Proper use for AOS Fiber Optic Patch Panel Procedure

ALMA-54.10.02.00-0007-B-PRO

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Change Record

Version	Date	Affected Section(s)	Author	Reason/Initiation/Remarks
A	2013-03-05	All	Leonardo Bustos Vega	Initial draft
B	2016-01-28	4,9.2	Jorge Castillo	Add the a remark warning about the risk of connecting a Morita LLC to a baseline PAD, and a correction on the patch panel ideal configuration. Add the switch gear and the weather stations. Correct the ideal configuration of the CLO configuration.

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1 Description

1.1 Background

In order to improve the fiber optic routing and reduce the damage in the connectors, in the cables and patch panel, it was decided to develop a procedure for maintenance and operation in order to increase the life time of the different components of it.

1.2 Purpose

This document describes the different procedures needed to operate the AOS Patch Panel in efficient assuring adequate levels of safety for personnel; specifically this document describes the proper use and care of the AOS Patch Panel.

1.3 Scope

This instruction document is limited to the optical fiber cabling of the AOS patch and inside the Technical Building.
The optical fiber cable carries four signals to/from each antenna station:

- Data Transmission System (DTS): the scientific data, from Antenna to TB
- Local Oscillator (LO): an accurate time reference, from TB to Antenna
- Monitor and Control (M&C): Ethernet LAN, 2 signals, bi-directional
- And four fiber spare.

2 Related Documents and Drawings

2.1 Applicable Documents

Appl.	Document Title	ALMA Doc. Number
[AD01]	AOS Connectivity Checklist	AIVD-20.01.00.00-004-B-PRO
[AD02]	ALMA Fiber Optic Cleaning Procedures	ALMA-50.00.00.00-156-A-PRO

Table 1 Applicable Document List

2.2 Reference Documents List

Ref	Document Title	ALMA Doc. Number
[RD01]	ALMA BACK END FIBER OPTIC PATCH PANEL AOS TECHNICAL BUILDING Statement of Work	ALMA-54.00.00.00-011-A-SOW
[RD02]	ALMA BACK END FIBER OPTIC PATCH PANEL FOR AOS TECHNICAL BUILDING Specification	ALMA-54.00.00.00-012-A-SPE

Table 2 Reference Document List (RDL)

3 Definitions, Abbreviations and Acronyms

ACA	Atacama Compact Array
AD	Applicable Document(s)
AOS	Array Operations Site (Chajnantor)
BE	Back End
Cabinet	Enclosed framework for mounting equipment
Cable Assembly	Multi-fiber cable with connectors pre-terminated at both ends
DTS	Data Transmission System
FO	Fiber Optic
LO	Local Oscillator
M&C	Monitor and Control
NAOJ	National Astronomical Observatory of Japan
NRAO	National Radio Astronomy Observatory
OSF	Operations Support Facility
PP	Patch Panel
Patchcord	1 or 2 fiber cable with connectors on both ends
Pigtail	1 or 2 fiber cable with connectors on one end only
Rack	Any framework that can accommodate equipment
RD	Reference Document(s)
TB	Technical Building
ESG	Engineering services group

4 General

ALMA consists of 66 millimeter wave antennas, the antennas are grouped in two arrays: the ALMA-B composed by 50 Antennas, 25 of them were funded and build by NRAO and the other 25 by ESO, and the MORITA Array (In honor of Professor Koh-Ichiro Morita, ALMA System Verification Scientist, who died in Santiago on May 7th 2013. Morita-san was very well liked and highly respected by his colleagues and a renowned astronomer in his field.) Composed by 16 antennas build and funded by NAOJ. Each ALMA-B antenna can be located on any of 177 fixed locations (antenna stations), while each MORITA antenna can be located in any of 22 fixed locations.

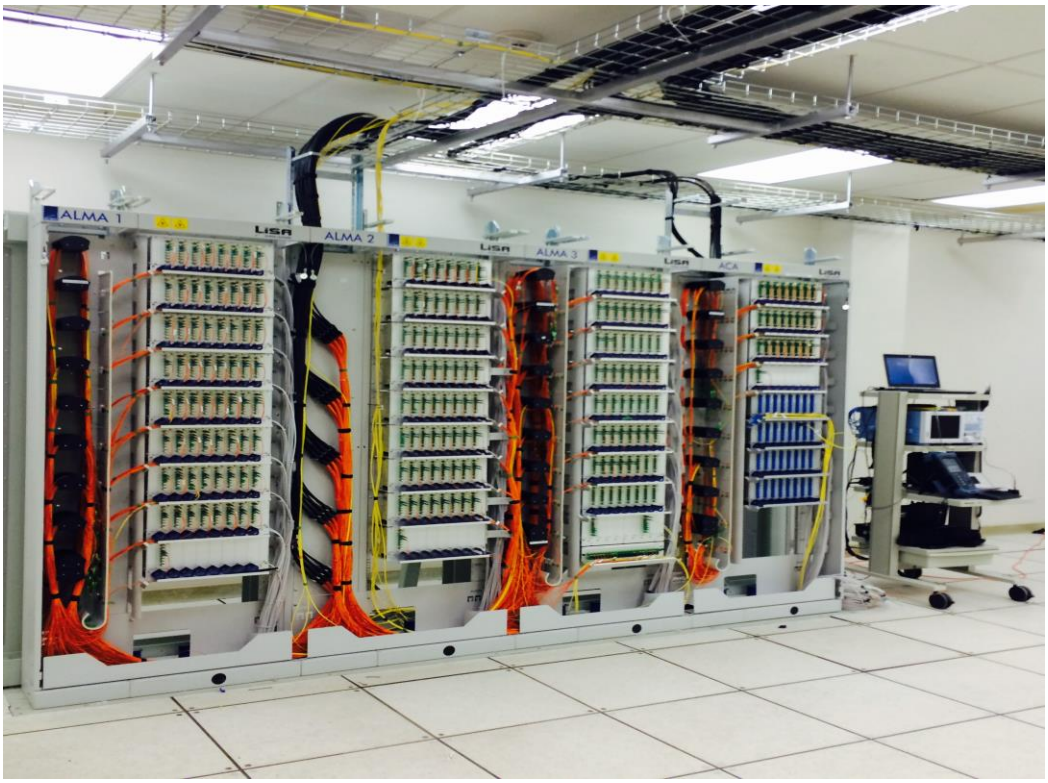

Figure 1 AOS PATCH PANEL ROOM

Each antenna station is connected by optical fibers to the Technical Building, where control and signal processing electronics is located.

The room of the TB in which the Patch Panel is installed is the Patch Panel room. The DTS as well as the M&C destinations are located in the Patch Panel, while the LO destinations are in a separate room, the LO room.
Additionally, Patch Panel support others fibre optics services. Under ACA Patch Panel, are installed the SWGR sub-rack's connections with SC connectors. SWGR (Switch gear) is used for monitoring and control for Remote Recovery in case of unexpected

electrical shutdown. At the same location (under ACA Patch Panel), are installed the Meteorology Stations (MS), sixteen of them are distributed across the AOS. The operation of this section of the patch panel, is as simple as matching the fibre label with its matching label on the sub-rack.

5 Design

The sketch below shows a block diagram of the connectivity requirements of the patch panel room and is the basis for the design.

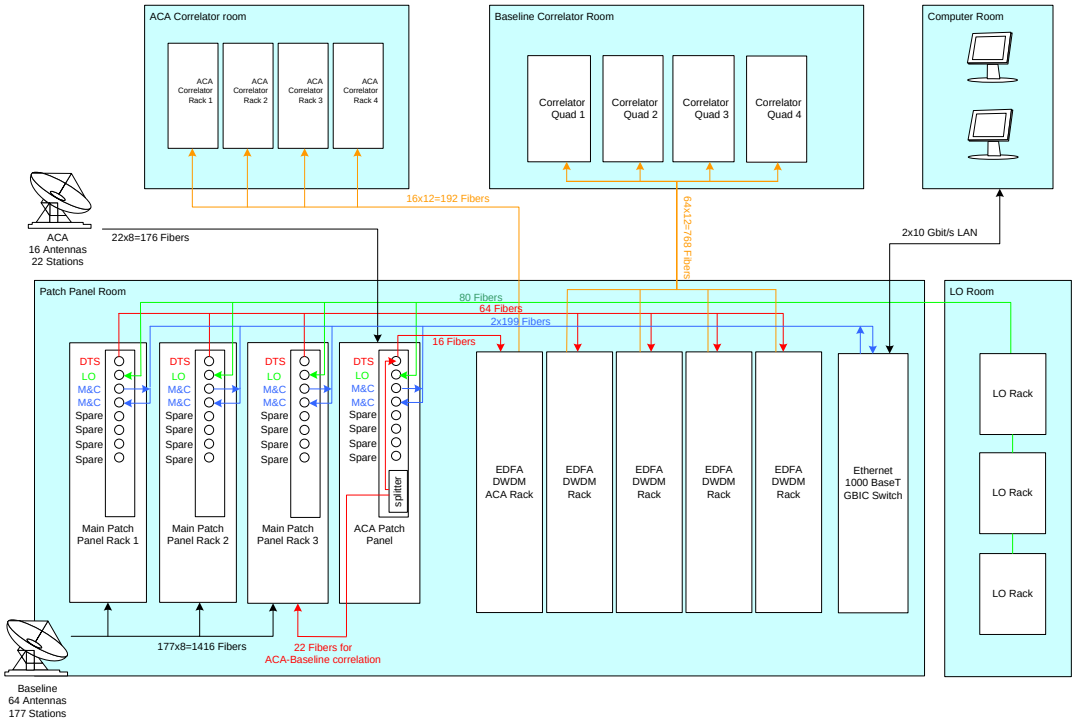

Figure 2 Connectivity Block Diagram

The Patch Panel consists of four racks, three for handling the ALMA-B pads connectivity and one for the MORITA pads connectivity. The aim is to provide a clear layout for easy and safe operation. All fibers from one station terminate on the same connector module, and the modules are presented in numerical order from top left in the rack. Within each module, the functions M&C, DTS, LO are color coded on both the patch sheath and the connector, and the connectors are also keyed to prevent incorrect connection.

1)	DTS	Re mark RED color
2)	LO	Re mark Yellow color
3)	MC in	Re mark Blue color
4)	MC out	Re mark Light Blue color
5)	Spare	Green
6)	Spare	Green
7)	Spare	Green
8)	Spare	Green

Table 3 Color Code

The Patch Panel is designed to handle a total of 66 antennas, 50 of which are capable of being positioned on any of the 177 baseline stations (ALMA-B) and the remaining 16 antennas distributed over 22 MORITA stations.
28 spare connection modules were considered in the Patch Panel racks, in order to accommodate future extensions of the Array.
The DTS signal coming from the MORITA stations is split within the ACA Patch Panel and brought both to the ACA and the ALMA-B from panel.
Only the DTS connections from the MORITA stations are split to feed both ACA and the baseline systems.

Each station is connected to the TB by means of eight fibers. This provides for 4 spare fibers per station. Each connection module on the Patch Panel provides 8 connections, including the 4 spare fibers.

6 Fiber Connector Modules

The key to the ordered design and patching in the distribution cabinet is the use of commercial fiber connector modules.

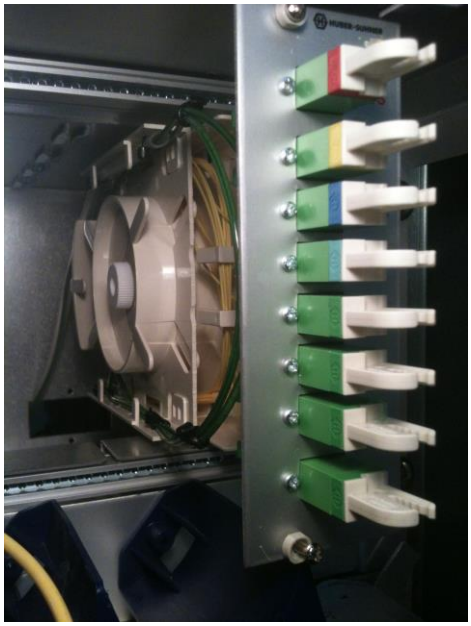

Figure 3 Fiber Connector modules

7 Laser Safety

All items involving laser are marked with the appropriate safety labelling and be fully compliant with ANSI Z136.2 and /or IEC 60825-2. The patch panel racks have laser safety labels. The labels are written both in English and Spanish.
Any work on panels that includes the removal of fiber cables and patch leads must be authorized by Backend team leader and coordinated with fiber optic staff where it is confirmed that optical transmission has been stopped.

8 Laser risk protection

The possibility of injury to staff eyesight is minimized by the use of E2000 connectors. These fittings incorporate a plastic shutter that closes when removing connectors preventing stray laser light from being emitted. On the patch panel, fiber connector modules are fitted with E2000 connectors and attenuators. Removal of any of these items means that the optical path will automatically be closed off by the shutter arrangement protecting all plugged components.

In case some of these connectors don't have plastic shutter, this should be notified to the supervisors or patch panel responsible to repair or replace this connector.

9 Proper use of the AOS patch panel

During the maintenance periods the AOS patch panel has been ordered, cleaned and labelled to prevent damages in the fibers and connectors.
To meet the above must follow and respect the following steps:

9.1 Fiber Optic movement:

- Comply with the procedure indicated in the reference document [AD01]:
- The MC fibers are labeled according at the PAD associated (M&C XXX PP) and never should be disconnected from patch panel.
- The LO fibers are labeled and assigned to each antenna (PP LO_XX) and this must be connected according at the Table 4 Ideal LO fiber distribution.
- The DTS fibers are labeled and assigned at each FOAD (DTS PP XX) which is designated by the correlator staff at each antenna.

The fibers were routed and stored in the patch panel according to its signal, each route and storage is labeled (see Figure 4 and Figure 5).

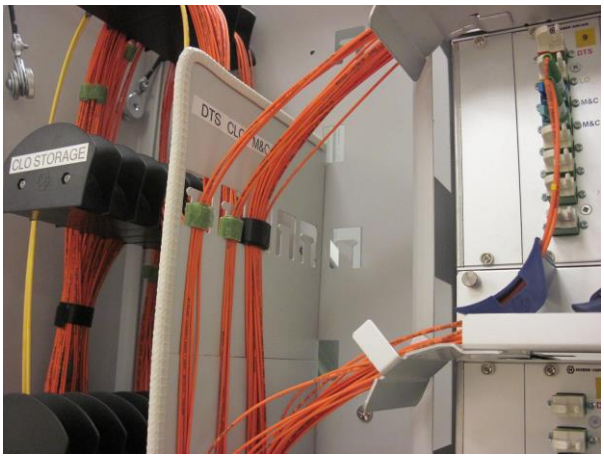

Figure 4 Fiber route

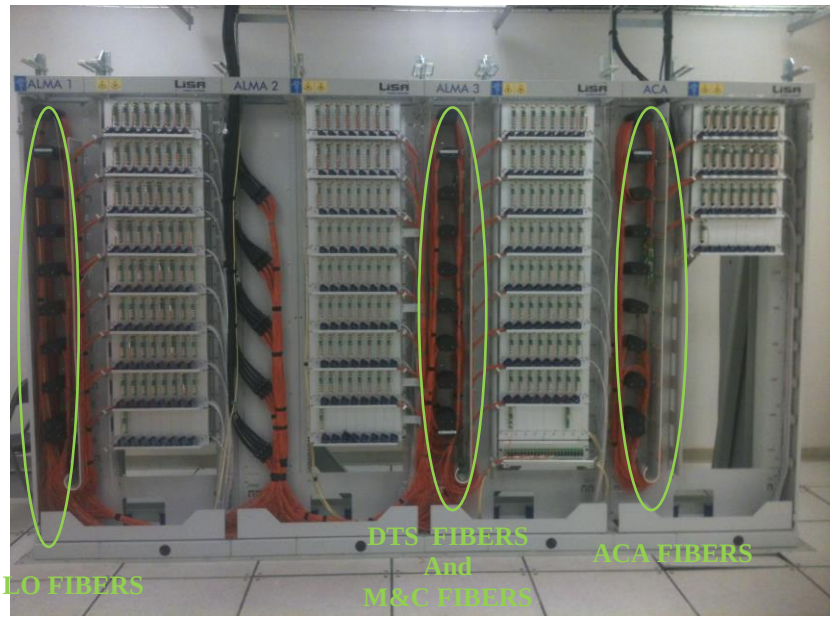

Figure 5 Location storage

ANTENNA	FIBER LABEL
DV01	PP LO_01
DV02	PP LO_02
DV03	PP LO_03
DV04	PP LO_04
DV05	PP LO_05
DV06	PP LO_06
DV07	PP LO_07
DV08	PP LO_08
DV09	PP LO_09
DV10	PP LO_10
DV11	PP LO_11
DV12	PP LO_12
DV13	PP LO_13
DV14	PP LO_14
DV15	PP LO_15
DV16	PP LO_16
DV17	PP LO_17
DV18	PP LO_18
DV19	PP LO_19
DV20	PP LO_20
DV21	PP LO_21
DV22	PP LO_22
DV23	PP LO_23
DV24	PP LO_24
DV25	PP LO_25
DA41	PP LO_26
DA42	PP LO_27
DA43	PP LO_28
DA44	PP LO_29
DA45	PP LO_30
DA46	PP LO_31
DA47	PP LO_32
DA48	PP LO_33

ANTENNA	FIBER LABEL
DA49	PP LO_34
DA50	PP LO_35
DA51	PP LO_36
DA52	PP LO_37
DA53	PP LO_38
DA54	PP LO_39
DA55	PP LO_40
DA56	PP LO_41
DA57	PP LO_42
DA58	PP LO_43
DA59	PP LO_44
DA60	PP LO_45
DA61	PP LO_46
DA62	PP LO_47
DA63	PP LO_48
DA64	PP LO_49
DA65	PP LO_50
CM01	ACA PP LO_65
CM02	ACA PP LO_66
CM03	ACA PP LO_67
CM04	ACA PP LO_68
CM05	ACA PP LO_69
CM06	ACA PP LO_70
CM07	ACA PP LO_71
CM08	ACA PP LO_72
CM09	ACA PP LO_73
CM10	ACA PP LO_74
CM11	ACA PP LO_75
CM12	ACA PP LO_76
PM01	ACA PP LO_77
PM02	ACA PP LO_78
PM03	ACA PP LO_79
PM04	ACA PP LO_80

Table 4 Ideal LO fiber distribution

9.2 ACA Fibers use restriction.

It is important to note, that given the current design of the patch panel, the ACA fibers shall be used exclusively to connect ACA PADs. Not following this restriction will increase the risk of damaging the fibers due to the short dimensions of them; as an exception, if a high priority requirement is made to perform such a connection, the fiber shall be extended using a patch cord; this exceptional connection shall be registered and removed as soon as it is no longer required.

9.3 Cleaning procedure:

- Before connecting the fibers to an antenna that was placed in a PAD they must be cleaned in accordance at reference document [AD02] and next tips.
- Discover the E-2000 cap with H+S TOOL-SPEC-FLSH-SERV-ADA, according to Figure 6 and Figure 7. And slide the connector over the dry tape one or two times.

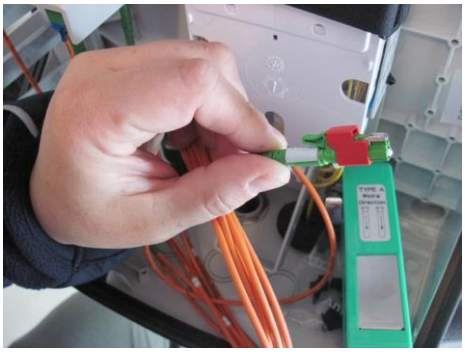

Figure 6 E-2000 connector

Figure 7 E-2000 special tool

- Internal Cleaner: Used for pig tail into the E-2000 connection in Patch panel. You can push 2 or 3 times into the E-2000 ferrule (see Figure 8).

Figure 8 Internal cleaner

9.4 Connection and Disconnection of fibers:

- Before any disconnection and connections, make sure the ID resources.
- Verify the new resources before any rerouting.
- The MC fiber never should be disconnected from PAD (Slot fiber).
- If the slot are used for other LO and DTS fibers, please be careful in disconnect the fibers and reroute to the storage location in patch panel.