



Requirements for Polarizing Grid

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1 Introduction:

1.1 General:

A freestanding millimeter wave polarizer is specified. The device will be used in a millimeter-wavelength spectrometer application where the characteristics of both the transmitted and reflected field components are important. The plane that contains the polarizer will be orientated 45 degrees to the incident wave front. That is, the electric field of one linear polarization will be parallel with one dimension of the polarizer and the electric field of the orthogonal linear polarization will be orientated 45 degrees to the plane of the polarizer.

1.2 Scope:

This document describes all electrical and mechanical requirements of a millimeter wave polarizer operating within the described environmental conditions. In this document, the term *polarizer* is used to describe a complete device capable of separating linear orthogonal polarizations. The external mechanical characteristics of the device are specified in a mechanical drawing 340570-001. The term *wire grid* is used to describe a particular method of implementing a polarizer where a grid of parallel wires is attached to a rigid metal frame. The polarizer requirements are based upon electrical consideration, but a suggested wire grid design showing wire characteristics is included in the mechanical drawing.

1.3 Applicable Documents:

The following document forms part of the requirements to the extent specified herein.

[1] "Spectrometer Grid Frame" drawing number 340570-001, drawn by G. Gay, 25 Jun 2003 and checked by R. Freund, 1 Mar 2005.

2 Operating Conditions:

2.1 Environmental Requirements:

Two different environmental requirements shall apply. The performance of the device during operation shall be described by the "Operating Environment" requirements. Unless otherwise stated, all electronic and mechanical requirements shall be met when the device is subjected to these conditions. At all other times, the conditions described by the "Storage Environment" requirements shall apply. Exposure to these non-operating conditions shall not damage or modify the device so that it is unable to meet the specified electrical and mechanical requirements.

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2.2 Operating Environment:

A terrestrial environment at an elevation within the range of sea level to 1000 meters shall apply.

A normal laboratory environment maintained at a nominal temperature of 25C shall apply. A temperature range from 15C to 35C shall apply.

A normal laboratory environment subject to humidity within the range of 30% to 90% with no condensation shall apply.

A stable mechanical environment where no shock and vibration exist shall apply.

2.3 Storage Environment:

An environment within the temperature range of -50C to 75C shall apply.

An environment within the humidity range of 5% to 95% shall apply.

The shock and vibration associated with normal manual handling and common carrier transportation shall apply.

3 Technical Requirements:

3.1 Mechanical Requirements:

3.1.1 Frame:

The polarizer shall be placed within a rectangular metal frame with overall dimensions of 7.500 x 4.500 inches. The frame thickness shall be 0.250 inches. The dimension tolerances shall be ± 0.005 inches. The required material is 6061-T6 aluminum protected with a chromate chemical conversion coating per MIL-C-5541 Class 3. Details can be found in drawing 340570-001.

3.1.2 Aperture:

The frame aperture shall not be smaller than 5.500 x 3.500 inches. The inside corners can have a maximum radius of 0.125 inches. The polarizer shall fill the entire aperture to within 75 microns of the specified aperture width. Details can be found in drawing 340570-001.

3.1.3 Frame sag:

The sides of the frame over which wires might be attached shall not droop or sag by the force of the attached wires by more than 0.002 inches from the unstressed condition. This requirement applies at the location of maximum displacement.

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3.1.4 Frame flatness:

The flatness shall be maintained to less than 0.0005 inches over the 7.500 x 4.500 inch dimensions of the frame. This requirement applies after the polarizer has been installed. Detail can be found in drawing 340570-001

3.1.5 Glue trough:

A glue trough is permitted. The glue puddle shall not exceed 0.100 inches above the surface of the polarizer frame. The exact location of the glue trough is not specified.

3.1.6 Mounting holes:

Ten counter-bored through holes for number 8 screws shall be provided. Details can be found in drawing 340570-001.

3.2 Electrical Requirements:

3.2.1 Frequency range:

The polarizer shall meet the remaining electrical specifications over the frequency range of 65 GHz to 600 GHz.

3.2.2 Orientation:

The polarizer shall meet the remaining electrical specifications when orientated at a 45-degree angle with respect to the incident wave front.

3.2.3 Cross-polarization:

The polarizer shall deliver polarized waves with less than a -20 dB cross-polarized component.

3.2.4 Signal loss:

The reduction in the original signal by the combined effects of dissipated losses and propagation effects shall be less than 3.0% (approx. 0.13 dB). Propagation effects included any unwanted signal reflected from the polarizer or any unwanted signal leakage through the polarizer

4 Conformance:

Two different approaches to performance verification are permitted. One involves radiometric measurements of the polarizer and directly characterizes the device. The other indirectly characterizes the device by requiring analysis of a model using references to generally accepted theories. When implemented by a wire grid, conformance to the model shall be supported by physical measurements of the grid characteristics.

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4.1 Direct Measurements:

Two different radiometric measurements are to be made at three frequencies across the band of interest. The following sections describe the tests and the measurement frequencies.

4.1.1 Frequencies:

The performance of the device shall be characterized at three frequencies; 70 GHz, 200 GHz, and 550 GHz.

4.1.2 Loss:

The combination of dissipated losses and unwanted reflected signal from the polarizer or unwanted signal leakage through the polarizer shall be measured.

4.1.3 Cross Polarization:

The percentage of cross-polarized signal in the through path and reflected path shall be measured.

4.2 Indirect Measurements:

A mathematical model of the device based upon recognized theories shall be used to determine the design. The device shall be physically measured to determine its compliance with the model. For a polarizer implemented by a wire grid, measurements of the wire-to-wire spacing and wire diameter are required. For other implementations, additional modeling and mechanical measurements shall be provided to assess the device loss. This section details the required physical measurements for a wire grid.

4.2.1 Model:

The specific references to theory shall be provided. The design provided shall include the nominal wire diameter and wire-to-wire spacing.

4.2.2 Average Periodicity:

Measured values of the wire-to-wire spacing shall be provided. Measurements shall be made at three locations across the grid's aperture, at approximately 15%, 50% and 85% of the aperture width. The average standard deviation obtained from these three locations shall be less than 10% of the design spacing. The spacing of 30 wires at each location shall be used as the basis for the standard deviation measurements. Three microphotographs of the measured sections shall be provided to support the results.

4.2.3 Worst Case Periodicity:

The maximum or minimum spacing between any two wires anywhere within the aperture window shall be less than 130% or 70% of the design spacing respectively. The three microphotographs provided shall be used to confirm this requirement. Adherence to this requirement is not limited to the measurements detailed in the microphotographs.

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