



Subsea view of the Wave Glider SV3

Liquid Robotics Frequently Asked Questions (FAQs)

Q: Who is Liquid Robotics?

A: Liquid Robotics instruments the ocean with fleets of networked, wave-powered ocean robots, solving critical problems for our defense, oil & gas, commercial, and science customers. Our Wave Gliders are transforming ocean observation, making data collection and monitoring easier, safer, and more cost-effective. [VantagePoint Capital Partners](#), [Riverwood Capital](#) and [Schlumberger](#) are the key investors in Liquid Robotics.

Q: What is the unique innovation behind the Wave Glider?

A: The Wave Glider's key innovation is its' ability to harvest energy from ocean waves to provide essentially limitless propulsion, providing a persistent presence at sea. Wave Gliders run totally on renewable energies; using wave and solar energy for propulsion and solar power for communications, navigation and computing. No fuel, no manpower, no emissions, zero carbon impact on the environment.

Wave Gliders operate at the surface of the ocean and can travel across great expanses for a year at a time without the need to return to port for refueling. They navigate the World's oceans collecting data, monitoring the coastlines and connecting the subsea world to shore, air and space. They love the high risk, long duration, and severe conditions missions.

Q: How does the Wave Glider work?

A: Think of the Wave Glider as a floating data center or a floating sensor platform. It's the world's first *wave and solar powered ocean robot*. Solar energy provides power for onboard computing, sensor payloads, navigation, communications and extra thrust.

The Wave Glider is composed of two parts, the float (size of a surfboard), and a sub with a wing rack. Connected by 4-meter (13 ft.) umbilical tether, the float is on the surface of the ocean where conditions are the harshest while the sub is below the surface protected from the severe conditions. This two part system enables the Wave Glider to get its' propulsion by harvesting the up and down motion of the waves converting this energy into forward thrust.

The Wave Glider is equipped with sophisticated computers for navigation, communication systems, and state of the art ocean sensors to measure the environment around it. Highly customizable, it supports a growing array of sensors able to collect a wide variety of scientific and commercial data. Sensors have been integrated to measure weather, sea conditions, water quality and chemistry, bottom topography and currents. Acoustic microphones and arrays enable real time communications from subsea to space and can detect passing ships and capture vocalizations of whales and monitor other mammals.

For the Defense market, the Wave Glider is branded as the SHARC (Sensor Hosting Autonomous Remote Craft).

Q: What are the problems addressed by the Wave Glider?

A: Liquid Robotics addresses problems for the Defense, Oil & Gas, Maritime Security and Scientific markets. Wave Gliders are helping customers across the globe explore and monitor expanses of the world's oceans never before possible. From monitoring coastlines and marine sanctuaries against illegal activities to monitoring offshore oil wellheads for leakage; to providing navies' real time communications from undersea to aerial assets; to environmental monitoring for climate change, and hurricanes/typhoons/cyclones, Wave Gliders are lowering the risks and costs to ocean observation and security.

Q: What are the applications for the Wave Glider?

A: The Wave Glider is versatile and addresses a broad array of applications. With the capability to connect and communicate from the seafloor to space, fleets of Wave Gliders address the following commercial and defense applications.

- **Defense and National Security:** Anti-Submarine Warfare (ASW), Mine Countermeasure Operations, coastal & border security (drug & human trafficking interdiction), Maritime Domain Awareness (MDA).
- **Oil & Gas:** seismic surveys, seep detection, marine mammal monitoring, well head monitoring and oil rig security
- **Commercial Security:** Maritime Domain Awareness for Marine Protected Areas (MPAs)/Exclusive Economic Zones (EEZs) enforcement, and surface vessel detection.
- **Commercial and Science:** Meteorological and Oceanographic (METOC), tsunami detection for early warning, and Fisheries (Tracking and Stock Management), environmental monitoring

Q: What is the technical classification for the Wave Glider?

A: Both the Wave Glider and SHARC are categorized as Unmanned Surface Vehicles (USVs).

Q: Where are Wave Gliders operating?

A: From the Arctic to Antarctic and around the globe, Liquid Robotics and our partners have deployed Wave Gliders across the world's five major oceans, the Great Lakes in the United States to the Loch Ness in Scotland to the South China Sea.

Q: How long can a Wave Glider stay out at sea?

A: We have operated Wave Gliders on missions up to a year (with periodic servicing), although typical missions range from 6-9 months.

Q: What is the longest mission a Wave Glider has accomplished?

A: The Pacific Crossing or PacX Challenge Wave Gliders, Papa Mau and Benjamin, completed their one-year historic journey across the Pacific traveling over 9000 and 9442 nautical miles, respectively. The Guinness World Record organization awarded Liquid Robotics the record for “traveling longest journey by an unmanned, autonomous surface vehicle on Earth. Collectively, Wave Gliders have traveled over 425,000 nautical miles on missions around the globe.

Q: How long has Liquid Robotics been in business?

A: The Wave Glider was first invented 2005 by Roger Hine. Liquid Robotics was incorporated in January 2007 with first customer shipments in 2009. For a brief summary of the Company’s history please visit www.liquidr.com/company/about-us.html.

Q: How many employees are employed at Liquid Robotics?

A: We have 110+ employees and growing. We are always looking for new talent and people who have a passion for the ocean.

Q: Where is Liquid Robotics headquartered?

A: World headquarters is located in Sunnyvale; CA. Our Marine Engineering & Test Facility is located on the Big Island of Hawai’i in Kamuela, HI. Our oil and gas joint venture with Schlumberger, Liquid Robotics Oil & Gas, is located in Houston, TX.

Q: Is Liquid Robotics a public company?

A: No, Liquid Robotics is a venture-funded company with VantagePoint Capital Partners, Schlumberger and Riverwood Capital as the key investors.

Q: How many Wave Gliders have we sold? How many are in the ocean at any one time?

A: We have produced over 350+ Wave Gliders and growing. At any one time, there’s approximately 1/4 of the fleet at sea.

Q: Do you sell your products direct or use channel partners?

A: Both. Liquid Robotics sells directly and has a global partner ecosystem of strategic channel, integration and reseller partners.

For the oil & gas business, Liquid Robotics and Schlumberger formed Liquid Robotics Oil & Gas (LROG) to provide unmanned maritime services to global oil & gas companies. For the defense market, we have a strategic teaming agreement with Boeing Defense, Space and Security for maritime surveillance. Across the globe, Liquid Robotics works with go-to-market and technology partners to deploy large fleets of autonomous vehicles to address critical business and environment assessments needs.

Q: Has the Wave Glider or Liquid Robotics been recognized for their innovation?

A: Indeed, Liquid Robotics and Liquid Robotics Oil & Gas, our joint venture with Schlumberger, have received prestigious awards for the Wave Glider and customer solutions. A few of these are:

- RBR 2015 Top 50 Robotics Companies
- 2014 World Oil Award for Innovation
- Fast Company’s Top 10 Most Innovative Robotics Companies, 2014
- Hart Energy’s 2014 Meritorious Engineering Award Winners for System Integration, Liquid Robotics Oil & Gas and Schlumberger
- World Economic Forum Technology Pioneer for 2013
- Edison Awards for Innovation 2013 – Gold Winner
- Global Cleantech Top 100 Companies 2012, 2013, 2014

- Going Green Global 200 – 2011 thru 2014
- Fast Company 50 Most Innovative Companies 2012
- RBR Top 100 Companies 2012, 2013 and 2014
- Ocean Exchange Gulfstream Navigator Award 2011
- Wall Street Journal Technology Innovators Award 2010

Q: How are Wave Gliders piloted?

A: They can operate autonomously or controlled virtually via any secure Internet connected device. Data can be stored onboard or transmitted in real time via satellite or Wi-Fi / Cellular depending on the distance to shore.

Q: How fast can a Wave Glider travel?

A: The speed depends on the sea state, since we derive our propulsion from the action of the waves. The Wave Glider SV3 travels through water at a maximum speed of 3 kts.

Q: What software manages the Wave Gliders?

A: Regulus, the Wave Glider’s Software Operating Environment, and the Wave Glider Management System (WGMS) combine to manage and control the vehicles. Regulus is based on Linux and Java and has industry standard services, client plug-ins and APIs. Together, this architecture provides the most advanced operating environment of any autonomous ocean vehicle. Following are the key features:

- Autonomy including vessel detection and avoidance
- Remote piloting and navigation
- Data delivery and Management
- Secure communications

Q: What is the Wave Glider’s power system?

A: On the Wave Glider SV3, Liquid Robotics has designed the Adaptable, Modular Power System (AMPS) to provide scalable power to support the most “power hungry” sensors. Designed to be highly extensible and modular, power can be configured as necessary to support the sensor payloads, computing resources and communications. The onboard battery storage scales from 0.9-4.5kWh.

Q: What is the length and weight of the Wave Gliders?

A: The Wave Glider SV3 is 305cm x 81cm x 23cm ,120in x 32in x 9in and weighs 150kg (330lbs).

Q: What are the communications capabilities of the Wave Gliders?

A: Wave Gliders communicate via a variety of secure communications methods depending on the proximity to shore. They are Iridium satellite, RUDICS (optional), cellular, Wi-Fi. All data communications are encrypted.

Q: Have Wave Gliders ever been in a hurricane?

A: To date our Wave Gliders have traveled through over 16 hurricanes, typhoons and cyclones. The most severe storm recorded was a Category 5 Super Typhoon Rammason in the South China Sea. In the United States, Wave Gliders have traveled through Hurricanes Isaac and Sandy. Through these severe storms they continue to transmit real time weather data from the surface of the ocean. This is a breakthrough for meteorologists.

Q: I’ve heard about a thruster. What is this?

A: To address the mission challenges of operating in the oceans’ extremes (doldrums to high currents), the Wave Glider SV3 has an auxiliary electric thruster that can be turned on to batter the extremes or to provide a burst of energy for avoidance. This innovation converts solar energy into electrical thrust.

Q: Is the Wave Glider or SHARC easy to detect?

A: The SHARC, the Wave Glider branding for the Defense/National Security market, has low observability and detectability. Through its' innovative commercial design it is not detected by radar, nor has a thermal image and is acoustically silent.

Q: What type of sensors can you put on the Wave Glider?

A: A wide range of sensors can be put on the Wave Gliders, in it, under it and towed by it. Sensors range from ADCPs, weather stations, fluorometers, hydrophones, and cameras to water quality sensors and many more. For a complete listing visit www.liquidr.com.

Q: Can you tow sensors behind the Wave Glider?

A: Yes, Wave Gliders can tow a variety of sensors ranging from tow-fish to seismic arrays.

Q: Is Liquid Robotics working on future Wave Glider technology?

A: Yes, Liquid Robotics has an active product development roadmap.