

# Thin Film Approach

to the miniturization of Microwave & RF Filters

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Microwave Products Group

# Introduction to MPG



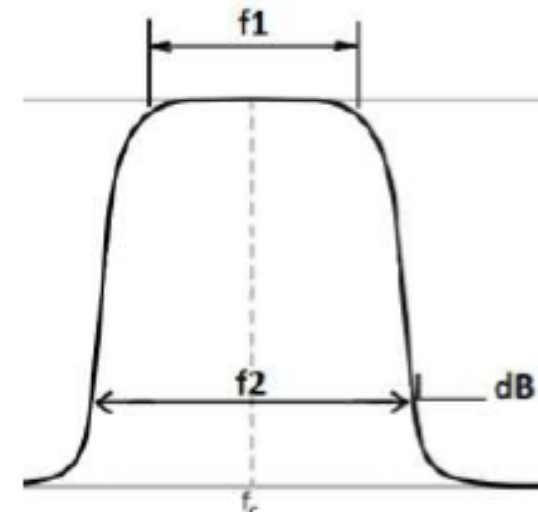
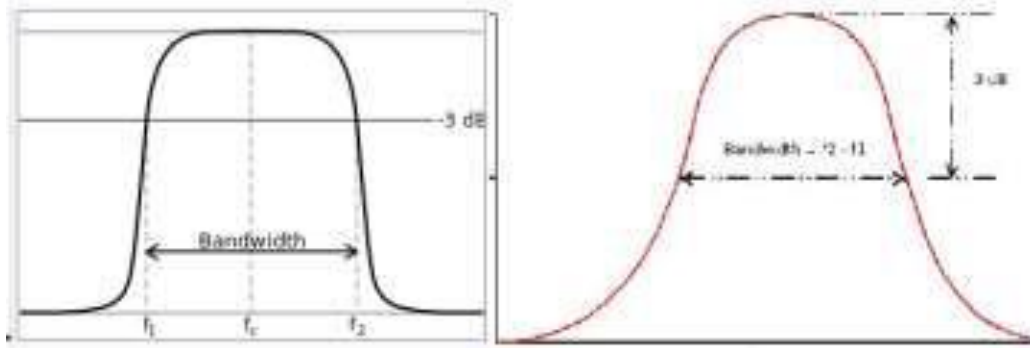
- Mission-Critical Components & Subsystems
- 4 Business Units
- Expertise in communication-based products for demanding applications



# Filter Design & Mathematical Methods

$$\text{Approximate } Q = 8.7 \times F_c \times (N - 1.5) / \text{bw} \times \text{insertion loss}$$

$$N \approx \frac{f_1}{f_2} \times 2.5 \sqrt{\text{dB}}$$



$$\text{Approximate } Q = 8.7 \times F_c \times (N - 1.5) / \text{bw} \times \text{insertion loss}$$

# Traditional Equipment

- Lumped Equipment
- Dielectric Resonator
- Helical Filters
- Cavity Filters



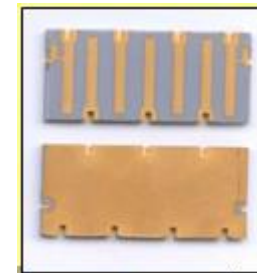
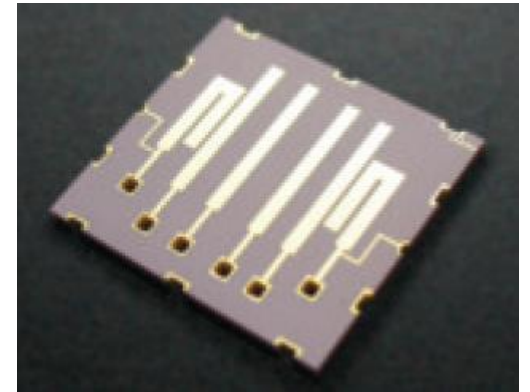
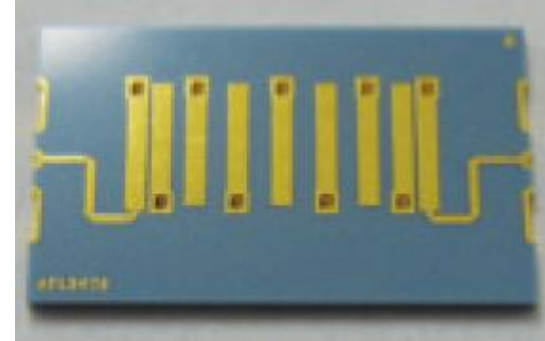
# Thin Film

## Typical Characteristics

- RF Power handling up to 20 watts
- Steep Selectivity “n” 2 to 16 poles
- Fractional bandwidths up to 80%
- Solder or chip and wire surface mount design

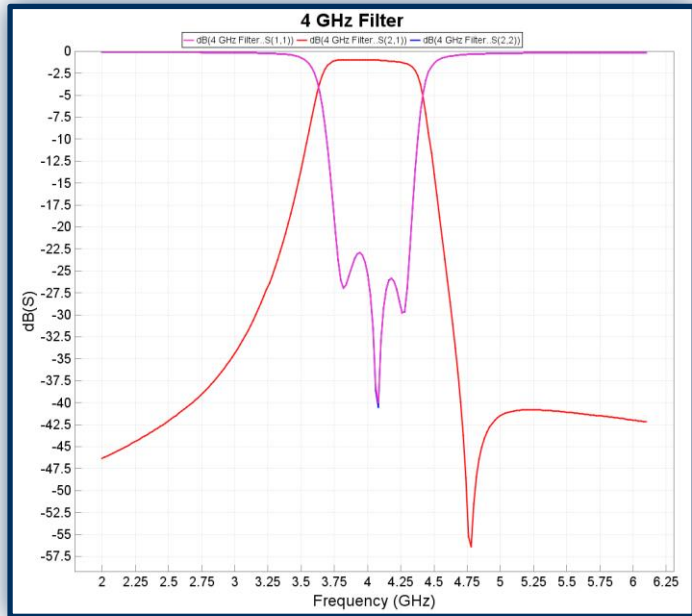
## Typical Filter types

- Bandpass 700MHz to 26GHz
- Lowpass 700MHz to 26GHz
- Highpass 700MHz to 40GHz
- Duplexers 1GHz to 30GHz

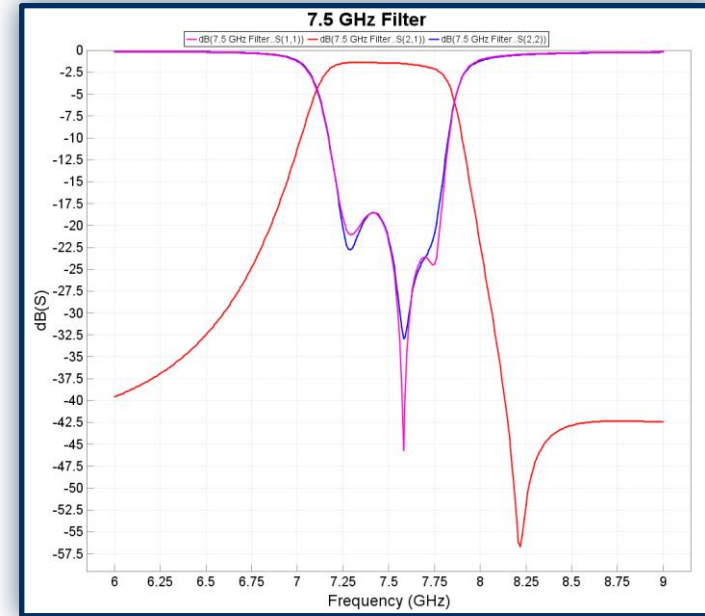
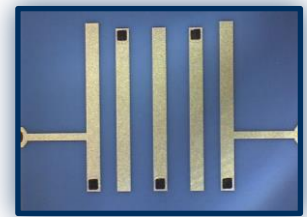




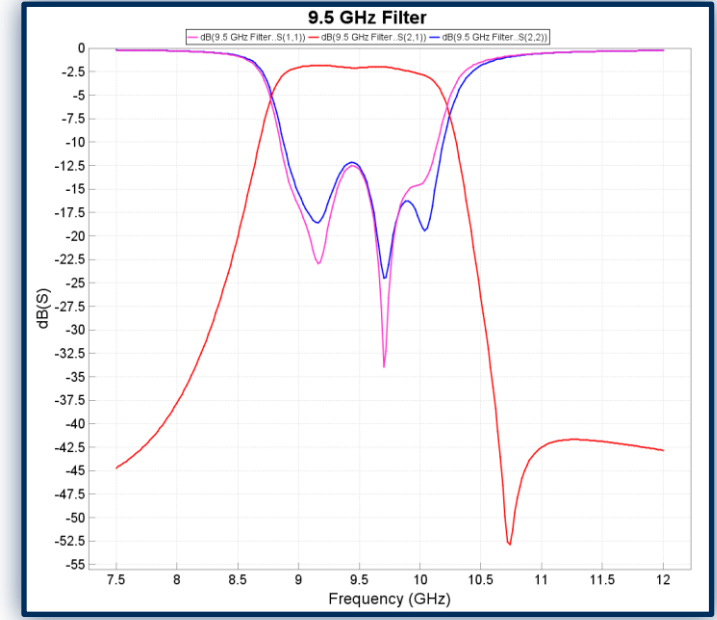
# Thin Film



Above: 4 GHz Bandpass filter response. Size: 9 x 9 mm.



Above: 7.5 GHz Bandpass filter response. Size: 9 x 7 mm.



Above: 9.5 GHz Bandpass filter response. Size: 9 x 7 mm.



# Thin Film Filter – Notes



## Insertion Loss

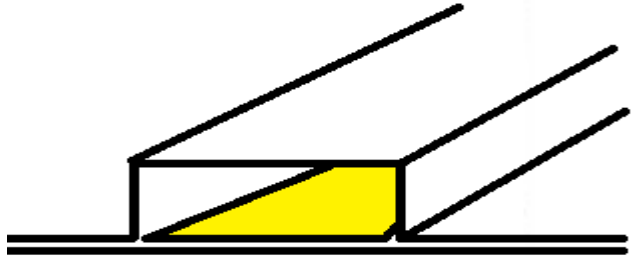
Insertion loss is a combination of multiple sources of loss, which include: Dielectric Loss (related to  $D_f$  or Loss Tangent), Connector Losses, Impedance Mismatches (Reflections), Conductor Losses and Radiation Losses.

From a design perspective, the primary sources for insertion loss to consider in terms of ceramic performance are the dielectric loss and the conductive losses.

At frequencies up to 3GHz with very low loss materials (loss tangent 0.0003), conductive loss might dominate dielectric loss 3 to 1. As frequencies increase, the conductive loss and dielectric loss ratio will change to a point where they could be similar in value depending on the material performance across frequencies.

# Thin Film Filter – Notes

## Fixing filter to ground



Solder attachment process is difficult to repeat accurately as frequency increases. Board may “float” on solder.

Surface mount transitions become difficult to align and stray capacitance has a significant impact on circuit performance. Parasitics become difficult to model.

Epoxy bond technique may give better registration. Thermal bond also good. Place a 2 to 3 mil layer of epoxy (Araldite HY5052 [ablebond] or similar). Positive pressure on circuit may be required to give good adhesion.

If extremes of temperature are to be handled consider the thermal expansion of different materials Aluminium 21 ppm, CG = 9 ppm, CF = 9ppm.

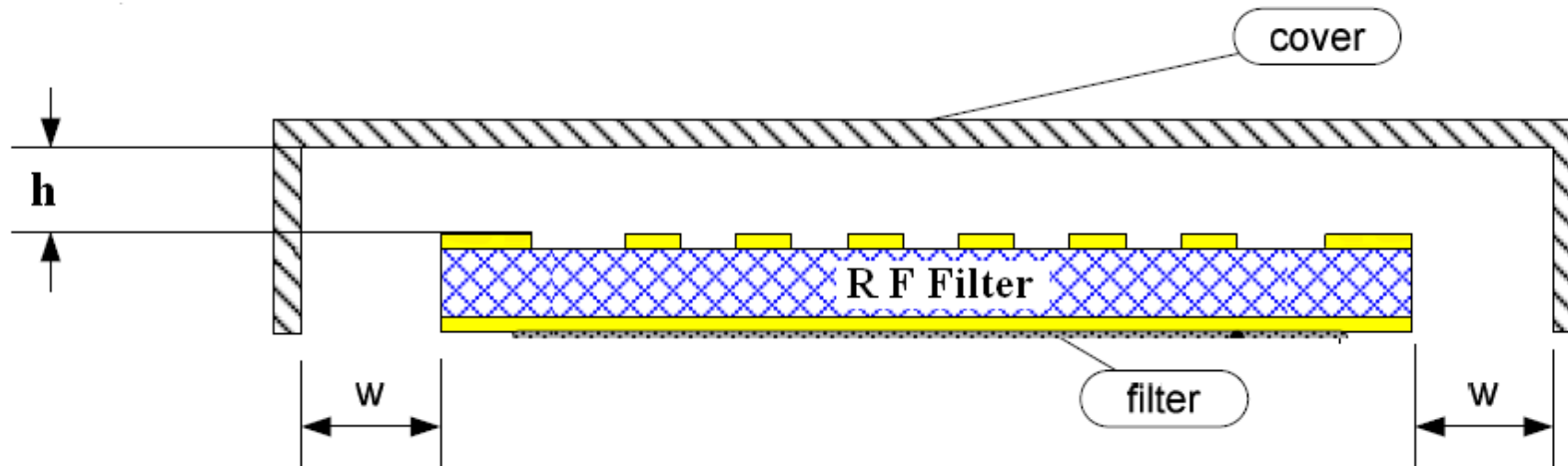


# Thin Film Filter – Notes

## Filter Shielding:

If the customer provides its own shielding for the filter, it is very important to know the channel width and cover height that will enclose the device. This dimension will be taken into account during the design and test to ensure the part will work in its next level of assembly.

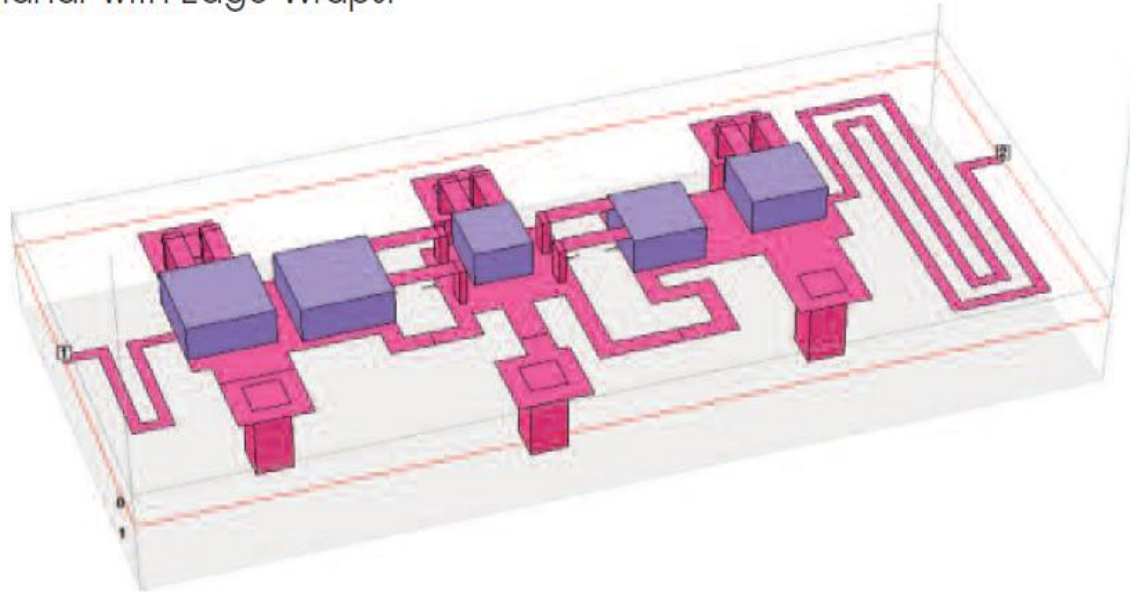
Typically the distance from  $w$  from the part edge to the housing wall is recommended to be 0.25 to 0.40mm. Cover heights  $h$  are typically set to 3 to 5 times the thickness of the filter substrate. Standard filter thicknesses are 0.508 and 0.381mm.



# Thin Film Lumped Equipment Filters (TFLE)

## Thin Film Lumped Elements (TFLE)

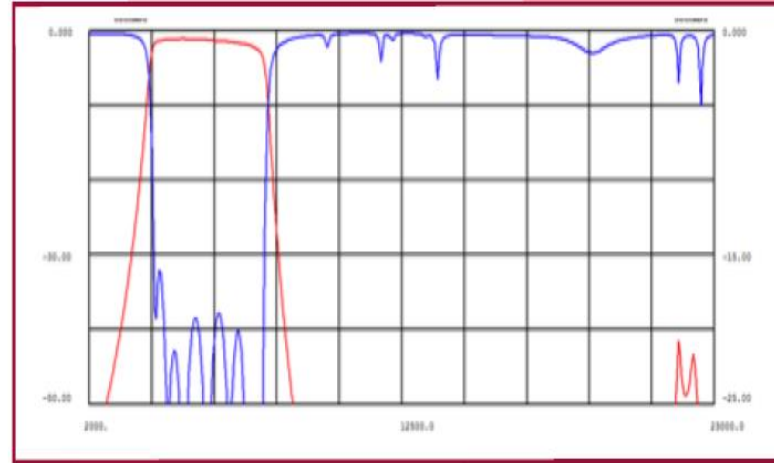
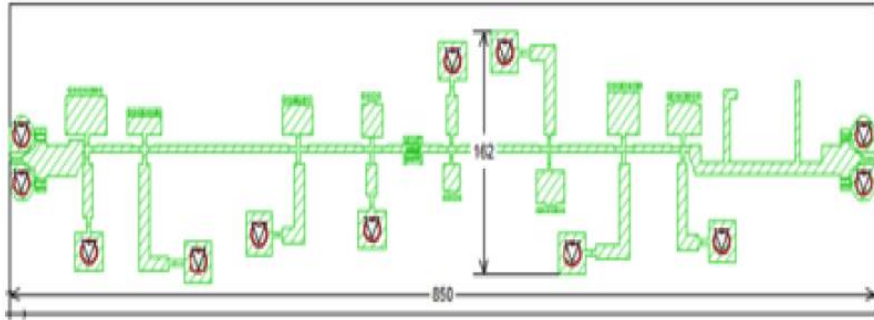
Small size and substrate-based material are perfect for SMT configurations such as Microstrip, Coplanar with Filled Vias, and Coplanar with Edge Wraps.



*Example of TFLE Alumina Substrate Construction Measuring 0.25" x 0.16" x 0.1" with Cover*

# Thin Film Lumped Equipment Filters (TFLE)

◆ Example:  $N=8+LPE$ ,  $F_0=6000$  MHz,  $BW=3500$  MHz



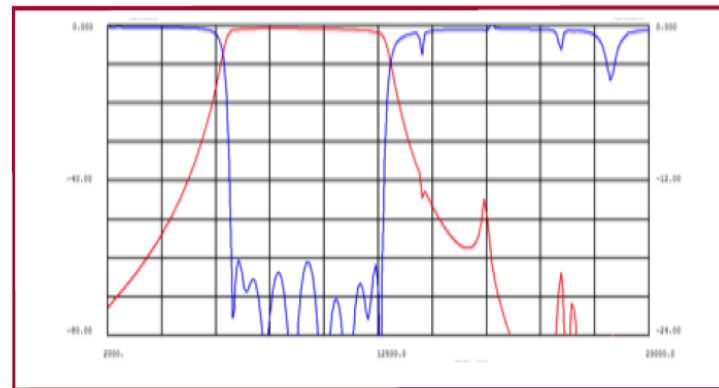
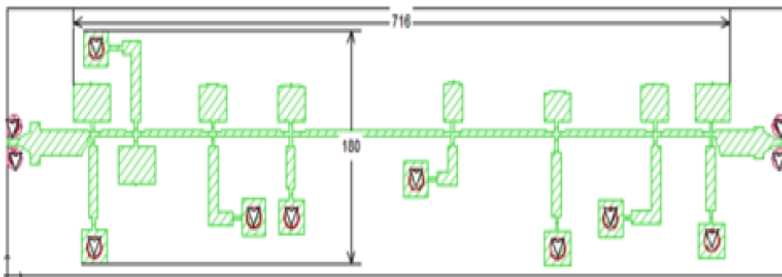
**TFLE:**

BroadBand

Spurious Free

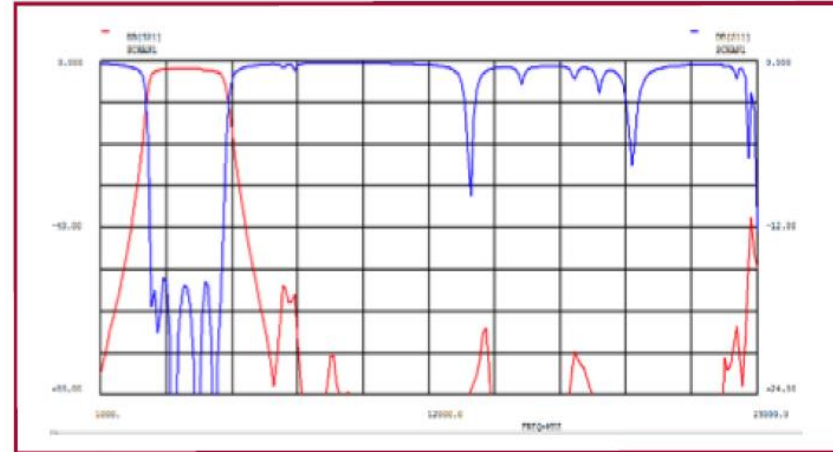
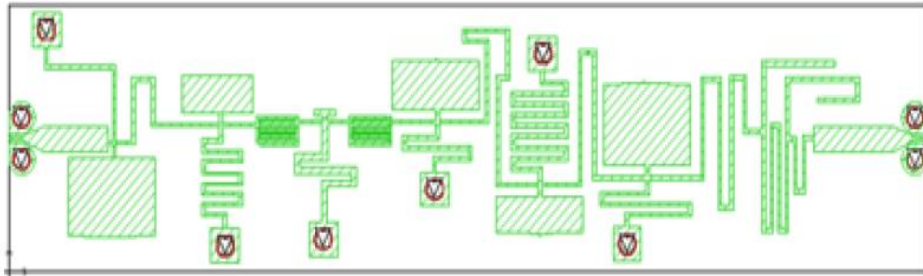
Versatile skewing factor

◆ Example:  $N=8$ ,  $F_0=10000$  MHz,  $BW=5300$  MHz

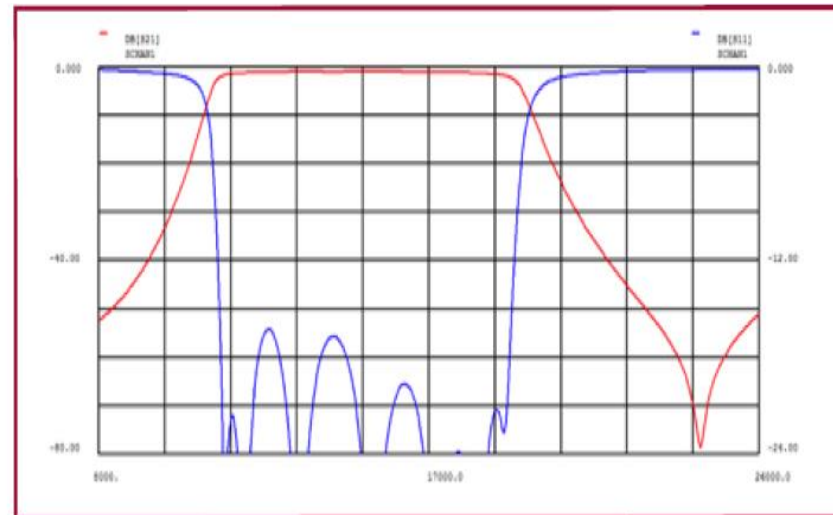
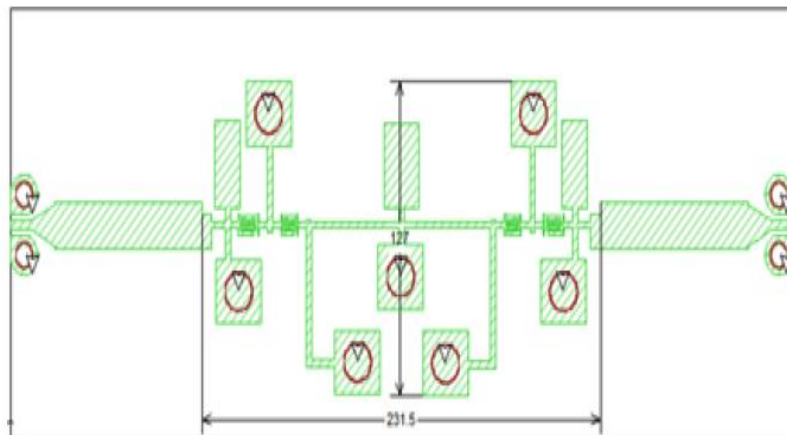


# Thin Film Lumped Equipment Filters (TFLE)

- ◆ Example:  $N=6+LPE$ ,  $F_0=3800$  MHz,  
 $BW=2200$  MHz (57.8%), Measures: .85" x .2" x .02"



- ◆ Example:  $N=7$ ,  $F_0=15000$  MHz,  $BW=6600$  MHz





# Thin Film Lumped Equipment Filters (TFLE)

## Design tools



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### Filter Wizard® Search Results

Type	Item ID	IL	inch/mm	I/O Type	Go To
Film	8AB1-7000/E4145.2-1 <a href="#">Click to Hide</a>	1.47 dBa	0.55 x 0.30 x 0.14 13.97 x 7.62 x 3.56	Launch ‡	<a href="#">Details »</a>
Film	5TFA11-7000/T3500-1 <a href="#">Click to Hide</a>	1.33 dBa	0.49 x 0.32 x 0.14 12.34 x 8.05 x 3.56	Launch ‡	<a href="#">Details »</a>

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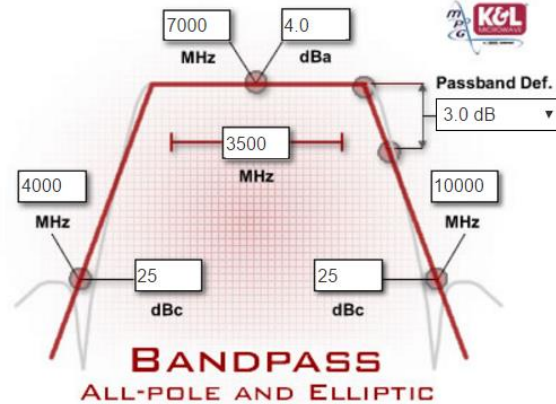
[Show All](#)

# See Details screen for connector types other than default.  
& See Details screen for interface options.  
‡ See Details screen for launch type and cover options.

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Revised: 03/24/2017

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# Thin Film Lumped Equipment Filters (TFLE)

## Filter Wizard® Part: 5TFA11-7000/T3500-1

This part is a product of [Dover Corporation's Microwave Products Group](#). Click [here](#) for information on all K&L Microwave® brand product offerings.

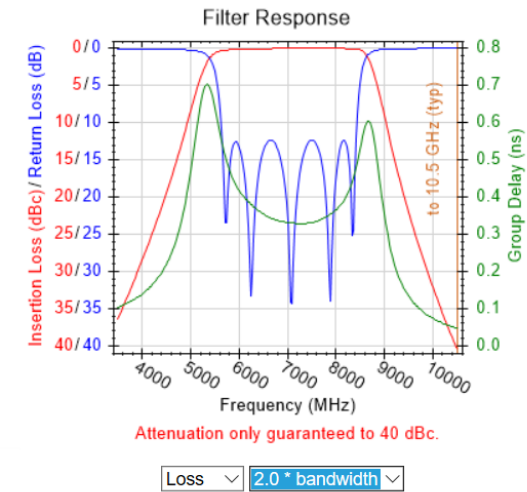
### Cover, SMT Bonding Method, and Launch Options

K&L's Thin Film Lumped Element (TFLE) on Alumina parts require a cover for proper performance. Two Surface Mount Technology (SMT) bonding methods (solder and epoxy) and four end launch options are offered here. Hover the cursor on a launch option image for more information. Please contact the factory for further customization.






	Spec:	Typical:
Center Frequency:	7000 MHz	7084.4 MHz
3.0 dB Bandwidth:	3500 MHz	3500.0 MHz
Insertion Loss:	1.5 dBa	1.33 dBa
Stopband Atten. (4000 MHz):	25 dBc	28.50 dBc
Stopband Atten. (10000 MHz):	28 dBc	32.10 dBc
Filter Type:	Thin Film	
Spec Return Loss:	9.5 dB (2.0:1 VSWR)	
Typ Ult Rej:	10500 MHz	
Inches:	0.49 x 0.32 x 0.14 inches	
Millimeters:	12.34 x 8.05 x 3.56 mm	

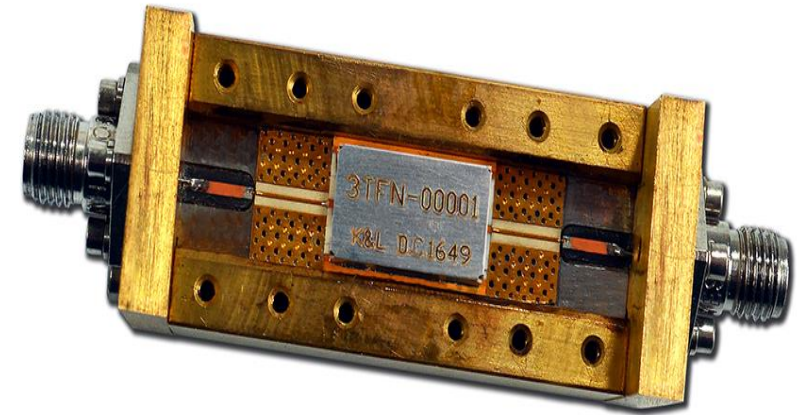


# Thin Film Lumped Equipment Filters (TFLE)



## End Product Fully optimized for customer's PWB Transition

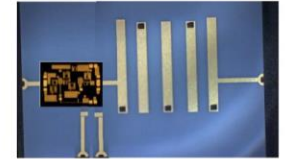
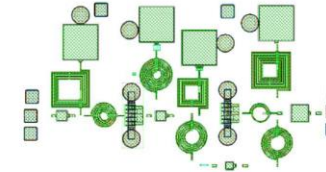
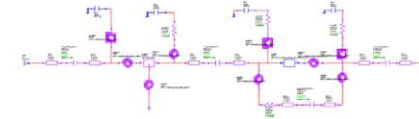
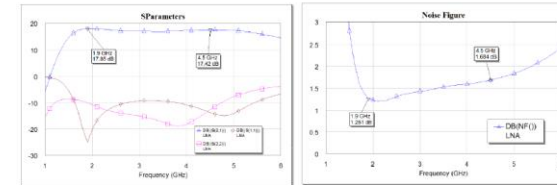
- PWB information is exchanged
- Mismatch is analyzed on CST and optimized to match into 50Ω.
- Filter is designed in 50Ω system using Sonnet.
- The design is optimized accounting for the cascading of the S-parameter mismatch.
- Final Test fixture is made



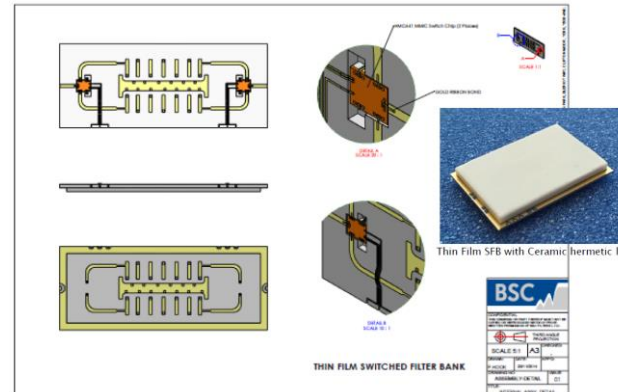
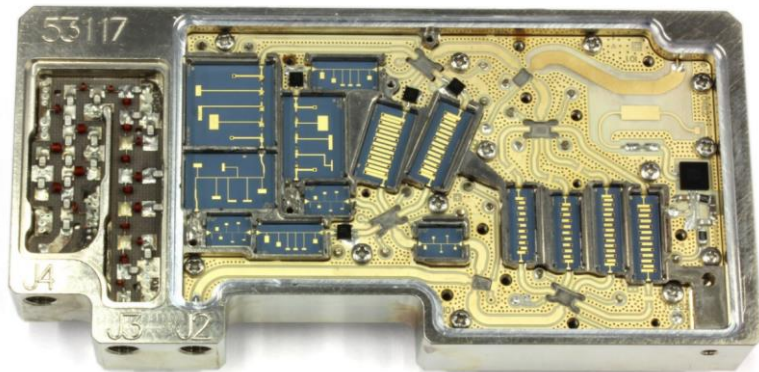
# Thin Film Lumped Equipment Filters (TFLE)

## Applications:

- GPS Guided missile applications
- EW Airborne fighter jet requirements
- Satellite FM model filters where weight and volume are restricted.
- AESA Radar T/R Module or element array



Nominal 3dB passband :	2-4GHz
Passband Gain @ Fo	15dB
RL (in/out)	10dB
Rejection	
1GHz	35dBc
4GHz	40dBc
NF	2dB
Output P1dB	+15dBm min
IP3 +24dBm	
Recovery TBD	
Max Input power Survival	+37dBm
Max output power	+25dBm (TBA)
Size:	15x10x1.5mm
Supply	10V @ 60mA





Questions?  
Comments?

Find us at booth #17

