A NUMERICALLY OPTIMIZED CONTIGUOUS DIPLEXER

Richard L. Mole
Hughes Aircraft Company
Space and Communications Group
El Segundo, California 90245

ABSTRACT

A contiguous diplexer is designed using a numerical optimization technique to meet the critical performance requirements of a spacecraft communication system. The diplexer consists of two, 3 section, bridge-coupled, singly terminated filters. The diplexer is realized in a coaxial structure whose measured performance is in good agreement with the calculated values.

Introduction

A diplexer is required to sum the outputs of two transmitters for a spacecraft communications application. The performance requirements are summarized in Table 1. Using the conventional design approach, the diplexing requirements can be met with two 3 section notch filters and the out-of-band rejection requirement can be met by adding a 3 section bandpass filter to the common output. However, it was reasoned that two 3 section bandpass filters could meet the same requirements and thus reduce the size and weight by a factor of 2.5. Because of the proximity of the signals (4 MHz separation) the filters need to be of a contiguous, single-ended design. Also, because the signal bandwidth is much less than the filter bandwidth, the filter's passband need not be equiripple. For these reasons a numerically optimized design is selected over the standard design techniques.

Table 1

Diplexer Performance Requirements

<table>
<thead>
<tr>
<th>Ports</th>
<th>Frequency (MHz)</th>
<th>Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH1 TO OUTPUT</td>
<td>2213.9 to 2214.1</td>
<td>≤ 1.4</td>
</tr>
<tr>
<td></td>
<td>2208.6 to 2209.6</td>
<td>≥ 20</td>
</tr>
<tr>
<td></td>
<td>2033.9 to 2034.5</td>
<td>≥ 55</td>
</tr>
<tr>
<td>CH2 TO OUTPUT</td>
<td>2208.6 to 2209.6</td>
<td>≤ 1.4</td>
</tr>
<tr>
<td></td>
<td>2213.9 to 2214.1</td>
<td>≥ 20</td>
</tr>
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<td></td>
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</tr>
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Realization

The diplexer is realized in a coaxial structure with 1.75 inch square cavities machined in a solid aluminum housing with .33 inch diameter resonators. The resonators are segmented from invar and aluminum to provide a temperature stability of less than 2.5 ppm/F. The input and common output ports are capacitively coupled. The positive couplings use inductive irises at the base of the resonators and the negative coupling uses a capacitive probe near the top of the resonators. The two rows of resonators are offset so that all couplings can be easily realized. (See Figure 2). The diplexer is tuned by first setting each coupling individually to the calculated values and then making minor adjustments to achieve the overall response.

Results

The theoretical return loss achieved by this design is very close to an equiripple response. Figure 3 shows that the computed and measured return losses are in good agreement. The second loss pole is due to the diplexing of the two filters. Each filter by itself would produce only one loss pole. The slope of the out-of-band attenuation except for frequencies near the loss poles is very similar to that of a single, 3 section filter with one bridge coupling which is somewhat less than that of a 3 section Chebyshev filter as predicted.

Conclusion

In conclusion: a convenient, temperature compensated, low weight, coaxial structure which employs diagonal bridge couplings to achieve significant opposite channel rejection is used to realize a numerically optimized diplexer design.

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References


BAND PASS PROTOTYPE NETWORK
Figure 1

DiPLEXER CROSS SECTION
Figure 2

MEASUREMENT AND PREDICTED
DIPLEXER LOSS VS. FREQUENCY
Figure 3