## Revision Table

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Author</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>10/05/11</td>
<td>Matthieu CATTIN, CERN</td>
<td>Initial version.</td>
</tr>
<tr>
<td>1.0</td>
<td>24/10/11</td>
<td>Matthieu CATTIN, CERN</td>
<td>Update after beta test feedback.</td>
</tr>
<tr>
<td>1.1</td>
<td>26/10/11</td>
<td>Matthieu CATTIN, CERN</td>
<td>Update screen-shots and add automatic computer switch OFF</td>
</tr>
<tr>
<td>1.2</td>
<td>24/05/13</td>
<td>Matthieu CATTIN, CERN</td>
<td>Add calibration test, requires a new version of the calibration box and 2ns LEMO cables.</td>
</tr>
<tr>
<td>1.3</td>
<td>06/05/14</td>
<td>Matthieu CATTIN, CERN</td>
<td>SPEC attached to the computer case (flexible PCIe extender), Ubuntu 14.04.</td>
</tr>
<tr>
<td>1.4</td>
<td>06/02/18</td>
<td>Dimitris LAMPRIDIS, CERN</td>
<td>Add EEPROM read-back test to Table 1. Update instructions to reflect password-less sudo.</td>
</tr>
</tbody>
</table>
# Table of contents

Revision Table........................................................................................................................................2
Table of contents..................................................................................................................................3
Introduction..........................................................................................................................................4
List of tests............................................................................................................................................5
PTS Hardware and Software elements..........................................................................................6
First Time Set-up..............................................................................................................................7
Test Procedure....................................................................................................................................9
Log files retrieval................................................................................................................................14
Common causes of test failure..............................................................................................................16
  Test00..................................................................................................................................................17
  Test01..................................................................................................................................................17
  Test02..................................................................................................................................................17
  Test03..................................................................................................................................................17
  Test04..................................................................................................................................................18
  Test05..................................................................................................................................................18
  Test06..................................................................................................................................................18
  Test07..................................................................................................................................................18
  Test08..................................................................................................................................................19
  Test09..................................................................................................................................................19
  Test19..................................................................................................................................................19
  Test22..................................................................................................................................................19
  Test23..................................................................................................................................................19
  Test25..................................................................................................................................................20
What to do in case of error of the application?..................................................................................21
Introduction

The FmcAdc100M14b4cha (later called FMC-ADC) 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: +/-50mV, +/-0.5V, +/-5V. An advanced offset circuit is used in the front-end design of the ADC board, and allows a voltage shift in the range of +/- 5V that is independent on the chosen gain range.

Production Test Suite, or PTS, is the environment designed for the functionality tests of the FMC-ADC 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 Repository¹, 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.

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¹ http://www.ohwr.org
List of tests

The PTS consists of a set of 15 independent tests, each one checking a different part of the FMC-ADC board. Table 1 gives a short description of each one of them.

<table>
<thead>
<tr>
<th>Test</th>
<th>Short description</th>
<th>User Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Loads firmware and test mezzanine presence</td>
<td>No</td>
</tr>
<tr>
<td>01</td>
<td>1-wire: read serial unique ID and store</td>
<td>No</td>
</tr>
<tr>
<td>02</td>
<td>I2C EEPROM: write, read back and compare</td>
<td>No</td>
</tr>
<tr>
<td>03</td>
<td>LEDs: Switch ON and ask operator</td>
<td>Yes</td>
</tr>
<tr>
<td>04</td>
<td>Sampling clock (Si570): read configuration (I2C) and check SerDes lock</td>
<td>No</td>
</tr>
<tr>
<td>05</td>
<td>ADC serial communication: enable test pattern and check data</td>
<td>No</td>
</tr>
<tr>
<td>06</td>
<td>Trigger input: check that acquisition FSM changes state</td>
<td>No</td>
</tr>
<tr>
<td>07</td>
<td>Offset DACs: check positive, negative offset and clear</td>
<td>No</td>
</tr>
<tr>
<td>08</td>
<td>Analogue front-end: check all MOSFET switches</td>
<td>No</td>
</tr>
<tr>
<td>09</td>
<td>Analogue front-end: frequency response</td>
<td>No</td>
</tr>
<tr>
<td>22</td>
<td>Wait for the FMC board to reach a stable temperature</td>
<td>No</td>
</tr>
<tr>
<td>19</td>
<td>ADC and offset DAC calibration</td>
<td>No</td>
</tr>
<tr>
<td>23</td>
<td>IPMI and calibration data write to FMC EEPROM</td>
<td>No</td>
</tr>
<tr>
<td>47</td>
<td>Read back FMC EEPROM and check validity</td>
<td>No</td>
</tr>
<tr>
<td>25</td>
<td>Calibration verification</td>
<td>No</td>
</tr>
</tbody>
</table>

*Table 1: List of tests*
PTS Hardware and Software elements

In terms of hardware, the PTS is composed of:

- A desktop computer.
- A bar-code reader.
- A PCIe flexible extender, SAMTEC PCIEC-064-0200-EC-EM-P.
- A SPEC (Simple PCIe FMC Carrier) board.
- Four spacers and height screws to fix the SPEC board to the computer case.
- A 8 GB USB memory stick.
- A mouse and a keyboard.
- An arbitrary waveform generator (AWG), Agilent 33250A.
- A USB to RS232 converter.
- A calibration box (version 2).
- A USB cable (type A to type B).
- 7x 2ns LEMO cables (“OUT”, “SYNC”, “TRIG”, “1”, “2”, “3” and “4”).
- 2x BNC to LEMO adapters.
- A series of bar-code stickers with the FmcAdc100M14b4cha serial number.
- Two power cords (for the computer and the AWG).
- An anti-static wrist band.

Additional required material (not provided):

- A monitor (VGA or DVI).

In terms of software, the provided computer is equipped with the following:

- Ubuntu Linux, with kernel 3.13
- Python 2.7.
- The PTS environment and its dependencies.

Although not necessary for normal PTS operation, the user login is the following:

Username: user
Password: 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 PCIe Extender is plugged into the slot indicated in Illustration 4.

![Illustration 4: PCIe slot to be used.]

2) Mount the SPEC board on the computer case and connect the PCIe extender as shown in Illustration 5.

![Illustration 5: SPEC board mounted on the computer case.]

3) Plug the bar-code reader into one available USB slot of the provided computer.

4) Plug the USB to RS232 converter into one available USB slot of the provided computer.

5) Connect the AWG to the USB to RS232 converter, using the RS232 null modem cable.

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

8) Connect the cable labelled “TRIG” to the calibration box “TRIG”.

9) Connect the four remaining LEMO cables to the calibration box outputs “CH1” to “CH4”. Cable “1” to “CH1”, and so on.

10) Connect the USB input of the calibration box into one available USB slot.
11) Switch ON the computer and make sure the date is correct. If not, set it up.
12) 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 damages when handling the boards and the cables.

2) Place the provided bar-code sticker on the bottom of the FMC-ADC board. The position is indicated in yellow in Illustration 9.

3) Place the FMC-ADC board to be tested on the FMC connector of the SPEC board.

4) Connect the cable labelled “TRIG” to the “TRIG” input of the FMC-ADC board.

5) Connect the four other LEMO 00 cables to “CH1”, “CH2”, “CH3” and “CH4” inputs of the FMC-ADC board. Cable “1” to channel “1” and so on.

Illustration 9: Bar-code sticker position.

Illustration 10: Connections to board under test (from calibration box).
6) Make sure the AWG is switched ON.

Illustration 11: Overview of the test set-up.

7) Switch the computer on 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.

8) After the computer has finished with the booting procedure, a terminal appears automatically on the screen.

9) 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 blinking in the terminal
   iii. Place the bar-code reader in front of the bar-code sticker of the FMC-ADC board under test at around 10 cm; then press the reader’s button. Try again if it did not work.
   iv. When the code appears in the terminal. 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].
10) The program will automatically start executing tests 00 -> 09, 22, 19, 23, 47 and 25.

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

12) Wait for the tests to finish.

13) At the end of the tests the user will be asked if the tests should be repeated. If the tests report 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 technical contact at CERN.
user@fmc-adc-pts-04:~

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

running test 22
  FMC temperature: 54.375°C
  test 22  OK

running test 19
  test 19  OK

running test 23
  test 23  OK

running test 25
  test 25  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] n

Illustration 13: Example of a successful test (no error reported).
14) 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 14: Example of errors during test.

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\(^2\) navigate to \texttt{/home/user/pts/log\_fmcadc100m14b4cha}

3) Select all the .zip files in this folder and copy them to the USB memory. To copy them, just right click and select \textbf{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 \textbf{paste}.

\(^2\)File explorer is accessed via the Launcher. To open the Launcher point the mouse on the left of the screen. Then the File explorer is the second icon from the top.
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 technical contact 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. The error message is very concise. For detailed information, the test log files can be found in `/home/user/pts/log_fmcadc100m14b4cha`.

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_fmcadc100m14b4cha` 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.](image)
**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 3P3V AUX 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.
**Test47**

This test validates the contents of the FMC EEPROM, previously written by Test23.

Common problems:
- EEPROM content invalid.

**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 technical contact at CERN.