MPE
Quality, Reliability, Performance

# Company Bulletin

for EMC, EMP & TEMPEST Protection

Issue 15

## MPE PEOPLE

### MPE in 2017 . . . a year of impressive growth

**MPE's sales continued to grow in 2017 and have risen by some 30% across the last three years. Again, 2017 saw record-breaking levels of export business, with strong growth from South Korea, Turkey and the USA. MPE delivered solutions for very high profile projects such as the Presidential and National Voice Conferencing system protecting Air Force One. Back at base we have invested heavily in our Engineering and Manufacturing teams, building improvement and new equipment, but perhaps the most important aspect is that our head count increased by some 27% over the year.**

**Click for more details**

### Spotlight on Marcus Wright

**Marcus Wright has joined MPE in the newly created position of Manufacturing Manager. His priorities will be to review, develop and improve all production processes, including their physical layout and operating procedures. He will be using Lean Manufacturing techniques to move the company to the "next level" and accommodate the significant increase in throughput made necessary by MPE's rapid sales growth worldwide. He aims to improve the organisation and planning of how product moves through the factory, eliminating waiting time between processes, uneven workloads and non-value-added activity.**

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## MPE TECHNOLOGY

### US Army Corps of Engineers (USACE) compliance

**During the last quarter of 2017 Technical Sales Solutions (TSS), MPE's Gold Certified Partner for the USA, spearheaded the testing of MPE's HEMP filter solutions in accordance with USACE and UFGS requirements. This has resulted in a single report providing all required USACE and UFGS compliance information. Both MPE's standard performance and extended performance HEMP filters were tested, with the tests being conducted by Directed Energy Technologies (DeTech) in Virginia, Intertek Testing Laboratories in Michigan and MPE in Liverpool.**

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### Launch of new TEMPEST filters for navies

**In response to market trends and direct enquiries, MPE has developed a range of TEMPEST protection filters for installation within naval applications. The new range comprises high-performance two-, three- and four-wire variants with low line-to-earth current leakage. The filters support system and equipment compliance with the overarching requirements of NATO TEMPEST SDIP-27 and SDIP-29 Standards. The new range includes models from 16A through to 125A, providing high levels of attenuation from 100kHz right up to 10GHz – and with extremely low line-to-chassis leakage properties from 16.6mA down to 3.6mA.**

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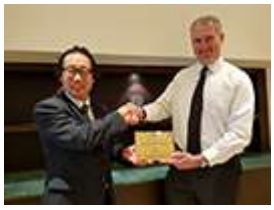
## MPE DISTRIBUTOR NEWS

### Partner Program launched by MPE



**MPE has launched a Distribution Partner Program, providing partners with a clear view of the expectations MPE has of them and, in return, the significant benefits and support associated with partner status. The Program is a tiered structure with four distinct levels – Bronze, Silver, Gold and Platinum. This allows the setting of goals for each partner, whilst enabling MPE to apply a uniform approach to, and measurement of, all partners in all territories, however new or well established. Here Mr Jun Sun Park, CEO of Eretec, Inc, receives his company's Gold Partner award.**

### Oman added to MPE distribution

**With demand for its EMC and EMP filters continuing to grow across the Middle East, MPE has seen its activity in the region increase significantly over the past two years. As a result, following comprehensive territory research and in territory visit activities, MPE is pleased to announce the appointment of Khimji Ramdas LLC as its distribution partner for the Sultanate of Oman. Headquartered in Muscat, the Khimji Ramdas group has been established for some 147 years and is recognised as a market leader in consumer, infrastructure and industrial sectors alike.**

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# MPE APPLICATIONS

## Filters for high-speed digital data

**MPE has developed a new four-line filter for use on 9600 baud rate digital datalines on a mobile radar application in the USA. The system itself was to be, wherever possible, compliant with the HEMP protection requirements of the current MIL-STD-188-125, but also, amongst other stipulations, high-speed data equipment needed to be protected for operation in command-and-control shelters. The challenge that MPE met was to configure circuits which have a high input inductance in conjunction with surge suppression devices providing minimal residual pulse let-through, whilst not affecting the required data signals.**

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## Filters for Airbus A330 refuelling tanker

**MPE is currently manufacturing filter solutions incorporated into Kappa Optronics GmbH's Enhanced AAR Vision Systems for in-flight surveillance on various aircraft including the state-of-the-art Airbus A330 air-to-air refuelling tanker transport (MRTT). Size and weight were significant factors and proved to be among the most challenging design aspects for MPE. Following design meetings facilitated by Bronze-Certified territory distributor Electrade GmbH and held at Kappa's facility in north-western Germany, a development program was conducted at MPE, resulting in a two-line, 28V DC equipment filter solution for scheduled deliveries over the coming years.**

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# FAST FACTS ON MPE LTD

- MPE has traded since 1925 and employs over 50 people.
- MPE has designed, manufactured and shipped in excess of 8,000,000 high-performance EMC, EMP and TEMPEST filters and feedthrough capacitors in the last 30 years.
- Many products have been in service for more than 20 years with undiminished performance.
- MPE has a portfolio of over 20,000 custom product designs to meet all possible requirements.
- The MPE factory at Knowsley, Liverpool, is certified to the quality standard ISO 9001:2015, and its products meet all applicable defence standards.


**For comprehensive information about MPE's products and services, contact the Sales and Marketing Department, MPE Ltd, Hammond Road, Knowsley Industrial Park, Liverpool, L33 7UL, U.K.**
**Tel +44 (0)151 632 9100.**
**Email sales@mpe.co.uk. Website www.mpe.co.uk**
**If you have a friend or colleague who you think might find the MPE Company Bulletin informative, then why not forward it to them?**

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# Company Bulletin

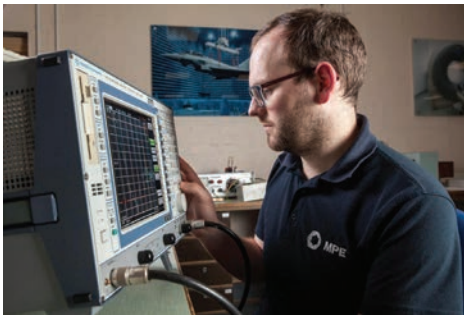
**for EMC, EMP & TEMPEST Protection**

Issue 15

David Seabury – Managing Director, MPE Ltd


US Presidential jet Air Force One


MPE's expanding manufacturing facility



Testing filter performance at MPE

## MPE in 2017 . . . a year of impressive growth

" If this were MPE's school report for 2017, it would certainly state "Exceeded expectations", and I would be a very proud parent. What is clear is the significant growth that MPE experienced throughout 2017 but, with the year having passed by seemingly in a flash, it is only on reflection that I recognise just how many other notable achievements we accomplished together.

MPE's sales continued to grow in 2017 and have now risen by some 30% across the last three years. Again, 2017 saw record-breaking levels of export business, with strong growth specifically from South Korea, Turkey and the USA.

The introduction of a new Partner program for MPE's territory distributors was a major step forward. This tiered program not only focuses precious resource toward the most appropriate areas, but also provides our partners with clear targets to aim for. In addition, during the Autumn MPE appointed new distribution partners for China and Oman, with their first sales already realised.

The USA continued to represent one of MPE's largest export territories, with MPE now very often the first-choice HEMP filter provider for US defence applications. MPE delivered solutions for some very high profile projects such as the Presidential and National Voice Conferencing system – filters protecting Air Force One are going to be hard to top! Then significantly, in late 2017, via our Gold-Certified US partner TSS, MPE's HEMP filters achieved US Army Corps of Engineers (USACE) compliance, providing a further platform for growth within this territory.

Back at base, to meet the increased demand for product, MPE invested heavily in our Engineering and Manufacturing teams. Several building improvement projects were completed and new equipment procured, including further balance meters and spectrum analysers, but perhaps the most important aspect of all is that MPE's head count increased by some 27% over the year.

Notable new additions saw the Engineering team further strengthened, with Satnam Singh joining in August as Design Engineer and, at the close of the year, Marcus Wright being brought on board to head up MPE's Manufacturing functions. Following on from the successful introduction of the company's first apprentices in 2016, this program was expanded with the enlistment of Gillam Prescott and Liam Reed during September 2017.

Technology-wise MPE had two patent applications accepted for innovative techniques in surge arresting. A further expansion of our well-established HEMP filter range was also achieved, with HEMP filters now accounting for almost 50% of MPE's overall business.

Again thinking of export territories, I was very pleased to see Paul Currie, our Sales and Marketing Director, being invited to present

MPE
Quality, Reliability, Performance

# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15


Paul Currie of MPE (on front row, fourth left) joins the KIEES Committee at the EMSEC Workshop in Seoul last October

a further keynote address to the Energy Council of the North-East (ECNE) community in the USA and also to be one of only two non-Korean speakers asked to present at the annual EMSEC Workshop hosted by the Korean Institute of Electromagnetic Engineering and Science (KIEES) in Seoul in October.

Meanwhile John Jephcott, Key Account Manager at MPE, was asked to present to a select group of the Institute of Electrical and Electronics Engineers (IEEE) in Sweden. These regular invitations are a testament to MPE's position as a world leader in filter technology.

So, looking ahead, with a strong order book and MPE being drawn towards further new export territories, I expect MPE to sustain its growth trajectory, resulting in nothing short of "triple A's" on next year's school report!

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# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15

Marcus Wright

## Spotlight on Marcus Wright

Marcus Wright is delighted to have joined MPE in January in the newly created position of Manufacturing Manager. His priorities will be to review, develop and improve all production processes, including their physical layout and operating procedures. He will be using Lean Manufacturing techniques to move the company to the “next level” and accommodate the significant increase in throughput made necessary by MPE’s rapid sales growth worldwide.

He aims to improve the organisation and planning of how product moves through the factory, eliminating waiting time between processes, uneven workloads and non-value-added activity. He will also be expanding the use of the existing material requirements planning (MRP) system to optimise resource utilisation and capacity planning.

The coordination of component supply, so that all constituent elements of a given product come together for assembly at the same time and the right time, will be an important aspect of Marcus’s work. That responsibility will extend into all areas involved – design, purchasing, manufacturing and assembly, quality assurance, stores and despatch, with the clear objectives of giving more accurate lead-times and achieving on-time deliveries, whilst satisfying the requisite quality approvals and certifications. Product customisation has always been a strong point of MPE and will remain so, but, whilst maintaining that operational flexibility and versatility, opportunities exist for more standardisation for the clear benefit of the customer.

During most of his career in engineering since he gained his B.Eng Honours degree in Manufacturing Engineering at Salford University in 1994, Marcus has been active in introducing and implementing MRP systems and Lean Manufacturing practices.

From 2002 to 2017 he was Manufacturing / Engineering Manager at 360 Vision Technology Ltd, a CCTV equipment OEM based at Runcorn and set up by Senior Managers previously at nearby Honeywell (Video Controls Ltd), where Marcus was employed between 1999 and 2002 as their Manufacturing Engineer. At Honeywell he improved the efficiency of one of their production lines by 100%, and increased capacity by up to 400% in the same space, using Lean Manufacturing tools.

Previous to that, he had occupied various posts in Technical and Production Management and Engineering after graduation. Prior to University he underwent a five-year indentured apprenticeship, from the age of 16, as Aeronautical Production Engineer at British Aerospace, Chester. There he worked on such massive projects as the wings for the Airbus, the BAe125 business jet and Airbus A380 superjumbo jet.

Marcus is married and lives at Frodsham in West Cheshire. His keenest leisure interests are road cycling, mountain biking, swimming, music, and reading sports autobiographies and travel books. In June 2018 he will be climbing Ben Nevis, Scafell Pike and Snowdon in the National Three Peaks Challenge for charity.

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# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

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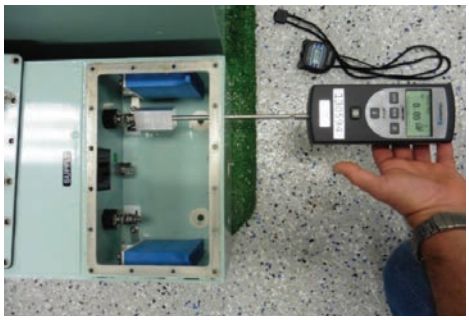
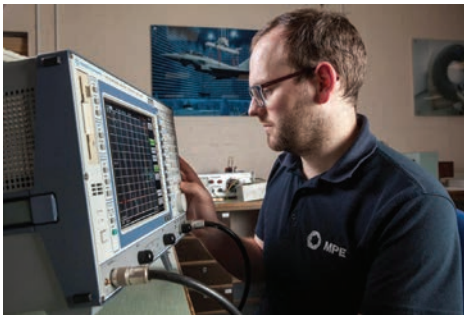
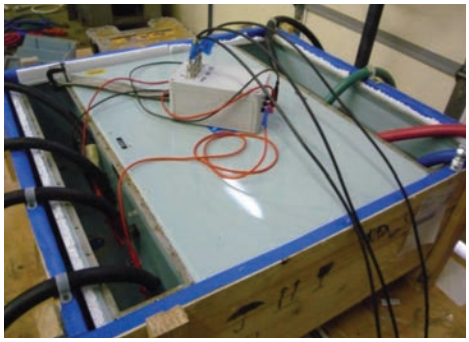


Terminal pull test set-up at Intertek, Michigan



Insertion loss testing at MPE, Liverpool



MPE filter during harmonic distortion testing at DeTech, Virginia

## US Army Corps of Engineers (USACE) compliance

As one of the primary HEMP filter suppliers for US defence applications, MPE is often requested to provide evidence of compliance with the United States Army Corps of Engineers (USACE) filter test specification, section 13 27 54.01 10, filter section 2.5, paragraph 2.5.5, as well as the United States Department of Defense (DoD) Unified Facilities Guide Specification (UFGS) 13.49.20.00 10, filter section 2.7, paragraph 2.7.5.

Previously MPE has demonstrated such compliance via individual test reports, in combination with historical supply information. Whilst this has been wholly acceptable for the vast majority of applications, it is often not the most efficient or succinct method of communicating compliance.

During the last quarter of 2017 Technical Sales Solutions (TSS), MPE's Gold Certified Partner for the USA, spearheaded the testing of MPE's HEMP filter solutions in accordance with these USACE and UFGS requirements. This has resulted in a single report providing all required USACE and UFGS compliance information.

Both MPE's standard performance and extended performance HEMP filters were tested, with the tests being conducted by Directed Energy Technologies (DeTech) in Virginia, Intertek Testing Laboratories in Michigan and MPE in Liverpool.

The USACE and UFGS specifications stipulate that tests be conducted on specific terminal strength; insertion loss; voltage drop; current overload; reactive shunt current; dielectric withstand voltage; insulation resistance; harmonic distortion; and filter life. These tests were completed in their entirety for the MPE filters.

As the majority of the required tests have well defined test methodologies and are often requested of MPE, unsurprisingly the test results proved that the MPE filters exceeded all electrical performance requirements and showed no signs of damage or degradation following the mechanical tests.

A less common test requirement is total harmonic distortion (THD), although the test method and maximum permitted THD levels are again well defined within IEEE 519-0-2014; IEC 61000-4-7; UFGS 26-35.46.00 20; and UFGS 13.27.54.00 10. The most stringent of these standards allows a maximum THD threshold of 2.5%. Test results showed that the THD of the MPE filters fell well within this threshold, at a maximum of 0.5% THD.

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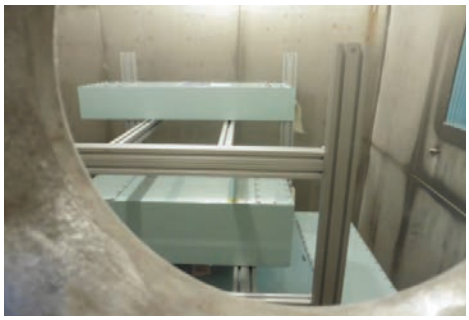
# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15



MPE filters undergoing thermal shock testing at Intertek, Michigan

MPE filter during current overload testing at MPE, Liverpool

MPE filters mounted to shield for shield effectiveness testing at DeTech, Virginia

As per the requirements of USACE and UFGS, thermal shock testing was also conducted. The MPE filters were subjected to ten cycles of testing at four different temperatures ranging from -55˚C and +85˚C, with filters being exposed to each temperature for at least eight hours. Following this extensive testing, the filters were again electrically tested and found to be compliant with the stipulations of USACE and UFGS.

Insertion loss testing at 20%, 50% and 100% of rated load is also required by both the USACE and UFGS specifications, in order to validate that the filters do not saturate under load conditions. This testing under load was conducted by DeTech from 14kHz to 3GHz. In all cases the MPE filters were not only compliant but each showed an additional safety margin, in some cases up to 20dB.

As permitted in the USACE and UFGS specifications, the final test requirement, filter life test, was satisfied via provision of a list of prior installations, where MPE HEMP filters have been operational and in service for over five years. This was reinforced by the additional provision of a 24-hour temperature rise test conducted on MPE's 1200A high-current HEMP filter. This report demonstrated clearly that, at 200% load current (2400A), the temperature rise of the MPE filter was insignificant, at less than 0.3˚C.

In addition to this laboratory testing, further shielding effectiveness measurements were provided for MPE's 1200A filters installed under operational load conditions. These measurements showed that the MPE filters exceeded all specification requirements by some margin.

Although originally formulated for, and used primarily in, US defence applications, the USACE and UFGS specifications are also in some cases adopted by project authorities in other territories as their benchmark performance specifications. The proven full compliance of MPE filters with these specifications is therefore a major benefit to any integrator or authority requiring documented evidence of such compliance.

The full test report is available via controlled release. Any request for a copy should be directed either to Terry Murch at Technical Sales Solutions terry@techsalesolutions.com or to Paul Currie at MPE pcurrie@mpe.co.uk

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# Company Bulletin

**for EMC, EMP, HEMP & TEMPEST Protection**

Issue 19

16A TEMPEST power line filter manufactured by MPE for the Royal Navy

Astute Class submarine

The new Royal Navy Type 26 frigate

## Launch of new TEMPEST filters for navies

In response to recent market trends and direct enquiries, MPE has now developed a range of TEMPEST protection filters specifically for installation within naval applications. This follows on from the “floating earth”, ultra-low-leakage power line filter range developed by MPE during 2017, as reported in Company Bulletin Issue 12.

The new range of ground-breaking filters comprises high-performance two-, three- and four-wire variants with low line-to-earth current leakage. The filters support system and equipment compliance with the overarching requirements of NATO TEMPEST SDIP-27 and SDIP-29 Standards and provide high levels of attenuation across the full frequency spectrum. They meet the line capacitance limitations of DEF-STAN 59-411 and MIL-STD-461 and are designed to be compatible with a ship’s integral DC leakage detection systems.

The new filters have been developed for any naval application where TEMPEST protection is a requirement, typically briefing rooms, radio rooms, electronic warfare hubs, and navigation or command-and-control locations.

Indeed, MPE has many years of accumulated expertise and experience in manufacturing low-leakage filters, for use in applications such as secure communications systems, computer installations, portable screened enclosures and mobile tactical shelters.

The new range of TEMPEST protection filters includes models from 16A through to 125A, providing high levels of attenuation from 100kHz right up to 10GHz – and with exceptionally low line-to-chassis leakage properties from 16.6mA down to 3.6mA.

Mechanically these filters utilise stainless steel enclosures for enhanced corrosion resistance in marine environments, and are finished with high-quality epoxy paint. They have a very high resistance to shock and vibration, and are designed to have an extremely long service life.

Incorporating the same field-proven, ultra-high-reliability components as have been used for decades in MPE’s other power line filter ranges, these ultra-low-leakage filters have already been designed into the highest profile marine platforms such as the Royal Navy’s Astute Class submarines and their new Type 26 frigate as pictured here.

You can download your personal copy of the comprehensive, six-page datasheet on MPE’s new TEMPEST power line filters for marine applications from here.

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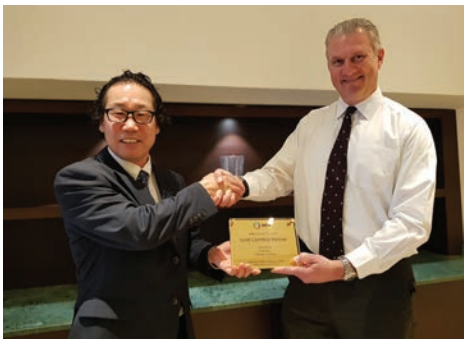
# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15



Mr Jun Sun Park, CEO of Eretec, Inc, (pictured left) is presented with his company's Gold Partner award by David Seabury, Managing Director of MPE

Mr Dieter Mühlberger, Managing Director of Electrade GmbH, (on the left) receives the Bronze Partner award from John Jephcott, Key Account Manager at MPE

## Partner Program launched by MPE

With a growing number of distributors around the world, effective resource application and support for these partners have become ever more challenging for MPE. The disparate nature of each individual distribution partner and territory previously made the comparison and measurement of performance difficult.

Accordingly, last year MPE launched an innovative Partner Program, providing partners with a clear view of the expectations MPE has of them and, in return, the significant benefits and support associated with partner status. The Program also provides a clear vision for any potential distributor considering a future relationship with MPE.

The MPE Partner Program is a tiered structure with four distinct levels – Bronze, Silver, Gold and Platinum. This allows the setting of achievable and individual goals for each partner, whilst enabling MPE to apply a uniform approach to, and measurement of, all partners in all territories, however new or well established.

Performance measurement parameters are based deliberately not only on financial yardsticks but also on sales and marketing activity, providing new partners with the ability to develop new customers or market sectors and an attainable progression route to the next tier.

Pleasingly, during this first introduction, the three partners Eretec (South Korea), IMCA (Turkey) and TSS (USA) achieved Gold Partner status for 2018, with a further two partners achieving Silver Partner status and four partners entering the Program at Bronze Partner level. These partner statuses were communicated to each party at the start of the year and are now prominent on the distribution partner pages of the MPE website www.mpe.co.uk/distributors.

MPE will be working closely with all of its territory partners throughout the next 12 months, ensuring that maximum benefits are mutually realised from the new Partner Program.

**Gold Partners**

ERETEC INC.

imca electronics
demand generation based distribution

tss
Technical Sales Solutions

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# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15

Tactical shelter application such as in other countries

Military vehicle application in other territories

Data centre application typical globally

## Oman added to MPE distribution

With demand for its EMC and EMP filters continuing to grow across the Middle East, MPE has seen its activity in the region increase significantly over the past two years. As a result, following comprehensive territory research and in territory visit activities, MPE is pleased to announce the appointment of Khimji Ramdas LLC as its distribution partner for the Sultanate of Oman.

Headquartered in Muscat, the Khimji Ramdas group has been established for some 147 years and is recognised as a market leader in consumer, infrastructure and industrial sectors alike. Khimji Ramdas boasts some 40 divisions sitting within four strategic groups: consumer products, lifestyle, infrastructure and projects and logistics.

Working primarily with the infrastructure group, whilst EMC and EMP filtering are new technologies to Khimji Ramdas, these are natural additions to its existing offerings and are very relevant within the projects that it currently serves. Since appointment, Khimji Ramdas and MPE have presented jointly to various potential customers in country.

Paul Currie, MPE Sales & Marketing Director, commented on the appointment: “With demand from the Middle East region continuing to grow, distribution partners in this region are increasingly important for MPE’s business going forward. Its market presence and commitment to quality and customer satisfaction make Khimji Ramdas an ideal partner for MPE in Oman.”

Khimji Ramdas commented: “The addition of MPE’s EMC and EMP filters to our portfolio enables us to offer further value and differentiation to our customer base. Whilst the market for such filters is relatively new, we have already seen interest from several sectors, and we are pleased to be able to offer MPE’s quality and reliable solutions to address these new requirements.”

For information on Khimji Ramdas, please visit the company’s website www.khimji.om or, for product enquiries within the Omani market, email Kishore Kumar at k.sundaramurthy@kr.om

KR
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www.kr.om

MPE
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# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15

Example of a mobile radar installation in the USA

A typical MPE dataline filter

## Filters for high-speed digital data

During 2016 MPE conducted a complex and extensive filter development program to meet the exacting requirements of a new mobile radar application in the USA. The system itself was to be, wherever possible, compliant with the HEMP protection requirements of the current MIL-STD-188-125, but also, amongst other stipulations, high-speed data equipment needed to be protected for operation in command-and-control shelters.

Data filters and higher frequency signal filters require a wider frequency passband to allow high-speed signals to pass without attenuation. Unfortunately part of the energy spectrum of the HEMP pulse falls also within this range, and so, for a filter to allow the data to pass, the filter will necessarily allow part of the HEMP energy to pass, displayed as a residual current.

This makes it impractical to be fully compliant with the requirements of MIL-STD-188-125 Parts 1 and 2, since to do so would negatively impact upon the data signals. Therefore the challenge for a filter manufacturer is to configure circuits which have a high input inductance in conjunction with surge suppression devices providing minimal residual pulse let-through, whilst not affecting the required data signals.

Following meetings with the system integrator in the USA, MPE embarked upon a new filter design. The foundations for this were already in place, with the filter ultimately being based on a combination of MPE's field-proven HEMP filter designs and its established, non-HEMP, dataline filter ranges.

Using practical application data, PSpice modelling and laboratory testing at MPE, a prototype unit was developed containing two different circuits which allowed both pulse current injection (PCI) testing and system level testing to be conducted in the USA. Upon completion of both these test procedures and selection of the most appropriate prototype circuit, MPE was contracted to prepare the finished product design and to deliver production units.

The finished product is a four-line data filter for use on 9600 baud rate digital datalines, providing attenuation against wideband EMI and with modified circuits to protect against fast pulse and HEMP. Mechanically the filter is bulkhead mountable for ease of installation, with connections made via spade tags and both end compartments being accessible to assist surge arrestor maintenance.

After MPE and its Gold-Certified territory partner Technical Sales Solutions LLC (TSS) (www.techsalesolutions.com) had afforded all necessary support during the installation of the system, a suite of the filters was supplied, and they have now been in successful operation in this mobile radar application for more than 12 months.

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# Company Bulletin

**for EMC, EMP & TEMPEST Protection**

Issue 15

Air-to-air refuelling by an Airbus A330 tanker of the Royal Australian Air Force (RAAF)

A Kappa Enhanced Vision System camera as mounted on the A330 refuelling tanker for in-flight surveillance

A range of MPE equipment filters

## Filters for Airbus A330 refuelling tanker

Via its Bronze-Certified territory distributor Electrade GmbH (www.electrade.com), MPE continues to be a trusted supplier to Kappa Optronics GmbH based at Gleichen in north-western Germany. Kappa have been developing and manufacturing application-specific, day-and-night-vision cameras for over 30 years. Kappa provide flexible solutions to meet a broad range of requirements in markets spanning defence, aviation, vehicles, microscopy, power distribution and factory automation.

So MPE is currently manufacturing filter solutions used on Kappa's Enhanced AAR Vision Systems deployed within various airframes including the state-of-the-art Airbus A330 multi-role tanker transport (MRTT) aircraft.

The Airbus A330 MRTT is a military derivative of the A330-200 wide-body, twin-engine jet airliner. It is designed as a dual-role, air-to-air refuelling transport aircraft and has been ordered and commissioned by the Royal Australian Air Force (RAAF), Royal Air Force (RAF), South Korean Air Force, United Arab Emirates Air Force, Royal Saudi Air Force and Republic of Singapore Air Force.

Initially MPE was approached to design a solution that would ensure the integrity of TEMPEST classified systems within the application, specifically within the power supply to this equipment. Alongside the required electrical performance parameters, since the equipment was to be rack-mounted within the airframe, size and weight were also significant factors and proved to be among the most challenging design elements for MPE.

Following design meetings facilitated by Electrade and held at Kappa's Gleichen facility, a development program was conducted at MPE, resulting in a two-line, 28V DC equipment filter solution being delivered by MPE. This solution provides full performance across a 100kHz to 1GHz range, whilst minimising the space envelope required for integration into the optical equipment rack. To date around 100 units have been delivered by MPE, with supply set to continue over the coming years.

In addition to this specialised custom equipment filter, MPE provides many other varied equipment filter solutions, details of which can be found on the product pages of MPE's website www.mpe.co.uk/category/equipment-filters or by downloading the product catalogue link via this link:

www.mpe.co.uk/wp-content/uploads/2014/10/8318-MPE-Equipment-Filters.pdf

ELECTRADE
ELEKTRONIK-VERTRIEB
UND CONSULTING