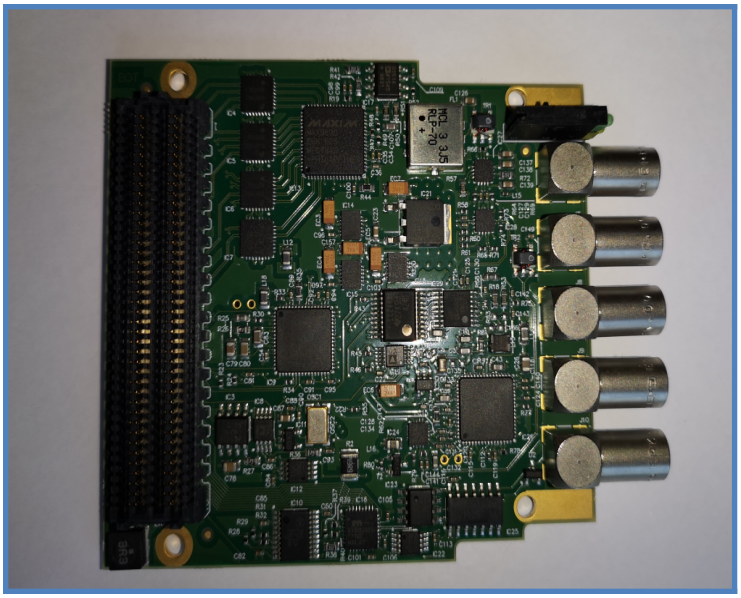
FmcDac600M12b1chaDDS

Production Test Suite

User Manual



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Revision Table

Revision	Date	Author	Comments
2.0	08/02/2019	Marek Gumiński	PTS adapted to FMC v3.
1.1a	26/11/2015	Jacek Kołodziejski	English language correction
1.1	25/11/2015	Mariusz Mróz	Formatting according to CERN feedback.
1.0	12/11/2015	Mariusz Mróz	New template used.
0.3	27/10/2015	Marek Gumiński	Changes according to further CERN feedback.
0.2	17/08/2015	Marek Gumiński	Formatting according to CERN feedback. Test environment fully specified.
0.1	25/06/2015	Marek Gumiński	Initial version.

Table of Contents

Introduction 1

Welcome to the Production Test Suite for the FmcDac600m12b1chaDDS boards – DAC-DDS PTS.

The DAC-DDS Production Test Suite (PTS) is an extension of the original PTS which allows to perform functionality tests on FmcDac600m12b1chaDDS boards after manufacturing. The original PTS was intended for testing boards designed for the Open Hardware Repository, but it proved to be adaptable to other boards. It assures that the boards comply with a minimum set of quality rules, in terms of soldering, mounting and fabrication process of the Printed Circuit Boards (PCB).

It is important to note that the DAC-DDS PTS covers only to the functionality tests of the boards and does not cover any verification or validation tests of the design. This document describes the DAC-DDS PTS components and its use.

Figure 1: DAC-DDS PTS view

The main elements of the PTS are listed in Table 1.

Table 1: DAC-DDS PTS elements

Item	Comments
Computer	Power cord (provided). A motherboard with two 4 line PCIe slots is required (provided)
Monitor	Not provided
Keyboard, Mouse	Not provided
Barcode reader	With USB connection to the computer
ESD wrist strap	With banana type connection to the computer chassis
PCIe extender cable	Two spacers and four screws to fix the PCIe extender board to the computer case (provided)
SPEC board	Four spacers and height screws are used to fix the board to the computer case
SPEC-ADC boards	SPEC + FmcAdc100M14b4cha FMC board
FmcDac600m12b1chaDDS	Board under test (reference board)
3x LEMO cables	Any length (2ns recommended)
LEMO-uFL cable	Any length (2ns recommended). Use of connector standard adapters is allowed.
Documentation	This user guide plus the one-page testing procedure

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

Table 2: PTS software requirements

Ubuntu Linux 14.04.03 LTS
Python 2.7
The PTS environment installed

The user login is:

Table 3: Computer login

Username	user
Password	baraka

Note that the computer should not be connected to the network and no updates should be allowed.

The following paragraphs provide an overview of the required items.

The DAC-DDS mezzanine board is tested while mounted on a SPEC carrier board, as Figure 2 shows. The SPEC carrier board provides access to the PCIe interface of the computer. The computer hosts the DAC-DDS PTS software which provides the automated testing environment.

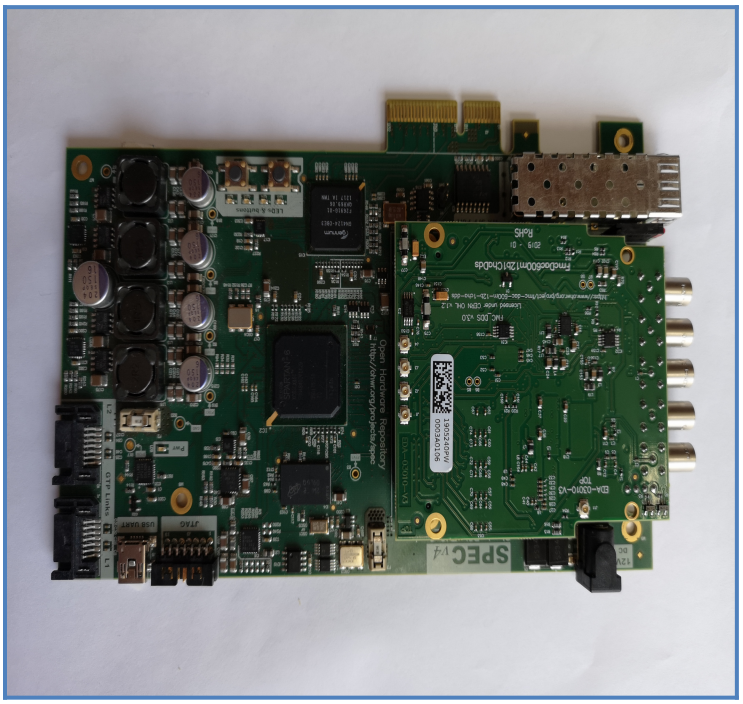

Figure 2: SPEC-DAC-DDS combination

To facilitate the testing setup, the SPEC carrier is fixed on the computer's box and a PCIe extender cable is used.

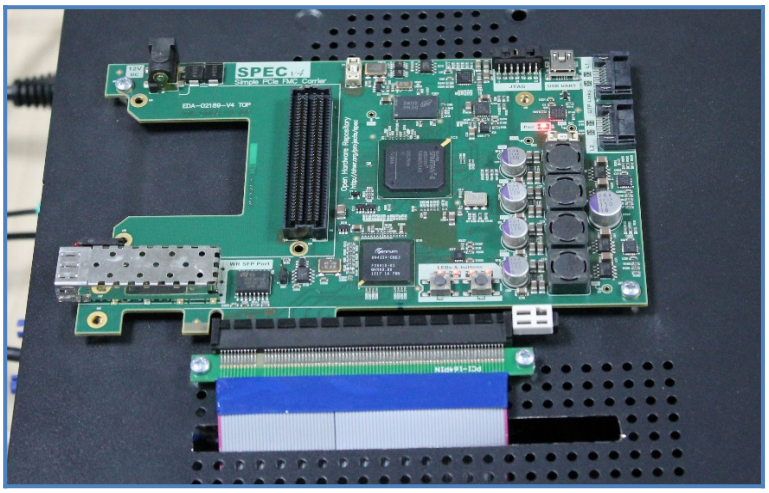

Figure 3: SPEC connected to the PCIe extender

An additional SPEC, carrying a FMC ADC 100M 14b 4cha board, is also required to perform the tests. The SPEC-ADC boards should be plugged directly into the PCIe slot of the computer.

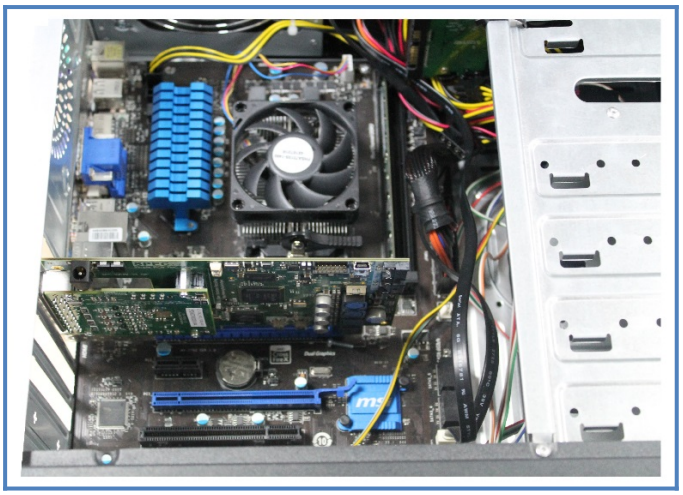

Figure 4: SPEC-ADC boards mounted in to the PCIe slot

A set of LEMO cables is used for the connections between DAC-DDS board and FMC-ADC board. It is convenient to use 2ns LEMO cables.

The connection matrix is shown on Figure 5. Both FMC cards should be plugged into the FMC connectors of the SPEC boards as described in the Chapter *First Time Setup*.

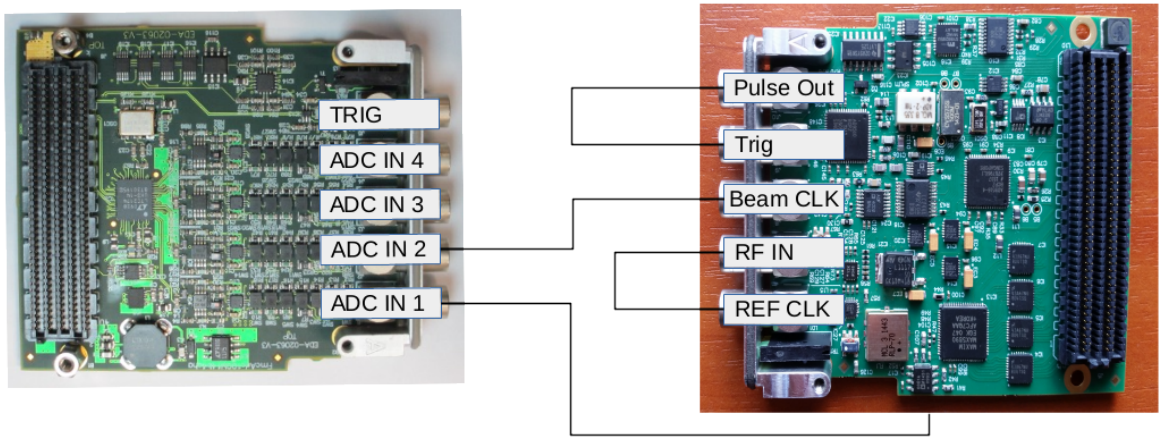

Figure 5: Test setup connections.

The test of a single DAC-DDS board, including functionality tests, lasts around **twelve minutes.**

In brief, the operator needs to:

- mount the DAC-DDS board onto the **SPEC carrier**
- connect the LEMO **cables** between the **DAC-DDS** and the **FMC-ADC**
- run the **software**
- at certain points of the tests an **intervention** needs to be done by the operator (e.g.: scan the board's barcode or check the font panel); the interventions are explicitly signaled by the DAC-DDS PTS software and this manual.

At the end of the functionality tests the operator receives a PASS/FAIL notification. In case of a FAILED board, information is provided on the failing components.

All test results are automatically saved in a folder on the computer.

A board is considered to have passed the PTS testing if it has successfully completed all the functionality tests.

For a FAILED board, you can repeat the test only one more time! If a board FAILs twice, please report to the CERN responsible.

DAC-DDS Board Functionality 2

The FmcDac600m12b1chaDDS, DAC-DDS (EDMS: EDA-03010) is a FMC (FPGA Mezzanine Card) format board used to distribute Radio Frequency (RF) signals over a White Rabbit (WR) network.

This board contains a Radio Frequency Clock input used in master mode. RF clock frequency is divided to produce a reference clock frequency that is distributed via a WR network, and reproduced on multiple slave devices. Beam Clock and Reference Clock outputs of FmcDac600m12b1chaDDS will be phase locked with the Reference Clock (and RF clock on master node).

Each node is capable of capturing the time (Time Stamping) of events denoted by the signal connected to the Trigger Input. FmcDac600m12b1chaDDS can also trigger external devices by generating a signal on Pulse output. Time of output pulse may be tuned with 10 ps precision.

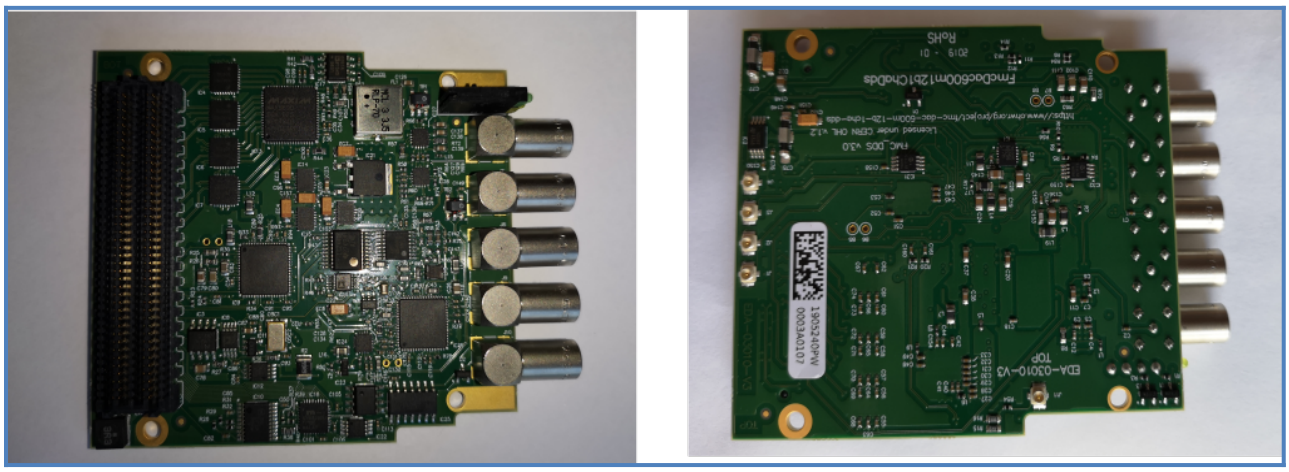

Figure 6: Top and bottom views of the DAC-DDS board

The DAC-DDS mezzanine board is tested while mounted on a SPEC carrier board. The SPEC provides FPGA logic, power supplies, memories, clocking resources, White Rabbit support and interface to the PCIe bus.

PTS Functionality Tests 3

The PTS consists of a set of seven independent tests, each one checking a different part of the DAC-DDS board. Table 4: List of tests gives a short description of each one of them.

Table 4: List of tests

Test	Short Description	Operator's Intervention
00	Loads firmware, tests mezzanine presence, tests communication with carrier	Yes
01	Tests of IC9 (AD9516) part: SPI communication, oscillator connection, PLL-FPGA clock line, DAC's controlling oscillator, lock detect and reset lines	Yes
02	MAX5890 DAC tests. Chip functionality is verified. Each digital data line is tested separately.	No
03	Tests of IC26 (AD9516). SPI communication, function line, input and output clock lines are tested (except for BEAM CLK).	No
08	Test of BEAM CLK output.	No
04	ADF4002 (PD) and AD7980 (ADC) tests. PD communication interface, clock inputs and charge pump output are tested. ADC communication and analogue input is tested.	Yes
05	Trigger input test. SY8929 delay line and temperature sensor are tested.	No
10	DS18D20 communication and temperature measurement test.	No
11	MCP9800 communication and temperature measurement test.	No
07	EEPROM test and IPMI bitstream writing.	No

Log files retrieval 4

The log files need to be delivered to CERN after completing the tests for all of the boards. To do so, please follow the instructions below:

- Plug the provided USB memory key in to the computer.
- Wait until Ubuntu mounts automatically the device.
- Using the file explorer navigate to **/home/user/pts/log_fmcdac600m12b1chadds directory.**
- Select all the .zip files, right click and select copy.
- Using the file explorer, click on the USB device that appeared on the left column, right click and selecting paste.
- Click on the eject button on the left of the file explorer window and remove the USB key.
- Transfer the data to another computer with Internet access.
- Finally, send the .zip file by email to the responsible of tests at CERN.

First Time Setup 5

The following list explains how to setup the DAC-DDS PTS environment for the first time.

1) Make sure that the computer is switched off.
2) Plug the FmcAdc100M14b4cha board into the FMC slot in one of the SPEC boards and secure it with 4 screws.
3) Plug the SPEC board with the FmcAdc100M14b4cha to the PCIe slot of the test PC

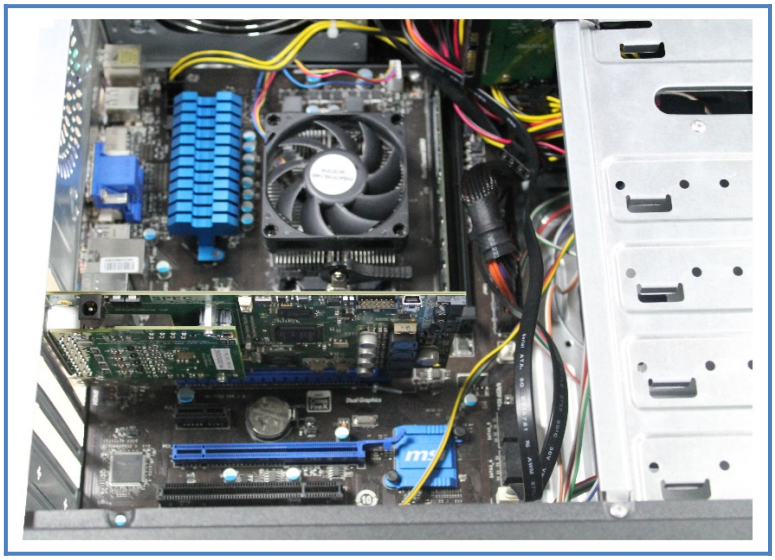

Figure 7: SPEC-ADC set mounted in PCIe slot

4) Plug the PCIe Extender board into the second PCIe slot and use the provided spacers and screws to attach the PCIe Extender to the computer box.
5) Screw the **SPEC board** on the top side of the computer cover, as Figure 8 shows. Connect one side of the **PCIe extender cable** to the SPEC. Pass the other side of the cable through the dedicated cut of the computer cover.

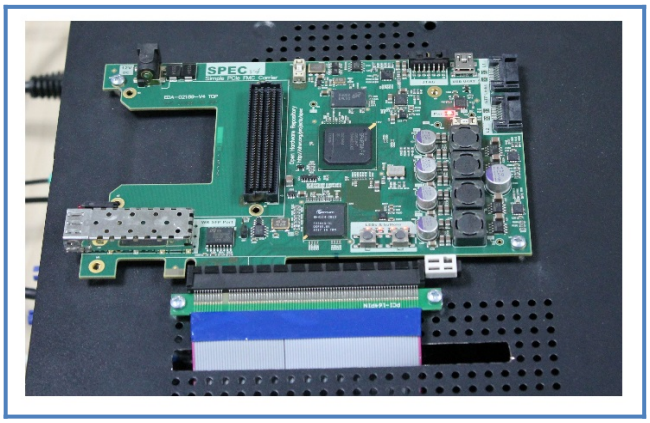

Figure 8: SPEC mounted on the computer cover

6) Plug the other side of the **PCIe extender cable** into the computer slot indicated in Figure 9. Mount the computer cover back to close the computer box. Make sure the screws are back on their place.

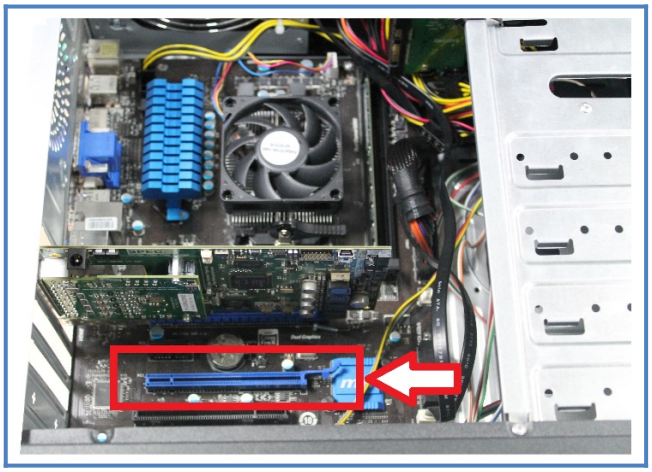

Figure 9: PCIe slot for the extender cable

7) Plug the **barcode-reader** into an available USB slot of the computer.

8) Connect the **monitor, keyboard and mouse** to the computer.

Testing Procedure

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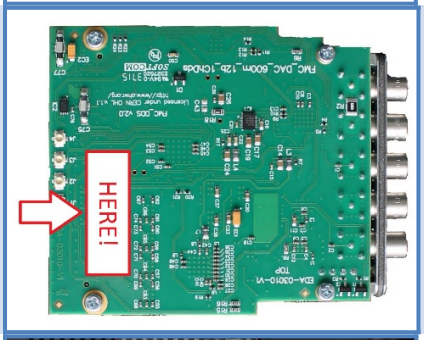
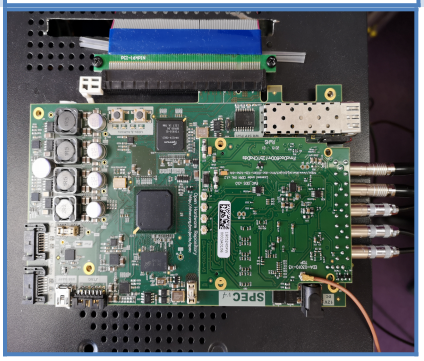
1) **Place the ESD strap on your wrist.**

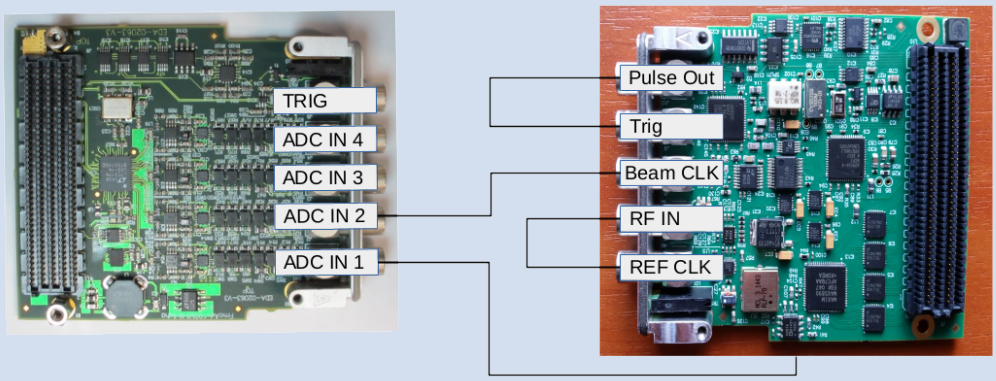
2) **Put the barcode sticker on the Bottom side of the DAC-DDS under test, in the position indicated in red.**



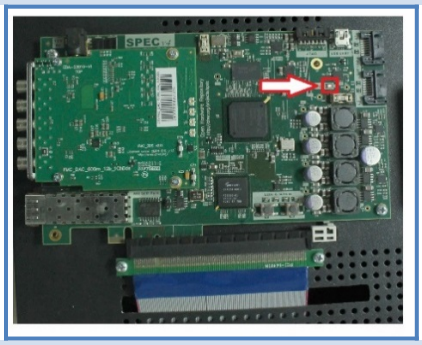
3) **Mount the DAC-DDS-under-test on the SPEC board.**



4) **Connect DAC-DDS with SPEC-ADC using LEMO cables as indicated on figure below.**
   - **Connect the REF CLK port of the DAC-DDS with the RF IN port of the DAC-DDS (Loopback),**
   - **Connect the Trig. port of the DAC-DDS with the Pulse Out port of the DAC-DDS (Loopback),**
   - **Connect the Beam CLK of the DAC-DDS with ADC IN 2 of the SPEC-ADC**
   - **Using the uFL-LEMO00 cable connect the WR CLK OUT with ADC IN 1 of the SPEC-ADC**



5) **Switch ON the computer.**
   - **Verify that the "Pwr" LED on the SPEC board is ON. This will confirm that the SPEC board is properly plugged.**
   - **If the LED is OFF there is a problem with the power supply lines.**



6) **After the computer has finished with the booting procedure, a terminal will appear automatically in the middle of the screen. When asked, type the password: "baraka" and [ENTER]**

7) **The program asks for the barcode of the board.**

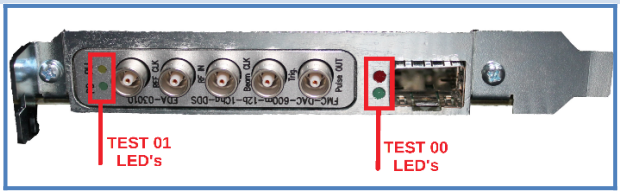
   Check that the cursor is on the terminal, press the button/trigger on the barcode reader.
   The code will appear on the terminal. Press [ENTER].

   The program will ask for a second barcode, in case the manufacturer has a different serial number system.
   Scan the second barcode and press [ENTER], or if there is none, just press [ENTER].

8) **The program will automatically execute tests 00 to 07.**

9) **Tests 00, 01 and 04 ask for the user's intervention.**

   Test 00 will ask you to verify if the LED's on SPEC front panel are ON and then OFF.
   Test 01 and 04 will ask you for verify if PLL and PD LEDs on DAC-DDS front panel are ON and then OFF.



10) **At the end the operator is informed of the results of all the tests and is asked if he wants to repeat the whole process.**

If no error had occurred, type [n] and then [ENTER].

In case of error, you could repeat the tests (functionality and calibration) once by typing [y] and [ENTER].

11) **When prompted to switch off computer:**
Type [y] and confirm with [ENTER].

A board is considered to have passed the PTS testing if it has successfully completed all the functionality tests.

For a FAILED board, you can repeat the test only one more time! If a board FAILs twice, please report to the CERN responsible.

Common Causes of Test Failure 7

Once the testing has finished, all the errors 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_fmcdac600m12b1chadds.**

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

zip_run_<run id>_<timestamp>_fmcdac600m12b1chadds_<serial number>.zip.

To extract the documents on the provided computer. Go to the following directory: **/home/user/pts/log_fmcdac600m12b1chadds** using the file explorer as indicated above, right-click on the .zip file and select Extract Here in the listed menu.

Common problems with software setup

Following problems might affect each test.

SPEC board with FmcDac600m12b1chaDDS was not detected

- Verify that the board is connected to the PCIe port.
- Verify that the spec and fmc drivers were properly mounted in the kernel.
- Make sure that no more than 2 SPEC boards are connected to the PC.
- Make sure that FmcAdc100M14b4cha it is configured with valid IPMI information.
- Make sure that FmcDac600m12b1chaDDS does not have IPMI information or it is valid.

SPEC board with FmcAdc100M14b4cha was not detected

- Verify that the board is connected to PCIe port.
- Verify that the spec, fmc, zio and fmc_adc_100m14b drivers were properly mounted in the kernel.
- Make sure that no more than 2 SPEC board are connected to the PC.
- Make sure that FmcAdc100M14b4cha is configured with valid IPMI information.
- Make sure that FmcDac600m12b1chaDDS does not have IPMI information or it is valid.

Functionality test

Test 00

Loads firmware, tests communication with SPEC board, tests mezzanine presence.

Common problems for firmware and mezzanine presence:

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

Common problems for communication:

- Driver not properly installed.
- Firmware not loaded

Test 01

Test verifies AD9516 (IC9) PLL and DAC (IC8) controlling VCXO (OSC1/OSC2) oscillator.

Common problems for AD9516:

- No access using SPI: bad soldering.
- AD9516 PLL does not lock: faulty PLL
- Faulty clock connection with the FPGA: bad soldering.
- Reset on LD lines doesn't work: bad soldering.

Common problems for VCXO:

- Faulty oscillator
- Faulty voltage control DAC

Test 02

Test MAX5890 DAC (IC13).

Common problems:

- Bad soldering (both – not connected bits and shorted bits can be detected).
- Faulty clock connection from AD9516 PLL.

Test 03

AD9516 (IC26) PLL tests. Tests the following LEMO connectors: RF IN, REF OUT.

Common problems with AD9516:

- SPI communication: bad soldering.
- Lock Detect and Function Lines: bad soldering.
-

Common problems with clock inputs and outputs caused by bad soldering:

- Clock connection between AD9516 and FPGA.

- RF IN port.
- REF CLK port.

Test 08

Test BEAM CLK port and IC26 output 4.

Common problems:

- Bad soldering (both – not connected bits and shorted bits can be detected).
- Faulty clock connection from AD9516 PLL.

Test 04

It is not possible to test separately the AD4002 phase detector and AD7980 analog to digital converter. These devices are checked together.

Common problems of AD4002 (IC24):

- SPI interface: bad soldering.
- Lock detect output not working: bad soldering of AD4002 or SN74LVC244 (IC18) buffer.
- Clock REF and RF inputs: bad soldering.
- Charge pump: bad soldering of low pass filter components.

Common problems of AD7980 (IC19):

- Communication problems: bad soldering.

Test 05

Test of the Trig. Input port, Pulse Out port and Delay chip (IC16).

Common problems with the Trigger input and Pulse Out port:

- Bad soldering.

Common problems with the Delay chip:

- Bad soldering.
- Faulty device.
- Faulty clock buffer (IC10).

Test 10

Test of DS18B20U (IC22) temperature sensor.

Common problems with communication:

- Bad soldering

Common problems with temperature measurement:

- Faulty chip
- Bad power

Test 11

Test of MCP9801 (IC31, IC32) temperature sensor.

Common problems with communication:

- Bad soldering

Common problems with temperature measurement:

- Faulty chip
- Bad power

Test 07

This test writes and verifies the IPMI to the EEPROM.

Common problems:

- Badly soldered EEPROM or FMC connector.