APP Mark6 Recorder/OFLS PAI Test Report

ALMA-05.11.40.03-0001-A-REP

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Change Record

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Chapter 1

Introduction

1.1 Purpose

This document describes the tests performed at Haystack and Charlottesville on the OFLS to establish preliminary acceptance in-house (PAI).

1.2 Scope

This unit was manufactured in Japan according to specifications from the NAOJ part of the APP team (Markei Honma *et al.*). It was extensively tested in Japan after delivery to NAOJ, then shipped to Haystack (tested again but with the recorders), then finally shipped to Charlottesville for the formal test. The more detailed tests were repeated at ALMA (PAS, [RD1]) where equipment to perform the tests was available.

1.3 Reference Documents

The following documents contain additional information, are referenced in this document, and should be consulted for further, more detailed information.

Table 1.1: *Reference Documents*

Reference	Document Title	Document ID
[RD1]	APP Optical Fiber Link Installation and Test Report	ALMA-05.11.40.03-0002-A-REP
[RD2]	APP Update to Corr/Control Design	ALMA-05.11.61.01-0001-A-DSN
[RD3]	APP Mark6 Recorder Test Procedures	ALMA-05.11.50.02-0001-A-PRO

1.4 Acronyms

ALMA Atacama Large Millimeter/submillimeter Array

APP ALMA Phasing Project

AOS Array Operations Site

DBE Digital Back End

MIT Massachusetts Institute of Technology

NAOJ National Astronomical Observatory of Japan

OSF Operations Support Facility

OFLS Optical Fiber Link System

PAI Preliminary Acceptance in House

PAS Preliminary Acceptance on Site

PIC Phasing Interface Card

Chapter 2

OFLS Testing at Haystack

The Optical Fiber Link System (OFLS) was shipped to Haystack in the summer of 2013 for testing with the recorders and software development of the software Device which would monitor and control the units. The Mux and DeMux (functionally identical, but the names refer to their roles at ALMA) units were racked as shown in Figure 2.1 and placed on the network.

Figure 2.1: Optical Fiber Link System Racked at Haystack.

2.1 Functionality Testing

In order to test the system with no PICs or DBEs, we arranged a connection between recorders as shown in 2.2. and realized as shown in Figure 2.3.

In this configuration, and since the OFLS units are bi-directional, packets could be generated on either end of the link and received at the other. The arrangement of the fibers between the ports is such that all ports must be working properly for packets to be received. *I.e.* if any of the nine
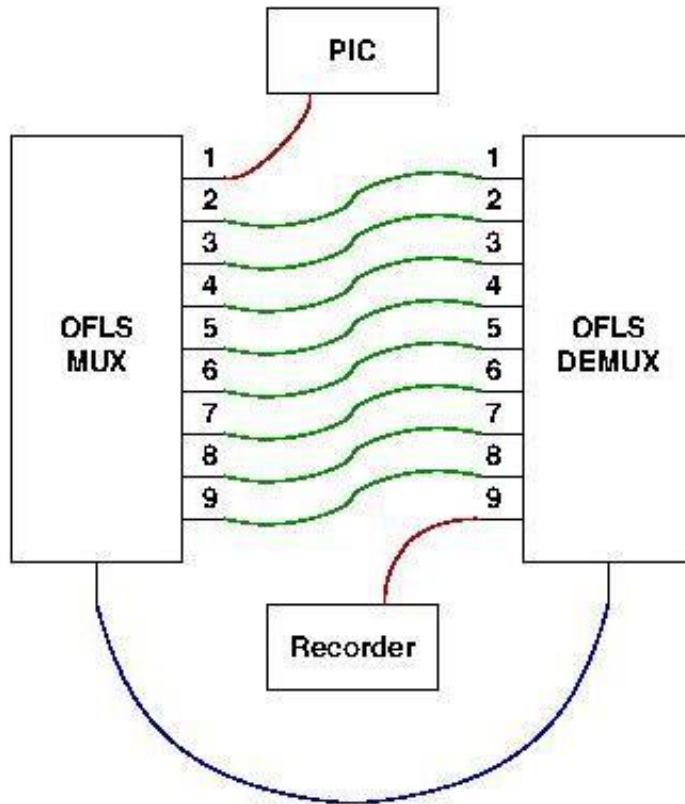
Figure 2.2: *Diagram of cabling for one pass through the system. Here PIC and* `Recorder` *could as well be different network ports on one or two recorders.*
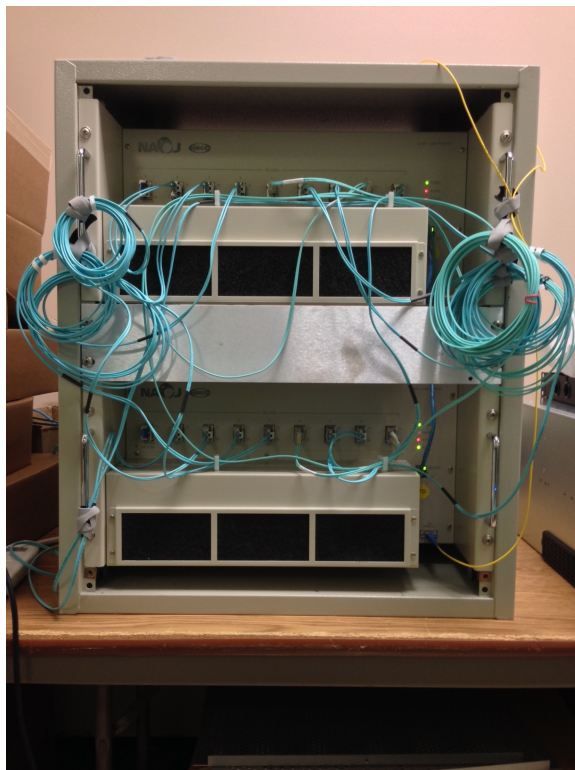
Figure 2.3: *Cabling for one-pass through the system.*

OFLS ports were to fail to pass the packet, the packet would not be received. In the event, there were no issues. (*I.e.* any time a packet was sent it was counted as received.)

As software development (`CONTROL/Device/HardwareDevice/VLBIOFLS`) this constituted a thorough exercise of the device, no additional testing was deemed necessary at this stage.

2.2 Pre-Ship Testing

Prior to shipment to Charlottesville, the OFLS was tested with the "spare" recorder (Mark6–4004) which was to accompany it there to support PIC testing. For this test, "doit" was configured to perform the `loopback.sh` test as outlined in [RD3], Section 7.2.1.

In this case, (simulated) packets were pushed out to ethernet device `eth3`, passed through the OFLS units (all 9 ports), and and recorded at ethernet device `eth5`.

Modules `MHO%0006` and `MHO%0007` were paired as one group (12) and `MHO%0019` and `MHO%0020` were paired as another (34). Then one hour of (loopback) recording was performed through the OFLS onto each module pair.

```
./doit-4004.sh medium C05 12
# from log:
!mstat?0:0:
    12:1:MHO%0006/32000/4/8:8:8:31979:32000:open:ready:sg:
    12:2:MHO%0007/32000/4/8:8:8:31979:32000:open:ready:sg:
    34:3:MHO%0019/24000/4/8:8:8:23992:24000:closed:unprotected:sg:
    34:4:MHO%0020/24000/4/8:8:8:23992:24000:closed:unprotected:sg;
./doit-4004.sh medium C06 34
# from log:
!mstat?0:0:
    12:1:MHO%0006/32000/4/8:8:8:30627:32000:open:ready:sg:
    12:2:MHO%0007/32000/4/8:8:8:30627:32000:open:ready:sg:
    34:3:MHO%0019/24000/4/8:8:8:23982:24000:open:ready:sg:
    34:4:MHO%0020/24000/4/8:8:8:23982:24000:open:ready:sg;
```

In the event, the "medium" configuration generated a schedule with 17 scans ranging with (random) durations between 90 and 240 seconds. Due to operator error (and a bug in the `cplane` application), the disks from the first test were also active in the second, so the packets were in fact written to all four modules.

The last scan of the first session was not recorded (due to a timing error in the test script).

All recorded scans passed the size check.

All scans fragments passed the scan_check.

Chapter 3

OFLS Testing at Charlottesville

The Optical Fiber Link System (OFLS) units were shipped to Charlottesville for use with the PIC development system in April of 2014, and integrated in the correlator lab as shown in Figure 3.1.


Figure 3.1: OFLS testing in the correlator lab.

The correlator test hardware ("blackhole") is at the right. The rack at the left houses the recorder (top) and the two OFLS units (bottom).

3.1 End-to-End Test

The first test performed was an End-to-End test from the PIC through the OFLS units to be recorded on Mark6–4004 (May 5, 2014, Figure 3.2). In order to simulate the attenuation over the AOS to OSF fiber link, we assembed spools of similar fiber to an agregate length of 33 km. For this fiber the coefficient of loss was $\alpha \sim 0.25dB/km$ and the attenuation was measured as 8.14 dB.
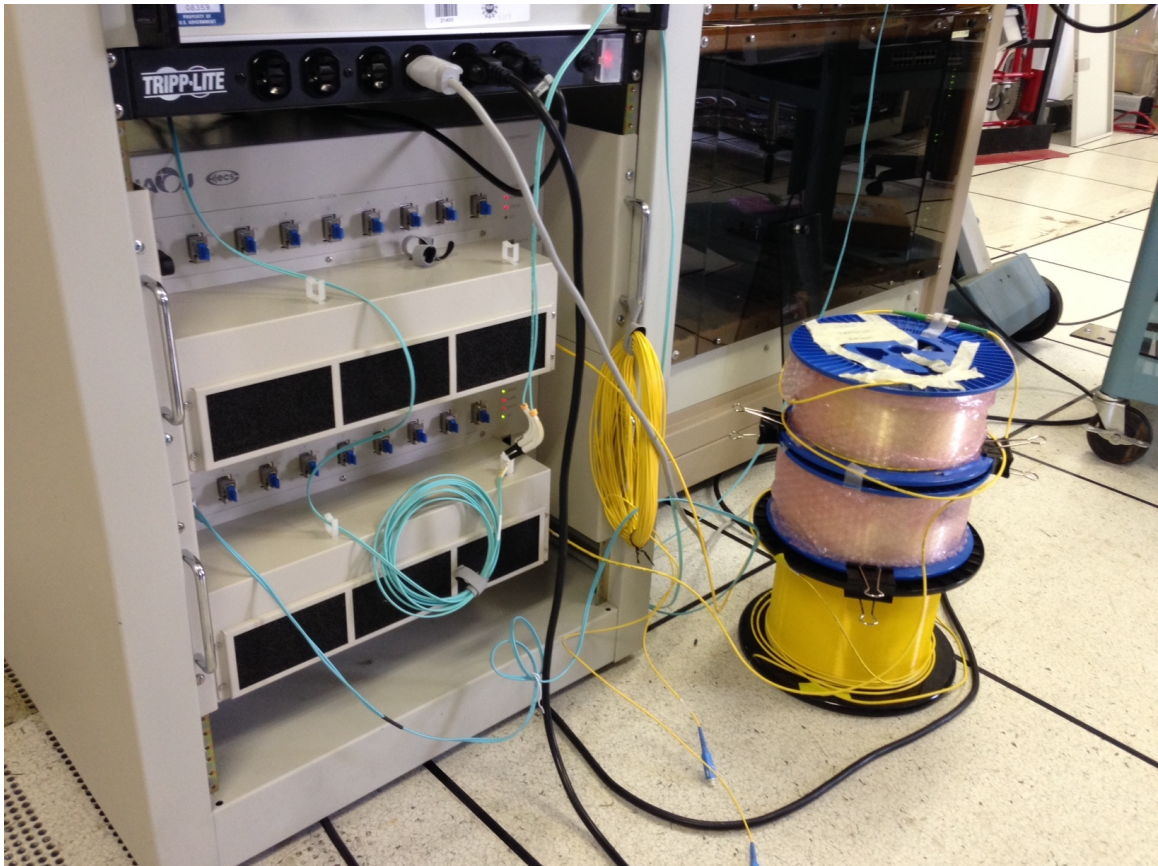
Figure 3.2: *Fiber spool used to simulate AOS—OSF link.*

At this time, the nascent PIC application was not able to generate packets, so instead we used a simple application (`pslt.py`) which generates small packets and (expecting a loopback fiber connection) reports the receipt of each packet sent. The loopback connector is the black object attached to the top OFLS unit at the left-most port (1). A screenshot of the execution of the test is shown in Figure 3.3.
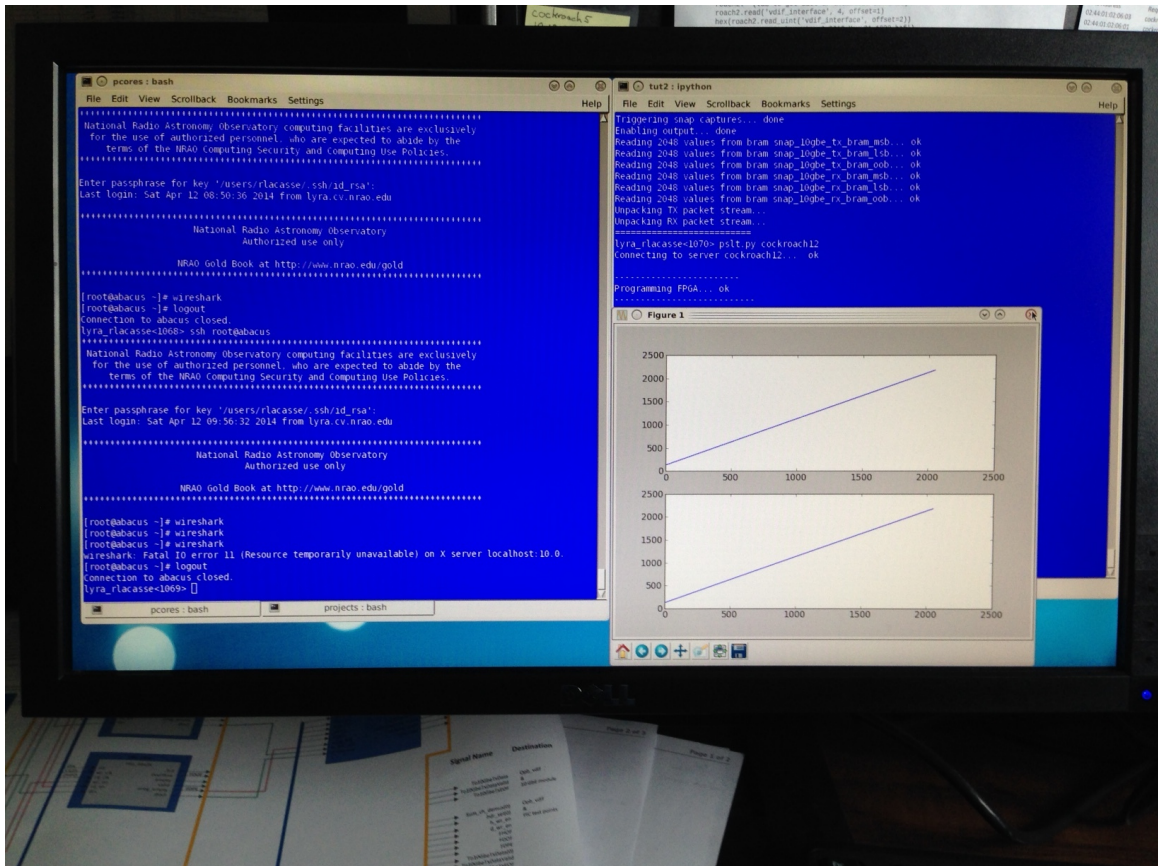
Figure 3.3: Charlottesville End-to-End test.

In this figure, the window with the two linear plots are the counts of packets sent and received with time. The point of this test was to establish that the hardware connections worked so that the OFLS units could be shipped to Chile for integration at a time commensurate with the APP/NAOJ travel schedule.

3.2 OFLS (Recorder) Loopback Test Setup

More thorough testing of the unit in the correlator lab could (at this time) be performed using the Mark6 recorder and the `loopback.sh` script as described in [RD3], Section 7.2.1.

For this test, the ethernet device `eth5` of the recorder (Mark6–4004) was connected to port 1 of the DeMux OFLS unit, and the corresponding Mux OFLS unit port was connected to ethernet device `eth3`. The cabling arrangment is as shown in Figure 3.4, where only port 1 is used. (You can see the fiber connection to the leftmost port on each unit. The other ports, 2-9 only have blue plugs.) The spool of fiber, providing the simulated attenuation from AOS to OSF is as in the previous test, an overall attenuation of 8.14 dB.

After testing in this configuration, the two connections to the recorder could then be stepped through all ports in sequence and the test repeated.

Finally, a long-duration test was conducted overnight.

3.3 OFLS (Recorder) Loopback Test Results

Since the emphasis of this test is on the OFLS rather than the recorders, we focus on the packet measurements ([RD3], Section 7.3.1). For clarity, the `ifconfig` commands can be reduced to their essense with the following UNIX command:
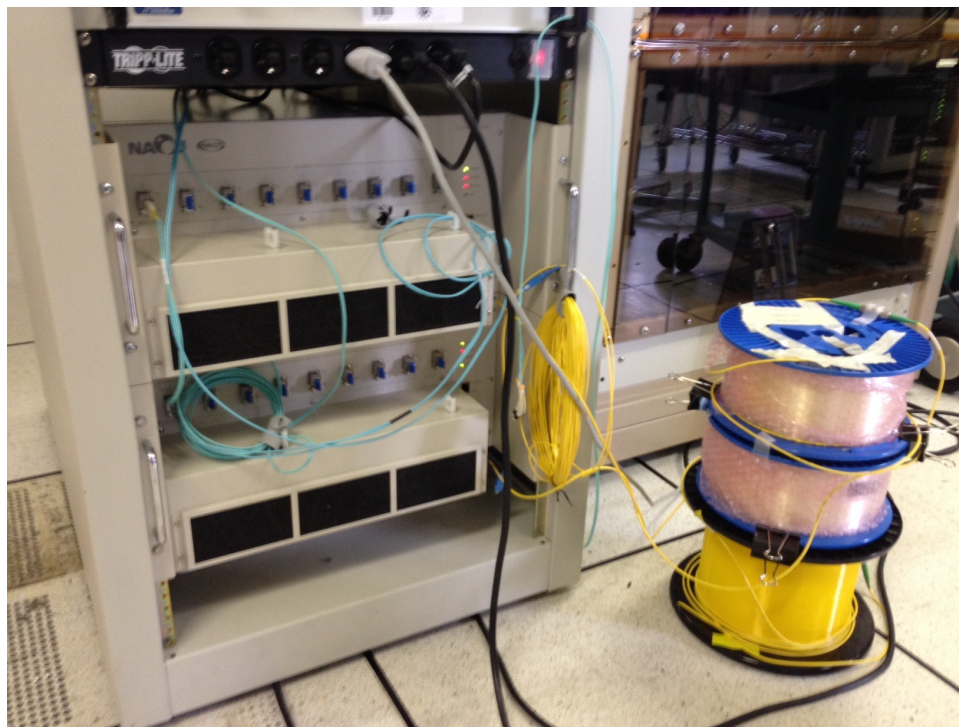
Figure 3.4: Recorder loopback test.

```
( echo eth5-rx ; /sbin/ifconfig eth5 ;
  echo eth3-tx ; /sbin/ifconfig eth3 ) | grep -i '[RT]X' | grep -v que
```

which strips out the non-essential information. These tests were begun with a few initial tests, hence the initial packet counts are not zero. By following the packet and byte counts between each test setup, we can monitor whether the OFLS is working properly or not.

```
# at start of these tests:
eth5-rx
        RX packets:7781875 errors:0 dropped:0 overruns:0 frame:0
        TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
        RX bytes:62892464076 (58.5 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:7781893 errors:0 dropped:0 overruns:0 carrier:0
        RX bytes:0 (0.0 B)  TX bytes:62892465480 (58.5 GiB)

# move fiber cable to port #8
./doit-4004.sh short F0sh2 12
# logged to: m6t-m.2014-125-2011.log
# starting test loopback.sh F0sh2 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
        RX packets:29442600 errors:0 dropped:0 overruns:0 frame:0
        TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
        RX bytes:237954443526 (221.6 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:29442618 errors:0 dropped:0 overruns:0 carrier:0
        RX bytes:0 (0.0 B)  TX bytes:237954444930 (221.6 GiB)

# move fiber cable to port #7
```

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```
./doit-4004.sh short F0-n7 12
# logged to: m6t-m.2014-125-2023.log
# starting test loopback.sh F0-n7 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:51139290 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:413307092106 (384.9 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:51139308 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:413307093510 (384.9 GiB)

# move fiber cable to port #6
./doit-4004.sh short F0-n6 12
# logged to: m6t-m.2014-125-2035.log
# starting test loopback.sh F0-n6 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:72859042 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:588846127770 (548.4 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:72859060 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:588846129174 (548.4 GiB)

# move fiber cable to port #5
./doit-4004.sh short F0-n5 12
# logged to: m6t-m.2014-125-2043.log
# starting test loopback.sh F0-n5 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:94553985 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:764184657096 (711.7 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:94554003 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:764184658500 (711.7 GiB)

# move fiber cable to port #4
./doit-4004.sh short F0-n4 12
# logged to: m6t-m.2014-125-2104.log
# starting test loopback.sh F0-n4 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:116119095 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:938473876116 (874.0 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:116119113 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:938473877520 (874.0 GiB)

# move fiber cable to port #3
./doit-4004.sh short F0-n3 12
# logged to: m6t-m.2014-125-2112.log
# starting test loopback.sh F0-n3 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:137548651 errors:0 dropped:0 overruns:0 frame:0
```

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```
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1111667547708 (1.0 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:137548669 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1111667549112 (1.0 TiB)

# move fiber cable to port #2
./doit-4004.sh short FO-n2 12
logged to: m6t-m.2014-125-2119.log
# starting test loopback.sh FO-n2 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:158717717 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1282755939120 (1.1 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:158717735 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1282755940524 (1.1 TiB)

# move fiber cable to port #1
./doit-4004.sh short FO-n1 12
logged to: m6t-m.2014-125-2138.log
# starting test loopback.sh FO-n1 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:179998752 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1454749263990 (1.3 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:179998770 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1454749265394 (1.3 TiB)

# move fiber cable to port #9
./doit-4004.sh short FO-n9 12
# logged to: m6t-m.2014-125-2150.log
# starting test loopback.sh FO-n9 hrs=.1 idle=20,20 durs=20,20 ...
eth5-rx
          RX packets:201095252 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1625251176990 (1.4 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:201095270 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1625251178394 (1.4 TiB)

# leave fiber cable on port #9
./doit-4004.sh long FO-n9l 34
# logged to: m6t-m.2014-125-2204.log
# starting test loopback.sh FO-n9l hrs=10 idle=20,20 durs=120,1200 ...
eth5-rx
          RX packets:201095252 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1625251176990 (1.4 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:201095270 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1625251178394 (1.4 TiB)
```

3.4   OFLS (Recorder) Loopback Test Summary

Comparing the packet statistics at the beginning and the end of this test sequence (reproduced from above for convenience):

```
# at the start
eth5-rx
          RX packets:7781875 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:62892464076 (58.5 GiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:7781893 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:62892465480 (58.5 GiB)

# at the end
eth5-rx
          RX packets:201095252 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:1625251176990 (1.4 TiB)  TX bytes:1872 (1.8 KiB)
eth3-tx
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:201095270 errors:0 dropped:0 overruns:0 carrier:0
          RX bytes:0 (0.0 B)  TX bytes:1625251178394 (1.4 TiB)
```

That is, a grand total of (about) 1.4 TB was successfully passed through the 9 ports of the OFLS.

And comparing the TX and RX values, which reflect the 18 pings transmitted at times when there was no connection (prior to the test sequence of the preceeding section), we find the same deficit (18 packets of 78 bytes, or 1404 bytes total) at the end.

That is, by packets:

7781893	−	7781875	=	18
201095270	−	201095252	=	18

or by bytes:

62892465480	−	62892464076	=	1404
1625251178394	−	1625251176990	=	1404

all bits were successfully transmitted.

An examination of the `loopback.sh` log files, `*.scans` and `*.chk` files showed that the recorder also recorded all these bits.

Chapter 4

Preparations for Shipment to Chile

The OFLS units were later shipped to the ALMA for PAS and installation at the AOS (Mux) and OSF (DeMux).

In preparation for this, we changed the network addresses of the units to those they would have in Chile. The procedure is shown in Figure 4.1.

Connect to OFL via telnet at port 9999, and then following message will appear.

Press "Enter" and you will see the following menu.

Press "0" and "Enter", and the prompt shows the four numbers of the current IP address one by one.

Above is the first number, and put the number to which you would like to change. Then, press "Enter" to move onto the next number and complete all the four numbers. Following is an example in which IP address is set to 192.168.1.196.

For other queries, just press "Enter" to keep default settings, and you will come back to the following menu.

Figure 4.1: *Resetting Network Addresses.*

After changing the address, we brought each unit up on a private network simulating the destination addresses. Figures 4.2 and 4.3 are screen shots showing that communication was successfully established.

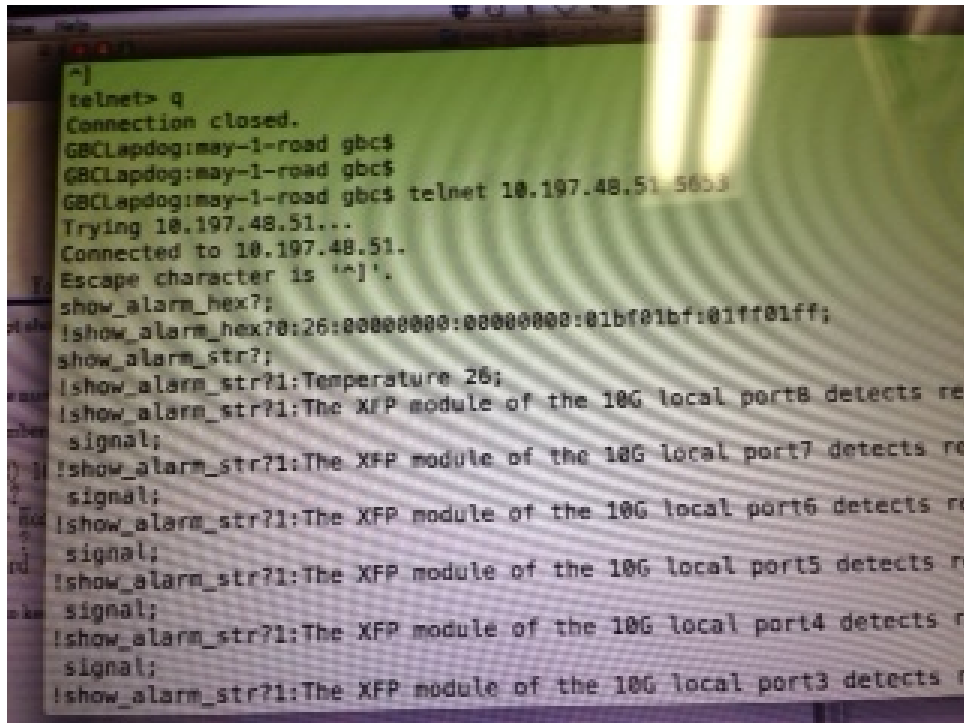After shipment, the units were installed and tested as described in [RD1].

**APP Mark6 Recorder/OFLS
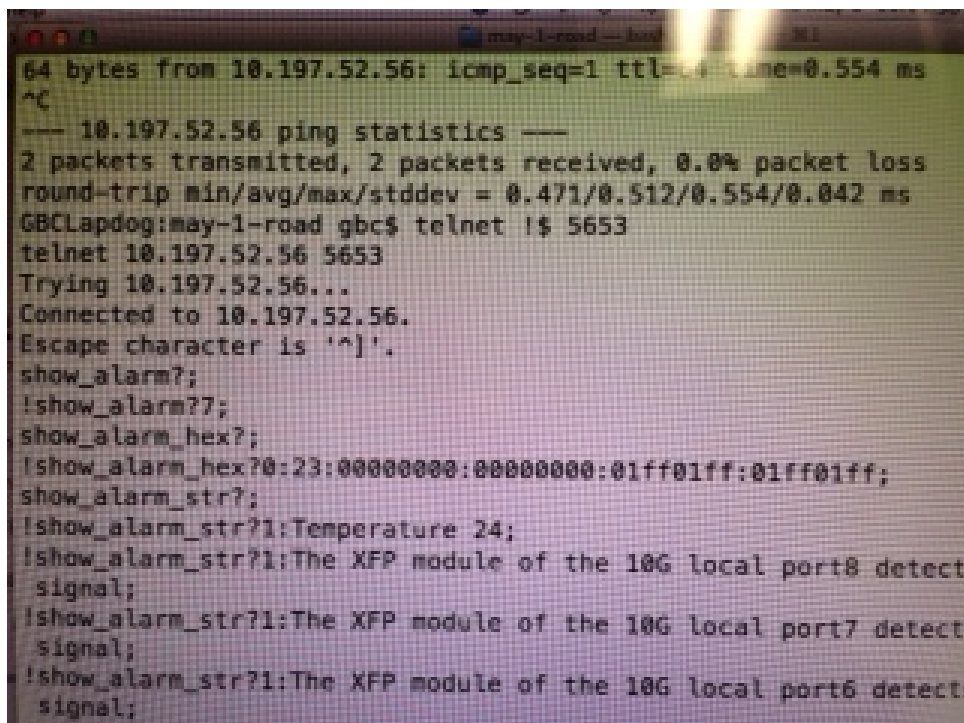PAI Test Report**

Figure 4.2: Resetting Netword Address on Mux Unit.

Figure 4.3: Resetting Netword Address on DeMux Unit.