



**SHARP**<sup>TM</sup>  
**Eye**



**ACROSS OCEAN, LITTORAL AND LAND**

**SITUATIONAL INTELLIGENCE, THE WORLD OVER**

# RADAR REINVENTED

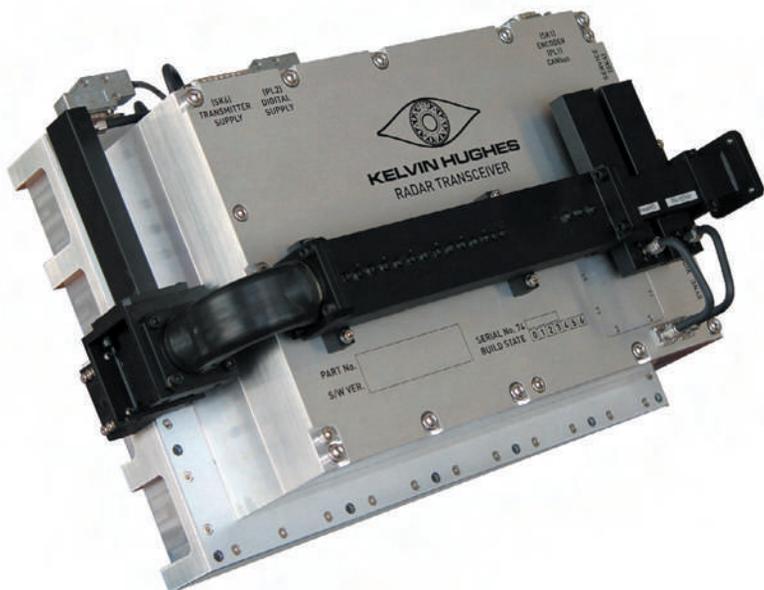
**From our naval background to our latest ground-based radar solutions, Kelvin Hughes provides surveillance across ocean, littoral and land.**

With a long and proud history in the supply of marine navigation systems behind it, the name Kelvin Hughes has become synonymous with engineering excellence and outstanding performance. Out of this nautical pedigree, dating back to the 18th Century, the company has over the last 65 years established a reputation as one of the world's foremost suppliers of surveillance radars to both the naval and merchant marine markets.

## **PUSHING THE FRONTIERS**

Our culture of innovation and rich expertise in radar design and development has enabled us to constantly push back the boundaries of technology since we introduced the world's first commercially available marine radar in 1947. Kelvin Hughes subsequently established its presence in the naval sector through several generations of magnetron-based navigation radars, culminating in the highly successful Type 1007 system and the follow-on KH 2007 series (available in both I-band and E/F-band variants).

More recently, we redefined the state-of-the-art for both commercial marine and naval operators with the introduction of SharpEye™ technology. SharpEye™ represents a radical departure from legacy marine navigation radar practice through its embodiment of a low-power solid-state transceiver design and advanced pulse-Doppler processing techniques. The result is a fully coherent sensor that delivers superior situational awareness and outstanding in-service reliability at a price point significantly below that associated with traditional naval surveillance radars.



The introduction of SharpEye™ is testament to Kelvin Hughes' solution-led ethos. Capitalising on our broad knowledge in radio frequency engineering, antenna design, algorithm development and performance modelling, underpinned by taut programme and risk management, we broke the mould by introducing a solid state navigation radar offering the combined attributes of much improved small target detection performance (even in heavy clutter conditions), high reliability, reduced maintenance and low through-life costs.

As the world's first affordable multi-capability radar with multi-site configuration options, SharpEye™ overcomes the limitations of conventional magnetron-based radars by using an ultra-stable low power amplifier transceiver with a peak output power of just 200W and a duty of 10%. This contrasts with conventional magnetron based marine navigation radar systems which have a 30kW output and duty typically less than 0.05%.

Using advanced digital pulse compression techniques, SharpEye™ outputs an equivalent peak power of 200 kW (assuming a maximum pulse compression ratio of 1:1,000), achieving detection ranges significantly in excess of those obtained using a conventional navigation radar. To provide the extra dimension, SharpEye™ uses coherent integration and Doppler processing to deliver system performance offering vastly superior detection and tracking of small targets in inclement conditions day or night.

How is this performed? SharpEye™ transmits relatively long pulses in order to illuminate targets with sufficient energy for detection. To provide the required short range performance, SharpEye™ transmits a patented sequence of pulses of differing length, with each pulse optimised to cover a specified but overlapping range bracket.

A filter bank processes the echoes received from the pulse sequence to extract the radial velocities of targets and clutter alike. Within the digital signal processor detection thresholds for each of the filters within the bank are calculated adaptively according to sophisticated algorithms, providing optimum control of false alarms while maximising clutter suppression and target detection.

The innovative RF architecture of SharpEye™ delivers major reliability benefits. The absence of a magnetron and modulator eliminates the high voltages and critical components that most frequently fail in conventional radar systems. Instead, SharpEye™ operates off a simple low voltage power supply.

Signal processing algorithms are implemented within a single device in the receiver, thereby ensuring a very low component count within the transceiver. This combination of low voltage and a rationalised hardware package ensures a very high mean time between failures. Furthermore, the removal of lifed items (magnetrons typically need changing every one or two years) means there is no requirement for routine maintenance, and spares stockholdings are thus reduced commensurately.



# SHARP<sup>TM</sup> Eye

The I-band and E/F-band variants of SharpEye<sup>TM</sup> have now entered naval service, providing host platforms with improved navigation, surface surveillance and helicopter control capabilities. A mobile land-based variant uses the same SharpEye<sup>TM</sup> radar as a remote coastal surveillance sensor.

Kelvin Hughes is also continuing to develop the SharpEye<sup>TM</sup> radar for maritime applications through the introduction of a compact variant optimised for small craft such as rigid inflatable boats and fast insertion craft. This latest iteration will put the improved picture clarity and target discrimination offered by coherent radar into the hands of boarding parties and Special Forces teams previously reliant on conventional navigation radars.

## **SURVEILLANCE SOLUTIONS**

Today, recognising the growing global requirement for high performance yet cost-effective surveillance solutions, Kelvin Hughes has broadened its market horizons by establishing a focused Surveillance Systems Business to meet the emerging security and situational awareness needs of customers at sea and on land. Already a key provider of radar systems to the world's navies, we are now exploiting our extensive background in radar surveillance and small target detection to meet the exacting requirements of military, quasi-military, law enforcement and commercial security agencies charged to ensure the protection of borders, bases, critical infrastructures and key lines of communication.

To do this, we are leveraging the proven pedigree of our core SharpEye<sup>TM</sup> technology to meet the specific surveillance needs associated with the land environment. Test and trials activities using an existing SharpEye<sup>TM</sup> sensor have demonstrated the accurate detection and tracking of small ground moving targets in a variety of conditions and scenarios. What's more, the intrinsic reliability of the technology opens the way for multiple systems to be networked so as to provide comprehensive surveillance coverage over a wide area, and/or in physically remote locations.

In parallel, we have invested in the selective engineering of new subsystems specifically matched to land-based applications. The result is BOXER, a family of coherent radar solutions scaled for portable, deployable and fixed applications. BOXER offers attributes of low cost, low power, lightweight and superior performance by adopting maximum

commonality with the modular low-power architecture and advanced signal processing already embodied in the I-band variant of SharpEye<sup>TM</sup>. It additionally introduces a new electronically scanned array, delivering the performance benefits associated with electronic beam steering in azimuth, and affording further reliability improvements by removing all moving parts from the antenna.

Serving applications within the portable radar market, this device inherits the frequency generation, up conversion, receiver and signal processing functionality from the existing SharpEye<sup>TM</sup> product, but repackages these components into a lightweight configuration.

In addition, a new modular power amplifier provides 50W peak power and graceful degradation in the event of failure. This approach enables the use of our proven Doppler processing techniques to discriminate slow moving targets from background clutter, and provide long range detection of larger objects.

## **PHASED ARRAY TECHNOLOGY**

This technology is integrated with a phased array antenna solution providing a 2 degree beamwidth and an azimuth beamsteering capability. This assembly is suitable for tripod mounting, vehicle mounting with a rotating antenna option to achieve 360 degree coverage, or mast mounting for portable, mobile and semi-permanent applications. Power can be provided via a variety of sources using existing, in service battery and power management technology. This enables the system to be operated using mains supply, vehicle batteries or portable batteries, with recharging capability.

Finally, BOXER can identify and classify targets and incorporate ground and terrain mapping on a range of suitable displays.

The first member of the BOXER family is a lightweight and easily re-locatable Man-Portable System (MPS) that can be transported in its entirety by just two people. Mobile (trailer-mounted) and fixed site BOXER variants will follow in due course.

After over two centuries producing and supplying instrumentation and equipment to the marine world, Kelvin Hughes is now tailoring its leading edge solid state radar technology to meet the surveillance, safety and security needs of defence forces, quasi-military organisations and security agencies. We are setting new benchmarks in situational intelligence, the world over.



### COASTAL SURVEILLANCE

A remotely-operated SharpEye™ coastal radar network combines attributes of low maintenance, high reliability and excellent target detection and discrimination in all conditions

### HELICOPTER CONTROL

SharpEye™ enables robust detection and tracking of helicopters down to the deck, and its excellent performance avoids the need for dedicated echo-enhancing transponder systems

### BORDER

BOXER radars can provide pattern of life intelligence and early threat warning as part of a multi-sensor surveillance system



### FORWARD OPERATING BASE

A network of vehicle-mounted BOXER sensors can be rapidly established in the field to provide perimeter protection for a temporary operating base

### PALACE

Discretely installed, and requiring minimal maintenance, BOXER provides vital early warning at range



### INFANTRY PLATOON

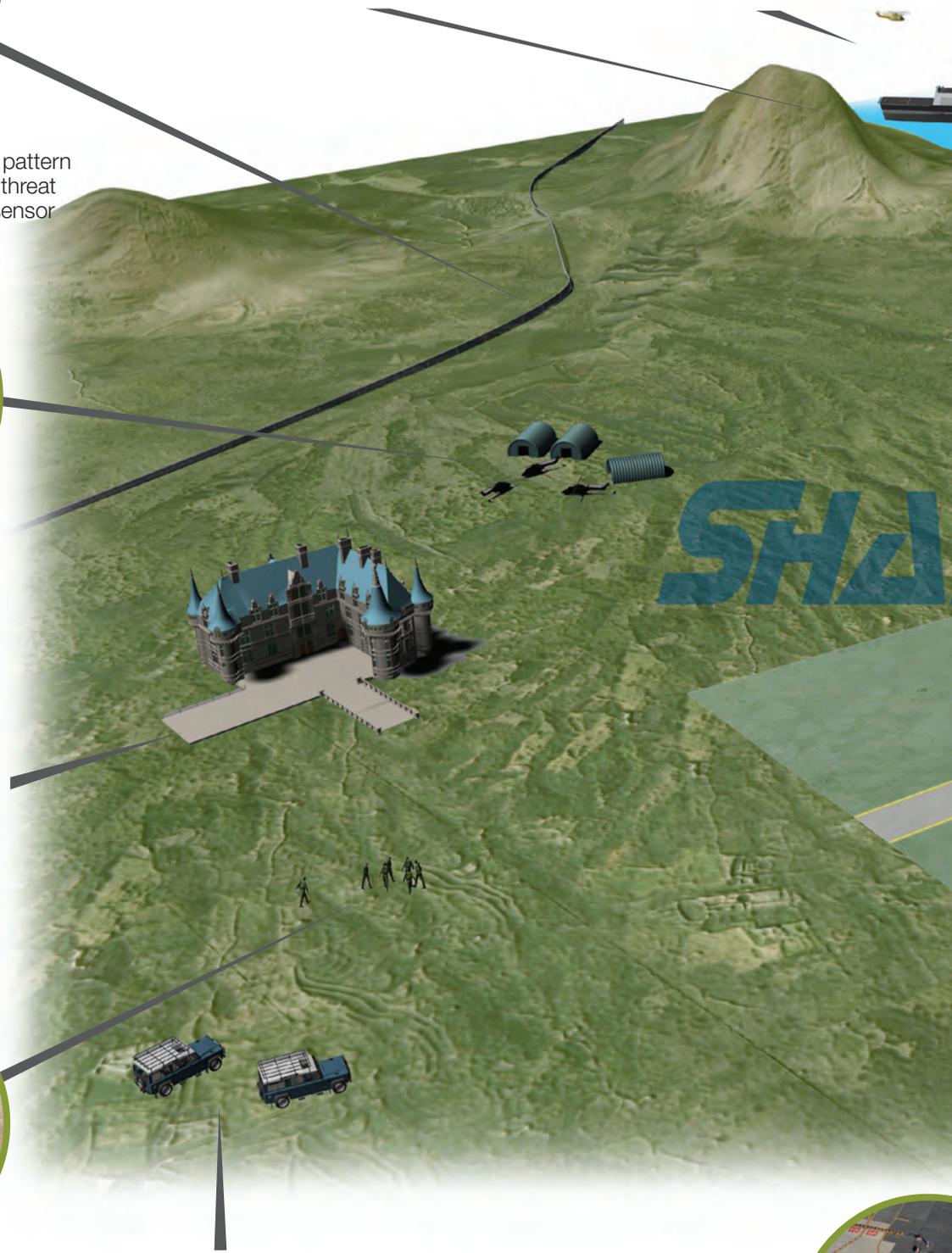
Designed to be easily transported on the battlefield, the portable BOXER system gives ground forces a lightweight, self-contained and low power ground surveillance capability

### PORTABLE RADAR

A towed or vehicle-mounted BOXER system can be rapidly redeployed to meet critical surveillance needs

### SURFACE MOVEMENT RADAR

The clarity and precision of the SharpEye™ real-time picture allows for tracking of aircraft and vehicles on runways and taxiways



**SURFACE SHIP**

SharpEye™ delivers outstanding surface situational awareness, and brings unmatched small target performance against low RCS targets, such as FIACs and periscopes, in heavy clutter



**PORT**

A solution from the SBS product family is able to detect extremely small and slow targets, even in cluttered and crowded harbour environments



**RIGID INFLATABLE BOAT**

SharpEye™ SCV delivers small craft with an organic capability for tactical situational awareness, increasing their safety and mission autonomy



**CRITICAL INFRASTRUCTURE**

A fixed BOXER installation provides a persistent but unobtrusive means of intruder detection over a wide area



**EXCLUSION ZONE**

Offering timely and accurate intruder alerts, BOXER is ideally suited to exclusion zone surveillance



**PERIMETER SECURITY**

BOXER can be configured to scan a wide area, or cover a specific sector, feature or access route



RP™  
Eye

# SUPERIOR SURVEILLANCE

Based on a solid-state architecture, and exploiting pulse compression and Doppler processing techniques to dramatically improve small target detection, the SharpEye™ family of surveillance radars transcending multiple domains and applications.

Kelvin Hughes coherent surveillance radar solutions have been developed to provide the defence, quasi-military and security customers with high performance sensor solutions able to pinpoint the most difficult targets regardless of the clutter environment. They are exceptionally reliable, easy to use and packaged to meet the demands of the harshest environments, at sea or on-land, in static, deployable or portable modes.

The modular and scalable design embodied in SharpEye™ brings solid state technology within reach across all surveillance applications for the first time.

## AT SEA

SharpEye™ was specifically designed for navigation and surface situational awareness at sea, and exceeds the stringent performance requirements mandated by the IMO under IEC 62388. It aids safe navigation and collision avoidance, and supports complex tactical manoeuvres between ships in close company.

The threat posed by FIACs and other asymmetric surface threats demands improved surface surveillance out to the radar horizon. Compared to conventional magnetron-based navigation radars SharpEye™ delivers an improvement in sub-clutter visibility in the region of 30 dB, enabling small radar cross section (RCS) targets to be detected even in the presence of heavy sea and weather clutter.

Submarine periscopes present another difficult target set on account of their low RCS and intermittent exposure. However, while conventional navigation radars have little chance of detecting periscopes, SharpEye™ Doppler processing enables the separation of these very low RCS targets from background sea and weather clutter.

SharpEye's™ coherent Pulse Doppler capabilities also enable the robust detection and tracking of helicopters

down to the deck, eliminating the need for transponder systems for helicopter tracking and control.

Furthermore, helicopter approaches can

be controlled from the bridge using a common navigation/helicopter control sensor.

We have developed the lightweight SharpEye™ SCV transceiver to meet emerging requirements for improved small boat situational awareness. By reducing radar mass and footprint, and able to integrate with a number of display solutions, SharpEye™ SCV overcomes the inherent performance limitations of commercial-type navigation radars in cluttered environments and present small craft operators with a high quality radar picture.

For special forces and raiding teams, SharpEye™ SCV provides a discreet means of building an organic surveillance picture out to the horizon, so reducing reliance on external communications links and informing real-time tactical decision-making. The advantages of organic domain awareness also translate to boarding operations, where a forward deployed interdicator craft can now manage its own tactical picture and share information with a mother vessel so as to extend its picture beyond the horizon.

## COASTAL SURVEILLANCE

Installed at fixed shoreline sites, or deployed in a mobile configuration, our SBS (Shore Based System) provides the ability to detect, monitor and track traffic in the littoral zone as part of a coastal protection solution. Affording a capability to detect targets with widely differing characteristics and behaviours – including small and slow targets, fast craft and larger vessels – SharpEye™ is ideally suited to integration as part of a wide area coastal



surveillance network.

Furthermore, radar outputs can be integrated, via standard open interface, with a variety of radar tracker extractors, display/command systems and geographic information system (GIS) products.

To meet requirements for a rapidly deployable coast surveillance capability, we have developed an autonomous trailer-based system (a member of the BOXER family) that can be towed or airlifted to ensure littoral protection when and where it is needed most. Combining the outstanding radar picture of the SharpEye™ radar with an adjunct optronic sensor head – mounted on an extendable, elevated platform to allow maximum coverage – the system can be set up in less than 30 minutes.

Operator workload is reduced by automatically providing the location and bearing information of the system on a GIS; radar tracks and the field-of-view of optronic sensors are also overlaid onto the GIS. The optronics subsystem can be automatically cued by a radar detection, or controlled manually by the operator.

## ON LAND



Leveraging core SharpEye™ technology, and introducing the performance and reliability benefits associated with an electronically-scanned antenna, the BOXER family of coherent radars has been designed by Kelvin Hughes to meet the specific requirements of defence, quasi-military and security users. The result is a modular and scalable architecture that packages our solid state technology for a wide range of portable, deployable and fixed applications.

The electronic scanning antenna and Doppler processing technology employed by BOXER enables the detection of extremely small and slow targets, even if they are moving in cluttered environments and/or difficult terrain. Operation in the I (X) band affords better range/resolution performance than higher frequency radar systems in all weather conditions. The ultra-high reliability and low power consumption of solid state technology is an important factor when minimal infrastructure is available in the field.

To meet forward observation and force protection requirements at platoon level, we have developed a modular and highly portable BOXER system providing ground forces a lightweight, self-contained and low power ground surveillance capability. Easily broken down for transportation, the BOXER MPS comprises a complete radar (including a 1.5 x 0.5 m planar antenna array) in one packing case, with a second case accommodating all

ancillary elements (a mounting system, power supply and ruggedized laptop or tablet display).

We have optimised BOXER MPS for battlefield operations at the platoon level (with a typical mission duration of 2-5 days), providing an infantry unit with a means to establish tactical situational awareness in its local area.

To address surveillance requirements for forward operating bases and encampments, a network of vehicle-mounted BOXER sensors can be assembled as part of a perimeter surveillance and protection system. Each node is typically networked into a single common display, which may itself be integrated into a larger command and control infrastructure alongside additional optronic sensors.

## CRITICAL INFRASTRUCTURE

There is a growing recognition across stakeholders in government, industry and commerce of the potential vulnerability of coastal and land-based critical infrastructures and energy supply lines to attack from terrorist groups and



organised criminal syndicates. Examples include nuclear facilities, ports and transshipment areas, power stations, oil platforms, petro-chemical plants, pipelines, airports, military bases and VIP residences.

A fixed BOXER installation provides affordable surveillance for critical infrastructure protection, providing high confidence long range early warning of intruders and/or vehicles, change detection over time, and intelligence on unusual patterns of behaviour. BOXER can provide wide area surveillance, or be set to scan a narrow sector in order to cover a specific facility or point of access.

Unobtrusive, easily installed and requiring minimal maintenance, BOXER can use local power supplies. It further lends itself to integration with other perimeter security sensors such as CCTV and infrared cameras.

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# A NEW STANDARD IN SURVEILLANCE

**LAUNCHING INNOVATIVE AND UNIQUE PRODUCTS  
TO THE SURVEILLANCE RADAR MARKET.**

With 250 years' experience in the marine world, Kelvin Hughes is the leading supplier of innovative, high end, yet affordable situational awareness radar technology to 30 of the world's navies. Utilising SharpEye™ technology, we are now delivering our surveillance capabilities to the full market spectrum – at sea, onshore and on land.

Alongside our naval, coastal surveillance and VTS radar offerings, Kelvin Hughes Surveillance is now introducing a number of new, specialist solutions. These include a portable and lightweight sensor and phased array antenna technology for land applications, lightweight radar solutions for fast watercraft such as RHIBs, and airport surface movement radar systems.

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