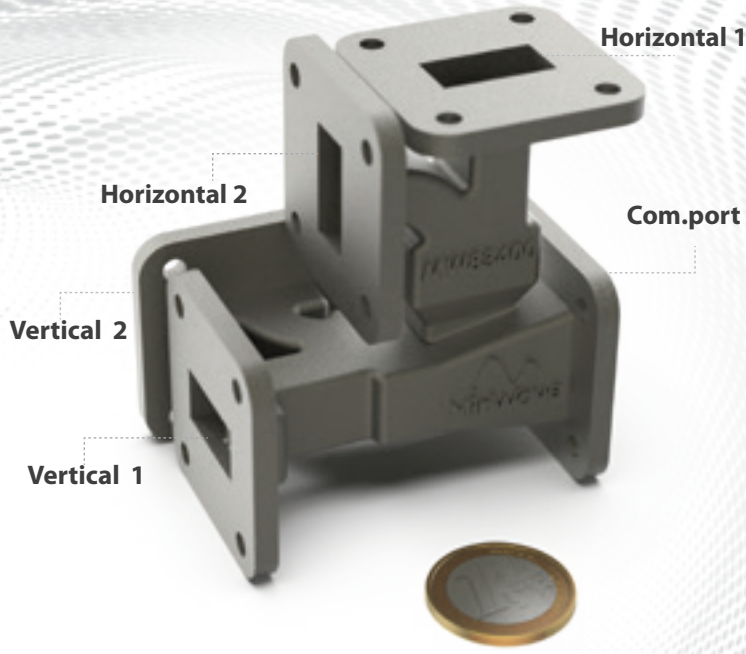
MinWave

Miniaturized Microwave Solutions

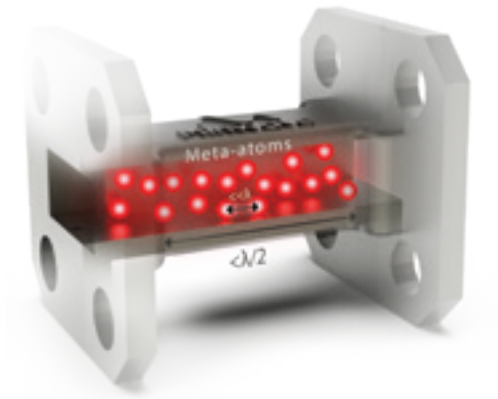


MinWave core technology

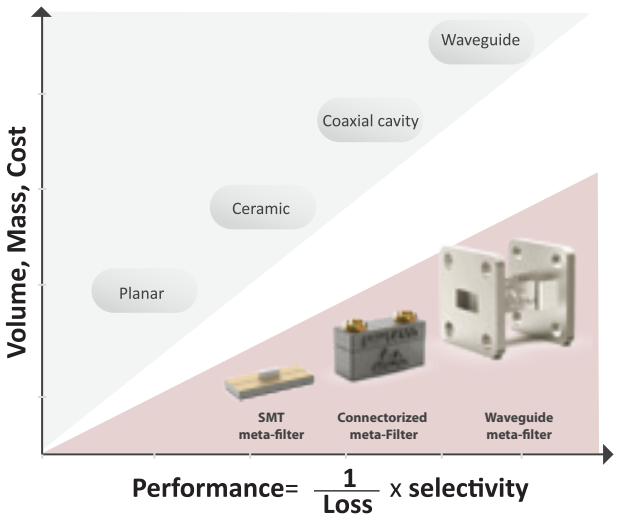
MinWave employs patented cutting-edge metamaterial wave engineering methods to develop ultra-compact, low-loss, and lightweight RF front-end (RFFE) solutions to reduce the cost/bit in Telecom and Satcom. We offer a wide range of custom and standard devices compatible with various interfaces, such as waveguide, surface mount, and coaxial ports.

MinWave meta-devices

MinWave designs and manufactures RF front-end solutions, such as filters, antennas, and filtering antennas, based on novel metamaterial wave engineering methods. The **MinWave** artificial structure can filter and radiate the waves in a deep subwavelength scale. It also provides sharp selectivity, high rejection level and wide band rejection. The **MinWave** low-loss miniaturized meta-waveguide devices and integrated systems offer a superior alternative to traditional filters, such as cavities, planar and ceramic filters, and antennas.



Minwave technology = $\underbrace{\varepsilon \leq 0 \text{ or } \mu \leq 0}_{\text{Sharp selectivity}} + \underbrace{\text{sub-}\lambda}_{\text{Miniaturized low loss}}$



Products

- Filters: standard and non-standard waveguide ports, Coaxial connectors and SMT packages
- Diplexers/ Multiplexers
- Integrated modules: Ortho-mode transducers (OMT), antenna feed assemblies and feed chain
- Impedance/interface Transitions

Market

- 4G and 5G Radios in LTE, FR1 and FR2
- Satcom applications for L-band to Ka-band
- Point to point links
- mmWave consumer devices

Manufacturing

MinWave develops components and appropriate fabrication methods based on the application. We have experiences in customizing SLM (metal 3d print), casting, and CNC machining to fabricate devices to meet the space and telecommunication industry's needs. Furthermore, we are working with experienced partners to utilize the appropriate manufacturing methods to provide integrated and high-quality RF front-end solutions for various applications.

MinWave RF front-end solutions

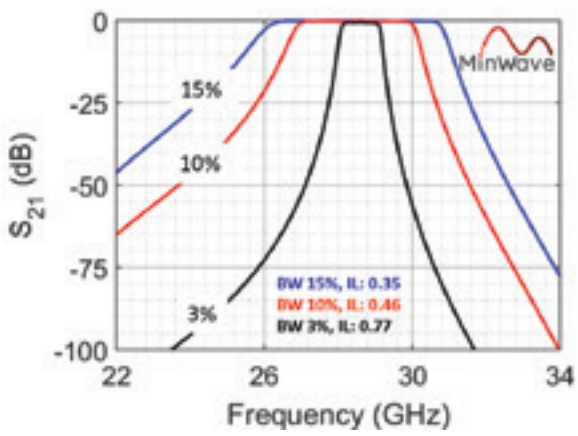
Customizable meta-filters

The metamaterial nature of **MinWave** filters enables customizable bandwidth (1–50%) while maintaining low insertion loss, very high-quality factor, and fixed sub-λ (miniaturized) total length of the filter. Furthermore, **MinWave** metamaterial designs introduce higher-order poles and a stack of zeros to regulate the selectivity without a considerable change in the footprint.

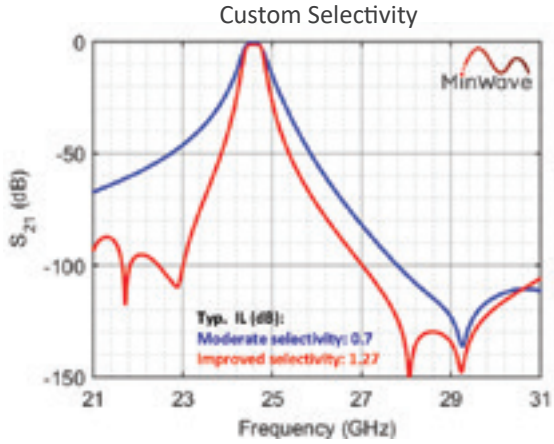
Key features:

- Ultra-small (sub-λ) footprint
- Customizable bandwidth (1 - 50%)
- Sharp roll-off and high selectivity
- High quality factor and low insertion loss

Custom bandwidth

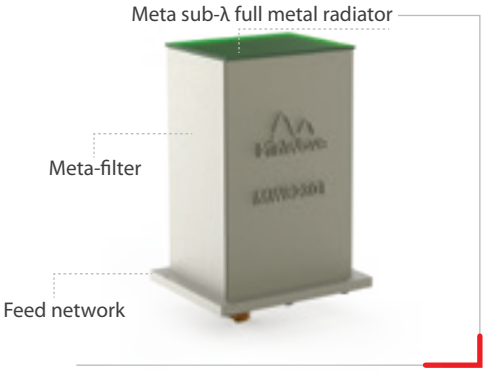


Custom Selectivity



Connectorized and integrated RF components

MinWave has developed various connectorized solutions with various coaxial connectors and surface mount techniques (SMT). Furthermore, integrated meta-filters and antennas for lower loss and passive intermodulation risk are a must for modern high-quality systems. We have developed integrated meta filtering antennas to reduce the cost and increase the quality of the RF front-end.



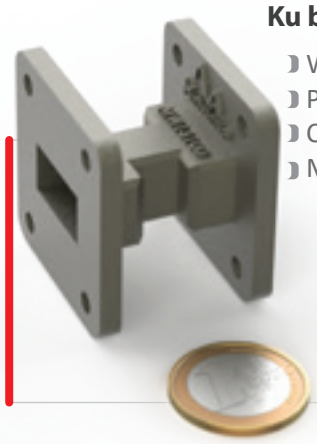
Meta filtering antenna

SMP meta filter

SMT meta filter

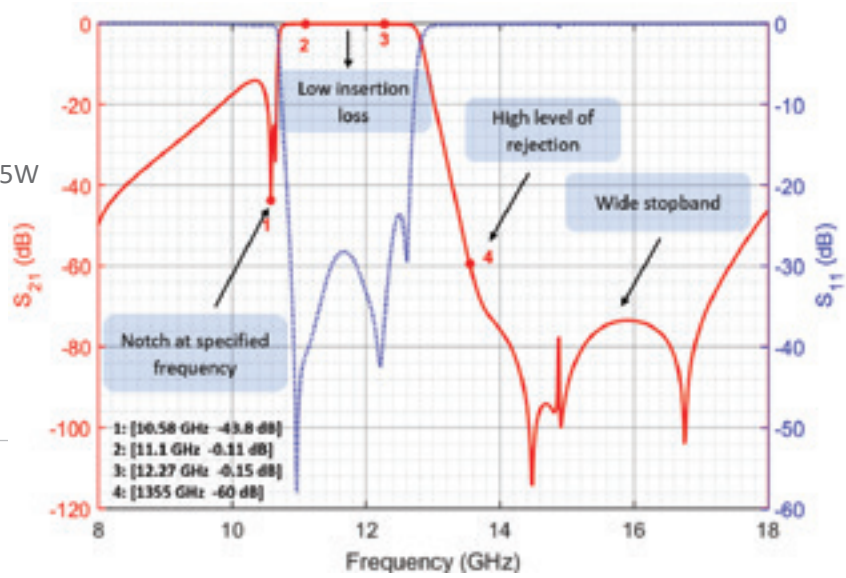
MinWave metamaterial filters

MinWave designs and manufactures RF front-end solutions from C band to Ka-band. Our technology is based on a novel metamaterial filter with low insertion loss, high selectivity, high rejection, and wide stopband. Due to the metamaterial nature of the designs, the passband has a sharp roll-off with a deep level of rejection. To improve the selectivity of the pass band and/or maximize the rejection at a specific frequency, a single or stack of TZs can be added at the appropriate frequencies without increasing the footprint. Our filters are compatible with waveguide ports, and coaxial as well as surface mount interfaces.



Ku band filter

- WR75 ports
- Peak power: 230W
- Continuouspower: 65W
- Multipaction free



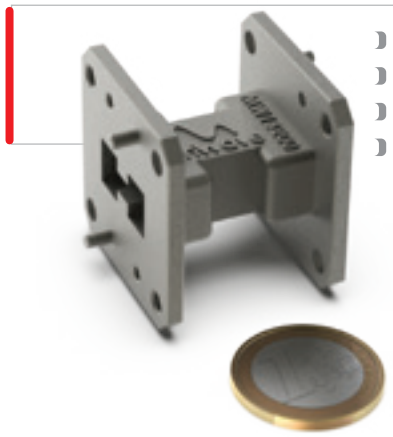
Product features:

- Very small footprint
- Ultra-lightweight
- Low insertion loss
- Sharp roll-off
- Wide stop band
- No tunning screws
- Customizable frequency and bandwidth
- Customizable interfaces and pipe shapes

Ku band bent filter

- WR75 ports
- Sharp bend
- Ultra-small footprint for monolithic assembly
- Low insertion loss

Double ridge Ku-band filter



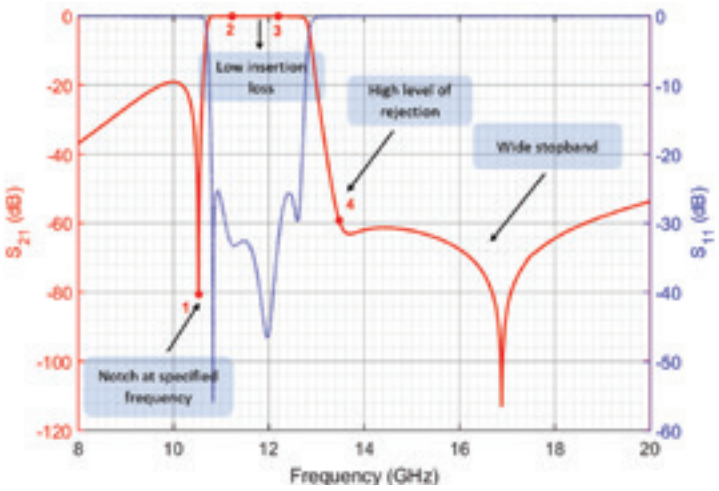
- WRD750 ports
- Low insertion loss
- Wide stopband
- Ultra-compact

Ka band filter

- WR28 ports
- Sharp roll-off
- Low insertion loss
- Ultra-compact

Connectorized solutions

MinWave team have developed a connectorized version of filters with smaller footprint especially for 4G and 5G telecommunications. However custom solutions from C band to Ka-band are available, which are considerably smaller and lighter than conventional coaxial filters and more power efficient than ceramic filters. As in waveguide versions, the sharp roll-off of Minwave filter can improve the spectral efficiency, required by telecom operators.



Ku band

- SMA ports
- Low insertion loss
- Sharp roll-off
- Ultra-compact

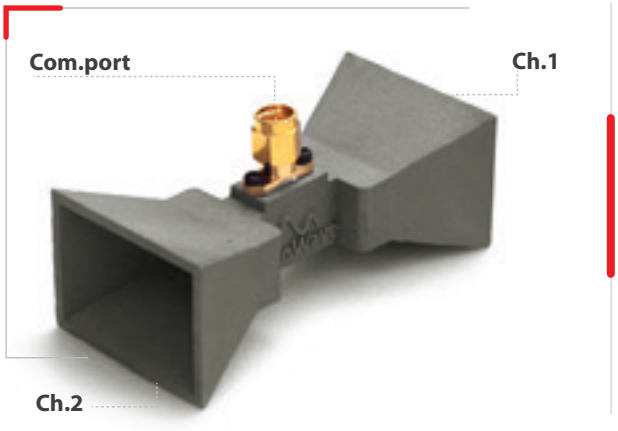
Diplexers/ Multiplexers

Taking advantage of our miniaturized lightweight filters novel designs, we develop other passive devices and RF front-end modules such as diplexers and multiplexers in wide range of frequency bands. Thanks to the use of the additive manufacturing method, complex integrated miniaturized geometries are fabricated at **MinWave.**

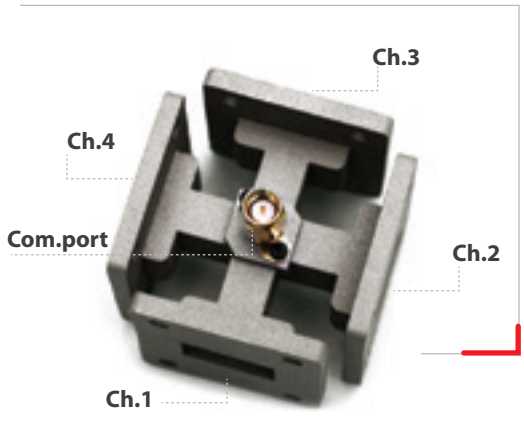
Product Features:

- Magnified miniaturization
- Monolithic assemblies
- Less dissipation
- Custom interfaces

Ku band Diplexer

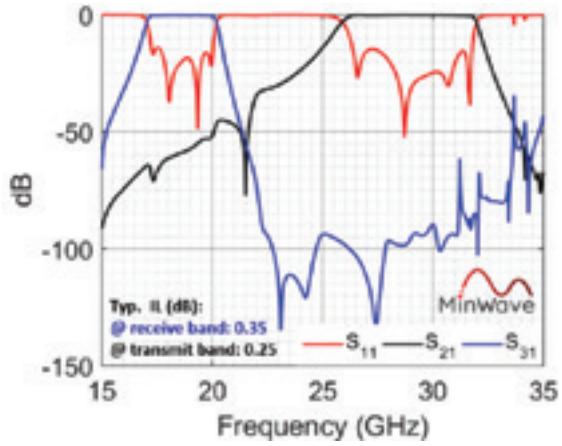


Ku band Multiplexer



K-band non-continuos channels diplexers

MinWave produces ultra-compact duplexers for non-contiguous channels at the K band, for space and terrestrial terminals of high throughput satellites developed based on our techniques. This product enables merging receive and transmit antennas with in small RF front-end systems.



Waveguide K band duplexer
(17-21GHz , 27-32GHz)

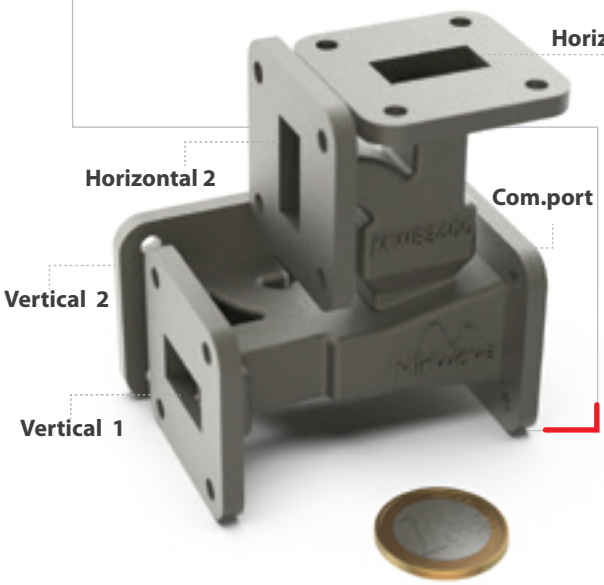
K band diplexer with SMP connectors
(17-21GHz , 27-32GHz)

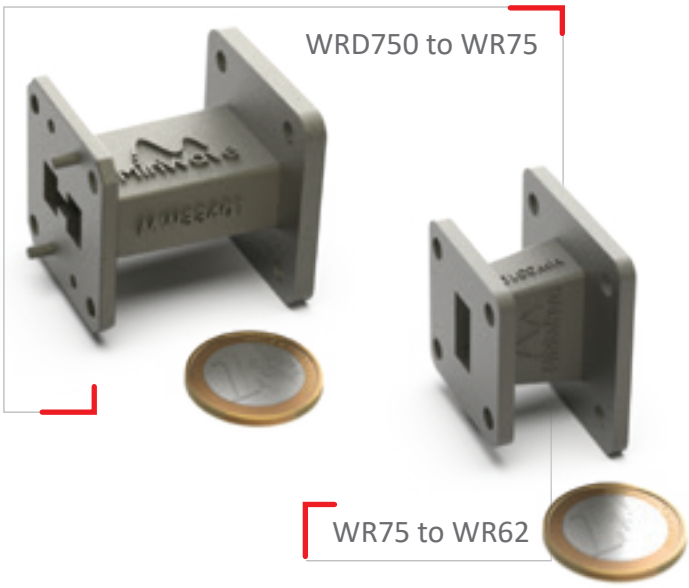
Integrated modules

MinWave's design group designed different options of integrated modules including OMT, feed assemblies and feed chain. Since these modules are integrated in one single device, they offer less power dissipation and passive inter modulation (PIM) levels while they are very compact in size and are lightweight.

- WR75 ports
- Monolithic assembly
- Ultra-Compact
- Less dissipation
- Dual-polarized
- Double frequency band

Miniaturized TX/RX monolithic feed assembly





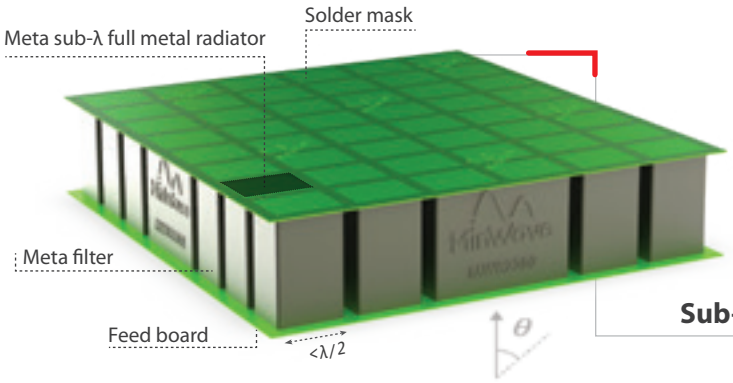
Transitions

MinWave offers various types of ultra-compact transitions with low loss including:

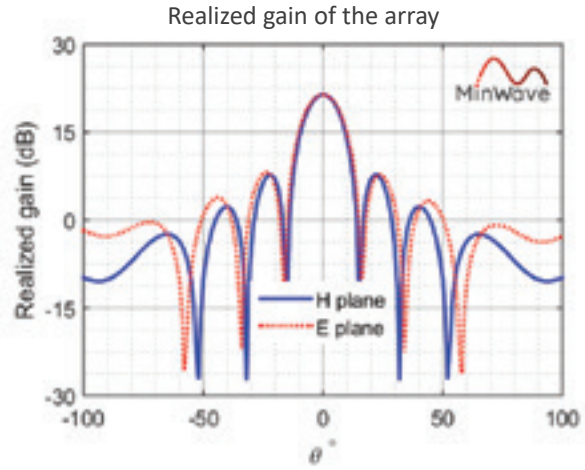
- Standard waveguide to standard waveguide
- Non-standard waveguide to standard waveguide
- SMA to standard waveguide
- SMA to non-standard waveguide

Meta-filtering antenna array

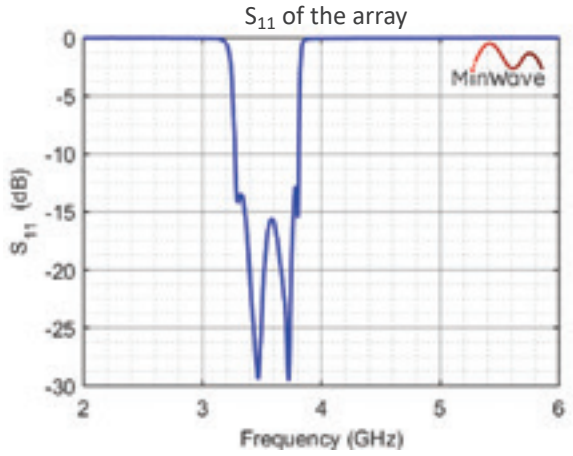
MinWave integrated filtering antenna is designed to provide superior performance in crowded environments from C-band to Ka-band. Each antenna element in the array is monolithically integrated with the small meta-waveguide filter to reduce the cost and risk of PIM. It allows low loss, high spectral efficiency, high gain, and throughput in a small footprint (<λ/2xλ/2). It also provides sharp selectivity and high-level rejection as an alternative for coaxial cavity and ceramic filters that eliminates interference, while it can also radiate with high gain. As an example, the C-band meta-filtering is presented here, which can be used with coaxial connectors or mounted on PCB with a small footprint.



Realized gain of the array



S_{11} of the array



Sub-6 GHz meta-filtering antenna

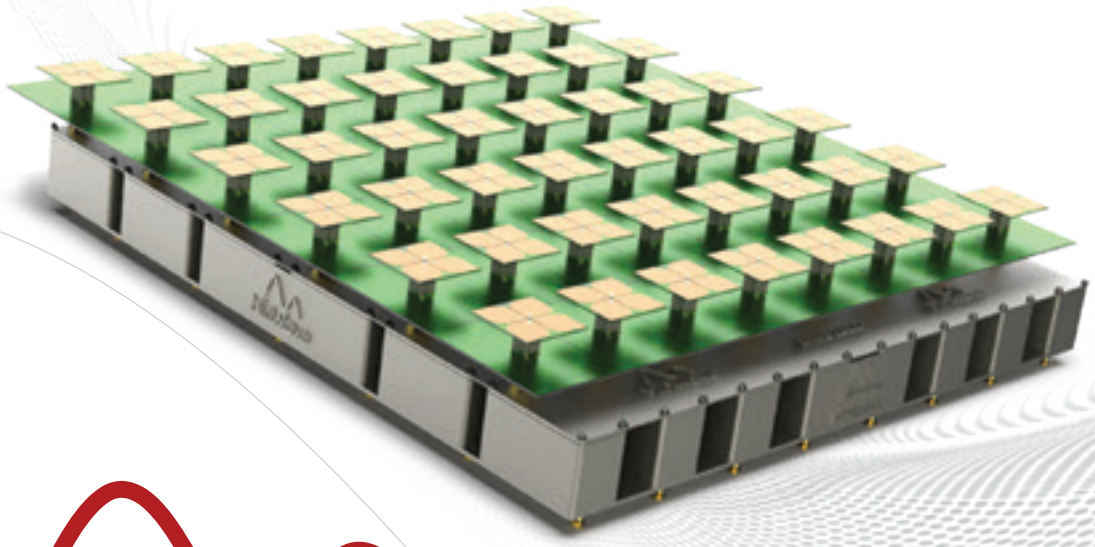
K-band meta-filtering antenna

This is a panelized metallic K-band metamaterial filtering antenna based on an array of subwavelength waveguide-based filters for LEO high throughput satellites. The array can be fed by coaxial connectors or mounted on PCB with a footprint <0.5x and a length 10x smaller than conventional waveguide arrays. Both linear and circular polarization versions are available.

Meta-filtering antenna array

Key Features:

- Merging filtering and antenna with sharp selectivity
- Low loss using a full-metal structure
- Subwavelength meta-filtering and small size
- Highly steerable beam using a subwavelength array (<λ/2 is possible)
- Low insertion loss and assembly loss Linear and switchable left- and right-hand circular polarization
- Low-cost by monolithic fabrication of the array and filters



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