



Skyworks' RF Ceramics Corporate Overview

1955 – 2015

OVER 50 YEARS OF EXCELLENCE

Worldwide Presence



- Sales Offices
- ◆ Design or R&D Centers
- ★ Manufacturing

RF Ceramics History

1955

Trans-Tech Founded

- Trans-Tech Inc. founded in Rockville, MD by Dr. Herbert H. Greger

1981

Trans-Tech Joins Alpha

- Trans-Tech, Inc. becomes a wholly-owned subsidiary of Alpha Industries

2002

Alpha and Conexant
(wireless) merge

- Skyworks Solutions, Inc. created
- Trans-Tech, Inc. becomes a wholly-owned subsidiary of Skyworks Solutions, Inc.

2011

TTI purchases M/A-Com
isolator business

- Skyworks Ireland, Ltd. Is formed and becomes part of Skyworks' RF Ceramics business unit



Ferrite and Dielectric materials, Isolators/Circulators for the Wireless Infrastructure Market

Ingots, Powders and Components for the Aerospace, Automotive, Military and Medical Markets



Trans-Tech in Adamstown, MD



- 140,000 square feet
- Powder Manufacture
- Technical ceramics pressing and firing
- Employees: 220
- 59 years of continuous operations
- 24 by 7 operations

**Vertically Integrated Industry Leader in
RF Ceramic Products**

Ceramic Oxides

- Do:** Beta Tricalcium Phosphates, Dielectric modifiers, Hexaferrites, High Q and Temperature-stable dielectrics, Hydroxyl Apatites, Microwave ferrite materials, Perovskites, Refractory thermal barrier coatings, RF Absorbers, Solid oxide fuel cell materials, Spinel
- Don't do:** High Purity Alumina, Structural Zirconia, Nitrides, Carbides, Borides, Steatite, High Volume Forsterite, Cordierite

Ceramics Processing

Powder Preparation

- Solid State Reactions (no chemical or sol-gel)
- Vibratory Milling
- Ball Milling
- Spray Drying

Forming

- Dry Press (2-125 tons)
- Extrusion (110 tons, 6" Ram)
- ISO Press (30,000 – 60,000 PSI)

Sintering

- Tunnel Kiln
- Periodic Kiln
- Bottom Load Kiln
- Air-fired & Pressurized

Grinding

- CNC
- Surface Grinding
- Lapping
- Through-Feed Grinding
- ID Slicing
- OD Slicing
- Center-Less Grinding

Products

- Band Pass / Notch / Diplex Filters
- Coaxial Resonators / Inductors
- 300 to 7 GHz (NEW HIGHER Fo)
- Surface mount or connectorized



Benefits

- High Q
- Reduced size
- Better Shielding
- Superior Temperature Performance

Applications

- High Q Wireless Communications
- Transmit / Receive functionality
- Voltage Controlled Oscillators



Ceramics in Military Applications



Tactical Radio Communications

Homeland Security



JTRS



Man-Pack



THALES



Ceramic-based filters are the technology of choice when performance is key.

- **NPI on Smaller Resonators**
- **Patent Pending on SIR Designs**
- **1.85mm > 1.5 mm**
- **Currently have 1.85mm designs and**
- **Pre-Production on 1.5 mm filters**
- **Going into Reducing X,Y and Z dimensions for your Applications**
- **Also working on Replacing Typical cavity Style Filters with a Ceramic Based SMT or Connectorized Filter, High Power >100 Watts. Less weight, Similar Cost**
- **Also working to exceed the typical 5.5 GHz with Ceramics, achieving designs up to 7.0 GHz**

1.85mm Subminiature Ceramic Filter – NEW CAPABILITIES, GOING SMALLER

Applications

- Electronic warfare
- Portable transceivers for both military and homeland security radio communications

Features

- Relatively low insertion loss
- SMT designs
- Frequency range from 350 MHz to 6 GHz
- Power handling, with up to 3 W CW
- Wide operating temperature range
- Light weight
- Smaller profile compared to a typical ceramic design
- Easy drop-in solution
- Quick turnaround on new designs
- RoHS-compliant
- Available in various frequencies (contact TTI for more information)



Table 1. Electrical Specifications (Note 1)

Parameter	Symbol	Test Condition	Minimum	Typical	Maximum	Units
Center frequency	f_0			1300		MHz
Poles				7		-
Bandwidth:	BW					
Bandwidth			f_0		80	MHz
Insertion Loss @ BW					4	dB
Ripple @ BW					1.7	dB
Return Loss @ BW					12	dB
Attenuation:						
1576 MHz			65			dB
1024 MHz			69			dB
Impedance				50		Ω
Temperatures:						
Storage	T_{STG}		-65		+150	$^{\circ}\text{C}$
Operating	T_A		-40		+85	$^{\circ}\text{C}$
Power handling				1 W continuous minimum		

Note 1: Performance is guaranteed only under the conditions listed in this table.

High Frequency Ceramic Filter Moving Up Towards the 7.0 GHz, New Capability

Applications

- Electronic warfare
- UAV
- Portable transceivers for both military and homeland security
- Radio communications

Features

- Frequencies up to 7 GHz
- Extremely light weight
- Ultra-small ceramic resonator footprint
- Power tested to 10 Watts CW
- Improved insertion loss with higher Q material, supported by Trans-Tech internal R & D
- Quick turnaround on new designs (typically less than 6 weeks, with minimum NRE)
- Available in various frequencies (contact TTI for more information)



High Frequency Ceramic Filter
Dimensions (inches): 0.269 x 0.205 x 0.086

12mm & 20mm High Power Ceramic Filters, Replacing your Bulky Metal Cavity

Applications

- Electronic warfare
- Power amps
- Portable transceivers for both military and homeland security radio communications

Features

- Low insertion loss
- SMT or connectorized (as shown) designs
- Frequency range from UHF to 2.0 GHz
- Superior power handling, with up to 100 W Continuous Wave (CW)
- Wide operating temperature range
- Lightweight
- Smaller profile compared to a typical cavity design
- Easy drop-in solution
- Quick turnaround on new designs
- Reconfigurable for many different connector types
- RoHS-compliant
- Available in various frequencies (contact TTI for more information)

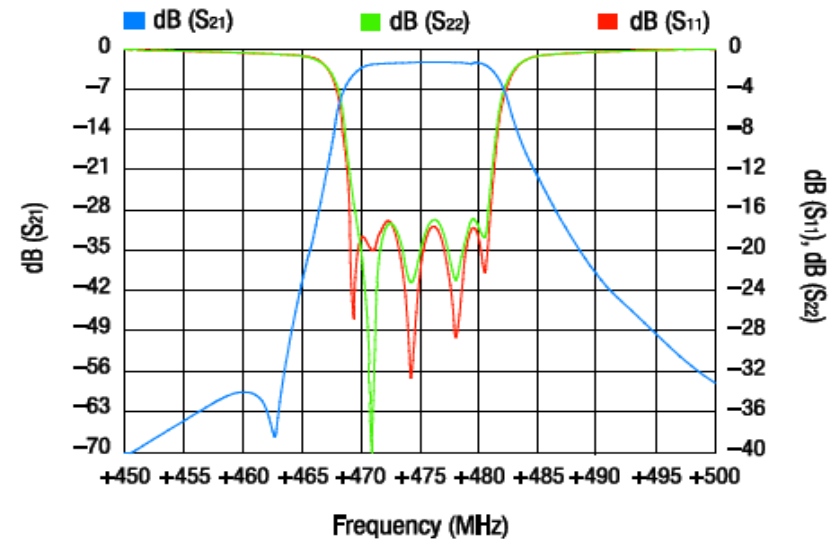


Figure 1: 12 mm UHF High Power Ceramic Filter

Micro Miniature Filter

New 1.55 mm SIR Technology

Applications

- Electronic warfare
- Power amps
- Portable transceivers for both military and homeland security
- Radio communications

Features

- Bandpass, notch filters from VHF to SHF
- Overall sizes reduced by up to 50% using new ceramic technology
- New 1.55 mm designs
- Trans-Tech ceramic foundry, located in the USA
- Improved insertion loss with higher Q material, supported by Trans-Tech internal R & D
- Quick turnaround on new designs (typically less than 6 weeks, with minimum NRE)
- Available in various frequencies (contact TTI for more information)

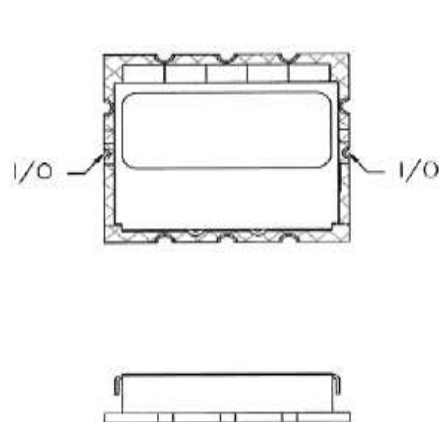


Figure 1. Diagram of the Microminiature Filter

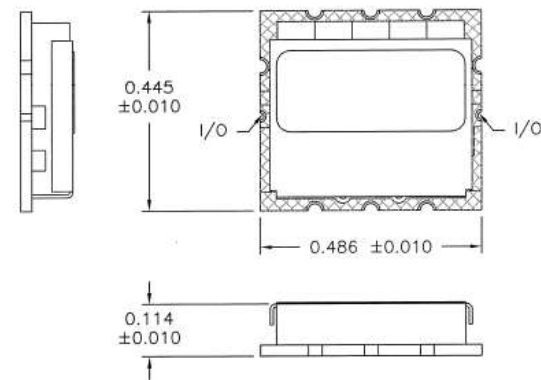


Figure 2. Dimensions for the Conventional Ceramic Filters

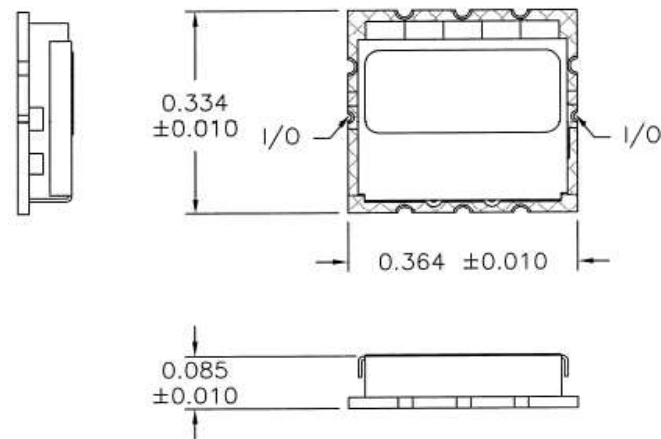


Figure 3. Dimensions for the Microminiature Filters

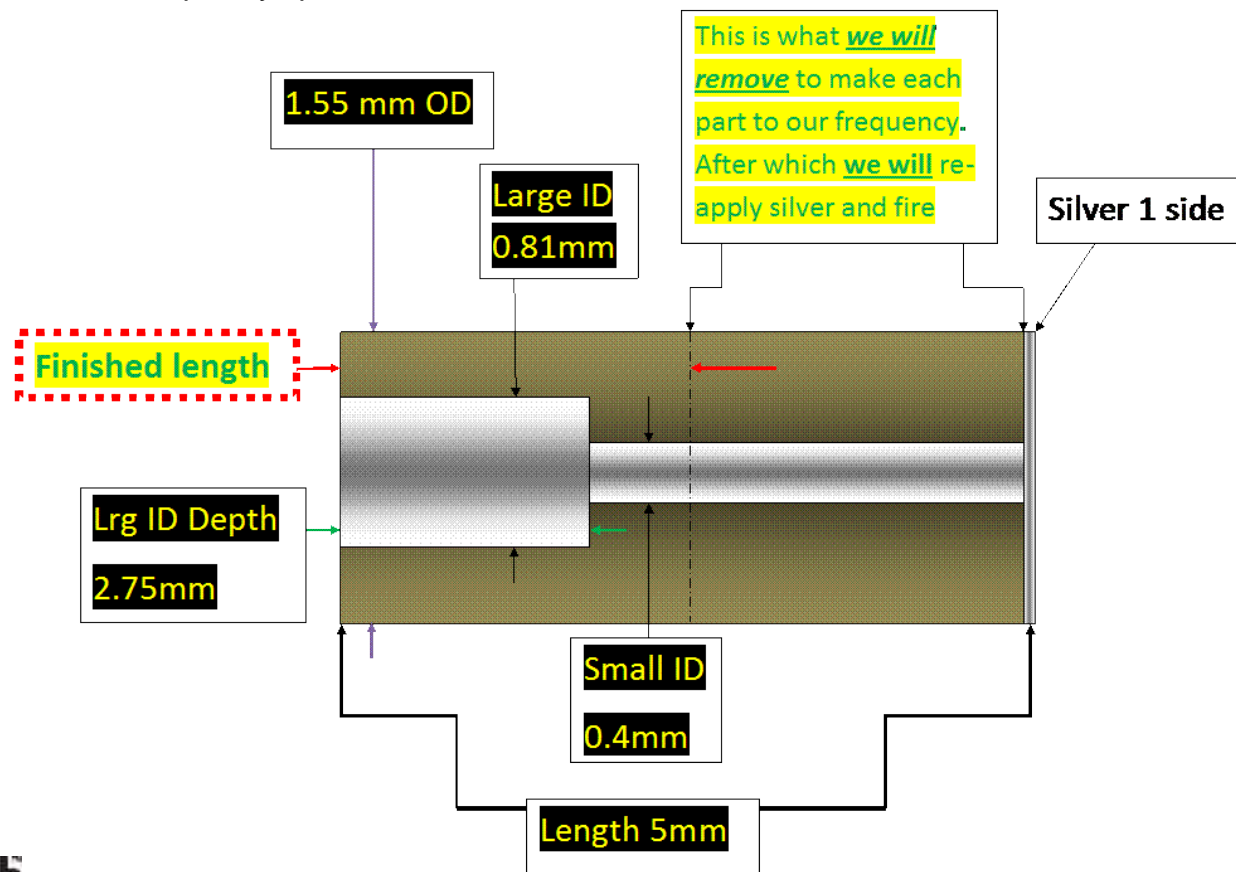
SIR Coaxial Resonators

What are they:

SIR Resonators - Stepped Impedance Resonators

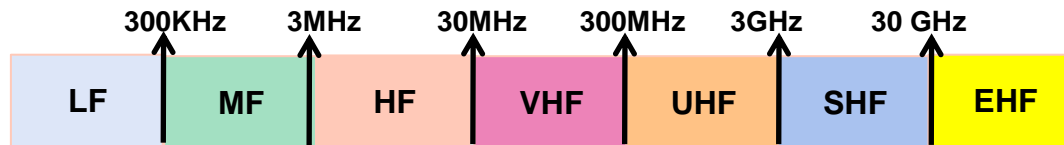
Saves board space with Minimal impact on Q

- Opens up designs in all RF frequency spectrums



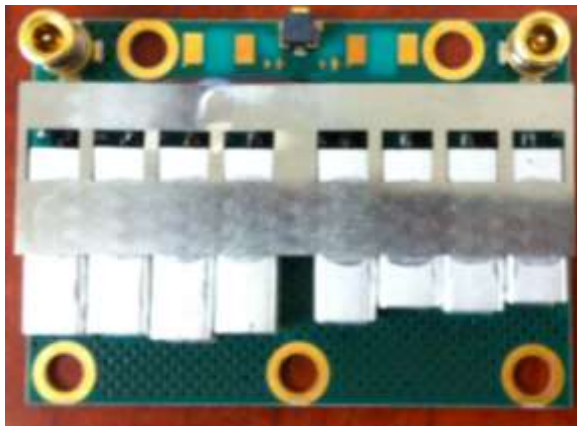
SIR (Step Impedance Resonators)

Radio Frequency Spectrum



240 MHz to >5.5 GHz

Our Ceramic Filters Operate Here



•Use reverse SIR Techniques for Frequencies >6GHz

•Utilize higher DK material for lower frequencies

Filter Selection Guide – What we can do

- **Center Frequency**
- **Number of Poles**
- **Resonator Sizes**
- **Bandwidth**
- **Insertion Loss**
- **Attenuation**
- **Impedance**
- **VSWR**
- **Operating Temperature Range**
- **Package Type**
- **300–7000 MHz**
- **2 – 10**
- **2,3,4,6,8, and 12 mm**
- **1% to 10% Fo Typical – Other by Request**
- **1-4 dB Typical**
- **Dependent Upon Number of Poles**
- **50 or 75 Ohm**
- **2.0:1 Maximum**
- **-40C to +85C**
- **PCB and Flatpack Surface Mount, Through Hole, Connectorized**

IED / EW



Test Equipment



Commercial Security



RFID



TCAS / GPS



Medical



Many applications can utilize the performance of ceramics.

Designing a Custom Filter

What Do We NEED FROM YOU ?

- Center Frequency
- Pass Band (B/W)
- Desired Insertion Loss
- Desired VSWR
- Desired Rejections
- Power Requirements
- Real Estate, Size Limitations, X,Y and Z
- Get Us COST Targets
- GET Us Applications
- Timing, Proto Required WHEN ?
- Is NRE Available, Typically TTI is LOWEST COST vs.
- END RESULT , 10 & Commission
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LORCH
MICROWAVE

K&L
MICROWAVE
A DOVER COMPANY

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technologies corp.



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