Band-9 LO Frequency Multiplier

SPECIFICATIONS AND REQUIREMENTS

Status: Draft

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1. Introduction

This document details the specifications for the ALMA Band 9 millimeter wave frequency multiplier/sextupler comprising of a cascade of a frequency doubler and a frequency tripler integrated into a single metal housing.

2. Scope

This document provides details of the electrical and mechanical specifications for the Band 9 frequency multiplier/sextupler.

3. Related Documents and Drawings

3.1. Applicable Documents and Drawings

The following documents are a part of this document to the extent specified herein. If not explicitly stated differently, the latest issue of the document is valid.

Reference	Document Title	Document ID
[AD1]	ALMA Band-9 Coolable Frequency Sextupler – Mechanical Details	FEND-40.10.00.00-030-A-DWG
[AD2]	Non-standard waveguides and flanges used in Frequency Multipliers	FEND-40.10.00.00-013-C-DWG
[AD3]	ALMA Environmental Specification	ALMA-80.05.02.00-001-A-SPE

3.2. References

The following documents contain additional information and are referenced in this document.

Reference	Document Title	Document ID
[RD1]	ALMA Acronyms and Abbreviations	ALMA-80.00.00.00-004-A-LIS

Abbreviations and Acronyms

A limited set of basic acronyms used in this document is given below. A complete set of acronyms used in the ALMA project can be found in [RD1].

ALMA	**A**tacama **L**arge **M**illimeter **A**rray
NRAO	**N**ational **R**adio **A**stronomy **O**bservatory
VDI	**V**irginia **D**iodes, **I**nc.

4. Product Requirements

The requirements for the frequency multiplier/sextupler are presented below.

4.1. ALMA Band 9 Frequency Sextupler

Mechanical Specifications:

1. The outer dimensions of the frequency multiplier, the input and output waveguides and their flanges shall confirm to the mechanical drawing in [AD1]. Basic/nominal dimensions for the waveguides and their flanges are as follows:
    a. **Input waveguide**: WR-8 (2032 μm x 1016 μm nominal), Modified flange UG-387/U-M, with no boss relief on block as per [AD2].
    b. **Output waveguide**: WR-1.5 (381 μm x 191 μm nominal), Modified flange UG-387/U-M, with no boss relief on block as per [AD2].
2. The total mass of the completed assembly shall not exceed 30 grams.
3. The units shall be capable of withstanding vibrations as per [AD3].

Electrical Specifications:

1. **Input waveguide**: WR-8
2. **Output waveguide**: WR-1.5
3. **Output Power**: Goal should be greater than 40 μW output power at frequencies from 608 – 712 GHz with an input drive power of 30 mW in the 101.33 – 118.67 GHz frequency range at room temperature. Actual/measured output power should be greater than 20 μW output power at frequencies from 608 – 712 GHz with an input drive power of 30 mW for room temperature operation. The corresponding specifications for cooled 77 K operation (to be verified on receipt of the units by NRAO) shall be greater than 40 μW output power at frequencies from 608 – 712 GHz, again with an input drive power of 30 mW in the 101.33 – 118.67 GHz frequency range.
4. **Output power variation**: With a constant input power of 30 mW, the maximum output power shall not exceed the minimum output power by more than 6 dB at any frequency in the specified frequency range.
5. **Input Return Loss**: The design goal shall be to achieve a return loss of better than 12 – 15 dB over the specified frequency range with a 30 mW input drive power.

6. **Maximum Input Power Rating**: The frequency multiplier shall be able to withstand continuous input power of up to 40 mW CW without any degradation in performance.
7. **Spurious Output signals**: The frequency sextupler shall not exhibit any chaotic oscillations or have output CW components unrelated to the input drive signal when driven with a well matched source (such as an amplifier followed by an isolator) and with the output connected to a matched load.
8. **Harmonic content**: The level of the fourth, fifth and the seventh harmonics of the input signal should be less than -20 dBc.

Specifications for Cryogenic Operation:

The frequency multipliers will be operated at temperatures between 70 and 110 K and must meet their specifications at these temperatures. The units must be capable of withstanding temperature changes of 1 K/minute. During their lifetime, the units are expected to withstand at least 30 temperature cycles between room temperature and 70 K.