PowerDrive Archer
High build rate rotary steerable system for increased reservoir exposure
PowerDrive Archer RSS does more than execute complex 3D wells in one run—it increases potential for hydrocarbon production.

**PowerDrive Archer** RSS delivers well profiles previously only possible with motors—yet with the ROP and wellbore quality of a fully rotating RSS. This revolutionary system repeatedly and consistently delivers high build rates from any inclination—in field trials more than 17°/100 ft. All PowerDrive Archer external parts rotate, which reduces the risk of mechanical or differential sticking and improves wellbore quality for easier well completion. The system can drill complex 3D wells from shoe to shoe and openhole sidetrack at any point. Built on the proven and reliable technologies of PowerDrive X6* RSS, the PowerDrive Archer RSS with a unique hybrid steering unit maximizes reservoir exposure and reduces risk.

### Increased reservoir exposure

The PowerDrive Archer RSS eliminates flat time because it can kick off from vertical, drill complex curves and trajectories, drill horizontal sections, and perform openhole sidetracks all in one run—without requiring a trip out of the hole. Higher build rate capability enables this RSS to kick off deeper and land early in the reservoir. Accurate and precise directional control lands the wellbore in the best place, whether the reservoir is close to the surface or thousands of feet below, and keeps the well trajectory in the reservoir’s sweet spot and can even extend the horizontal section to TD.

### A new tool for the drilling engineer

The PowerDrive Archer RSS provides the extra assurance that well profiles can be drilled as planned. The increased dogleg capability gives control in unconsolidated formations and punches through hard stringers.

Fast, reliable, directional openhole sidetracks can be completed to reduce time on multilateral wells and allow wells to be placed exactly where required.

Pushing the kickoff deeper enables the drilling engineer to mitigate risk and cost by reducing the inclination in unstable formations and the footage to the reservoir.

### Table: PowerDrive Archer vs. Conventional RSS

<table>
<thead>
<tr>
<th></th>
<th>PowerDrive Archer RSS</th>
<th>Conventional RSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Depth</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

**Unique hybrid steering unit**

All external components rotate

PowerDrive X6 control unit for wider operating envelope and increased reliability

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*Note: PowerDrive Archer and PowerDrive X6 are trademarks of National Oilwell Varco, Inc.*
Drilling engineering with the reliability of a true hybrid
The PowerDrive Archer hybrid steering system has demonstrated good reliability as its moving components are internal and do not make contact with harsh environments. This true hybrid system has internal pads that push against an articulated sleeve pivoted on a universal joint to point the bit in the desired direction. It also enables openhole side-tracking at any point in the well because of reduced dependence on wellbore contact.

Control unit provides wider operating envelope
The precision steering that high build rates require is managed by a control system based on the proven, reliable system used in the PowerDrive X6 RSS. The radical new design of this control unit allows drilling with higher mud weights and a much wider flow range. The PowerDrive Archer RSS also features a closed loop inclination hold mode that ensures pinpoint accuracy at any drilling speed.

Fully rotating rotary steerable
All external parts on the PowerDrive Archer RSS rotate, which improves hole cleaning and reduces the risk of stuck pipe. This rotation also increases ROP by eliminating the sliding intervals and trips required when using a positive displacement motor. Wellbores drilled with the PowerDrive Archer RSS are smooth and consistent, even when build rates are high. These smooth wellbores reduce torque and drag, allowing good weight transfer to the bit to maximize ROP, and can extend the distance horizontal sections can be drilled.

Smooth wellbores to ease completions
The high-quality, smooth wellbores produced by a fully rotating RSS make it easier to run casing and wireline logs. And with reduced friction and tortuosity, wells drilled with PowerDrive Archer RSS also enable completions engineers to run intelligent completions with a larger OD, as rugosity is reduced.
Fatigue management prediction

When subjected to rotation through aggressive build rates, the BHA experiences high bending moments. As build rate increases, fatigue life reduces exponentially, shortening the life of BHA components to hours. Schlumberger performed finite element analysis (FEA) and a detailed strain-based fatigue study on all components of the PowerDrive Archer BHA to understand the effects of high build rates. These tests produced a predicted fatigue life for the BHA components. Tracking fatigue life is extremely complex—with rpm, ROP, and dogleg severity (DLS) all being factors. The PERFORM Toolkit* data analysis service automatically performs this complex fatigue management and enables real-time monitoring in the field.

Steerability assurance

Steerability is paramount in achieving aggressive build rate curves. With modeling and rigorous testing of BHA behavior at a Schlumberger drilling technology center and in the field, PowerDrive Archer RSS brings with it advanced techniques to design the ideal bit for performance and steerability, as well as stringent controls for BHA and bit design.

Application-specific bit and BHA design

Forces from the bit, the PowerDrive Archer steering unit, and various contact points downhole influence the steerability of the PowerDrive Archer BHA. For this reason, dedicated design engineers use the IDEAS* integrated drillbit design platform from Smith Bits, a Schlumberger company, for finite element analysis (FEA) modeling of the bit, BHA, and drillstring; the well profile; and the geology to analyze how the drilling system as a whole will perform. Every PDC drill bit designed for use with the PowerDrive Archer RSS is validated for stability, steerability, ROP, and durability.

The PERFORM Toolkit service provides real-time tracking of steering and fatigue management in a time-depth log—combined with a precise graphic representation of the BHA. This intelligent rig-state-detection engine enables accurate analysis of drilling performance and continuous assessment of torque-and-drag models.
In this well, PowerDrive Archer RSS was able to kick off from vertical, drill a 3D curve with more than a 100° change in azimuth, and hold an unplanned tangent section made necessary by a landing point change of more than 70 ft. The RSS quickly built to 16°/100 ft once the geological marker was found, and then soft landed the well from 85° to 90° at a 2° build rate.

Deliver well profiles previously only possible with a motor, yet with the ROP and wellbore quality of a RSS.

**Well planning and best trajectory**

Designing the optimal trajectory requires a very powerful engineering application. Drilling Office® integrated drilling software (DOX) integrates trajectory design with drillstring and BHA design, hydraulics, and torque and drag, enabling Schlumberger drilling engineers to quickly run multiple scenarios to evaluate the best design to reach TD quickly. When planning a well that will be drilled with PowerDrive Archer RSS, DOX is used to design the path for best success in landing and drilling efficiency.
PowerDrive Archer RSS is the only RSS to build high angles from any deviation. The system maximizes ROP for optimal performance in the vertical section and pushes kickoff deeper. Couple these benefits with hitting the reservoir sooner and drilling further in the horizontal section, and operators can maximize reservoir exposure and increase hydrocarbon potential.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>PowerDrive Archer 675</th>
<th>PowerDrive Archer 475</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal OD (API), in [mm]</td>
<td>6.75 [171.45]</td>
<td>4.75 [120.65]</td>
</tr>
<tr>
<td>Hole size, in [mm]</td>
<td>8½ to 8½ [212.73 to 222.25]</td>
<td>5½ to 6¼ [149.22 to 171.45]</td>
</tr>
<tr>
<td>Overall length, ft [m]</td>
<td>16.15 [4.92]</td>
<td>14.98 [4.57]</td>
</tr>
<tr>
<td>Maximum collar build rate1, °/ft [°/m]</td>
<td>15/100 [15/30]</td>
<td>18/100 [18/30]</td>
</tr>
<tr>
<td>Maximum operating torque, ft.lbf [N.m]</td>
<td>16,000 [21,693]</td>
<td>8,000 [10,846]</td>
</tr>
<tr>
<td>Maximum operating load, lbf [kg]</td>
<td>400,000 [181,437]</td>
<td>272,000 [123,377]</td>
</tr>
<tr>
<td>Maximum weight on bit, lbf [N]</td>
<td>As per Smith PDC bit guidelines</td>
<td>As per Smith PDC bit guidelines</td>
</tr>
<tr>
<td>Flow range, galUS/min [L/min]</td>
<td>230 to 650 [871 to 2,461]</td>
<td>220 to 350 [833 to 1,325]</td>
</tr>
<tr>
<td>Mud weight, lbf/galUS [kg/L]</td>
<td>8.3 to 18 [1 to 2.16]</td>
<td>8.3 to 18 [1 to 2.16]</td>
</tr>
<tr>
<td>Maximum rotational speed1, rpm</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Stick/slip</td>
<td>±100% mean rpm</td>
<td>±100% mean rpm</td>
</tr>
<tr>
<td>Maximum temperature, degF [degC]</td>
<td>302 [150]</td>
<td>302 [150]</td>
</tr>
<tr>
<td>Maximum hydrostatic pressure, psi [kPa]</td>
<td>20,000 [137,895]</td>
<td>20,000 [137,895]</td>
</tr>
<tr>
<td>Pressure drop across tool</td>
<td>(lbf/galUS × galUS/min²)/56,000 [kg/L × L/min²]/25,400</td>
<td>(lbf/galUS × galUS/min²)/14,500 [(kg/L × L/min²)/6,577]</td>
</tr>
<tr>
<td>Recommended pressure drop across bit, psi [kPa]</td>
<td>600 to 750 [4,137 to 5,171]</td>
<td>600 to 750 [4,137 to 5,171]</td>
</tr>
<tr>
<td>Maximum sand content</td>
<td>1% by volume</td>
<td>1% by volume</td>
</tr>
</tbody>
</table>

**Rotary Connections**

- Bit box: 4½ Reg
- Control collar upper connection: 4½ IF box

**Steering Section**

- Stabilizer OD, in [mm]: 8½ to 8½ [209.55 to 219.075] 5½ to 6¼ [146.05 to 168.27]
- Strike ring configurations, °: 0.6, 0.8, 0.9, 1.0

**Sensors**

- Inclination accuracy, °: ±0.11
- Azimuth accuracy, °: ±2
- Gamma ray accuracy, %: ±5
- Shock detector threshold, radial: 50 g, ± 5 g

1 Engineered BHA and bit design is required to deliver optimum system performance.
Find out more about PowerDrive Archer RSS at slb.com/PowerDriveArcher

Animation
Watch the animation to see how PowerDrive Archer RSS hybrid technology enables it to achieve high build rates.

Case Studies
Read about how PowerDrive Archer RSS
- drilled a slimhole well through the curve and lateral to TD in one run in the Permian basin
- maximized performance of an integrated BHA in a shallow well offshore Thailand
- performed openhole sidetracks in one run for Middle East multilaterals, drilling 11,738 ft total in slim wellbores.

IDEAS
Integrated drillbit design platform
slb.com/IDEAS

i-DRILL
Engineered drilling system design
slb.com/iDRILL