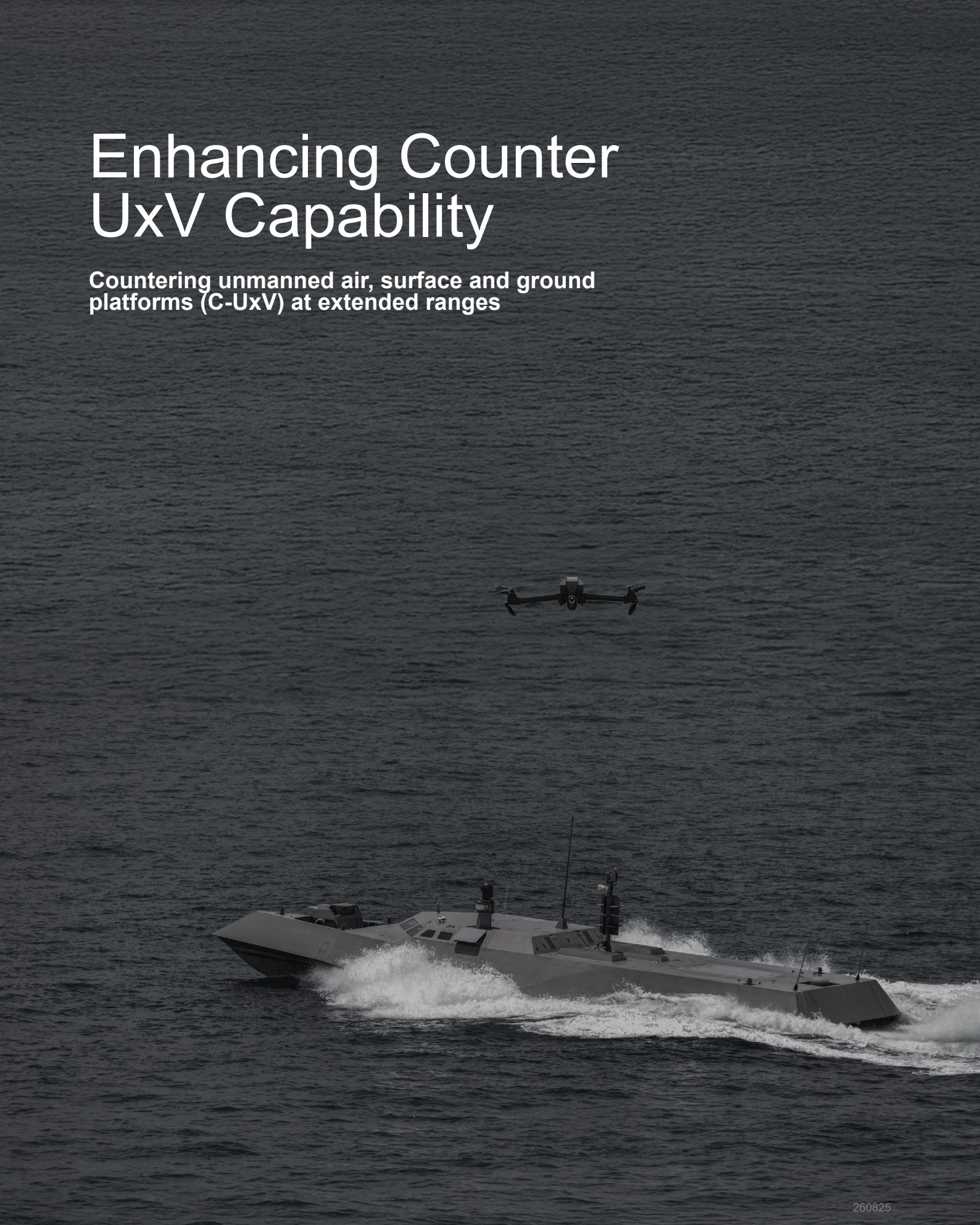
# Enhancing Counter UxV Capability

**Countering unmanned air, surface and ground platforms (C-UxV) at extended ranges**



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# The challenges of a coaxial-based Counter UxV system

Unmanned and autonomous platforms/vehicles (UxV), be they air, land or sea based, have rapidly become prevalent in applications related to Intelligence, Surveillance and Reconnaissance (ISR) activities and as payload carriers to provide offensive military capability.

Their low cost, operational flexibility, and unmanned capabilities make them ideal for accomplishing tasks in high risk areas.

Swarms of UxVs pose a significant problem in mitigation, especially if the swarm is acting as a cohesive unit rather than a large group of individual threats which are seen and mitigated regularly.

This makes C-UxV systems essential on the modern battlefield, but these systems often suffer from the following challenges due to being based on coaxial cabling.

## Reduced Engagement Range for Defeating UxV Threats

Coaxial data distribution systems tend to use power amplification that is co-located with, or a part of, the signal generation equipment that generates the effect.

This equipment is usually deep inside the platform, which leads to reduced RF transmit power at the antenna through the coaxial cable losses, in turn reducing the engagement range for the EA effect.

## Sub-Optimal Antenna Placement

The key to deliver an effective capability is antenna placement, relative to targets and other RF emitters on the platform.

Given EW systems are often constrained by coaxial cabling, the antennas are often located in sub-optimal positions, located near an RF emitter that interferes with received signals, for example, or blocked by platform structures such as masts or turrets.

Using coaxial cable, antennas have to be close enough to the signal receivers/generators to ensure that even high power signals remain detectable, and have enough transmit power to engage a target.

## Fixed Point-To-Point (P2P) Network Topologies

If an EW system uses coaxial cabling in a fixed P2P network topology, this links specific antennas in sub-optimal positions to wideband signal generators/receivers that are only using a fraction of their full capability.

This capability limitation manifests when capable and wideband signal generators/receivers are linked to a banded antenna, limiting the scope of the signal generator/receiver to that of the antenna.



# The solutions provided by an RFoF-based Counter UxV system

**Vs Coax, RF Over Fibre Achieves:**

**5X INCREASE IN DETECTION RANGE**

**7X INCREASE IN ENGAGEMENT RANGE**

## Increased Engagement Range for Defeating UxV Threats

Losing only 0.02 dB over 10 m compared with a loss of 3.6 dB over 10 m for coaxial*, an RFoF distribution solution provides a step change in EW capability, as well as supporting the coexistence of both analogue and digital RF formats to maintain future flexibility.

This lossless nature of an RFoF distribution solution manifests as a 5x increase in detection range (compared with a 10 m coaxial based antenna at 18 GHz), and a 7x increase in engagement range (compared with a 4 m coaxial based antenna system at 6 GHz with equivalent amplification).

## Antenna Suite Optimisation

The lossless nature of the fibre optic cabling removes any constraint on distance between antenna and signal generator/receiver.

This enables the antenna position to be optimised to:

- Reduce interference from other platform RF emitters
- Improve field of ‘view’ for unimpaired receiving/transmitting of RF signals.

## Optical Distribution (Hub/Star Network Topology)

An RFoF based solution allows any antenna and signal generator/receiver link to be mapped, and the signal routed. This enables the the EW system to dynamically optimise to the operational threat and theatre in less than a second.

This dynamic routing, or any-to-any mapping, removes the previous scope limitations and unlocks the full capability of the typically wideband signal generators/receivers in the EW system.

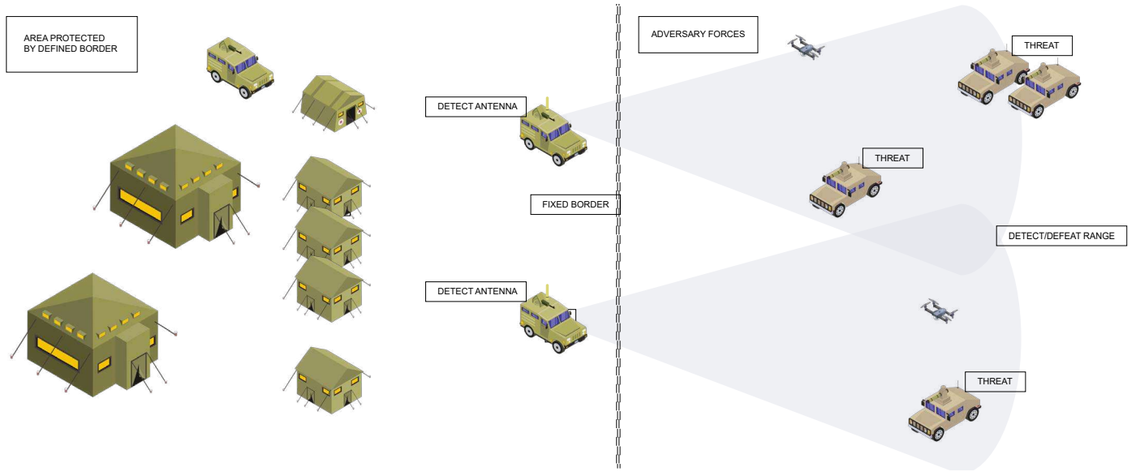
*(LMR-400-DB coaxial cable at 6 GHz and fibre optic at 1550 nm)

# Border/defined perimeter protection

One approach to providing an effective C-UxV capability is to focus on protecting a defined area such as a national border, or perimeter around a ship / critical infrastructure (e.g., airports). In these instances a more targeted DEFEAT effect is typically desired, as this minimises collateral disruptions and maximises engagement range.

To deliver this targeted effect, the C-UxV system (or other Electronic Surveillance systems) will DETECT the threat typically via its command link or positioning signal, then LOCATE it (typically as a bearing) and hand this data off to the DEFEAT element of the C-UxV system. This element of the system aims its directional antenna at the UxV positon, delivering a targeted DEFEAT effect at range.

The below illustration shows a border protection scenario, where a number of adversary UAVs are flying towards the border. These UAVs are detected and located, with the location data being used to control the direction of the DEFEAT effect, which can be triggered when the the UAVs are considered a threat.




A more complete C-UxV solution could encompass a mixture of a border / perimeter protection solution (i.e., directional antenna with positioner solution) and an individual platform protection solution (i.e., an omni direction antenna solution)

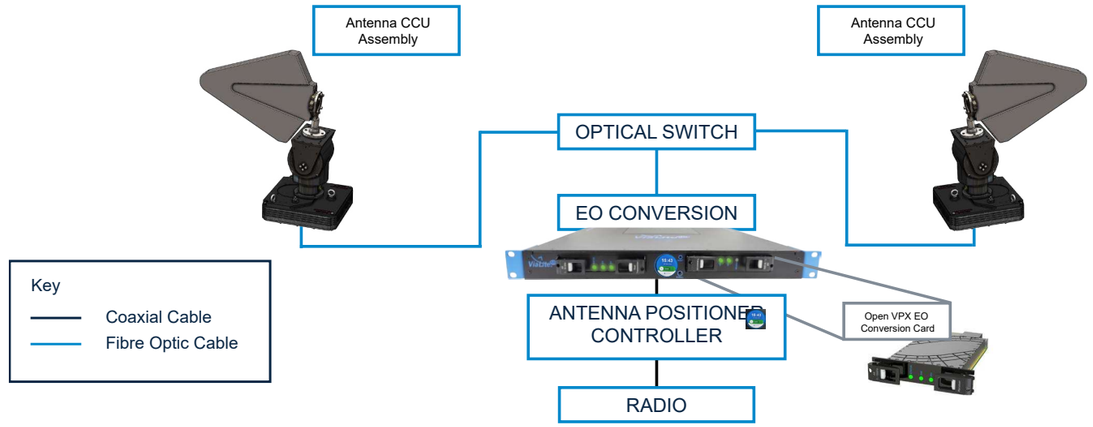




## Example Customer Solution – RF Tx for Defined Border Protection

**PART NUMBER: M543011**

An overview of an example customer solution where two antenna CCU assemblies with directional antennas provide the RFoF Tx capability.




**Class 1, 2 and 3 C-UAS Defeat** Frequency range to cover Class 1, 2 and 3 UASs with a Tx ERP order of magnitude greater than equivalent coaxial based solution.

**C-USV/UGV Defeat** Upgraded antenna positioner enables variable azimuth and elevation so that USVs/UGVs can be defeated as well as UASs.

**Enhanced Platform Coverage** Ability to integrate and switch between multiple Antenna CCU assemblies so that more enhanced coverage of the platform or location can be achieved. For example, a port and starboard assembly on a ship so an operator can switch between them depending on threat direction.

**Directional Antenna with Positioner** Detect and locate capabilities provided by the platform, (eg radar or RFaaS), then operator points antenna in the direction of the threat to defeat it. Currently manual control, but could readily be automated.

**OpenVPX Capable** The EO conversion cards in the optical chassis could be in an OpenVPX form factor to slot into OpenVPX chassis alongside OpenVPX SDRs.

**Radio Equipment Agnostic** RF input from the radio or signal generator equipment to EO converter, making the solution agnostic of the radio or signal generator equipment.

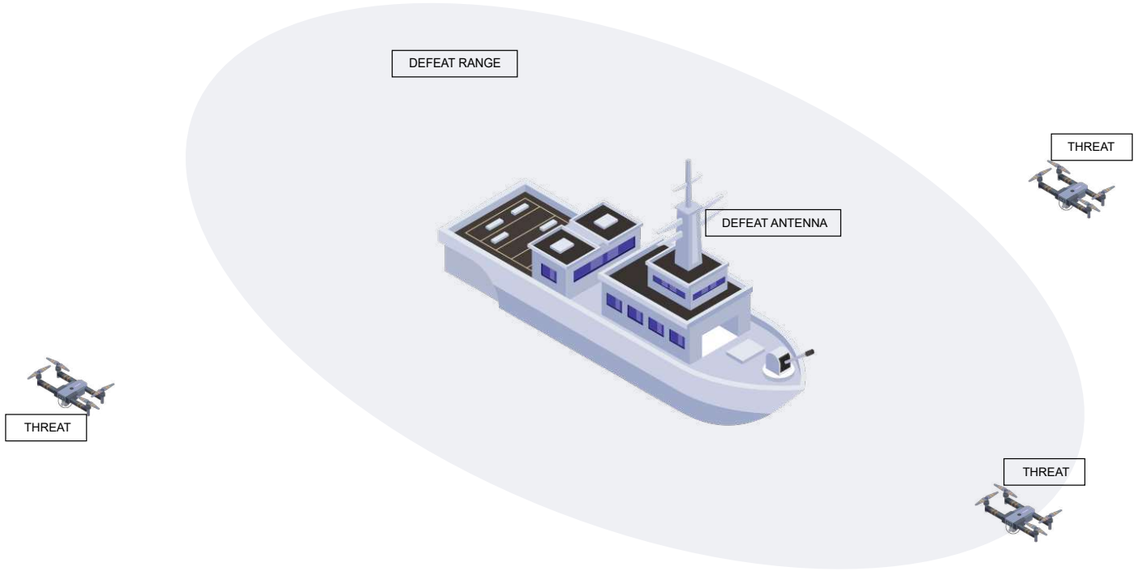
| | |
|---|---|
| **Frequency Range** | 400 MHz to 6 GHz, variants up to 18 GHz are available |
| **RF performance** | Transmit ERP from 50 to 120 W dependent on frequency. Optimised for Barrage jamming, but compatible with complex / modulated DEFEAT signals |
| **Environmental** | IP67 rated with operating temperature -40°C to +55°C for all external equipment, corrosive salt environment protected.<br>Designed for operation in harsh maritime and land environments as per DefStan 00-035. |
| **Modular Architecture** | Plug and Play' design that is radio equipment agnostic and enables easy integration with DETECT and LOCATE products (if not already provided by the platform e.g., radar or RFaaS). |
| **Azimuth & Elevation Control** | +/-120° azimuth and +/- 60° elevation with a beam width of 30° to enable fast moving targets in the air, or on the sea/ land to be efficiently defeated. |
| **Ease of Installation** | Up to 3 km cable run between antenna CCU and radio equipment enabling optimised positioning for maximum effect. Ruggedised fibre cable that can use existing coaxial cable runs. |

# Individual platform protection

An individual platform is vulnerable to all-round attack from UxV, therefore an omni-directional capability is required to provide the protective bubble indicative of a Force Protection system that will prevent both individual UxV and swarms from coming into range for either kinetic attack or ISR purposes. Example uses cases are:

1. A naval vessel is transiting through the Suez canal and is deemed at risk of attack from multiple Class 1 FPV UAS# (Swarm)
2. A land platform is being recovered following kinetic attack and is deemed at risk of attack from class 1-3 UxV

The below illustration shows and example scenario where a maritime platform is being attacked by a swarm of Class 1 UAVs. The omni-directional solution provides all round coverage to efficiently DEFEAT the UAVs regardless of their path of attack.




A more complete C-UxV solution could encompass a mixture of a border / perimeter protection solution (i.e., directional antenna with positioner solution) and an individual platform protection solution (i.e., an omni direction antenna solution).

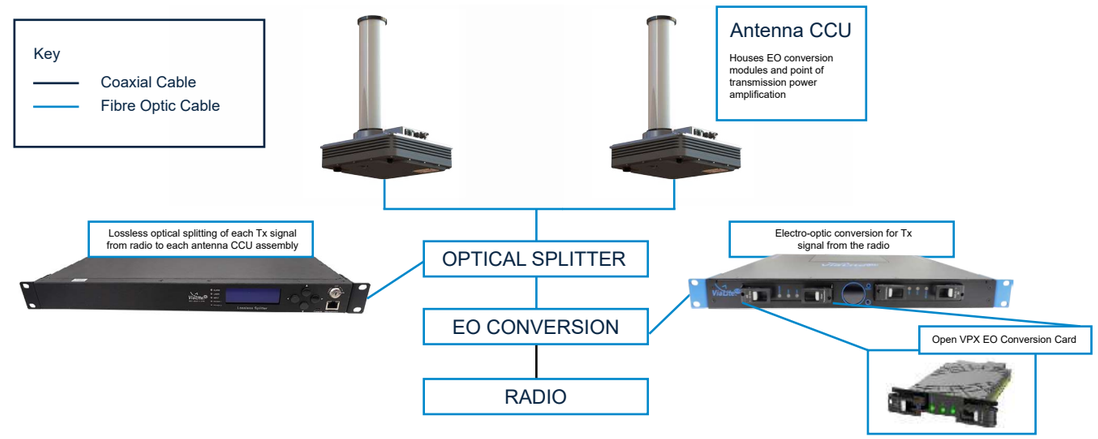




## Example Customer Solution – RF Tx for Individual Platform Protection

**PART NUMBER: M543012**

An overview of an example customer solution where two antenna CCU assemblies with omni-directional antennas provide the RFoF Tx capability.




**UAS Swarm Defeat** Omni directional antennas used to defeat multiple threats from different directions simultaneously i.e., defeating a swarm of UAS. The Tx ERP of this solution is an order of magnitude greater than a coaxial equivalent.

**WiFi Bands Only** Tailored to the WiFi bands only for operating frequencies to optimise performance against small/class 1 UAS.

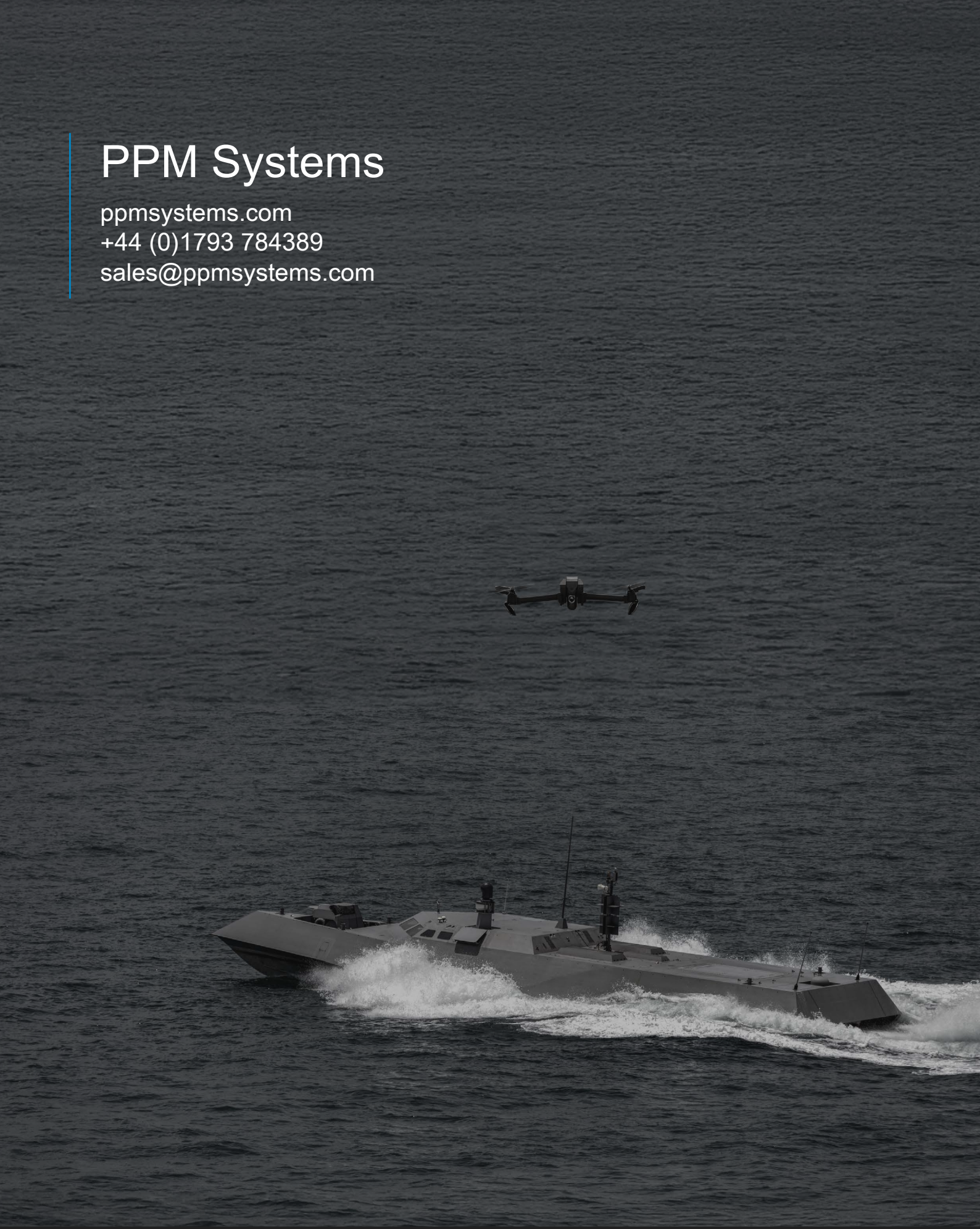
**Class 1 UAS Optimised** Performance optimised around the WiFi bands that Class 1 UAS's are most likely to be using, with reduced performance outside of these bands.

**Enhanced Coverage** The optical splitter enables the Tx signal from a single radio/signal generator to be split out to multiple Antenna CCU assemblies without any performance impact so that enhanced coverage of the platform or location can be achieved. For example, a port and starboard assembly on a ship.

**Radio Equipment Agnostic** RF input from the radio or signal generator equipment to EO converter, making the solution agnostic of the radio or signal generator equipment.

**OpenVPX Capable** The EO conversion cards in the optical chassis could be in an OpenVPX form factor to slot into OpenVPX chassis alongside OpenVPX SDRs.

| | |
|---|---|
| **Frequency range** | Optimised for WiFi bands, but with coverage either side of these bands. |
| **RF performance** | Transmit ERP of ~100 W at optimised frequencies. Compatible with complex/ modulated DEFEAT signals, but optimised for Barrage jamming. |
| **Modular architecture** | 'Plug and Play' design that is radio equipment agnostic and enables easy integration with DETECT and LOCATE products (if not already provided by the platform e.g., radar or RFaaS) |
| **Environmental** | IP67 rated with operating temperature -40°C to +55°C for all external equipment, corrosive salt environment protected.<br>Designed for operation in harsh maritime and land environments as per DefStan 00-035. |
| **Ease of installation** | Up to 3 km cable run between antenna CCU and radio equipment enabling optimised positioning for maximum effect.<br>Ruggedised fibre cable that can use existing coaxial cable runs. |

# PPM Systems

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