Filter Products Guide



mpg BSC

A DOVER COMPANY

Innovative RF and Microwave
Filter Based Solutions

RUPP tronik

# Innovative RF *and* Microwave Filter Based Solutions

BSC specialise in the design and manufacture of Microwave filters, diplexers, waveguide and coaxial components, from single research prototypes, up to high volumes in the supply chain for the broadband access marketplace.

Working up to 94 GHz, BSC are dedicated to excellence in all aspects of filters and diplexers, specialising in Waveguide, Interdigital, Combline, Cavity, Lumped Element and Microstrip devices. Other components include: Couplers, Equalisers, Switched Filter Banks, Transitions and Waveguide Assemblies.

## Innovation in Design

The quest for ever higher levels of performance and cost competitiveness drives our design and development initiatives.

BSC are pioneers in the use of 'Exact Filter' and our patented 'Elliptic' technologies. We are constantly expanding our suite of proprietary software to push forward our use of 'right first time' prototyping.

BSC's custom filter design expertise and production facilities are used to produce devices ideally suited to the particular needs of any application.

## Accreditations

ISO9001:2008
Certificate No. FM 32460

ISO14001:2004
Certificate No. EMS 583706

RoHS

## Manufacturing Excellence

BSC's leading-edge design technology is fully supported by machining and measuring techniques capable of providing the highest levels of precision, quality and repeatability demanded in today's market.

Utilising in-house CNC machining centres, BSC operates a highly flexible manufacturing system, addressing customer requirements from initial prototyping through to high volume production.

## Committed to Quality

At BSC quality is not just another stage in the manufacturing process, it is a commitment which drives all processes and systems within the company, from initial enquiry through to delivery of the end product.

## Product Range

| | | |
|---|---|---|
| **Agile and Tuneable** | BP, BS: 1 MHz – 18 GHz | BW = 2 - 20% |
| **Thin Film** Q250 - 400 | BP, BS, LP, HP: 2 GHz – 18 GHz | BW = 5% - multi-octave |
| **Helical** Q800 - 1200 | BP, BS: 50 MHz – 1.3 GHz | BW = 0.5 - 5% |
| **Lumped Element** Q50 - 300 | BP, BS, LP, HP: 300 KHz – 3 GHz | BW = 1% - multi-octave |
| **Ceramic** Q400 - 600 | BP: 500 MHz – 4.5 GHz | BW = 1 - 30% |
| **Tubular** Q300 - 700 | LP: 20 MHz – 11 GHz | |
| **Combline** Q500 - 4000 | BP: 400 MHz – 20 GHz | BW = 1 - 50% |
| **Interdigital** Q1000 - 4000 | BP: 800 MHz – 33 GHz | BW = 0.5 - 100% |
| **Suspended Substrate** Q400 - 600 | BP, BS, LP, HP: 500 MHz – 50 GHz | BW = 10% - multi-octave |
| **Waveguide** Q1000 - 20,000 | BP, BS, LP, HP: 1 GHz – 100 GHz | BW = 0.5 - 5% |
| **Modules and Added Function** | SDLVAs; Software-Defined Filtering | • Amplification & Gain Control • FPGA Control & User-Reprogramming • Frequency Synthesis • Built-in Test, Detectors & Noise sources • Up-Conversion & Down-Conversion • Electronic Temperature Compensation/ Offsets |

www.bscfilters.com





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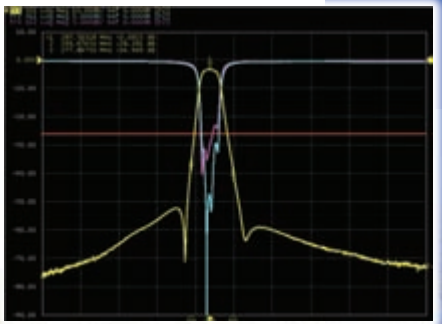
# Agile & Tuneable *Filters*

Pioneering new technological approaches to modern-day system requirements.

Measured response of tuneable filter; Fc = 287.5 MHz, selected by control word 089 (01011001).



Taking a novel approach to the demand for continuously-variable filtering solutions, BSC have surpassed the industry standard in combined selectivity and power handling for electronically-tuneable filters.

Using high-Q resonators combined with unique tuning and control methods, a true cross-coupled Bandpass response can be generated and aligned with accuracy and speed across a wide operating band. Notch variants are also available based on the same infrastructure core. The User Control Interface is based on FPGA technology allowing configurable communications protocols for ease of implementation and reconfiguration without changing hardware.

BSC Agile filters offer higher selectivity than currently available products and improved power handling with 'hot' RF switching functionality. The architecture is scalable in frequency, with an array of tuning mechanisms (solid-state and also mechanically-tuned solutions), making our Tuneable & Agile technology ideal for a variety of applications and platforms ranging from frequency-hopping radio protocols to EW receiver protection applications.

## Scope

- Frequency Range: 1 MHz to 18 GHz
- Tuning Speed: 100 ns to 10 s (depending on tuning mechanism)

## Topologies

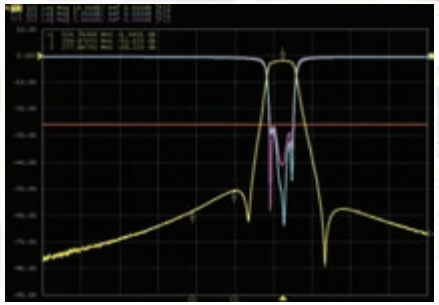
- Bandpass
- Bandstop

## Applications

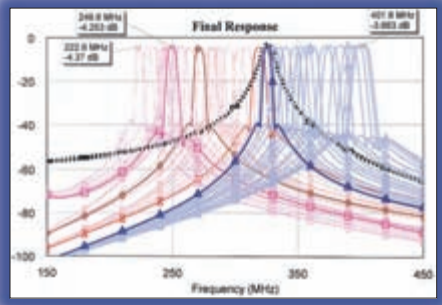
- Military Comms.
- Software-Defined Radio Systems
- EW System Protection

## Features

- Open FPGA control architecture for "In Situ" reconfiguration
- Hot RF switching
- True cross-coupled responses available



Measured response of tuneable filter; Fc = 324.0 MHz, selected by control word 141 (10001101).




Simulated example of tuning range and responses. Note the dashed line, representing the current industry standard of equivalent devices.

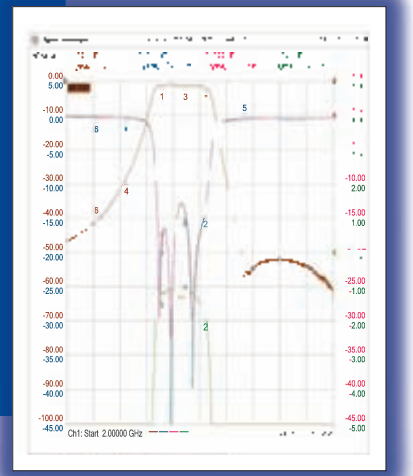
# Thin Film *Technology*

Beyond the limits of traditional substrates, Thin Film technology facilitates huge reductions in footprint, whilst maintaining market-leading performance.

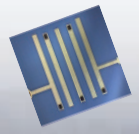
Miniaturisation of RF Filtering requires an entirely specialist approach to design and manufacture. Surpassing conventional Thin Film technology, BSC utilise materials that offer significant advantages over the traditional Alumina solutions, with improved size, loss, temperature stability and manufacturing repeatability.

For surface-mount applications where real-estate is critical, BSC Thin Film devices offer performance otherwise unachievable in such a small space. Unique high-k substrates enable high-Q filters to be realised many times smaller than more traditional ceramic or air dielectric-based structures. Thin Film devices offer SAW-style miniaturisation, operating up to 18 GHz, and offering much greater bandwidths.

The manufacturing process involves tight control and characterisation of the substrate material using highly refined, proprietary techniques. Stringent processing procedures control the tolerances required during manufacture to necessitate absolute accuracy; this in turn precipitates repeatability. Thin Film solutions are attractive not only for their miniaturisation but for high-volume applications in mass-produced modules or phased array antennas.

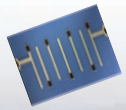


Measured response at 4 GHz.



Interdigital structure centred at 4 GHz. Size 9 x 9 mm.

Combline structure centred at 7.5 GHz. Size 9 x 7 mm.



Interdigital structure centred at 9.5 GHz. Size 9 x 7 mm.

9 x 7mm Interdigital structure at actual size

Device under test.

## Scope

- Frequency Range: 2 GHz to 18 GHz
- Bandwidth: 5% to Multi-octave

## Topologies

- Bandpass
- Lowpass
- Highpass
- Bandstop

## Applications

- Phased Arrays
- UAVs and Missiles
- High-volume Applications
- Small-size, Low-mass Applications
- Temperature-stable Applications

# RF *Modules*

With broad-ranging capability in Amplification, Switching & Control, Logic, Power Circuitry and PCB Layout, the expert Design Team at BSC can offer more than simple filtering alone.

Maximising integration is key to offering the best possible performance in any system, in the minimum possible size. By introducing higher-level functionality in a smaller number of modular subsystems, the risk and complexity of the system is lowered when compared to using entirely discrete components.

As filtering experts, BSC have built on a historic reputation of quality and performance by adding active function around our passive RF devices. Multiple functions can be carried out by a single self-contained block incorporating amplification/gain control, temperature compensation and offsets, digital functionality using FPGA control & calibration, to name a few.

### **Example 1:** Successive Detector Log Video Amplifier (SDLVA)

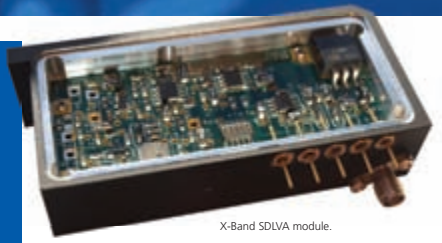
BSC developed an integrated X-Band SDLVA module for a demanding airborne platform. Functions include:

- Bandpass Filtering and novel Gain Equalisation
- Electronically-adjustable Dynamic Range
- Temperature Compensation
- Electronically User-Programmable Temperature Offset

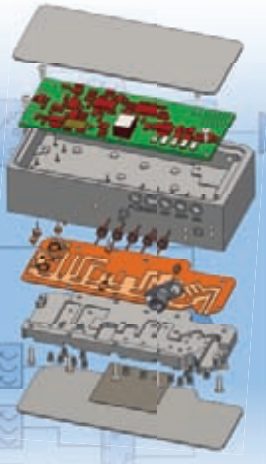
### **Example 2:** 14-Channel S-Band IF Preselector Module

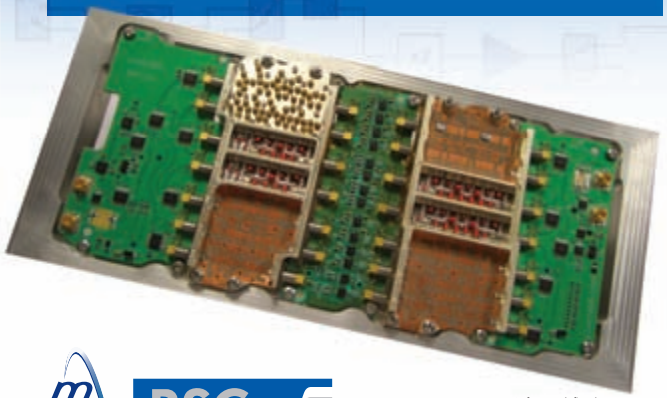
A highly-versatile Software-Defined Radio system requires an equally flexible filtering stage. The solution presented by BSC offers high-speed continuous switching between channels; this is achieved whilst additional parameters can be simultaneously controlled. Features include:

- High Level of MMIC Integration
- Front-end Adjustable Dynamic Range
- 64 dB Digitally-controlled Variable Gain



X-Band SDLVA module.





Software-defined preselector module.

### Features Available

- Amplification
- Limiters
- Adjustable Gain Control
- Temperature Compensation and Offsets
- Integrated Equalisation
- Built-in Test, Integrated Detectors and Noise Sources
- Logic, On-board Memory and Internal Data Bus Control
- Customer Reprogramming 'in-situ'
- Integrated DC Supply & Biasing
- Up-Conversion and Down-Conversion
- Frequency Synthesis



# BSC **Space Heritage**

Since 2003, BSC have been designing and manufacturing RF filters for use in space; from Low Earth Orbit to the surface of Mars.

GIOVE-A

Many modern commercial satellite programs are increasingly looking to use non S-Level components in order to bring space technology to corporations and developing nations at a more affordable price than traditional satellite infrastructure.

The space environment poses unique technical challenges for RF devices; extreme temperature ranges, mechanical stress , vacuum and radiation must be taken into account from the smallest component up to the top-level design.

BSC are able to offer a range of design and build standards, from COTS-standard devices with minimum modification to facilitate space use, up to bespoke designs which undergo full qualification and flight hardware which is assembled using space-proven components and materials to industry standards.

BSC are proud to have manufactured flight hardware for the following programs:

- TopSat (2005)
- GIOVE-A (2005)
- RapidEye (2008)
- NovaSAR-S (2013)
- CyGNSS (2013)

NovaSAR-S

### Applications

**Satellites:**

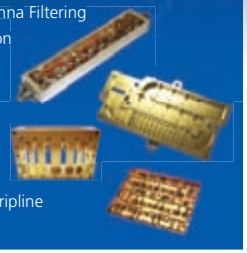
- Uplink / Downlink Antenna Filtering
- Co-Site Antenna Isolation
- Surface Reflectometry
- Synthetic Aperture Radar

**Rovers / Landers:**

- Uplink / Downlink Antenna Filtering
- Scientific Instrumentation

### Space-Proven Filter Technologies

- Lumped Element
- Waveguide
- Combline / Interdigital
- Suspended Substrate Stripline



RapidEye

TopSat, GIOVE-A, RapidEye, NovaSAR-S and CyGNSS mission references and images courtesy of Surrey Satellite Technology Ltd.

# Cavity *Filters*

For applications where low Insertion Loss, high performance and ruggedness are important.

Cavity structures can be used to realise Bandpass or Bandstop filters and also Multiplexers. They can be used exclusively, or seamlessly integrated with other structures to provide even higher performance where the application requires.

High Q performance, narrow Bandwidth and mechanical strength are key benefits of Cavity structures, making them especially suited to Military and Commercial in-the-field applications.

Within novel, space-saving design layouts, Cross-Coupling is extensively used to achieve high selectivity whilst maintaining low Insertion Loss. Temperature compensation can be optimised to stabilise performance over extreme temperature ranges.

The Stopband performance of our Cavity filters may be increased up to many times the Centre Frequency by combining with Tubular, Suspended Substrate or Combline technologies.

BSC have considerable experience in designing outline packages for direct integration into the application, thus ensuring maximum space efficiency and cost savings whilst still meeting the most demanding of environmental requirements.

### Scope

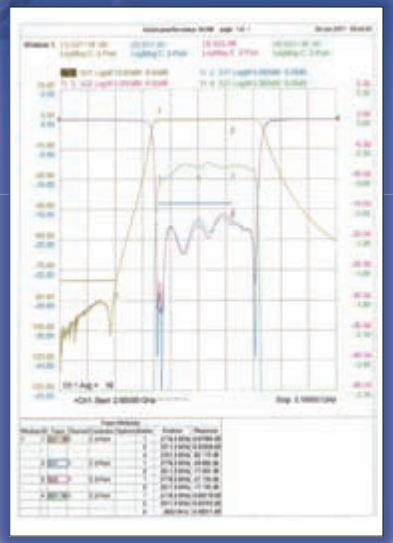
- Frequency Range: 400 MHz to 3 GHz
- Bandwidth: 1% to 10%
- Stopband: Typically 4x Fc (or higher if hybridised)

### Topologies

- Bandpass
- Bandstop
- Multiplexer

### Applications

- WiMax
- Base Station
- Test Equipment



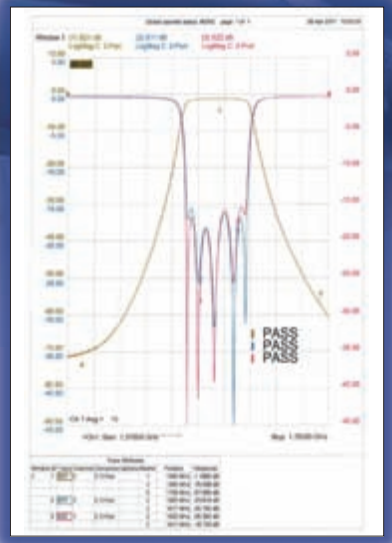
# Ceramic *Filters*

For low-power applications where low cost, small size and High Q are required.


Between 500 MHz and 4.5 GHz Centre Frequency, our Ceramic filters can be realised as Bandpass or Diplexer topologies, and can offer rejections exceeding 60 dB, with excellent thermal stability. Each filter is manufactured to exacting standards and fine-tuned to give predictable, repeatable performance from part to part.

BSC Ceramic filters are available in two to six resonant sections and can be surface mounted or manufactured in connectorised packages. The surface mount variants are especially suited to high volume applications; the low cost and high performance of BSC Ceramic filters prove to be the ideal solution for low-power systems produced up to quantities numbering in the thousands.

GPS, Telecommunications and Defence (RADAR and Comms) applications are common situations where high production quantities, small size and light weight are important and BSC Ceramics are commonly utilised as part of these systems.




### Scope

- Frequency Range: 500 MHz to 4.5 GHz
- Bandwidth: 1% to 30%
- Stopband: Up to 6 GHz
- Power Handling: Low power, < 5W

### Topologies

- Bandpass
- Diplexer

### Applications

- GPS Receiver
- Telecommunications
- Defence (Radar and Comms)

# Combline *Filters*

For applications where size, Insertion Loss or Stopband performance need to be optimised.

Giving a large degree of parameter flexibility, BSC Combline filters can be optimised effectively to meet the demands of the application, in Bandpass, Diplexer or Multiplexer topologies. By altering the resonator sizes from a thirtieth to a quarter of a wavelength, a variety of filter requirements can be realised.

BSC Combline filters are available as traditional Chebyshev designs, or the more exotic Cross-Coupled and Extracted Pole varieties for higher performance applications.

Low-loss by design, our Combline filters are machined from solid in our state-of-the-art machining facility and are an ideal choice in applications where high rejections and a wide-reaching Stopband are required, in a compact, connectorised or drop-in package. This technology lends itself particularly well to narrow-band applications.

Combline filters can be used as low power, low loss protective devices for GPS receivers or SatCom terminals. Other designs can pass kilowatts of power for use in RADAR or Transmit applications.

In medium-power systems, this filter type lends itself to most situations, and can operate over wide temperature ranges, withstand extreme shock and vibration as required by demanding Military specifications. As with most of our filters, this technology can be environmentally sealed to Fine Leak rates.

### Scope

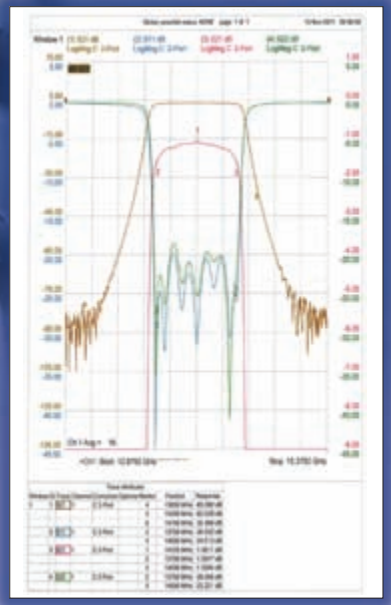
- Frequency Range: 200 MHz to 20 GHz
- Bandwidth: 1% to 60%
- Stopband: Up to 7x Fc

### Topologies

- Bandpass
- Diplexer
- Multiplexer

### Applications

- Tx / Rx
- Test Equipment
- Medium / Low Power



# Diplexers *and* Multiplexers

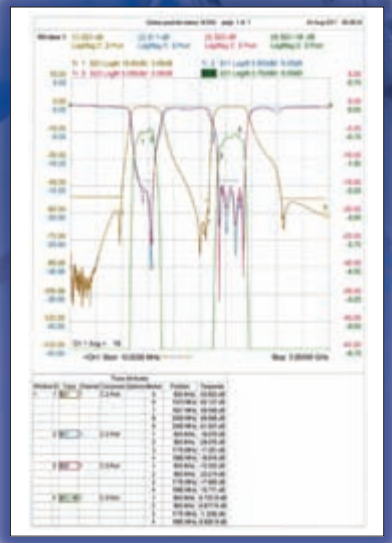
For transmit / receive over a single antenna, transmission line sharing and signal-splitting.

Our Diplexer and Multiplexer range extends from low frequency Lumped Elements at 10 MHz through Combline and Suspended Stripline technology, up to high frequency Waveguide devices at 60 GHz, based on BSC's Exact Filter Technology.

At BSC, our design experience has allowed us to construct Diplexers and Multiplexers with contiguous and non-contiguous Passbands, meeting the most demanding technical requirements. Multiplexers with up to seven contiguous outputs have been designed and manufactured utilising several technologies.

The extremely high accuracy in-house machining and specialist surface finishing used in the manufacture of our world-class Waveguides mean that BSC can, when demanded by the application produce repeatable, predictable tuning-free performance.

Using Exact Filter Technology in our Waveguide Diplexers means that tuning elements and screws (which by their nature disrupt the optimum waveguide construction) can be eliminated from the design. The result is lower Insertion Loss, high Port Isolation and a very symmetrical response.



### Scope

- Frequency Range: 10 MHz to 90 GHz
- Stopband: Up to 7x Fc

### Technologies

- Waveguide
- Suspended Substrate
- Lumped Element
- Cavity
- Combline & Interdigital

### Topologies

- Diplexer
- Multiplexer, Up to 8 Channels

### Applications

- Base Station Tx / Rx
- Multi-Channel Transmit
- Wide Bandwidth Signal Splitting
- Military ECM

# Interdigital *Filters*

For most Microwave applications, where a perfect combination of size, performance and ruggedness is required.

BSC's Interdigital filters use rectangular, quarter-wavelength resonators, machined from solid in our state-of-the-art machining facility. They offer very symmetrical frequency responses over wide bandwidths, whilst still maintaining a high Q.

In medium-power systems, this filter type lends itself to most situations, and can operate over wide temperature ranges, withstand shock and vibration, and as with most BSC, can be environmentally sealed to Fine Leak rates. Interdigital filters can be realised within connectorised, drop-in or surface-mount packages.

Giving a large degree of parameter flexibility, our Interdigital filters can be optimised effectively to meet the demands of the application, in Bandpass, Diplexer or Multiplexer topologies. Should the application require an extension of the Stopband, we can combine our Interdigital filters with integrated Tubular structures, giving excellent overall performance.

### Scope

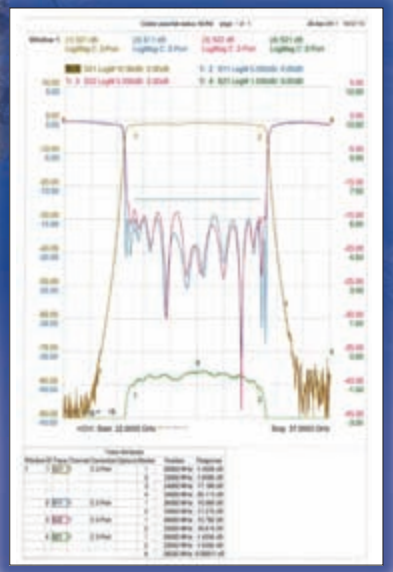
- Frequency Range: 800 MHz to 33 GHz
- Bandwidth: 0.5% to 110%
- Stopband: Up to 2.5x Fc - (3x Fc in special designs)

### Topologies

- Bandpass
- Diplexer
- Multiplexer

### Applications

- Medium Power Transmit / Receive
- Test Equipment
- Wideband
- Military ECM



# Lumped Element *Filters*

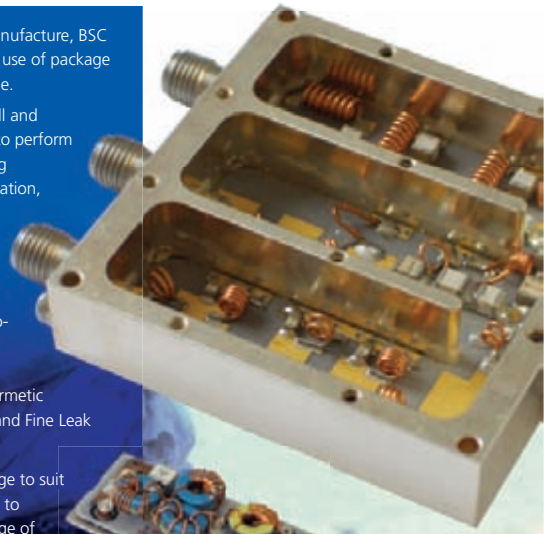
BSC's Lumped Element structures are a fitting solution to many requirements from DC up to 3.5 GHz.

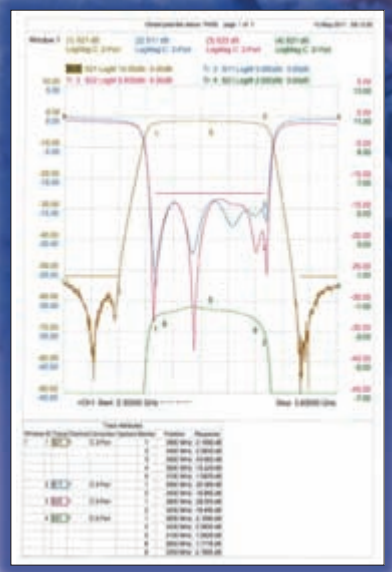
Utilising years of experience in Lumped Element design and manufacture, BSC can employ creative, novel design techniques to make efficient use of package space, allowing high performance within a small space envelope.

Incredible versatility, high selectivity and performance in a small and lightweight package; our Lumped Element structures are able to perform under the harshest conditions. We can use integrated stabilising materials during manufacture to protect against shock and vibration, and can perform live testing under extremes of temperature. Our devices have been qualified for use in the most severe applications, where shock levels of 500G are commonplace.

From large scale, economical production runs to complex one-off designs, BSC excels in quality and innovative design. Pseudo-elliptic technology is frequently incorporated into our designs, resulting in very high selectivity and high close-in attenuation, with Stopbands right up to ten times the Centre Frequency. Hermetic sealing with solder or laser welding is available, to both Gross and Fine Leak specifications.

Lumped Element structures can be manufactured with a package to suit every need; from Silver-plated Aluminium machined from solid, to folded Stainless Steel or Surface Mount PCB, and in a wide range of connectorised and feedthrough terminations.





### Scope

- Frequency Range: DC to 3.75 GHz
- Bandwidth: 3-5% to Multi-octave
- Stopband: Up to 10x Fc

### Topologies

- Bandpass
- Highpass
- Lowpass
- Notch
- Diplexer
- Multiplexer

### Applications

- Broadcast & Telecommunications
- SatComs & Defence
- Small, Low-Frequency Applications
- IF Filters

# USELT *and* NANo

For most microwave applications, where a perfect combination of size, performance and ruggedness is required.

## ULTRA SHORT END LAUNCH TRANSITION (USELT)

**A compact, cost-effective solution for applications requiring Waveguide to Co-axial transition, incorporating BSC's Patented USELT design.**

The BSC USELT performance is comparable to that of high-quality conventional right-angled transitions, having a Return Loss typically well above 20dB, whilst occupying little more space than that of a standard Waveguide flange.

Launching axially into a Co-axial connector from the end of the Waveguide, the USELT is smaller, lighter, easier to install, more cost-effective and simply revolutionary in concept. Available in either Brass or Silver-plated Aluminium, and in a variety of mount and flange options, USELTs cater for applications between 1.75 GHz and 37.0 GHz.

BSC USELTs can be customised to the requirements of the application, for optimum performance over specific frequency bands.

USELTs provide excellent broadband matching, superior performance, occupying the absolute bare minimum of space, and are a true example of BSC's' innovation and design creativity.


### Scope

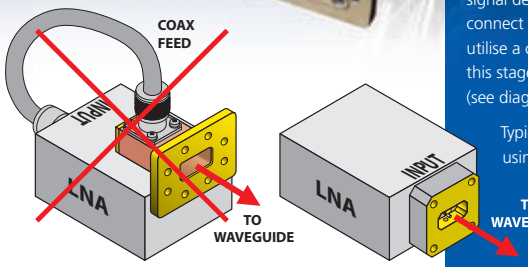
- Frequency Range: 1.75 GHz to 37.0 GHz
- Waveguide Sizes: WG8 to WG22 (WR430 to WR28)
- Bandwidth: 10% to full band
- Return Loss: > 20dB Typical

### Applications

- RADAR receivers
- Waveguide Comms systems
- SatComs
- Frequency Converters
- Test Bench
- Low Noise Amplifiers

## NEAT ADAPTOR NO CONNECTOR (NANo) TRANSITION

The NANo launches directly onto the pin of an adjacent RF module, thus removing the need for a coaxial interface and the attendant signal degradation and losses. Where a module is required to connect directly to a Waveguide, traditional system design would utilise a coaxial feed with the added complexity and space envelope; this stage is eliminated from the system when utilising a BSC NANo (see diagram).



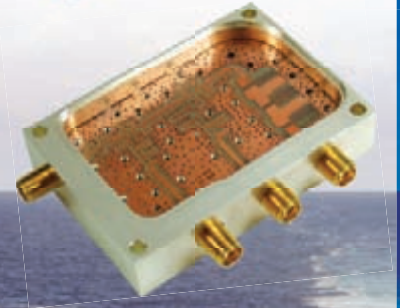

Typical uses include Low Noise Amplifiers. Testing is carried out using field-replaceable co-axial connectors, which are then removed and replaced by the NANo. The NANo is then securely fixed to the module, forming one mechanically integrated unit.

A result of BSC's design innovation and experience, the Patented NANo range has comparable performance to precision right-angled transitions, with more than 20 dB Return Loss for most models. The range is available in either Brass or Aluminium, with the option of hermetically sealed connections.



# Suspended Substrate *Stripline*

Ultra wide band applications call on BSC's SSS filter structures for elliptical responses and extended Stopbands.



BSC Suspended Substrate Stripline technology utilises a photo-etched copper-clad dielectric substrate (usually PTFE), secured between Silver-plated precision-machined housings. This delivers outstanding performance, with high Q, low Insertion Loss across wide Passbands with good, close-in Rejection points.

The small, lightweight and incredibly durable construction combined with the electrical performance of the SSS structure results in a filter which lends itself ideally to wide band applications (ECM, ESM & ELINT), and other Military systems.

BSC's compact, in-line Coaxial Gain Equalisers also utilise SSS technology in a space little wider than the transmission cable itself. Available with Linear and Parabolic gain slopes, a design exists for most applications.

BSC have many years of experience designing and prototyping bespoke SSS outlines, making an almost limitless variety of space-saving layout configurations possible. Because SSS structures utilise high-accuracy mechanically-realised elements in a stable configuration, they offer excellent repeatability and durability. Our SSS enclosures can be hermetically sealed to Fine Leak specifications.

BSC's Suspended Substrate designs are also used in Cryogenic applications where demanding performance at just a few K is paramount for system sensitivity.

Rejection of above 60 dB can be achieved at only 15% from the Bandedges. Combine this with the supreme versatility and specialist ingenuity of BSC's design, and you have an obvious choice for low-power, high quality wide band applications.

### Scope

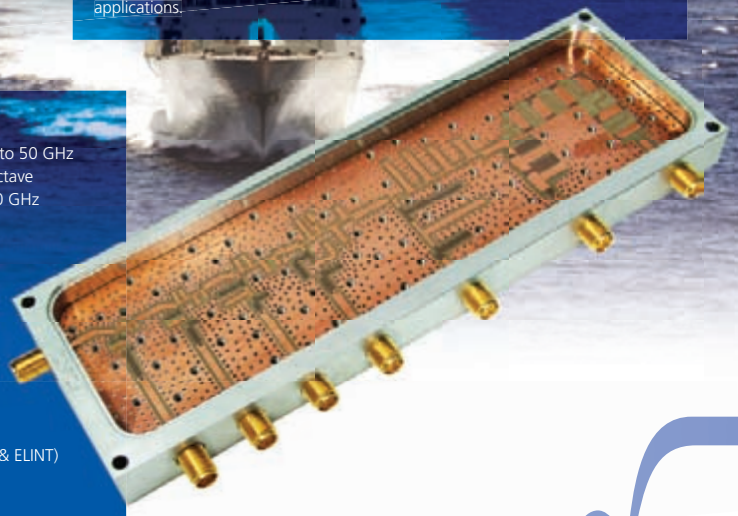
- Frequency Range: 500 MHz to 50 GHz
- Bandwidth: 10% to Multi-octave
- Stopband: Can Extend to 60 GHz

### Topologies

- Bandpass
- Bandstop
- Lowpass
- Highpass
- Multiplexer
- Linear Gain Equaliser
- Parabolic Gain Equaliser

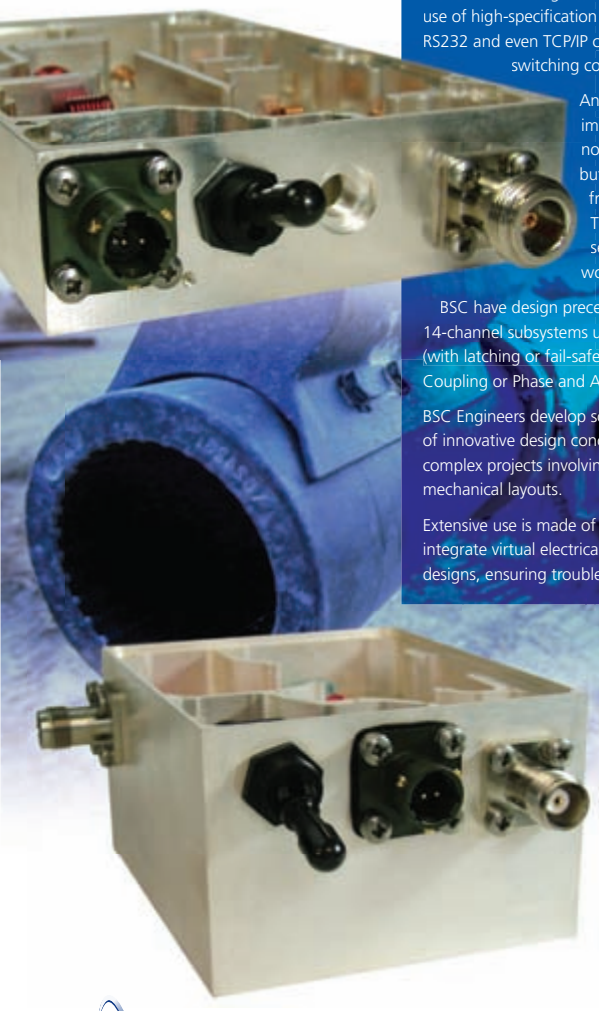
### Applications

- EW Systems (DF, ECM, ESM & ELINT)
- Military & Aerospace
- Space-borne Applications



# Switched *Filter Banks*

Bespoke, high-speed and compact SFBs utilising advanced PIN diode-driven designs in up to 16 channels.



Seamless switching in nanoseconds is possible by careful design and the use of high-specification components in BSC SFB devices; controlled by TTL, RS232 and even TCP/IP communication interfaces, the possibilities for remote switching configurations are practically endless.

An important part of the SFB design process is the implementation of the control sub-systems. At BSC, we not only consider outstanding RF performance a must, but we also ensure the logic and PSU subsystem benefit from in-house design by the same Engineering team. This way, the BSC SFB performs flawlessly as a whole self-contained unit and can be relied upon to be the workhorse of any RF system.

BSC have design precedent extending from simple 2-way designs to complex 14-channel subsystems using PIN diode, MMIC or electromechanical switching (with latching or fail-safe functionality), and incorporating Amplification, Coupling or Phase and Amplitude matching across channels or devices.

BSC Engineers develop solutions to challenging requirements through the use of innovative design concepts, drawing on our wide-ranging experience of complex projects involving multiple technologies, topologies and demanding mechanical layouts.

Extensive use is made of 3D CAD / CAM technology to allow customers to integrate virtual electrical and mechanical models into higher level system designs, ensuring trouble-free integration prior to hardware manufacture.



### Scope

- Frequency Range: 500 MHz to 40 GHz
- Bandwidth: 1% to multi-octave
- Stopband: Can extend over 50 GHz
- Switching Speed: 50 ns typical

### Filter Topologies

- Bandpass
- Bandstop
- Lowpass
- Highpass
- Multiplexer

### Applications

- EW Systems (ECM, ESM, ELINT & DF)
- Military & Aerospace
- Communications
- Channelised Receivers



# Tubular *Filters*

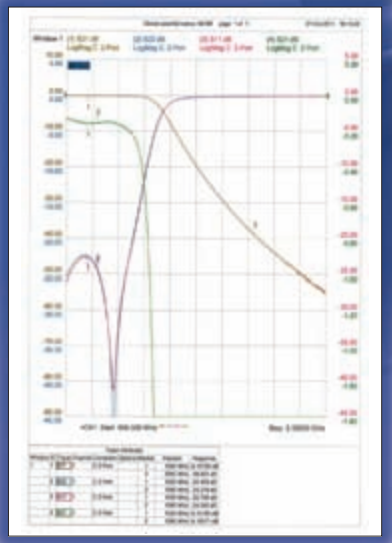
Where a high-power, low-loss Co-axial Lowpass filter is required in a limited space envelope, BSC Tubular structures are an ideal solution.

Our Tubular structures are naturally suited to extended Stopbands, high Rejection and Power Handling. The small cross-section, axial configuration offers an excellent solution for transmitter output cleanup, suppressing harmonics and spurious emissions above the frequencies of operation, whilst providing low loss in the Passband.

Multiple Tubular filters can be incorporated either sequentially (to extend Stopbands), or in parallel to provide multi-channel operation, with designs being optimised to meet the customers' needs.

Where other primary filter structures are used, BSC Tubular structures can be seamlessly integrated with these to extend the Stopband to many multiples of the original band of interest. Designs have been realised holding Stopband performance to over 30 times the frequency of interest.

The characteristically low Insertion Loss of the Tubular structure is well suited to a Hybrid arrangement; offering large performance gains for little trade-off in loss and overall physical size. Available with various connector fittings and mechanical mounting configurations, Tubular structures can offer some of the lowest Insertion Losses available in a passive filter.



### Scope

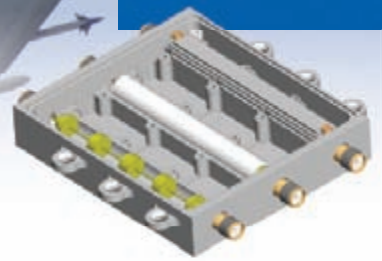
- Frequency Range: 500 MHz to 14 GHz
- Stopband: Typically up to 10 times Fc

### Topologies

- Lowpass

### Applications

- Co-axial Transmitter Output Cleanup
- Multi-Structure Hybrid, Extended Stopband



# Waveguide *Filters*

Available in a wide range of designs and materials, BSC Waveguide structures incorporate world-leading technology and innovation.

# Technical *Data*

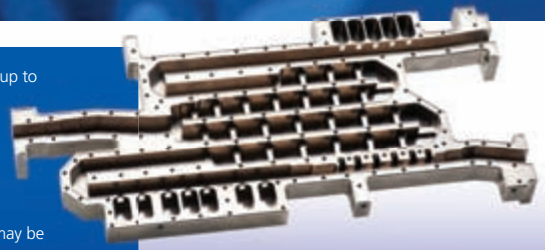
BSC's Waveguide structures utilise Iris-Coupled resonant cavities up to millimetric frequencies, and our pioneering implementation of Pseudo-Elliptic Technology in this field is second-to-none.

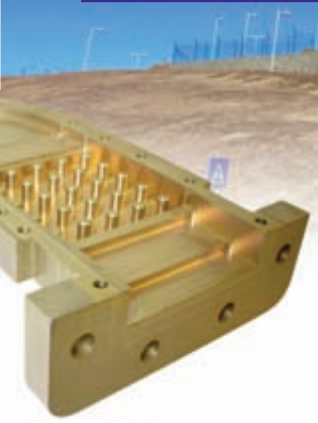
BSC Exact Filter Technology allows filters to be designed and manufactured with such accuracy that they do not require alignment, thus reducing lead time and manufacture costs in large production volumes. Further high volume cost reductions may be realised by calling on BSC's expertise in Casting and Extruded Iris methods.

Our specially developed software allows for "right first time" designs, reducing the need for prototype engineering in the design process. This in turn reduces development cost and lead time.

BSC have perfected low Insertion Loss and high power handling in Waveguide designs, enabling the highest specifications to be exceeded by a good margin. Our principles of innovation and sideways-thinking have enabled BSC to produce specialist solutions far surpassing other designs in both performance and reliability.

High power handling in excess of 60 kW, or frequencies as high as 100 GHz are well within reach of our design capability, and our range of features, materials and finishes, flanges and assemblies at our disposal means that whatever the requirement, BSC can provide a solution.





## Scope

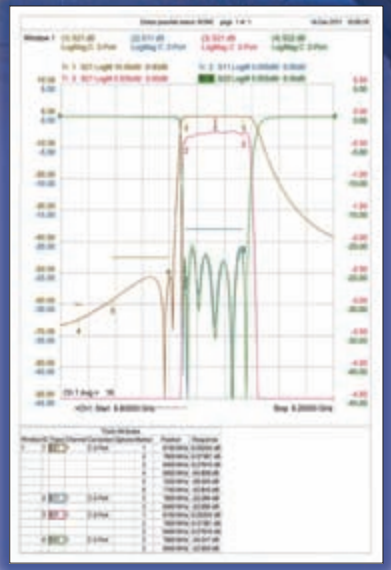
- Frequency Range: 1 GHz to 100 GHz
- Bandwidth: 0.1% to 25%
- Stopband: Up to 5x Fc

## Topologies

- Bandpass
- Bandstop
- Lowpass
- Highpass
- Multiplexer
- Coupler

## Applications

- RADAR
- SatComs
- Point-to-Point
- Test Bench



### Conversions

| | |
|---|---|
| 1 mm | 0.039 inches |
| 1 M | 3.281 feet |
| 1 km | 0.621 miles |
| 1 litre | 0.220 gallons |
| 1 gram | 0.035 ounces |
| 1 kg | 2.205 pounds |
| °C | (°F-32) x 5/9 |

### Microwave Bands

| Band | Frequency (GHz) | Wavelength (cm) |
|---|---|---|
| L | 1.0 - 2.0 | 30.0 - 15.0 |
| S | 2.0 - 4.0 | 15.0 - 7.50 |
| C | 4.0 - 8.0 | 7.50 - 3.25 |
| X | 8.0 - 12.4 | 3.25 - 2.42 |
| Ku | 12.4 - 18.0 | 2.42 - 1.67 |
| K | 18.0 - 26.6 | 1.67 - 1.13 |
| Ka | 26.5 - 40.0 | 1.13 - 0.75 |
| U | 40.0 - 60.0 | 0.75 - 0.05 |
| V | 50.0 - 75.1 | 0.06 - 0.40 |
| W | 75.0 - 110.0 | 0.40 - 0.27 |

### VSWR Return Loss (dB)

| VSWR | Return Loss |
|---|---|
| 1.01 | 46.06 |
| 1.02 | 40.09 |
| 1.03 | 36.61 |
| 1.04 | 34.15 |
| 1.05 | 32.26 |
| 1.06 | 30.71 |
| 1.07 | 29.42 |
| 1.08 | 28.3 |
| 1.09 | 27.31 |
| 1.10 | 26.44 |
| 1.12 | 24.94 |
| 1.14 | 23.69 |
| 1.16 | 22.61 |
| 1.18 | 21.66 |
| 1.20 | 20.83 |
| 1.30 | 17.69 |
| 1.40 | 15.56 |
| 1.50 | 13.98 |
| 1.60 | 12.74 |
| 1.70 | 11.73 |
| 1.80 | 10.88 |
| 1.90 | 10.16 |
| 2.0 | 9.54 |
| 2.5 | 7.36 |
| 3.0 | 6.02 |

### Waveguide Data and Dimensions

| Designation | | | | Frequency Range | Internal Dimensions | External Dimensions |
|---|---|---|---|---|---|---|
| Europe | | USA | | | | |
| R | WG | RG | WR | GHz | mm | mm |
| 14 | 6 | 69/U - 103/U | 650 | 1.14 - 1.73 | 165.10 x 82.55 | 169.16 x 86.61 |
| 18 | 7 | 337/U - 338/U | 510 | 1.45 - 2.20 | 129.54 x 64.77 | 133.60 x 68.83 |
| 22 | 8 | 104/U - 105/U | 430 | 1.72 - 2.61 | 109.22 x 54.61 | 113.28 x 58.67 |
| 26 | 9A | 112/U - 113/U | 340 | 2.70 - 3.30 | 86.36 x 43.18 | 90.42 x 47.24 |
| 32 | 10 | 48/U - 75/U | 284 | 2.60 - 3.95 | 72.14 x 34.04 | 76.20 x 38.10 |
| 40 | 11A | 340/U - 341/U | 229 | 3.22 - 4.90 | 58.17 x 29.083 | 61.42 x 32.33 |
| 48 | 12 | 49/U - 95/U | 187 | 3.94 - 5.99 | 47.5 x 22.149 | 50.80 x 25.40 |
| 58 | 13 | 343/U - 344/U | 159 | 4.64 - 7.05 | 40.39 x 20.193 | 43.64 x 23.44 |
| 70 | 14 | 50/U - 106/U | 137 | 5.38 - 8.18 | 34.85 x 15.799 | 38.10 x 19.05 |
| 84 | 15 | 51/U - 68/U | 112 | 6.58 - 10.0 | 28.50 x 12.624 | 31.75 x 15.88 |
| 100 | 16 | 52/U - 67/U | 90 | 8.20 - 12.5 | 22.86 x 10.16 | 25.40 x 12.70 |
| 120 | 17 | 346/U - 347/U | 75 | 9.84 - 15.0 | 19.05 x 9.525 | 21.59 x 12.06 |
| 140 | 18 | 91/U - 349/U | 62 | 11.90 - 18.0 | 15.80 x 7.90 | 17.83 x 9.93 |
| 180 | 19 | 351/U - 352/U | 51 | 14.50 - 22.00 | 12.95 x 6.477 | 14.99 x 8.51 |
| 220 | 20 | 53/U - 121/U | 42 | 17.6 - 26.7 | 10.67 x 4.318 | 12.7 x 6.35 |
| 260 | 21 | 354/U -355/U | 34 | 21.7 - 33.0 | 8.636 x 4.318 | 10.67 x 6.35 |
| 320 | 22 | 271/U | 28 | 26.4 - 40.1 | 7.112 x 3.556 | 9.14 x 5.60 |
| 400 | 23 | 272/U | 22 | 33.0 - 50.1 | 5.690 x 2.845 | 7.72 x 4.88 |
| 500 | 24 | 358/U | 19 | 39.3 - 59.7 | 4.755 x 2.388 | 6.81 x 4.43 |
| 620 | 25 | 88/U - 273/U | 15 | 49.9 - 75.8 | 3.759 x 1.880 | 5.79 x 3.92 |
| 740 | 26 | 274/U | 12 | 60.5 - 92.0 | 3.099 x 1.549 | 5.13 x 3.58 |
| 900 | 27 | 359/U | 10 | 73.8 - 112.0 | 2.540 x 1.270 | 4.57 x 3.30 |

### Properties of Materials

| | Resistivity (relative to Copper) | Temperature Stability (ppm/°C) |
|---|---|---|
| 1 | Copper, annealed (1.742E - 8ohm mtrs) | 17.0 |
| 1.03 | Copper, hard drawn | 17.0 |
| 0.95 | Silver | 19.7 |
| 1.42 | Gold | 14.2 |
| 1.64 | Aluminium | 22.0 |
| 3.25 | Tungsten | 4.5 |
| 3.4 | Zinc | 29.0 |
| 3.9 | Brass | 18.5 |
| 5.05 | Nickel | 13.0 |
| 6.165 | Platinum | 9.0 |
| 52.8 | Stainless Steel | 16.0 |

### dB Ratio

| dB | Ratio | Transmission Loss % | Transmitted Power % |
|---|---|---|---|
| 0.1 | 1.02 | 2.28 | 97.72 |
| 0.2 | 1.05 | 4.5 | 95.5 |
| 0.3 | 1.07 | 6.67 | 93.33 |
| 0.4 | 1.1 | 8.8 | 91.2 |
| 0.5 | 1.12 | 10.87 | 89.13 |
| 0.6 | 1.15 | 12.9 | 87.1 |
| 0.7 | 1.18 | 14.89 | 85.11 |
| 0.8 | 1.2 | 16.82 | 83.18 |
| 1 | 1.26 | 20.57 | 79.43 |
| 1.5 | 1.41 | 29.221 | 70.79 |
| 2 | 1.59 | 36.9 | 63.1 |
| 2.5 | 1.78 | 43.77 | 56.23 |
| 3 | 1.99 | 49.88 | 50.12 |
| 4 | 2.51 | 60.19 | 39.81 |
| 5 | 3.16 | 68.38 | 31.62 |
| 6 | 3.98 | 74.88 | 25.12 |
| 7 | 5.01 | 80.05 | 19.95 |
| 8 | 6.31 | 84.15 | 15.85 |
| 10 | 10 | 90 | 10 |
| 20 | 100 | 99 | 1 |
| 30 | 1000 | 99.9 | 0.1 |
| 40 | $1x10^4$ | 99.99 | 0.01 |
| 50 | $1x10^5$ | 99.999 | $1x10^{-3}$ |

Note: Every care has been taken to ensure that the information in these tables is correct, however the Company cannot accept any liability for errors.

The Microwave Products Group (MPG) is a leading global provider of mission/system-critical engineered electronic components and assemblies Enabling Communication and Signal Control. MPG designs and manufactures high-performance RF and Microwave Filters, Switched Filter Banks, fast-tune Frequency-Agile (hopping) Filters, Integrated Cosite Equipment (ICE), Referenced and Referenceless Cancelers, Low Noise and Cosite Power Amplifiers, Integrated Microwave Assemblies and low insertion loss, high cycle Switches and Switch Matrices.

MPG is comprised of four divisions and five manufacturing locations. The divisions are BSC, Dow-Key Microwave, K&L Microwave and Pole/Zero Corporation. All are well-established companies uniquely contributing to a proud heritage that distinguishes MPG as a partner to be trusted. Three of the divisions are located in the United States, and one is in the United Kingdom, with a shared manufacturing facility in the Dominican Republic. Product offerings across the four divisions are complementary in terms of components and integrated assemblies provided and geographical compliance considerations.

Company expertise is centered on the design and manufacture of application specific products, components and assemblies essential to meeting engineers' requirements in the military/defense, aerospace/avionics, space/satellite, communications, telecom, test and measurement, medical and industrial electronics markets, where function and reliability are crucial.

MPG aims to be the leader in every market served, to the benefit of customers and the promotion of mutual long-term success. MPG is committed to achieving this by:

- Understanding customers' real needs and providing products and services to meet and exceed them.
- Providing better products and services than competitors.
- Investing in product development, manufacturing processes and employee talent.
- Insisting on the highest ethical standards and a business culture of trust, respect and open communication.
- Embracing a culture of Innovation and Continuous Renewal.

MPG is part of Dover Corporation, a diversified global manufacturer with multi-billion dollar annual revenues, delivering innovative equipment and components, specialty systems and support services through four major operating segments: Energy, Engineered Systems, Fluids and Refrigeration & Food Equipment. Dover combines global scale with operational agility to achieve and maintain market leadership. Upholding a recognized entrepreneurial approach of nearly 60 years, a team of over 27,000 employees takes an ownership mindset, collaborating with customers to redefine what's possible. Headquartered in Downers Grove, Illinois, Dover trades on the New York Stock Exchange under "DOV." Additional information is available at www.dovercorporation.com.


**BSC Filters Limited**
Dover House, 10-11 Stirling Park,
Bleriot Way, Clifton Moor,
York, YO30 4WU UK

Phone: +44 1904 694250
Fax: +44 1904 694260
Email: sales@bscfilters.com
Web: www.bscfilters.com

**Dow-Key Microwave**
4822 McGrath Street
Ventura, CA 93003
USA

Phone: +1 805 650 0260
Fax: +1 805 650 1734
Email: askDK@dowkey.com
Web: www.dowkey.com

**K&L Microwave**
2250 Northwood Drive
Salisbury, MD 21801
USA

Phone: +1 410 749 2424
Fax: +1 443 260 2268
Email: sales@klmicrowave.com
Web: www.klmicrowave.com

**Pole/Zero Corporation**
5558 Union Centre Drive
West Chester, OH 45069
USA

Phone: +1 513 870 9060
Fax: +1 513 870 9064
Email: support@polezero.com
Web: www.polezero.com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