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Making the Millimeterwave Technology More Accessible
让毫米波技术成为触手可及

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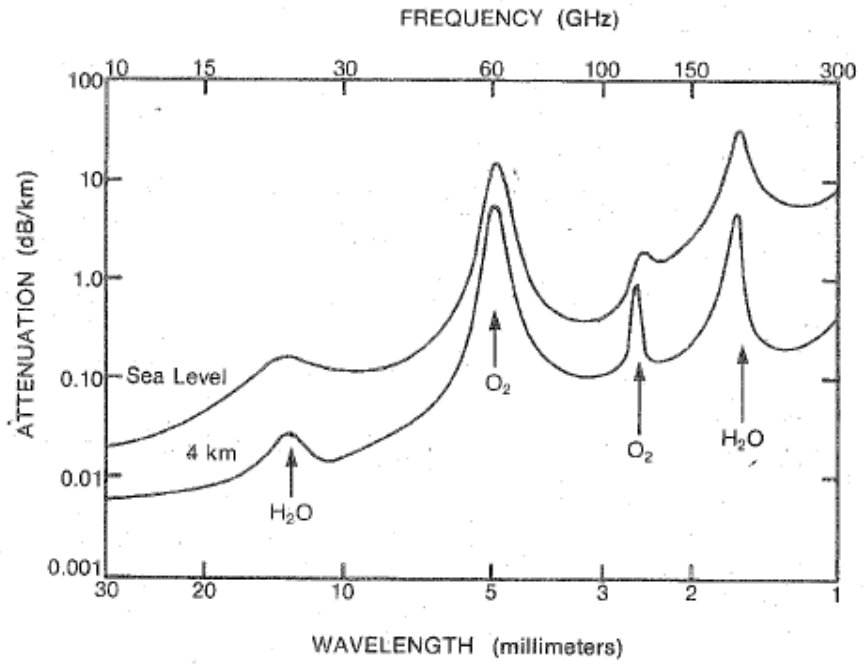
- Millimeterwave and Millimeterwave Technologies
- System Integrators' Challenges
- Making the Technology More Accessible:
  - Components and Modules (COTS)
  - Waveguide Connectors for Packaging
  - Testing and Accessories
- Conclusions

Millimeterwave and Millimeterwave Technologies

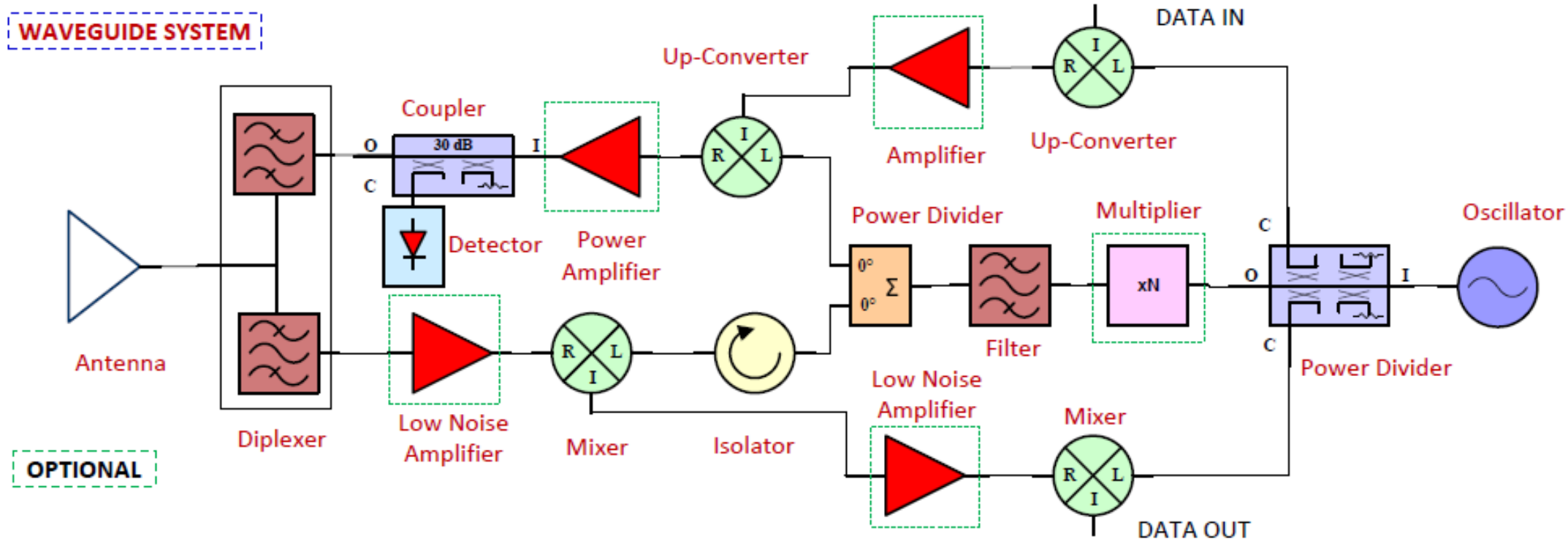
Frequency Coverage: 30 to 300 GHz

It is not a brand new technology, but it is also not a mature technology. It requires continuously improvements to reach higher frequency, better performance and lower cost so that it further its traditional and new applications.

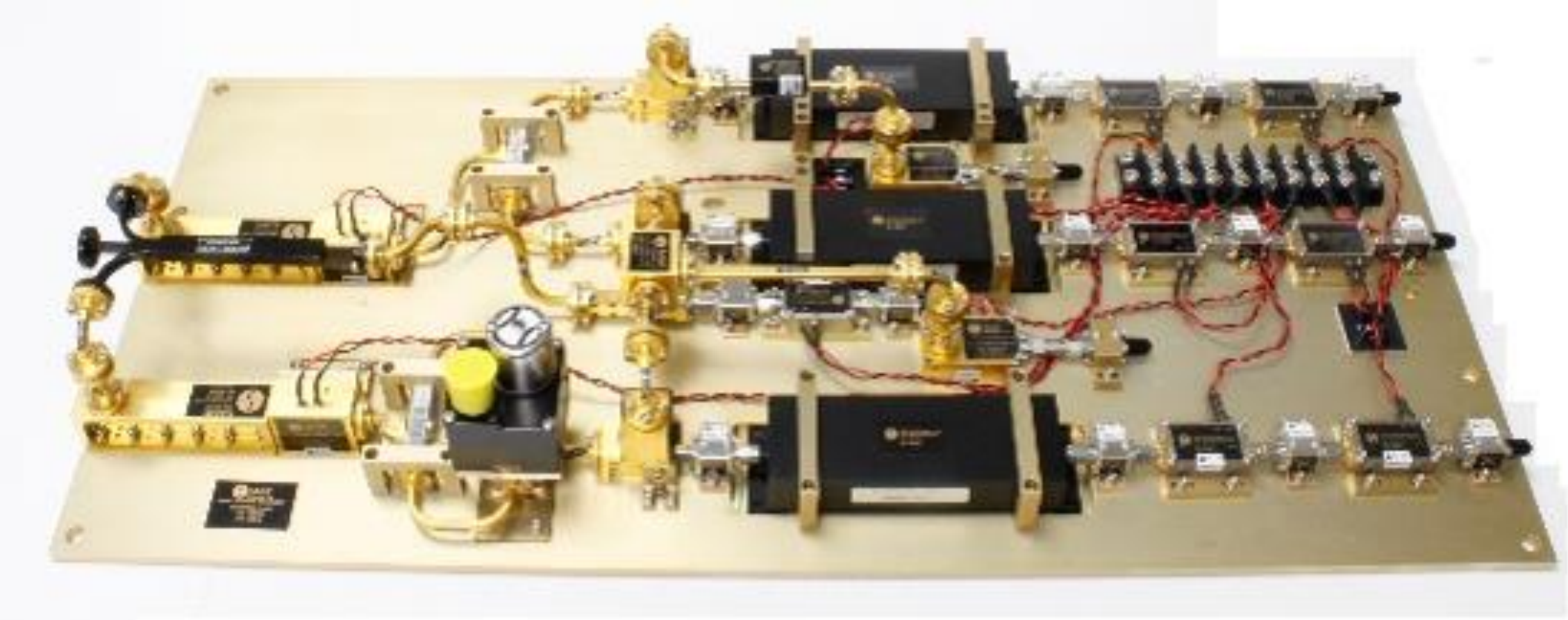
- Traditional Applications: Science, Aerospace and Military.
- New Applications: 5G, 6G, IoT, NewSpace, Automotive, Traffic Management, Industrial, Commercial and Consumer Systems, etc.
- Continuously finding new applications: AI, Medical System, Material Science, etc.



System Integrators' Challenges



System Integrators' Challenges



System Integrators' Challenges

- The challenges have been limiting the accessibility and affordability of the technologies.

  The high entry barrier may limit it to find the new applications and large scale implementations.

  - Few standard building blocks available, led to custom designed products, requiring
    - High cost
    - Longer development cycle
    - Experienced, knowledgeable and high skill level workers
  - High manufacturing cost
    - Expensive test equipment
    - High test uncertainty

More Accessible: Components and Modules

- **Several industrial leaders have developed some standard modular products, but only Eravant offers the full range of commercial-off-the-shelf (COTS) products to cover the millimeterwave spectrum, 30 to 300 GHz, from antenna, amplifiers to passive components.**
  - **Eravant offers the most standard COTS millimeterwave components to the market covering 18 to 300 GHz. Its offering includes 10 product families.**

1. Antennas and Accessories
2. Amplifiers
3. Coaxial Passive Components
4. Frequency Converters
5. Control Devices
6. Ferrite Devices
7. Oscillators
8. Waveguide Passive Components
9. Test Equipment and Extenders
10. Sensors and Modules

More Accessible: Components and Modules

- **Other industry leaders are also offer some standard modular products with certain focus.**

  - **ACST GmbH offers the high-performance millimeter and sub-millimeterwave components to cover 50 GHz to 500 GHz.**

    1. **Passive Multipliers**
    2. **Active Multiplier Chains**
    3. **Mixers**
    4. **Detectors**
    5. **THz Horn Antennas**
    6. **THz Waveguide Components**
    7. **Modules**

More Accessible: Components and Modules

- **Other industry leaders are also offer some standard modular products with certain focus.**
  - **Virginia Diodes offers the high-performance millimeter and sub-millimeterwave components to cover 40 to 540 GHz. It is working on to reach 880 GHz.**

1. **Schottky Diodes**
2. **Passive Multiplier**
3. **Mixers**
4. **Detectors**
5. **Amplifiers**
6. **THz Waveguide Components**
7. **THz Horn Antennas**

More Accessible: Waveguide Connectors

- **Waveguide interface is the main RF port interface for millimeterwave components and modules due to its lower loss and high-power handling. Unlike the coaxial interface, the most waveguide interfaced components and modules require custom-designed package to accommodate the waveguide ports. This process is time consume and costly.**

More Accessible: Waveguide Connectors

- **Waveguide interface is the main RF port interface for millimeterwave components and modules due to its lower loss and high-power handling. Unlike the coaxial interface, the most waveguide interfaced components and modules require custom-designed package to accommodate the waveguide ports. This process is time consume and costly.**
  - **Eravant invented the Waveguide Connector, which is similar to the field replaceable coaxial connector. This invention has greatly impacted the millimeterwave components and module packaging.**



More Accessible: Waveguide Connectors

- It is a waveguide connector. The way it is used is exactly same as a coax connector but offers the waveguide interface. Therefore, the standard glass-bead fed package can be used for either coaxial or waveguide port configurations without Electrical Engineering (EE) and Mechanical Engineering (ME) efforts. This reshapes the current microwave and millimeter-wave connectorized products' packaging technology.
  - Waveguide connector reduces the waveguide interfaced product development cycle time and cost.
  - Waveguide connector offers flexible port configurations.
  - Waveguide connector preserves hermeticity.
  - Waveguide connector improves inventory efficiency.
- All above is helping to make the millimeterwave technology more accessible and affordable.

More Accessible: Waveguide Connector

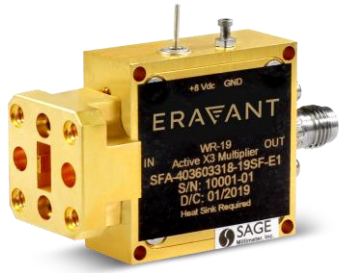
- **Waveguide connector application illustration**

One Standard Housing
Result Nine Packages

K(F) – K(F)

CO – WG (V)

CO – WG (H)



WG (V) - CO

WG (H) - CO

WG (V) – WG (V)

WG (V) – WG (H)

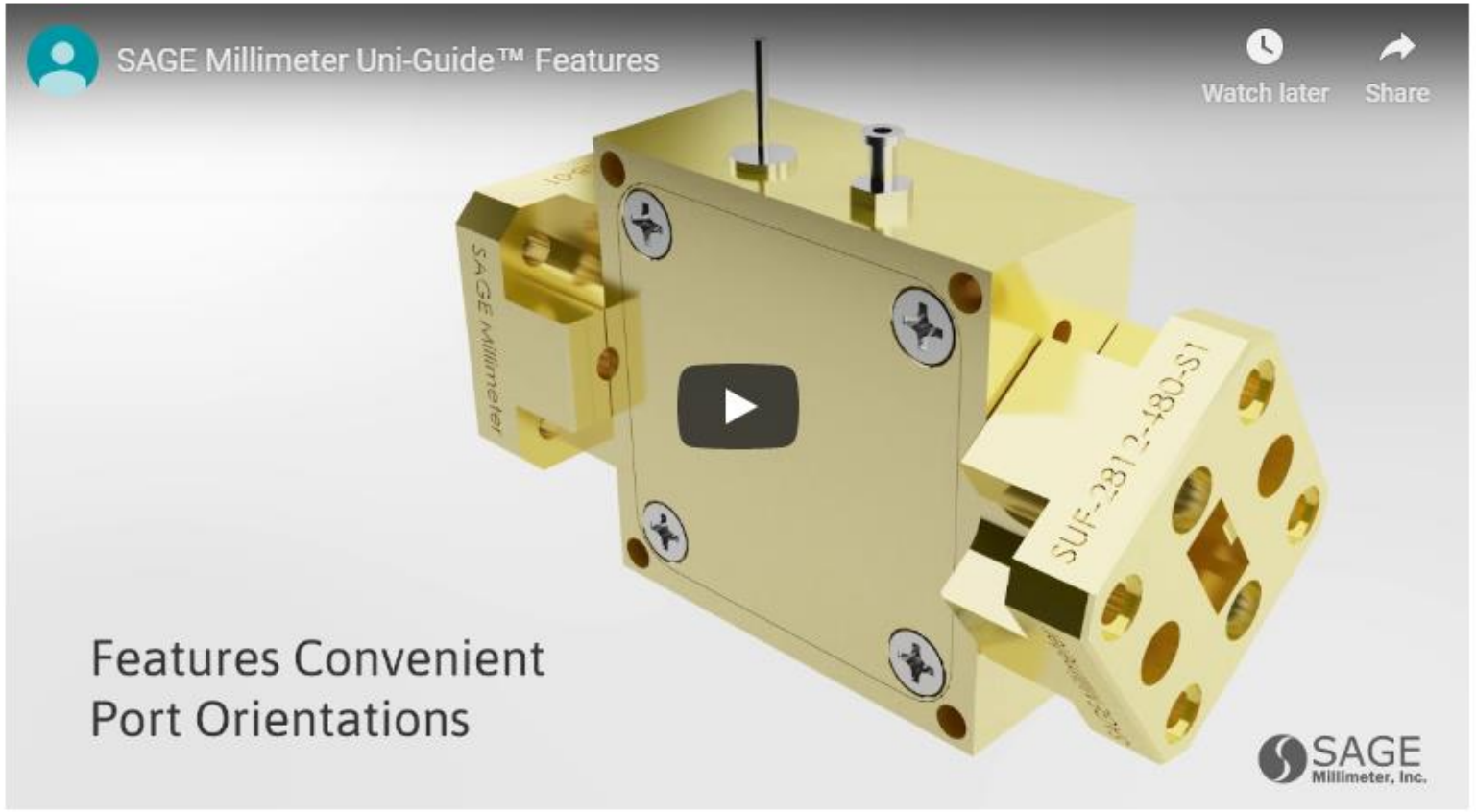
WG (H) – WG (V)

WG (H) – WG (H)

More Accessible: Waveguide Connectors

- **Waveguide connector application illustration**

Uni-Guide™ Informational Video

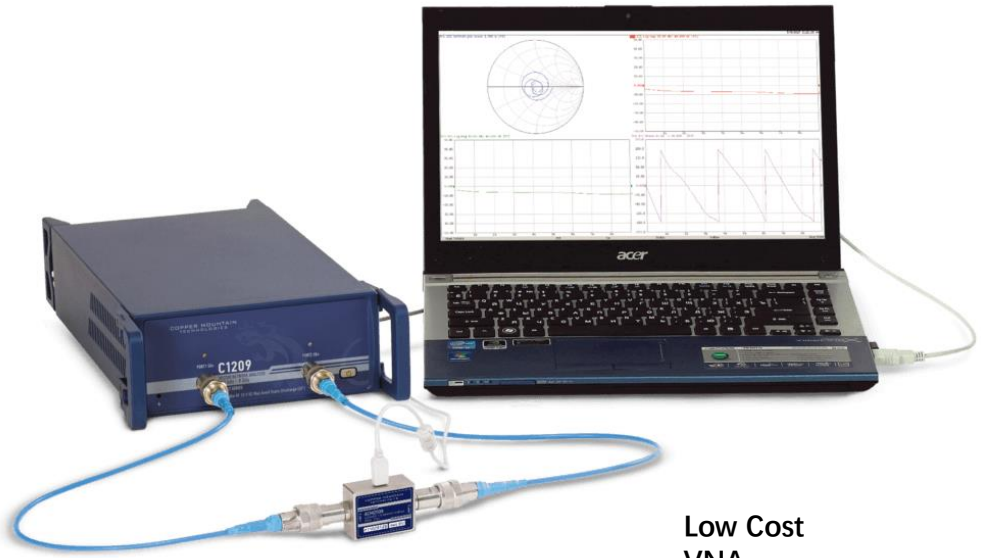


More Accessible: Testing and Accessories

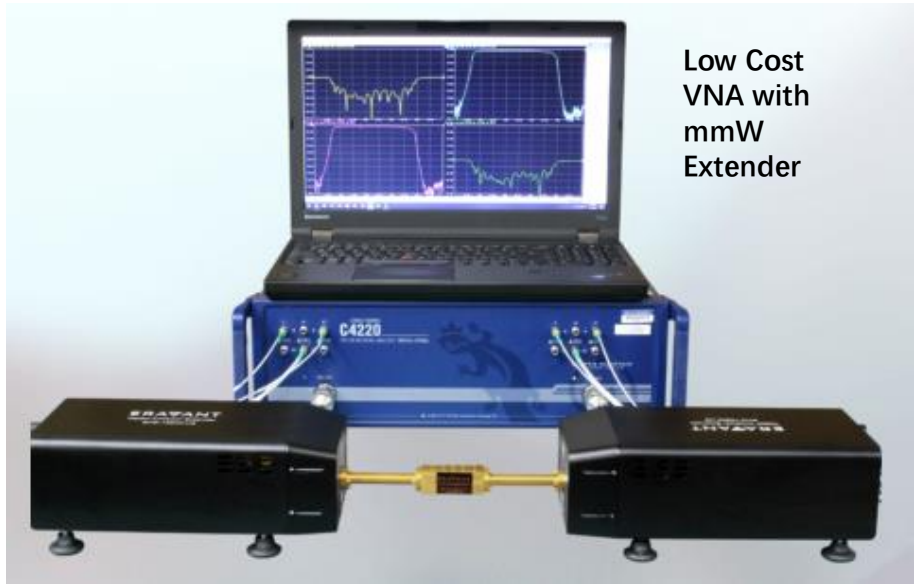
- **Testing millimeterwave component, module and system could be a challenge in the following aspects.**
  - **Expensive Test Equipment, Vector Network Analyzers (VNA), Signal Generators and Spectrum Analyzers etc. require the heavily investment.**
  - **Setup, calibration and testing are performed by experienced engineers and technicians, which could be expensive and hard to perform.**
  - **Uncertainty and repeatability and hook up time required has slowed the productivity of the millimeterwave products.**
- **Several industrial leaders have developed the low-cost VNAs and calibration kits, the frequency extenders and test accessories to cover the full millimeterwave spectrum, 30 to 300 GHz and beyond.**

More Accessible: Testing and Accessories

- **Copper Mountain offers the low-cost and software driven VNA to lower the millimeterwave [S] parameter measurement test barriers.**



Low Cost VNA



Low Cost VNA with mmW Extender

More Accessible: Testing and Accessories

- **Virginia Diodes offers the VNA extenders and frequency extenders to reach up to 1 THz.**

VNA Extender

Spectrum Analyzer Extender

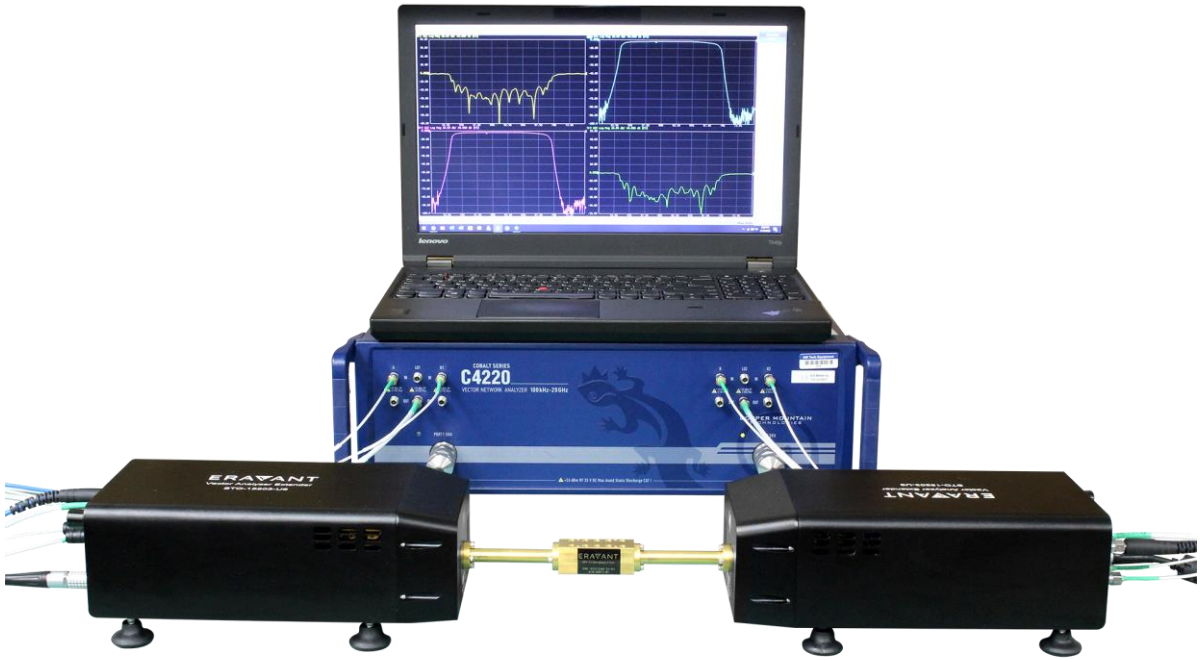
Down Converter

Frequency Extender

Power Meter

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**



VNA Extenders with Copper Mountain Model C4220 VNA to Reach 220 GHz

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

Evarant's VNA Calibration Kits cover the frequency range 18 to 220 GHz.

- Beryllium Copper for durability
- Precisely Machined
- Can offer NIST tracible calibration data and certs with additional fee.

Complete VNA Calibration kits datasheets can be obtained from Eravant Website.

VNA Calibration Kits to Reach 220 GHz

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

Frequency Extenders to Extend Frequency Generators to Reach 325 GHz

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

Frequency Down Converters to Extend the Spectrum Analysers to Reach 170 GHz

More Accessible: Testing and Accessories

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Noise Figure and Gain Test Extenders to Extend the Noise Figure Meter to Reach 170 GHz

More Accessible: Testing and Accessories

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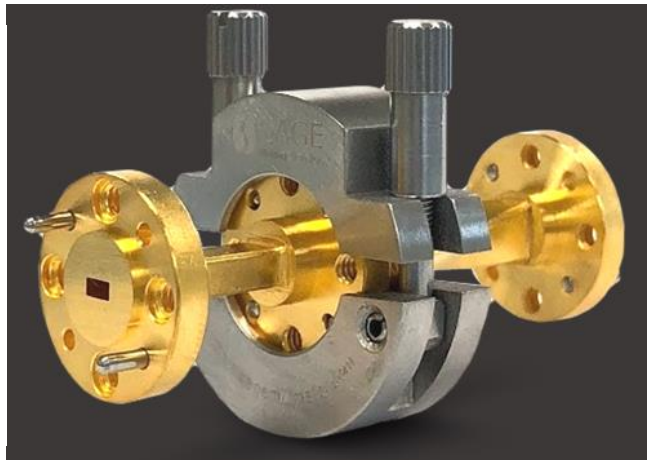

Quick-Connect to Make the Waveguide Connections Faster and More Reliable

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

Contactless Flange **(Proxi-Flange™)** to Make the Waveguide System Calibration and Product Testing More Reliable and More Accurate

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

Contactless Flange (Proxi-Flange™) with the Rail System (Wave-Glide™)
to further the millimeterwave VNA Testing Experience by Offering
Improved Accuracy, Repeatability and Productivity

More Accessible: Testing and Accessories

- **Eravant offers many innovative test equipment and accessories to further assist the millimeterwave testing and measurements.**

VIDEO

Contactless Flange (Proxi-Flange™) with the Rail System (Wave-Glide™)
to further the millimeterwave VNA Testing Experience by Offering
Improved Accuracy, Repeatability and Productivity

More Accessible: Testing and Accessories

- Millimeterwave Vector Analyzer (VNA) is a must test equipment in modern millimeterwave engineering and manufacturing process. The affordability of the millimeterwave VNA is a key limiting factor. Along with the VNA extenders, high precision and cost effective VNA Calibration Kits is also required.

- Many microwave frequency band equipment can be extended to millimeterwave by adapting the extenders, such as spectrum analyzers and noise meters.

- To test waveguide components and systems is tedious and time consuming due to ridged connections between DUT and test equipment via screws. Waveguide Quick-Connect is invented and manufactured for 50 to 325 GHz and beyond waveguide products testing to speed up the measurement process.

- Testing speed, repeatability and accuracy are the main challenges in any millimeterwave engineering and manufacturing products process. It is especially true when the frequency reaches 50 GHz and above. The new invented, patent pending and trademarked test apparatus Contactless Flange/Rail, will cause a significant update of millimeterwave testing world.

Conclusions

- **The standard commercial off the shelf (COTS) components and sub-systems** have been providing a convenient way for system integrators or developers to configure and develop their systems for concept proof and new applications. The COTS products helped to reduce the cycle time and cost.

- **The waveguide connector (Uni-Guide™)** has offered a revolution way to the packaging technology to further reduce development cycle time and cost of the millimeterwave components and subsystems.

- **The millimeterwave frequency extenders** have offered a lower cost way to transform the low frequency (microwave) standard equipment to millimeterwave frequency up to 1 THz. This helps lowing the millimeterwave entry barriers and save huge capital investment funds.

- The millimeter test accessories, **Quick-Connect, Proxi-Flange™ and Wave-Glide™** further improves the millimeterwave products testing accuracy, repeatability and productivity, which would lead to lower the volume production cost.

All above has helped to make the millimeterwave technology more accessible and affordable.