

5 WORK CLASS ROV SYSTEMS

5.1 Schilling Robotics HD WROV system



Havila Subsea are equipped with 2 x Schilling Robotic HD WROV systems. The HD™ WROV is a 150hp, compact remotely operated vehicle that is designed for accommodating the specific needs of the IMR and drill support markets. The HD™ system is optimized for installation onboard drilling rigs and ROV support vessels, where available deck space is limited.

It features an unique power management system and advanced automatic piloting modes that deliver superior operational stability and precise control. Based on integrated sub-systems, the HD reduces complexity, increases efficiency, and lowers the cost of owning and operating an ROV.

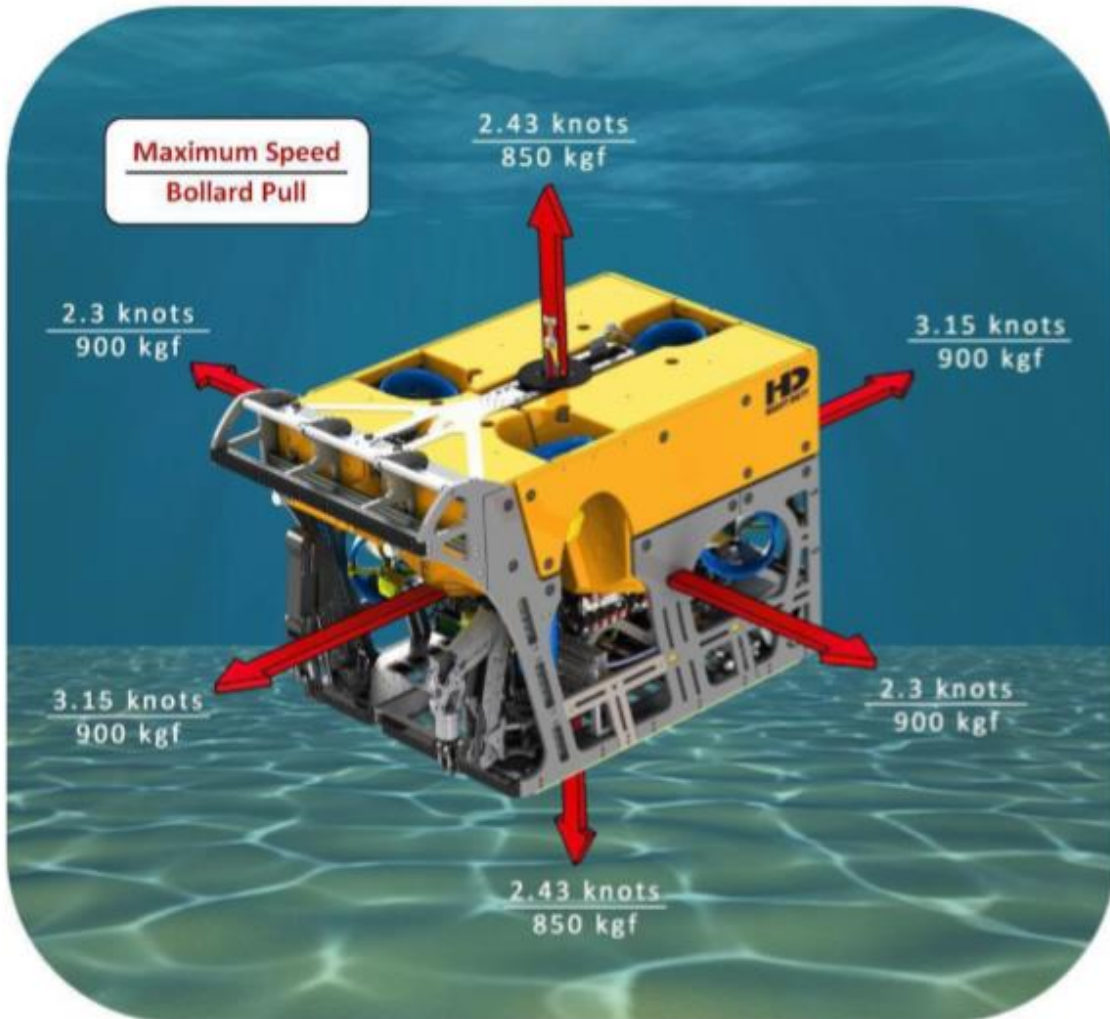
It includes dedicated interfaces for integrating intervention or survey tooling. Ergonomic design provides users with spacious access to the system for maintenance and onboard capacity for installing additional intervention tools and work packages within the vehicle's footprint. Combined with Schilling's electric standard model TMS system, the WROV is capable of excursions up to 425-meters. One of the two WROV systems onboard Havila Subsea have a 850 m TMS system installed. This compact system is configured for ease of road transportation and rapid mobilization, while providing the flexibility to perform a wide variety of deepwater operations.

- Hydraulic Power 150-hp; Auxiliary Power 40-hp
- Depth Rating: 3,000msw Standard
- Delivers Industry Leading Work-class ROV Performance for IMR, Drill Support, and Heavy-Duty Construction Operations
- Optimizes Work Performance with Automatic Power Efficiency Management
- Increases ROV Pilot Efficiency through Intuitive ROV Control Interface, Automated Navigation, and Positioning Systems
- Rapid System Reconfiguration Provides Market Flexibility
- Customer Configurable, Modular Control System Simplifies Tooling Integration
- Dedicated Propulsion and Tooling Hydraulic Circuits – Optimizes ROV and Tooling Performance
- Optimized System Footprint to Support Rapid Mobilizations and Road Transportability.

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| Specifications Docking interface SWL Through-Frame lift: Weight in air: Dimensions: Payload: | 9700 kg 3000 kg 3600 kg 2.9 x 1.7 x 1.9 m 250 kgf |
| Peak Thrust Performance Fwd/Aft/Lateral Vertical – Up/Down | 900 kgf 850 kgf |
| Equipment fit Manipulators Cameras Depth sensor Heading sensor DVL Strobe Lights Pan & Tilt Valves | Any Schilling model SD and HD options Digiquartz TOGS RDI Navigator 1200 kHz ST400AR (10) 120 VAC LED Schilling Electric (16) 8 LPM (2) 32 LPM (1) 160 LPM |
| Hydraulic system HPU Auxillary Operating pressure Thrusters | 150 Hp 40 Hp 207 bar (7) Sub-Atlantic |
| Hydraulic requirements Fluids Max. Flow at 3000 psi | Shell Tellus or Royal Purple 70 LPM |

5.1.1 Vehicle performance

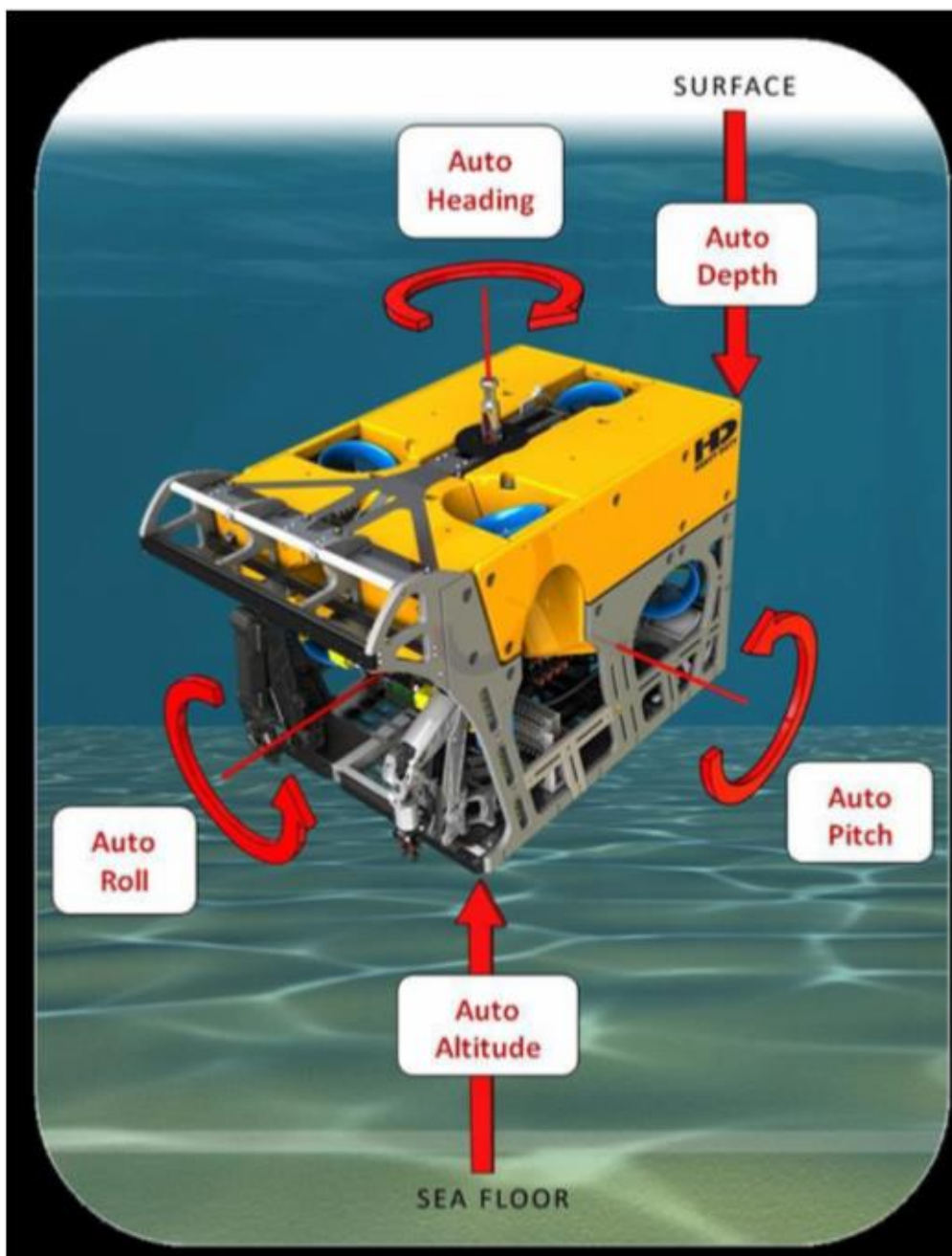
The HD performance characteristics are as follows:



5.1.2 Vehicle controls

The HD features the following automatic control modes to assist piloting the system:

- Auto Heading: $\pm 2^\circ$, 360° range
- Auto Pitch: $\pm 2^\circ$, $+12 / -5^\circ$ range
- Auto Roll: $\pm 2^\circ$, $\pm 6^\circ$ range
- Auto Depth: ± 15 cm
- Auto Altitude: ± 15 cm
- Stationkeep: 10 cm watch circle (see below)



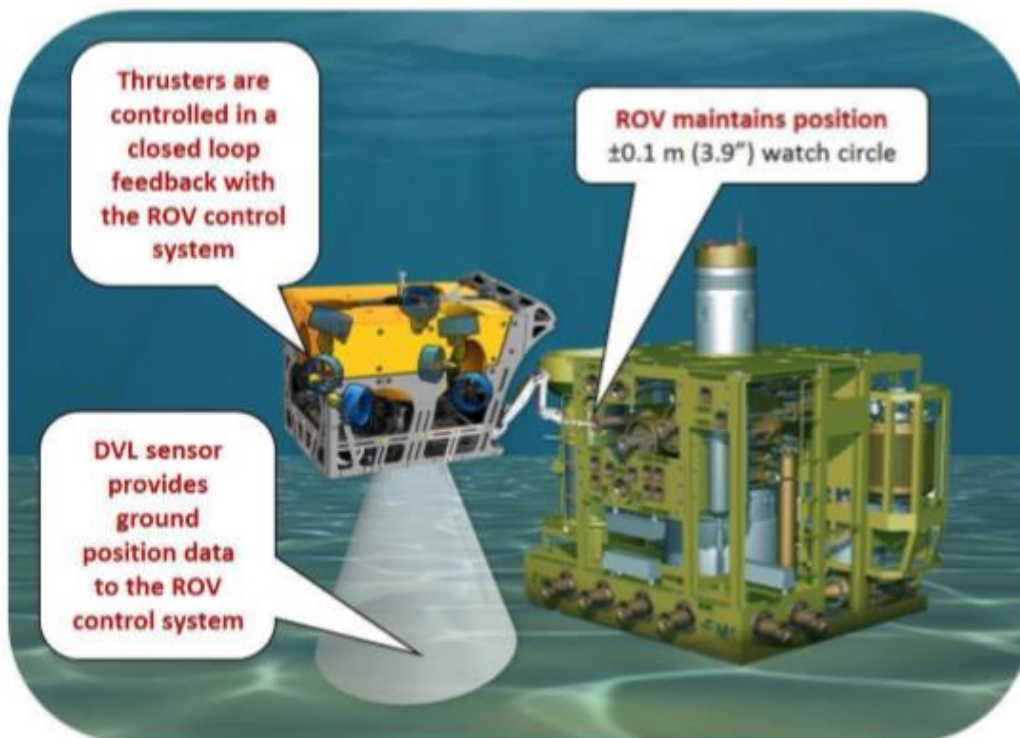
5.1.3 Stationkeep (SK)

Since 2000, the FMC Schilling Robotics ROV product line has featured the StationKeep (SK) function, which provides the operator with the subsea equivalent of vessel dynamic positioning. While in SK the vehicle control system takes command of the vehicle and automatically maintains position relative to a point on the seafloor. The control system also maintains the vehicle position while external forces such as current are applied (up to the vehicle's capability). When SK is selected the pilot is able to release manual vehicle control and focus completely on manipulator or tooling tasks.

While many ROVs currently offer position-holding capability, the accuracy of FMC Schilling Robotics' StationKeep mode is unmatched in its ability to maintain vehicle position within a 100 mm watch circle in currents in excess of 2 knots. FMC Schilling Robotics' unique method of monitoring the thruster speed and providing this feedback into the control system allows for almost unperceivable movement of the ROV system relevant to its surrounding. This allows the operator to perform tasks requiring high-precision operations, such as hot stab insertions and extended inspections, while in SK, without needing to stabilize the vehicle using subsea structures or disturbing the seabed.

The Benefits of SK include:

- Safety of ROV in low/nil visibility
- Lower wear and tear on ROV
- Significant reduction of crew fatigue associated with continual flying for long periods
- Accurate focus of camera on specific task
- Ability to perform manipulator tasks adjacent to a subsea structure without the need to grab on
- Accurate deployment of transponder arrays and other subsea hardware
- Ability to assist with engagement of tooling packages with subsea structures
- Accurate grid searches and surveys
- Improved interception of down-lines and loads by holding relative position and ascending
- Maintaining position whilst seabed disturbance clears during deployment of heaving loads
- Maintaining accurate position during lengthy observation tasks, with current present



5.1.4 AutoTrack

In AutoTrack mode, the vehicle control system can accept coordinate inputs from an external source, such as a survey computer, to allow automatic flight over a pre-planned route at a speed controlled by the operator.

The ROV control system and position sensors keep the ROV on the designated survey line, closing the control loop with feedback from the survey system that reports the vehicle's variance (cross-track error or lateral offset) from the survey line. AutoTrack moves the ROV in the forward flight direction only (not aft) along the survey line.

*Dependent on survey company equipment accuracy.

