FmcDelay1ns4cha
Production Test Suite

User Manual

Revision 1.2
## Revision Table

<table>
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<th>Revision</th>
<th>Date</th>
<th>Author</th>
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<tr>
<td>0.1</td>
<td>15/05/12</td>
<td>Bert GOOIJER, INCAA</td>
<td>Initial version.</td>
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<td></td>
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<td>Computers BV</td>
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<td>1.0</td>
<td>22/06/12</td>
<td>Bert GOOIJER, INCAA</td>
<td>Update after test feedback and updated screen-shots.</td>
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<tr>
<td>1.1</td>
<td>13/07/12</td>
<td>Bert GOOIJER, INCAA</td>
<td>Added test05 IPMI</td>
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<tr>
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<td>10/06/13</td>
<td>Tomasz WŁOSTOWSKI, CERN</td>
<td>Added new tests &amp; automated calibration box</td>
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<tr>
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<td>04/07/13</td>
<td>Tomasz WŁOSTOWSKI, CERN</td>
<td>Documented DDMTD cross-check and updated figures/screenshots.</td>
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Introduction

The FmcDelay1ns4cha is a 4 channel 1ns accuracy delay card in FMC (FPGA Mezzanine Card) format using an LPC connector. The module will take in a TTL trigger signal and will send it out to four different outputs. The delay from the trigger input to each of the outputs can be set independently in a range from 600 ns to 120 seconds. It is implemented using a dedicated time-to-digital converter IC from the European company Acam.

Production Test Suite, or PTS, is the environment designed for the functionality tests of the FmcDelay1ns4cha 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.

¹http://www.ohwr.org
**List of tests**

The PTS consists of a set of six independent tests, each one checking a different part of the FmcDelay1ns4cha 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, test mezzanine presence, test I2C (EEPROM), test SPI (SGPIO and AD9516 PLL), test 1-wire temp sensor, test ACAM interface, test delay line control</td>
<td>No</td>
</tr>
<tr>
<td>01</td>
<td>Test of LEDs: Switch ON / OFF and ask operator</td>
<td>Yes</td>
</tr>
<tr>
<td>02</td>
<td>Perform a external TDC-based calibration procedure for determining zero offsets. Cross-check with internal DDMTD calibrator. Test all outputs &amp; output enable lines.</td>
<td>No</td>
</tr>
<tr>
<td>03</td>
<td>Perform VCXO center frequency calibration</td>
<td>No</td>
</tr>
<tr>
<td>04</td>
<td>Perform TDC intrinsic jitter test</td>
<td>No</td>
</tr>
<tr>
<td>05</td>
<td>Prepare IPMI EEPROM &amp; calibration block</td>
<td>No</td>
</tr>
<tr>
<td>06</td>
<td>Test EEPROM and write IPMI &amp; calibration data.</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 computer with Mouse and keyboard.
  - 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.
  - An arbitrary waveform generator (AWG) 33250A.
  - An timer/counter/analyzer (Pendulum) CNT-91.
  - A Fine Delay Calibration Box
  - A USB to RS232 converter.
  - 2x USB cables (USB A – USB B)
  - 3x LEMO 00 4ns cables
  - 5x LEMO 00 1ns cables
  - 3x BNC to LEMO 00 adapters.
  - 1x LEMO 00 1:2 splitter.
  - A series of bar-code stickers with the FmcDel1ns4cha serial number.
  - 4x screws to mount FmcDel1ns4cha board on the SPEC board.
  - Three power cords (for the computer, the AWG and the CNT-91).
  - 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 2.6.38 or higher.
  - Python 2.7.
  - The PTS environment installed.
  - Driver spec installed.
  - Driver usbtmc installed
  - Driver cp210x (with GPIO patches) installed

- The user login is the following:

  **User-name**
  user

  **Password**
  baraka
The provided computer must not be updated 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.](image)

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

![Illustration 5: PCIe extender plugged in the corresponding slot and fixed with the spacers.](image)
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) Plug the 2 USB cables (connector A) into available USB slots of the provided computer.

6) Connect the CNT-91 with one USB cable (connector B).

7) Connect the Calibration box with the other USB cable (connector B).

8) Connect 5 \textbf{1 ns} LEMO 00 cables to the I/Os of the Calibration Box labelled CH1....CH4 and TRIG. \textit{Use only the 1ns LEMO cables supplied with the kit.}

9) Put in a LEMO-BNC adapter followed by a LEMO 2-way splitter in the CNT-91’s input A. connect the AWG output to one of the splitter inputs using supplied 4ns LEMO cable (see illustrations below).

Illustration 6: Connection from AWG. Illustration 7: Connections to CNT-91 (from AWG and delay card).

10) Connect the input B of the CNT-91 to the output CNT-B of the Calibration Box. Connect the second output of the LEMO splitter to the input AWG of the Calibration box (see figure below). \textbf{Use only the 1ns LEMO cables supplied with the kit.}

Illustration 8 shows the schematic diagram of test instrument and mezzanine connections.
Illustration 8: Test system connections diagram
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 FmcDelay1ns4cha board. The position is indicated in yellow in Illustration 9.

Illustration 9: Bar-code sticker position.

3) Place the FmcDelay1ns4cha board under test on the FMC connector of the SPEC board. Fix the FmcDelay1ns4cha board to the SPEC board using the provided screws.

4) Connect the calibration box to the card using short 1ns LEMO cables. Make sure labels on the Calibration Box match those on the card being tested.

Illustration 10: Connections to board under test.
5) Plug the SPEC board in the corresponding connector of the PCI Extender.

6) Make sure the AWG is switched ON and the output is switched OFF.

7) Make sure the CNT-91 is switched ON.

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 “testDelay” then [ENTER] to start the test program (see Illustration 11).

![Illustration 11: 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 FmcDelay1ns4cha 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 to 06.

14) Test 01 requires the user’s intervention. The first will ask the user to visually check the LEDs and the second for connecting the LEMO connectors after each other.

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.
Illustration 12: Example of a successful test (no error reported).
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 14 indicates.
Note that the AWG and the CNT-91 can remain switched ON while the next board to test is put in place.

Illustration 13: Example of test repetition due to errors.

Illustration 14: 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 navigate to `/home/user/pts/log_fmc delay1ns4cha`

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 15: File explorer.

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2File 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 16: 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_fmc_delay1ns4cha.

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>_FmcDelay1ns4cha_<serial number>.zip`

To extract the documents at the provided computer, go to the following directory: /home/user/pts/log_fmc_delay1ns4cha using the file explorer as indicated above, right-click on the .zip file and select *Extract Here* in the listed menu.

*Illustration 17:*

Extracting .zip file.
**Test00**

Loads firmware, test mezzanine presence, test I2C (EEPROM), test SPI (SGPIO and AD9516 PLL), test 1-wire temp sensor, test ACAM interface, test delay line control

Common problems for firmware and mezzanine presence:
- Bad soldering of the FMC connector.
- Driver not properly installed.
- Firmware not loaded

Common problems for I2C (EEPROM):
- EEPROM or FMC connector badly soldered.
- Problem with 3P3VAUX power supply

Common problems for SPI (SGPIO and AD9516):
- No access using SPI: bad soldering.
- AD9516 PLL does not lock: faulty PLL

Common problems for 1-wire temp sensor:
- 1-wire thermometer or FMC connector badly soldered.
- Problem with the 1-wire pull-up.
- Problem with 3P3V power supply.

Common problems for ACAM host interface:
- No communication: bad soldering.

Common problems for delay line control:
- Bad soldering on one of the components.
- Faulty component.
- Problem with 3P3V power supply.

**Test01**

This test checks the LEDs on the FmcDelay1ns4cha front panel. It switches the LEDs ON/OFF separately and ask operator to confirm that their actually ON and OFF

Common problems:
- Bad soldering on one of the components.
- Faulty component (LED, transistor).
- Problem with 3P3V power supply.
- AWG badly connected.
**Test02**

This test performs a calibration procedure using the CNT-91 to calibrate the card’s trigger-to-output delay. The calibration results are cross-checked against the built-in DDMTD calibrator.

Common problems:
- Bad soldering on one of the components of the output path (output flip-flops, delay lines, AD8009 opamps, 100EPT23 buffers, fuses, SSRs or LEMO connectors).
- No arrival of the clock into FPGA: bad soldering problem.
- Bad soldering of DDMTD calibration components (flip flops, multiplexer or DDMTD sampling clock distribution)
- Badly soldered FMC connector

**Test03**

This test calibrates the VCXO center frequency using the CNT-91’s internal oscillator as the reference. If the mezzanine will be used in free-running mode (no White Rabbit), this will improve its time base accuracy.

Common problems:
- Badly connected CNT-91 or calibration box
- Faulty VCXO (VM53) or DAC (AD5662)

**Test04**

This test measures the intrinsic jitter of the TDC input by feeding it with an FPGA-generated calibration signal put at a constant offset with respect to the TDC start.

Common problems:
- Bad decoupling capacitors causing P8V supply instability (see EDMS documentation V5-1 changes)

**Test05**

This test assembles the IPMI information and prepares card’s calibration data.

Common problems:
- none foreseen (no real testing done, just crunching files).
Test06

This test writes and verifies the IPMI and calibration information to the EEPROM.

Common problems:
  • badly soldered EEPROM or FMC connector.
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.