e2v Microwave capability

Delivering precision effects

e2v.com
RF systems & sub-systems

e2v is recognised and respected for pioneering new developments in microwave devices: specifically microwave radar components, microwave products and RF technology. Within the solid-state microwave and electronics operation, this respect continues as customers choose e2v’s products and engineering skills to meet ever-more demanding technological challenges.

Today’s solid-state microwave and electronics operation provides a wide range of microwave and electronic components and sub-systems to markets including defence radar, marine radar, civil airborne radar, communications, medical industrial processing and EW market arenas.

Industrial processing systems

Building on our experience in the design and production of RF technology, e2v is able to offer advanced microwave generation capability with our ProWave microwave generator range for bulk materials processing applications. By delivering a generator with enhanced capability and reliability and after installation support, we take full responsibility for the technology and allow customers to maximise the value from use, reducing the overall cost of system ownership.

ProWave systems are designed, developed and manufactured to be part of high reliability, flexible systems that out-perform traditional industry processing techniques at every stage of your operations. Utilising the latest advances in industrial microwave technology, ProWave generators will help transform the financial and operational performance of your bulk material processing.
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, ECM (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.

Safe-Stop™

Safe-Stop™ is a non-contact engine jamming system that overcomes problems encountered in all other vehicle arresting systems. Reliable on the majority of engines (car, motorbike, truck, boat) at both range and speed, it allows the user to bring targets to a controlled stop without collateral damage.

Applications:
- Convoy protection
- Maritime policing
- Hostile Vehicle Mitigation (HVM)
- Vehicle arresting
- Checkpoint enforcement
- Harbour entry protection
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Microwave & RF sources

Modulators
e2v offers a range of modulator systems based around its patented solid-state switching technology designed for medical, non-destructive testing and cargo scanning applications. e2v offers high and low power solid state modulators with the following benefits:

• Compatible with e2v’s range of Linac magnetrons
• Maintains flat magnetron current pulse in all operating conditions
• 9 field replacement units for ease of servicing
• Comprehensive pulse by pulse remote diagnostics

Magnetrons
e2v is the world’s largest manufacturer of pulse magnetrons and a world leader in magnetron anode, cathode and vacuum technologies.

Manufactured under the EEV brand for several decades, e2v’s magnetrons offer a range of capabilities for the medical, marine, science, security and industrial market.

Capabilities include:

• Frequencies from 1GHz to 100GHz
• Peak Power ranging from 1kW to 75MW
• High quality and long life
High power microwave amplifiers

**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 tubes covering; 6-18 GHz, 4.5-18 GHz and a class leading 2-18 GHz with 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-band helix TWT. This provides both high PRF operation with low noise under vibration and CW, and can be used in more conventional.

- **Communications** – e2v provide compact TWTs for Satellite uplinks capable of delivering 200W over Ku-Band and X-Band.

**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.
**TWT Amplifiers**

e2v offers a wide range of TWT Amplifiers (TWTA) including highly compact Microwave Power Modules (MPMs).

The TWTA combine helix TWTA with a solid state driver module, a high density power supply, in a rugged lightweight package. These robust units have been designed for use in the harshest environments; ground mobile, high altitude fast jet and shipborne, for a wide range of applications that include:

- Electronic Counter Measures
- Communications
- Radar

The units cover the frequency range 2-18 GHz and offer:

- High Power Density
- High efficiency
- High linearity

In addition to the standard range of products e2v is able to offer bespoke solutions tailored to meet customer requirements.

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**Inductive Output Tubes (IOTs)**

e2v is a world-leading manufacturer of plug-in and build-up IOTs for TV broadcasting and high power scientific applications. These devices have been proven in many applications and offer the following:

- High efficiency and reliability
- Typical life of over 80,000 hours
- Up to 90kW CW power in scientific applications
- 130kW peak in COFDM broadcasting
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

Circulators and isolators

Employing faraday rotation effects in ferrite materials, these non-reciprocal devices perform vital duplexing and match improving functions in many microwave systems.

Waveguide junction circulators

Covering most waveguide sizes in H-Plane and E-Plane, and can be supplied with inclusive terminations as isolators.

Phase shift circulators

Capable of significant high power, phase shift circulators provide the heavyweight end of ferrite device operation.

Coaxial circulators

An extensive range is available, for frequencies from 400MHz to 18GHz.

Resonance isolators

High power capabilities in the range 1.2GHz to 6.4GHz, at up to 5MW peak power.
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 $-10$GHz to over $125$GHz, and offers custom-designed products for bespoke applications.
The standard range of diodes includes:
- Microwave sources
  - Graded gap Gunn diodes: $35 – 125$GHz
- Mixer and detector diodes
  - Schottky diodes, beam leads and flip chips:
    $10 – 110$GHz
- Tuning diodes
  - Microwave tuning varactors
- Control diodes
  - P-I-N and N-I-P diodes
- Passive components
  - MIS capacitors, gold bonding preforms
Data converters
e2v’s semiconductor division provides a selection of microwave capable data converters for receiver and transmitter signal chains in a wide range of applications including:
• Industrial
• Military
• Space systems
These products are ADC and DAC chips which connect the digital world to the analogue microwave world. e2v’s data converters contribute significantly to take the digital world up to antenna level in many systems.
e2v’s ADCs digitise signals with high linearity and high RF contrast at frequencies up to S-Band without frequency down conversion. e2v’s DACs are capable of generating microwave signals at frequencies up to C-Band without frequency converters, from streams of software defined digital data. This opens the way to software defined microwave.

Microprocessors
Thanks to our long-standing experience and in close partnership with Freescale Semiconductor, e2v semiconductors offers a wide range of microprocessor and microcontrollers products dedicated to serve Hi-Rel Applications such as avionics, defence, space and industrial. The offering is based on:
• Microprocessors and Microcontrollers using the PowerPC®, 68k and ARM architecture
• A range of key peripherals supported in partnership with IDT
• Magnetoresistive random-access memories (MRAM) with Everspin