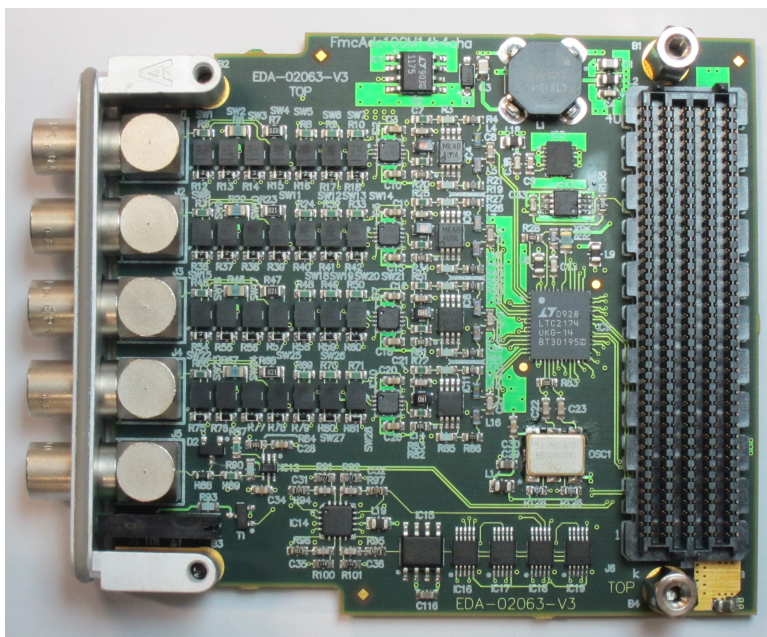




# FmcAdc100M14b4cha Production Test Suite

## User Manual

Revision 1.2



# Revision Table

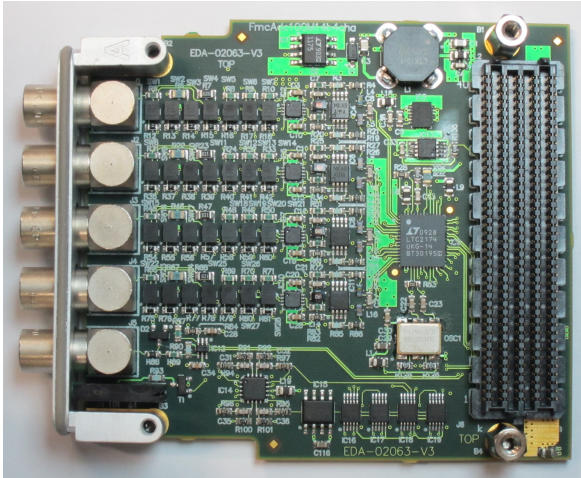
Revision	Date	Author	Comments
0.1	05/10/11	Matthieu CATTIN, CERN	Initial version.
1.0	24/10/11	Matthieu CATTIN, CERN	Update after beta test feedback.
1.1	26/10/11	Matthieu CATTIN, CERN	Update screen-shots and add automatic computer switch OFF
1.2	24/05/13	Matthieu CATTIN, CERN	Add calibration test, requires a new version of the calibration box and 2ns LEMO cables.

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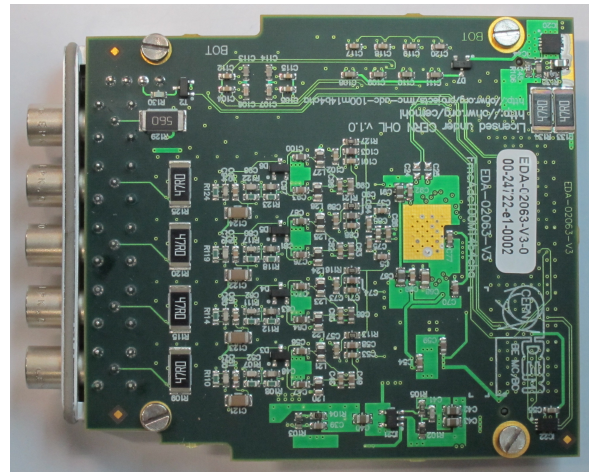
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# Introduction

The FmcAdc100M14b4cha is a 4 channel 100MSPS 14 bit ADC card in FMC (FPGA Mezzanine Card) format using an LPC connector. The gain can be set by software in three steps:  $\pm 50\text{mV}$ ,  $\pm 0.5\text{V}$ ,  $\pm 5\text{V}$ . An advanced offset circuit is used in the front-end design of the ADC board, and allows a voltage shift in the range of  $\pm 5\text{V}$  that is independent on the chosen gain range.



*Illustration 1: FmcAdc100M14b4cha board top view.*



*Illustration 2: FmcAdc100M14b4cha board bottom view.*



*Illustration 3: FmcAdc100M14b4cha board front panel.*

Production Test Suite, or **PTS**, is the environment designed for the functionality tests of the FmcAdc100M14b4cha boards after manufacturing. It assures that the boards comply with a minimum set of quality rules, in terms of soldering, mounting and fabrication process of the PCBs.

PTS was originally intended for testing the boards specifically designed for the Open Hardware Repository<sup>1</sup>, but it can also be adapted to testing other boards.

It is important to note that PTS refers only to the functionality testing of the boards and it is not covering any verification or validation tests of the design.

This document describes the PTS components and its use.

<sup>1</sup><http://www.ohwr.org>



# List of tests

The PTS consists of a set of nine independent tests, each one checking a different part of the FmcAdc100M14b4cha board. Table 1 gives a short description of each one of them.

Test	Short description	User Intervention
00	Loads firmware and test mezzanine presence	No
01	1-wire: read serial unique ID and store	No
02	I2C EEPROM: write, read back and compare	No
03	LEDs: Switch ON and ask operator	Yes
04	Sampling clock (Si570):read configuration (I2C) and check SerDes lock	No
05	ADC serial communication: enable test pattern and check data	No
06	Trigger input: check that acquisition FSM changes state	No
07	Offset DACs: check positive, negative offset and clear	No
08	Analogue front-end: check all MOSFET switches	No
09	Analogue front-end: frequency response	No
22	Wait for the FMC board to reach a stable temperature	No
19	ADC and offset DAC calibration	No
23	IPMI and calibration data write to FMC EEPROM	No
25	Calibration verification	No

Table 1: List of tests

# PTS Hardware and Software elements

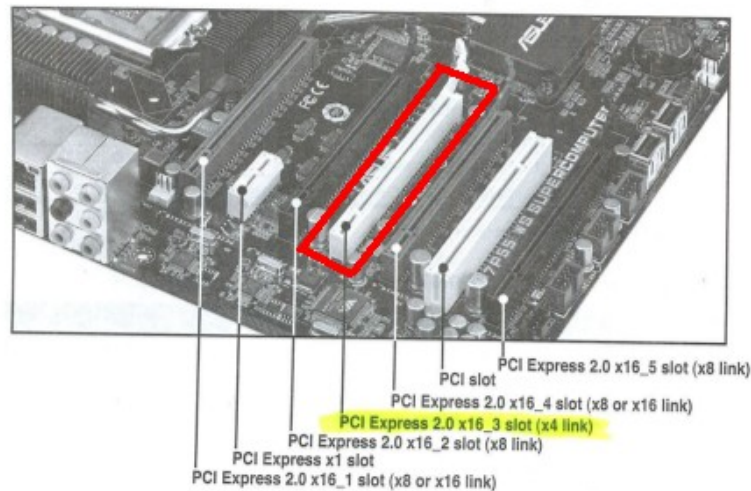
- o In terms of hardware, the PTS is composed of:
  - A computer.
  - A bar-code reader to be plugged to the USB port of the computer.
  - A PCIe Extender board to be plugged to the PCI port of the computer.
  - Two spacers and four screws to fix the PCIe extender board to the computer case.
  - A SPEC (Simple PCIe FMC Carrier) board.
  - 4 GB USB memory key.
  - Mouse and keyboard.
  - An arbitrary waveform generator (AWG) 33250A.
  - A USB to RS232 converter.
  - A RS232 null modem cable (DB9 female – DB9 female).
  - A calibration box (version 2).
  - 7x LEMO 00 2ns cables (“OUT”, “SYNC”, “TRIG”, “1”, “2”, “3” and “4”).
  - 2x BNC to LEMO 00 adapters.
  - A series of bar-code stickers with the FmcAdc100M14b4cha serial number.
  - 4x screws to mount FmcAdc100M14b4cha board on the SPEC board.
  - Two power cords (for the computer and the AWG).
  - An anti-static wrist band.
- o Additional required material (not provided):
  - A monitor (VGA or DVI).
- o In terms of software, the provided computer is equipped with the following:
  - Ubuntu Linux, with kernel 2.6.38 or higher.
  - Python 2.7.
  - The PTS environment installed.
  - Driver *gnurabbit* installed.
- o The user login is the following:

<b>Username</b> user
<b>Password</b> baraka

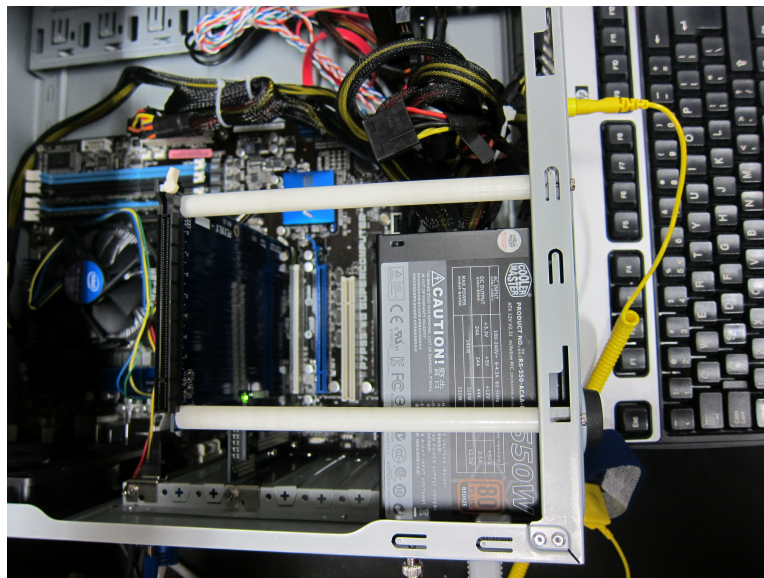
**The provided computer must not be update and should not be connected to the network.**

# First Time Set-up

- 1) Make sure that the computer is switched off and plug the PCIe Extender board into the slot indicated in Illustration 4. Use the provided spacers and screws to attach the PCIe Extender to the computer box, see Illustration 5.



*Illustration 4: PCIe slot to be used.*



*Illustration 5: PCIe extender plugged in the corresponding slot and fixed with the spacers.*

- 2) Plug the bar-code reader into one available USB slot of the provided computer.
- 3) Plug the USB to RS232 converter into one available USB slot of the provided computer.
- 4) Connect the AWG to the USB to RS232 converter using the RS232 null modem cable.

- 5) Connect the AWG “Output” to the calibration box “AWG IN”, using the cable labelled “OUT” and the BNC to LEMO 00 adapter.
- 6) Connect the AWG “Sync” to the calibration box “SYNC”, using the cable labelled “SYNC” and the BNC to LEMO 00 adapter.

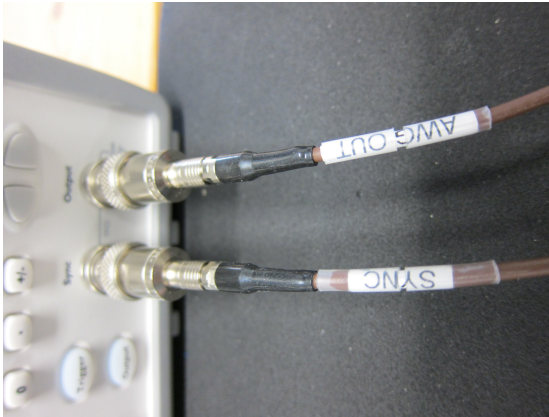


Illustration 6: Connections from AWG.

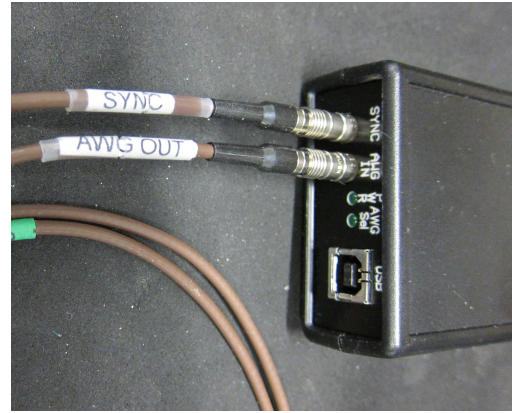


Illustration 7: Connections to calibration box (from AWG).

- 7) Connect the cable labelled “TRIG” to the calibration box “TRIG”.
- 8) Connect the four remaining LEMO 00 cables to the calibration box outputs “CH1” to “CH4”. Cable “1” to “CH1”, and so on.

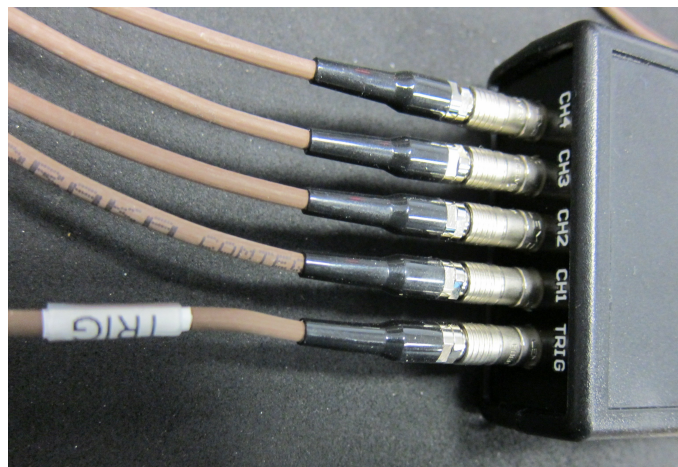


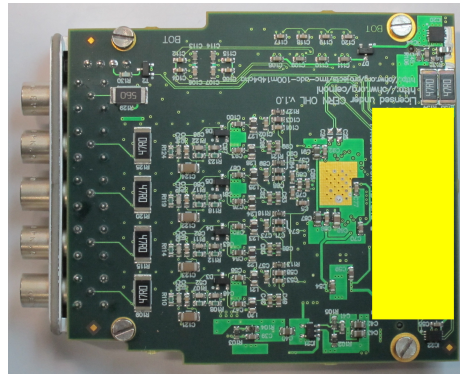
Illustration 8: Connections from calibration box.

- 9) Connect the USB input of the calibration box into one available USB slot of the provided computer.
- 10) Switch ON the computer and make sure the date is correct. If not, set it up.
- 11) Switch OFF the computer.



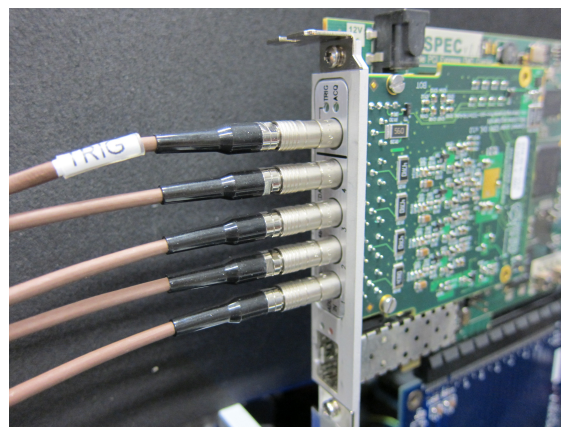
# Test Procedure

- 1) Before starting the test procedure, it is needed to wear an anti-static wrist band to avoid electrostatic issues when handling the boards and the cables.
- 2) Place the bar-code sticker on the bottom of the FmcAdc100M14b4cha board. The position is indicated in yellow in Illustration 9.



*Illustration 9: Bar-code sticker position.*

- 3) Place the FmcAdc100M14b4cha board under test on the FMC connector of the SPEC board. Fix the FmcAdc100M14b4cha board to the SPEC board using the provided screws.
- 4) Connect the cable labelled “TRIG” to the “TRIG” input of the FmcAdc100M14b4cha board.
- 5) Connect the four other LEMO 00 cables to “CH1”, “CH2”, “CH3” and “CH4” inputs of the FmcAdc100M14b4cha board. Cable “1” to channel “1” and so on.



*Illustration 10: Connections to board under test (from calibration box).*

- 6) Plug the SPEC board in the corresponding connector of the PCI Extender.



- 7) Make sure the AWG is switched ON.

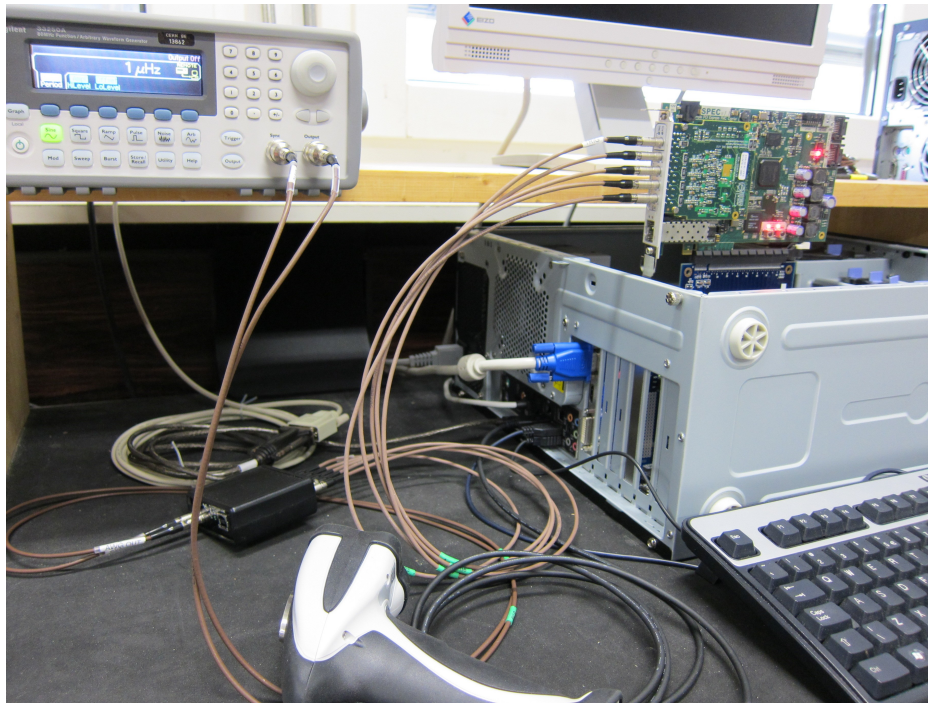


Illustration 11: Overview of the test set-up.

- 8) Switch on the computer and verify that the “Pwr” LED on the SPEC board is ON. This will confirm that the board is properly plugged.

If the LEDs is off, there is a problem with the power supply lines.

- 9) After the computer has finished with the booting procedure, a terminal appears automatically in the middle of the screen.

- 10) Type “test” then [ENTER] to start the test program (see Illustration 12).

```
user@baraka: ~  
File Edit View Search Terminal Help  
user@baraka:~$ test  
  
*****  
*                FmcAdc100M14b4cha Test program                *  
*****  
  
[sudo] password for user: █
```

Illustration 12: Starting the test program from a terminal.

- 11) When asked, type the password: **baraka**

- 12) The program asks for the serial number of the board.

- i. Make sure that the bar-code reader is well plugged in any of the USB ports of the computer.
- ii. Check that the cursor is on the terminal
- iii. Place the bar-code reader in front of the bar-code sticker of the FmcAdc100M14b4cha board under test at around 10 cm; then press the reader's button. Normally the code will appear on the terminal.
- iv. Press [ENTER].
- v. The program will ask for a second serial number, in case the manufacturer has a different serial number system. Type or scan the second serial number and press [ENTER].  
If there is no second serial number, just press [ENTER].

13) The program will automatically start executing tests 00 -> 09, 22, 19, 23 and 25.

14) Test 03 require the user's intervention and will ask the user to visually check the LEDs.

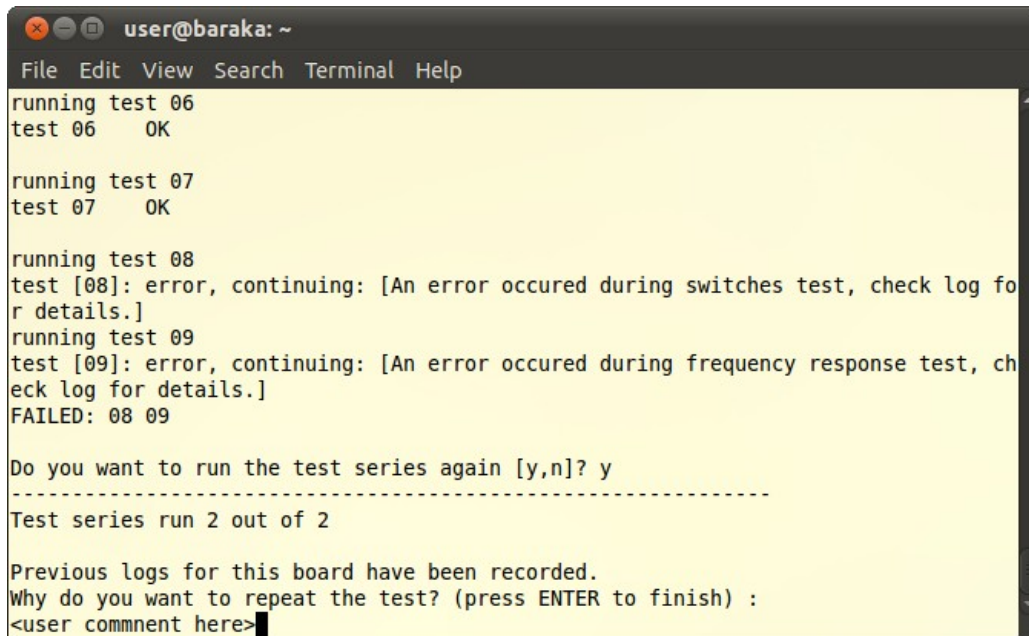
15) Wait for the tests to finish.

16) At the end of the tests the user will be asked if the tests should be repeated. If the tests reports no errors, type [n] and then [ENTER]. In case of error, one can repeat the tests once by typing [y] and [ENTER].

**If you need to repeat the tests more than two times for the same board, please report to the responsible of tests at CERN.**

```
user@baraka: ~  
File Edit View Search Terminal Help  
*****  
*                               FmcAdc100M14b4cha Test program                               *  
*****  
[sudo] password for user:  
Please scan CERN serial number bar-code, then press [ENTER]: 1234  
If needed input extra serial number and press [ENTER] OR just press [ENTER]: 5678  
  
-----  
Test series run 1 out of 2  
  
running test 00  
test 00    OK  
  
running test 01  
test 01    OK  
  
running test 02  
test 02    OK  
  
running test 03  
-----  
Are the front panel LEDs (TRIG and ACQ) switched ON? [y,n]y  
-----  
Are the front panel LEDs (TRIG and ACQ) switched OFF? [y,n]y  
  
test 03    OK  
  
running test 04  
test 04    OK  
  
running test 05  
test 05    OK  
  
running test 06  
test 06    OK  
  
running test 07  
test 07    OK  
  
running test 08  
test 08    OK  
  
running test 09  
test 09    OK  
  
All tests OK  
  
Do you want to run the test series again [y,n]? n  
-----  
End of the test, do you want to switch the computer OFF? [y,n]
```

Illustration 13: *Example of a successful test (no error reported).*



```
user@baraka: ~  
File Edit View Search Terminal Help  
running test 06  
test 06    OK  
  
running test 07  
test 07    OK  
  
running test 08  
test [08]: error, continuing: [An error occured during switches test, check log fo  
r details.]  
running test 09  
test [09]: error, continuing: [An error occured during frequency response test, ch  
eck log for details.]  
FAILED: 08 09  
  
Do you want to run the test series again [y,n]? y  
-----  
Test series run 2 out of 2  
  
Previous logs for this board have been recorded.  
Why do you want to repeat the test? (press ENTER to finish) :  
<user comment here>
```

Illustration 14: **Example of test repetition due to errors.**

- 17) At the end of the test, the user is asked if he wants to switch the computer OFF. Type [y] and then [ENTER] to switch the computer OFF and repeat the test procedure for another board. Type [n] then [ENTER] to quit the test program and keep the computer ON. To switch the computer OFF later, click on the power icon placed in the upper right corner of the desktop and select **Shut Down**, as Illustration 15 indicates. Note that the AWG can remain switched ON while the next board to test is put in place.

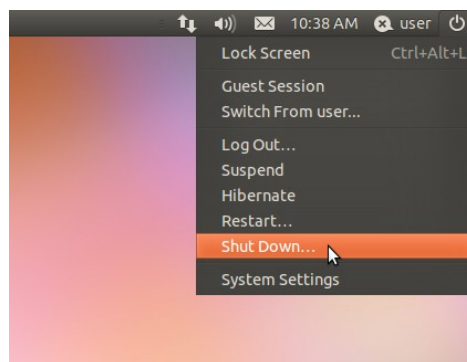
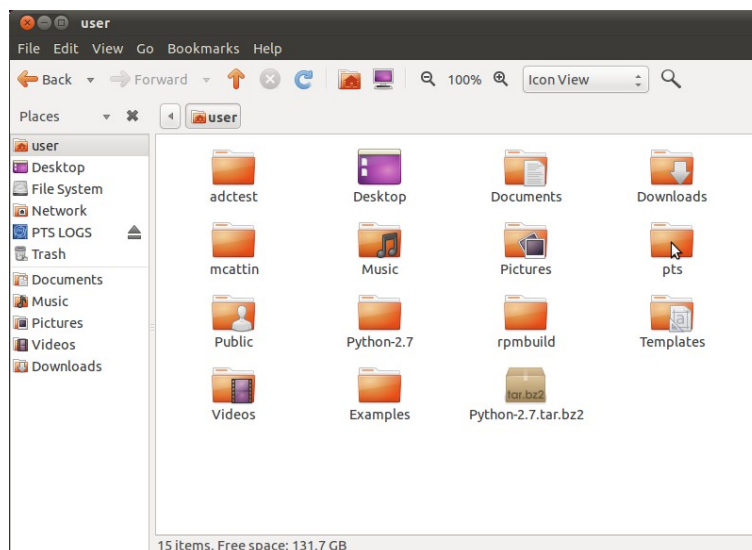


Illustration 15: Shutting down the computer.

# Log files retrieval

When the testing of all the boards has finished, it is needed to deliver all the log files to CERN. To do so, please follow the instructions:

- 1) Plug the provided USB memory key in the computer.
- 2) Wait until Ubuntu mounts automatically the device and using the file explorer<sup>2</sup> navigate to **/home/user/pts/log\_fmcdc100m14b4cha**
- 3) Select all the .zip files in this folder and copy them to the USB memory. To copy them, just right click and select **copy**. Using the file explorer, click on the USB device that appeared on the left column, and copy the .zip files using right click and selecting **paste**.



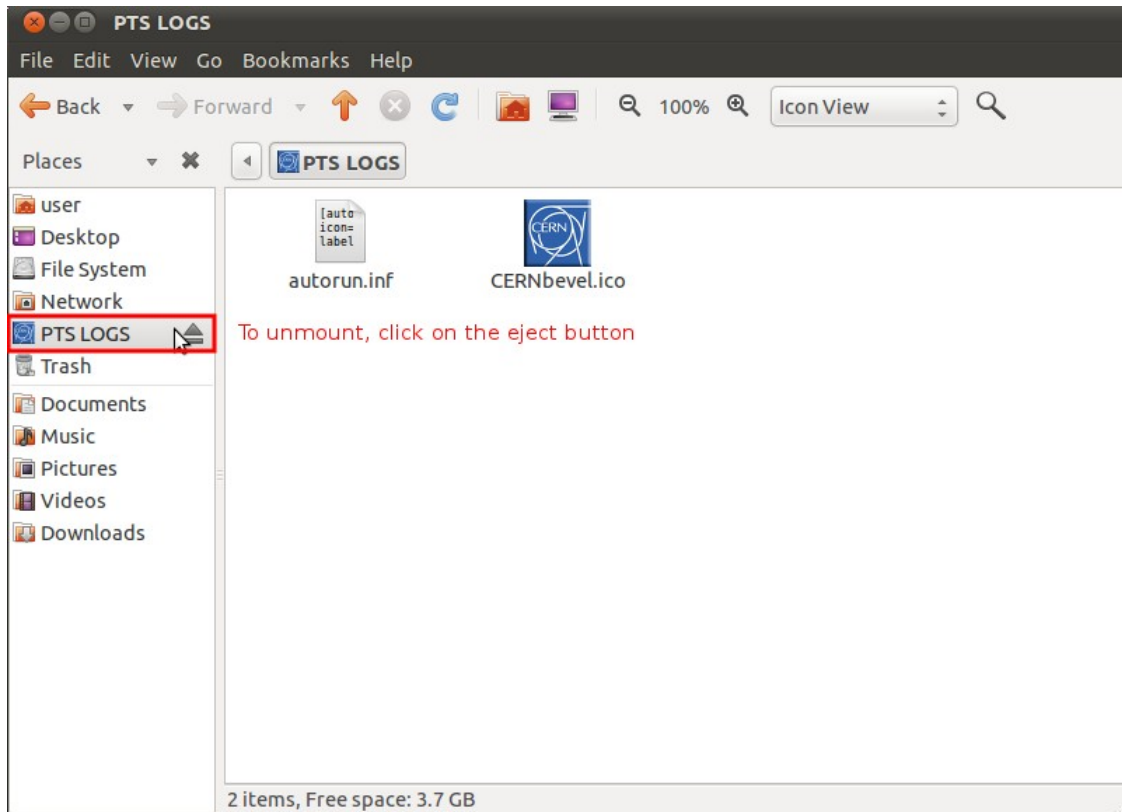
*Illustration 16: File explorer.*

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<sup>2</sup>File explorer is accessible by clicking “Places” in the upper panel and then “Home Folder”



- 4) Click on the eject button on the left of the file explorer window and remove the USB key.



*Illustration 17: Removal of the USB key.*

- 5) Transfer the data to another computer with Internet access.
- 6) Finally, send the .zip file by email to the responsible of tests at CERN.

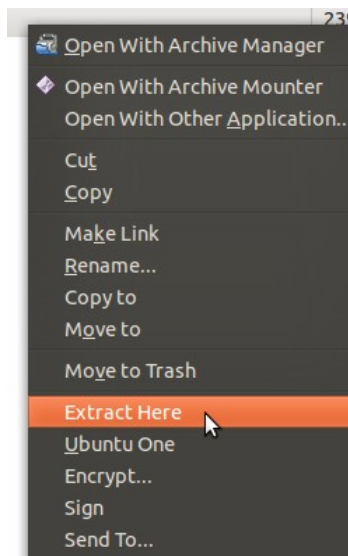
# Common causes of test failure

Once the testing has finished all the errors that may have appeared will be listed on the screen. Usually, the error message is self-explanatory. If you need detailed information, the test log files can be found in **/home/user/pts/log\_fmcdc100m14b4cha**.

Log files with detailed descriptions of the tests will have been automatically generated and archived in a .zip file called:

**zip\_run\_<run id>\_<timestamp>\_FmcAdc100M14b4cha\_<serial number>.zip**

To extract the documents at the provided computer, go to the following directory: **/home/user/pts/log\_fmcdc100m14b4cha** using the file explorer as indicated above, right-click on the .zip file and select *Extract Here* in the listed menu.



*Illustration 18:  
Extracting .zip file.*

## Test00

This test loads the test firmware and test mezzanine presence.

Common problems:

- Bad soldering of the FMC connector.
- Driver not properly installed.
- Firmware not loaded.

## Test01

This test checks the 1-wire thermometer with unique ID (DS18B20U+). It reads the serial unique ID and store it in the log file.

Common problems:

- 1-wire thermometer or FMC connector badly soldered.
- Problem with the 1-wire pull-up.
- Problem with 3P3V power supply.

## Test02

This test checks the I2C EEPROM (24AA64T-I/MC). It first scans the I2C bus and verify that the EEPROM responds at the expected address. Then it writes data to the EEPROM, reads it back and compares against written data.

Common problems:

- EEPROM or FMC connector badly soldered.
- Problem with 3P3VAUX power supply.

## Test03

This test checks the LEDs on the FmcAdc100M14b4cha front panel. It switches the LEDs ON and ask operator to confirm that their actually ON.

Common problems:

- Bad soldering on one of the component.
- Faulty component (LED, transistor).
- Problem with 3P3V power supply.

## Test04

This test checks the sampling clock, coming from an oscillator control over I2C (Si570). It reads the default configuration and verify it. It also check that the SerDes receiving the ADC data are locked.

Common problems:

- No access using I2C: bad soldering.
- No arrival of the clock into FPGA: bad soldering problem.
- Unstable clock: faulty oscillator.
- Problem with 3P3V power supply.

## Test05

This test checks the ADC serial communication. It enables the test pattern in the ADC chip and check received data.

Common problems:

- ADC or FMC connector badly soldered.
- Faulty ADC.
- Problem with VADJ and/or +1.8V power supplies.

## Test06

This test checks the external trigger input. It checks that acquisition FSM changes state when an external trigger pulse arrives.

Common problems:

- Bad soldering on one of the component.
- Faulty component (LVDS repeater, etc...).
- AWG or calibration box badly connected.
- AWG badly configured (RS232 baudrate, etc...).

## Test07

This test checks the offset DACs. It checks positive, negative offset and clear input.

Common problems:

- Bad soldering on one of the component.
- Faulty component (DAC, OPA, ADC, etc...).
- Problem with +5.5V and/or +12V\_filtered and/or -8V\_filtered power supplies.

## Test08

This test checks all the MOSFET switches of the analogue front-end.

Common problems:

- Bad soldering on one of the component.
- Faulty component (MOSFET switch, OPA, ADC, etc...).
- Problem with +6V and/or -6V power supplies.
- AWG or calibration box badly connected.
- AWG badly configured (RS232 baudrate, etc...).

## Test09

This test checks the frequency response of the analogue front-end.

Common problems:

- Bad soldering on one of the component.
- Faulty component (MOSFET switch, OPA, ADC, etc...).
- Wrong value of one or several passive components.
- AWG or calibration box badly connected.
- AWG badly configured (RS232 baudrate, etc...).

## Test19

This test calibrates the ADC and offset DACs for the three input ranges (10V, 1V and 100mV).

Common problems:

- Unstable reference voltage.
- Unexpected reference voltage.

## Test22

This test waits for the FmcAdc100M14b4cha board temperature to be stable.

Common problems:

- Unstable room temperature.
- Unexpected air flow (open window).

## Test23

This test writes IPMI information and calibration data to the FMC EEPROM.

Common problems:

- Data written and read from EEPROM differ.



## Test25

This test verifies the calibration performed by test19.

Common problems:

- Unstable reference voltage.
- Board temperature different from calibration temperature.

# **What to do in case of error of the application?**

Report the problem explaining it, attach a screen-shot or a copy of all the information present on the terminal and send it to the responsible in charge of the tests at CERN.