Microwave capability
RF systems & sub-systems

Industrial processing systems
Building on our experience in the design and production of RF technology, e2v is able to offer a complete system capability under our ProWave microwave power range of industrial processing systems for bulk materials processing applications, including vermiculite processing. By delivering a complete system with enhanced reliability, we take full responsibility for the technology, set up and service, reducing the overall cost of system ownership.

ProWave systems are designed, developed and manufactured to out-perform traditional industry processing techniques at every stage of your operations. Utilising the latest advances in industrial microwave technology, ProWave systems will transform the financial and operational performance of your bulk material processing.

Microwave Power Modules
The MTA2000 series is a range of Microwave Power Modules (MPM) designed and manufactured by e2v, combining mini-helix Travelling Wave Tubes (TWTs) with solid-state pre-amplifiers and optimised high density power supplies. The lightweight, compact packages have been designed for ground, air-borne and ship-borne applications. Variants within the range are suitable for use in Electronic Counter Measures (ECM), radar and communications systems.

Integration of the power supply, TWT and solid state drive unit at source enables the device to be optimised for performance, life and reliability, offering the system designer a highly-efficient RF amplifier solution, negating many of the risks associated with interconnection and installation of TWTs and power supply components.

In addition to the standard range of products, e2v is able to offer bespoke solutions to meet customer-specific requirements designed for the most demanding environments.

Satcom amplifiers
e2v offers a wide range of high-power satellite uplink amplifiers (HPAs) under the StellarCool, StellarMini and new Stellar TS brands, covering all of the primary satellite frequency bands including: C-band, X-band, Ku-band, DBS, Tri-band and Quad-bands.

With over 30 years experience in the design and manufacture of high-powered Travelling Wave Tube (TWT) amplifiers, the Stellar family is designed to be extremely robust and highly-efficient, yet lightweight, with proven performance in high temperature and high humidity environments.
Microwave & RF sources

Modulators

e2v offers a range of compact modulator systems based around its patented solid-state switching technology. High-power pulsed systems are developed for radar and for linear accelerators used in industrial, scientific and medical applications.

The compact modulator is a direct switching unit, designed to drive either e2v’s microwave tubes or those from other manufacturers. The high-voltage modulators and semiconductor switches provide a real proven alternative to conventional “line and hard valve type” modulator technology. Using innovative assemblies of solid-state switches, together with compatible power supplies and energy storage units, gives a significant improvement in pulse shape and quality. A flexible control system gives the ability to remotely vary the pulse parameters on a pulse-to-pulse basis. These features make the units ideal for systems where precise energy control is essential.

Magnetrons

e2v is the world’s largest manufacturer of pulse magnetrons and a world leader in magnetron technology. Its product capabilities range in frequency from below 1GHz to over 90GHz at powers from 1.5kW to 6MW and encompass a wide range of anode, cathode and tuning technologies, dependent upon the application.

The company has been manufacturing magnetrons, established under the EEV brand, for several decades. e2v aims to meet the stringent specifications for the military market, the power, long life and low running costs for industry and medicine, and to achieve the price performance requirements for the highly competitive marine and airborne radar markets along with radiotherapy linear accelerator use.

Integrated microwave assemblies

For optimum RF system performance, e2v integrate matched combinations of microwave modules and components into a single package. This integrated design approach offers the following advantages:

→ Low-risk solutions due to an integrated project team working on component design and sub-assembly integration
→ Single point of contact for all through-life support
→ Bit In Test (BIT) capability

Application-specific solutions

e2v works closely with its customers to develop high performance RF sub-systems that fall into the categories of defensive radar, ECTR (Electronic Counter Measures), and novel systems. These systems can be pulsed-power or CW (Continuous Wave) at average power levels from tens of watts to tens of kilowatts, and peak powers of kilowatts to tens of megawatts.

Typically these systems incorporate RF or microwave valves with bespoke control electronics and power supplies to achieve leading-edge performance in compact ruggedised packages.

By carefully applying decades of design, manufacturing, and application knowledge with the latest modelling and simulation design software, e2v is able to provide everything from conceptual design to serial manufacturing of custom solutions to its military customers on air, sea, and land.
Travelling Wave Tubes (TWTs)
e2v has extensive expertise in the design and manufacture of high quality helix TWTs, producing the first glass tube devices in the 1950s before progressing to the production of metal/ceramic tubes a decade later. These rugged and compact designs have since become the market leaders. e2v now supplies to both commercial and military markets.

We specialise in developing tailor-made products to satisfy the specific requirements of our customers. Our engineers draw upon world-class facilities and decades of technical knowledge, while using the most advanced TWT simulation tools. Our range of helix TWT products covers both commercial and military applications:

- **ECM** – our broadband devices, incorporating multiple collectors, have been proven at localised temperatures of over 250°C and can withstand very high levels of shock and vibration. The product range includes multi-octave bandwidth (eg 4.5 to 18GHz) tubes at average power levels of 100, 200, and 300W. Packaging variants include full protection, unpackaged and special versions configured for towed decoy use.

- **Radar** – we have developed a unique technology that has been introduced to a Dual-Mode X-band helix TWT. This provides both high PRF operation with low noise under vibration and CW, and can be used in more conventional radar tubes in C and X band.

Klystrons
e2v UHF klystrons are still in use worldwide in analogue television transmitters and electron beam accelerators for high energy physics applications. Although now replaced in new transmitters by IOTs and the even higher-efficiency ESCIOT, e2v klystrons are still available for special order as spares to keep existing systems operational.

Inductive Output Tubes (IOTs)
e2v is a world-leading manufacturer of a wide range of plug-in and build-up EEV Inductive Output Tubes (EEV IOTs) and their high-efficiency versions, the Energy Saving IOT (EEV ESCIOT®). These devices are used as the final amplifier stage in UHF television transmitters and as CW amplifiers in high power scientific applications such as the diamond light source where several standard e2v IOTs operating at 500MHz are power combined to deliver 300kW continuous wave power to each accelerating cavity. EEV IOT technology is a highly cost-effective solution for analogue television transmitters over 10kW peak sync and digital transmitters over 5kW average power.

Frequency Sources
e2v has developed a range of Gunn oscillators, providing stable low-noise sources for a range of sensor and radiometer applications. Millimetre and sub-millimetre wave designs are available, offering milliwatts of output power at frequencies into the Terahertz region. e2v oscillators are voltage tuneable either by Gunn pushing, or Varactor biasing. The range of frequency sources also utilises DDS (Direct Digital Synthesis) techniques to produce wide-band agile frequency outputs.
Microwave devices

e2v utilises a broad spectrum of technologies to produce highly-integrated RF modules for key defence applications. A full range of components and modules designed and integrated by e2v includes:

- Reference oscillators
- Power amplifiers
- Circulators
- Limiters
- Low noise amplifiers (LNAs)
- Mixers
- Local oscillators
- Performance monitors
- Filters
- Pressure windows
- Noise sources

**Microwave amplifiers**

Amplification of microwave power is key to a number of microwave systems: pre-amplifiers for TWTs and GaN power amplifiers to low-noise receivers. e2v has a long history of amplifier capability integrating bare chips and MMICs into bespoke subsystems. Typical performance parameters include:

- Multi-octave bandwidths
- Low noise and limiting GaAs FET variants available
- Custom designs available

**Example**

X-band power amplifier with integrated variable attenuator capable of 30dB of attenuation in 0.5dB steps. Output power 28dBm with integrated precision video detectors allowing monitoring of input and output power levels. High input-output isolation (60dB) and low mass (700 grammes). Military airborne environment compatibility.

**Limiters and receiver protectors**

For each application, e2v limiters are custom-designed to provide the optimum combination of low loss in the through state and high attenuation in the limiting state. Dependent on application, functionality of the limiter can include:

- Time-swept attenuation enabling precise Sensitivity Time Control (STC) of the radar receiver and matched STC performance from unit-to-unit.
- Gas switch for high-power fault protection
- Microstrip limiter design approach into surface-mount, ‘drop-in’ packaged devices, particularly suited to phased array radar modules 2-18 GHz.

**Integrated receivers**

Comprising a low-noise down-converter Low Noise Front End (LNFE) followed by IF bandwidth switching, logarithmic amplifier and video output stages. Automatic frequency control (AFC) is achieved by use of digital frequency counting techniques applied to the transmit pulse leakage present at the LNFE input and corrective control is then applied to the down-converter local oscillator to maintain alignment of the IF with the filters.

Sensitivity to -97.5dBm with noise figures at 3.7dB for 3GHz and 4.8dB at 9GHz, these units offer capabilities for the most demanding radar requirements, functioning particularly well with e2v receiver protectors.
Low noise amplifiers

Gain in the first stage of the receive chain is vital for good overall system noise performance. e2v offers a number of commercial solutions for marine radar together with military high performance, custom solutions. Overall optimisation and lowest noise figure is achieved through integration of the amplifier with e2v’s receiver protectors and mixers to form a sub assembly.

Typical LNA performance:
→ Frequency to 18GHz (and beyond but application specific)
→ Bandwidth: 2%, 5% optimises performance, wider bands available
→ Gain: typically 20dB
→ Noise figure: typically 1.5dB around 10GHz, increasing with frequency
→ Output: typically 13dBm, but up to 30dBm available
→ Input and output VSWR: typically 1.5:1

Mixers

e2v offers an extensive range of standard mixers covering RF frequencies up to 110GHz and IF frequencies to greater than 1GHz. Waveguide, coaxial, thin and thick film structures are available supported by e2v’s own silicon and gallium arsenide schottky diode capabilities. Designs can be customised to meet the most demanding requirements. Options include single-ended, balanced, double-balanced (SSB) often integrated with amplifier stages to provide improved noise figure performance.

Semiconductor diodes

e2v has a 50-year history in the design and manufacture of semiconductor diodes and has recently opened a new fabrication facility, based at the University of Nottingham, to exploit leading edge semiconductor materials and devices. e2v produces a range of compound semiconductor products, covering frequencies from ~10GHz to over 125GHz, and offers custom-designed products for bespoke applications. The standard range of diodes includes:

→ Microwave sources
  – Graded gap Gunn diodes: 35 – 125GHz
→ Mixer and detector diodes
  – Schottky diodes, beam leads and flip chips: 5 – 110GHz
→ Tuning diodes
  – Microwave tuning varactors
→ Control diodes
  – P-I-N and N-I-P diodes
→ Passive components
  – MIS capacitors, gold bonding preforms