Pbar Note 675

Microwave Absorber Design in Pbar Accumulator Core Cooling Upgrade

Ding Sun
07/2002

1. Introduction

There are three frequency bands in new core transverse stochastic cooling system. The center frequency of the three bands is: 5 GHz, 6 GHz and 7 GHz. The bandwidth of each band is 1.3 GHz. The widths of beam pipe for these three bands are: 1.872", 1.590" and 1.45". The height of beam pipe is 1.244" for all three bands. Microwave absorbers (TT2-111R from Trans-Tech Inc.) are placed in the following places: from entrance to band 1 (length: 6 inch), between band 1 and band 2 (length: 7.5 inch), between band 2 and band 3 (length: 7.5 inch), and between band 3 and exit (length: 6 inch.) The function of these absorbers (and the goal of the design) is to prevent microwave signal or power from traveling between adjacent bands as well as to minimize any possible reflected microwave signal or power. Most absorbers are placed on the narrow sides (1.244 inch) of the beam pipe and provide most absorption. This note provides design detail and simulation results of these side absorbers.

In addition to these side absorbers, 4 pieces of absorbers (2.375:"x1.25"x0.090") are placed on top (2 pieces) and bottom (2 pieces) of the beam pipe near the places of these side absorbers to add more absorption (~ 2- 4 db). Detail of these top and bottom absorbers can be found in mechanical drawings.

2. Design description

There are 4 features in the side absorber design:

1. Absorbers are placed inside the beam pipe to get maximum absorption. (in Debuncher cooling upgrade, absorbers are flush with inner surface of the beam pipe.)
2. To simplify the mechanical engineering, beam pipe width is abruptly changed (step change) between different bands instead of a tapered transition section that is traditionally used for minimizing reflection of microwave power.
3. However the feature 1 and 2 usually cause larger reflection. Therefore different thicknesses of absorbers are combined to get both high absorption and very low reflection.
4. A quasi-quarter wave step of microwave absorber is used at entrance and exit paces for each band to further reduce reflection.

Shown in Figure 1, 3, 6 and 9 are schematic drawings of these absorbers

Shown in Figure 2, 4, 5, 7, 8 and 10 are corresponding simulation results using HFSS software (Ansoft Inc.) Complex permittivity and permeability parameters of TT2-111R used in each simulation were measured and extracted during Debuncher cooling upgrade.

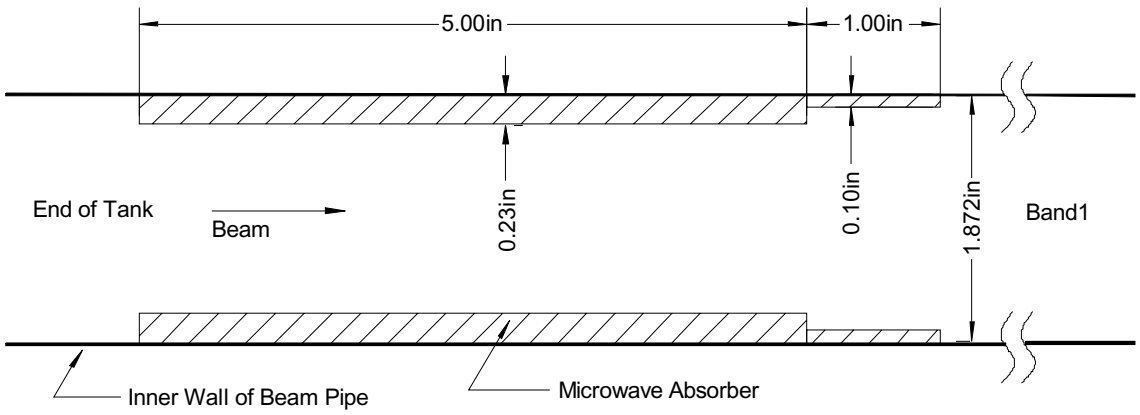

Figure 1. Top View of Side Absorber in Entrance Area of Band 1.

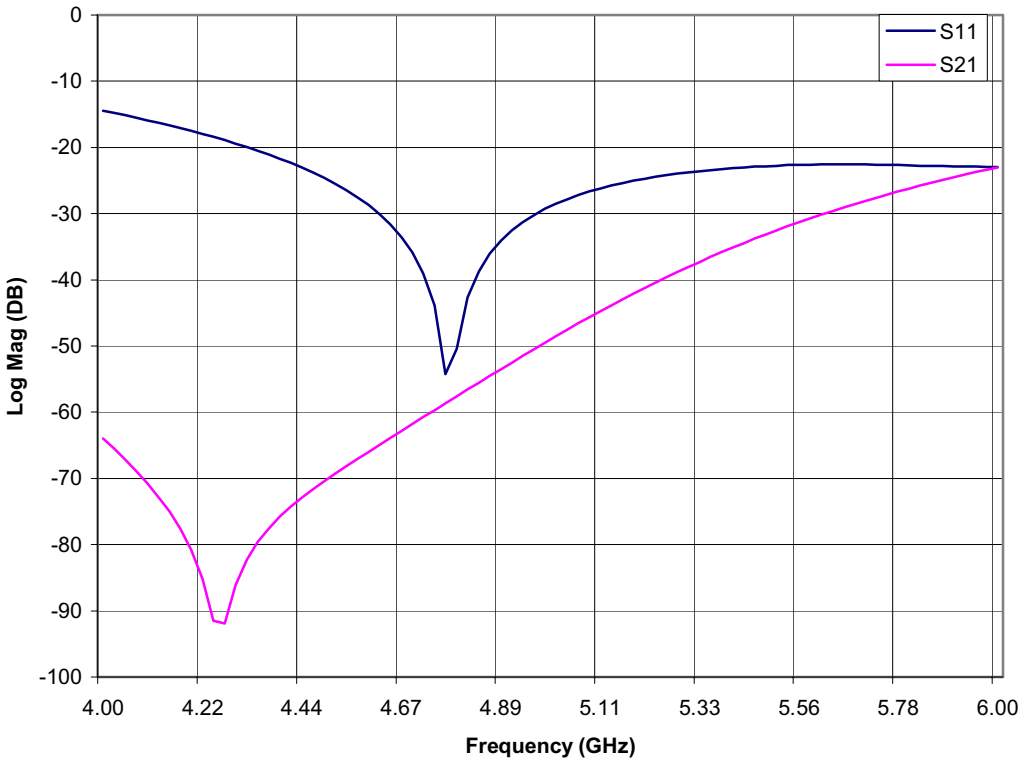

Figure 2. Reflection and Transmission in the Entrance Area of Band 1.
Note: Port 1 is on the right side of Figure 1. Port 2 is on the left side of Figure 1. S11 measures power reflected back to band 1. S21 measures power transmitted out of cooling system.

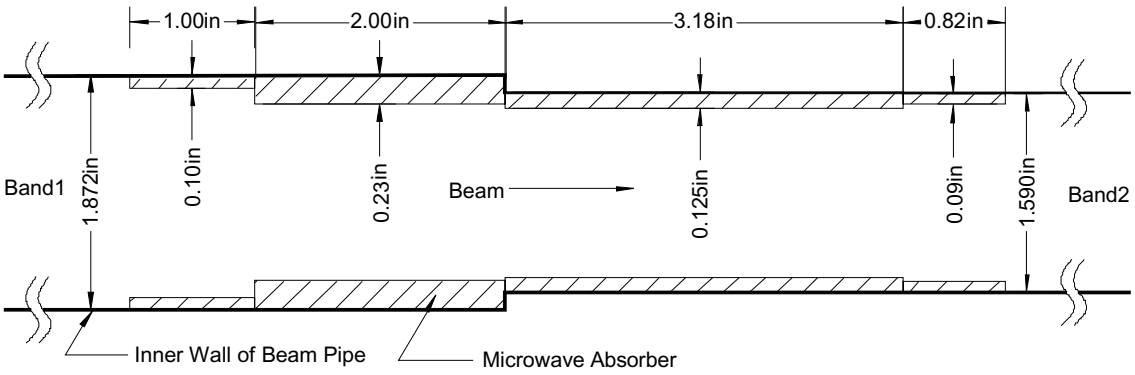

Figure 3. Top View of Side Absorber in the Area Between Band 1 and Band 2.

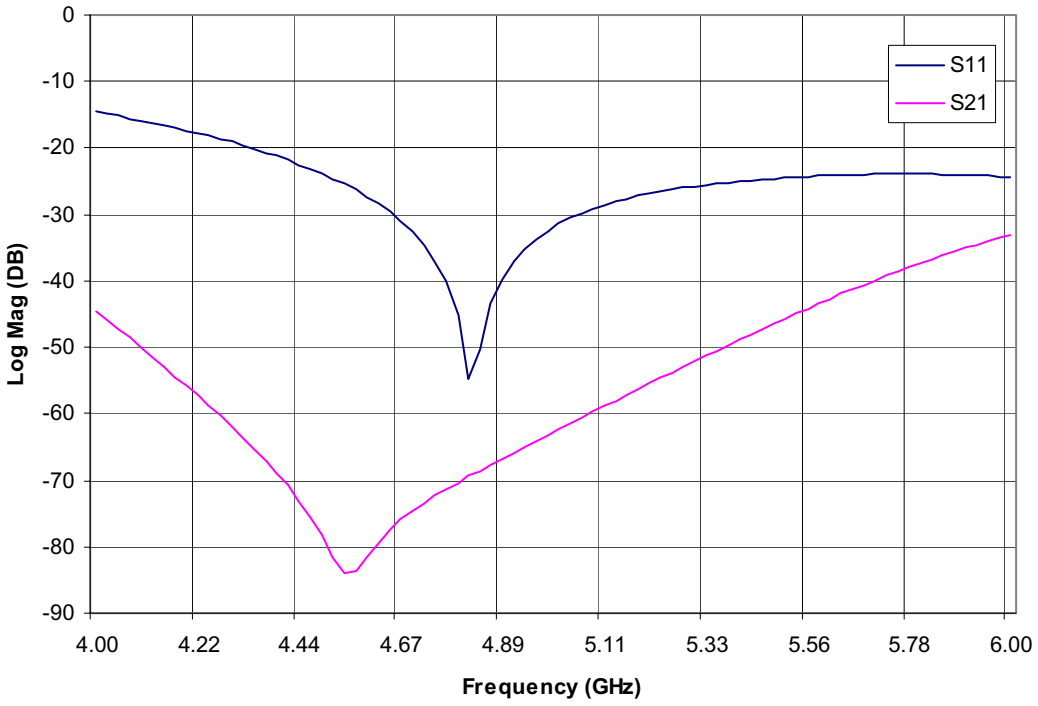

Figure 4. Reflection and Transmission in the Area Between Band 1 and Band 2.
Note: Port 1 is on the left side (band 1) of Figure 3. Port 2 is on the right side (band 2) of Figure 3. S11 measures power (~ 5 GHz) reflected back into band 1 area. S21 measures power transmitted from Band 1 area (~ 5 GHz) to Band 2 area.

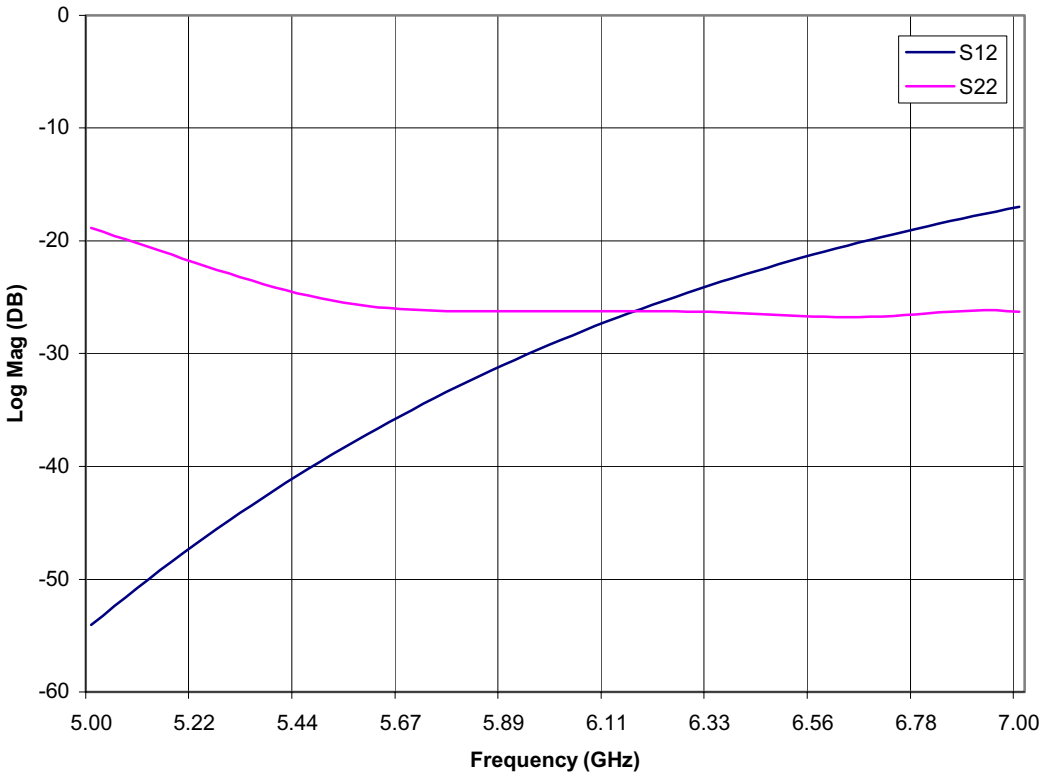

Figure 5. Reflection and Transmission in the Area Between Band 1 and Band 2.
Note: Port 1 is on the left side (band 1) of Figure 3. Port 2 is on the right side (band 1) of Figure 3. S22 measures power (~ 6 GHz) reflected back into band 2 area. S12 measures power transmitted from Band 2 area (~ 6 GHz) to Band 1 area.

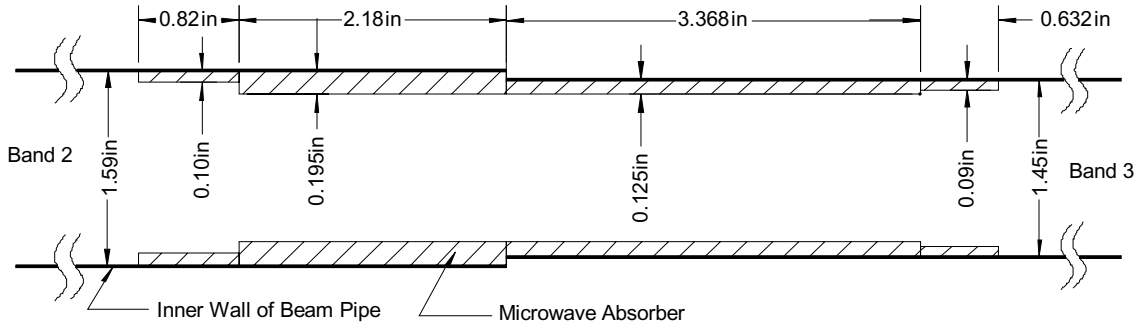

Figure 6. Top View of Side Absorber in the Area Between Band 2 and Band 3.

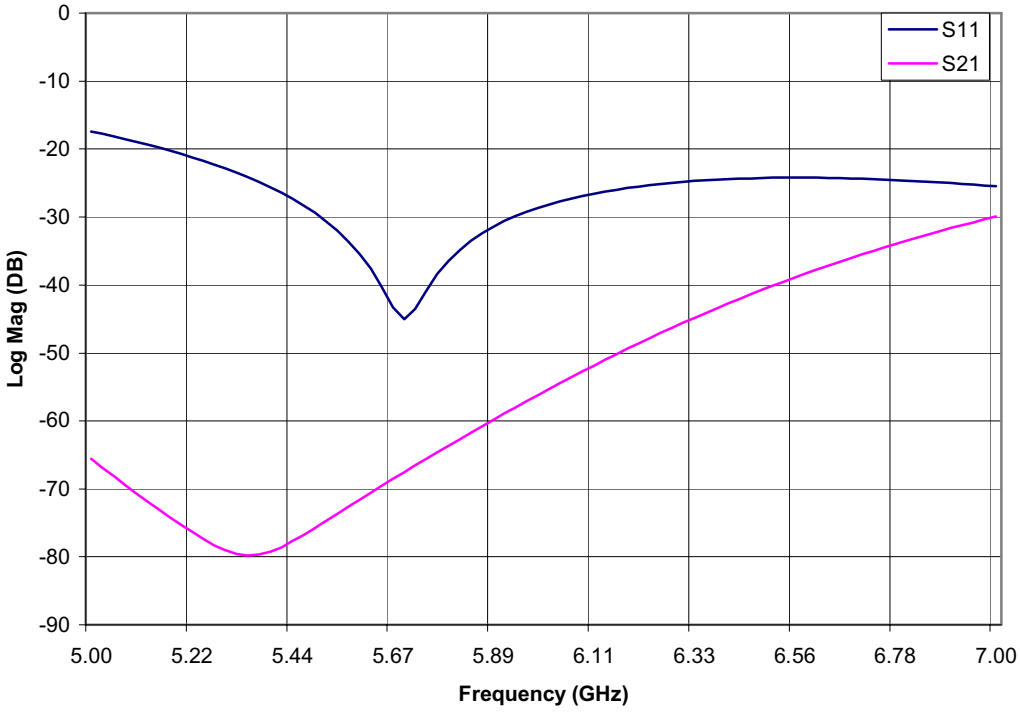

Figure 7. Reflection and Transmission in the Area Between Band 2 and Band 3.
Note: Port 1 is on the left side (band 2) of Figure 6. Port 2 is on the right side (band 3) of Figure 6. S11 measures power (~ 6 GHz) reflected back into band 2 area. S21 measures power transmitted from Band 2 area (~ 6 GHz) to Band 3 area.

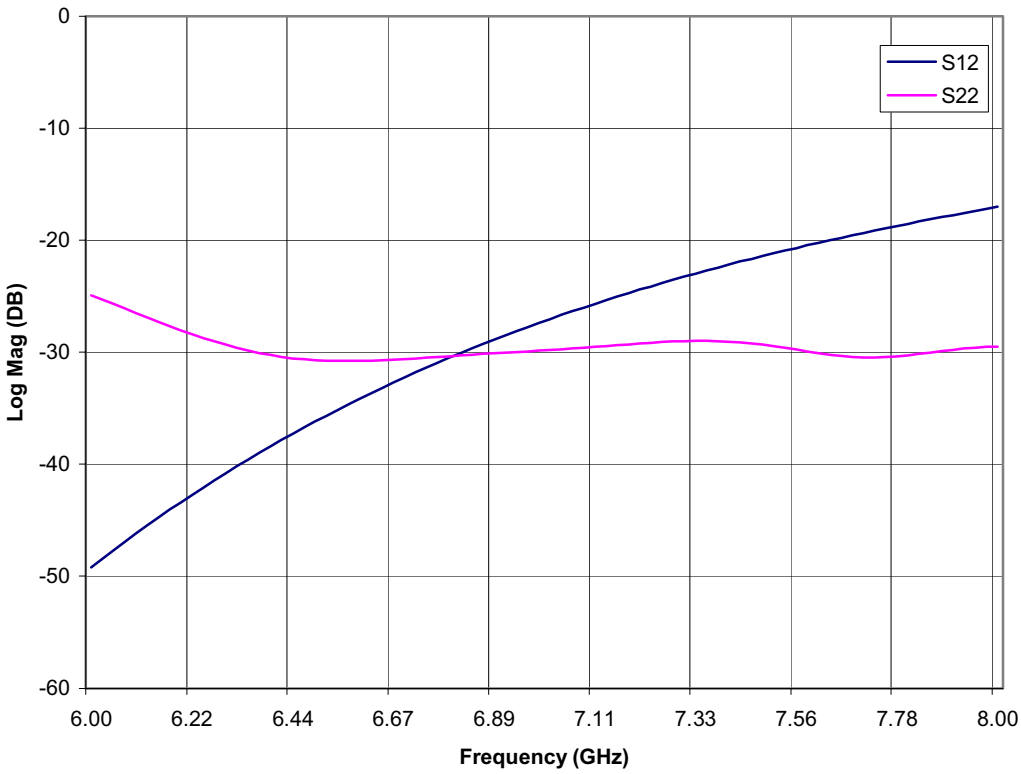

Figure 8. Reflection and Transmission in the Area Between Band 2 and Band 3.
Note: Port 1 is on the left side (band 2) of Figure 6. Port 2 is on the right side (band 3) of Figure 6. S22 measures power (~ 7 GHz) reflected back into band 3 area. S12 measures power transmitted from Band 3 area (~ 7 GHz) to Band 2 area.

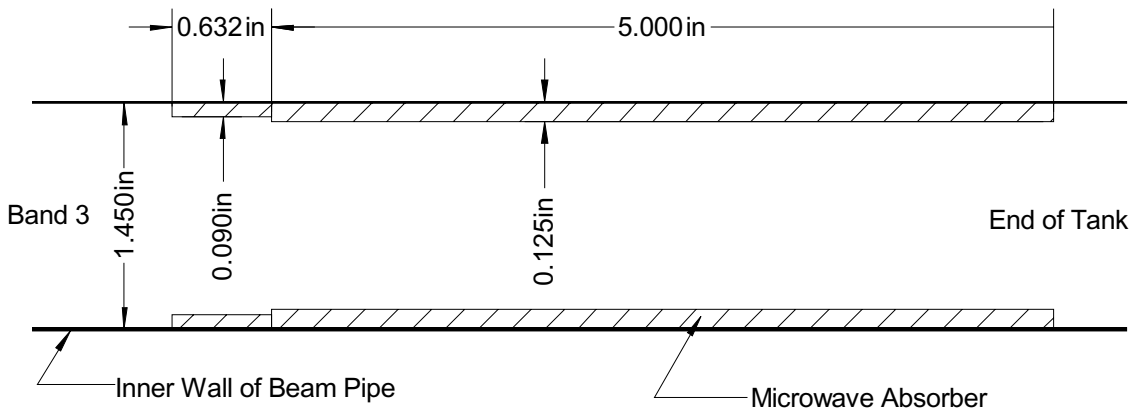

Figure 9. Top View of Side Absorber in Exit Area of Band 3.

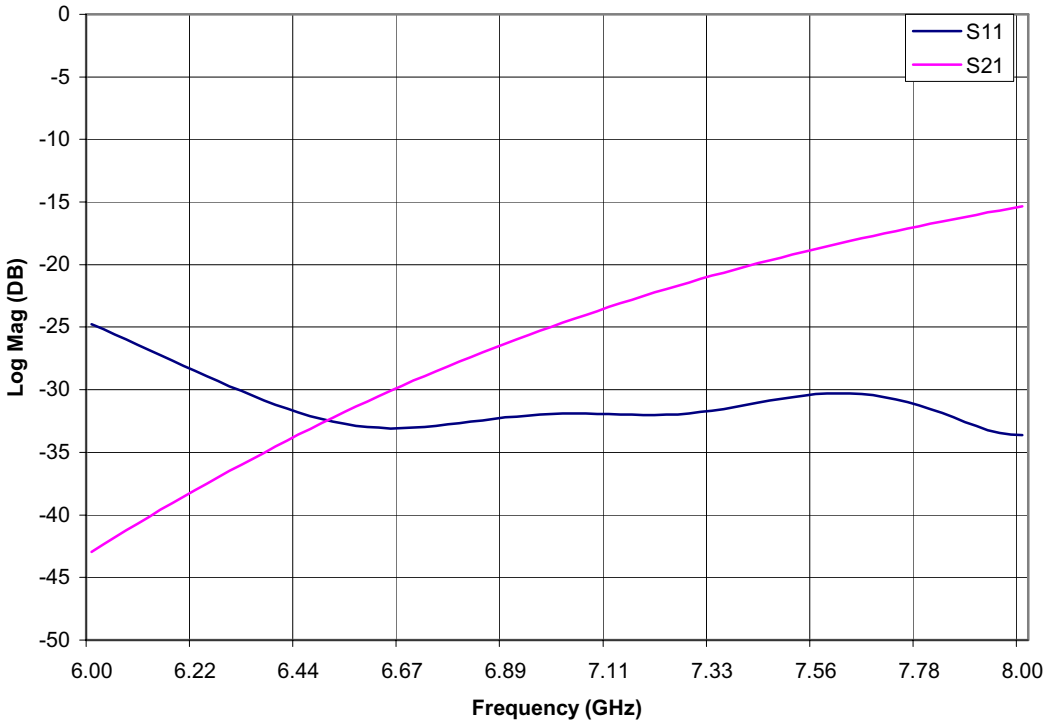

Figure 10. Reflection and Transmission in The Exit Area of Band 3.
Note: Port 1 is on the left side (band 3) of Figure 9. Port 2 is on the right side of Figure 9. S11 measures power (~ 7 GHz) reflected back to band 3. S21 measures power (~ 7GHz) transmitted out of cooling system.