



# RF Filters

Custom Ceramic Filters,  
Resonators and Diplexers

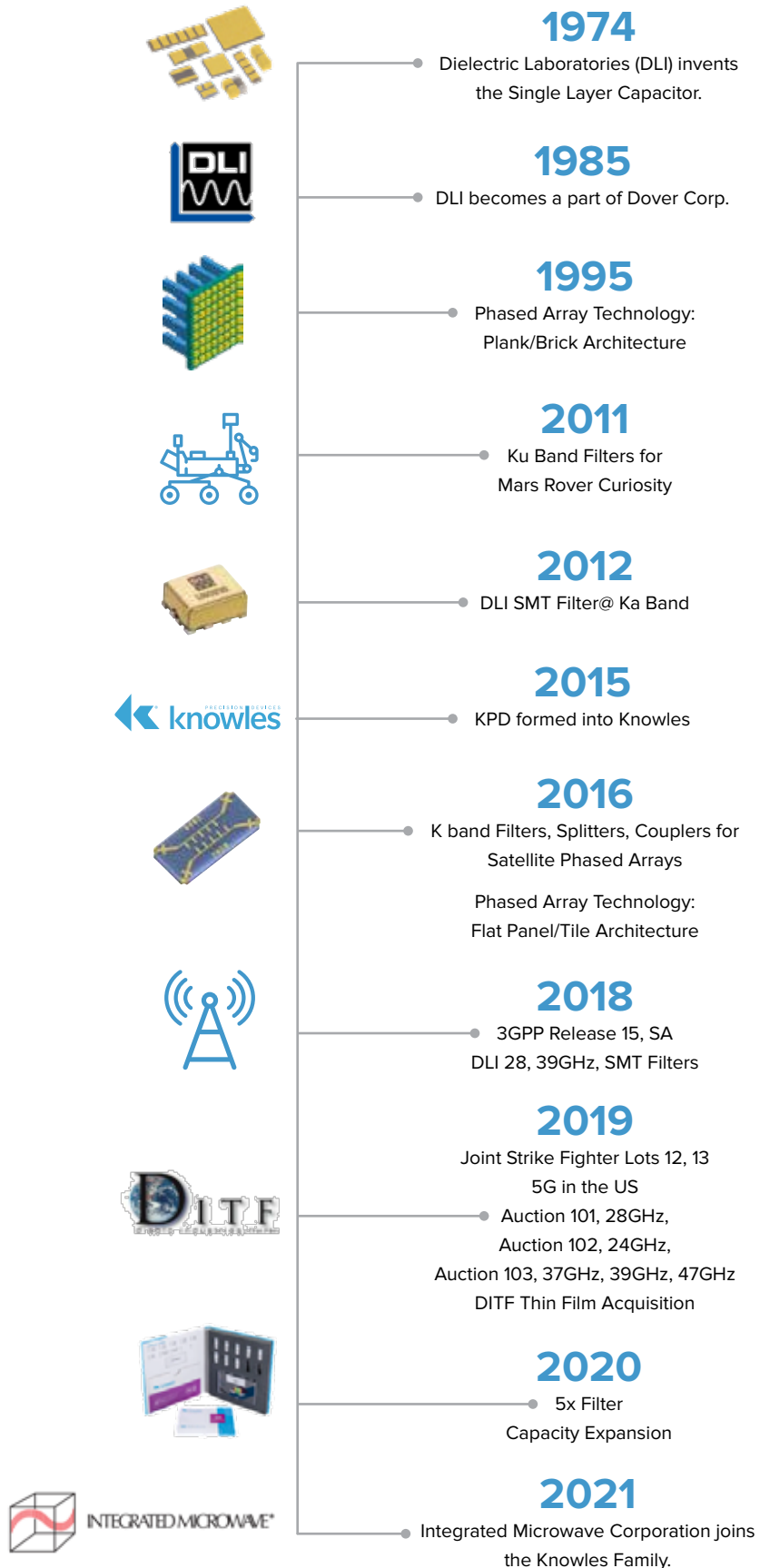


Knowles Precision Devices (KPD), a division of Knowles Corporation, focuses on production of a wide variety of highly engineered capacitors and RF to mmWave components for use in critical applications in the military, medical, electric vehicle, space and 5G market segments. The company was initially formed by combining Dielectric Laboratories, Johanson Manufacturing, Novacap, Syfer and Voltronics, each well-established specialty capacitor makers with a combined history of over 200 years, into a single organization.

As a specialty components manufacturer, Knowles Precision Devices chooses to take on the complex challenges that come with high-reliability, high-temperature, high-performance, and high-frequency solutions. The Knowles Precision Devices DLI brand of technologies addresses the complex challenges of implementing high-performance mmWave filters across the widest range of specifications.

40+ Year of  
Microwave  
Expertise

## Knowles Microwave Product Timeline



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# Technology at Your Service

Knowles Precision Devices provides a full range of engineering expertise and services. These capabilities are fully utilized in providing custom filter solutions to fit your needs.

## COMPUTER-AIDED CAPABILITIES

- Synthesis/Analysis
- Design
- Engineering
- Manufacturing
- Full MIL Standard Environmental Testing
- QA Tracking

## TRANSFER FUNCTIONS

### Frequency Domain

- Chebyshev
- Butterworth
- Elliptic (Cauer)
- Pseudo-Elliptic

### Transitional

- Gaussian (6 dB)
- Gaussian (12 dB)

### Time Domain

- Gaussian
- Bessel
- Linear Phase (.05°)
- Linear Phase (.5°)

## FREQUENCIES

- DC to 40 GHz
- Quasi-Elliptical

## TECHNOLOGIES

- Ceramic
- Coaxial Ceramic Resonators
- Puck Resonators
- Patch Resonators
- Lumped Element
- Helical
- Combine
- Interdigital
- High Power

## The Knowles family of Microwave products has expanded!

With Integrated Microwave now part of the Knowles family, we can offer more products and capabilities to our customers.

Have questions? Reach out to our engineers! [DLIengineering@knowles.com](mailto:DLIengineering@knowles.com)

See our DLI/Knowles Microwave Products Catalog for more information.

FILTERS	<ul style="list-style-type: none"> <li>• Microstrip Filters</li> <li>• Cavity Filters</li> </ul>	<ul style="list-style-type: none"> <li>• Ceramic Filters*</li> <li>• Lumped Element Filters*</li> </ul>	<b>0.1 MHz - 67+ GHz</b>
COUPLERS	<ul style="list-style-type: none"> <li>• Wilkinson Couplers</li> <li>• Resistive Couplers</li> </ul>	<ul style="list-style-type: none"> <li>• Quadrature Hybrid Couplers*</li> </ul>	<b>0.3 - 60 GHz</b>
DIVIDERS	<ul style="list-style-type: none"> <li>• Wilkinson Power Dividers (or Combiners)</li> <li>• Resistive Power Dividers</li> </ul>		<b>2 - 60 GHz</b>
MULTIPLEXERS	<ul style="list-style-type: none"> <li>• Diplexers</li> </ul>	<ul style="list-style-type: none"> <li>• Duplexers</li> </ul>	<b>0.1 MHz - 67 GHz</b>
RESONATORS	<ul style="list-style-type: none"> <li>• Ceramic Resonators*</li> </ul>	<ul style="list-style-type: none"> <li>• Thin Film Resonators</li> </ul>	<b>0.3 - 65 GHz</b>
INTEGRATED PASSIVES	<ul style="list-style-type: none"> <li>• CRC Networks</li> </ul>	<ul style="list-style-type: none"> <li>• Custom Solutions</li> </ul>	<b>DC - 67+ GHz</b>

\*Expanded Offerings



# Ceramic Technology

## High Performance Ceramic Filters & Diplexers

- ▶ **Bandwidth:** 7% - 40%
- ▶ **Frequency Range:** 200 MHz - 12 GHz
- ▶ **Available Packaging:** Connectorized, SMT, Pin

### Materials

Ceramic components are manufactured using our own materials; dielectric constants of 9, 13, 20, 36, 84, 98 and 110. Resonators are pressed in profiles from 2mm to 18mm, then metallized with thick-film silver.

### Design and Performance

Compliance with design and performance parameters can only occur if all project phases, from modeling to production, are monitored for strict conformance to customer requirements and design standards. Electrical and mechanical parameters, including size, insertion loss and rejection, are constantly checked, so that completed components represent the highest standards of workmanship and compliance to applicable specifications.

### Assembly

The manufacturing process includes the design, fabrication of the component's coupling structure, housing, I/O configuration and resonator frequency adjustments are performed. The unit is cleaned and inspected, then sent on for final testing.

### Testing

All products are 100% tested and verified to AS9100 guidelines; test/tune stations incorporate ATE testing to ensure 100% compliance with customer electrical and mechanical specifications.

### Product Evolution - New Technology

Knowles Precision Devices is constantly seeking new ways to enhance product performance and manufacturing techniques. Ongoing research focuses on ways to reduce parts count and costs for greater cost effectiveness, extension of product frequencies with new ceramic powder formulations, and use of robotics for increased automation of manufacturing processes.

### Assuring Design Compliance

Compliance with design parameters can only occur if all phases from modeling to production are monitored for strict conformance to customer requirements and design standards. Knowles Precision Devices takes pride in the close and constant attention paid to every aspect of the design process, from the acquisition of raw materials to final inspection and shipping of the finished product. Every component is continuously monitored for electrical and physical performance, workmanship and compliance to applicable specifications.

Unit-to-unit repeatability is assured by precision fabrication, certified soldering and fast, accurate testing. Complete in-house full MIL environmental testing facilities include thermal shock, thermal cycling, insulation resistance and hermeticity. Additional testing may include high-level vibration, mechanical shock, constant acceleration, Particle Impact Noise Detection (PIND) and radiographic inspection.



# Ceramic Technology

## Ceramic Filter Environmental Specifications

All ceramic filters are manufactured under exacting quality assurance and control standards. As a minimum, they will meet electrical specifications after being subjected to the following physical and environmental tests of MIL-STD-202, unless otherwise noted:

	Spec	MIL-STD-202	Method Condition
<b>Temperature, Operating</b>	-20 to +70°C (Commercial) -40 to +85°C (Industrial) -55 to +125°C (Military)	-	-
<b>Temperature, Storage</b>	-55 to +125°C	-	-
<b>Altitude</b>	From Lower Earth to Deep Space	105	E
<b>Humidity</b>	90% RH to Full Hermetic*	106	-
<b>Thermal Shock</b>	-55 to +125°C	107	B
<b>Solderability</b>	95% Coverage	208	-
<b>Solvent Resistance</b>		215	-

\*Depending on type of package ordered.

### Operating Temperature Stability

The ceramic filters created by Knowles Precision Device have excellent temperature stability, typically less than 5 ppm/°C.

### Packaging Type

- Tape and reel
- MIL Standard
- Nitrogen Packaging

### Soldering to Ceramic Lumped and Cavity Filters

Knowles uses high temperature solder to assemble internal components for both leaded and SMT ceramic filters. It is recommended that customers use 63Sn/37Pb or equivalent for attaching both signal and ground connections.

During solder installation, do not exceed the **absolute maximum ratings**:

**Pin Temperature: +260°C (10 seconds)**  
**Body Temperature: +215°C (maximum)**



# Package Options

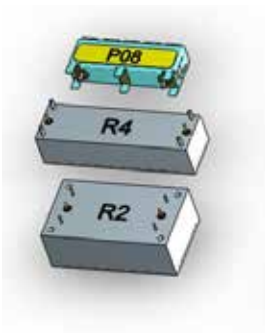
## Custom Work You Can Count On

Our engineers have the knowledge and expertise to create custom work to fit your business needs, which includes:

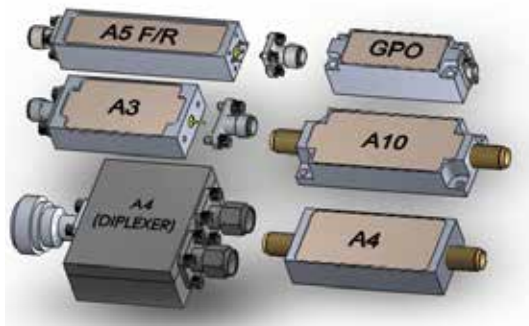
- ▶ Creating new solutions designed to your exact specifications.
- ▶ Recreating product from old designs - nothing is obsolete to us!
- ▶ We never expire designs, we have an extensive archive.
- ▶ Creating second source designs from existing solutions.
- ▶ No size limit - any numbers of sections can be ordered.

Below is just a sampling of the various packages Knowles Precision Devices can offer.

### PC Board Mount



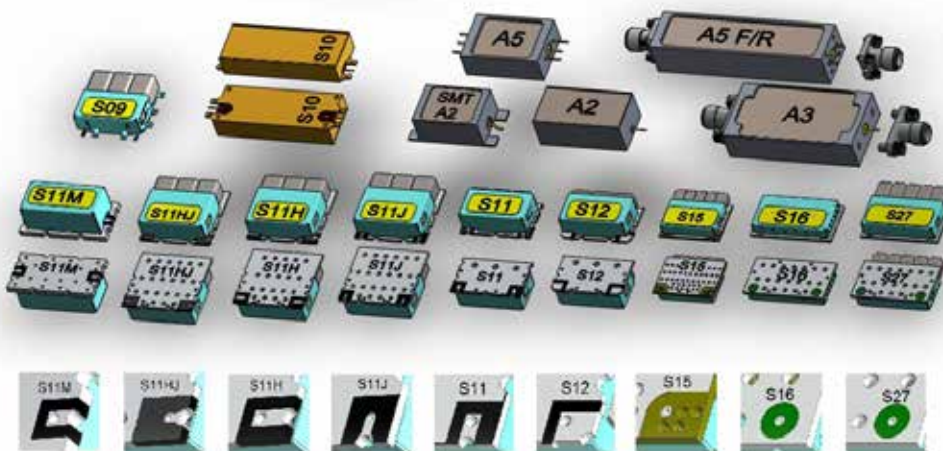
### Connectorized



### Available connectors include but are not limited to:

- |          |          |
|----------|----------|
| SMA-F    | SMA-M    |
| SSMA-F   | SSMA-M   |
| SMB-F    | SMB-M    |
| SSMB-F   | SSMB-M   |
| SMC-F    | SMC-M    |
| TNC-F    | TNC-M    |
| Type N-F | Type N-M |
| BNC-F    | BNC-M    |
| GPO-F    | GPO-M    |
| QMA-F    |          |
| mmcx-F   |          |

### Surface Mount



Reach out to our engineers for assistance with custom designs at:  
[DLengineering@knowles.com](mailto:DLengineering@knowles.com)

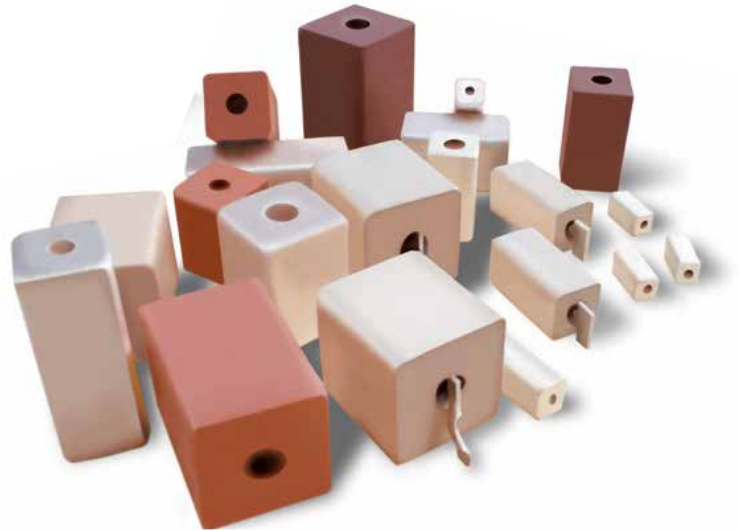
# Ceramic Resonators

## Coaxial TEM Resonators

Coaxial resonators made with modern, high performance ceramic dielectric materials are very useful as compact frequency standards, filter elements, and distributed inductive or capacitive circuit elements. The high Q obtained in the UHF, VHF, L, S, C bands and microwave frequency range makes these resonators ideal for many applications. **When cost, size, and stability are important, these resonators are the best choice.**

Coaxial resonators can be supplied as quarter wave resonators with one end fully metallized (i.e., shorted), and the other end open, fully metallized on both ends, or as half wave resonators with both ends open. For surface mounting, tabbed or tabless resonators can be provided for soldering directly to the circuit board. These resonators are pretuned to your specified frequency with a choice of tolerances.

In-house control of the pressing and firing of the green resonators ensures the optimum fired densities for the best electrical performance. Knowles Precision Devices proprietary silver metallization system produces the highest possible Q, exceptional solderability, and strongest metallization adhesion in the industry. Quarter and half wave resonators are precisely tuned to the specified frequency using the coupled transmission method and a network analyzer. Resonators are 100% screened for frequency to ensure that customer specifications are met.



### FEATURES:

- Rugged, thermally stable ceramics
- Thick film silver coating for excellent Q and solderability
- Superior silver adhesion - pull strengths greater than 20 pounds
- Standard frequency tolerance is 0.1% - 1.0%; tighter tolerances available
- SMT tabs, tabless or slotted no tab configurations available for each size resonator

### APPLICATIONS:

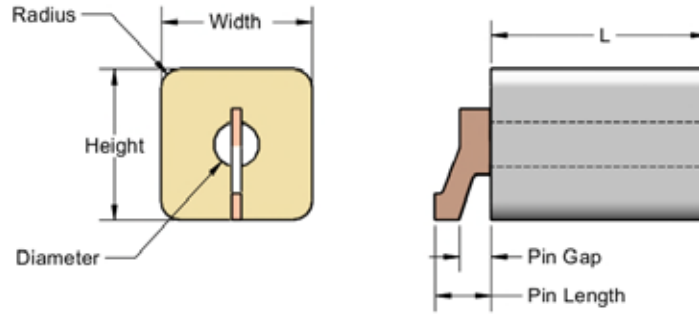
- Dielectric resonating oscillators (DRO)
- Voltage controlled oscillators (VCO)
- Global positioning systems (GPS)
- Cellular and wireless communications
- Bandpass/bandstop filters
- Narrowband/delay filters
- EMI filtering



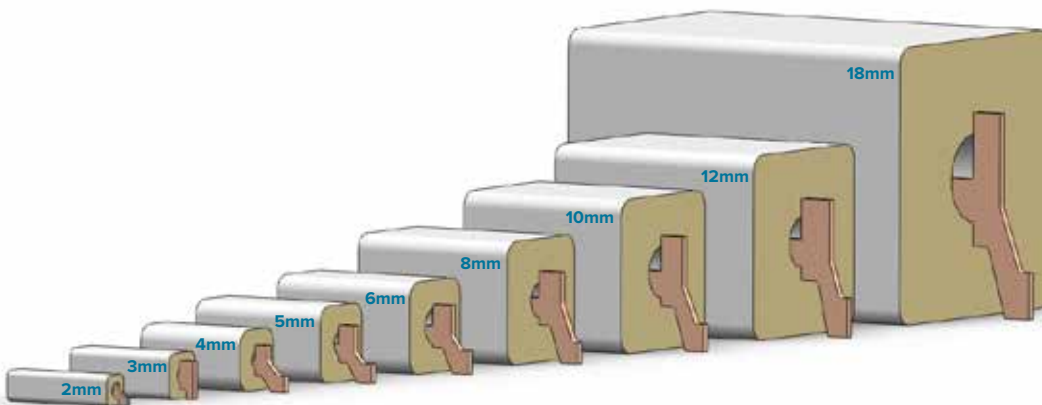


# Ceramic Resonators

## Tabbed Coaxial Resonators



Resonator Profile	Dielectric Material/Constant	Width		Height		Diameter		Radius		Pin Length		Pin Gap	
		inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
2 mm	9, 20, 38, 92	0.079" ± 0.003"	2 ± 0.08	0.079" ± 0.003"	2 ± 0.08	0.033" ± 0.003"	0.838 ± .08	0.015"	0.381	0.040"	1.016	0.020"	0.508
3 mm	5, 9, 13, 20, 36, 84, 98	0.118" ± 0.003"	3 ± 0.08	0.118" ± 0.003"	3 ± 0.08	0.045" ± 0.003"	1.143 ± 0.08	0.020"	0.508	0.040"	1.016	0.020"	0.508
4 mm	5, 9, 13, 20, 36, 84, 98	0.157" ± 0.004"	4 ± 0.102	0.157" ± 0.004"	4 ± 0.102	0.045" ± 0.003"	1.143 ± 0.08	0.040"	1.016	0.089"	2.261	0.049"	1.245
5 mm	5, 9, 13, 20, 36, 98	0.197" ± 0.005"	5 ± 0.127	0.197" ± 0.005"	5 ± 0.127	0.065" ± 0.003"	1.651 ± 0.08	0.040"	1.016	0.098"	2.489	0.054"	1.372
6 mm	5, 9, 13, 20, 36, 98	0.236" ± 0.005"	6 ± 0.127	0.236" ± 0.005"	6 ± 0.127	0.094" ± 0.004"	2.388 ± 0.102	0.040"	1.016	0.106"	2.692	0.059"	1.499
8 mm	5, 9, 13, 20, 36, 98	0.315" ± 0.005"	8 ± 0.127	0.315" ± 0.005"	8 ± 0.127	0.094" ± 0.004"	2.388 ± 0.102	0.040"	1.016	0.117"	2.972	0.066"	1.676
10 mm	5, 9, 13, 20, 36, 98	0.394" ± 0.006"	10 ± 0.152	0.394" ± 0.006"	10 ± 0.152	0.135" ± 0.005"	3.429 ± 0.127	0.040"	1.016	0.128"	3.251	0.073"	1.854
12 mm	5, 9, 13, 20, 36, 98	0.472" ± 0.008"	12 ± 0.203	0.472" ± 0.008"	12 ± 0.203	0.135" ± 0.005"	3.429 ± 0.127	0.040"	1.016	0.138"	3.505	0.079"	2.007
18 mm	5, 9, 13, 20, 36, 98	0.709" ± 0.020"	18 ± 0.508	0.709" ± 0.020"	18 ± 0.508	0.228" ± 0.010"	5.791 ± 0.254	0.040"	1.016	0.228"	5.791	0.097"	2.464



Material	Temperature Coefficient
09	<± 5ppm/°C
13	<± 5ppm/°C
20	<± 5ppm/°C
36	<± 5ppm/°C
84	<± 15ppm/°C
98	<± 15ppm/°C



# Ceramic Resonators

## Tableless Surface Mount Coaxial Resonators

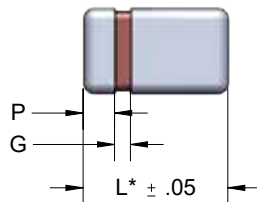


Ceramic resonators are also available in tableless configuration. This patent-pending technology represents a significant advance in reliability and accuracy, compared with traditional metal-tabbed resonators. The large solder pad eliminates misalignment and tab solder reflow problems, ensuring optimum performance.

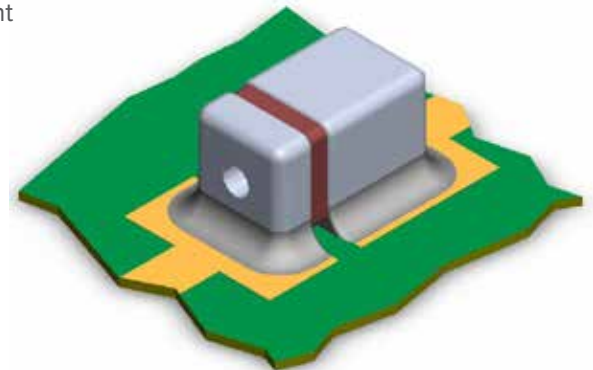
### FEATURES:

- No metal tabs
- Large solder pad
- No tab solder reflow problems
- No tab misalignment
- Higher Q

Resonator Profile	P	G
3mm	0.020"	0.025"
4mm	0.043"	0.050"
5mm	0.043"	0.050"
6mm	0.043"	0.050"
8mm	0.055"	0.073"
10mm	0.055"	0.073"
12mm	0.055"	0.073"



$$*L = 3200 / (\text{freq} \times \text{Sqrt}(K))$$



### Part Numbering System - Example: DR03F36Q1550AYB

DR  
Dielectric Coaxial Resonator

03  
Dielectric Profile

- 02 mm
- 03 mm
- 04 mm
- 05 mm
- 06 mm
- 08 mm
- 10 mm
- 12 mm
- 18 mm

F  
Material Source

36  
Dielectric Constant

- K5 = 05
- K9 = 09
- K13 = 13
- K20 = 20
- K36 = 36
- K98 = 98

Q  
Resonator Type

- Q = Quarter Wave
- H = Half Wave
- P = Fully Metallized Quarter Wave
- G = Fully Metallized Half Wave

1550  
Frequency

Units in MHz

A  
Frequency Tolerance

- A = ±0.25%
- B = ±0.50%
- C = ±0.75%
- D = ±1.00%
- E = Special

Y  
Tab

- Y = Std Tab
- N = No Tab
- G = Tableless
- Z = Tab 0.030" standoff

B  
Packaging

- B = Bulk
- T = Tape
- S = Special



# Cavity Filters

Knowles Precision Devices offers a full range of cavity filters for unsurpassed performance in a wide spectrum of applications, including aerospace, military, industrial and commercial requirements.

## Comblines

High Q miniature, elliptic response, delay equalized.

- ▶ **Bandwidth: .01% ~ 50%**
- ▶ **Frequency Range: 300 MHz ~ 40 GHz**
- ▶ **Available Packaging: Connectorized, SMT, Pin**

## Interdigital

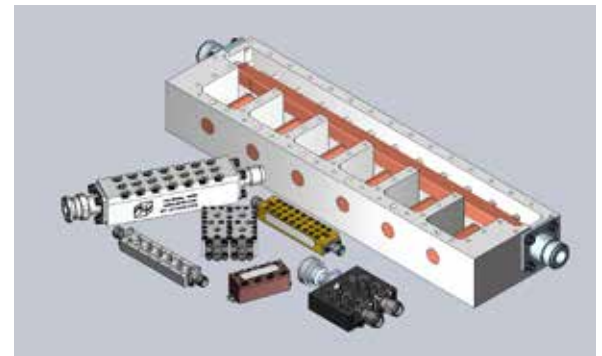
Wide band, high Q, symmetrical response.

- ▶ **Bandwidth: 10% ~ 75%**
- ▶ **Frequency Range: 300 MHz ~ 40 GHz**
- ▶ **Available Packaging: Connectorized, SMT, Pin**

## Cavity Bandpass/Band Reject

Unsurpassed notch depth and selectivity.

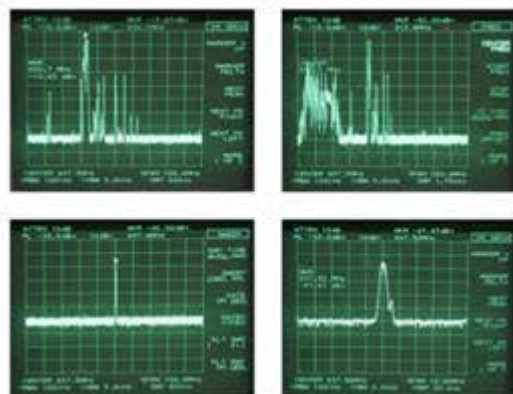
- ▶ **Bandwidth: .05% ~ 25%**
- ▶ **Frequency Range: 500 MHz ~ 40 GHz**
- ▶ **Available Packaging: Connectorized, SMT, Pin**



## Narrowband Filters for Studio Transmitter Link (STL) Receivers

Knowles Precision Devices offers narrowband cavity filters for Canadian and US STL bands (photo below). Ceramic filters are also available for STL applications in Mexico, Central and South America. These filters are designed for receiver preselector use, offering outstanding signal separation. Passband loss is

typically 7 dB or less, while rejection is 60 - 100 dB. These filters allow virtually private band use in congested areas. Wideband filters cover 100% of the STL band, while narrowband versions can be less than 750 kHz wide. Narrowband filters come pretuned to your STL frequency and STL bandwidth.



BEFORE

AFTER

**Before:** Actual example of radio congestion on top of mountain.

**After:** Displays the same view after the installation of STL filter.



# Lumped Element Filters

Lumped element filters offer small size at low frequencies not achievable by ceramic, cavity or waveguide implementations. Knowles Precision Devices's advanced modeling and design can achieve virtually any filter response shape.

## Elliptic

- ▶ True elliptic, pseudo-elliptic and quasi-elliptic functions are regularly used to increase selectivity, allowing wider bandwidths and decreased passband loss. This is achieved by adding band-reject resonances to the stop-band of conventional filters, allowing exceptionally steep skirts in the 1 MHz to 26 GHz range.

## Gaussian and Bessel

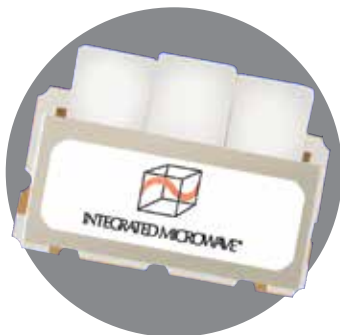
- ▶ Knowles Precision Devices has special expertise with lumped Gaussian, Gaussian elliptic, Bessel and Bessel elliptic, incorporating the low ringing and selectivity of Chebyshev.

## Conventional Chebyshev

- ▶ Our advanced software and modeling can achieve virtually any response shape from lowpass to highpass, and bandpass shapes in-between.

## Helical

- ▶ The Q of helical filters can be dramatically increased for narrow band/low frequency, in some cases matching the size and performance of ceramic filters up to 1 GHz.



## Bandpass Filters

- ▶ **Bandwidth:** .01% ~ 50%
- ▶ **Frequency Range:** dc ~ 26 GHz
- ▶ **Available Packaging:** Connectorized, SMT, Pin



## Lowpass Filters

- ▶ **Bandwidth:** .01% ~ 50%
- ▶ **Frequency Range:** 300 MHz ~ 40 GHz
- ▶ **Available Packaging:** Connectorized, SMT, Pin

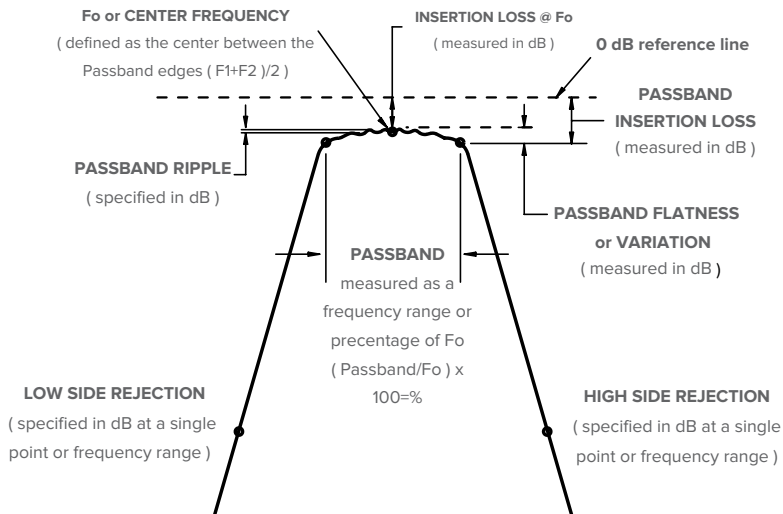


## Highpass Filters

- ▶ **Bandwidth:** .01% ~ 50%
- ▶ **Frequency Range:** 300 MHz ~ 40 GHz
- ▶ **Available Packaging:** Connectorized, SMT, Pin



# Bandpass Filters



## Applications:



Microwave Radar



Radio Communications



mmWave 5G

### Frequency Range:

DC – 40 GHz

Bandwidths: 0.1% ~ 200%

### Available Technology:

- ▶ Ceramic
- ▶ Cavity
- ▶ Lumped Element

### Available Packages:

- ▶ PC Mount
- ▶ Connectorized
- ▶ Surface Mount
- ▶ Customized
- ▶ RoHS
- ▶ Hermetic

Part Number	Description	Center or Cutoff Frequency (MHz)	Bandwidth (MHz)	Mounting Style
940121	Bandpass, VHF	255	30	Surface Mount
941008	Bandpass, UHF, STL	314.25	0.55	Type N-F Connectors
935384	Bandpass, UHF	400	20	SMA-F Connectors
942225	Bandpass, UHF, ISM band	914.5	24	PCB Mount
935535	Bandpass, UHF, STL	947.5	0.525	Type N-F Connectors
941699	Bandpass, L-Band, STL	1000	0.6	Type N-F Connectors
938663	Bandpass, GPS L2	1227.6	20	Surface Mount
938660	Bandpass, GPS L1	1575.42	20	Surface Mount
939606	Bandpass, GPS L1	1575.42	10	Type N-F Connectors
933827	Bandpass, L-Band	1600	200	Surface Mount
932342	Bandpass, S-Band	2000	100	SMA-F Connectors
932199	Bandpass, S-Band	2106.4	40	Surface Mount
938635	Bandpass, S-Band, LTE Band 1 (2100) downlink	2140	60	SMA-F Connectors
942651	Bandpass, S-Band	2245	100	Type N-F Connectors
942080	Bandpass, S-Band	2235	30	Surface Mount
942658	Bandpass, S-Band	2250	100	Surface Mount
942320	Bandpass, S-Band	2300	200	SMA-F, SMA-M Connectors
934450	Bandpass, S-Band, LTE Band 40 (TD 2300)	2350	100	Surface Mount
918565	Bandpass, S-Band	2450	100	Surface Mount
936908	Bandpass, S-Band	2600	90	Type N-F/ Type N-M Connectors

# Bandpass Filters...*continued*

Part Number	Description	Center or Cutoff Frequency (MHz)	Bandwidth (MHz)	Mounting Style
937017	Bandpass, S-Band	3100	20	Surface Mount
938738	Bandpass, S-Band	3450	20	Type N-F Connectors
936754	Bandpass, C-Band	4500	200	SMA-F Connectors
935061	Bandpass, C-Band	4700	600	Surface Mount
942274	Bandpass, C-Band	5000	2188	Surface Mount
935838	Bandpass, C-Band	5300	30	Surface Mount
936735	Bandpass, C-Band	5800	300	Surface Mount
933984	Bandpass, C-Band	6000	4000	SMA-F Connectors
930257	Bandpass, C-Band	7000	100	SMA-F Connectors
938949	Bandpass, C-Band	7250	120	Surface Mount
938533	Bandpass, X-Band	8150	500	SMA-F Connectors
931406	Bandpass, X-Band	9600	500	Surface Mount
938044	Bandpass, X-Band	10250	500	SMA-F Connectors
936333	Bandpass, Ku-Band	13000	500	SMA-F Connectors
940694	Bandpass, K-Band	18700	500	SMA-F Connectors
943501	Bandpass, K-Band, 5G n258	24000	50	Surface Mount
943502	Bandpass, K-Band, 5G n258	24000	100	Surface Mount
943503	Bandpass, K-Band, 5G n258	24000	200	Surface Mount
943504	Bandpass, K-Band, 5G n258	24000	400	Surface Mount
943440	Bandpass, Ka-Band, 5G n261	28000	50	Surface Mount
943441	Bandpass, Ka-Band, 5G n261	28000	100	Surface Mount
943442	Bandpass, Ka-Band, 5G n261	28000	200	Surface Mount
943443	Bandpass, Ka-Band, 5G n261	28000	400	Surface Mount
943480	Bandpass, Ka-Band, 5G n261	28000	800	Surface Mount

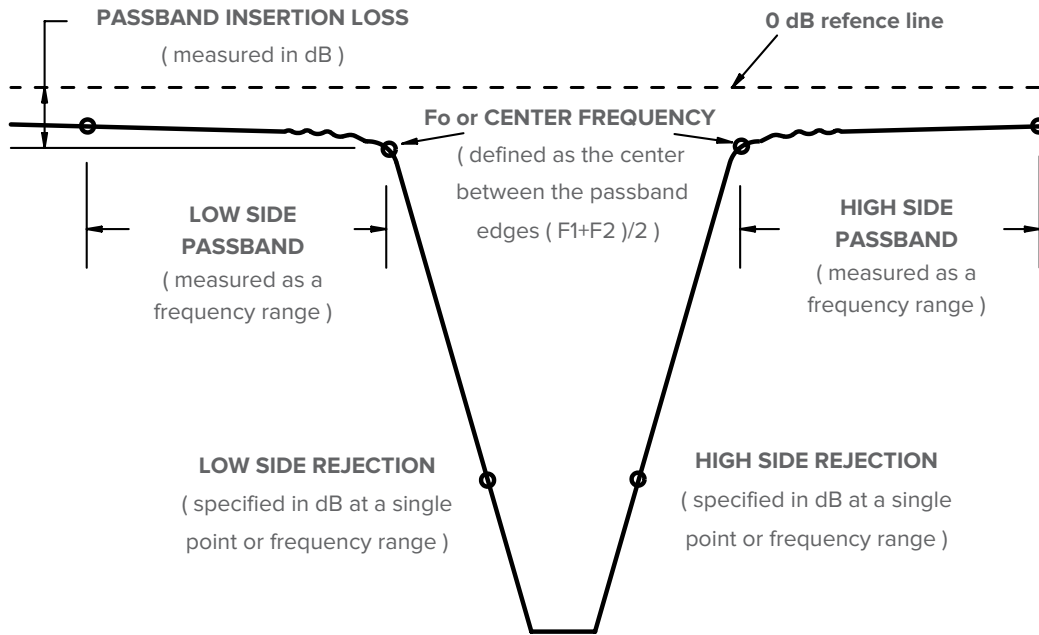
Visit our website for more information and to access the datasheets.

Any filter can be modified with different specs or package option.

**CUSTOM DESIGNS ARE ALWAYS AVAILABLE!**



# Bandreject Filters



**Frequency Range: DC – 30 GHz**

**Bandwidths: 0.1% ~ 200%**

**Available Technology:**

- ▶ Ceramic
- ▶ Cavity
- ▶ Lumped Element

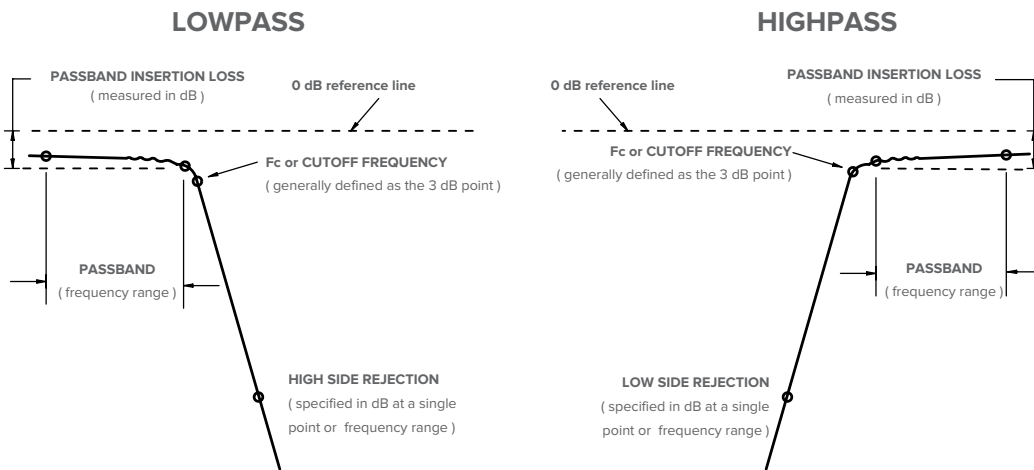
**Available Packages:**

- ▶ PC Mount
- ▶ Connectorized
- ▶ Surface Mount
- ▶ Customized
- ▶ RoHS
- ▶ Hermetic

Reach out to our engineers for assistance with custom designs at:

[DLIengineering@knowles.com](mailto:DLIengineering@knowles.com)

# Lowpass and Highpass



**Frequency Range:**  
DC – 20 GHz

**Available Technology:**

- ▶ Lumped Element

**Available Packages:**

- ▶ PC Mount
- ▶ Connectorized
- ▶ Surface Mount
- ▶ Customized
- ▶ RoHS
- ▶ Hermetic

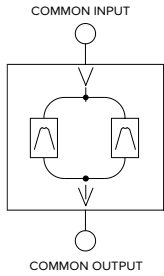
Part Number	Description	Center or Cutoff Frequency (MHz)	Bandwidth (MHz)	Mounting Style
923787	Lowpass, HF	10	N/A	Axial Pins
935265	Highpass, VHF	30	N/A	Type N-F, Type N-M Connectors
931190	Lowpass, VHF	80	N/A	Type N-F Connectors
930615	Lowpass, VHF	100	N/A	Type N-F, Type N-M Connectors
935263	Lowpass, VHF	200	N/A	Type N-F, Type N-M Connectors
935264	Lowpass, UHF	300	N/A	Type N-F, Type N-M Connectors
908704	Lowpass, UHF	400	N/A	Axial Pins
937144	Highpass, UHF	500	N/A	SMA-F Connectors
940989	Lowpass, UHF	700	N/A	SMA-F Connectors
938571	Lowpass, L-Band	1000	N/A	SMA-F Connectors
935579	Lowpass, L-Band	1250	N/A	SMA-F Connectors
938576	Lowpass, L-Band	1400	N/A	Surface Mount
938556	Highpass, S-Band	1600	N/A	SMA-F Connectors
936669	Highpass, S-Band	2000	N/A	SMA-F Connectors
931396	Lowpass, S-Band	3000	N/A	SMA-F Connectors
932413	Lowpass, C-Band	4000	N/A	SMA-F Connectors
937501	Lowpass, X-Band	9500	N/A	SMA-F Connectors
936740	Lowpass, X-Band	10000	N/A	GPO Connectors
940417	Highpass, Ku-Band	12000	N/A	SMA-F Connectors
936741	Lowpass, Ku-Band	18000	N/A	GPO Connectors



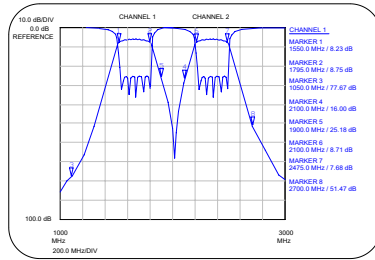


# Dual Bands / Multi-Bands & Diplexers Multiplexers

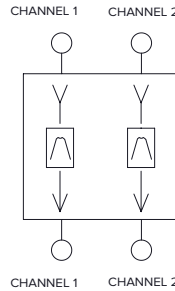
DUALBAND OR MULTIBAND



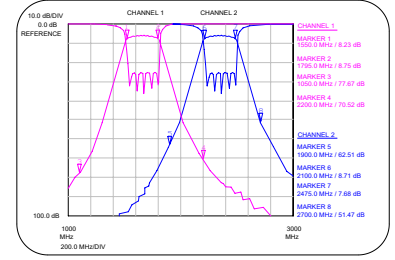
EXAMPLE NETWORK ANALYZER RESPONSE.



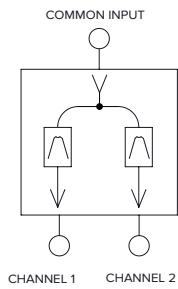
FILTERBANK, DUALBANK OR MULTIBANK



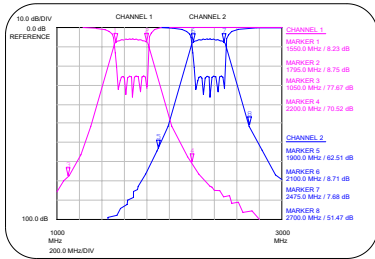
EXAMPLE NETWORK ANALYZER RESPONSE.



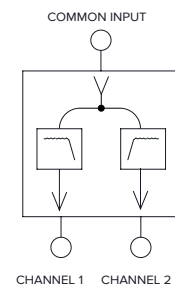
DIPLEXER, DUPLEXER OR MULTIPLEXER



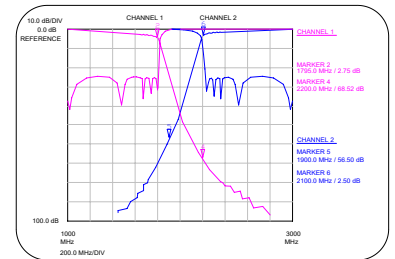
EXAMPLE NETWORK ANALYZER RESPONSE.



HI/O DIPLEXER, DUPLEXER OR MULTIPLEXER



EXAMPLE NETWORK ANALYZER RESPONSE.



## Multiplexers

Highly efficient, frequency selective dividers and combiners are typically a series of lowpass-highpass crossover junctions. The complexity usually ranges from one to four crossover junctions, in addition to close-up lowpass and highpass filters.

Multiplexers are available in narrow, moderate, and octave passbands. Typical multiplexers will have a 1:5:1 maximum passband VSWR and a 2:0:1 maximum crossover VSWR.

Frequency Range: DC – 40 GHz

Available Technology:

- ▶ Ceramic
- ▶ Cavity
- ▶ Lumped Element

Available Packages:

- ▶ PC Mount
- ▶ Connectorized
- ▶ Surface Mount
- ▶ Customized
- ▶ RoHS
- ▶ Hermetic

Part Number	Description	Center or Cutoff Frequency (MHz)	Bandwidth (MHz)	Mounting Style
943452	Bandpass, diplexer GPS L1/L2	1227.6, 1574.42	16, 16	Surface Mount
943627	Bandpass, dual band GPS L1/L2	1227.6, 1574.42	24, 24	Surface Mount
942330	Bandpass, diplexer, X-Band, satellite point to point	10827.5, 11322.5	255, 245	Type N-F/ SMA-F Connectors
942331	Bandpass, diplexer, X-Band, satellite point to point	11070, 11570	260, 260	Type N-F/ SMA-F Connectors

# Specialty Filters



## Linear Phase Filters

Knowles Precision Devices has the technology to model and produce filters that are capable of meeting both group delay and amplitude specifications simultaneously, without the use of separate equalizers. These filters can be designed to meet VSWR and attenuation specifications very nearly equal to more conventional Chebyshev or Butterworth designs, while maintaining a low-group delay variation over a large percentage of the passband. Insertion loss variation over the passband will closely track the group delay variation.

## Amplitude Equalizers

With amplitude equalizers, additional circuitry can be applied to further flatten passband variation by lowering the high ranges of the band relative to the band edges.

Visit [knowlescapacitors.com](http://knowlescapacitors.com) to view our DLI Gain Equalizers.

## Delay and Phase Equalizers

Sharp filter rejection roll-off is always accompanied by large group delay variation. When both fast roll-off and flat group delay are needed, equalizer can be used. Sometimes multiple equalizers are needed to achieve very flat group delay and phase performance.

- Send your requirements to us when you need both sharp roll-off and small group delay variation or flat phase. Delay equalizers can be implemented to almost any filter to flatten group delay and phase response by up to 20:1 ratios, at the expense of insertion loss.

## Absorptive Filters or Out of Band Return Loss Filters

An absorptive filter or also referred to as an out of band return loss filter can be translated as a terminated diplexer or triplexer where the out of band filter only has return loss.

Reach out to our engineers for assistance with custom designs at:

[DLIengineering@knowles.com](mailto:DLIengineering@knowles.com)



# Space Heritage

Our products are currently used worldwide and in space — in the most advanced military and aerospace instrumentation and communication systems.

## SPACE APPLICATIONS

2024	Artemis Lunar Lander
2023	Griffin Lunar Lander
2022	Peregrine Lunar Lander
	NISAR (NASA-ISO Synthetic Aperture Radar)
	NISAR TROPICS
2021	SWOT (Surface Water Ocean Topography)
	JPSS2 (Joint Polar Satellite System 2)
	New Glenn Blue Origin
2019	New Shepard Blue Origin
2017	JPSS1 (Joint Polar Satellite System 1)
2015	OG2 (Orbcomm Generation 2)
	MMS (Magnetosphere Multiscale Mission)
	SMAP (Soil Moisture Active Passive)
2014	WorldView-3
2013	MUOS (Mobile User Objective System)

2011	Suomi NPP (National Polar-orbiting Partnership)
2010	SBSS (Space Based Space Surveillance)
2009	WISE (Wide-field Infrared Survey Explorer)
	WorldView-2 LM-900
2008	GLAST (Gamma Ray Large Space Telescope)
2008	JEM-PM (Japanese Experimental Module "Kibo" Pressurized Module)
Various 2002 -	ATLAS Launch Vehicle
Ongoing 1998-	ISS (International Space Station)
	C2V2 (Common Communication for Visiting Vehicle)
	CONNECT
	IPP

## MARS & JUPITER MISSIONS

2026	Earth Return Orbiter
	Sample Return Lander
2023	Europa JUICE (Jupiter Icy Explorer)
	Europa RIME (Radar for Icy Moon Exploration)
2021	Orion
2020	Perseverance Rover
2018	InSight Lander (Interior exploration using Seismic Investigations, Geodesy and Heat Transport)
2016	ExoMars TGO (Trace Gas Orbiter)
2013	MAVEN (Mars Atmosphere and Volatile Evolution)
2011	Curiosity Sky Crane
	Curiosity Rover
2008	Phoenix Lander
2005	MRO (Mars Reconnaissance Orbiter)
2003	Opportunity Rover
	Spirit Rover

## TESTING CAPABILITIES

### RF PERFORMANCE TESTING

RF Performance GSG (ground signal ground)	100% or sample
RF Test Over Temperature	
Design Evaluation Boards	
Resistor Testing	100% or sample
TCR MIL	

### MECHANICAL TESTING

Constant Acceleration	MIL-STD-883, Method 2001
Mechanical Shock	MIL-STD-883, Method 2002
Solderability	MIL-STD-883, Method 2003
Visual	MIL-STD-883, Method 2008
External Visual	MIL-STD-883, Method 2009
Bond Strength	MIL-STD-883, Method 2011
Die Shear	MIL-STD-883, Method 2019
Ball Shear	ASTM 1269

### PHYSICAL TESTING

Vibration	MIL-STD-202, Method 201
Resistance to Soldering Heat	MIL-STD-202, Method 210
Acceleration	MIL-STD-202, Method 212
DPA	EIA-469

### ENVIRONMENTAL TESTING

Humidity	MIL-STD-202, Method 103
Immersion	MIL-STD-202, Method 104
Moisture Resistance	MIL-STD-202, Method 106
Thermal Shock	MIL-STD-202, Method 107
Temperature Cycling	MIL-STD-883, Method 1010





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