MicroHarmonics

Superior mm-Wave Components

25-400 GHz

Who We Are

Mission

To honor God by prospering our employees and serving our customers through the advancement of mm-wave component technology

Vision

To create superior components that enable the commercialization of technology in the mm-wave spectrum

What We Do

- Micro Harmonics specializes in the design and manufacture of advanced ferrite components such as
  - Faraday rotation isolators
  - Voltage variable attenuators
  - Hybrid circulators
  - Orthomode transducers
  - Cryogenic isolators
- Our products cover every standard waveguide band from WR-28 (26-40 GHz) through WR-2.8 (260-400 GHz).

About Us

- 2008 Founded by Dr. David Porterfield
- 2008-2015 Company operated as mm-wave design consultancy
- 2015-2018 Developed mm-wave ferrite isolators and Y-junction circulators
- 2018 First ferrite components released for sale
- 2019-2021 Developed cryogenic isolators and voltage variable attenuators
- 2021-2023 Developed patented hybrid circulators
- 2018-present Global distribution and sales of mm-wave products.

2023 Metrics

Revenue

$2 million

Growth

25%

Employees

10

What Sets Us Apart

Lowest insertion loss

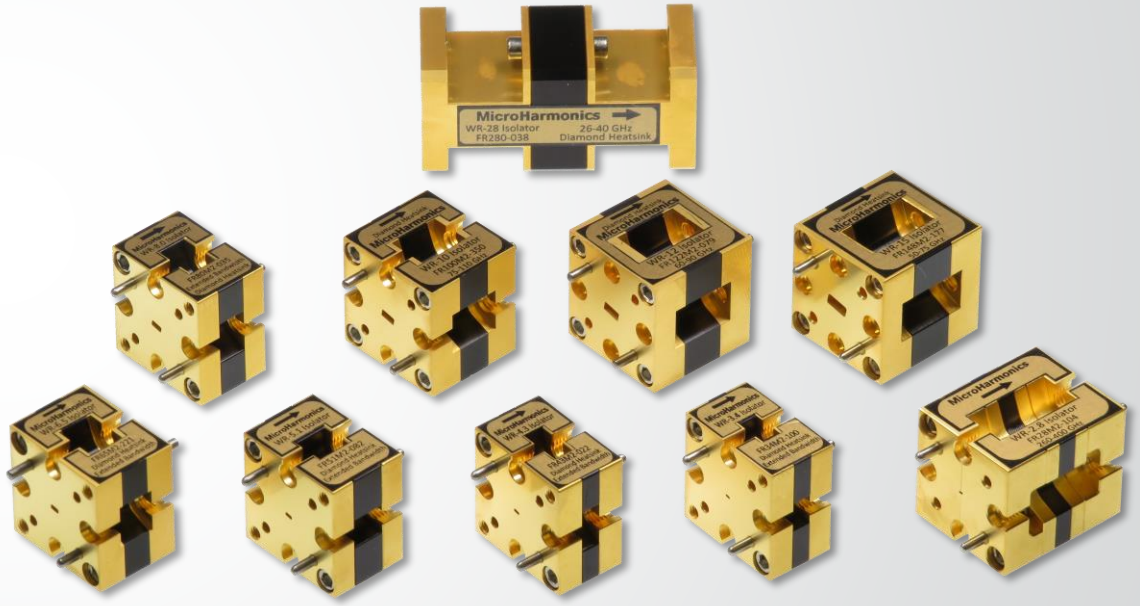
Highest power rating

RF test data for every unit

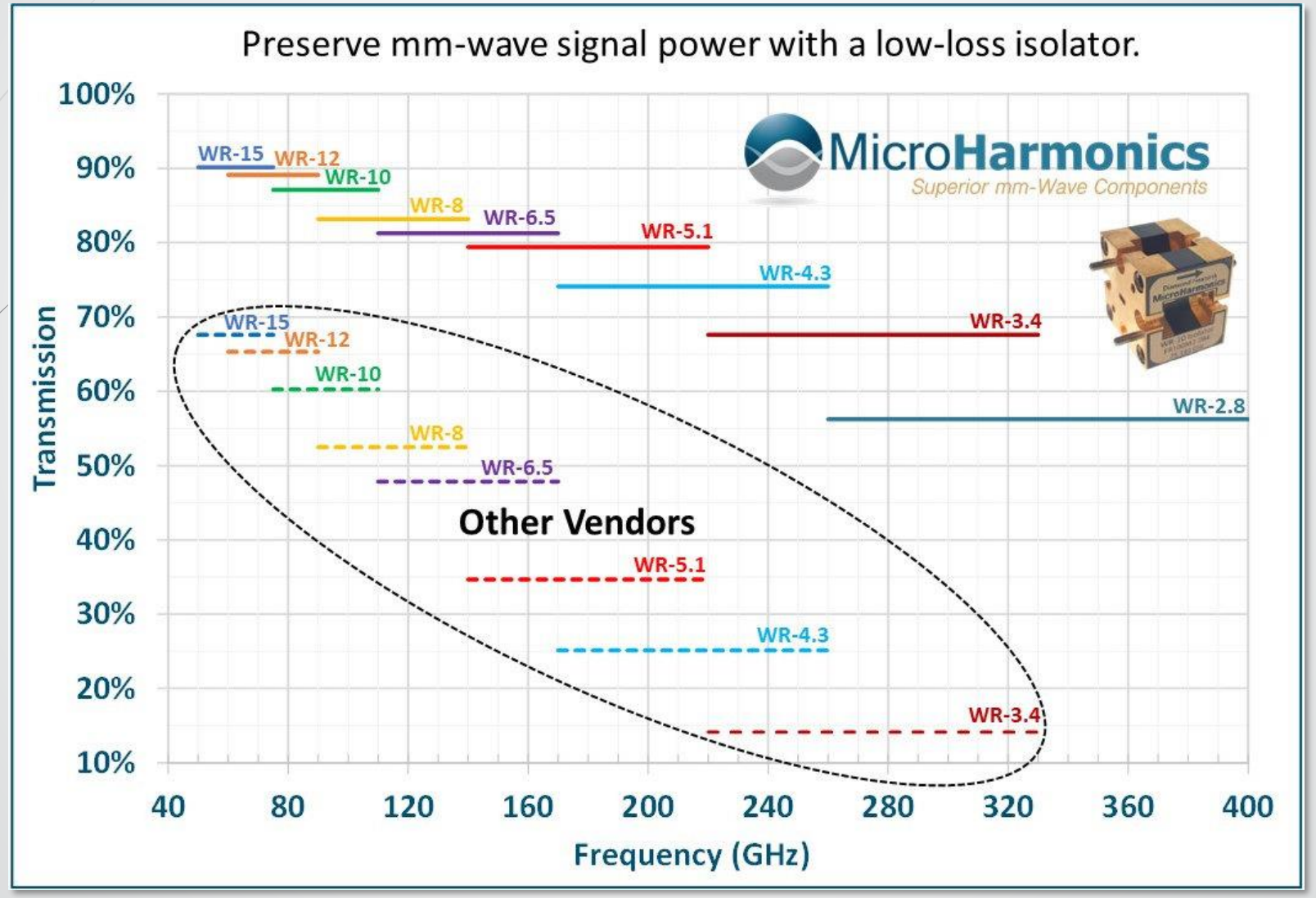
Our Guarantee: No two mm-wave components have the same exact frequency response. Unique signatures arise from small misalignments and variations in the internal parts. The differences can be substantial. Max, Min, and typical specs are helpful, but what you need to see are the actual test data for the components you are buying. Micro Harmonics tests every component across the full waveguide band on a vector network analyzer. We supply the test data to the customer at no additional cost. Don't settle for anything less.

Isolators – Overview

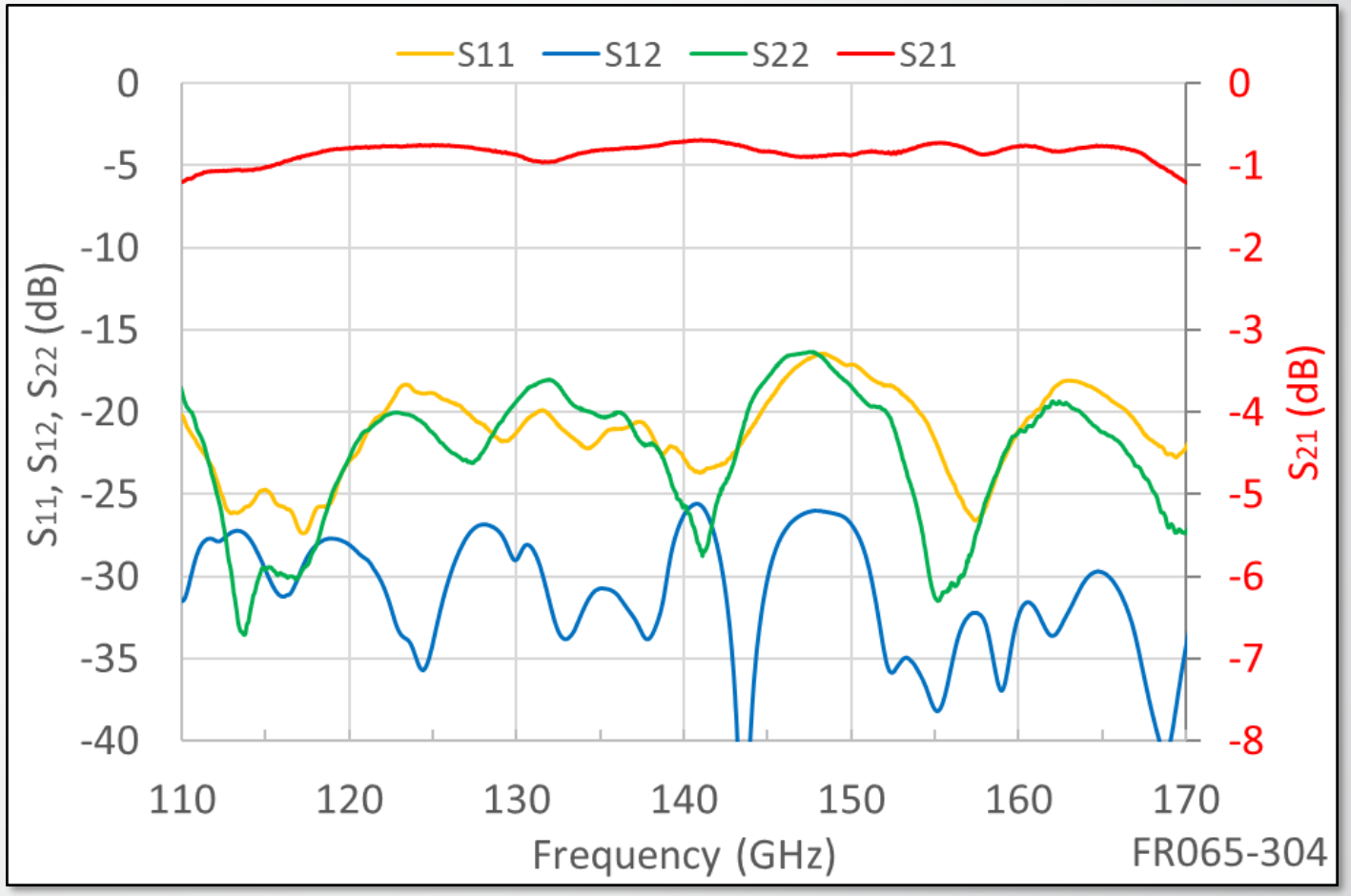
- WR-28 thru WR-2.8; 25 GHz to 400 GHz
- Anti-cocking waveguide flanges
- Comprehensive test data
- Lowest insertion loss
- High isolation
- Compact size
- Diamond heatsinks
- Resist stray magnetic fields
- Internal waveguide screw access



Isolators – Lowest Insertion Loss

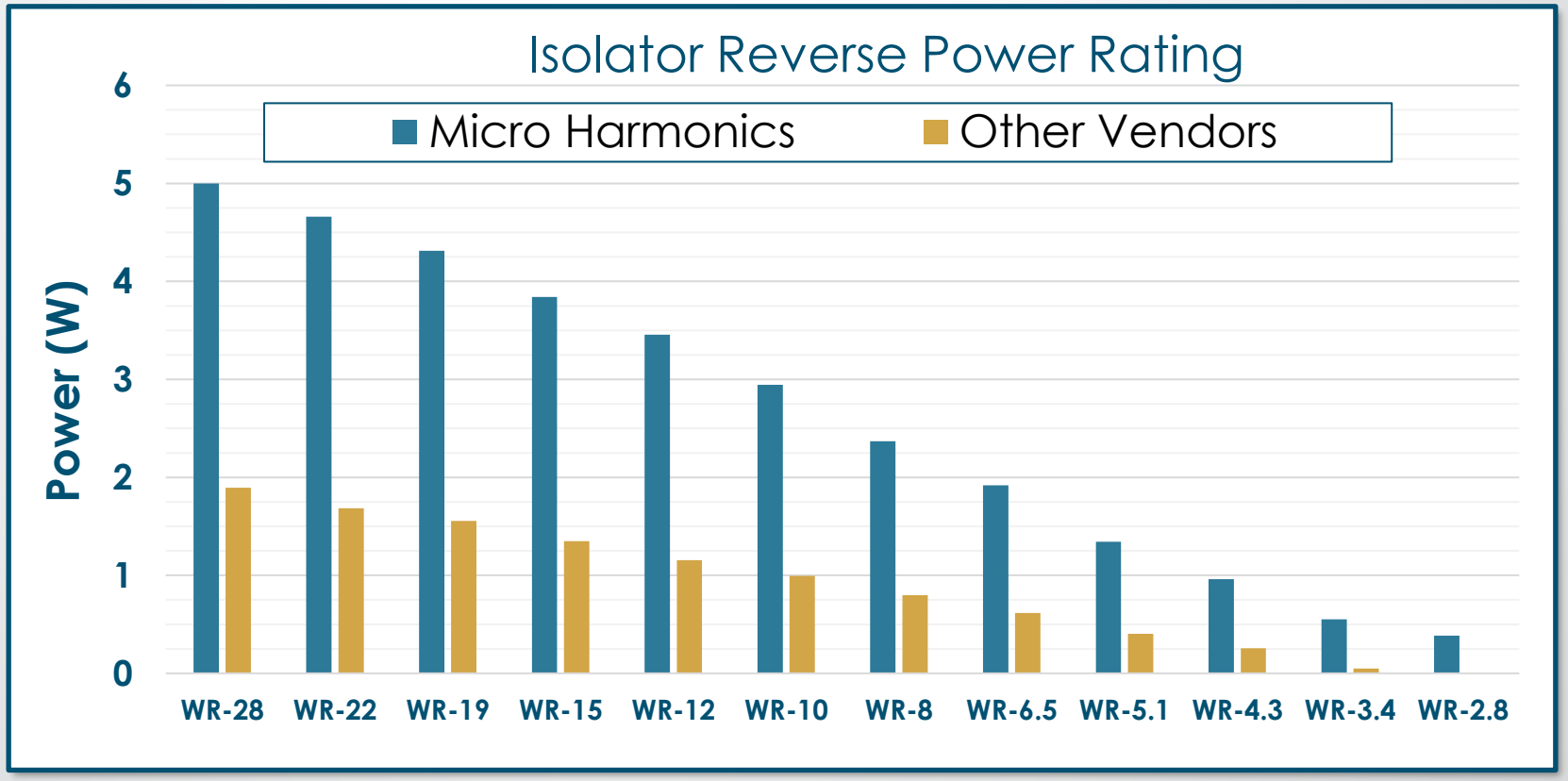


Isolators: Performance



Isolators – Highest Power Handling

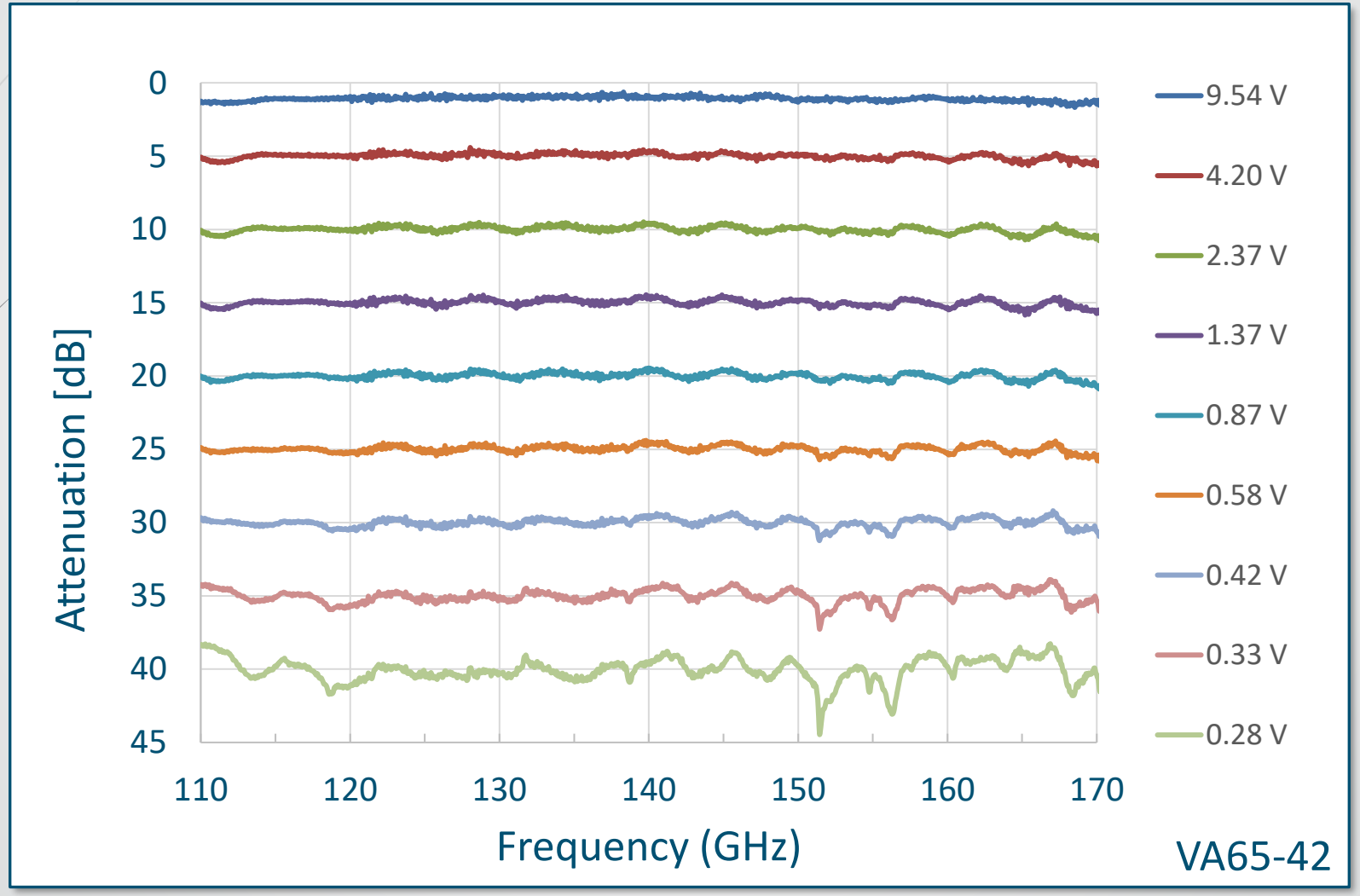
RF signals travelling in the reverse direction are absorbed in the isolator and converted to heat energy. Our isolators employ a unique diamond disc that disburses the heat and lowers the operating temperature. The graph shows the maximum reverse power ratings of our isolators (MHC) and the average of other vendors. The MHC power ratings are conservative to ensure low temperatures and long life.



Voltage Variable Attenuators – Overview

- WR-10, WR-6.5; 75 GHz to 170 GHz
- Anti-cocking waveguide flanges
- Comprehensive test data
- High dynamic range
- Low insertion loss
- Compact size
- Low VSWR

Voltage Variable Attenuators: Performance



Voltage Variable Attenuators: Comparison

- The two primary technologies used for electronically tunable attenuation in the mm-wave are PIN diode and rotary vane. A variable bias voltage applied to PIN diodes creates a variable loss mechanism. Rotary vane attenuators employ a motor driven mechanical actuator to introduce a resistive vane into a waveguide.
- Micro Harmonics Corporation (MHC) is developing a third technology that uses a Faraday rotator to rotate the RF signal into a fixed resistive layer. This is like a rotary vane attenuator but without the mechanical motion of the vane.
- MHC attenuators are passive and insensitive to ESD damage. The flat response and high dynamic range are much better than the PIN attenuators. The MHC attenuators can be scaled to at least 330 GHz. The power ratings of MHC attenuators are much higher than PIN devices. Port reflections in the MHC attenuators are significantly lower than those in the PIN devices. The insertion loss of the MHC attenuator is lower than the rotary vane or PIN attenuators. And finally, the MHC attenuators do not generate any measurable noise or harmonic content.

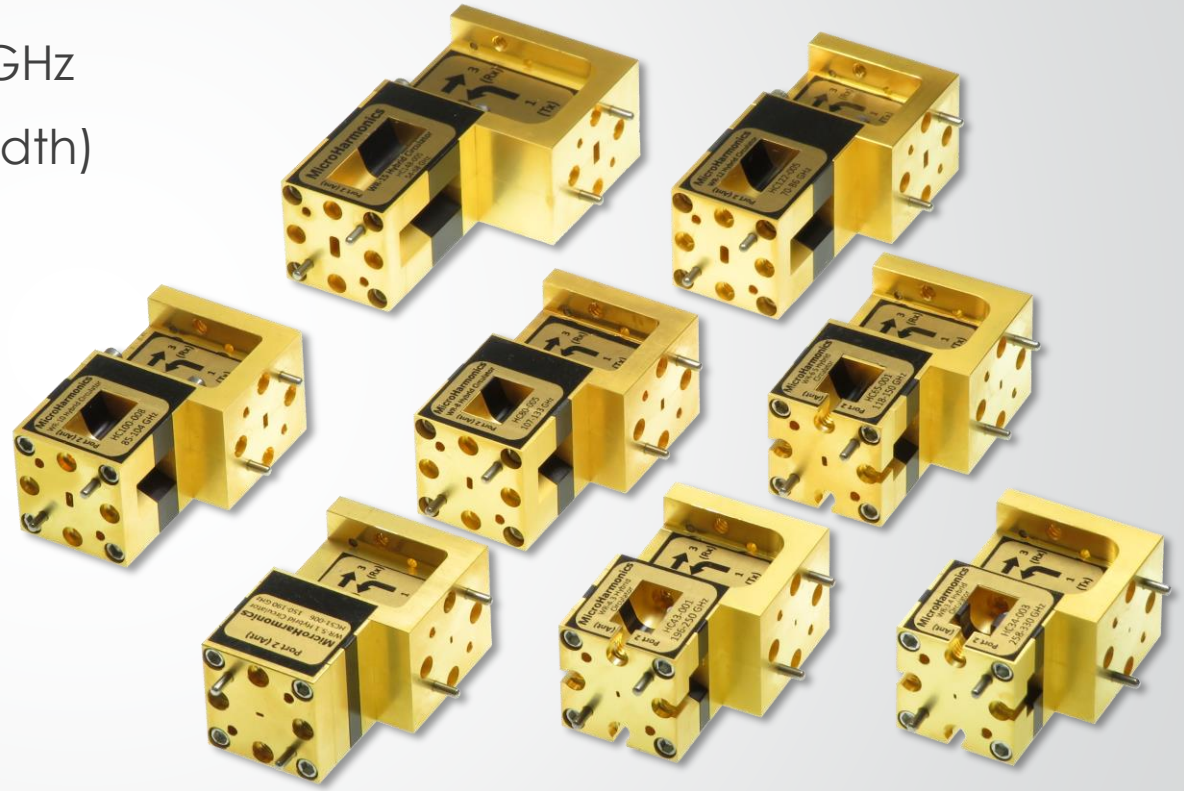
Comparison of PIN Diode Attenuators and MHC Ferrite Attenuators.

Band	Frequency Range (GHz)		Insertion Loss (dB)		Return Loss (dB)		Max Power (W)	
	PIN	Ferrite	PIN	Ferrite	PIN	Ferrite	PIN	Ferrite
WR-3.4	NA	220-330		2.7		17		0.4
WR-4.3	NA	170-260		2.5		17		0.7
WR-5.1	NA	140-220		2.3		17		1.0
WR-6.5	110-145	110-170	5	2.0	6	17	0.006	1.5
WR-8	90-140	90-140	4	1.8	6	17	0.006	1.8
WR-10	75-110	75-110	4	1.5	6	17	0.100	2.3

NA = Not Available.

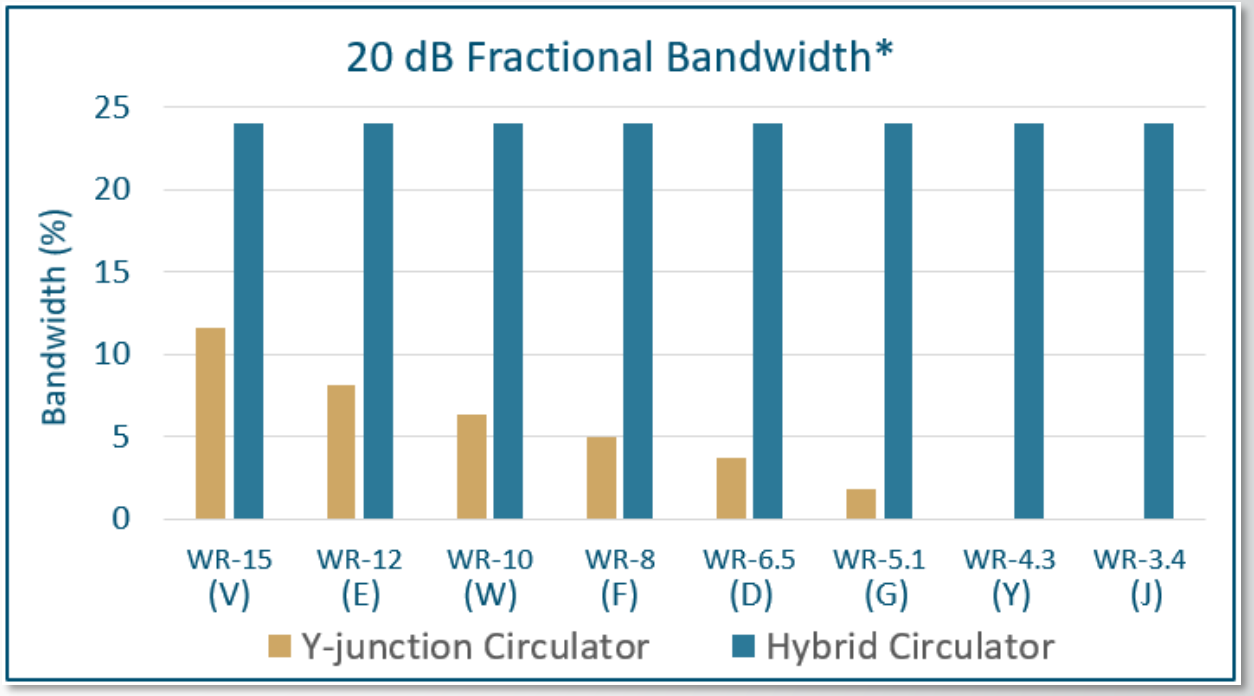
Hybrid Circulators – Overview

- WR-15 thru WR-3.4; 54 GHz to 330 GHz
- Wideband (24% fractional bandwidth)
- Internal waveguide screw access
- Anti-cocking waveguide flanges
- Resists stray magnetic fields
- Comprehensive test data
- Low insertion loss
- Patented



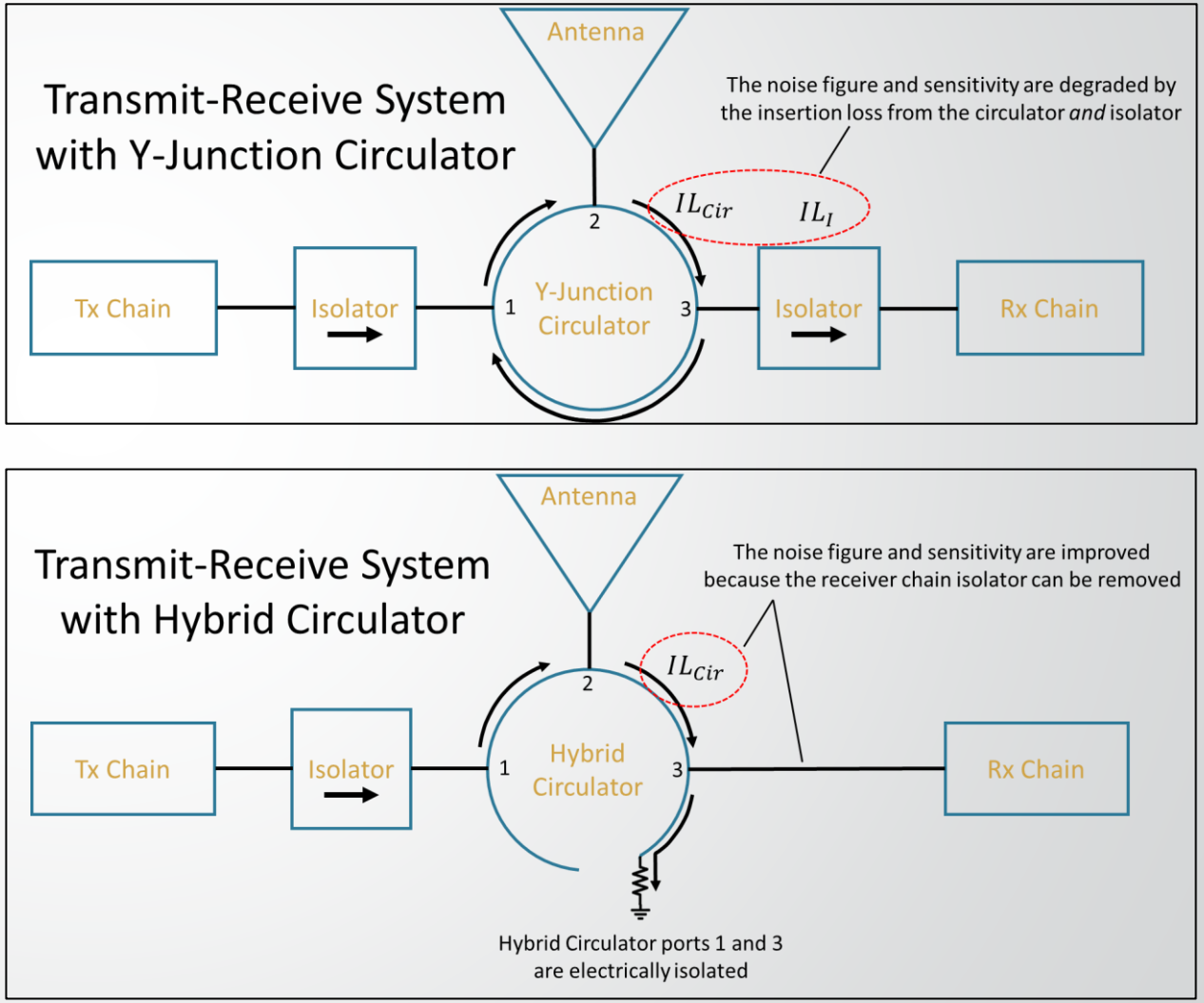
Hybrid Circulators – Bandwidth

- The Y-junction circulator has been the dominant technology at high frequencies for many decades. However, Y-junction circulators are very difficult to tune at the higher mm-wave frequencies because the fractional bandwidth is small, and the center frequency is highly sensitive to the ferrite core dimensions.
- The hybrid circulator has significantly greater bandwidth and higher frequency coverage than the traditional Y-junction. It comprises a Faraday rotator and an orthomode transducer which work together to achieve the circulator function with an astounding 24% fractional bandwidth and no bandwidth degradation at higher frequencies.



Hybrid Circulators – Comparison

- The top figure is an example of a transmit-receive system using a Y-junction circulator. Isolators are placed on both the transmitter and the receiver ports to reduce the signal power reflected to the transmitter. In a Y-junction circulator, signals reflected at the receiver are coupled to the transmitter port which is why a receiver port isolator is sometimes required.
- The hybrid circulator is configured by default so that the transmitter port is internally isolated from the receiver port. This asymmetry can save space, simplify the system architecture, and improve the noise figure and sensitivity of the receiver as illustrated by the figure on the bottom.

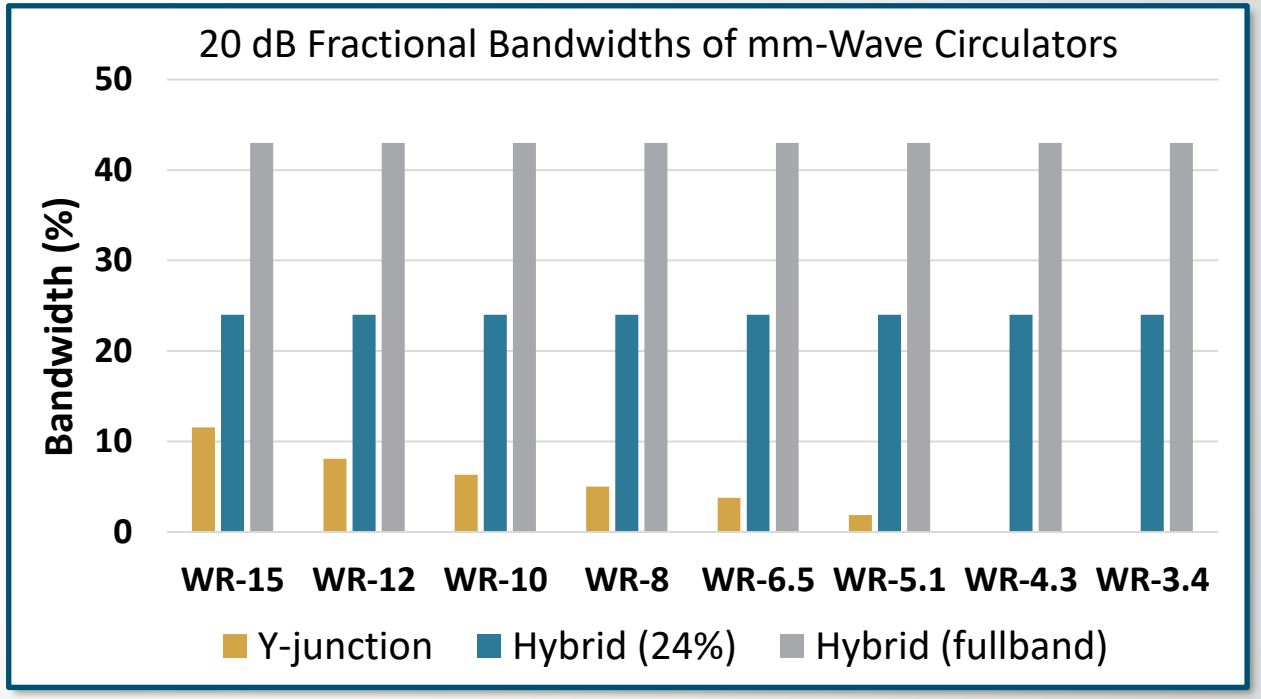


Hybrid Circulators: Frequency Coverage

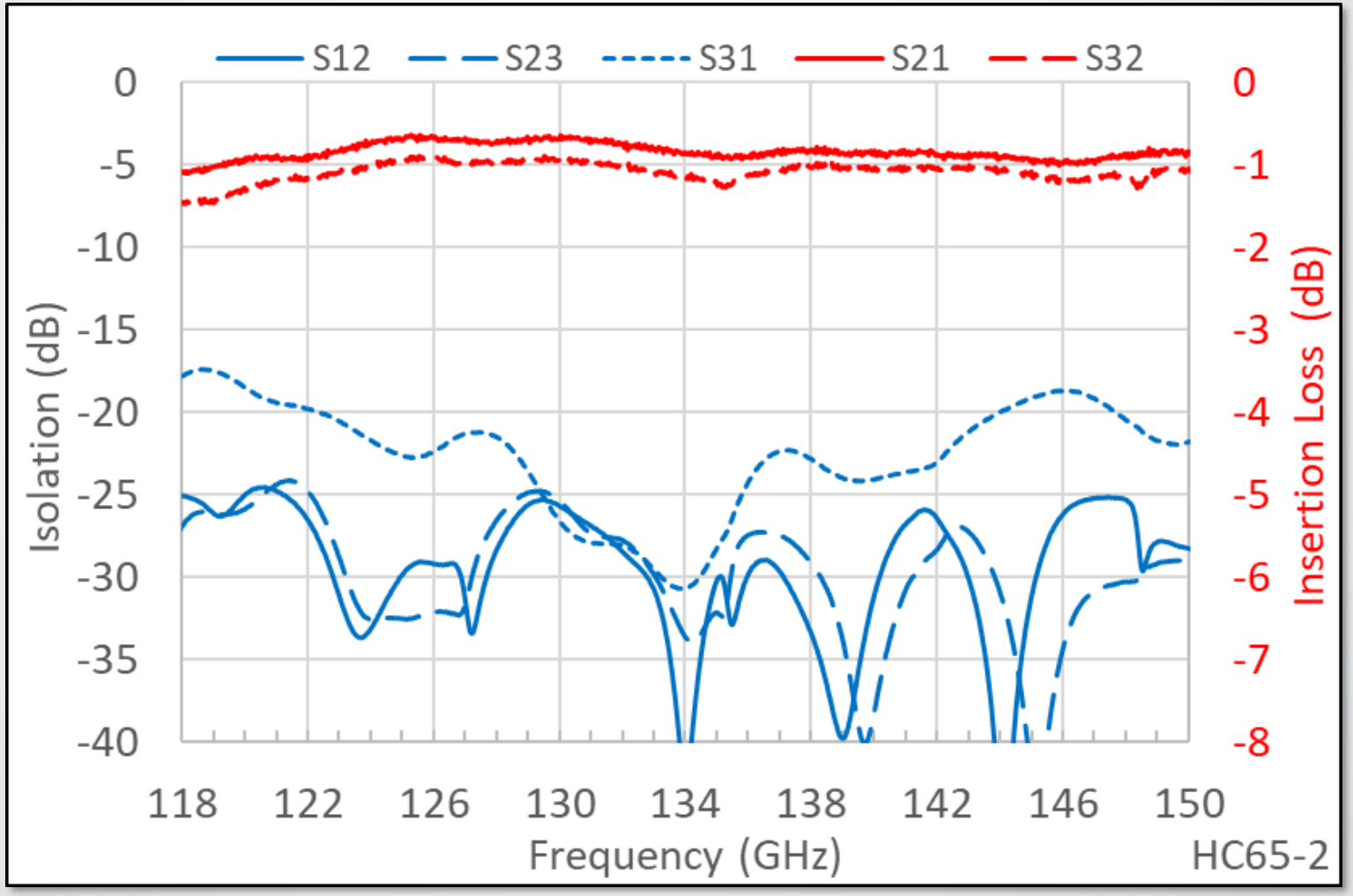
Model Name	EIA Flange	Band	Frequency (GHz)
HC148	WR-15	V	54 – 68
HC122	WR-12	E	70 – 88
HC100	WR-10	W	84 – 104
HC080	WR-8	F	107 – 133
HC065	WR-6.5	D	118 – 150
HC051	WR-5.1	G	150 – 190
HC043	WR-4.3	Y	196 – 250
HC034	WR-3.4	J	258 – 330

Hybrid Circulators – Fullband

- The asymmetric orthomode transducer in the hybrid circulator currently achieves a 24% fractional bandwidth. Micro Harmonics' is developing an orthomode transducer using a symmetric design which will achieve 40% fractional bandwidth. This new design in conjunction with our full band Faraday rotator will enable the manufacturing of full band hybrid circulators



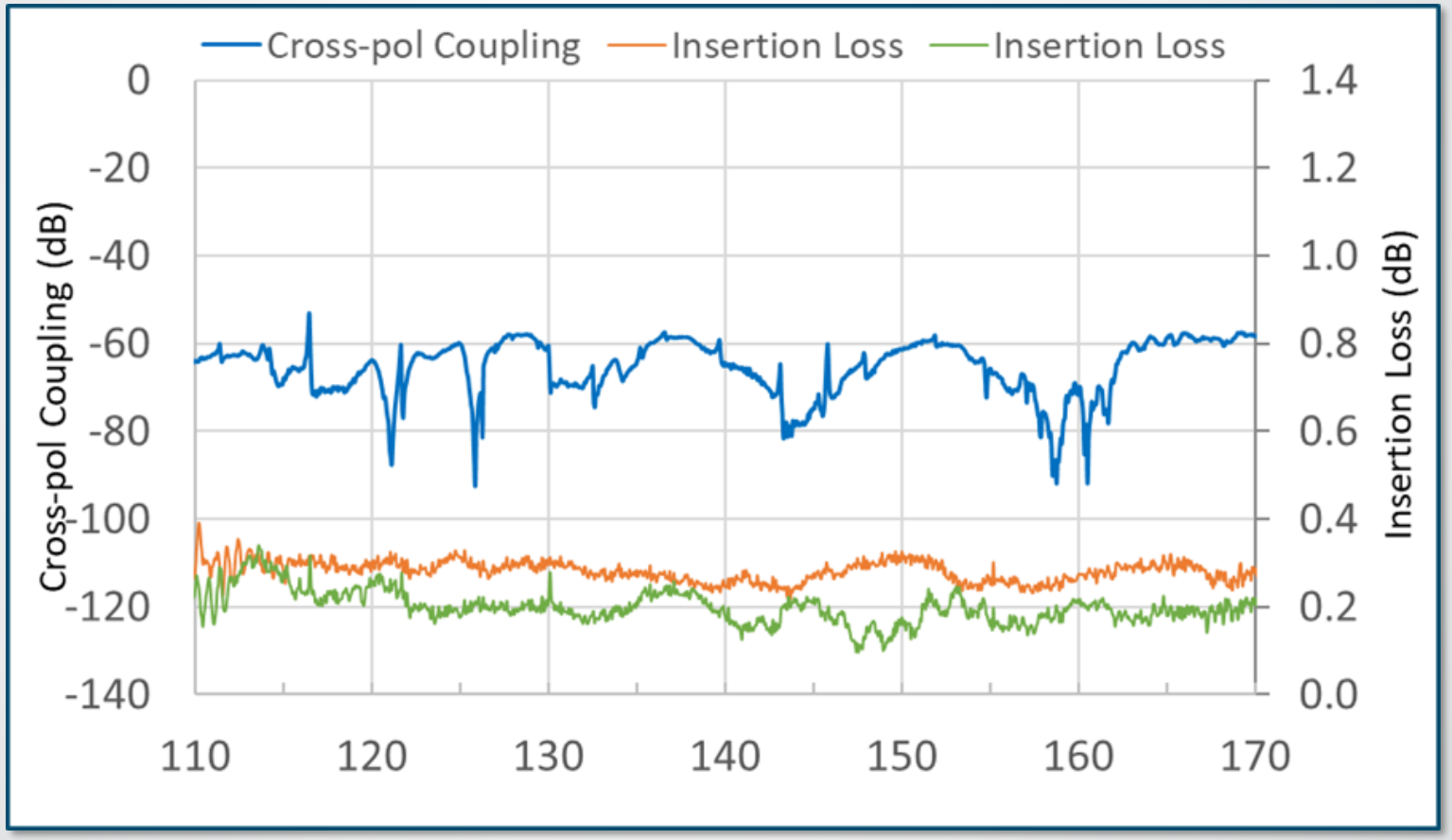
Hybrid Circulators: Performance



Orthomode Transducer – Overview

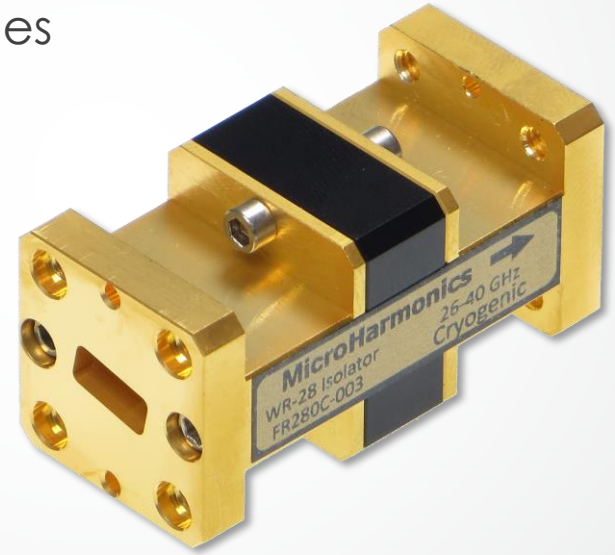
- WR-6.5; 110 GHz to 170 GHz
- Low cross-polarization coupling
- Anti-cocking waveguide flanges
- Resists stray magnetic fields
- Comprehensive test data
- Low insertion loss
- Compact size
- High isolation

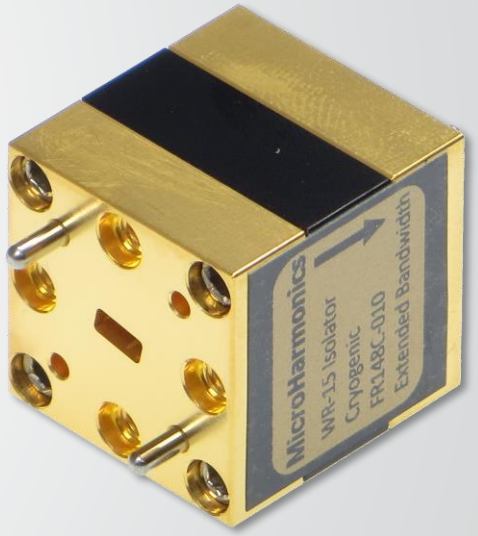
Orthomode Transducer: Performance



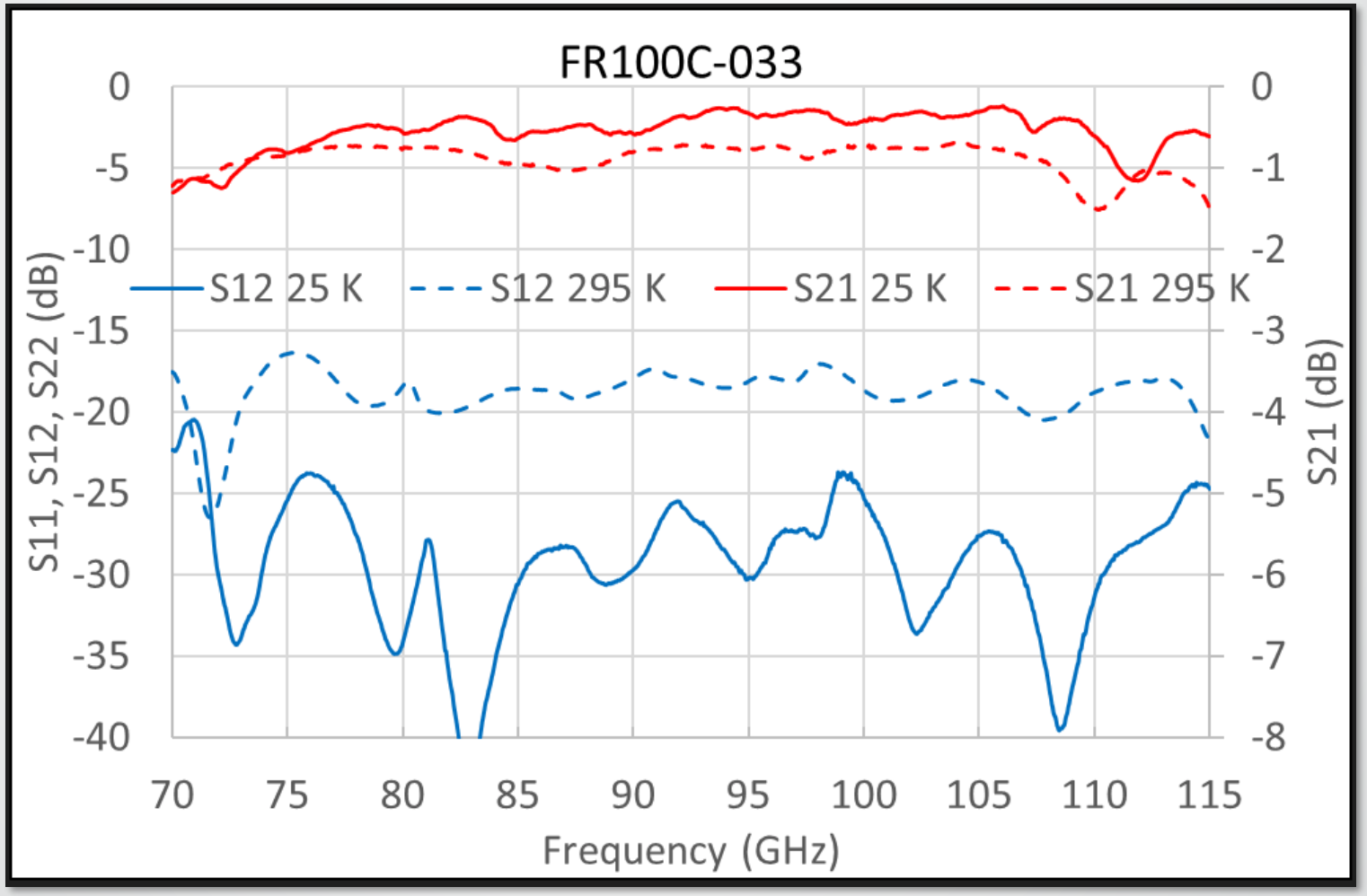
Cryogenic Isolators: Overview

- WR-28 thru WR-5.1; 26.5 GHz to 220 GHz
- Anti-cocking waveguide flanges
- Comprehensive test data
- Lowest insertion loss
- High isolation
- Compact size
- Optimized for 1 – 100K
- Resist stray magnetic fields
- Internal waveguide screw access





Cryogenic Isolators: Performance



Cryogenic Isolators: Why?

- It is a common misconception that isolators designed to work at room temperature will work reasonably well at cryogenic temperatures. The problem is that the ferrite materials have a strong temperature dependence that impacts the signal rotation. This can severely degrade performance at cryogenic temperatures.
- Our cryogenic isolators are routinely tested at 25 K in our cryostat. We use a resistive thin film for isolation that is not in the class of super conductors. The performance of our cryogenic isolators has been verified down to 1 K.
- MHC cryogenic isolators are designed to withstand the thermal stresses that are inherent in cryogenic systems.

Applications

- Atmospheric observation
- Biomedical
- Portal security
- Radio astronomy
- Research lab
- Remote sensing
- Standoff detection
- Telecommunication
- Test and measurement equipment
- University

Links

- Why are our distinctives important?
- Informational resources
- Blog
  - Hybrid Circulator
  - Variable Attenuator
- FAQ (coming soon)
- Our Videos

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Socio-Economic Category: SB

DUNS: 034119968

Cage Code: 6T4C6

HS Code: 8536 3010 90

NAICS: 334220, 334419, 541330, 541715

PSC: H259, AJ12, 5985, 5999

C219, AR12, C222, C215