

## TECHNOLOGY FEATURE



# PESA Technology gives Blighter Radar the Edge

By Mark Radford, CEO at Blighter Surveillance Systems

Passive electronically scanned array (PESA) radar technology continues to provide a low power, lower cost and highly reliable surveillance solution for both military and commercial markets

Whether for detecting smugglers, pirates, terrorists, insurgents or illegals in rough seas, hilly or mountainous terrain, at border crossings, airports and seaports, electronic-scanning Doppler radars provide an all-weather, wide-area, low false alarm rate (FAR) and high reliability persistent surveillance capability.

Recent developments in electronic-scanning (e-scan) radars has seen a move away from the expensive and power-hungry AESA (active electronically scanned array) military radar technology

to the newer and much lower-cost PESA (passive electronically scanned array) radar technology.

Low power PESA technology offers significant advantages over alternative architectures such as AESA technology being used in other e-scan radars. PESA technology is simple, though tricky to design in the first instance, but once the e-scan module is manufactured it can be used symmetrically on both the transmit and receive channels and it requires very low power consumption leading to low internal heating and hence high reliability.

Another benefit of these solid state PESA radars is that during scanning, the radar's microwave beam is entirely stationary,

allowing such systems to detect very small and slow moving targets in extremely cluttered environments. This improves their detection capabilities and reduces the false alarm rate. Contrast this with mechanically rotating radars, where the reflected signals received by the radar are always blurred by the continuous rotational movement of the antenna.

The Blighter® radar was the first commercial electronic-scanning ground surveillance radar (GSR) on the market and its modular solid state design – uniquely low power due to the PESA technology – continues to give Blighter the edge over other e-scan radars. It is now used in scores of countries including by the British Army for force protection,

Heathrow Airport for key zone surveillance, and by the South Koreans to protect its demilitarised zone (DMZ).

## How PESA works?

The Blighter radar series is based on a common, state-of-the-art set of technologies. Blighter uses a PESA antenna system allowing it to scan up to 360°, in steps of 90°, in azimuth with zero movement inside or outside of the radar system. With no moving parts and entirely solid-state technology, Blighter offers ultra high reliability, a long zero maintenance period of up to five years and an in-service life of up to 15 years.

Blighter's PESA e-scan modules use a unique waveguide structure to achieve the azimuth beam steering. Unlike traditional AESA antennas, which use multiple power-hungry power and phase control elements, Blighter's unique PESA units require just one efficient transmitter and one receiver unit per radar unit. Due to this compact and simple architecture, Blighter uses e-scan modules on both the transmit and receive paths resulting in exceptionally low side lobe levels, which allows it to operate in complex and cluttered environments without detecting phantom targets from large targets outside of the radar beam.

In the case of the B400 series radar, the e-scan modules inside the radar units can

*Blighter Revolution 360 ground surveillance radar on vehicle mast with long range camera system.*



*Korean DMZ – where Blighter radars provide a persistent surveillance capability. (copyright istock.com-gkgraphics).*

be configured with user interchangeable external antennas. For coastal security applications the M10S long-range antenna is recommended as its 10° elevation beam can achieve long detection ranges over the water surface, whereas the W20S antenna is more suited to the ground variant Blighter radar for use in hilly terrain. Both antenna types allow the Digital Beam Forming of the e-scan

modules to optimally scan the radar beam in only the direction of interest and with no wasteful overspill.

## Coactive Doppler fast-scan capability

Blighter's combination of technologies including PESA e-scan and Doppler, which are all controlled through sophisticated Digital Signal Processing (DSP) and Waveform Generation (WG) units, allows a wide diversity of radar waveforms and azimuth scan speeds. The Blighter radar allows both fast scanning simultaneous with Doppler velocity filtering using its 'Coactive Doppler fast-scan' capability. Traditional non-Doppler radar can scan fast, whereas traditional Doppler radars rotate slowly. Blighter achieves the best of both capabilities.

Blighter's advanced frequency modulated continuous wave (FMCW) transmission technology is an alternative to the traditional Magnetron pulse transmitters or solid-state pulse-compression transmitters used by older radars. Key attributes of FMCW include an enormous instantaneous dynamic range in the receiver channel, allowing small targets to still be detectable alongside large targets or clutter. FMCW is also very efficient allowing considerably less transmitter power to be required.

The FMCW transmission is like a whisper compared to the shout from traditional rotating radar's high power pulsed transmitters. Blighter's low power FMCW transmission therefore cannot be detected on conventional 'radar speed trap warning detectors' meaning that intruders are not aware that they are being monitored.



Combination of the Blighter B202 Mk 2 portable ground surveillance radar and Liteye's Aquila PTZ thermal surveillance system provides a virtual fortress around VIPs

The Blighter radar unit contains an integrated Digital Signal Processing (DSP) unit that provides all the functions performed by a stand-alone radar processing unit in traditional systems. The integrated DSP provides the FMCW, Doppler, Thresholding, CFAR, Plot Extraction and target filtering functions. The output from the Blighter radar is a low bandwidth digital data stream over a 10/100BASE-T/TX Ethernet interface.

Blighter's Doppler Signal Processing feature is a key benefit. On each and every radar scan all targets and clutter are measured and characterised by their Doppler velocity. As colour is to CCTV images, Doppler is to radar detection. Doppler adds a third dimension to target detection, so not only are targets identified in Azimuth (PESA) and Range (FMCW), but they are also discriminated by Doppler velocity. This allows valid targets to be discriminated and separated from the surrounding clutter.

### Blighter uses Ku radar band

The Blighter radar operates in the internationally recognised and approved Ku radar band, at around 15GHz. Ku Band offers some unique advantages for security applications. Firstly, the high frequency used means that radar, including its antennas, has twice the performance of an equivalent sized X band radar. Secondly, the Ku Band is considerably less congested than X band.

The Blighter radar includes a special 'Rain Filter' built into the integrated signal processor that enables it to continue detecting valid targets while suppressing unwanted target-like signals produced by the rain clutter itself.

### Inherently low power

The Blighter radars' FMCW transmission technology, combined with sensitive

Doppler target detection means that the radars requires only a fraction of the transmitter power used by traditional security type radars systems.

Blighter transmits only 4 Watts of power, just a little more than a cell phone and equivalent to a modern LED light bulb, yet it is able to detect a man sized target at ranges up to 10km away. This low power transmission requirement also means that the total power consumption is a fraction of other radars.

The Blighter B400 series radar consumes just 100 Watts of power enabling it to be operated continuously from battery-backed solar or wind powered generators. One square metre of solar panel in full daylight can provide enough energy to operate Blighter, though of course additional panels are required to charge batteries for operation through the night and in poor weather conditions.

The integrated Digital Signal Processing circuits in Blighter provide most of the radar processing functions performed by remote 'Plot Extractor' systems in other radars. The process of plot extraction dramatically reduces the data bandwidth such that instead of needing to distribute raw radar video with a bandwidth requirement of 10 to 20MHz, Blighter's processed Plot output is a mere 10kbits/s.

This narrow band data requirement enables simple, low cost and low latency distribution via many communication systems. Typically a simple Ethernet connection may be used, over copper or fibre, to carry multiple Blighter radar channels. But for remote operation, mesh radio systems, point-to-point microwave links or even Sat Comm can be used. If video from camera systems is required then Blighter's data channel will piggy-back on the video data channel consuming just a small percentage of the bandwidth required for camera video.

### Compact size

Unlike conventional surveillance systems, Blighter's Ku Band PESA technology means that it is incredibly compact in size. The main radar unit containing PESA e-scan modules, Transmitter, Receiver, Waveform Generator, Signal Processor and PSU is contained in a single unit about the size as a large briefcase. A variety of antennas attach to the front of the radar unit depending on coverage required, but even the antennas are narrower than the radar unit at about 0.5m.

For many remote radar sites, especially temporary ones, Blighter's compact size and light weight means that it can be hand-carried and installed without any lifting gear or specialist transport. Furthermore, it can if required be

mounted temporarily on tripods or other temporary structures.

As Blighter scans, it uses its PESA, Doppler and FMCW technology to immediately detect potential intruders and show them on an overlay map. As well as predicting the position of the target through extrapolation of the target's heading and speed, the BlighterView HMI 2 command and control software platform also records all historical target data.

Doppler radar, camera...action  
Almost every security radar system requires the interaction of a camera system in order to observe the object initially detected by the radar. Blighter is no exception, it provides early warning of intruders over long ranges and potentially thousands of square kilometres. Additionally it attempts to classify the target by assessing its key radar characteristics - the radar cross sectional area and Doppler velocity.

Although this target classification helps the BlighterView HMI 2 to filter different classes of target, every operator wants to see the intruder with their own eyes. BlighterView HMI 2 includes an extensive long-range camera control panel with lots of functionality to provide automatic, semi-automatic and manually initiated cueing of the camera system to observe the target or targets of interest.

Typical 'cameras' include multi-sensor electro-optic camera systems including daylight colour, night time thermal imager, often a wide field-of-view 'context' camera and sometimes a Laser Range Finder (LRF), though this is less necessary with the radar already providing accurate range measurement. Each alert zone can be configured to cue a selected camera either to a fixed point in the zone, the target position in that



Plextek Blighter B442 E scan radar.

zone, or to initiate auto-tracking. Some camera systems include a video tracking capability, which BlighterView HMI 2 supports.

### Key markets

Blighter ITAR-free PESA radars plus cameras, thermal imagers, trackers and software solutions are used worldwide in commercial, government and defence markets in area and asset protection for national border security, homeland security, critical infrastructure protection such as airports, coastal surveillance, and in military applications.

Blighter's B400 series long range radars have been operational in South Korea for some years providing a persistent surveillance capability along the Korean Demilitarised Zone (DMZ), a buffer zone which runs 250km across the Korean peninsula and separates North and South Korea. The region is considered one of the world's most mountainous areas with environmental extremes of -30°C in winter and a humid +40°C in summer. The Blighter radars work 24 hours a day, 365 days a year, monitoring the 4km-wide DMZ for any human, vehicle or low-flying aircraft incursions.

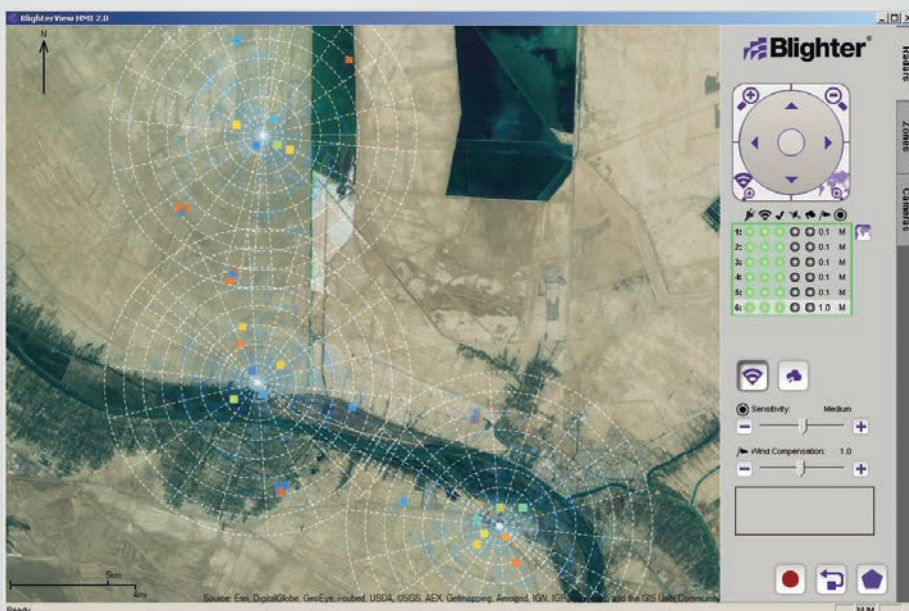
Blighter PESA radars are particularly well suited to border security applications due to their long-range detection capability (10m to 2km in steps up to 32km), 20° wide elevation beam and their ability to detect very small and slow targets even in cluttered environments.

### Borders and coastlines

The inherent modularity of Blighter's PESA radar technology makes it relatively straightforward to tailor the core technology to different markets or to address specific surveillance situations. For example, at this year's Eurosatory in Paris, the company will unveil Blighter Scout, a rapid deployment radar camera system for border security hotspots and other similar security applications.

Blighter Scout is a lightweight e-scan radar and camera surveillance system featuring the Blighter Revolution 360 PESA radar, low light camera, thermal imaging system and an integrated radar tracker. It's designed

BlighterView HMI 2.0 Screen Snapshot – Satellite Map – Zoomed Out





*Blighter B422 E-scan Radar and Liteye Aquila Daytime and Thermal Camera System at Airport*

for mounting on vehicle and trailer masts for field deployment in just minutes.

Blighter Scout provides a low cost and lightweight mobile surveillance capability for situations where fixed towers are prohibitively expensive, impractical to build or simply ineffective due to the terrain or environment. It enables security forces to deploy a surveillance platform to exactly where it's needed. For example, to monitor a hot spot on an extensive border or to follow intruder routes as they adapt to the seasons or in reaction to ground interdiction.

Blighter Scout can be supplied in a palletised form complete with a standard telescopic mast ready to slide onto the back of a standard 4x4 pickup truck or other surveillance vehicles/trailers. The complete system requires only a single mast as the electro-optic platform is mounted on top with the radar rotating around the mast section directly below it.

The radar can detect a walking person at 7.4 km (4.6 miles) or a large moving vehicle at 22 km (13.7 miles) and then cue the camera system to follow and identify targets. With its wide 20-degree continuous elevation beam coverage – which can be increased to 40-degrees via a simple built-in manual tilt control – Blighter Scout can operate in hilly or mountainous areas scanning hill tops and

valleys in a single sweep.

Blighter Scout integrates with a range of electro-optic camera systems. The standard complementary system for Blighter Scout is Chess Dynamics' Hawkeye electro-optic platform featuring the Piranha MRTV or LRTV high sensitivity colour daylight TV cameras and a Piranha TV wide field of view context camera – with an option for cooled or uncooled thermal imagers.

Similarly, Blighter has recently enhanced its B400 series PESA radars by adding a sea

clutter filter for coastal and harbour security applications. This filter enables Blighter's Doppler signal processing unit to uniquely filter out sea wave clutter returns in both velocity and amplitude. The Blighter coastal surveillance radar is optimised to detect small and slow moving targets under poor environmental conditions.

Blighter Surveillance Systems will be exhibiting at Eurosatory in Paris, France on 16-20 June (Hall 5, Stand K511) and at DVD, Millbrook Proving Ground, Millbrook, UK on 25-26 June (Stand SP49).

#### There are several products in the Blighter radar family:

- the 'B202 Mk 2' is a medium range (0-8km), lightweight, man-portable and/or vehicle-mobile radar capable of electronically scanning 90°.
- the B303 is a medium range (0-8km) compact mobile radar suited to mounting on a mast on vehicles or trailers. The 180° electronic scanning of the B303 provides a cost effective 360° solution using just two units back-to-back.
- the B400 series radars are for long range (0-2, 5, 8, 16 or 32km), fixed or mobile installations on towers, buildings or other pieces of fixed infrastructure. The B400 series radar is a modular design allowing from 90° of electronic scanning on the B402 up to a full 360° on a B442 radar.
- Blighter Revolution 360 radar is a low cost, lightweight vehicle-mobile radar for use on vehicle masts and trailer masts. Uses a single B400 series radar unit. Option with integrated electro-optic system is called Blighter Scout.