Atacama
Large
Millimeter /
submillimeter
Array

ALMA CLOA Central Racks Modification for the ALMA Phasing Project

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1 Introduction

1.1 Purpose

This document details the current status of the ALMA Central LO racks, and sets forth the requirements for a modification to include a custom hydrogen maser rack.

1.2 Scope

This document is intended for informational purposes only. It is not a Statement of Work.

1.3 Reference documents

[RD 1] ALMA Back End IPT Seismic Support Statement of Work, BEND-57.00.00.00-002-A-SOW, 2005-12-30

[RD 2] Backend IPT Seismic Support Specification, BEND-57.00.00.00-001-A-SPE, 2005-12-30

[RD 3] Back End IPT Addendum to Seismic Support Statement of Work, BEND-57.00.00.00-004-A-SOW, 2006-03-07

[RD 4] Backend IPT Addendum to Seismic Support Specification, BEND-57.00.00.00-003-A-SPE, 2006-03-06

[RD 5] SSLOR Seismic Support Design Report, Southwest Research Institute, Proj#12023, Doc #18.12023.01.101-DR1, April, 2006

[RD 6] ALMA Back End IPT Central LO Seismic Rack Statement of Work, BEND-57.02.03.00-003-A-SOW, 2006-10-19

[RD 7] ALMA Back End IPT Central LO Seismic Rack Specification, BEND-57.02.03.00-002-A-SPE, 2006-10-31

[RD 8] Central LO Rack Production Drawings, BEND-57.02.03.00-006-A-DWG, 2005-09-26

[RD 9] iMaser 3000, Installation, Operation, and Maintenance User Manual, T4-Science, Doc# T4S-MAN-0012, Issue 1.7, 28.05.2010

1.4 Acronyms

AC	Alternating Current
ALMA	Atacama Large Millimeter Array
AOS	Array Operations Site (Tehcnical Building)
CLOA	Central Local Oscillator Article
DC	Direct Current
HM	Hydrogen Maser
HMR	Hydrogen Maser Rack
LO	Local Oscillator
NRAO	National radio Astronomy Observatory
SOW	Statement of Work
UPS	Uninterruptible Power Supply

2 Background

In 2005 and 2006, the design of the ALMA Central LO racks and the support structure for these racks was completed. This included seismic compliance analysis and design features for the support structure, and seismic Zone 4 rating for the racks themselves. The design consisted of two rows of seven racks, with each rack bolted to the adjacent rack or racks, and each row of racks bolted to a seismic support structure. The seismic support structure was in turn bolted to the concrete floor which is an isolated concrete pad in the ALMA AOS Technical Building. Around the raised support structure and at the same level as the top of the support structure, a raised computer floor was installed. Beneath the computer floor was a pressurized plenum for cooling air ducted to the bottom of the racks, and a grounding pigtails for providing a rack connection to earth ground. Photos of these features are included as Fig 1—5.

The references to the prior work and the existing installation is made in **[RD 1—8]**. References **[RD 1—4]** contain the Statements of Work and specifications for the analysis and design of the seismic support structure, and **[RD 5**] is the final report against the contract for this work. References **[RD6—8]** contain the Statement of Work, specifications, and final drawing set for the Central LO racks.

3 AOS Technical Building LO Room

The AOS LO room houses all of the ALMA Central LO equipment. The AOS building itself is a technical building at 5000m elevation and contains the ALMA Correlator, Central Computing facility and Fiber Optic Patch Panel in addition to the Central LO. The LO room has a custom isolated concrete pad which was installed to provide vibration isolation to the sensitive LO equipment. The photo in Fig. 1 shows this pad during construction. The seismic mount and CLOA racks are now mounted on this concrete pad.

Figure 1 - Isolated concrete pad for AOS LO room

4 Seismic Support Structure

A seismic support structure was designed **[RD 5]**, and constructed and installed in the LO room. The photo in Figure 2 shows the initial layout of the support structure on the concrete floor. The

photo in Figure 3 shows a closeup view of one section of the seismic support structure. The photo in Figure 4 shows the installed support structure with the adjacent computer floor also installed so that both have surfaces that are at the same level.

Figure 2 - Frame of Seismic support structure shown laid out on top of the isolated slab prior to installation

Figure 3 - Close up photo of one section of the seismic support structure.

Figure 4 - Photo of the installed seismic support with the computer floor installed flush with the top surface

5 Central LO Racks

The Central LO Racks were designed to ALMA/NRAO specification [RD 7] by Equipto, Inc. The racks meet the Telcordia Technologies GR-63-CORE (formerly Bellcore GR-63) Issue 1, April 1995 or Issue 2, April 2002 Zone 4 Seismic Standard, as certified by an independent seismic testing laboratory.

These racks were delivered to NRAO in Charlottesville, VA in {insert date}. The racks were then outfitted and tested in Charlottesville, then shipped and reinstalled in the AOS LO room in 2009 (partial) and 2011. These racks are 611.2 mm, 916.0 mm, 1692.3 mm in width, depth, and height. The racks are intended to bolt to each other in the width direction with up to seven racks per row. In the final installation in 2011, only 12 of the 14 racks have been installed as shown in Figure 5. The two unused racks have been kept as spares.

Figure 5 - Final installation of Central LO racks

6 Central LO Racks Modification

An addition is now being planned for the Central LO racks installation. A new equipment rack consisting of a hydrogen maser and some auxiliary equipment will be added. However, the hydrogen maser does not fit into one of the original Equipto model racks. Instead, the plan is to procure a new, wider rack that will fit into the footprint allocated for the two endmost racks in the second row (see Figure 5). Though the rack shall be wider than the existing racks, it will be required to interface to the existing available bolt holes in the seismic support structure. (The seismic structure has four bolt holes for each rack location. Each bolt hole is 0.750 inch diameter thru hole. The existing racks and seismic structure both have thru holes, and the racks are attached to the seismic structure by means of an M16 x 2 x 70mm bolt with a torque nut on the underside of the seismic structure.)

It has been confirmed that a Zone 4 seismic rack form the same manufacturer (Equipto) is available with additional width of 11 inches.

7 Hydrogen Maser Rack (HMR)

The new hydrogen maser rack will be similar to the existing CLOA racks except having added width. A baseline plan is for the rack to have a width of 890.5mm (35.06 in.) instead of 611.2 mm (24.06 in.). The contents of the rack will include the items described in the following sections.

7.1 Hydrogen Maser

The hydrogen maser is Model Number "iMaser 3000" by T4 Science SA. The physical specifications are as detailed in Table 1. A photo of the maser is shown in Figure 6, and a view behind the front panel is shown in Figure 7.

Specification	Detail
Size	600 mm (W) x 870 mm (H) x 800mm (Depth)
Weight	110 kg
Rack	19-inch Smaract EMC 18U D800, see http://www.knurrusa.com/vmchk/Smaract%C2%AE-19-Compact-Rack-/-Enclosure-EMC-With-Sheet-Steel-Door.html
Rack Material	Sheet Steel, 3.0mm, passivated zinc finish
Mounting	The rack is mounted on four shock mounts part number 7002-GB from Paulstra-Vibrachoc

Table 1 – Hydrogen Maser Physical Specification

Figure 6 - Hydrogen Maser. Note: the maser assemblies are built into an RFI rack, which in turn will be mounted in a CLOA seismic rack.

The hydrogen maser assemblies built into this rack consist of:

- An electronics package: low-noise electronics, and secondary electronics
- A physics package: hydrogen supply, and storage bulb, microwave cavity, magnetic shield assembly, and vacuum systems

Additionally, external to the maser is a UPS battery assembly and charger, see next section.

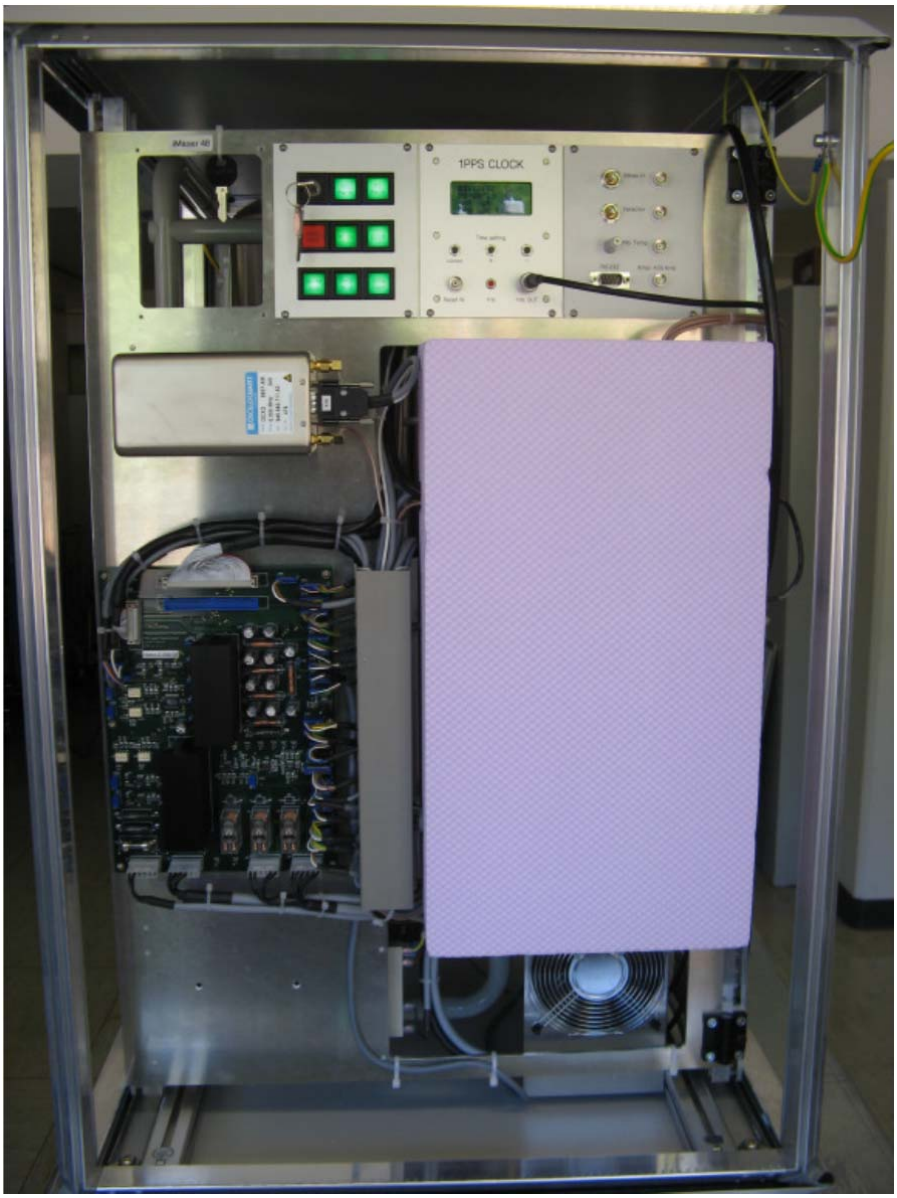

Figure 7 - H-maser front panel view

7.2 Batteries

The H-Maser has a UPS battery assembly consisting of two batteries and a charging assembly. The batteries charger assembly has a 230V, 50 Hz AC input with an IEC320 inlet receptacle connector. An AC power cord is required between the Power Distribution Unit and the battery charger assembly. The batteries are connected to the H-maser by a custom DC cable provided by the H-maser manufacturer. This assembly shall be hard mounted within the HMR. The batteries are installed in a battery box with dimensions of 600 mm (W) x 200 mm (D) by 400 mm (H), shown in Figure 8 - Photo of H-Maser UPS battery assembly

Figure 8 - Photo of H-Maser UPS battery assembly

8 Issues to Resolve

The following is an initial list of items that need require first new design and analysis; then possibly parts fabrication and assembly.

1. Seismic (non)-compliance of hydrogen maser: The maser rack is sheet steel and the contents may not be ruggedized. This is a one-of-a-kind instrument. The most straightforward approach is for all parties to accept risk of damage to this instrument but seek to minimize damage and protect secondary damage by external seismic mounting.
2. H-Maser Mounting Seismic Design
   - Procurement of seismic rack
   - Mounting Fixtures for H-Maser
3. Interface of new seismic rack with existing seismic support structure
   - Specification of bolts, spacings, …etc. and any necessary additional mounting features
   - Compliance of new CLOA support and rack structure with ALMA seismic requirements (Telcordia GR-63-CORE Network Equipment & Building Systems (NEBS) requirements for Zone 4 Seismic Earthquake Environments)
4. Battery Mounting and Enclosure Design
   - Safety
   - Battery maintenance
   - seismic compliance
   - UPS and battery seismic mounting/anchoring
     - Insulated shelf?
     - Spill recovery (use of absorbent material?)