

# DEFENCE - OVERVIEW

Chelmsford defence comprises of two key business areas



## CORE TECHNOLOGIES

Focused on the conventional application of our RF product portfolio in to defence applications. We have 60 years experience in providing RF Products in to demanding environments.

Customer funding or private venture funding allows us to modify or ruggedize our RF products so that can be used in defence applications.



## NOVEL SOLUTIONS

Building on core products and technical capability, within RF Power, to provide sub-systems and systems to our customers.

Applications are customer-specific and usually classified or highly classified.

Our customers do not fully understand their requirements so we help them to find a solution.

# DEFENCE CAPABILITIES

## Core Technologies



### Time Honoured

Our legacy business includes High Power Magnetrons and Coupled Cavity TWTs. Typical applications for our CCTWTs include ship, airborne and ground-based mobile radar systems



### Helix TWTs

We are the sole suppliers of Helix TWTs to leading defence primes around the world on some of the most advanced air platforms. Our rugged and compact Helix TWTs are amongst the smallest in the world in their class.



### MPMs

Our MPM offers super broadband capabilities for fast jet applications. The compact sub-system is amongst the smallest in its class, providing electronic countermeasure protection of high-value platforms around the world.

Travelling wave tubes

## Applications / Functions

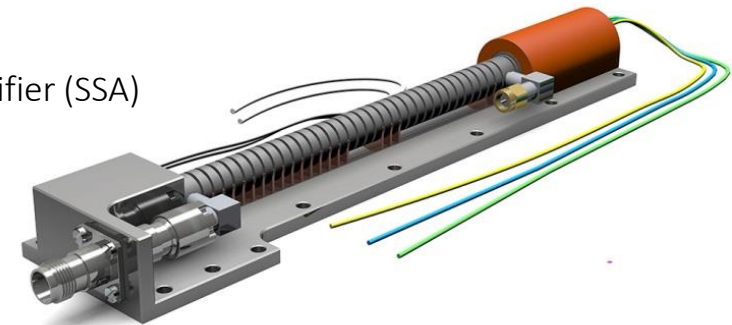
- Radar
- Jammers
- Power Amplifiers
- Towed Decoys

## Key Features

- 4.5 to 18GHz
- Output power 140 W (typical)
- Saturation gain 40 dB (typical)
- Prime power 540 W (typical)

## Also Available

- Narrow to multi-octave bandwidth
- 3-stage and single stage collectors
- Gain and or phase matched
- Paired with e2v Solid State Amplifier (SSA)



## Applications / Functions

- Electronic Warfare
- Power Amplifiers

## Key Features

- 6 to 18GHz
- Output power 100 W (minimum)
- 270V DC
- Prime power 580 W (max)
- Size 210 x 122 x 27 mm
- Weight 1.9 kg
- Contains e2v HVPS, e2v SSA and e2v TWT

## Also Available

- Narrow bandwidth



## Coupled Cavity Travelling Wave Tubes

### Applications / Functions

- Ship, airborne and ground-based mobile radar systems
- Airborne multi-mode surveillance radars
- Naval surveillance radars
- Tracking radars for fire control systems
- Ground-based acquisition
- Mobile military environments

### Product Portfolio includes:

- Peak powers up to 1MW
- Bandwidths up to 10%
- Frequency range: 5 GHz to 35 GHz



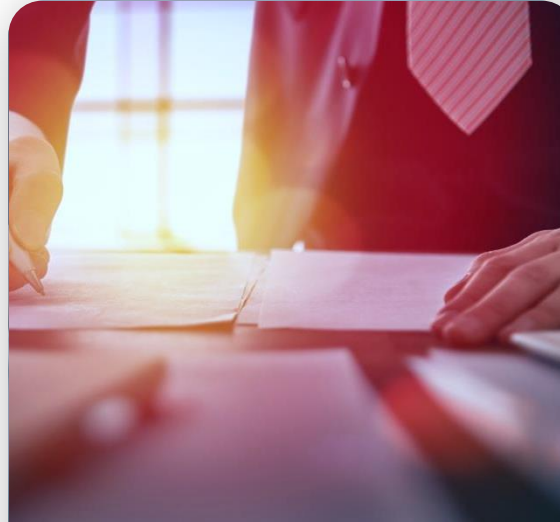
# DEFENCE CAPABILITIES

Novel solutions



## Time Honoured

Our products can be found on some of the biggest platforms and the ongoing support of these established platforms underpins some of our more progressive development activities.



## Customer Funded

Our cutting edge technology and capabilities attract funding from customers and development research institutes.

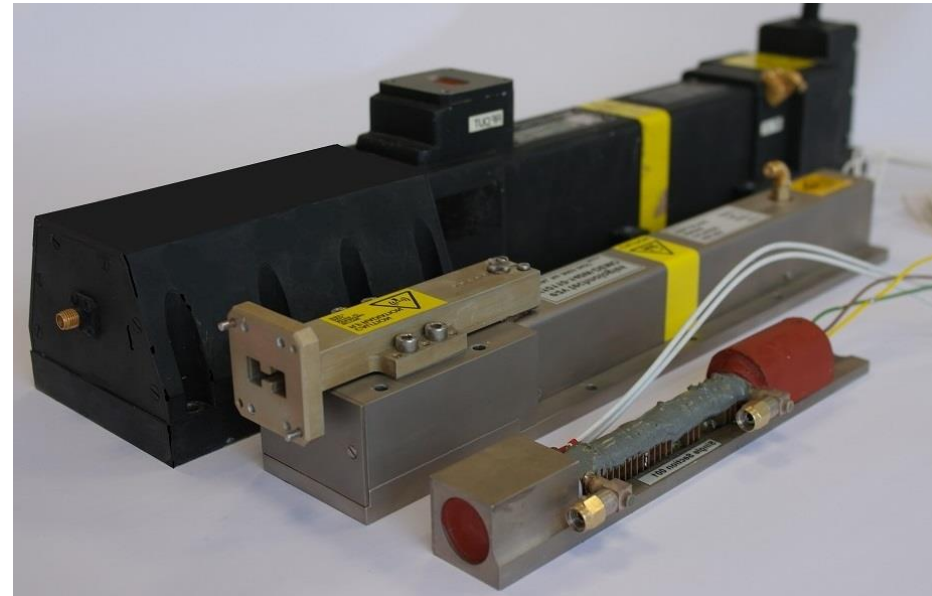
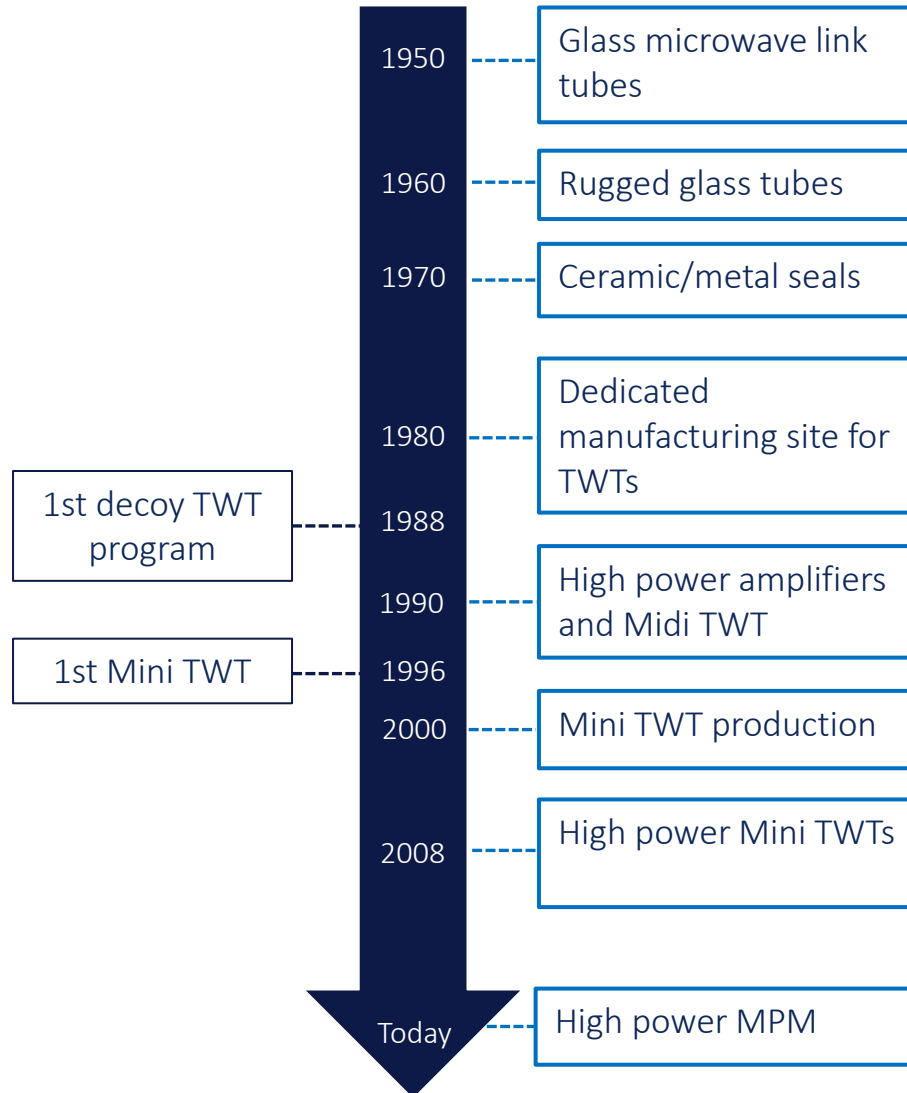
We regularly make patent applications for our concepts and ideas.



## New Products

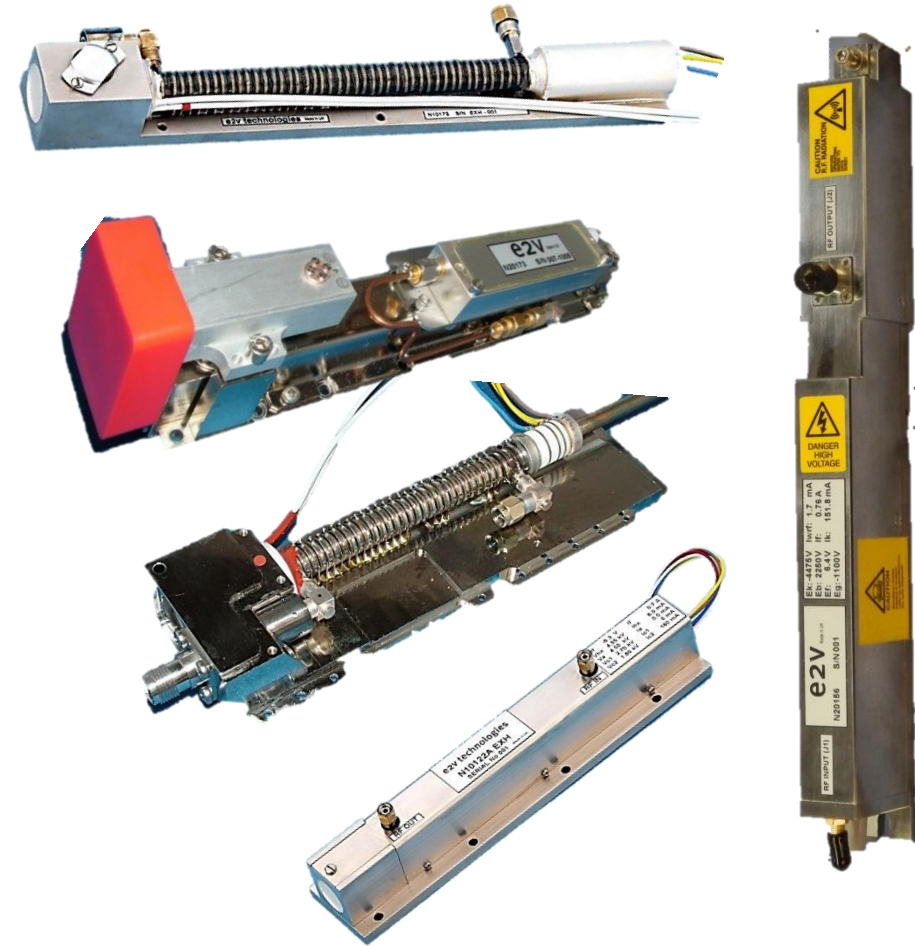
Our new products stretch from multi-channel spark gaps and magnetron combining, to our flagship RF Safe-Stop range; capable of bringing moving targets across land, sea and air to a controlled stop at a safe distance without collateral damage.

# TWT HERITAGE



# TWT PRODUCTS & CAPABILITIES

- Design adaptations to satisfy specific customer requirements
- RF connector orientation and type (TNC, Waveguide)
- Mechanical outline / customer interface
- Narrow band variants for communication applications
- Gain adjustment and equalisation
- Phase matched
- Linearization



# APPLICATIONS

## Military Communications

- + Amplifiers and MPMs for Satellite Uplinks
- + X and Ku Bands
- + 120W – 2.5 kW
- + Ground based, shipborne and fast jet



## Electronic Counter Measures (ECM)

- + Compact broadband MPMs (6-18 GHz > 100W)
  - + Fast Jet & Shipborne
- + Towed Decoy Systems
  - + On board power supply
  - + Towed Decoy Electronics



## Counter IED

- + Broadband transmitters and accessories
- + Ground based
- + Systems fitted to majority of UK Land Forces vehicles

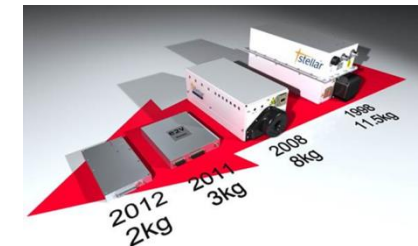
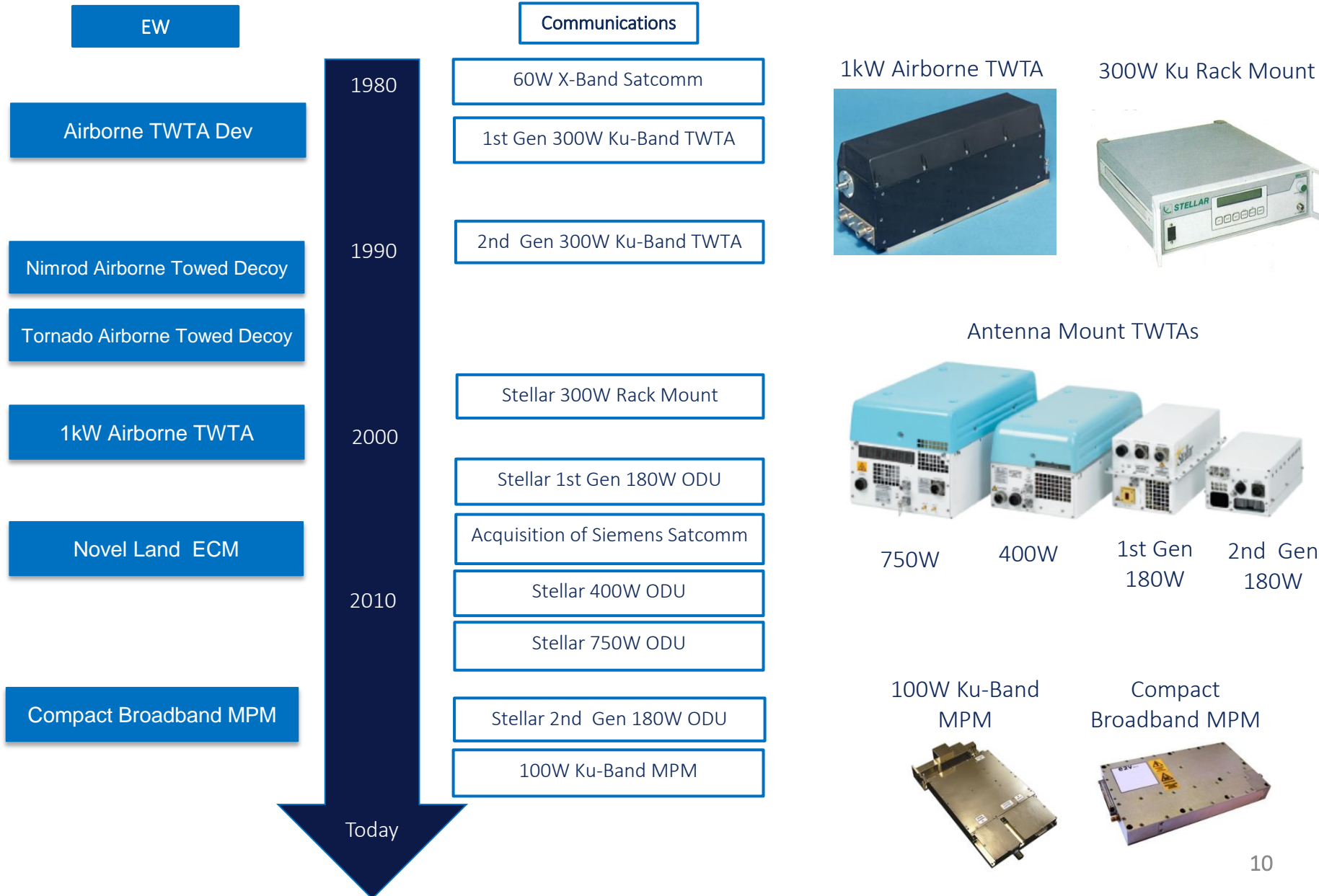


## Airborne Command Links

- + 1kW peak x-Band Transmitter
- + Missile command link
- + Fast jet up to 100,000ft



# Teledyne e2v TWTA Heritage



# TWTA PRODUCTS & CAPABILITIES

Electronics Design

## Provide

### TWT Supplies

- + Cathode/Helix
- + Collectors and Heaters
- + Control Electrodes

### LV Supplies

- + Control Electronics
- + RF Components

### Customer Interface

## Power Conversion

### Power throughput up to:

- + 2.5 kW Average
- + 10 kW peak

- + Output Voltage up to – 12kV
- + Power Density – 21W/in<sup>3</sup>
- + Grid/Focus Electrode Switching up to 100 kHz

## Input Supplies

- + Single Phase
- + Three Phase
- + 270 V DC
- + 28V DC
- + EMC Compliant

## Control

- + Simple discrete control/status reporting
- + Comprehensive Control and Status reporting
- + Serial Bus – RS242/485

# TWTA PRODUCTS & CAPABILITIES

## Manufacture

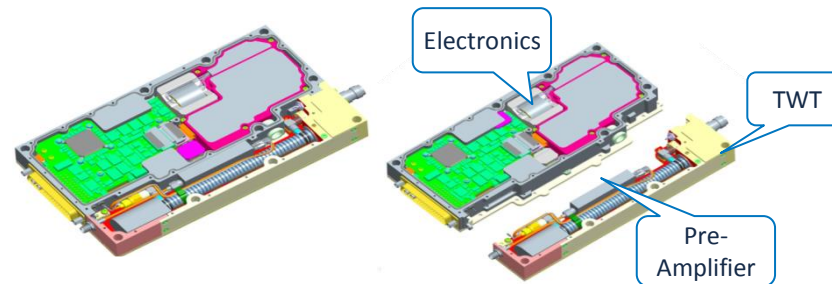
### TWT

- + In house manufacture or in some cases procure from 3rd party

### RF Assemblies

- + Procure to Te2v specification
- + Increase use of e2v MTC

### Modular construction | Flexible manufacture



### Electronics

- + Te2v design
- + Sub-contract manufacture

### Integration/Final Test

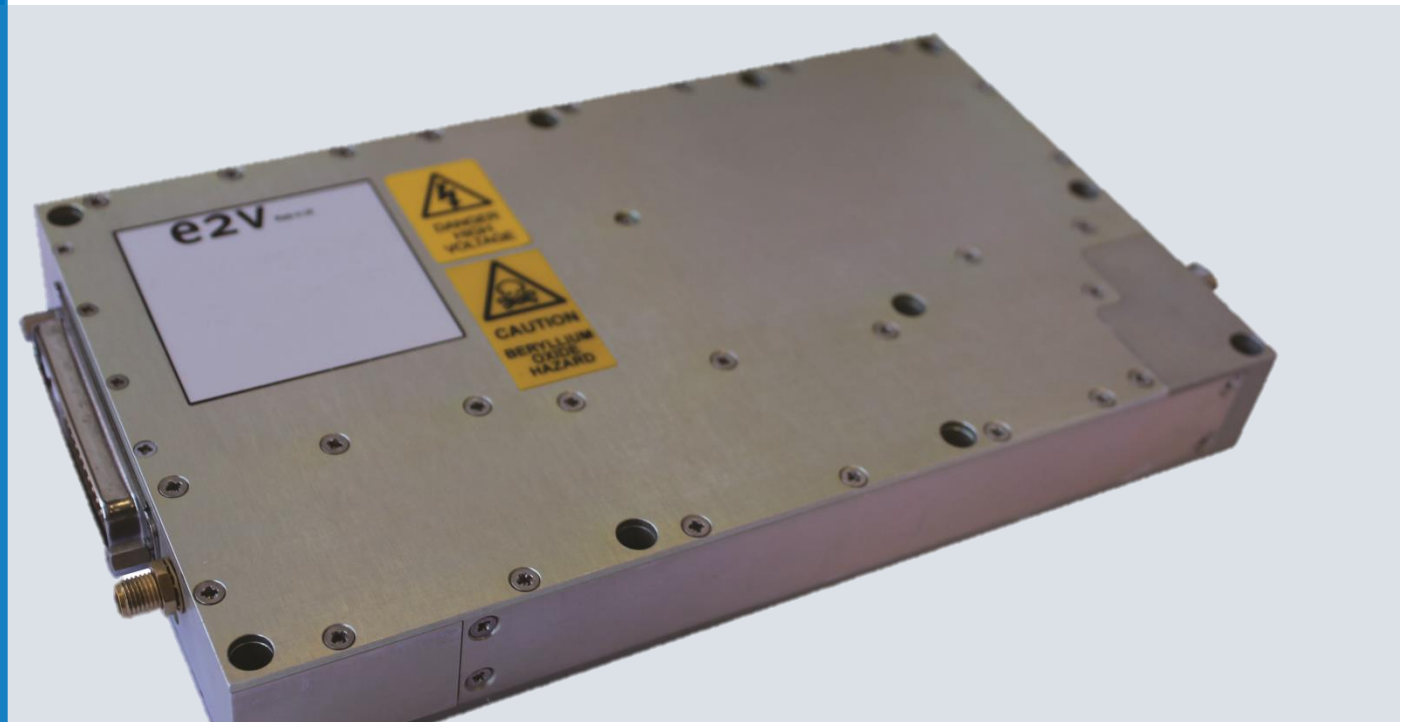
- + Performed at Te2v
  - + Final assembly + Stress Screening + Acceptance testing

# TWTA TWTA PRODUCTS & CAPABILITIES

MTA2006

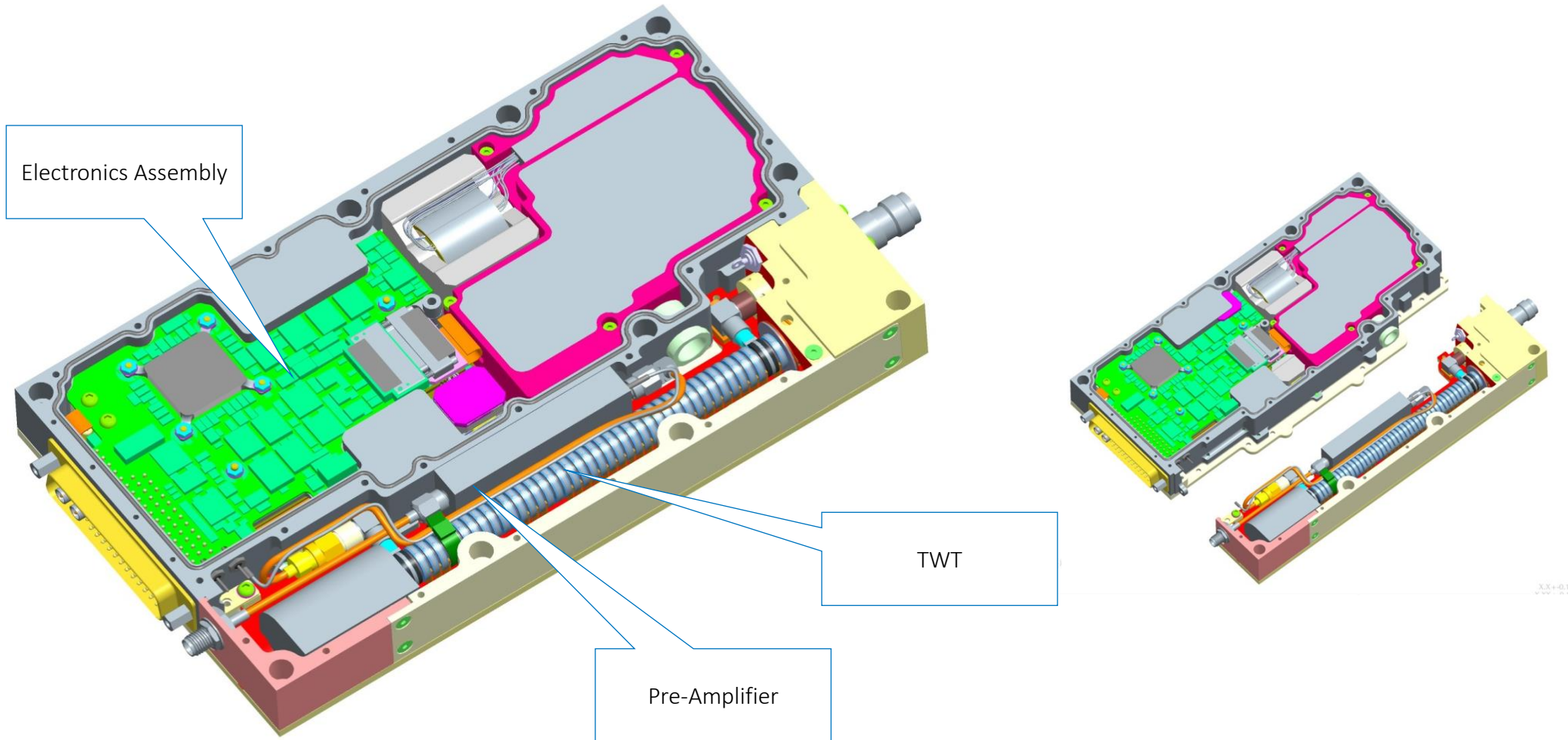
**MPM comprises; mini helix TWT, solid state pre-amplifier and power supply in a compact, rugged package.**

- + Designed for; Airborne ECM
- + Operate over 6-18 GHz
- + Provide in excess of 100W
- + Beam Modulation up to 100 kHz
- + Operate from 270 Vdc
- + Small size: 210mm x 120mm x 26mm
- + Light weight: 1.6 kg
- + Conduction Cooled
- + Operating temperature: -40°C to +85°C (Baseplate)



# TWTA PRODUCTS & CAPABILITIES

MTA2006 Design and Construction



# PRODUCTS & CAPABILITIES

MTA1000

The MTA1000 series is a new range of Microwave Power Modules (MPMs) for high rate data link applications.

The MTA1000 series combines a mini-helix travelling wave tube (TWT) with a solid state pre-amplifier, a power supply and control circuit in a lightweight, rugged package to offer an ITAR-free solution for defence systems.

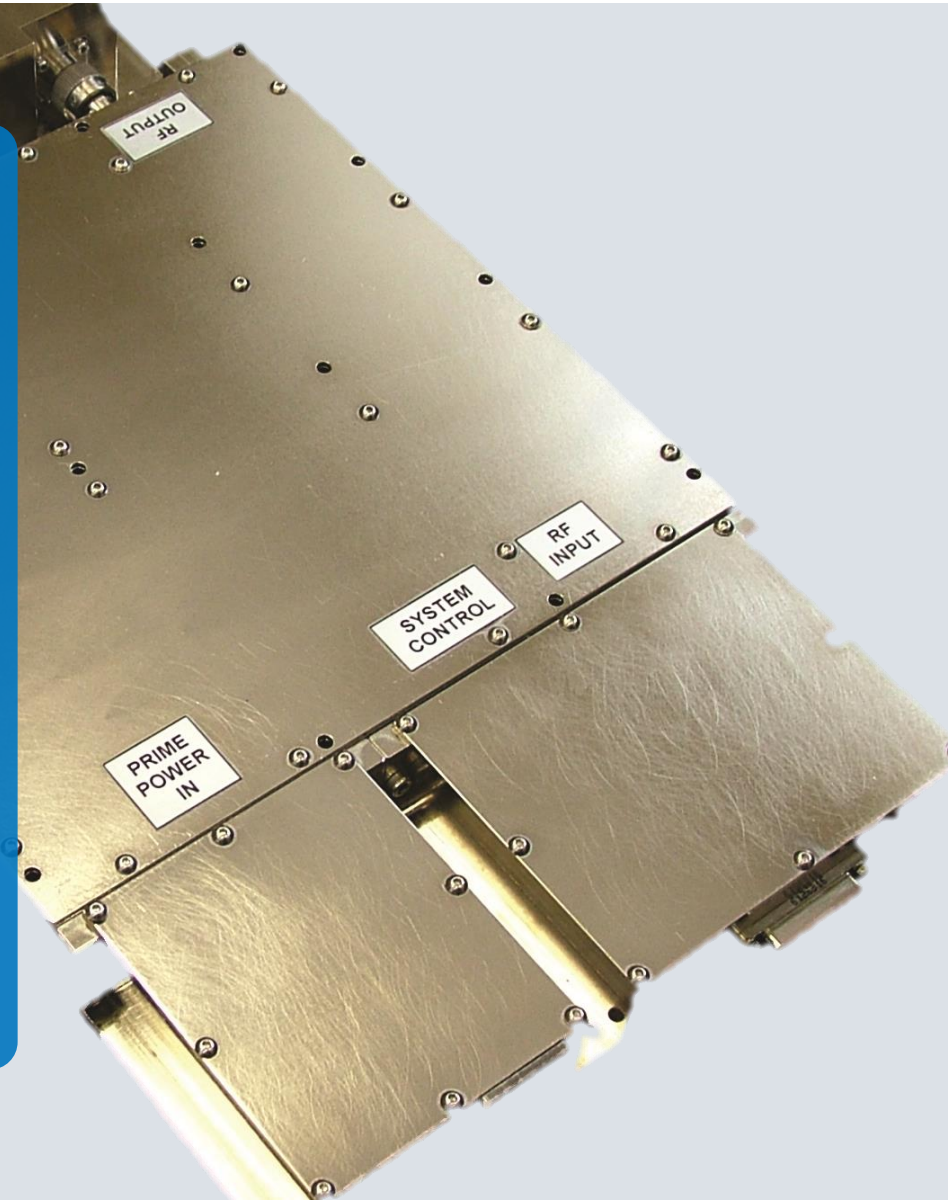
Range includes:

- + Ku-Band; 13.75 to 14.50 GHz, 100W
- + X-Band; 7.9 to 8.4 GHz, 80W

Operate from 270 Vdc

Conduction Cooled

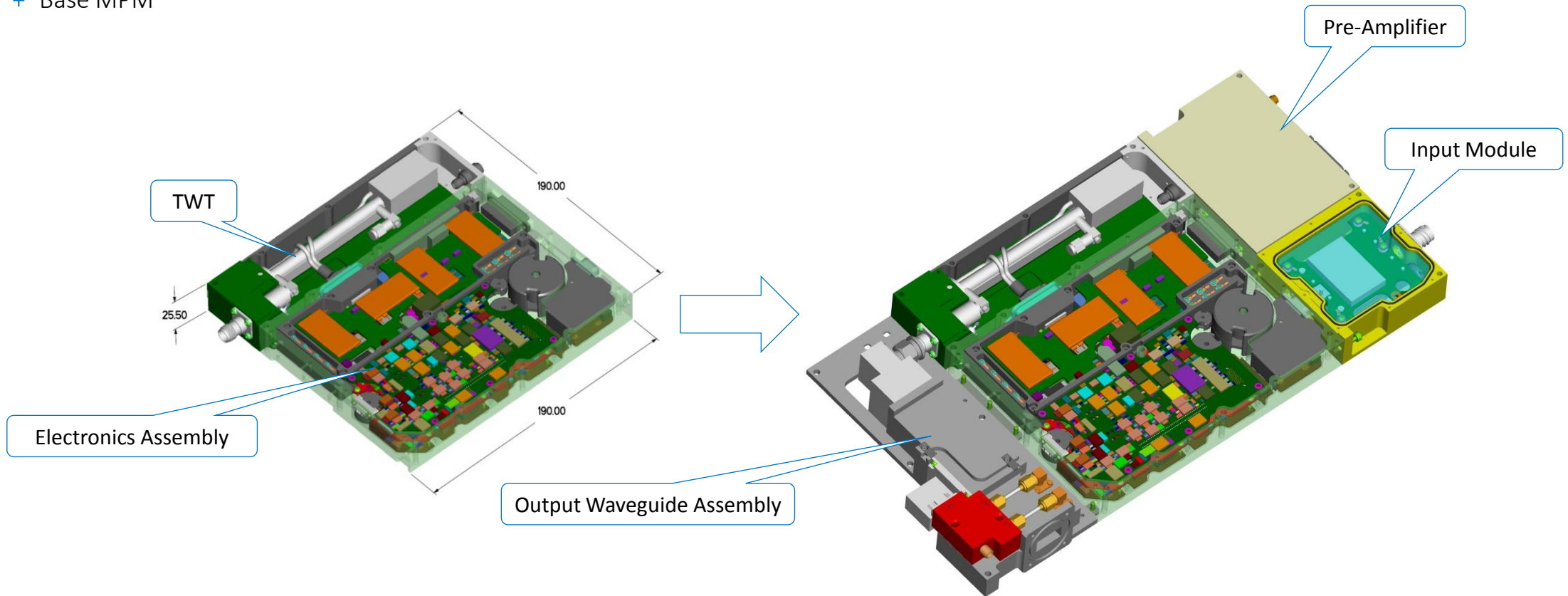
Operating temperature: -40°C to +85°C



# TWTA PRODUCTS & CAPABILITIES

MTA2006 Design and Construction

+ Base MPM



# TWTA TWTA PRODUCTS & CAPABILITIES

MTA4000

Amplifier for Ground Based Applications

Can easily be configured for various requirements

- + Communications –X-Band/Ku-Band 200W
- + Broadband - 6-18 GHz >100W

Operate from:

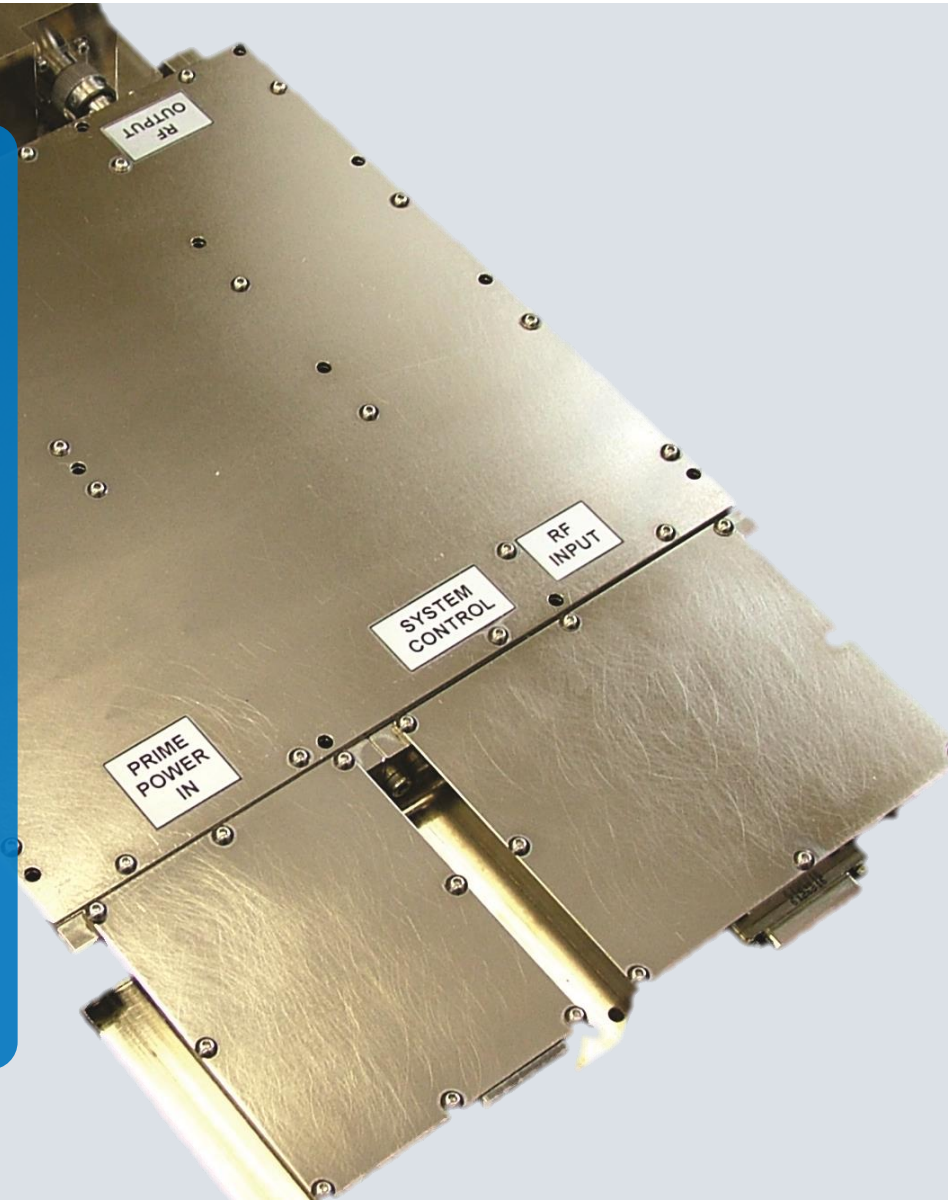
- + 99-264VAC Single Phase
- + 28V DC

Size – 348mm x 183mm x 132.5mm

Weight – 8 kg

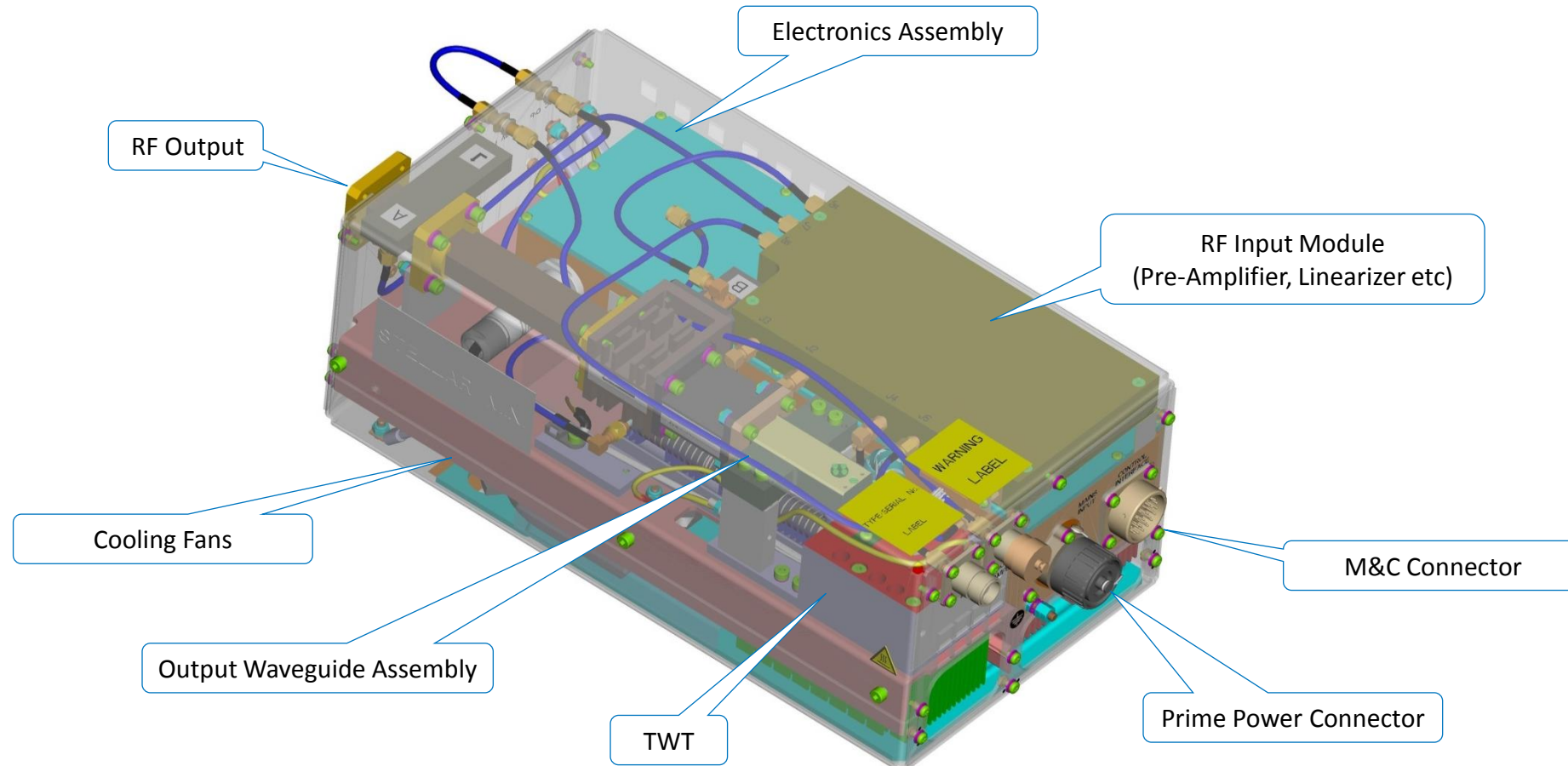
Integral forced air cooling

Operating temperature - -40°C to +60°C (ambient)



# TWTA PRODUCTS & CAPABILITIES

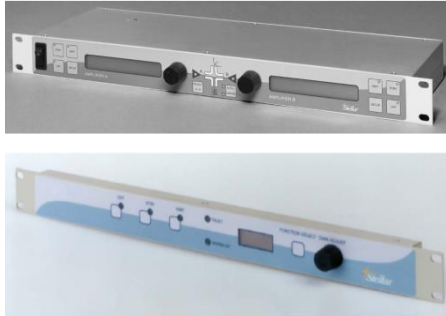
## MTA4000 GROUND BASED APPLICATIONS



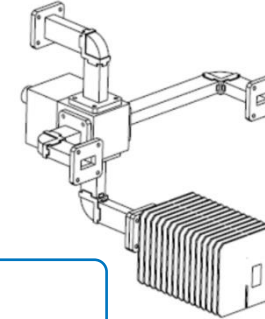
# TWTA PRODUCTS & CAPABILITIES

Accessories & Systems

## Controllers

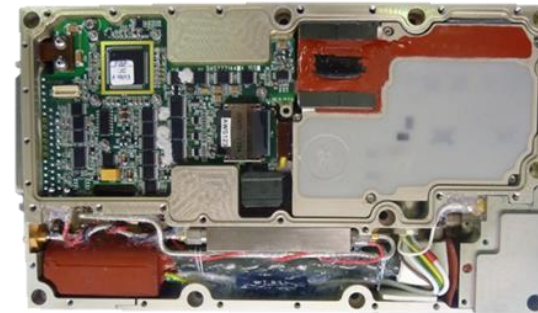
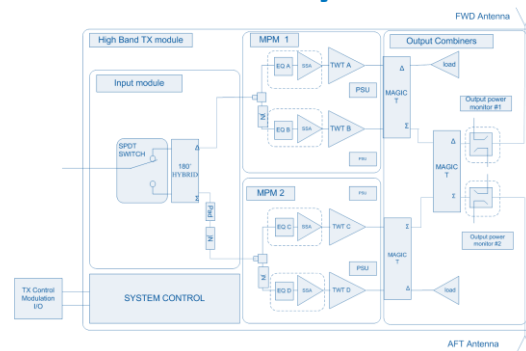


## Waveguide Assemblies



When you need more  
than just a TWTA

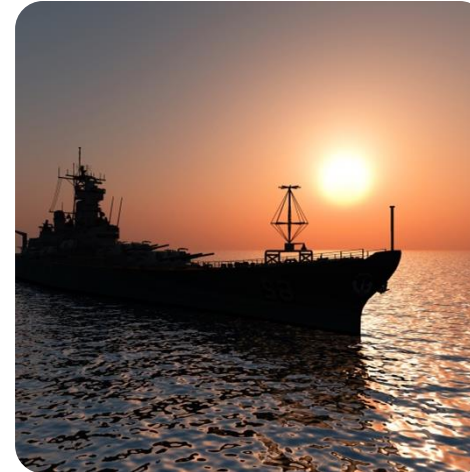
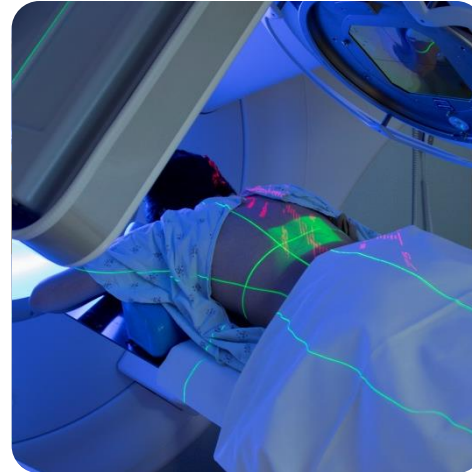
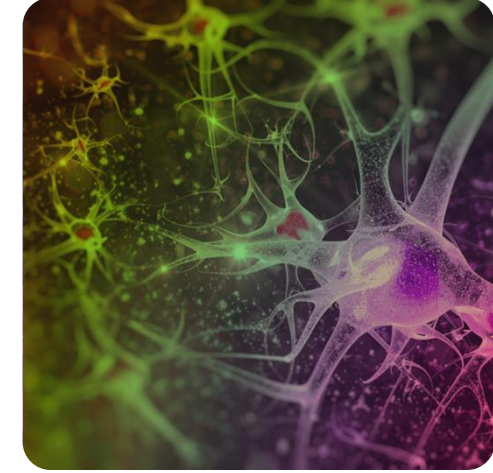
## Combined Systems



# THIS IS TELEDYNE e2V



Our innovations lead developments in healthcare, life sciences, space, transportation, defence and security and industrial markets



**Microwave  
Technology Centre  
Lincoln**

# MICROWAVE

Located in Lincoln, UK, RF Power's Microwave Technology Centre designs and manufactures microwave components and sub-assemblies for each of RF Power's four key business areas:

DEFENCE AND SECURITY

HEALTHCARE

TRANSPORTATION

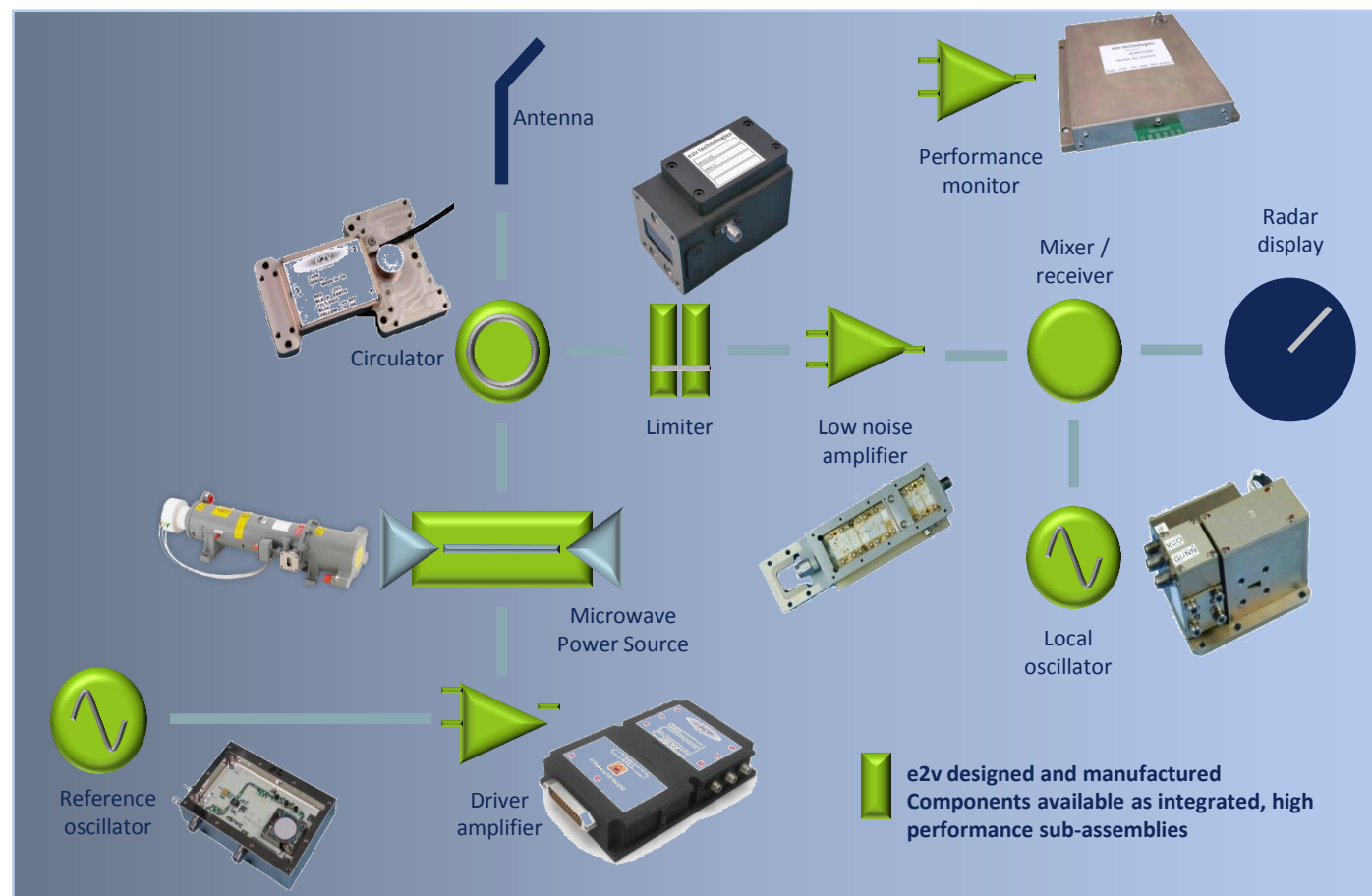
INDUSTRIAL



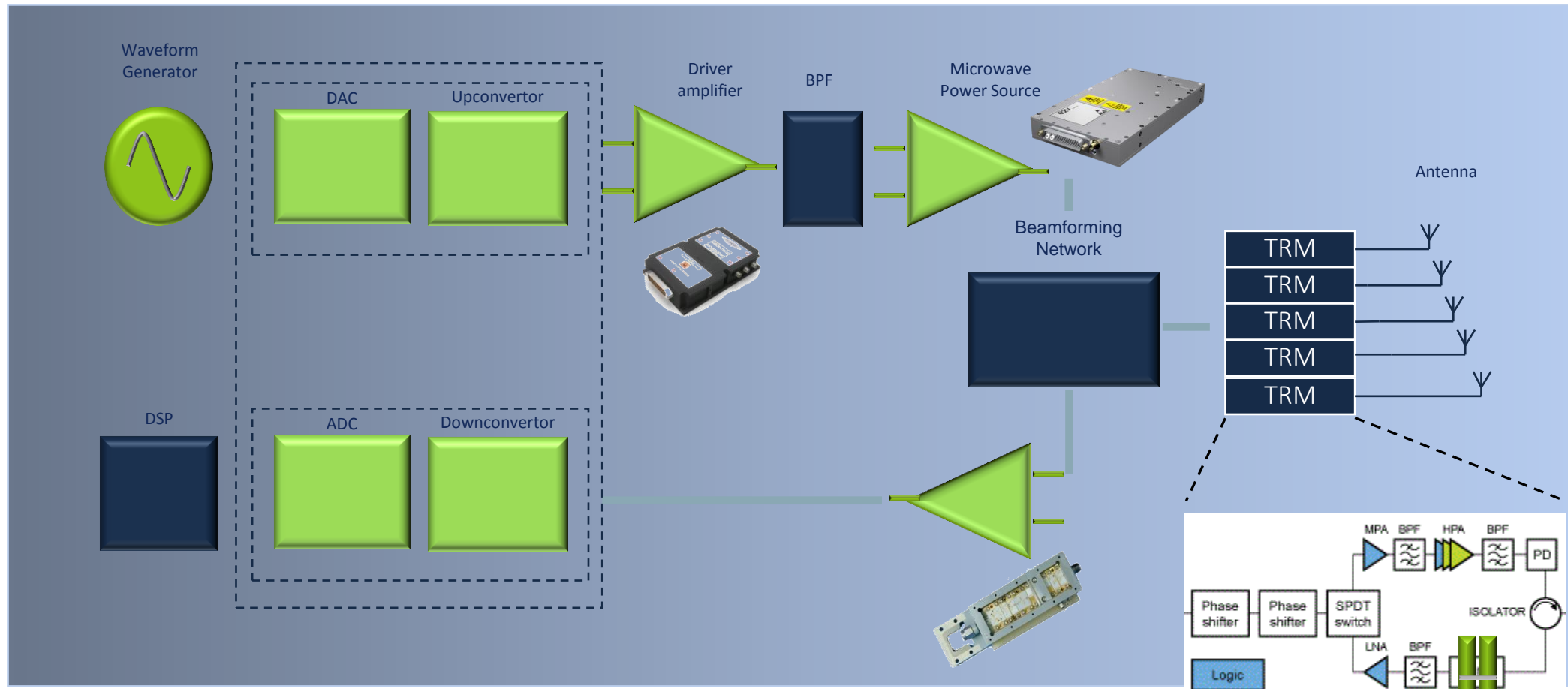
## MODULES & SUB-ASSEMBLIES



L	1-2 GHz
S	2-4 GHz
C	4-8 GHz
X	8-12 GHz
Ku	12-18 GHz
K	18-24 GHz
Ka	24-40 GHz
W	75-110 GHz



## MODULES & SUB-ASSEMBLIES

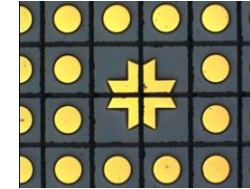


Radar  
display

e2v designed and manufactured  
Components available as integrated, high  
performance sub-assemblies

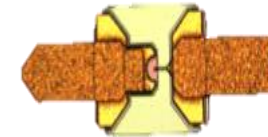
## Gunn Diodes

- FMCW Radar
- Missile Seekers
- Speed Cameras
- Imaging



## GaAs Schottky Diodes

- Ultra low capacitance Beam Lead Diodes
- Missile Seekers
- Imaging



### Based on our Graded Gap GaAs Gunn

- Low noise
- High Reliability
- Excellent temperature performance
- UK Source

### Frequencies

- >35GHz Fundamental Operation
- >60GHz harmonic operation
- >50mW at 77GHz
- 125GHz GaAs Gunn “limit”

### Tuning

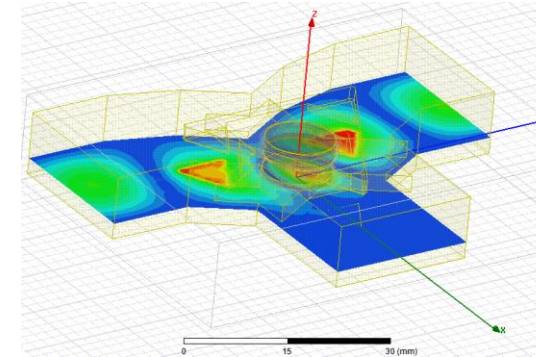
- Bias Pushed Gunn
- Varactor Coupled



# MICROWAVE

## CIRCULATORS AND FERRITE DEVICES

- Junction circulators
- Phase shift circulators,
- Resonance isolators,
- Novel drop in junction circulator
- Integration
- Current production designs from 896mhz to 62ghz
- Capability 300mhz to 100ghz
- On site power test



## RECEIVER PROTECTORS

### Receiver Protectors

- L-Band to Ka Band
- Wideband Microstrip solutions 2-18GHz
- Waveguide, Co-axial SMD QFN designs

### Passive or Active Protection

- Externally biased PIN diodes, a switch

### Quasi Active or Quasi Passive Protection

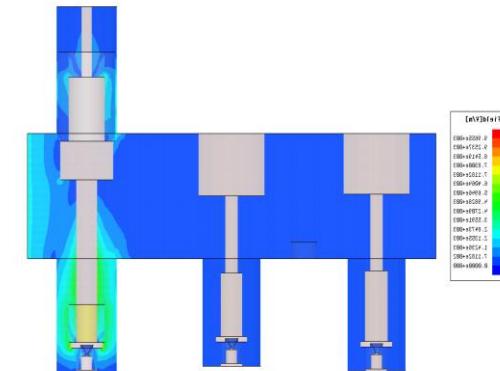
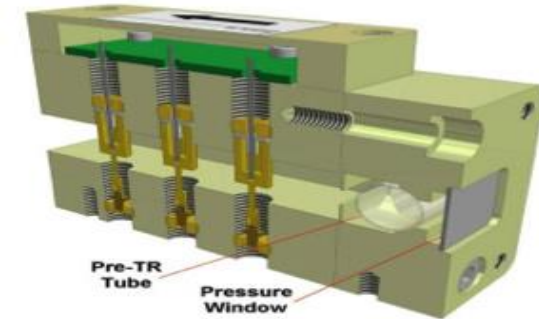
- Provides protection for non-synchronous pulses
- Provides protection in the powered down state

### Sensitivity Time Control (STC)

- Receiver blanking/controlled attenuation function

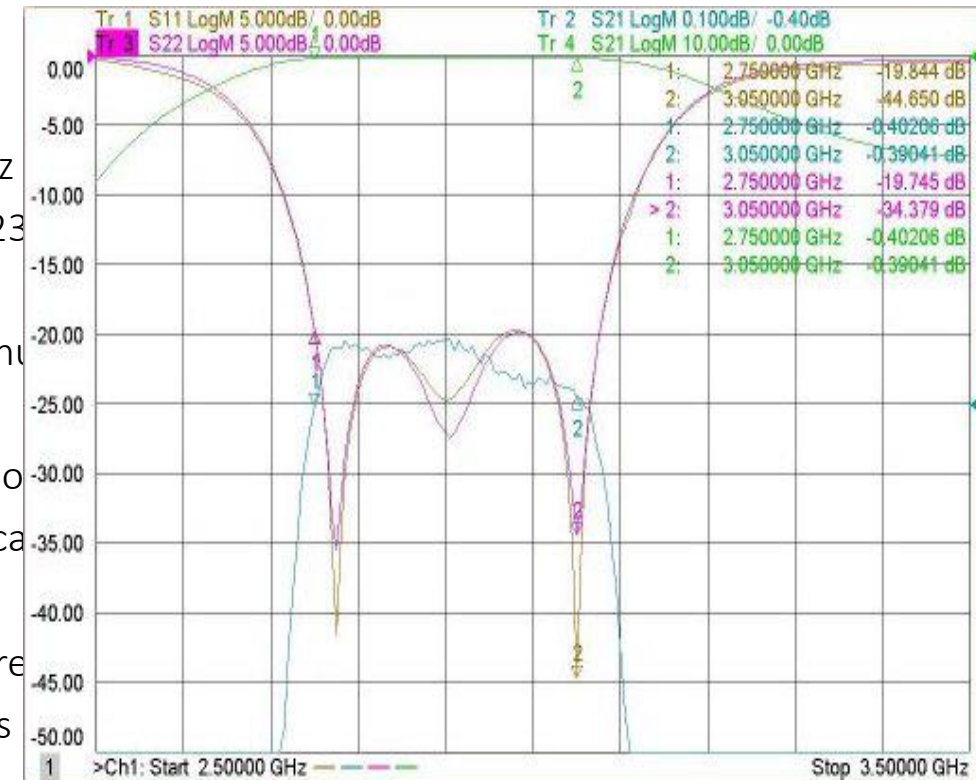
### Noise Generator

- Integrated noise diode



### Design Update for Enhanced 4G Signal Rejection

- 4G signals within the frequency bands 2.5GHz to 2.69GHz and 3.4GHz to 3.6GHz, with an incident peak power of +23 dBm can be incident on a S-band Radar limiter receiver protector, biasing its PIN diodes and adding attenuation into the receive path.
- A modified S-Band Pre-TR Limiter design improves Insertion Loss and Return Loss characteristics, mitigating 4G Communication interference in S Band Surveillance
- This design approach can be applied to other bands where high power interference from neighbouring transmissions can be incident on PIN diode based receiver protector devices.

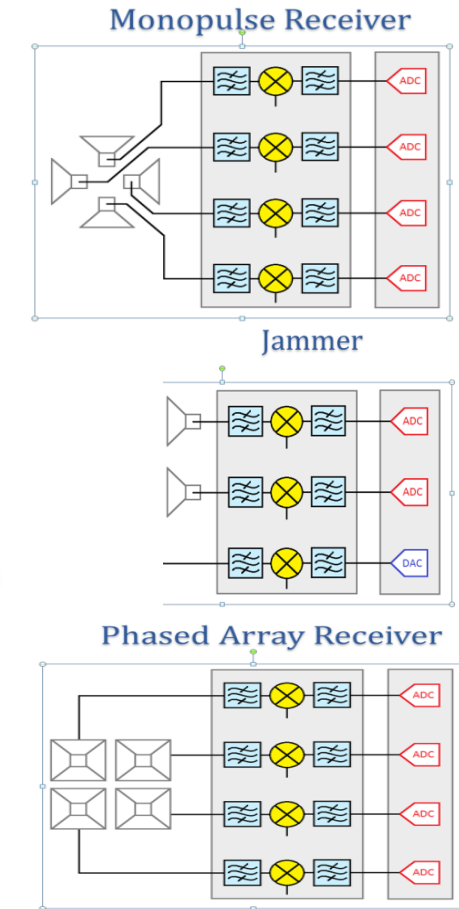


### Applications / Functions

- Radar
- Jammers
- Local Oscillator / Clock Distribution
- Frequency Extenders
- Power Amplifiers

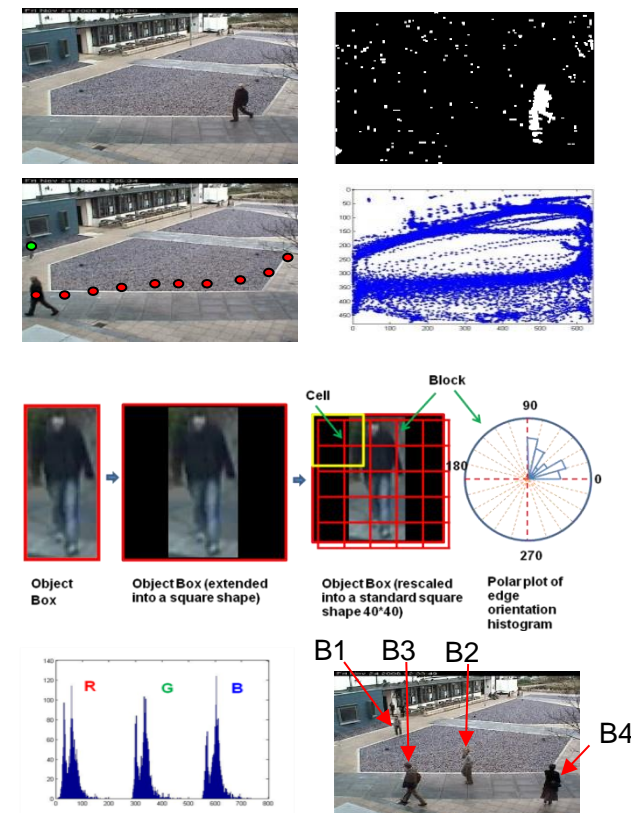
### Key Features

- VPX compatible
- SMA/ SMP /SMPPM/ K connectors
- Optional Filtered Bias Connectors
- Various Ejector / Sealing Options
- EMC screened housing / Improved Thermal Path
- Customisable Front Panel and Backplane Interface



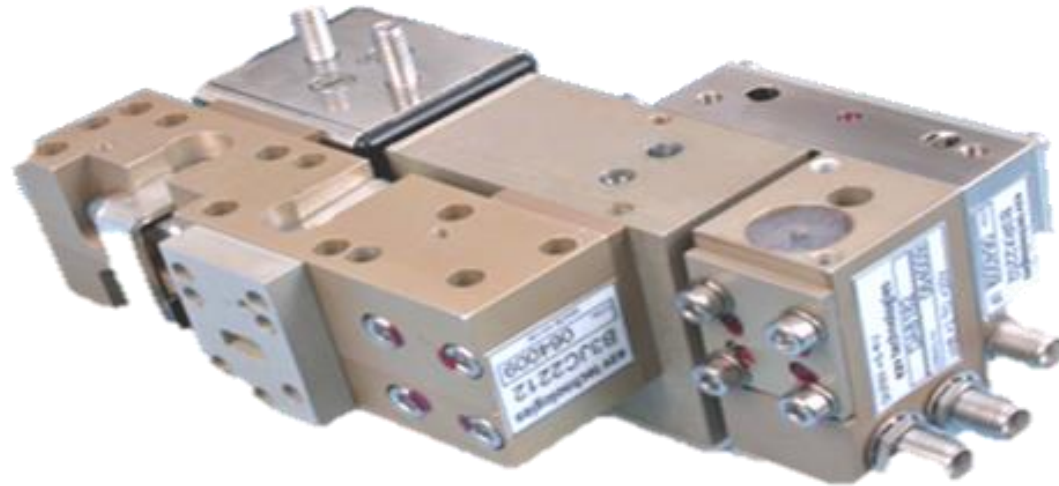
## ABNORMAL BEHAVIOUR DETECTION FROM VIDEO STREAM

- **BRAINS Basic Robust Architecture for Integrated Neural Sensors**
    - Neural Network selected and optimised for different tasks/situations
  - **BRAINS implements Neural Network algorithms on an FPGA**
    - Algorithms and hardware processing are both inherently parallel
    - Allows high speed data stream pre-processing
    - Fast classification of “significant” data
  - **Neural networks address these problems like our own brain**
    - Extracts important information, ignores non-important information
    - Learns, classifies, tracks and can produce a “signature” to track individuals
    - Creates rules for “normal” in any given situation - improves detection of “abnormal”
    - Continuously learns from operator classification of flagged events
- Process any complex data stream – not just graphics**
- Analogue/Digital
  - Radar/RF
  - Optical/IR/THz imaging systems



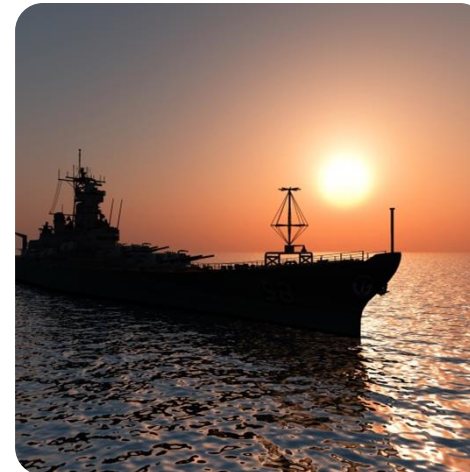
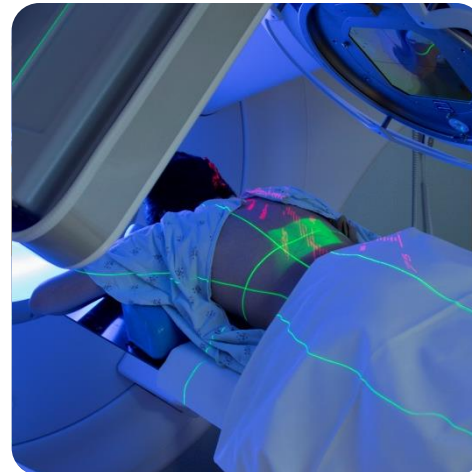
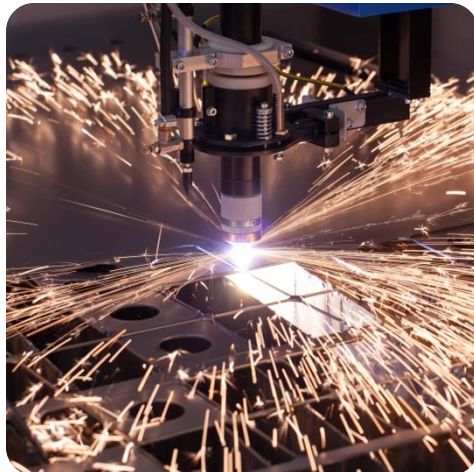
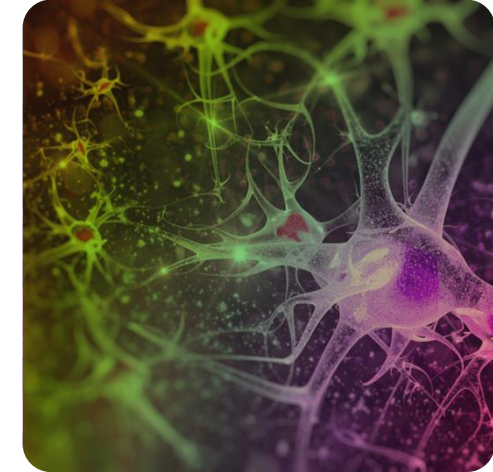
## Ka Band Radar Head Assembly

- 2kW Magnetron
- Circulator
- Local Oscillator
- Mixer
- Receiver Protector
- Low Noise Amplifier



# THIS IS e2V

Thank you for listening



Any questions?