

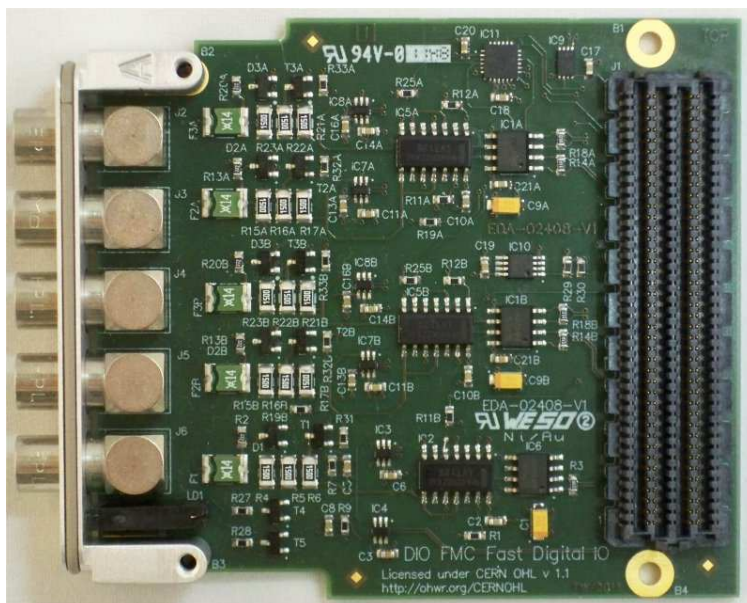


# FMC-DIO-5chTTLa

## Production Test Suite

### User Manual

Revision 1.2



# Revision Table

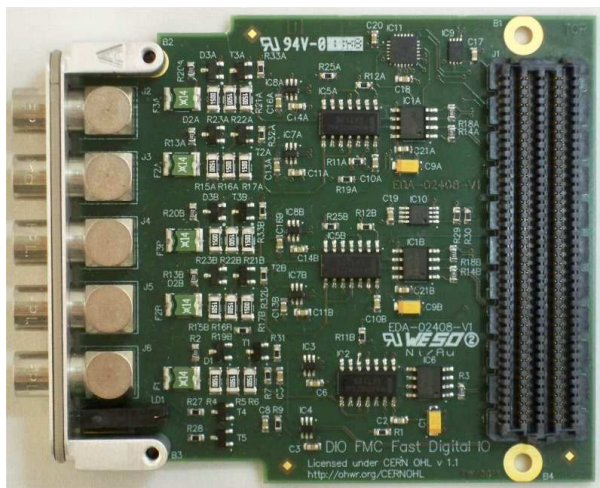
| Revision | Date      | Author                                    | Comments                          |
|----------|-----------|---|-----------------------------------|
| 0.1      | 9/4/2012  | Richard R. Carrillo, Seven Solutions S.L. | Initial version                   |
| 0.2      | 26/4/2012 | Richard R. Carrillo, Seven Solutions S.L. | Test02 changed                    |
| 1.0      | 29/4/2012 | Richard R. Carrillo, Seven Solutions S.L. | Format and content homogenized    |
| 1.1      | 1/5/2012  | Richard R. Carrillo, Seven Solutions S.L. | Number of tests incremented       |
| 1.2      | 6/5/2012  | Richard R. Carrillo, Seven Solutions S.L. | Order of test proc. steps changed |

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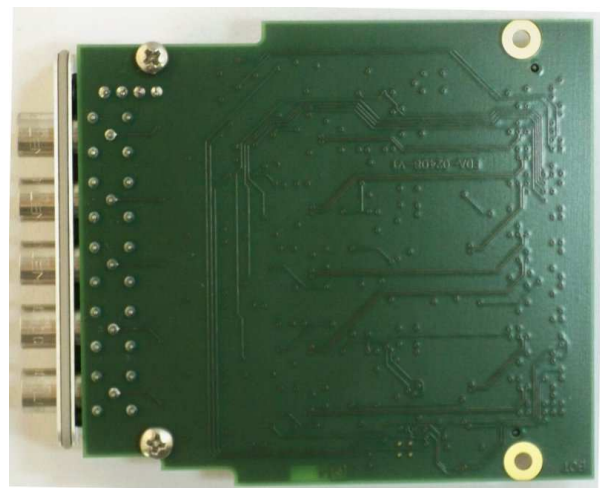
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# Introduction

The FMC-DIO-5chTTLa board is a 5-channel digital Input/Output (I/O) card in FMC (FPGA Mezzanine Card) format using an LPC connector. The I/O channels (ports) are accessed through LEMO-00 connectors and are TTL (transistor-transistor logic) compatible (supplying 3.3V). These ports include programmable voltage threshold (when the ports are configured as inputs), a configurable 50ohm termination resistor in each port, 2 LEDs (light-emitting diodes), a temperature measurement integrated circuit (IC) and a 64Kbit Electrically-Erasable Programmable Read-Only Memory (EEPROM).



*Illustration 1: FMC-DIO-5chTTLa board top view.*



*Illustration 2: FMC-DIO-5chTTLa board bottom view.*



*Illustration 3: FMC-DIO-5chTTLa board front panel.*

Production Test Suite, or PTS, is the environment designed for the functionality tests of the FMC-DIO-5chTTLa 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.

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

# List of tests

The PTS consists of a set of six independent tests, each one checking a different part of the FMC-DIO-5chTTLa board. Table 1 gives a short description of each one of them.

| Test | Short description  | User Intervention |
|------|--|-------------------|
| 00   | Check FMC-DIO-5chTTLa board presence (mezzanine presence line)         | No                |
| 01   | Check digital thermometer operation (acquire and store ID and temper.) | No                |
| 02   | Check EEPROM (write, read and verification)                            | No                |
| 03   | Check DAC (device presence and initialization)                         | No                |
| 04   | Check operation of board LEDs  | Yes               |
| 05   | Check board ports as output  | Yes               |
| 06   | Check board ports as inputs  | No                |
| 07   | Check output-enable circuit of board ports                             | No                |
| 08   | Check termination resistors of board ports                             | No                |

*Table 1: List of tests*

# PTS Hardware and Software elements

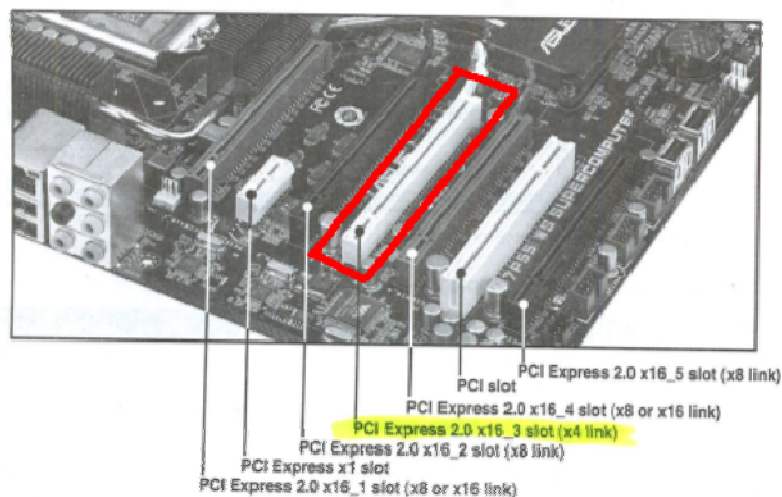
- In terms of hardware, the PTS is composed of:
  - A computer.
  - A bar-code reader to be plugged to the USB port of the computer.
  - A PCIe Extender board to be plugged to the PCI port of the computer.
  - Two spacers and four screws to fix the PCIe extender board to the computer case.
  - A SPEC (Simple PCIe FMC Carrier) board.
  - 4 GB USB memory key.
  - Mouse and keyboard.
  - 4x 60cm cable with 2 LEMO-00 plugs.
  - 3x LEMO-00 Y couplers.
  - A series of bar-code stickers with the FMC-DIO-5chTTLa serial number.
  - 4x screws to mount FMC-DIO-5chTTLa board on the SPEC board.
  - A power cord (for the computer).
  - 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 interpreter 2.7 or higher.
  - The PTS environment installed.
  - Driver *gnurabbit* installed.
- The user login is the following:

|                           |
|---------------------------|
| <b>Username</b><br>user   |
| <b>Password</b><br>baraka |

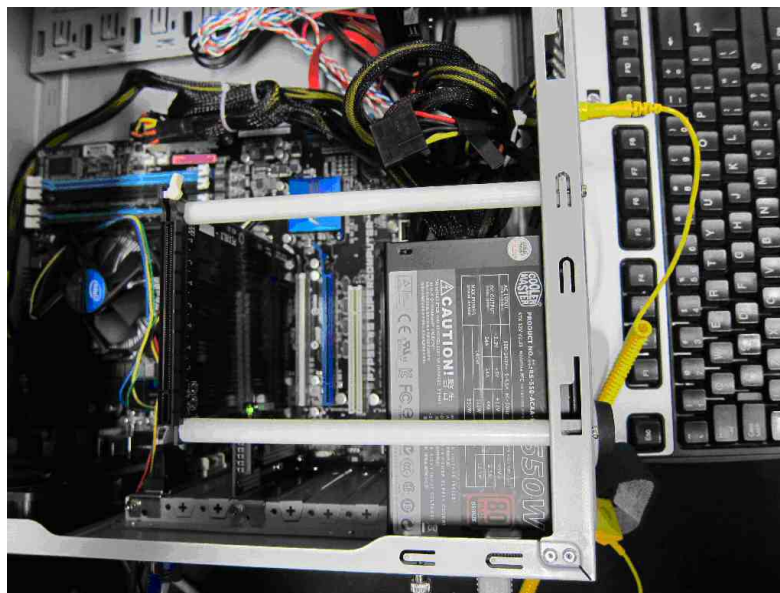
**The provided computer must not be update and should not be connected to the network.**

# 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) Connect the LEMO-00 cables to the Y couplers forming a chain as shown in Illustration 6 so that they are ready to be connected to the FMC-DIO-5chTTLa board at the beginning of the test procedure.

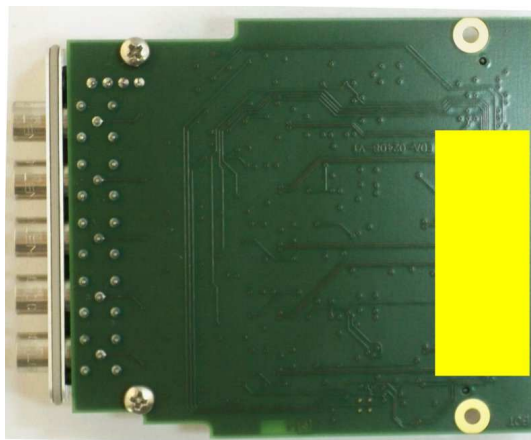


*Illustration 6: LEMO-00 cables and Y couplers assembled.*



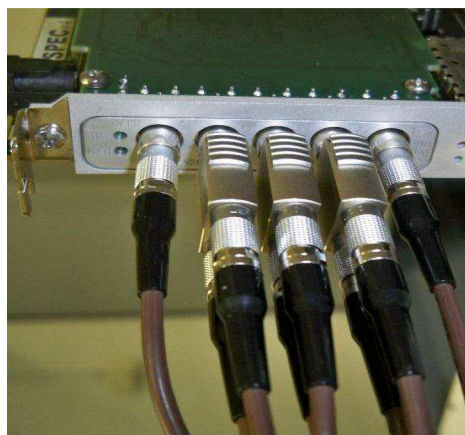
# Test Procedure

- 1) Before starting the test procedure, it is needed to wear an antistatic wrist band to avoid electrostatic issues when handling the boards and the cables.
- 2) Place the bar-code sticker on the bottom of the FMC-DIO-5chTTLa board. The position is indicated in yellow in Illustration 7.



*Illustration 7: Bar-code sticker position*

- 3) Place the FMC-DIO-5chTTLa board under test on the FMC connector of the SPEC board. **Fix the FMC-DIO-5chTTLa board to the SPEC board** using the provided screws.
- 4) Plug interconnection cables in the FMC-DIO-5chTTLa board as shown in Illustration 8.



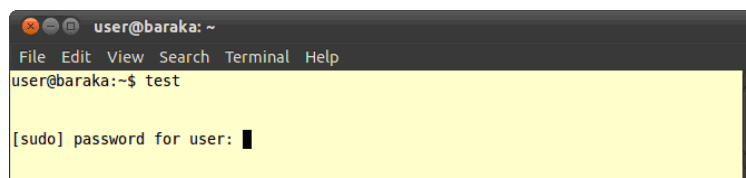
*Illustration 8: Interconnection cables plugged in the board under test.*

- 5) Plug the SPEC board in the corresponding connector of the PCIe extender as shown in Illustration 9.



*Illustration 9: Overview of the initial test set-up.*

- 6) 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 LED is off, there is a problem with the corresponding power-supply lines.
- 7) After the computer has finished with the booting procedure, a terminal appears automatically in the middle of the screen.
- 8) Type “test” then [ENTER] to start the test program (see Illustration 10)

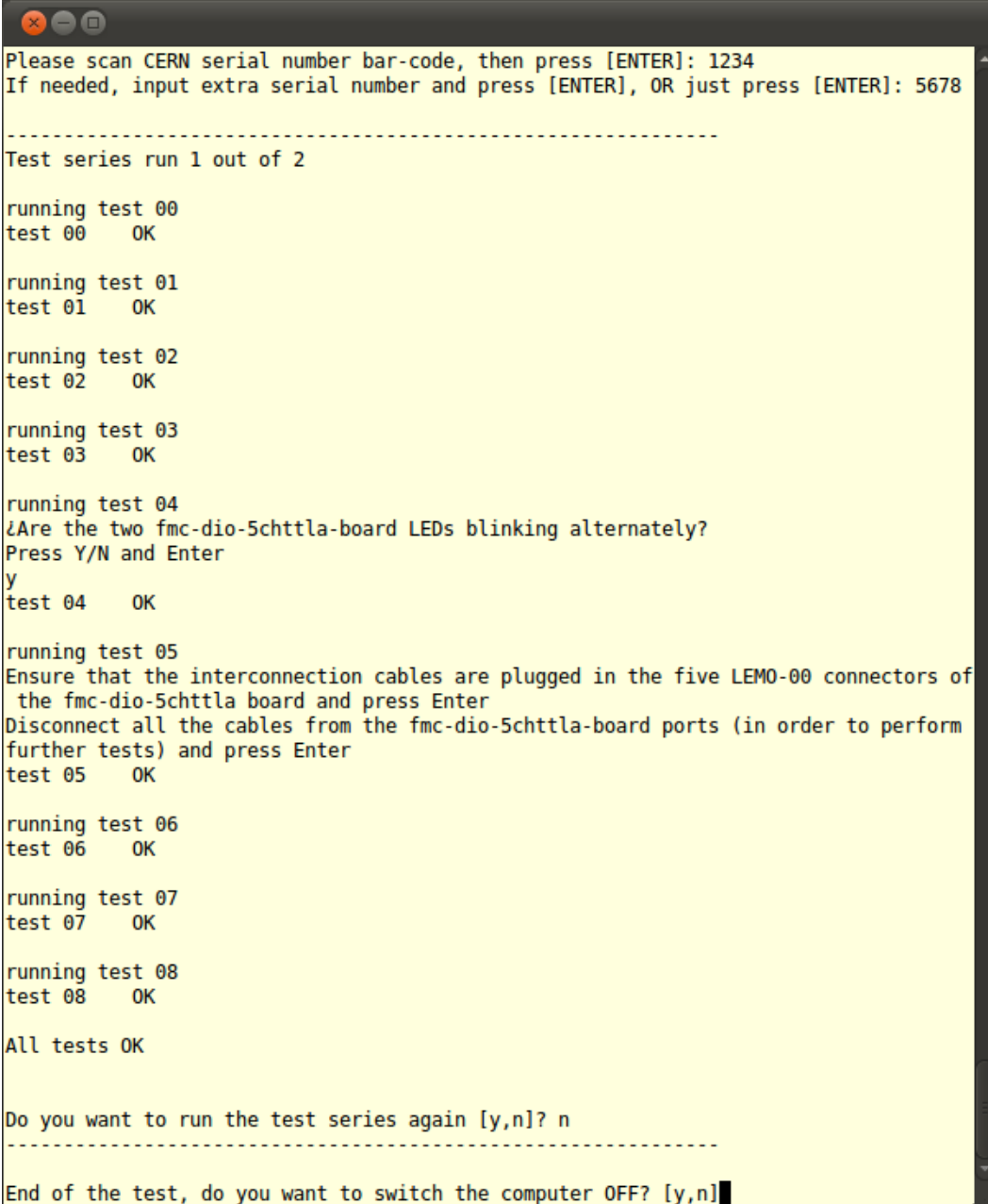


*Illustration 10: Starting the test program from a terminal.*

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

- 10) 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 FMC-DIO-5chTTLa 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]!
- 11) The program will automatically start executing tests 00 -> 08.
- 12) Test 04 requires the user's intervention and will ask the user to visually check the activation of the two LEDs.
- 13) Test 05 asks the user to verify that the interconnection cables are plugged. Since they have already been plugged in step 0, just press [ENTER]. When this test is completed, the user is asked to unplug these interconnection cables. After unplugging the cables press [ENTER]. In some rare cases (when no DAC channel is working) the user is asked to manually measure output activation of the board ports. This manual procedure can be skipped pressing [s] and [ENTER] when the user is asked.
- 14) Wait for the tests to finish
- 15) At the end of the tests the user will be asked if the tests should be repeated. If the tests reported 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.**

A screenshot of a terminal window with a dark background and a yellow highlight. The window has standard Linux window controls (close, minimize, maximize) in the top-left corner. The text inside the terminal is as follows:

```
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
test 03    OK

running test 04
¿Are the two fmc-dio-5chttla-board LEDs blinking alternately?
Press Y/N and Enter
y
test 04    OK

running test 05
Ensure that the interconnection cables are plugged in the five LEM0-00 connectors of
the fmc-dio-5chttla board and press Enter
Disconnect all the cables from the fmc-dio-5chttla-board ports (in order to perform
further tests) and press Enter
test 05    OK

running test 06
test 06    OK

running test 07
test 07    OK

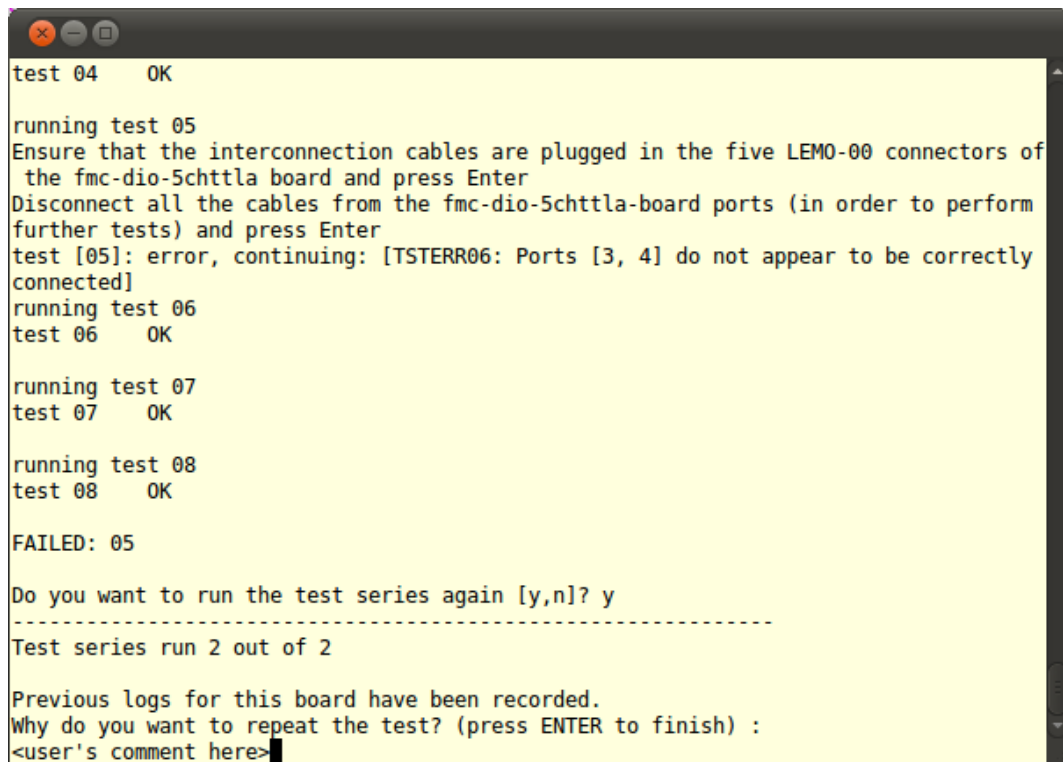
running test 08
test 08    OK

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



```
test 04    OK

running test 05
Ensure that the interconnection cables are plugged in the five LEM0-00 connectors of
the fmc-dio-5chttla board and press Enter
Disconnect all the cables from the fmc-dio-5chttla-board ports (in order to perform
further tests) and press Enter
test [05]: error, continuing: [TSTERR06: Ports [3, 4] do not appear to be correctly
connected]
running test 06
test 06    OK

running test 07
test 07    OK

running test 08
test 08    OK

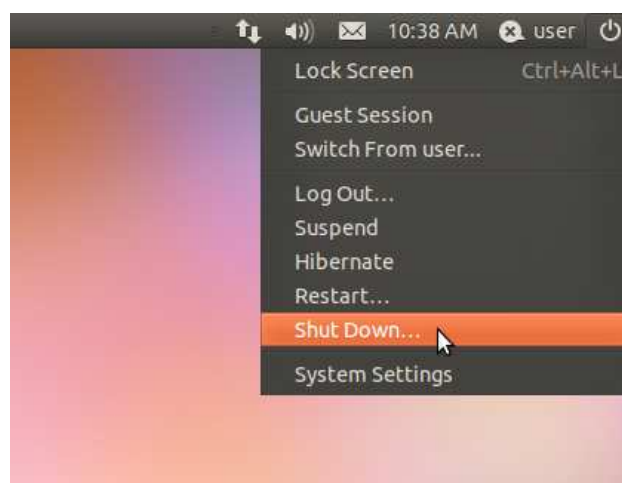
FAILED: 05

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's comment here>
```

*Illustration 12: Example of test repetition due to errors*

- 16) 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 13 indicates.

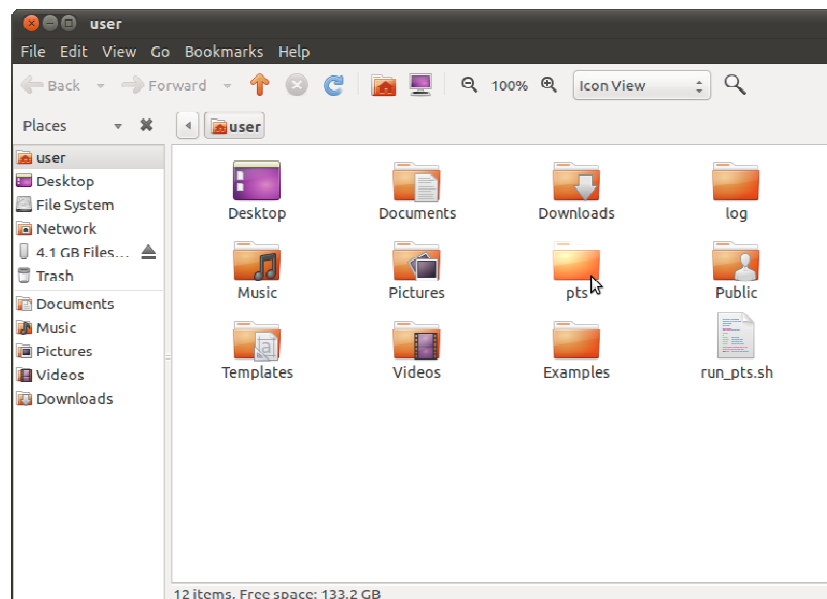


*Illustration 13: Shutting down the computer.*

# 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\_fmcdio5chttla**
- 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**.

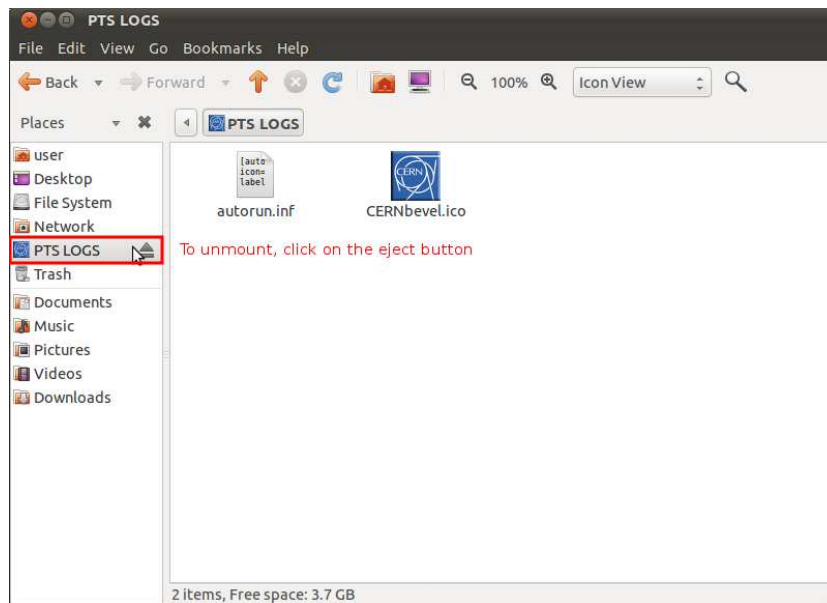


*Illustration 14: File explorer.*

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

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



*Illustration 15: 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.

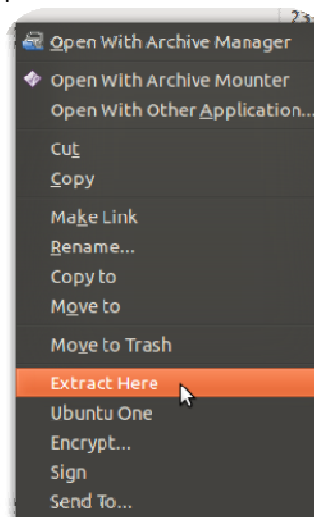
# Common causes of test failure

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\_fmcdio5chttla**.

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>\_FMC-DIO-5chTTLa\_<serial number>.zip**.

To extract the documents at the provided computer, go to the **/home/user/pts/log\_fmcdio5chttla** directory using the file explorer as indicated above, right-click on the .zip file using the file explorer and select *Extract Here* in the listed menu.



*Illustration 16: Extracting .zip file.*



## Test00

This test checks the FMC-DIO-5chTTLa-board presence by means of the mezzanine line.

Common errors:

- The driver is not properly installed.
- The firmware is not loaded.
- The FMC-DIO-5chTTLa-board is not correctly connected.
- Bad soldering of the FMC connector.

## Test01

This test checks the operation of the digital thermometer connected to the OneWire bus. It reads the I.C. unique ID, measures the temperature and stores these values in the log files.

Common errors:

- Bad soldering of the FMC connector.
- Bad soldering of the digital thermometer IC.
- Problem in the OneWire bus (short-circuit, open-circuit or faulty pull-up).

## Test02

This test checks the operation of the EEPROM connected to the I2C bus. First, the I2C bus is scanned verifying that this I.C. responds to the expected address. Then it writes several byte patterns and reads them back verifying the correct operation.

Common errors:

- Bad soldering of the FMC connector.
- Bad soldering of the EEPROM IC.
- Problem in the I2C bus (short-circuit, open-circuit or faulty pull-ups).

## Test03

This test checks the operation of the DAC connected to the I2C bus. First, the I2C bus is scanned verifying that this I.C. responds to the expected address. Then it initializes the device writing the configuration register and checks the responses.

Common errors:

- Bad soldering of the FMC connector.
- Bad soldering of the DAC IC.
- Problem in the I2C bus (short-circuit, open-circuit or faulty pull-ups).

## Test04

This test checks the operation of the two LEDs in the FMC-DIO-5chTTLa-board front panel. It blinks the two LEDs alternately and ask operator to confirm that they are actually blinking.

Common errors:

- Electrical connectivity problems in the LED activation lines of the FMC connector.
- Soldering problems of the LED circuit (LED, current-limiting resistor or switching transistor).

## Test05

This test checks FMC-DIO-5chTTLa-board ports as output. It tries to use the board DAC to automatically find any operation problem. If the DAC does not work, it offers the user the possibility to check the output manually using an external measuring instrument (for example, a LED with a 120ohm current-limiting resistor or an oscilloscope).

Common errors:

- The interconnection cables are not correctly plugged in the five LEMO-00 connectors of the board.
- Soldering problems (short-circuits and open-circuits) of the corresponding LEMO-00 connectors, corresponding lines (fuses) or voltage clamping components (short-circuits).
- Soldering problems of the corresponding port driver IC or the LVDS-to-LVCMOS IC.
- Electrical connectivity problems of the corresponding port control lines of the FMC connector.

## Test06

This test checks FMC-DIO-5chTTLa-board ports as inputs. It uses the board internal port drivers to generate specific voltages which are used as reference to check the board DAC and LVDS comparators.

Common errors:

- Something is connected to the LEMO-00 connectors of the ports. Ensure that nothing is connected to the ports while executing this test.
- Soldering problems (short-circuits) of the corresponding LEMO-00 connectors, corresponding lines (fuses) or voltage clamping components.
- Soldering problems of the corresponding port driver IC or the LVDS-to-LVCMOS IC.
- Soldering problems of the DAC or the corresponding voltage comparator.
- Electrical connectivity problems of the corresponding port control lines of the FMC connector.
- An incorrect port current-driver IC is mounted.

## Test07

This test checks the output-enable circuit of FMC-DIO-5chTTLa-board ports. It uses the input circuit of each port to verify the operation of the corresponding current-driver circuit.

Common errors:

- Something is connected to the LEMO-00 connectors of the ports. Ensure that nothing is connected to the ports while executing this test.
- Soldering problems (short-circuits) of the corresponding LEMO-00 connectors, corresponding lines (fuses) or voltage clamping components.
- Soldering problems of the corresponding port driver IC or the LVDS-to-LVCMOS IC.
- Soldering problems of the DAC or the corresponding voltage comparator.
- Electrical connectivity problems of the corresponding port control lines of the FMC connector.
- An incorrect port current-driver IC is mounted.

## Test08

This test checks the termination resistors of FMC-DIO-5chTTLa-board ports. It uses the input circuit of each port to verify the operation of the corresponding termination-resistor-activation circuit.

Common problems:

- Something is connected to the LEMO-00 connectors of the ports. Ensure that nothing is connected to the ports while executing this test.
- Soldering problems (short-circuits) of the corresponding LEMO-00 connectors, corresponding lines (fuses) or port input-voltage clamping components.
- Soldering problems of the corresponding port driver IC or the LVDS-to-LVCMOS IC.
- Soldering problems of the DAC or the corresponding voltage comparator.
- Electrical connectivity problems of the corresponding port control lines of the FMC connector.
- An incorrect port current-driver IC is mounted.

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

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