September 27\textsuperscript{nd}, 2011

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Department of Water Resources
Division of Integrated Regional Water Management
North Central Region Office
Bathymetry and Technical Support

\textbf{Multibeam Bathymetry Survey Report}

Middle River – North Canal – Victoria Canal

\textbf{Introduction}

The California Department of Water Resources, North Central Region Office (NCRO), Bathymetry and Technical Support Section, in collaboration with the FloodSAFE Environmental Stewardship and Statewide Resources Office (FESSRO), coordinated a bathymetric survey of Middle River, Victoria Canal, and North Canal in the region of Brentwood, California. The purpose of this survey was to provide a high resolution, accurate bathymetry data set with as much channel coverage as could be safely attained.

The survey area was split into two sections: Middle River from Connection Slough to Highway 4 and Victoria/North Canal from Middle River to Old River. The Middle River survey took place in June 2011 and was followed by the Victoria/North Canal survey which took place in August of 2011. Both surveys were conducted using the same instrumentation and survey methods.
Geodetic Settings

All data are referenced horizontally to the North American Datum1983 (NAD83), projected to California State Plane Zone III. The data are referenced vertically to the North American Vertical Datum 1988 (NAVD88). All units are in feet.

Instrumentation

NCRO’s multibeam bathymetry system and positioning system are composed of the following items (See Appendix A for instrument details):

• R2Sonic 2022 Multibeam Echo Sounder
• Trimble R-8 GNSS GPS Real Time Kinematic (RTK) positioning system
• Hemisphere Crescent VS100 GPS Heading Device
• SMC IMU-108 Motion Reference Unit (MRU)
• Odom Hydrographic Digibar Pro Sound Velocimeter
• Trimble Trimark 3 Radio Modem
• FESSRO’s North River Vessel

Survey Procedures

Pre-Survey

Prior to deploying the survey vessel, temporary benchmarks were established along the study area using RTK GPS technology. National Geodetic Survey (NGS) monument “B95503” was used as the horizontal and vertical datum control. Throughout the bathymetric survey, NGS monuments (B95503, B95340, DWR7, and OLD RM 3=Tidal 5) were observed to verify positional accuracy of the temporary benchmarks.

Prior to starting the survey, the multibeam sonar system was calibrated to ensure data accuracy. A multibeam sonar system is a complex system that requires complete synchronization of all of its individual instruments. In order for the multibeam sonar to collect accurate bathymetric data, the alignment of the following instruments must be calibrated collectively: the sonar head, heading device, and the motion reference unit. Hypack Hydrologic Survey Software offers a multibeam system calibration test called the Patch Test. During this calibration, data is collected on specific terrain types at different speeds and directions of travel in order to measure the alignment of the sonar system’s instruments. Once the Patch Test is completed the system is corrected for pitch, roll, yaw, and latency and the results are entered in to the Hypack software as offsets.

Sound velocity measurements were taken daily and entered into Hypack to further calibrate the multibeam sonar system. These measurements were taken with the Odom Hydrographic Digibar Pro Sound Velocimeter.
Survey

Due to the large scale and timeline of this bathymetry project, a 20% data overlap was agreed upon by FESSRO and NCRO and was achieved by NCRO throughout the bathymetric survey. While this level of overlap is sufficient to obtain an accurate surface of the channel bottom, a limited amount of data coverage was missed as a result.

NCRO surveyed the study area in sections to efficiently utilize the GPS radio signal’s effective radius. Surveying was completed on the following agreed upon priority plan:

- Priority 1 - Middle River near Woodward Island
- Priority 2 - Middle River near Victoria Island
- Priority 3 - Middle River near Bacon Island
- Priority 4 - Victoria Canal and North Canal

The objective of this multibeam bathymetric survey was to collect as much bathymetric information of the channel bottom as could be safely attained. Due to shallow water conditions and navigational obstructions, data coverage does not extend to the channel shoreline or other regions that hindered boat navigation. Structures such as bridges, pump platforms, ferry crossings, submerged piping and breakwaters are examples of navigational hindrances that resulted in data loss. These areas were generally avoided in order to ensure the safety of the survey staff and multibeam survey equipment.

In addition, because the bathymetric survey was conducted during the summer months, areas near the water’s edge and areas of shallow water depth were often occupied by aquatic vegetation. Dense aquatic vegetation interferes with the sonar’s ability to record reliable bathymetric information. Therefore, in order to properly represent the bathymetry of the entire channel, elevation data in areas of the channel occupied by dense aquatic vegetation were omitted from the final data set and appear as data gaps.

Data Processing

HYSWEEP EDITOR (Hysweep), an extension in the Hypack Hydrographic Survey Software, was used to process raw information gathered from each instrument including the following data inputs: sonar, heading, GPS, MRU, sound velocity, instrument offsets, and collective time stamps. Using Hysweep, elevation data is filtered to reject any values outside of that which is possible. Then, each survey line is individually examined for inconsistent and irregular values. At this point during data processing, anomalies are rejected and cleaned from the data set. Once the data set is thoroughly cleaned in Hysweep, it is exported from the Hypack software as a grid in an ascii XYZ text file format.

The final data quality review and analysis is completed using the ESRI ArcGIS 10 Desktop software. The ascii XYZ text file is imported in to ArcGIS and converted to a Point Feature Class and Raster dataset. The final density level of the data points in the main channels is a 3 foot grid that was derived from data on a 1 foot grid. Raster and point data are reviewed for any remaining anomalies and exported as the final data set.
The final products for the multibeam bathymetric survey include:

- Ascii XYZ files
- A series of maps displaying bathymetry (PDF)
- ArcGIS File Geodatabase
  - Point feature classes
  - Multipoint feature classes
  - Raster dataset

The final products for Priorities 1 -3 and Priority 4 were delivered digitally on July 29th, 2011 and September 27th, 2011, respectively.
Appendix A: Multibeam Echosounder Equipment List

CADWR-NCRO-Bathymetry and Technical Support Section

September 27th, 2011

• R2Sonic 2022 multibeam echo sounder
• SMC IMU-108 motion sensor
• Hemisphere Crescent VS100 Series GPS heading device
• Odom Hydrographic Digibar Pro sound velocity probe
• Trimble R-8 GNSS GPS-RTK system
• Trimble Trimmark 3 repeater radio

Manufacturer data sheets are attached to this document.
SONIC 2022
Multibeam Echo Sounder

Features:

- Ultra Compact
- Focused 1° Beam Width
- Selectable Frequencies 200-400kHz
- Selectable Swath Sector 10° to 160°
- System Range to 500m
- Embedded Processor/Controller
- Equiangular or Equidistant Beams
- Roll Stabilization
- Rotate Swath Sector

Applications:

- Hydrographic Survey
- Offshore Site Survey
- Pre & Post Dredge Survey
- Defense & Security
- Marine Research

System Description:

The Sonic 2022 is a compact wideband shallow water multibeam echo sounder, suitable for a wide variety of general mapping applications.

As with the higher resolution Sonic 2024 system, the Sonic 2022 provides over 20 selectable operating frequencies to chose from within the 200 to 400 kHz band, with unparalleled flexibility to trade off resolution and range and controlling interference from other active acoustic systems.

In addition to selectable operating frequencies, the Sonic 2024 provides variable swath coverage selections from 10° to 160° as well as ability to rotate the swath sector. Both the frequency and swath coverage may be selected ‘on-the-fly’, in real-time during survey operations.

The Sonar consists of the outboard projector and receiver modules, and the inboard Sonar Interface Module (SIM). Third party auxiliary sensors are connected to the SIM. The sonar data is tagged with GPS time.

The sonar operation is controlled from a graphical user interface on a PC or laptop which is typically equipped with navigation, data collection and storage applications software.

The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by the applications software.

Commands are transmitted through an Ethernet interface to the Sonar Interface Module. The Sonar Interface Module supplies power to the sonar heads, synchronizes multiple heads, time tags sensor data, and relays data to the applications workstation and commands to the sonar head.

The receiver head decodes the sonar commands, triggers the transmit pulse, receives, amplifies, beamforms, bottom detects, packages and transmits the data through the Sonar Interface Module via Ethernet to the control PC.

The compact size, low weight, low power consumption of 35W and elimination of separate topside processors make Sonic 2022 very well suited for small survey vessel or ROV/AUV operations.
### Systems Specification:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>200kHz-400kHz</td>
</tr>
<tr>
<td>Beamwidth, across track</td>
<td>1.0°</td>
</tr>
<tr>
<td>Beamwidth, along track</td>
<td>1.0°</td>
</tr>
<tr>
<td>Number of beams</td>
<td>256</td>
</tr>
<tr>
<td>Swath sector</td>
<td>Up to 160°</td>
</tr>
<tr>
<td>Max Range setting</td>
<td>500m</td>
</tr>
<tr>
<td>Pulse Length</td>
<td>15µs-500µs</td>
</tr>
<tr>
<td>Pulse Type</td>
<td>Shaped CW</td>
</tr>
<tr>
<td>Ping Rate</td>
<td>Up to 60 Hz</td>
</tr>
<tr>
<td>Depth rating</td>
<td>100m</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>0°C to 60°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-30°C to 55°C</td>
</tr>
</tbody>
</table>

### Electrical Interface

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains</td>
<td>90-260 VAC, 45-65Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>35W</td>
</tr>
<tr>
<td>Uplink/Downlink</td>
<td>10/100/1000Base-T</td>
</tr>
<tr>
<td>Data interface</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Sync In, Sync out</td>
<td>TTL</td>
</tr>
<tr>
<td>GPS</td>
<td>1PPS, RS-232</td>
</tr>
<tr>
<td>Auxiliary Sensors</td>
<td>RS-232</td>
</tr>
<tr>
<td>Deck cable length</td>
<td>15m</td>
</tr>
</tbody>
</table>

### Mechanical:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver Dim (LWD)</td>
<td>276 x 109 x 190 mm</td>
</tr>
<tr>
<td>Receiver Mass</td>
<td>7 kg</td>
</tr>
<tr>
<td>Projector Dim (LWD)</td>
<td>273 x 108 x 86 mm</td>
</tr>
<tr>
<td>Projector Mass</td>
<td>3.3 kg</td>
</tr>
<tr>
<td>Sonar Interface Module Dim (LWH)</td>
<td>280 x 170 x 60 mm</td>
</tr>
<tr>
<td>Sonar Interface Module Mass</td>
<td>2.4 kg</td>
</tr>
</tbody>
</table>

### Sonar Options:

- Snippets Imagery Output
- Switchable Forward Looking Sonar Output
- Mounting Frame & Hardware
- Over-the-side Pole Mount
- Sound Velocity Probe & Profiler
- Extended Sonar Deck Cable, 25m or 50m
- 3000m Depth Immersion Depth
SMC IMU
Motion Sensors

SMC has developed its IMU range of Motion Sensors to meet the requirements of the hydrographic and marine sectors. The IMU range provides high accuracy motion measurement data in dynamic environment in all areas from small hydrographic vessels to large oil rigs in all weather conditions.

Key Specifications
- Roll & Pitch 0.03° (RMS) Dynamic Accuracy
- Heave 5 cm or 5 %
- Accelerations / Velocities
- Velocity Input Formats RMC, RMA, VTG, VBV, VHW
- Heading Input Formats NMEA 0183, HDT, HDG
- Various Industry Protocols NMEA
- 2 years warranty

The SMC IMU uses solid state gyros and accelerometers to provide real time motion measurements with high dynamic accuracy even during accelerations. RS232 or RS422 outputs with RS232 velocity and heading inputs for aiding furing vessel turns. High quality titanium design, construction and assembly produce an IMU with an extremely high reliability in the most demanding marine environment.

Every SMC IMU is individually calibrated and tested for roll, pitch & heave as well as all directions of acceleration, inside a calibration machine with a controlled temperature environment between 0 and +55 degrees Celsius.

The SMC IMU is supplied with a data distribution unit, cables and windows based software for ease of set up and configuration. The configuration software enables the user to configure the IMU parameters for the installation.

The SMC IMU is available in a variety of design and depth options.
### Technical Specifications

<table>
<thead>
<tr>
<th>IMU</th>
<th>Roll / Pitch</th>
<th>Accelerations X, Y, Z</th>
<th>Heave</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMU-106</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>IMU-107</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IMU-108</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle Accuracy static</td>
</tr>
<tr>
<td>Angle Accuracy Dynamic</td>
</tr>
<tr>
<td>Resolution Angle</td>
</tr>
<tr>
<td>Resolution Heave</td>
</tr>
<tr>
<td>Angle range Roll/Pitch</td>
</tr>
<tr>
<td>Heave range</td>
</tr>
<tr>
<td>Heave Accuracy</td>
</tr>
<tr>
<td>Acceleration accuracy</td>
</tr>
</tbody>
</table>

### Communications

<table>
<thead>
<tr>
<th>IMU Configuration Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>The IMU is shipped with SMC configuration windows software allowing on site setup</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output Signal Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple, user selectable Output Protocols ASCII NMEA and binary</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communications Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output RS422 and RS232. Analog with remote converter (optional)</td>
</tr>
<tr>
<td>2 x RS232 External inputs, (not available on all models)</td>
</tr>
<tr>
<td>Velocity input formats RMC, RMA, VTG, VBV, VHW; Heading input formats HDT, HDG</td>
</tr>
</tbody>
</table>

### Physical

<table>
<thead>
<tr>
<th>Dimensions for IMU-10x (W x H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø89 (mounting plate Ø134, flange for IMU-10x-30 Ø110) x 120mm excl connector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>~2 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titanium</td>
</tr>
</tbody>
</table>

### Environmental

<table>
<thead>
<tr>
<th>Temperature (absolute max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° to +55° Celsius (-10° to +65°); Storage Temperature -40° to +65° Celsius</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mounting Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical or Horizontal mounting (factory set)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 - 30 VDC; 2 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MTBF (computed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 000 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP66 (standard); IP68 30 meter depth rated (optional)</td>
</tr>
</tbody>
</table>

### Warranty & Support

<table>
<thead>
<tr>
<th>Warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year Limited Hardware &amp; Software Warranty</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Technical &amp; Hardware support</td>
</tr>
</tbody>
</table>

### Bundled Delivery

<table>
<thead>
<tr>
<th>Junction Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Input &amp; Output Connection Case, including 10 m cable</td>
</tr>
</tbody>
</table>
Crescent® VS100 Series GPS Compass
Professional Heading and Positioning Receiver

Precise applications demand the heading and positioning performance of the Crescent VS100 Series GPS Compass. Ideal for professional machine control and navigation applications, the Crescent VS100 delivers reliable accuracy at significantly less cost than competitors products or traditional methods. The Crescent VS100 receiver with its display and user interface can be conveniently installed near the operator. The two antennas are mounted separately and with a distance between them to meet the desired accuracy.

Key Crescent VS100 Series Advantages

- Affordable solution delivers 2D GPS heading accuracy better than 0.1 degree rms
- Differential positioning accuracy of less than 60 cm, 95% of the time
- Integrated gyro and tilt sensor deliver fast start-up times and provide heading updates during temporary loss of GPS
- Fast heading and positioning output rates up to 20 Hz
- Differential options including SBAS (WAAS, EGNOS, etc.) and optional beacon differential
- COAST™ technology maintains accurate solutions for 40 minutes or more after loss of differential signal
- The status lights and menu system make the VS100 Series easy to monitor and configure

www.hemispherengps.com • precision@hemispherengps.com
Crescent VS100 Series GPS Compass

GPS Sensor Specifications
- Receiver Type: L1, C/A code, with carrier phase smoothing
- Channels: Two 12-channel, parallel tracking (Two 10-channel when tracking SBAS)
- Update Rate: Standard 10 Hz, optional 20 Hz (position and heading)
- Horizontal Accuracy:
  - < 0.6 m 95% confidence (DGPS)*
  - < 2.5 m 95% confidence (autonomous, no SA)**
- Heading Accuracy:
  - < 0.30º rms @ 0.5 m antenna separation
  - < 0.15º rms @ 1.0 m antenna separation
  - < 0.10º rms @ 2.0 m antenna separation
- Pitch / Roll Accuracy:
  - < 1 º rms @ 0.5 m antenna separation
- Rate of Turn: 90º / s max
- Cold Start: 60 s (No almanac or RTC)
- Heading Fix: < 20 s
- Satellite Reacquisition: < 1 s
- Antenna Input Impedance: 50Ω

Beacon Sensor Specifications (VS110 version)
- Channels: 2-channel, parallel tracking
- Frequency Range: 283.5 to 325 kHz
- Operating Modes: Automatic (signal strength), Database and Manual
- Compliance: IEC 61108-4 beacon standard

Communications
- Serial ports: 2 full duplex
- Interface Level: RS-232C
- Baud Rates: 4800 - 57600
- Correction I/O Protocol: RTCM SC-104, LDiff (Hemisphere GPS proprietary)
- Data I/O Protocol: NMEA 0183, Crescent binary, LDiff (Hemisphere GPS proprietary)
- Timing Output: 1 PPS (HCMOS, active high, rising edge sync, 10 kΩ, 10 pF load)
- 1 PPS Accuracy: 50 ns

Power
- Input Voltage: 9 to 36 VDC
- Power Consumption: < 5 W
- Current Consumption: < 360 mA @ 12 VDC
- Antenna Voltage Output: 5 VDC
- Antenna Short Circuit Protection: Yes

Environmental
- Operating Temperature: -32°C to +74°C (-25°F to +165°F)
- Storage Temperature: -40°C to +85°C (-40°F to +185°F)
- Humidity: 95% non-condensing
- Shock and Vibration: EP 455
- EMC: FCC Part 15, Subpart B, Class B, CISPR22, CE

Mechanical
- Dimensions: 189 mm L x 114 mm W x 71 mm H (7.4" L x 4.5" W x 2.8" H)
- Weight: 0.86 kg (1.9 lb)
- Status Indication: Power, primary GPS lock, secondary GPS lock, differential lock, and heading lock
- Power Switch: Miniature push-button
- Power Connector: 2-pin, micro-Conxall
- Data Connectors: DB9-female
- Antenna Connectors: TNC-male

Aiding Devices
- Gyro: Single axis gyro provides reliable <1º heading for periods up to 3 minutes when loss of GPS lock has occurred
- Tilt Sensor: Assists in fast start up of RTK solution

* Depends on multipath environment, number of satellites in view, satellite geometry, baseline length (for local services), and ionospheric activity
** Depends on multipath environment, number of satellites in view, and satellite geometry

Crescent® VS100 Series Heading Performance vs. Antenna Separation

© Copyright April 2007, Hemisphere GPS. All rights reserved. Specifications subject to change without notice. Hemisphere GPS and the Hemisphere GPS logo and Crescent and the Crescent logo are trademarks of Hemisphere GPS. Made in Canada. Warranty: Each Hemisphere GPS product is covered by a limited one-year warranty on parts and labor.
The Digibar Pro is the most cost-efficient and accurate means of determining water column sound velocities. It quickly calibrates acoustic systems regardless of sea state or current and is faster and safer than the traditional bar check method. Digibar Pro uses “sing-around” technology, which automatically compensates for all factors influencing sound velocity, including salinity, depth and temperature.

### General Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity Range</td>
<td>1400 - 1600 m/sec (4595 - 5250 ft/sec)</td>
</tr>
<tr>
<td>Velocity Resolution</td>
<td>0.1 m/sec (0.1 ft/sec)</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>4°C - 40°C (39°F - 104°F) Typical</td>
</tr>
<tr>
<td>Communications</td>
<td>RS232, selectable baud rate and choice of output formats, Display and download/logging SW included</td>
</tr>
</tbody>
</table>

### Probe Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sing-Around Frequency</td>
<td>11 kHz</td>
</tr>
<tr>
<td>Velocity Accuracy</td>
<td>+/- 0.3 m/sec (+/- 1 ft/sec)</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>10 Hz</td>
</tr>
<tr>
<td>Depth Sensor Accuracy</td>
<td>31.0 cm (1.0 ft)</td>
</tr>
<tr>
<td>Communications</td>
<td>RS485, 19.2 Baud (two way between handset and probe)</td>
</tr>
</tbody>
</table>

### Dimensions

- 37.3 L x 5.0 D cm (14.7 L x 2.0 D in)
- Weight: 1.9 kg (4.2 lbs) in air

### Hand Unit Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Requirement</td>
<td>Three &quot;C&quot; cell alkaline batteries in hand unit powers both hand unit and probe, External DC power supply available as an option for continuous SV output applications.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>29.0 L x 14.0 W x 9.4 D cm (11.4 L x 5.5 W x 3.7 D in)</td>
</tr>
<tr>
<td>Weight</td>
<td>1.2 kg (2.6 lbs)</td>
</tr>
</tbody>
</table>

### Cable Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-conductor, Polyethylene-jacketed with Kevlar strength member</td>
<td></td>
</tr>
<tr>
<td>Breaking Strength</td>
<td>182 kg (400 lbs)</td>
</tr>
<tr>
<td>Standard Cable length</td>
<td>20m</td>
</tr>
<tr>
<td>Maximum Cable length</td>
<td>100m</td>
</tr>
</tbody>
</table>

### Features

- Velocity profiles downloaded to a computer
- Handheld display/logger with computer interface
- Battery operated
- Detachable cable (in lengths up to 100 meters)
- Sampling by depth or time
- Stainless steel probe
- Waterproof
- Lightweight
- Portable
- Optional transit cases
- Optional Cable Reel
- Optional Kellems grip

See our entire product line at: [odomhydrographic.com](http://odomhydrographic.com)
DIGIBAR PRO™
FOR SEAFLOOR OR RIVERBED SURVEYS

MODEL DB1200
PROFILING SOUND VELOCIMETER

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company
The Trimble® R8 GNSS Receiver sets the new standard for full-featured GNSS (Global Navigation Satellite System) receiver technology. This integrated system delivers unmatched power, accuracy and performance in a rugged, compact unit.

**ADVANCED TRIMBLE R-TRACK TECHNOLOGY**

The Trimble R8 GNSS delivers the latest advancements in R-Track™ technology, designed to deliver reliable, precise positioning performance. In challenging areas for GNSS surveying, such as tree cover or limited sky view, Trimble R-Track provides unmatched tracking performance of GNSS satellite signals.

Trimble R-Track with Signal Prediction™ compensates for intermittent or marginal RTK correction signals, enabling extended precision operation after an RTK signal is interrupted.

The new CMRx communications protocol provides unprecedented correction compression for optimized bandwidth and full utilization of all the satellites in view, giving you the most reliable positioning performance.

Featuring the Trimble Maxwell™ 6 chip, the Trimble R8 GNSS advances the industry with more memory and more GNSS channels. Trimble delivers business confidence with a sound GNSS investment for today and into the future.

**Broad GNSS Support**

The Trimble R8 GNSS supports a wide range of satellite signals, including GPS L2C and L5 and GLONASS L1/L2 signals. In addition, Trimble is committed to the next generation of modernized GNSS configurations by providing Galileo-compatible products available for customers well in advance of Galileo system availability.

In support of this plan, the new Trimble R8 GNSS is capable of tracking the experimental GIOVE-A and GIOVE-B test satellites for signal evaluation and test purposes.

**FLEXIBLE SYSTEM DESIGN**

The Trimble R8 GNSS receiver combines the most comprehensive feature set into an integrated and flexible system for demanding surveying applications. The Trimble R8 GNSS includes a built-in transmit/receive UHF radio, enabling ultimate flexibility for rover or base operation. As a base station, the internal NTRIP caster provides you with customized access to base station corrections via the internet.

Trimble's exclusive, Web UI™ eliminates travel requirements for routine monitoring of base station receivers. Now you can access the health and status of base receivers and perform remote configurations from the office. Likewise, you can download post-processing data through Web UI and save additional trips out to the field.

**ENABLING THE CONNECTED SITE**

Pair the speed and accuracy of the Trimble R8 GNSS receiver with flexibility and collaboration tools of Trimble Access™ software. Trimble Access brings field and office teams closer by enabling data sharing and collaboration in a secure, web-based environment. With optional streamlined workflows, Trimble Access further empowers surveyors and survey teams for success. Now it is easier than ever to realize the potential of the Trimble Connected Site. Connecting the right tools, techniques, services and relationships enables surveying businesses to achieve more every day.

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1. **Galileo Commercial Authorization**
   - Receiver technology having Galileo capability to operate in the Galileo frequency bands and using information from the Galileo system for future operational satellites is restricted in the publicly available Galileo Open Service Signal-in-Space Interface Control Document (ISI SC ID) and is not currently authorized for commercial use.
   - Receiver technology that tracks the GIOVE-A and GIOVE-B test satellites use information that is unrestricted in the public domain in the GIOVE A + B Navigation Signal-in-Space Interface Control Document. Receiver technology having experimental GIOVE-A and B capability is intended for signal evaluation and test purposes.

2. For more information about Trimble and GNSS modernization, please visit http://www.trimble.com/new-satellite

3. Cellular modem required.
**TRIMBLE R8 GNSS RECEIVER**

**PERFORMANCE SPECIFICATIONS**

Measurements
- Trimble R-Track technology
- Advanced Trimble Maxwell 6 Custom Survey GNSS chip with 220 channels
- High precision multipath correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
  - GPS: L1C/A, L2C, L5E (Trimble method for tracking L2P), L5
  - GLONASS: L1C/A, L1P, L2CA (GLONASS M only), L2P
  - SBAS: L1C/A, L5
  - Galileo GIOVE-A and GIOVE-B

**Code differential GNSS positioning**
- Horizontal: 0.25 m + 1 ppm RMS
- Vertical: 0.50 m + 1 ppm RMS
- WAAS differential positioning accuracy: typically <5 m 3DRMS

**Static and Fast Static GNSS surveying**
- Horizontal: 3 mm + 0.1 ppm RMS
- Vertical: 3.5 mm + 0.4 ppm RMS

**Kinematic surveying**
- Horizontal: 10 mm + 1 ppm RMS
- Vertical: 20 mm + 2 ppm RMS
- Initialization time: typically <10 seconds
- Initialization reliability: typically >99.9%

**HARDWARE**

**Physical**
- Dimensions (WxH): 19 cm x 11.2 cm (7.5 in x 4.4 in), including connectors
- Weight: 1.34 kg (2.95 lb) with internal battery, internal radio, standard UHF antenna.
- Temperature: 3.70 kg (8.16 lb) entire RTK rover including batteries, range pole, controller and bracket
- Humidity: 100%, condensing
- Water/dustproof: IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)

**Shock and vibration**
- Tested and meets the following environmental standards:
  - Shock: Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth vibration.

**Electrical**
- Power: 11 to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable, 7.4 V, 2.4 Ah Lithium-Ion battery in internal battery compartment. Power consumption is 3.2 W, in RTK rover mode with internal radio. Operating times on internal battery:
  - 450 MHz receive only option: 5.8 hours
  - 450 MHz receive/ transmit option: 3.7 hours
  - GSM/GPRS: 4.1 hours
- Certification Class B Part 15, 22, 24 FCC certification. 850/1900 MHz. Class 10 GSM/GPRS module. CE Mark approval, and C-tick approval

**Communications and Data Storage**
- 3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dbus 9 pin)
- Fully integrated, fully sealed internal 450 MHz receiver/transmitter option:
  - Transmit power: 0.5 W
  - Range: 3-5 km typical / 10 km optimal
- Fully integrated, fully sealed Internal GSM/GPRS option?
- Fully integrated, fully sealed 2.4 GHz communications port (Bluetooth)?
- External cell phone support for GSM/GPRS/CDPD modems for RTK and VRS operations
- Data storage on 57 MB internal memory: 40 days of raw observables (approx. 1.4 MB /day), based on recording every 15 seconds from an average of 14 satellites
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning
- CMR+, CMR, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 Input and Output
- 16 NMEA outputs, GSOF, RT17 and RT27 outputs. Supports BIXEX and smoothed carrier

1 Accuracy and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, obstructions, and satellite geometry.
4 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
5 Receiver will operate normally to +60 °C, internal batteries are rated to -20 °C.
6 Varies with terrain and operating conditions.
7 Varies with temperature.
8 Varies with temperature and wireless data rate.
9 Bluetooth type approvals are country specific.

Contact your local Trimble Authorized Distribution Partner for more information.

Specifications subject to change without notice.

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www.trimble.com
RUGGED AND VERSATILE MULTICHANNEL RADIO MODEM

The TRIMMARK™ 3 radio modem provides a convenient, versatile means of establishing a robust wireless data broadcast network for real-time, high-precision GPS survey and telemetry applications.

The rugged, compact TRIMMARK 3 radio modem is designed for use in tough environments and in a variety of situations. The single unit is usable as a base station, repeater station, or rover receiver for maximum versatility. However you use it, you’ll appreciate its simplicity and famous Trimble reliability and quality.

SELECT THE POWER YOU NEED

The TRIMMARK 3 radio modem provides selectable power outputs of 2 W, 10 W, or 25 W to support both short and long-range operations, conserve battery life and minimize risk of interference with other systems.

A 25 W base unit broadcasts up to 15 km (8 miles) line-of-sight, under optimal conditions. Path obstructions and terrain can reduce the typical effective range to 10 km to 12 km (6 miles to 7 miles). One or two additional units can be networked as repeater stations to extend range, minimize base station moves, and provide seamless coverage around local obstacles such as large buildings or hills. The typical range of a 2 W repeater is 5 km to 8 km (3 miles to 5 miles).

A TRIMMARK 3 radio modem broadcasts or repeats data to Trimble survey-grade GPS receivers, such as the Trimble R8, 5800, Trimble R7, and 5700, that either contain an internal radio modem or are being used with an external rover radio. The TRIMMARK 3 is fully backward compatible with the TRIMMARK IIe radio modem, so it can be used in both new and existing systems.

CONFIGURE IT TO YOUR NEEDS

The TRIMMARK 3 radio modem can be configured completely and easily in the office by using the supplied WinFLASH utility on your computer. Many functions also can be configured in the field from the front panel or from the Trimble Survey Controller™ software used with your GPS survey receivers. The serial port communication settings are easily set to match the default settings on the GPS receiver.

You can configure each broadcast network to operate on one of up to 20 programmed channels via a built-in channel selector. Channel spacing of either 12.5 kHz or 25 kHz is programmable at the factory or by a service provider.

To reduce the risk of interference in a congested RF environment, you can use the built-in audio speaker to monitor activity on the selected channel. The unit also can automatically monitor the channel using its software selectable carrier detect function to detect other users on the channel before transmitting.

The TRIMMARK 3 radio modem is available as a stand-alone product as well as in convenient base and repeater equipment sets. Available in three frequency bands, the TRIMMARK 3 radio modem is designed to meet the licensing requirements of many countries around the world.

KEY FEATURES

Versatile: Use as base, repeater or rover
Flexible: 2 W, 10 W, or 25 W power output
Channel spacing programmable at 12.5 kHz or 25 kHz
Easy to use and configure
Built-in channel selector and monitor
Rugged and weatherproof
**STANDARD FEATURES**

- Selectable 20-channel capacity
- Rugged weatherproof construction
- Configurable from front panel, survey controller, or from supplied WinFLASH utility on your computer
- Up to 15 km line-of-sight range
- Same unit can function as base station, repeater station, or rover receiver
- Selectable power outputs of 2 W, 10 W, or 25 W
- Programmable channel spacing of 12.5 kHz or 25 kHz
- Built-in channel selector
- Supports up to two repeaters in a network
- 4800, 9600 and 19200 baud rate over the air
- Retrievable/storable radio diagnostic information

**TECHNICAL SPECIFICATIONS**

- Transmit Power¹: 2 W, 10 W, 25 W
- Wireless Data Rate: 4800 bps, 9600 bps, 19200 bps
- Frequency Bands: 410–420 MHz, 430–450 MHz, or 450–470 MHz
- Channel Spacing: 12.5 kHz or 25 kHz
- Number of Channels: Can be ordered with up to 20 programmed frequencies, internally stored
- RF Modulation Format: Gaussian Minimum Shift Keying (GMSK)

**TRIMMARK 3 BASE/REPEATER**

**Physical**

- Size: 12.5 cm W x 22.9 cm D x 7.9 cm H (4.9" W x 9.0" D x 3.1" H)
- Weight: 1.59 kg (3.5 lb)

**Electrical**

- Power: Input 12 V DC to 16 V DC, nominal
- Connectors: 2-pin LEMO (+VDC, GND)
- Data: 7-pin female LEMO (supports RXD, TXD and SGND)
- Antenna: TNC female

**Environmental**

- Operating Temperature: -40 °C to +65 °C (–40 °F to +149 °F)
- Storage Temperature: -55 °C to +75 °C (–67 °F to +167 °F)
- Humidity: 100%, fully sealed, weatherproof

**ANTENNA PHYSICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Antenna Type</th>
<th>Length (Typical)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dB UHF omni whip</td>
<td>47 cm (18.5 in)</td>
<td>0.5 kg (1.1 lb)</td>
</tr>
<tr>
<td>5 dB UHF omni whip</td>
<td>99 cm (39 in)</td>
<td>0.5 kg (1.1 lb)</td>
</tr>
</tbody>
</table>

1. Radios are configured as 25-W units at the factory.
2. Use the same frequency for all radio modems in the same wireless data network.
3. Varies with terrain and operational conditions. Up to 2 repeaters can be used to extend range.
4. Power consumption and battery life depend on the broadcast information content and wireless data rate (e.g., CMR versus RTCM SC-104 Ver 2.x packets at 1-Hz epoch rates).
5. Communications rate between the radio and GPS receiver, not wireless rate.

Specifications subject to change without notice.