MicroHarmonics
Superior mm-Wave Components

Cryogenic Faraday Rotation Isolators

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.

"We tried using regular isolators from one vendor. We cooled them down and assumed they would work, but they weren't behaving right."
Alexander Anferov, GRA
Shuster Lab, University of Chicago

"We can get down to less than 100 Kelvins with commercially available cryo-coolers…Our biggest challenge was finding an isolator that could perform at those temps. Fortunately for us, a company called Micro Harmonics had just designed some specifically for NASA."
Dana Wheeler, CEO
Plymouth Rock Technologies

At Micro Harmonics we are developing a line of isolators designed for optimal performance at cryogenic temperatures. We bias the ferrite in magnetic saturation for minimal insertion loss and trim the length of the ferrite rod to achieve the desired rotation at cryogenic temperatures.

Sophisticated models are constructed to simulate the thermal stress levels throughout the isolator as it is cooled. Materials are chosen that reduce thermal stress. Reliability is verified through repeated thermal cycling in a liquid nitrogen bath. Our isolators are built to withstand the rigors of repeated cryogenic cycling.

Our cryogenic isolators are routinely tested at 77 K and 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.

Cryogenic models are now available in bands from WR-15 through WR-9 and will soon be available up to WR-5.1. A model at WR-28 is currently being prototyped and will be released soon. Models at WR-4.3 and WR-3.4 will be added pending customer demand.

Model	Flange (EIA)	Band (GHz)	Insertion Loss (dB, typ @ 77 K)	Isolation (dB, typ @ 77 K)
FR280C	WR-28	26 - 40	0.5 (est.)	25 (est.)
FR148C	WR-15	50 - 75	0.5	28
FR122C	WR-12	60 - 90	0.8	25
FR100C	WR-10	75 - 110	0.4	30
FR90C	WR-9	82 - 122	0.5	30
FR80C	WR-8	90 - 140	Coming in 2021	
FR65C	WR-6.5	110 - 170	Coming in 2021	
FR51C	WR-5.1	140 - 220	Coming in 2021	
FR43C	WR-4.3	170 - 260	Coming	
FR34C	WR-3.4	220 - 330	Coming	

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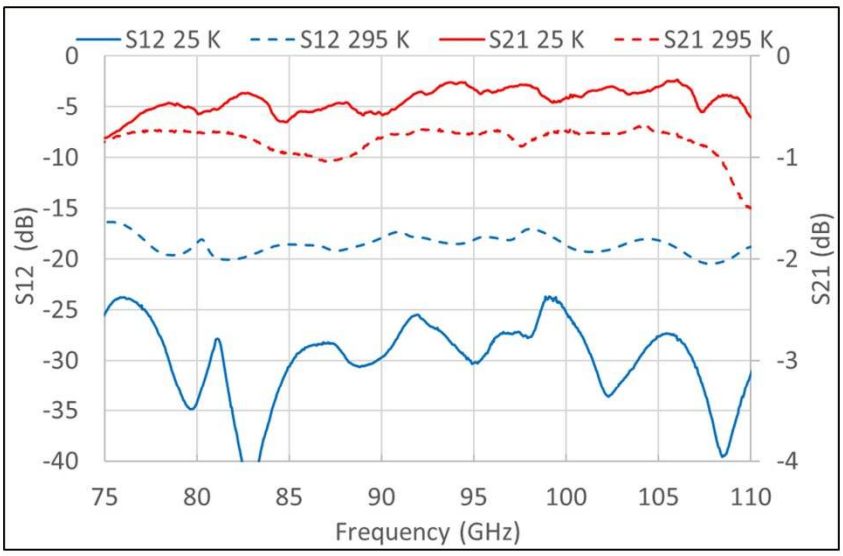
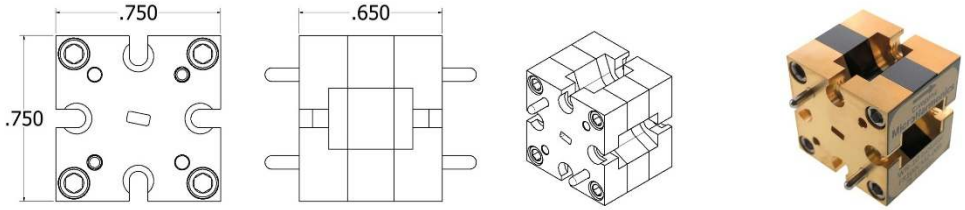
A typical specification sheet for a WR-10 cryogenic isolator is shown below. The isolator was tested both at room temperature (295 K) and at 25 K. The data clearly indicate improvement in the isolator performance at cryogenic temperatures both in terms of lower insertion loss and higher isolation.

Model: FR100CM2

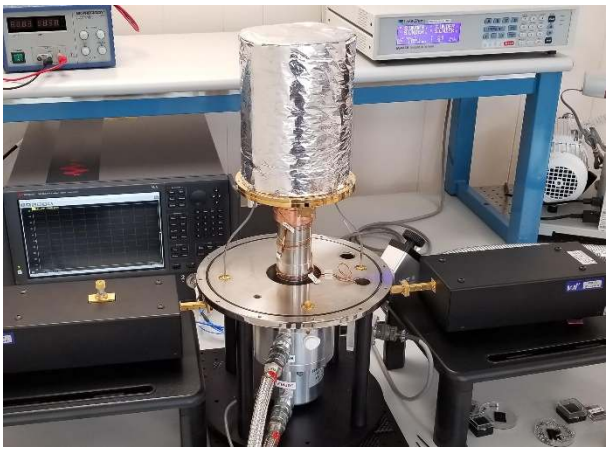
Specifications	
Flange	WR-10
Frequency (GHz)	75-110
Insertion Loss (dB, typ, 300K)	0.9
Insertion Loss (dB, typ, 77 K)	0.4
Isolation (dB, typ, 300 K)	19
Isolation (dB, typ, 77 K)	26
Input Return Loss (dB, typ)	20
Output Return Loss (dB, typ)	20
VSWR (max)	1.4:1
Maximum Power (W)	1.0
Diamond Heatsink	No

Every isolator is tested on a vector network analyzer to ensure conformity.





May 26, 2021



Micro Harmonics designs and manufactures all of our products in the United States. We do reliability testing (Belcore) and cryogenic cycling tests. Nylon thread lockers are used to ensure that our components stay assembled in the field. Every component is thoroughly RF tested and the data is shared with the customer. Every component is fully warranted. When you purchase a Micro Harmonics component you can rest assured that you are receiving the highest quality and best performance available on the global commercial market.

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