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410-993-5000 (outside USA)  
M/S 4016 | Email: [surecal@ngc.com](mailto:surecal@ngc.com)



Technical Note TN 13

## **Adapter Substitution Techniques utilized in the SureCAL RF Components Package**

### Overview:

This Technical Note describes adapter substitution techniques implemented within the RF Components Package. Also covered is a test case example of comparisons of full set of S Parameter measurements for a two port device between the three types of adapter handling techniques.

### Adapter Handling Techniques:

In vector network analyzer measurements adapters are normally handled using one of three possible methods:

- Adapter Removal
- Adapter Characterization
- Adapter Substitution.

Each method has benefits and drawbacks. While providing the best uncertainties, adapter removal and adapter characterization techniques require additional operator activity and may not be supported by all network analyzers. While providing the higher uncertainties, adapter substitution provides maximum ease of use. Since adapter substitution requires equal length calibration kit adapters if the calibration kit is supported it can be implemented.

In the initial release, the SureCAL RF Components Package supported only adapter substitution techniques.

### Adapter Substitution Evaluation:

The following graphs show results of an adapter substitution test study for a step attenuator with female Type N port connectors. The attenuator is set to the 20dB position. A complete set of S Parameter measurements is performed on the attenuator using three different adapter handling techniques. Adapter substitution occurs on the S<sub>22</sub> Port.

Adapter handling techniques used:

- Adapter Removal
- Adapter Characterization
- Adapter Substitution

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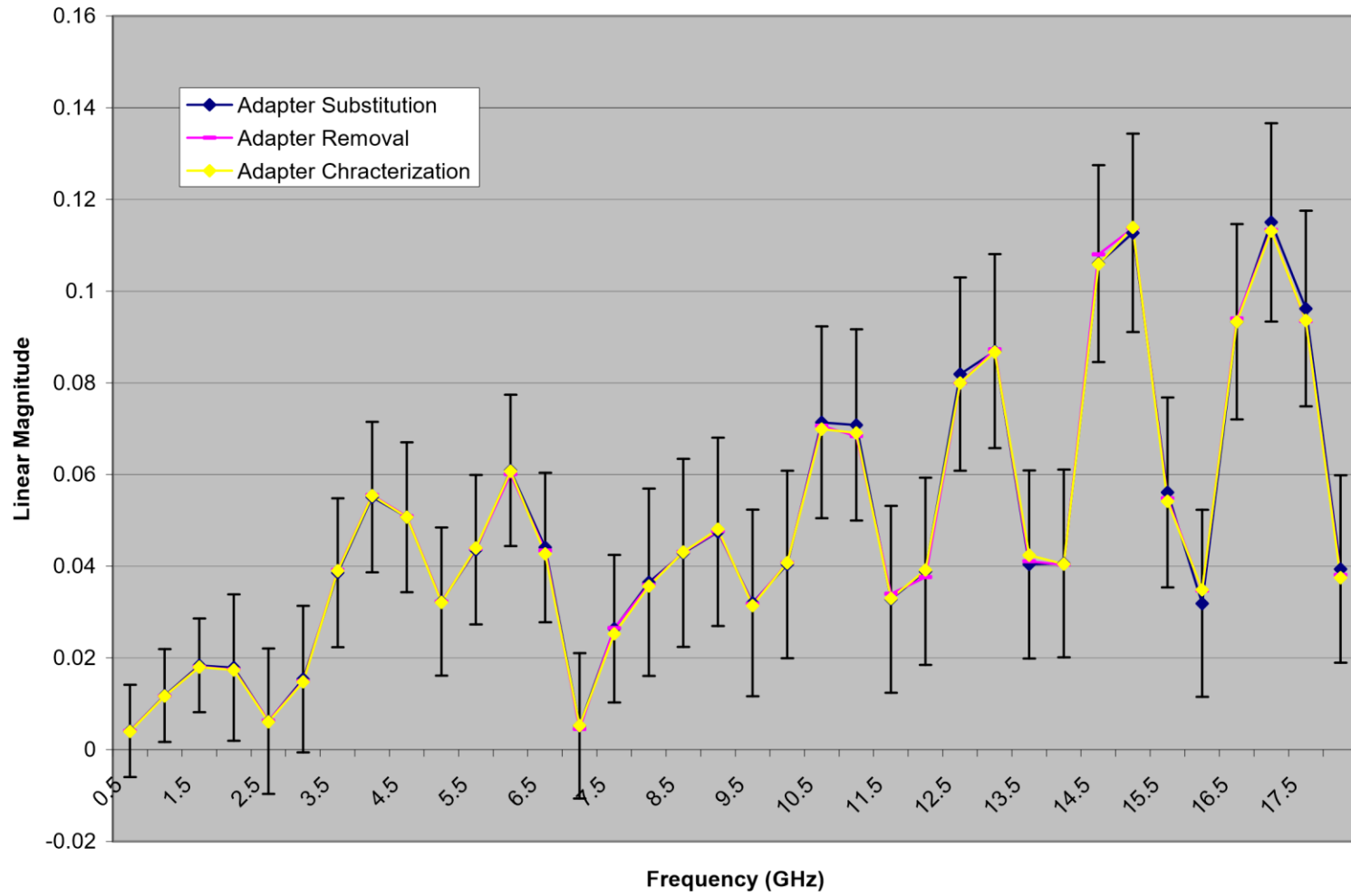
$S_{11}$ ,  $S_{21}$  and  $S_{12}$  magnitude and phase measurement results exhibit negligible variation between the three adapter handling techniques tested.  $S_{22}$  magnitude and phase, while exhibiting variations, track within the stated measurement uncertainty for the adapter substitution method utilized.

For clarity in graphing the vector analyzer phase results, the phase scaling at 4.5GHz and 14GHz have been extended through the +/-180 degree limits. In practice, the vector analyzer reports the reading at 4GHz of -180.43 degrees as +179.58 degrees and the reading at 14GHz of -187.63 degrees as +172.37 degrees.

#### Summary:

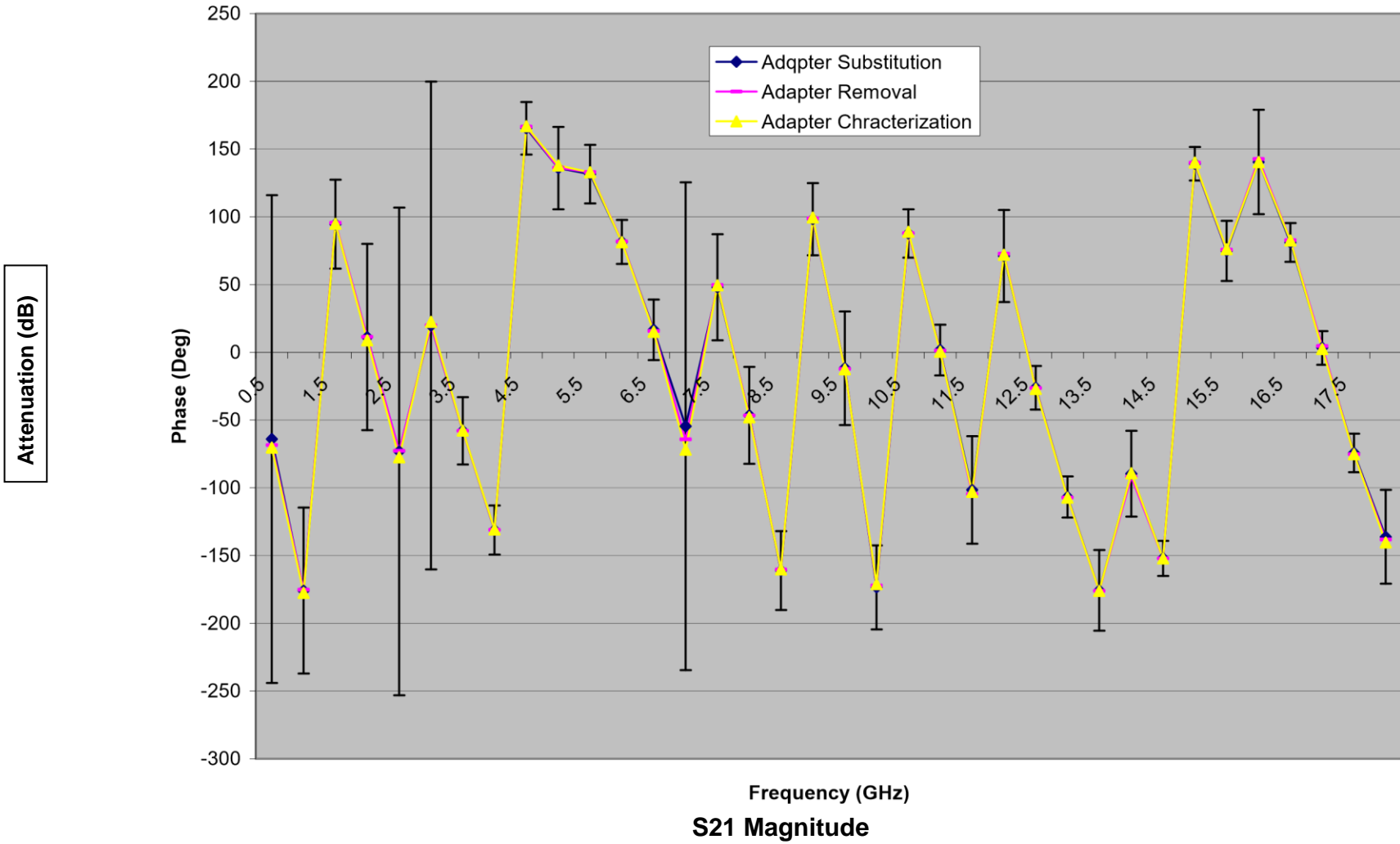
If the use of metrology grade, equal electrical length adapters is strictly adhered to, the adapter substitution method can provide reasonable uncertainties with minimal operator implementation requirements.

### S11 Magnitude

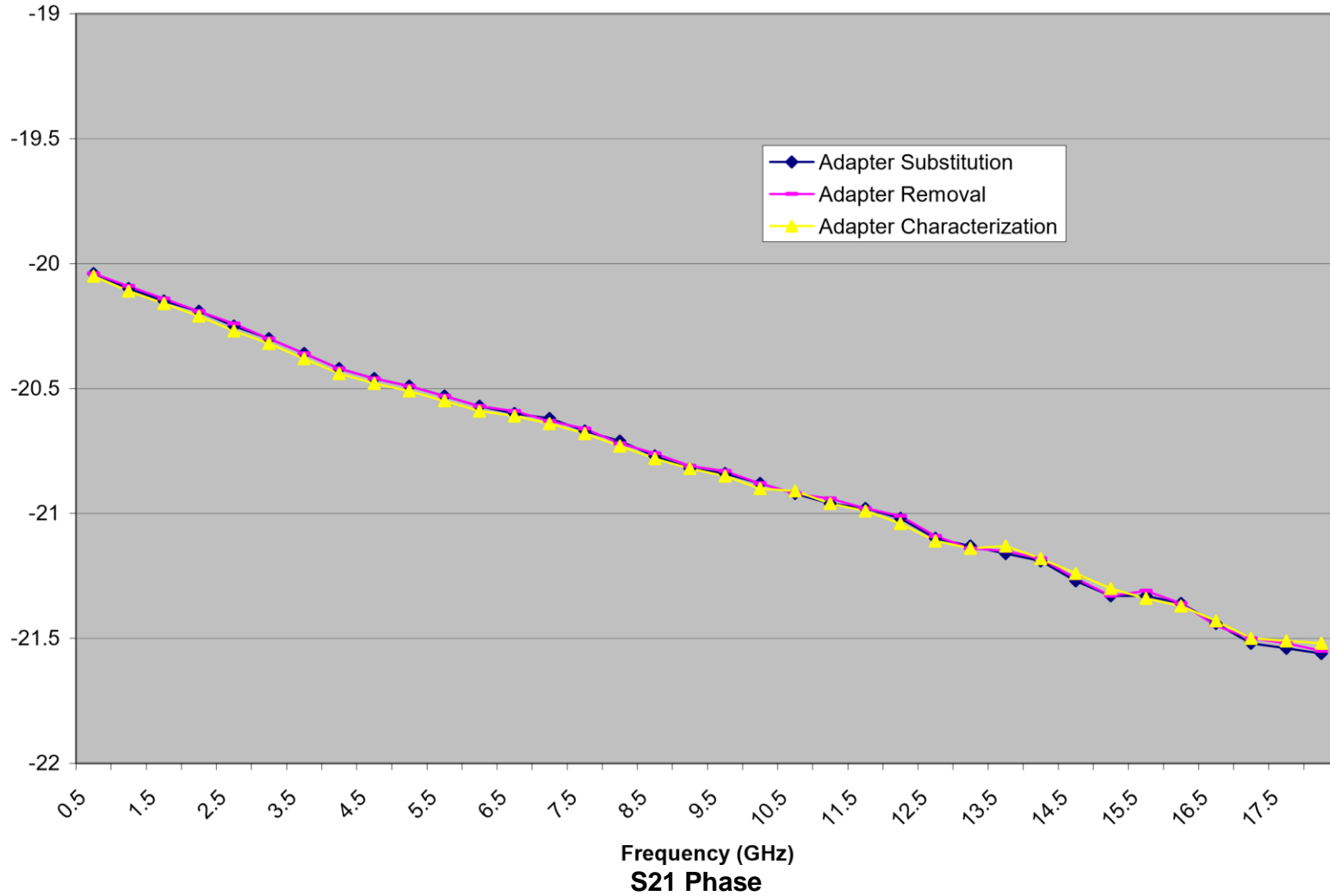


### S11 Phase

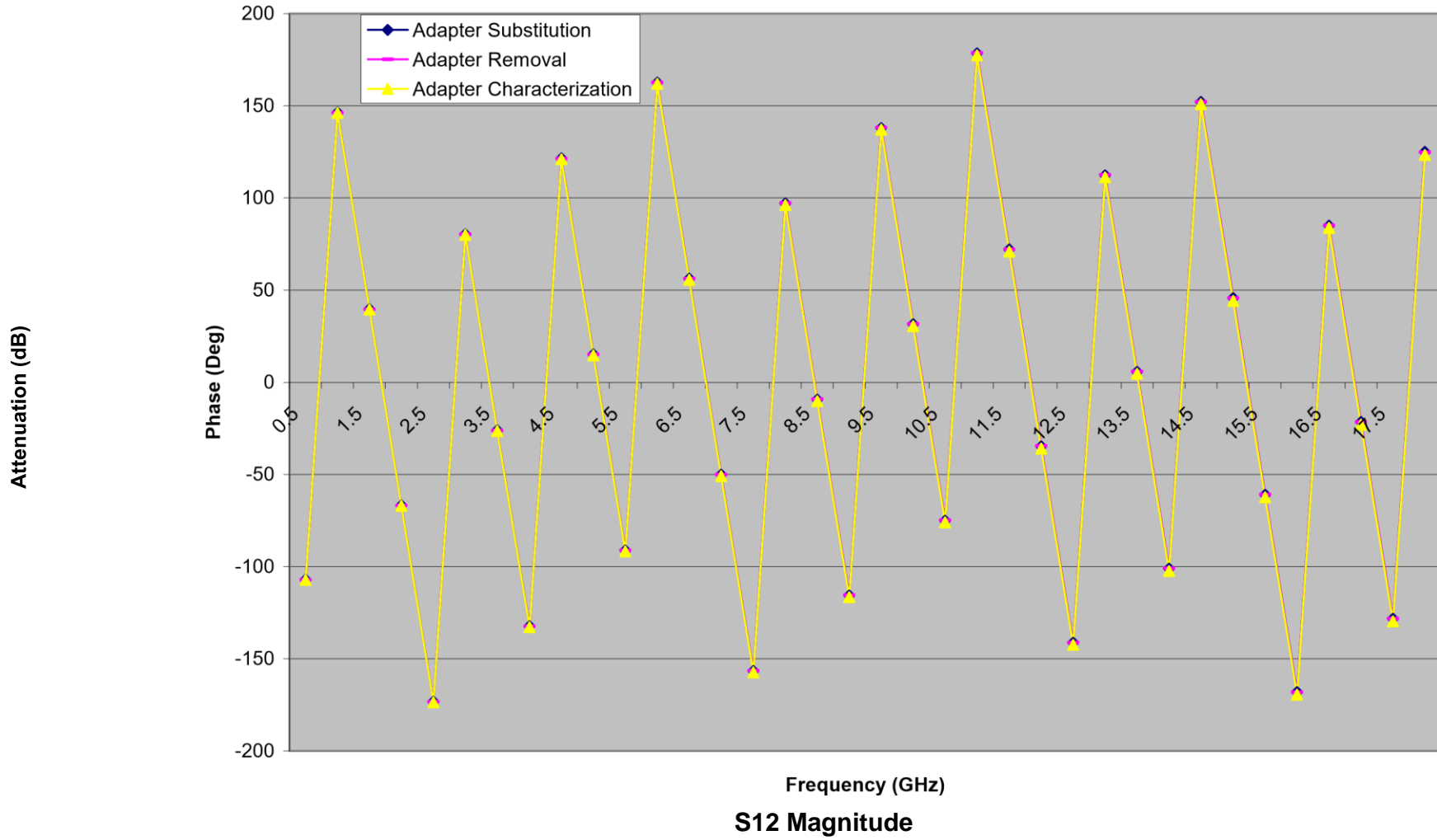
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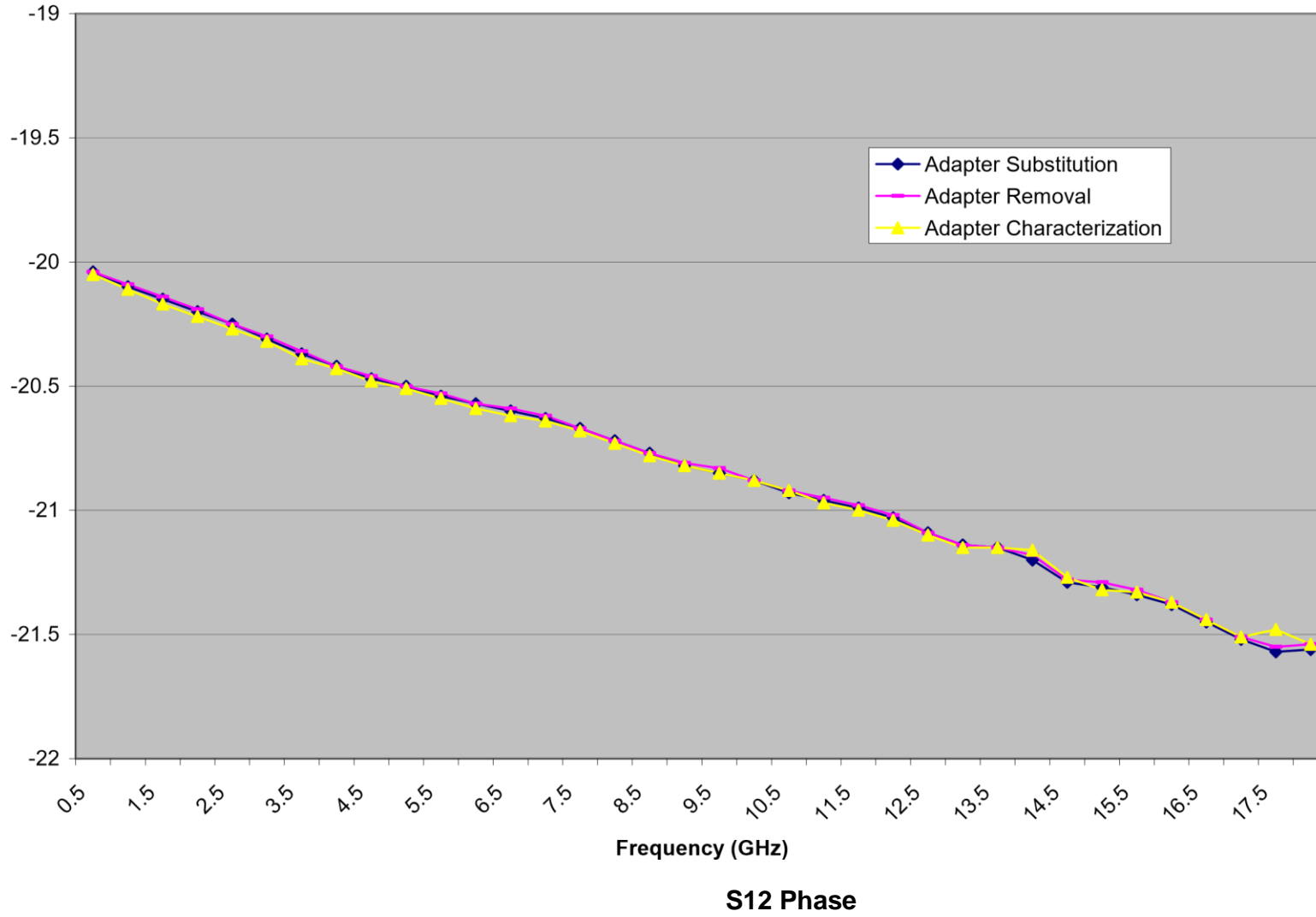
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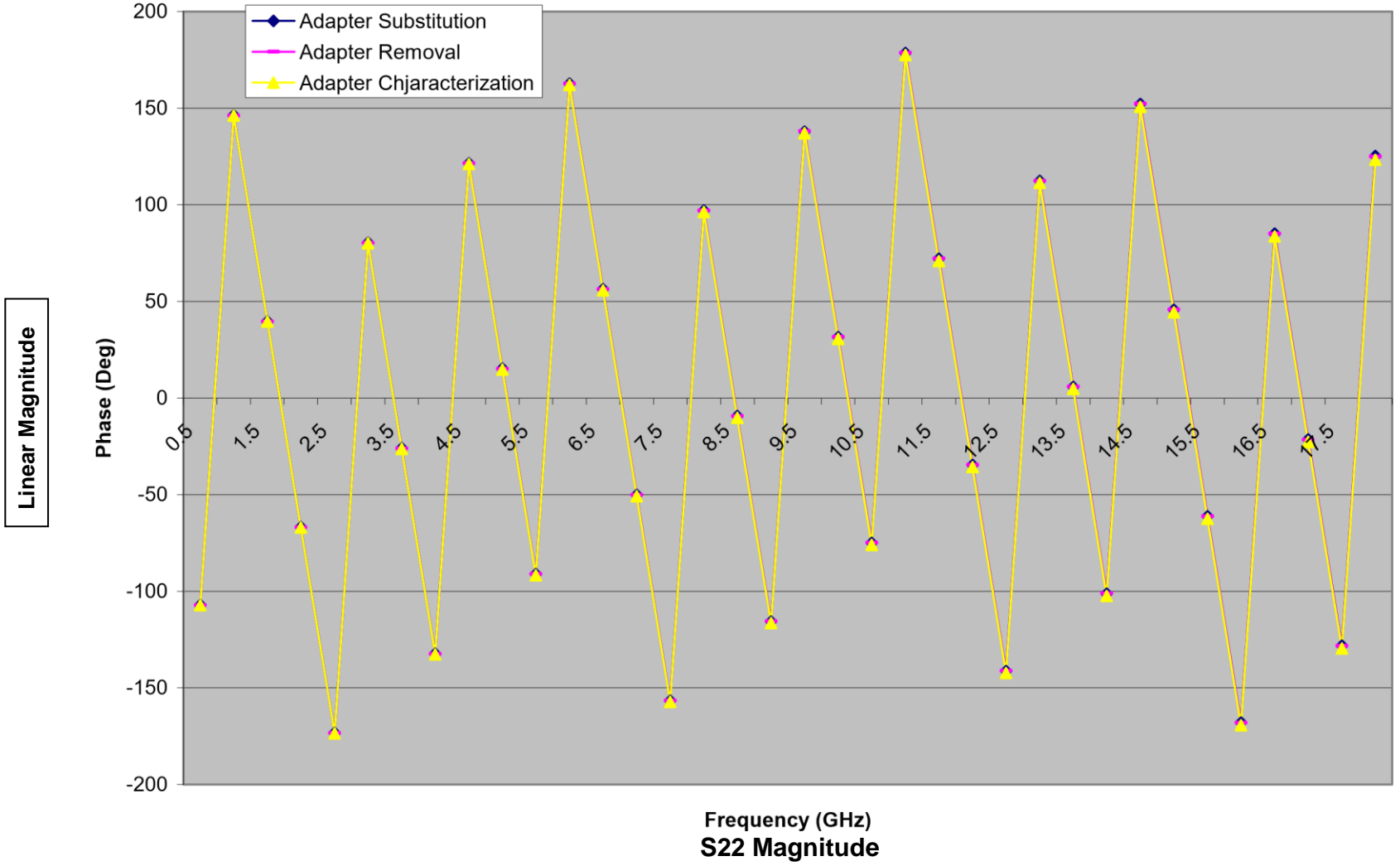
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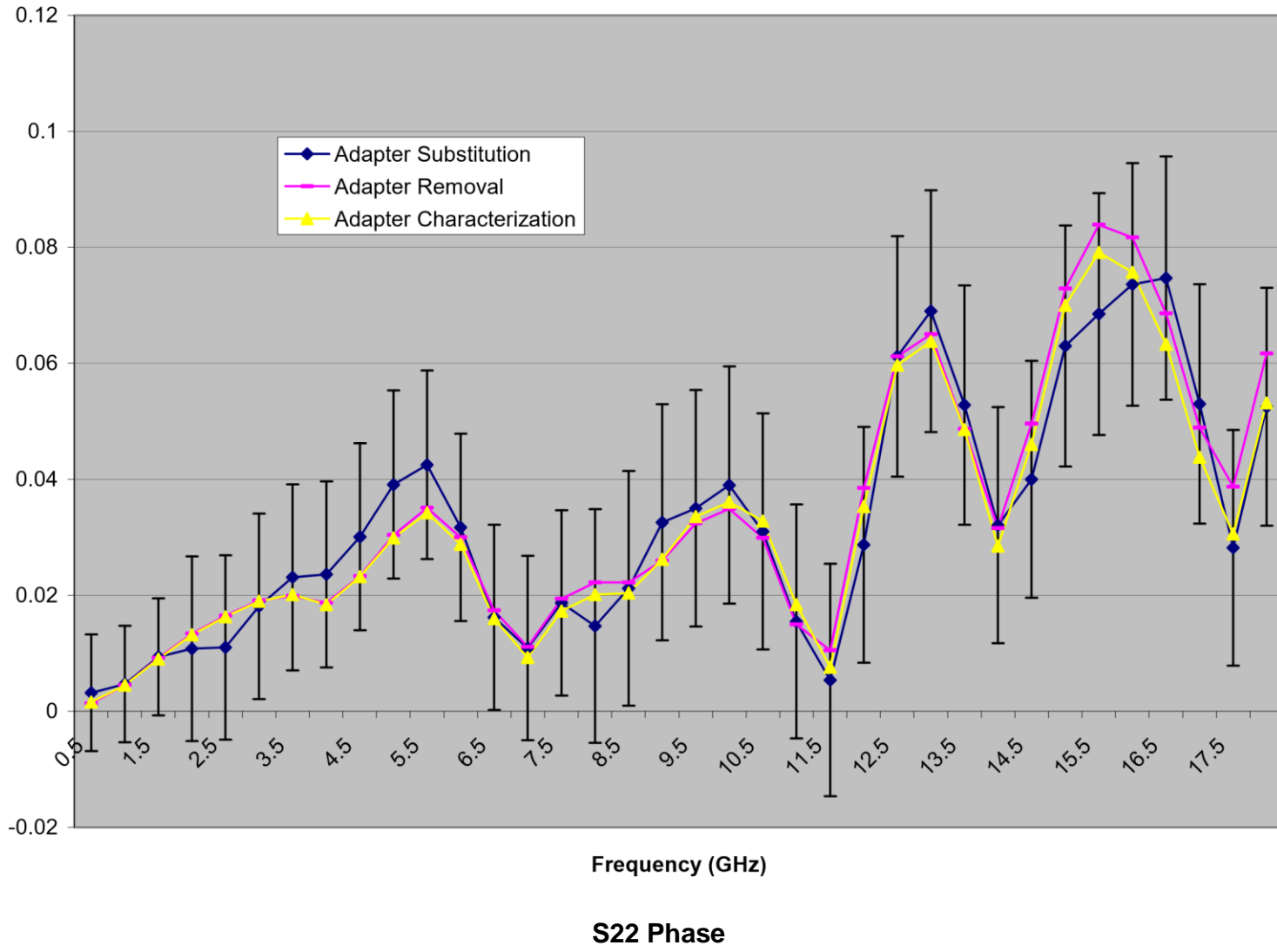


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