KLEIN SYSTEM 5900

High-Resolution, Multi-Beam Side Scan Sonar System

The Klein System 5900 represents L-3 Klein's most advanced multi-function side scan sonar platform.

Beginning in the late 1970s, L-3 Klein demonstrated the potential of using Commercial-Off-The-Shelf (COTS) side scan sonar for Mine Counter Measures (MCM) operations. Since that time, L-3 Klein has supplied side scan sonar equipment to governments and navies worldwide for use in various applications including Mine Counter Measures (MCM), broad area search, "Q" route survey, port and harbor security, hydrographic and oceanographic, as well as intelligence, surveillance and reconnaissance (ISR) missions. These applications have been accomplished from small inflatable boats, small and large vessels of opportunity, or dedicated vessels. Through extensive experience, L-3 Klein understands naval logistic and maintenance requirements and can provide support to meet a specific operational or infrastructure situation.

MULTI-BEAM SIDE SCAN SONAR

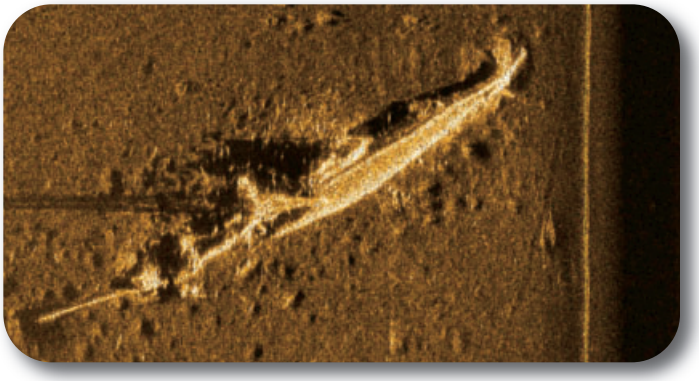
The System 5900 high-resolution Multi-Beam Side Scan Sonar (MBSS) improves upon the performance of its predecessor, the System 5000, by employing advanced signal processing techniques and superior acoustic design to improve the overall along-track target resolution by more than 100%. The System 5900 uses twice the number of acoustic channels available on the System 5000 Series Sonar, along with an increase in frequency and acoustic aperture length to produce a much higher-resolution along-track image.

SYSTEM 5900 APPLICATIONS

- Intelligence, surveillance and reconnaissance missions (ISR)
- Oceanographic missions
- Mine Counter Measures (MCM) missions
- Port and harbor security
- Anti-Terrorist Force Protection (ATFP)

KEY FEATURES

- High-resolution multi-beam side scan sonar
- High contrast ratio, enhanced target definition
- Swath Bathymetric Sonar (SBS)
- Gap-Filler Sonar (GFS) (optional)
- Integrated tow body sensors and subsystems
- Synchronized data processing
- High-speed operation and full bottom coverage
- Remote-controlled operation



Sonar Image: USS O-9 (Submarine #70, later SS-70)
1918–1941
New London, CT – 400 feet

MULTI-BEAM SIDE SCAN SONAR (MBSS)

Since the introduction of the System 5000 in 1996, well over 100 systems have been deployed worldwide and most remain in service today. In addition to various commercial sales, some of the government organizations using the Series 5000 systems include: the Royal Australian Navy (DSTO), the French Navy (GESMA), the U.S. National Oceanic and Atmospheric Administration (NOAA), the U.S. Naval Oceanographic Office (NAVO), the U.S. Navy MCM Fleet (Army/Navy nomenclature: ANSQH-4B), the U.S. Navy EOD Groups, the Defense Research Establishment (DRE) of Canada, the Estonia Navy MCMVs, the Indian Navy MCMVs, the Japanese Navy, the Netherlands Navy, the Republic of Korea Navy and the Finnish Navy.

The along-track resolution of the System 5900 is 6.2 cm out to 50 m (constant), 9.3 cm out to 75 m (constant), 12.4 cm out to 100 m (constant) and increasing to 0.07 degrees for ranges greater than 100 m. The across-track resolution of the System 5900 is 4.0 cm nominal, at all ranges.

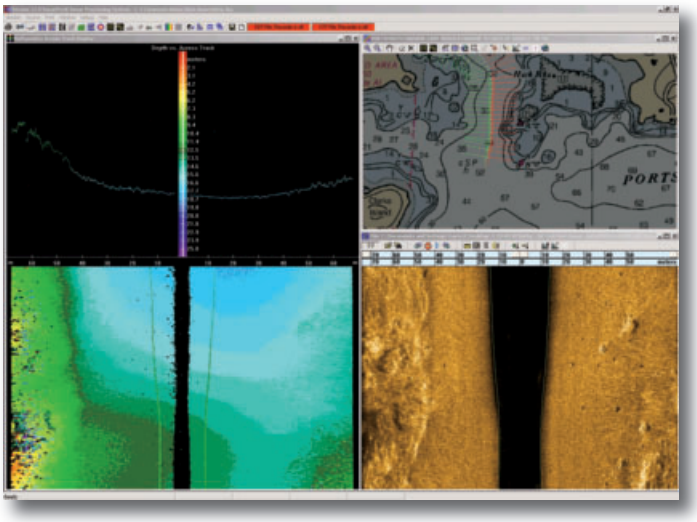
The System 5900 MBSS also uses dynamic beam-steering image stabilization techniques to remove artifacts caused by tow vehicle motion which would otherwise blur seabed images — especially at longer range where the effects due to angular perturbations are more pronounced. This is a marked improvement over the System 5000 family, which produced successive beams perpendicular to the tow body and were more susceptible to compressed or elongated images due to excessive towfish yaw. Image stabilization helps to effectively extend the range of the sonar by minimizing this distortion.

An added benefit of the System 5900 MBSS is a pseudo geo-referenced seafloor image. Like all towed side scan sonar systems, the System 5900 has no absolute position reference — hence the ability to provide a truly “geo-referenced” image is impossible. However, the advanced back-projection beamformer used on the System 5900 places adjacent sonar swaths on the seabed perpendicular to the best estimate of the tow body trajectory, thus producing a smooth, more accurate waterfall image in the seabed than a conventional towed side scan platform.

The Klein System 5900 sonar is capable of producing sonar imagery similar in quality to that produced by military multi-beam side scan sonar systems, which include the AN/AQS-14 and the AN/AQS-20.

SWATH BATHYMETRIC SONAR

Integrated into the System 5900 sonar architecture is a Swath Bathymetric Sonar (SBS). This sonar uses advanced interferometric signal processing to produce simultaneous estimates of the seabed topography out to the full-swath extent of the sonar, typically 10–12 times the overall altitude of the tow fish. This data is coregistered with the resulting side scan backscatter imagery and can be used to more accurately position seabed targets.



SonarPro® Real-Time Display

Side-looking sonars that do not have the ability to perform bathymetric measurements must assume a locally flat bottom when measuring the location of seabed targets. This can result in target position errors on the order of meters when surveying over sloped bottoms. This added seabed topographic measurement capability is extremely advantageous when performing missions involving shallow water, rapid area assessment.

GAP-FILLER SONAR

The System 5900 Sonar System comes with an optional Gap-Filler Sonar (GFS) used to provide high-resolution acoustic imagery in the vicinity of the side scan sonar “nadir gap”. All side scan sonar systems are incapable of adequately imaging the region directly beneath the sonar tow body. This resulting “nadir gap” region, which can be relatively large, depending on the tow body altitude, can only be covered by executing a sonar survey which encompasses 100% overlap on reciprocal adjacent survey lines. This requirement can greatly increase the survey time necessary to achieve full bottom coverage. The GFS on the System 5900 operates synchronous with the MBSS and covers a ±45 degree sector directly below, and slightly ahead of, the tow

Typical Topside Configuration

body path, resulting in full coverage over the entire sonar swath.

SYNCHRONIZED DATA PROCESSING

The System 5900 Transceiver Processing Unit, or TPU, (located topside, onboard the vessel of opportunity) uses a combination of high-speed processing electronics and integrated hardware to accurately synchronize and timestamp all sonar/sensor data with a time reference standard (1PPS via GPS). This is critical to ensure precise timing between sonar and sensor data to allow for accurate post-processing.

HIGH-SPEED OPERATION AND FULL BOTTOM COVERAGE

The System 5900 is designed to provide high-resolution imagery over its full operating speed envelope while maintaining 100% bottom coverage. The System 5900 can operate at tow speeds up to 12 knots while providing a sonar range of 150 m (swath width of 300 m).

REMOTE-CONTROLLED OPERATION

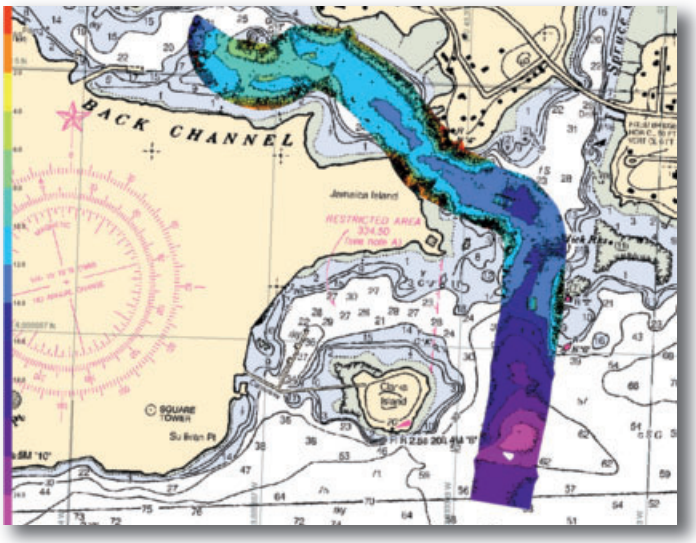
The System 5900 is optimally designed for use by an autonomous or semi-autonomous vessel allowing real-time data collection and transmission from mine hunting missions without placing personnel in danger. The remote-controlled operation allows the System 5900 to collect and transmit data while hosting other surveillance sensors.

The System 5900 can be deployed from a variety of vessels while reduced data sets are transmitted to observation platform or platforms.

INTEGRATED TOW BODY SENSORS AND SUBSYSTEMS

The System 5900 continues to support an array of advanced third-party sensors and subsystems to produce a fully integrated set of sonar/sensor data to aid in mission-specific, post-processing applications. These sensors include water temperature, tow body depth and tow body motion. The L-3 Klein-designed motion sensor uses state-of-the-art technologies to provide accurate and rapid measurements of tow body attitude/accelerations necessary to support image stabilization beamforming.

The System 5900 also incorporates a precision acoustic altimeter which is used to accurately



Swath Bathymetry Data Overlay

measure the attitude directly beneath the towfish. This information is not only critical for the safe operation of the tow body during a survey, but it is also used to provide single-point depth measurements beneath the tow vehicle track.

The System 5900 supports several ancillary sensors such as precision magnetometers and ultra-short base line (USBL) acoustic responders for more accurate tow body positioning.

KLEIN SYSTEM 5900

System 5900 Specifications

GENERAL SPECIFICATIONS	
Towfish Length	Without GFS: 2.37 m (7 ft. 9 in.) With GFS: TBD
Towfish Diameter	20 cm (8 in.)
Towfish Weight (in air)	Without GFS: 163 kg (360 lb.) With GFS: 192 kg (422 lb.)
Depth Rating	750m without GFS

MULTI-BEAM SIDE SCAN SONAR	
Operating Speed Envelope (100% bottom coverage)	4 to 12 kts
Number of Beams	Variable – increasing with speed as required to fulfill 100% bottom coverage (for given beam spacing)
Frequency	600 kHz
Pulse Type	4, 8 and 16 msec (LFM-Chirp)
Resolution (Along-Track)	6.2 cm to 50 m (constant) 9.3 cm to 75 m (constant) 12.4 cm to 100 m (constant) < 0.07° beamwidth for range > 100 m
Resolution (Across-Track)	4.0 cm, nominal
Maximum Operating Range	150 m per side (300 m swath)
Array Length	Receive: 1.8 m Transmit: 1.2 m
Background to Shadow Contrast Ratio (CR)	> 10 dB – Detection > 15 dB – Classification
Towfish Sensors (Standard)	3-axis linear acceleration, 3-axis angular attitude rate, pressure (depth) and altimeter
Output Data	Sonar Data Format (SDF)

Klein System 5900
Being Lowered Into Water

INTERFEROMETRIC BATHYMETRIC (OPTION)	
Maximum Tow Speed (with 100% bottom coverage)	Co-registered to SSS, one swath per ping
Frequency	455 kHz
Number of Beams	Single beam (one per side)
Resolution (Along-Track)	0.42°
Resolution (Across-Track)	Programmable
Pulse Type	4, 8 and 16 msec (LFM-Chirp)
Maximum Range	150 m (range slaved to SSS)
Vertical Resolution	Comparable to IHO Special Order (dependant on MRU)
Output Data	SFD, XYZ, Generic Sensor Format (GSF)

GAP-FILLER SONAR (OPTION)	
Frequency	750 kHz
Across-Track Coverage	2*45° athwart ship (projected to below the towfish)
Target Imaging Angle	30° grazing angle (declination below horizontal)
Transmit Vertical Beamwidth	Switchable, 7.5° or 15°
Transmit Horizontal Beamwidth	3 successive pulses, each 20° wide
Receive Horizontal Beamwidth	0.65°
Pulse Type	4 msec (LFM-Chirp)
Resolution (Along-Track)	4.8 cm
Resolution (Across-Track)	Receive horizontal beamwidth 0.65° (dynamically focused)
Sonar Data Format (SDF)	Integrated into SSS SDF

OPTIONAL ACCESSORIES
Responder Interface, Magnetometer Interface, Articulated Depressor Wing, Terrain-Following Using Controllable Tail, Sound Speed Sensor

The System 5900 data is compatible with the MEDAL Database.

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