



**Atacama
Large
Millimeter /
submillimeter
Array**

ALMA Phasing Project Hydrogen Maser Maintenance Plan

ALMA-05.11.21.01-0004-A-PLA

2014-10-03

Prepared by:	Organization Role:	Date and Signature:
S. Doeleman	MIT Haystack / SAO	
C. Jacques	NRAO	
Product Assurance Approval:	Organization Role:	Date and Signature:
Bob Treacy	APP Product Assurance Manager	
JAO Approval	Organization Role:	Date and Signature:
Michael Hecht	APP Project Manager	

Change Record

Version	Date	Affected section(s)	Author	Reason/Initiation/Remarks
A.1	2014-09-22	All		Initial draft
A	2014-10-03	5,7		Modified sect. 5, added sect. 7

Table of Contents

1.	Description	3
1.1.	Purpose.....	3
2.	Related Documents and Drawings	3
2.1.	Applicable Documents	3
2.2.	Interface Control Documents	3
2.3.	Abbreviations and Acronyms.....	3
3.	General Maintenance Considerations	4
4.	Monitor and Control.....	4
5.	External Maser Monitoring: 1pps	5
6.	Sending Maser Diagnostic Data to T4Science.....	5
7.	Tools, Licenses and Test Equipment	5

1. Description

1.1. Purpose

This document describes the maintenance plan for the APP Hydrogen Maser.

2. Related Documents and Drawings

2.1. Applicable Documents

Ref	Document Title	Document ID
[AD01]	H Maser Procedures	ALMA-05.11.21.02-0001-A-PRO
[AD02]	H Maser Manual	ALMA-05.11.21.05-0001-A-MAN
[AD03]	ALMA Phasing Project Hydrogen Maser Test Data Report	ALMA-05.11.21.03-0002-A-TDR

2.2. Interface Control Documents

Ref	Document Title	Document ID
[ICD01]	ICD between APP and ALMA Back End	ALMA-05.11.10.00-50.00.00.00-A-ICD

2.3. Abbreviations and Acronyms

AD	Applicable Document
ADE	ALMA Department of Engineering
AIV	Assembly, Integration and Verification
ALMA	Atacama Large Millimeter Array
AOS	ALMA Operation Site
APP	ALMA Phasing Project
BE	Back End
CLOA	Central LO Article
COTS	Commercial Off the Shelf
CRD	Central Reference Distributor
CRG	Central Reference Generator
HM	Hydrogen Maser
ICD	Interface Control Document
LO	Local Oscillator
Maser	T4Science Hydrogen Maser
MFS	Master Frequency Standard
MIT	Massachusetts Institute of Technology Haystack Obs.
NRAO	National Radio Astronomy Observatory
OSF	Operations Support Facility
PAI	Preliminary Acceptance In-House
PAS	Product Acceptance On-Site
RD	Reference Document
TBD	To Be Determined
TDR	Test Data Report
UC	Universidad de Concepcion

	ALMA Phasing Project Hydrogen Maser Maintenance Plan	Doc N: ALMA-05.11.21.01-0004-A-PLA Date: 2014-10-03 Page: 4 of 5
--	---	--

3. General Maintenance Considerations

The iMaser 3000 provided to JAO by the APP is covered by a 7-year maintenance contract, which was purchased at the time of procurement. This contract covers parts, labor and travel if necessary by T4Science personnel until March 2018. Any maser failure that cannot be mitigated by JAO personnel should immediately be communicated to T4Science for trouble shooting and diagnostic assistance.

The APP recommends that JAO arrange for purchase of an extension for this maintenance contract past March 2018.

4. Monitor and Control

The H Maser Procedure document [AD01] includes all procedures necessary for monitoring maser diagnostics. These are available to the ALMA Operator and should be routinely checked to ensure diagnostic values are within acceptable ranges. The APP team will work with JAO to establish the nominal levels.

All Monitor and Control points and commands are also included in the H Maser Procedure document. It is envisaged that JAO staff will create scripts and routines necessary for the ALMA Operator to carry out standard operations of the maser. These include:

- a) Alerts of Maser Faults. The Maser diagnostics should be monitored and an alert to the ALMA Operator issued if key diagnostics are out of nominal range.
- b) Turning off the maser. This is typically done when a long-duration power outage is planned, and allows the maser to draw less power than when fully operational. Turning off the maser system in the proper sequence is essential and covered in the H Maser Procedure document.
- c) Turning on the maser. After a scheduled shutdown, the maser systems must be powered on in a specific sequence, making sure that prior levels of some diagnostics have been reached before some systems are powered on. Scripts and routines that enable this operation will utilize Monitor and Control commands to ensure the proper sequence is followed.



5. External Maser Monitoring: 1pps

The 1pps tick from the maser can be compared at several points in the APP and ALMA systems as per the H Maser Procedure document. The history and current offset of the Maser 1pps and the GPS 1pps should be monitored and any change in drift or offset noted by the ALMA Operator. The drift has been almost entirely removed by the APP team, and it is not envisaged that JAO personnel should have to adjust this, though that capability exists.

When the maser has been turned back on after being powered down, it will be necessary to re-synchronize the maser 1pps with GPS. This can be accomplished by connecting the GPS 1pps signal to the “1pps Input” connector on the Maser rack for several seconds.

Alternatively, by monitoring the maser 1pps tick one can determine the offset from GPS to the ~100ns level and advance/delay the maser 1pps via software commands [AD01]. Note that the maser 1pps signal is not required for any ALMA functionality, but solely as a diagnostic of maser performance. The maser 1pps derived from the maser 5/10MHz outputs is monitored internally with the ALMA software system.

6. Sending Maser Diagnostic Data to T4Science

T4Science will review the Maser diagnostic data, looking for trends that require attention. It is recommended that the diagnostic data collected by the Maser and/or APP system be routinely sent to T4Science for such analysis.

7. Tools, Licenses and Test Equipment

During the installation and integration of the maser, it was useful to have on hand several pieces of test equipment as described in [AD03]. These are optional and not required for normal maintenance. If, however, a maser fault occurs, these tools (or similar) could be brought to the AOS for testing.

There are no special licenses required for running the maser or for any maintenance tasks.