod-pump control, a smaller footprint, and reduced power usage.

WellPilot Standard Variable-Speed RPC

Our standard variable-speed RPC delivers unsurpassed rod-pump control in dynamic well conditions.



Making a strong case for safe, reliable operation

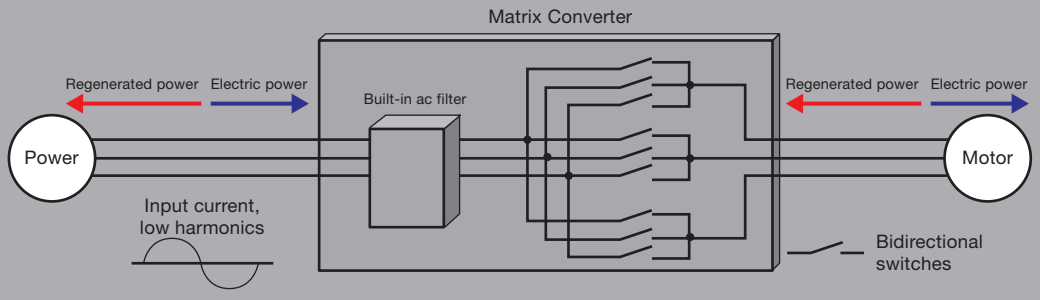
The rugged housing of WellPilot variable-speed RPCs protects sensitive electronics from the harshest environmental conditions in every corner of the world, including extreme temperature variations. The dual-compartment housing features a low-voltage section that provides technicians access to all I/O and communications without exposure to hazardous voltages. You'll also find plenty of additional room in the housing to add optional components.

Customized rod-pump control that is easy and at your fingertips

WellPilot variable-speed RPCs are extremely flexible and user friendly—so your rod-pump system can be up and running smoothly with minimal time and effort. Simply hook up the three input wires from the power supply and the three output wires to the motor, connect your sensors, and you're ready to go. Then, just follow the guided, step-by-step setup screens to configure the controller based on your unique well conditions and production goals.

WellPilot Regenerative Variable-Speed RPC

Our premium variable-speed RPCs have built-in capabilities to regenerate power and reduce harmonics.



WellPilot Variable-Speed RPCs

Specifications

	Variable-Speed Rod Pump Controller	
	Standard	**Regenerative, Low-Harmonic**
Input Supply		
Three-phase voltage	230, 380, 480, or 600 Vac (-15%, +10%)	230 or 480 Vac (-15%, +10%)
Three-phase frequency	50 to 60 Hz (±5%)	50 to 60 Hz (±5%)
Single-phase voltage	230, 480 Vac (±10%)	N/A
Single-phase frequency	50 to 60 Hz (±5%)	N/A
Output Rating		
Voltage	0 to input voltage, three-phase	Proportional to input voltage
Frequency	0 to 400 Hz	0 to 400 Hz
Overload current	120% of rated output for one minute (normal duty) 150% of rated output for one minute (heavy duty)	
Technology		
Rectifier unit	Six-diode, three-phase (six-pulse) full-wave bridge	Matrix converter
Inverter unit	Six-IGBT, four-quadrant, trap or sinewave output	
Diode silicon-controlled rectifier	Six-phase (12-pulse)	
Environmental		
Operating temperature	-40 to 122°F (-40 to 50°C)	
Relative humidity	5 to 95% noncondensing	
Available Inputs and Outputs (combined RPC and VSD ports)		
Analog inputs (5, expandable to 11)	-10 to 10 Vdc, 0 to 10 Vdc, 1 to 5 Vdc, or 4 to 20 mA	
Analog outputs (3)	-10 to 10 Vdc or 4 to 20 mA	
Pulse input	2	
Pulse output	1	
Digital inputs	10, expandable to 16	
Digital outputs	5 configurable, 2 fault; expandable to 11 configurable, 2 fault	
Communications	8500 protocol, Modbus ASCII, Modbus RTU, Modbus TCP/IP	
Modbus port	EIA RS232 and RS422/485, 1,200 to 115,000 kbps Modbus ASCII, Modbus RTU	

Enclosure

- UL listed
- Type 3R or optional IP55 enclosure
- Separate low- and high-voltage compartments
- Designed to support optimal operator and environmental safety
- Engineered for all weather conditions
- Door interlocked with main disconnect
- A range of available sizes to accommodate your specific equipment package
- Leg kits available on request

Built-In Electronics Protection

- Analog input loss
- External fault
- Motor thermal protection
- Underload
- Motor phase loss
- Communications fault
- Overcurrent
- Short circuit
- Drive overload
- Undervoltage
- Input phase loss
- Ambient temperature
- Drive overtemperature
- Internal fault
- Overspeed

Field-proven position and load sensors—to position your well for optimal performance.

When it comes to essentials, such as measuring rod-pump position and load, operators across the globe trust Weatherford inclinometers and load cells to get the job done accurately and reliably.

Accelerometer-based inclinometers

By combining position and acceleration data throughout the stroke, our accelerometer-based inclinometer gives you accurate measurements under all conditions. This compact, easy-to-mount device attaches magnetically to either side of the beam and can be used on conventional or improved-geometry pumping units. Its vibration-compensating design improves accuracy, and it works with all existing Weatherford controller packages as an affordable sensor solution.

Stainless steel polished-rod load cells

In addition to advanced, industry-proven sensor technology, Weatherford polished-rod load cells are enhanced with temperature compensation for accurate load measurement in extreme conditions. Impervious to salt spray and hydrogen sulfide, the hermetically sealed sensor housing is constructed of 300-series stainless steel and is filled with nitrogen gas. This rugged construction minimizes the adverse effects of impact loading and provides long-term stability. Lightning-suppression circuitry protects the sensors against high-voltage current surges. A wireless option is available when cable installation is not ideal, such as when deploying the Rotaflex long-stroke unit or hydraulic units.

Features and Benefits

All WellPilot RPC Units

Whether you need fixed- or variable-speed control, every WellPilot RPC unit comes loaded with features that help your rod-pump system to produce more, last longer, give you better insight, and react automatically to changing conditions.

- Guided, step-by-step setup screens provide easy configuration and optimization.
- Built-in, real-time inferred production measurement enables better day-to-day control and helps extend the productive life of the well.
- Capability of detecting pump-off reduces power consumption when compared to using a timer or running the well continuously.
- Fast, automated response minimizes mechanical stress on equipment.
- Direct load and position measurements provide accurate fluid-level calculations.
- A configurable menu provides easy access to critical information.
- The graphic dynamometer display provides real-time performance data at a glance.
- A built-in communication module enables easy interface with a variety of compatible devices and host systems.
- The Modified Everitt-Jennings calculation engine (MEJ) uses finite differences to solve the wave equation accurately and in real time.
- Continual updates to the MEJ enable optimal compatibility with changing completion technologies and production techniques.
- Accurate pump-fillage calculations, regardless of downhole conditions, deliver more informed, reliable control.
- Enhanced downhole calculation uses dual iteration for damping, pattern recognition, fluid load lines, fluid level, and pump-intake-pressure calculations.
- Programmable load violations protect against overstresses to rods and equipment, which can lead to damage and associated deferred production.
- Historical data storage for up to 120 days enables easy access to pump-performance trends.
- Well-performance output enables integration with pump-performance-tracking software, such as Weatherford LOWIS® and CygNet® packages.
- Multiple input/output (I/O) ports provide a readily accessible framework for expansion and integration.

WellPilot Variable-Speed RPC Models

WellPilot variable-speed RPCs deliver all the features and benefits offered by the WellPilot RPC, plus continuous speed control and other functionalities to further optimize your production. This comprehensive package of control functionalities provides optimal results for rod-pumped applications.

- Inherent soft start reduces inrush current.
- Operating motor at optimal levels reduces power consumption.
- Adjustable speed eliminates the need for sheave changes.
- Capability of fine-tuning speed throughout each stroke improves pump operation.
- Adjustable pump fillage with speed set points reduces fluid pound.
- The drive keypad can archive and store the critical drive parameters to transfer the information to another drive or reload the values.
- PC interface software enables transfer of critical drive parameters to PC for storage and reference.
- An autolearn function enables the controller to find the optimum speed settings of the well.
- An autotune option calibrates the drive to the motor for maximum efficiency and performance.
- Power regeneration can reduce input-power requirements (regenerative model).
- Harmonic distortion of less than 5% protects drive components and improves efficiency (regenerative model or standard model with passive-filter upgrade).
- Maximum torque from zero speed eliminates the need to oversize your drive to start the motor.
- High-speed operation at up to 1.5 times the rated motor speed enables a wider range of pumping speeds to maximize production when fluid is available.
- Single to three-phase power generation enables use of single-phase power input in areas that do not have three-phase input (standard model).
- Advanced rod-load control improves performance in heavy oil or highly deviated boreholes.
- Advanced multispeed control for long-stroke pumping units increases production by enabling these units to operate above the stated maximum speed.
- Available loop power for external inputs provides a built-in power source for external devices.
- A programmable restart function enables automatic recovery after power loss or fault.
- Protection against ac-input overvoltage and undervoltage safeguards the system against motor overload, short circuit, and voltage fluctuations.

Lift Smarter™

Controllers for rod-pump optimization represent only a fraction of our production solutions. With our unparalleled experience and an unmatched breadth and depth of solutions for all forms of artificial lift, we can optimize production in any well. Our customer service centers are conveniently located in every major oil-producing area of the world to address your needs efficiently wherever you operate. We also offer comprehensive artificial-lift training programs that enhance your team's expertise and productivity.

Discover how Weatherford WellPilot rod-pump controllers, using the proprietary Modified Everitt-Jennings calculation engine, are uniquely designed to deliver the most thorough and accurate control data in the industry. Speak to your Weatherford representative or visit **weatherford.com**.

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