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RiverRay ADCP

For Moving Boat Discharge Measurement

Prepared By

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RiverRay ADCP

Teledyne RD Instruments is excited to introduce RiverRay, a new ADCP for moving discharge measurement. This sleek new moving boat system has been designed with a mind for accuracy and an eye for simplicity.

RiverRay's design includes several substantive improvements that will deliver improved performance and greater convenience while operating over a broader range of environments and conditions. A number of engineering advances have been included, notably, Teledyne RDI's innovative and patented 600 kHz Phased Array transducer technology, embedded intelligence to create a fully automated system, improved bottom tracking performance, new next-gen electronics, and an improved Trimaran float design. We expect RiverRay's groundbreaking ease-of–use will encourage widespread use of the ADCP, increasing the number of shallow sites where acoustic profiling can be used to measure discharge.

With growing worldwide application since 1991, Teledyne RDI's river ADCPs have become the de-facto standard for modern technology making accurate discharge measurements. This provides us with two key sustainable competitive advantages -- an unmatched user / experience base and a best-in-class reputation for reliable products and dependable data quality.

In RiverRay, we are using Teledyne RDI's patented phased array design to provide a small, flat, single-face design with several key advantages. First this design causes less flow disturbance, which can be problematic in shallow depths. Second, having a flat face makes the ADCP velocity data insensitive to the changes in the salinity (and therefore speed of sound) along the path traveled; this will be a key advantage in estuaries. Third, the new design is more compact that leads to advantages of smaller size and lighter weight for both the ADCP and the fully integrated float.

A distinguishing feature of RiverRay is the introduction of *auto-modic* operation. User setup is not required – there is no more selection of modes. In fact there is no more selection of anything! We have embedded intelligence to create a fully automated system that takes care of auto-setup at the riverbank and then continuously optimizes measurements from bank-to-bank while water depth and flow conditions vary. This is like having an autopilot or cruise control. Considering discharge is often identified by the parameter Q, we have called this feature *on-board Qrz-control*. In shallow waters, each beam is setup independently of the others for optimal bottom tracking near riverbanks. Furthermore, RiverRay interleaves a new, independent, and short-range measurement to improve the discharge computation in the critical surface layer. Teledyne RDI's WinRiver2 software is fully compatible with the turnkey deployment, auto-modic operation, and near-surface measurements of the new ADCP.

For optimizing its data pings, the ADCP uses a bootstrapping process. The ADCP sets up each data ping automatically for the ambient water conditions—considering depth, speed, and level of turbulence. Starting with a robust ping suitable for fast flows, the ADCP emits a series of test pings that are tuned progressively to match better with the observed water conditions. This refinement permits RiverRay data to satisfy the

requested precision and accuracy without averaging batches of profiles and without requiring users to specify expected flow conditions. RiverRay is integrated with the Trimaran float and is designed with a quick-fit mounting – making it more portable and easier to install. The float, which is designed and built by OceanScience, has reduced drag, causes less flow disturbance, and provides improved handling at high water velocities and in waves.

The transducer assembly consists of a patented Teledyne RDI 2-dimensional phased array transducer operating at 600 kHz. The Phased Array creates four narrow 2 deg acoustic beams inclined at 30° relative to vertical. These beams are a Janus configuration for improved precision, accuracy, and reliability of current profiling and bottom tracking. Operating at 600 kHz and using low power, RiverRay provides a 40 m profiling range (over a wider range of water conditions). Further RiverRay's bottom-tracking velocities are less affected by water-bias errors than higher frequency ADCPs'. These errors stem from bottom tracking speeds being biased by currents near the riverbed in the presence of resuspended sediments. As a result, discharge values obtained from bottom tracking with higher frequencies are more likely to be underestimated. Using RiverRay, you can leave the river confident you are right on Q.

The ADCP is housed in a single, compact, cylindrical Delrin canister that contains both electronics--a compact stack of four circuit boards-- and the flat-face transducer. The electronics and transducers use state-of-the-art technologies to achieve high system performance as well as flexible operation. The canister will connect via a single small cable to an external 12 VDC battery housed within the Trimaran float. The link to the shore-based control laptop computer is via Bluetooth™ radio communication. Protection against reverse polarity connection is included. The Phased Array offers an upgrade pathway to add a vertical beam for refined bottom depth measurement. For difficult conditions where moving bed is problematic, data from an external DGPS can be integrated directly into the RiverRay data message.

RiverRay is compatible with Teledyne RDI's WinRiver 2 software product, which has a development team in regular contact with the USGS. The software is well documented, easy to use, and widely used, both within the US and abroad. The software is targeted to acquire, display, and record discharge transects in a simple, complete, and thorough process. The software is also designed for efficient and flexible playback and post-processing that includes export of data and summary tables.

Design Choices

1200 kHz vs. 600 kHz	Advantages of 600 kHz • Lower frequency has more robust bottom tracking performance in presence of resuspended material near river bed • Bottom track in "moving bottom" & high sediment concentrations • Deeper profiling in high sediment concentrations
Phased Array vs. Piston transducer design	Advantages of Phased Array transducer • X10 reduced transducer volume • Flat transducer face • Minimal submersion depth • Reduced flow disturbance, air entrainment, drag • Horizontal velocity accuracy is not degraded due to errors in speed of sound
Broadband vs. Narrowband signal processing	Advantages of BroadBand • High time, space & velocity resolution in shallow water • 2 – 5 higher spatial/time/velocity resolution • 2 – 4 times improved accuracy for a given ADCP operating frequency
Next-Gen electronics vs. WorkHorse electronics	Advantages of Nex-gen electronics • Efficient implementation of algorithms • Faster ping rate – DSP processing • Reduced X2 size for electronics (High density surface mounted) • Lower power consumption (3V operating voltage for DSPs) using integrated circuits developed for cellular phones