Atacama
Large
Millimeter
Array

APP Optical Fiber Link maintenance manual

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1 Introduction

1.1 Purpose

This document summarizes the way of the maintenance of the Optical Fiber Link system in the APP.

1.2 Reference Documents

[RD 1] ALMA Phasing Project Plan
[RD 2] Optical Fiber Link System Design
[RD 3] Optical Fiber Link Operation Manual

1.3 Abbreviations and Acronyms

APP	ALMA Phasing Project
AOS	Array Operations Site
DWDM	Dense Wavelength Division Multiplexing
FIT	Failures In Time
ITU	International Telecommunication Union
OFL	Optical Fiber Link
OSF	Operations Support Facility
MTBF	Mean Time Between Failure
NAOJ	National Astronomical Observatory of Japan
PIC	Phasing Interface Card
VLBI	Very Long Baseline Interferometry

2 Specification of the OFL system

2.1 General specifications

The purpose of the OFL system is to transmit the antenna sum data from the AOS to the OSF while using minimal fiber resources [RD01]. The eight 10 GbE data streams are wavelength-division-multiplexed onto one fiber at the AOS. This data is transmitted to the OSF where it is demultiplexed and routed to the appropriate recorder sub-system. The optical fiber link system (a pair of a transmitter and a receiver) is fully symmetric and the two devices are inter-changeable as they are totally in the same design. The device has no packet monitoring capability, so it is a passive participant in the VLBI phasing system.

The part of this subsystem that is installed at the AOS is called the Fiber Multiplexer (MUX). The part that is installed at the OSF is called the Fiber Demultiplexer (DeMUX). The

Multiplexer and Demultiplexer are identical devices. Both can transmit and receive data. In the APP application, the Multiplexer will transmit to the Demultiplexer, but no transmission is planned in the other direction.

2.2 Exchangeable units

The following units that compose the Multiplexer and Demultiplexer are exchangeable. For prompt recovery from failure of these units, spare units are in stock for 10GBASE-SR, cooling fans, and power supply. For 10GBASE-ZR, the nine modules all differ from each other as they have independent wavelengths for TX and RX, and thus the spare unit for replacement should be built on order. This may take a few months to a half year to have new ZR module. However, the redundant 9 ports in MUX and DeMUX still allow regular operation in case that one of ZR modules is in failure.

- **10GBASE-SR module (*)**
- **10GBASE-ZR module**
- **Cooling fans (*)**
- **Power supply module (*)**

(*) modules with spare units in stock

3 Regular Maintenance

For operating the OFL, the following cleaning is required as regular maintenance.

- Cleaning of fiber connectors to 10GBASE-SR and ZR modules: in particular fibers connected to 10GBASE-SR modules need to be cleaned every ~6 months, both for the MUX at AOS and DeMUX at OSF. The fibers connected to 10GBASE-ZR ports may need cleaning occasionally.
- The filter of the air intake (on the front panel of MUX and DeMUX) also needs occasional cleaning. This also applies to both the MUX at AOS and DeMUX at the OSF.

To conduct the cleaning the fibers to the 10GBASE-SR modules, simply pull out the optical fibers from the SR ports on the front panel. For cleaning the fibers connected to 10GBASE-ZR modules, please see figures 13 to 15 below for accessing the ZR modules.

To remove the air intake filter for its cleaning purpose, please refer to figures 13 and 14 below.

4 Finding out troubles

4.1 Basic diagnostics

In case that there is possible failure related with OFLs, the first thing to do is to check the status of the MUX and DeMUX through the network connection. This can be done by sending "show_alarm_str" command, see the operation manual [RD3]. Possible alarms are:

(1) Temperature alarm
(2) FANx(x=1~3) alarm
(3) All XFP modules are stopped.
(4) AC/DCx(x=1or2) alarm
(5) The XFP module of the 10G local portx(x=1～9) is not present
(6) The XFP module of the 10G ZR portx(x=1～9) is not present
(7) The XFP module of the 10G local portx(x=1～9) detects operational fault.
(8) The XFP module of the 10G ZR portx(x=1～9) detects operational fault.
(9) The XFP module of the 10G local portx(x=1～9) detects receiver loss of signal.
(10) The XFP module of the 10G ZR portx(x=1～9) detects receiver loss of signal

In case of alarm (1), check the environmental temperature and also the fans.
In case of alarm (2), check the fans, and if necessary, replace the failed fan with a new one
The alarm (3) is issued in case of temperature alarm, or two or more FAN alarms, and in that case all the XFP modules are stopped for self-protection. Check the fans and the environmental temperature.
In case of alarm (4), check the power supply module (see below on how to do this), and replace it with a new one if necessary.
In case of alarm (5)-(6), check the relevant SR or ZR modules are properly set to the MUX/DeMUX.
In case of alarm (7)-(10), first check the optical power in a way summarized below. If the module is apparently in failure, replace it with new one. If not, clean up the connectors again.

4.2 10GBASE-SR/ZR optical power

Measuring the optical power of 10GBASE-SR and ZR modules are powerful diagnostics to test if these modules are working properly. Use an optical power meter to check the output/input power of the SR and ZR modules. Remember to use a multi-mode fiber for SR measurements, and a single-mode fiber for ZR. The following table summarizes typical range of inputs/outputs. If the measurements are far out of that range, the corresponding module is likely to be in failure (if the minimum input power is improper, it implies that there is trouble in the counterpart module or transmission line).

Module type	Typical output	Minimum input
10GBASE-SR	-4.0 +/- 2.5 dBm	-25 dBm
10GBASE-ZR	+1.5 +/- 2.5 dBm	-25 dBm

Note that there may be power attenuation in connectors and/or fibers between the module under measurement and the optical power meter.

5 Parts replacement

In case that the failure part should be replaced with a new one, please following the instructions below.

5.1 How to replace a 10GBASE-SR transceiver

Figure 1 shows a view of the front panel with nine 10GBASE-SR transceivers. To replace a transceiver, pull up the bale clasp to unlock position as shown in Figure 2, and pull out the XFP transceiver (Figure 3). To attach a new XFP transceiver, just reverse the steps above.

Figure 1: How to replace a 10GBASE-SR transceiver

5.2 How to replace a fan

The rear panel has three fans, as shown in Figure 2. To change a fan, remove four screws that fix the fan panel first (the left panel of Figure 3). Note that the power cables of the fans are still connected to the board at this time (the right panel of Figure 3).

Figure 2: Rear panel with three fans

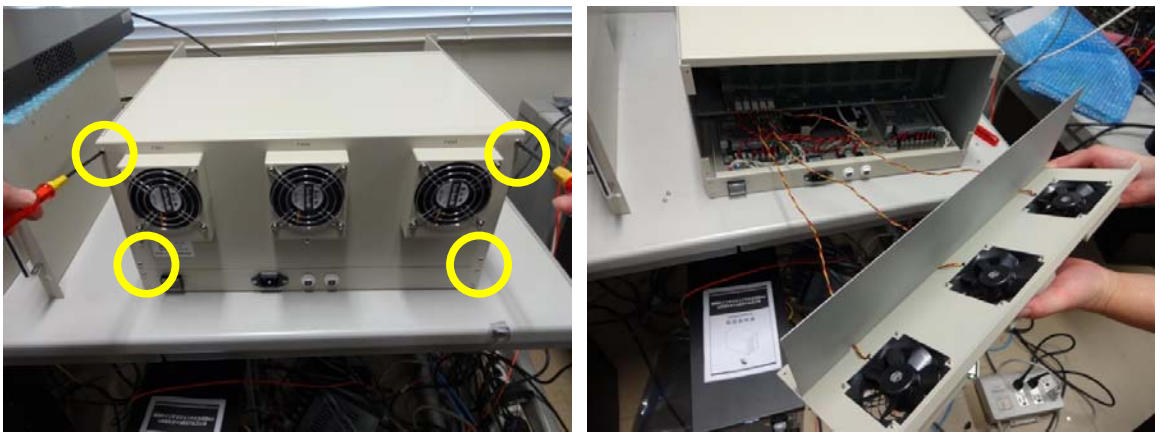

Figure 3: Removing the rear panel

Remove all of the three power cables, shown in Figure 4, from the board.

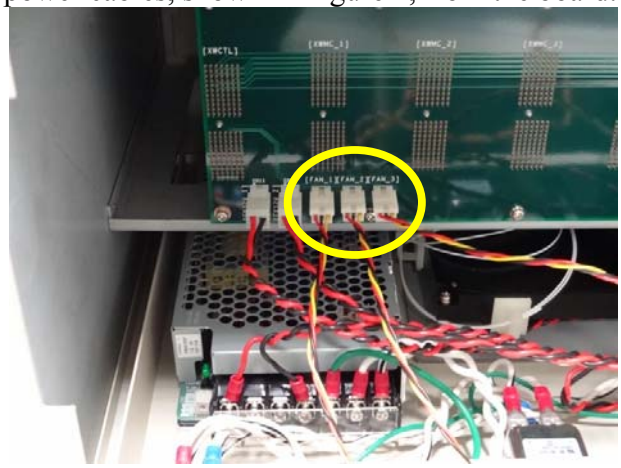

Figure 4: Power cables on the board

Remove four screws of the fan cover, as shown in Figure 5.

Figure 5: Removing screws of the fan cover

Pull out the power connector of the fan, as shown in Figure 6, and then the fan can be taken out. To attach a new fan, just reverse the steps above.

Figure 6: Power connector of the fan

5.3 How to replace a power supply module

To change a power supply module, follow the steps for changing a fan (Section 4) until the fan panel is removed. Then pull out the two power lines connected to the board, as shown in Figure 7.

Figure 7: Power lines on the board

Remove the four screws, which is marked in Figure 8, and pull out and take out the power supply board as shown in Figure 9.

Figure 8: Screws of the power supply board

Figure 9: Pulling out the power supply board

Pull out another connector with white and green cables, which is shown in Figure 10.

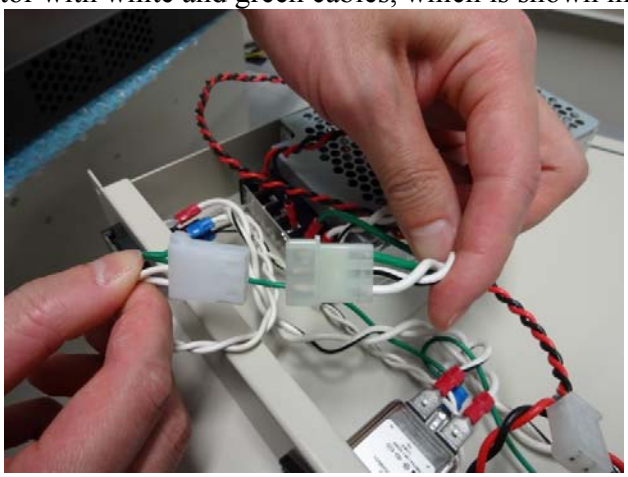

Figure 10: Disconnection of white and green cables

Turn around the power supply board and remove the two screws, which are marked in Figure 11. Then power supply module is removed from the power supply board (Figure 12).

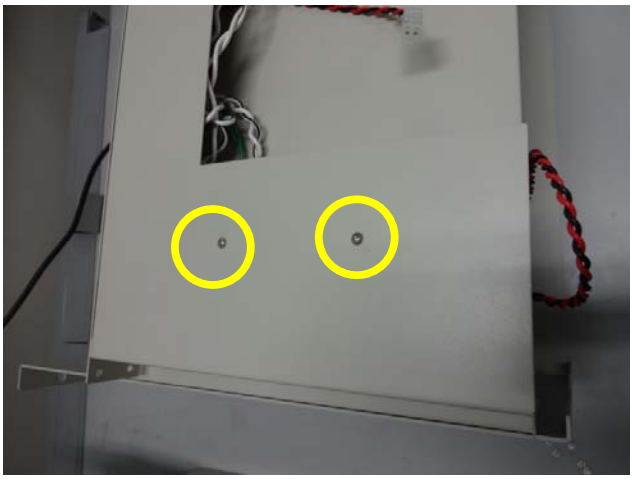

Figure 11: Screws, fixing the power supply module

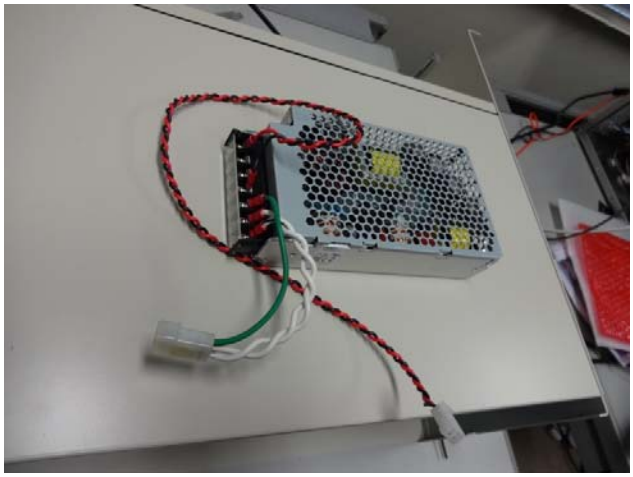

Figure 12: Power supply modules, fixed at the board

5.4 How to replace a 10GBASE-ZR module

To change the 10GBASE-ZR module, remove the four screws, shown with yellow circles and a yellow arrow in Figure 13, of the air filter box. Pull out the box, and then you find the nine optical fibers connecting ZR modules to the DWDM module (Figure 14).

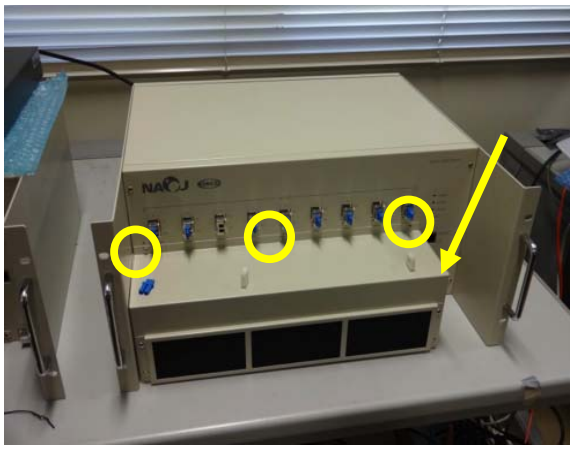

Figure 13: Screws, fixing the air filter box

Figure 14: Pulling out the air filter box (left) and optical fibers (right)

Pull out the optical fibers attached to the 10GBASE-ZR module to be removed, as shown in Figure 15.

Figure 15: Pulling out the optical fiber

Pull up the bale clasp and pull out the ZR module (in the same manner with 10GBASE-SR modules), as shown in Figure 16.

Figure 16: Pulling up the bale clasp before pulling out the ZR module.