

Production Test Procedure

Antenna Processing Subrack Clock and Translator (APSCT)

PCB nr.: 03116

	Organisatie / Organization	Datum / Date
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1 Introduction

1.1 Document Scope

This document is intended for PCB assembly, manufacturers and test facilities. It describes the test that have to be performed on the LOFAR2.0 APSCT during production. The ASPCT is described in RD.1. For each board the test results have to be recorded. **ASTRON is open for adjustment to this test plan. These adjustments however should be discussed and an update of this document will be made.**

In section 2 an overview of the test configuration, all steps that have to be taken prior to testing, is described. Section 3 describes the verification steps during the assembly steps and to the steps which must be performed on the PCBA or module. How to handle anomalies and procedure variation is described in section 4. Annexes to this document can be found in section 5.

1.2 List of Terms and acronyms

ANSI	American National Standards Institute
AD-n	nth document in the list of Applicable Documents
APSCT	Antenna Processing Subrack Clock distribution and Translator
BOM	Bill Of Material
DMM	Digital multi meter
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
IPC	Association Connecting Electronics Industries
ICT	In Circuit Test
LOFAR	Low Frequency Array
NCR	Non-Compliant Report
PO	Purchase Order
PCB	Printed Circuit Board
PPS	Pulse per second
PV	Procedure Variation
RD-n	nth document in the list of Reference Documents
RoHS	Restriction of Hazardous Substances
SW	Software
TCC	Test Control Computer
TBC	To be confirmed
Vpp	Volt peak-to-peak

1.3 Applicable documents (AD)

Ref.nr.	Doc. number	Title	Author
AD.1	EN55022-B	EMC standards	
AD.2	IEC 61000 -4-3	Radiated immunity	
AD.3	IEC 61000 -4-6	Conductive immunity	
AD.4	IEC 62305	Protection against lightning	

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1.4 Reference documents (RD)

Ref.nr.	Doc. number	Title	Author
RD.1	PMS00044	APSCT Product Manufacturing Specifications	Gijs Schoonderbeek
RD.2	PAD00054	APSCT Product Assembly Document	Gijs Schoonderbeek

1.5 Test results storage

The results of all inspections, functional and delivery tests should be stored in the ASTRON database. This makes it possible to verify that a test was successful.

The OEM can use its own data base for storing a detailed report on the production process. An export with the summary of the production process has to be transferred to the ASTRON data base. This report should include at least:

- The passing of each step from bare board inspection to final delivery check. Each step should include a time stamp.
- The repairs done on the product

The format of this summary should be a PDF file ready to be imported in the ASTRON database.

Figure 1 and Figure 2 are showing an example of the ASTRON database.

I&S Boarden

Search in ALL fields (also those not displayed here):							
Number	Serial nr.	Type-Version	Status	Location	Project	Housing	Production
		UniBoard2					
437	26287-004	UniBoard2-1.3	Tested	Dwingeloo	ARTS	Uni2Box	14-07-2017
436	26287-003	UniBoard2-1.3	Tested	Dwingeloo	ARTS	Uni2Box	14-07-2017
435	26287-002	UniBoard2-1.3	Tested	Dwingeloo	ARTS	Uni2Box	14-07-2017
434	26287-001	UniBoard2-1.3	Tested	Dwingeloo	ARTS	Uni2Box	14-07-2017
433	26287-005	UniBoard2-1.3	Working	Dwingeloo	ARTS	Uni2Box	14-07-2017
8	26054-003	UniBoard2-1.3	Working	Italy	UniBoard2	Uni2Box	15-12-2015
7	26054-004	UniBoard2-1.3	Errors	JIVE	UniBoard2	Uni2Box	15-12-2015
6	26054-005	UniBoard2-1.3	Working	France Bordeaux	UniBoard2	Uni2Box	15-12-2015
5	26054-002	UniBoard2-1.3	Working	Manchester	UniBoard2	Uni2Box	14-12-2015
4	26054-001	UniBoard2-1.3	Working	France Nancay	UniBoard2	Subrack	15-12-2015
3	26054-007	UniBoard2-1.3	Ready for test	Lab Dwingeloo	UniBoard2		15-12-2015
2	26054-006	UniBoard2-1.3	Working	Duitsland	UniBoard2	Uni2Box	15-12-2015
1	26012-001	UniBoard2-1.3	Working	Demo-Board	UniBoard2	Uni2Box	04-05-2015

Figure 1 Overview of the "I&S Boarden" web form.

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Board information

Board information			Wijzigen
Board Type	UniBoard2		
Board Version	1.3		
Serial number	26287-001		
Status	Tested		
Location	Dwingeloo		
Firmware	Switch 2.82c, unb2b		
Production date	14-07-2017		
Project	ARTS		
Housing	Uni2Box		
Schematic			
Repairs	Node 0 VCCRGXB SMPS gedraaid op de print.		
Remarks	B.S. OK ready for firmware test.		
Results			
Bestand 1	R_434_1.jpg		Vervang
Bestand 2	R_434_2.png		Vervang
Bestand 3			Nieuw

Figure 2 Example of one board.

2 Test configuration

2.1 Identification of the test article

The item under test is the APSCT. For a description refer to RD.1.

2.2 Objectives of the test

The objective of the test is to fully test all solder joints, press-fit connections and mounting of mechanical part on the APSCT such that the product can be installed on a remote location. All components should be mounted and placed correctly.

2.3 Configuration control

Prior to the test, the test configuration shall be established and recorded

1. Test equipment type, serial number and calibration due date
2. APSCT test environment SW (scripts) version/date
3. Test equipment settings

All test results tagged with the relevant serial number shall be stored digitally. The test results shall be available for later evaluation when requested by ASTRON. Copies and or prints of this information shall be available for the test result summary.

The content of the test database shall be handed over to ASTRON after delivery of each production batch.

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2.4 Safety

The following ESD and personnel safety precautions shall be taken:

- The board is ESD sensitive. ESD precautions must be taken at any time during the assembly and handling of the board or individual components (use a wrist strap connected to a ground terminal).
- An external fan for cooling shall be used, to prevent overheating of the boards. The test engineer shall verify that the fan is running before a test is performed.

2.5 Test responsibilities

It is the responsibility of the test-designer (ASTRON):

- Design a test with covers all aspects
- Design a test which is easy to perform.
- Design a consistent and repeatable test.

It is the responsibility of the test-conductor:

- Executing the test(s) following the test instructions.

The checklist of section 5.3 can be used as a guideline to verify that all verifications are performed.

2.6 Test facility requirements

The environmental specifications of the test facility shall be maintained within the values given below:

- Temperature: 18 °C to 25 °C
- Humidity: 50% to 70%
- Cleanliness: "normal" office environment or better
- EMC protected area as described in EN55022-B [AD.1]
- Radiation and conductive immunised area as described in IEC 61000 [AD.2][AD.3]
- Area protected against lightning as described in IEC 62305 [AD.4]
- Antistatic, ESD protected area (EPA)

3 Test description

This section describes the verifications that are required prior, during and after the production of this PCBA. The purpose of the verifications is to confirm good quality of the assembly process and can be divided in events required during the production of the PCBA (section 3.1) and events after completion of the PCB assembly (section 3.2).

A verification event can be one or a combination of the following actions:

Demonstration	Operation of the system, subsystem or a part of the system that relies on observable, functional operation, not requiring use of instrumentation, special test equipment or subsequent analysis.
Test	Operation of the system, subsystem or a part of the system using instrumentation or other special test equipment to collect data for later analysis.
Analysis	Processing of accumulated data obtained from other qualification methods.
Inspection	Visual examination of system components, documentation, certifications, etc.

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3.1 PCB Production verification

Incoming PCB's must be visually inspected for anomalies in order to confirm that a PCB is qualified for the following production step. All PCBs have to full fill the IPC-A-610 standard. All PCBs have to pass an electrical test as specified by IPC-9252 to test all interconnections. Use a copy of the test result check list in 5.3 to record the test data and if the test has passed or failed. The results of the following verifications need to be analysed for each individual board in order to confirm that the board is properly assembled and suitable for the function test.

3.1.1 In-line assembly inspections

The goal of In-line assembly tests are:

- Direct feedback during the product assembly process.
- Verify that the right components are placed at the right location.

3.1.2 Feeder Setup Verification

During the filling of the pick and place machine the feeders containing the components will be checked that the correct reel is placed.

3.1.3 Automated Solder Paste Inspection (SPI / API)

Automated solder paste inspection is used to verify that the right amount of solder paste is placed on the board. With the right amount of paste well defined solder joints can be made without spoiling solder (loose solder joints). In Figure 3 an example of SPI is shown.

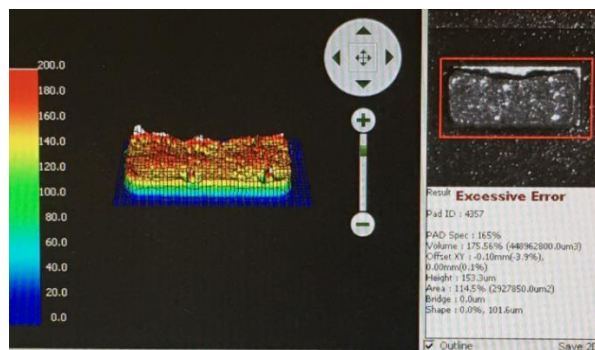


Figure 3 Example of Automated Solder Paste Inspection

3.1.4 Automatic Optical Inspection (AOI)

Automated optical inspection must be used to verify that all parts are placed at the correct location with the correct rotation and the correct alignment. In Figure 4 an image of a single component AOI is shown.

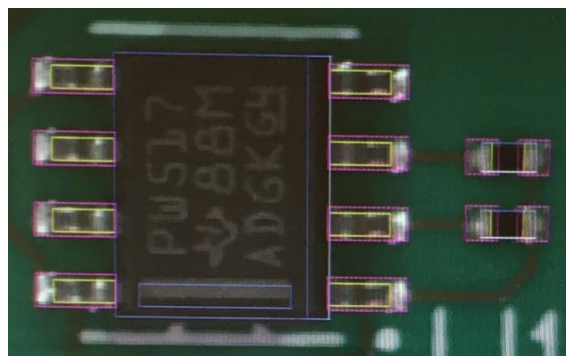


Figure 4 Image of an AOI scan of a SOIC8 package

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3.1.5 Automated X-Ray Inspection (AXI)

Automated X-Ray inspection or manual X-Ray inspection must be performed for the APSCT to verify the solder quality of solder joints which cannot be verified by AOI, like no lead packages (QFN, SON, DFL). An example is shown in Figure 5.

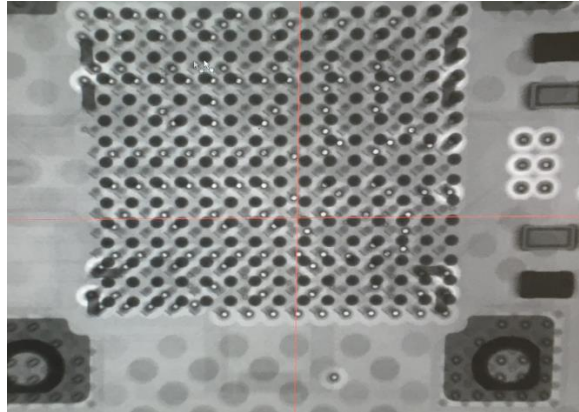


Figure 5 X-Ray image of a BGA connector.

3.2 Configuration of the Raspberry Pi CM4

In order to perform the functional test, a Raspberry Pi CM4 module is required, see the APSCT Product Assembly Document [RD.2] for more details of the assembly. Before this module can be placed on the APSCT, the module must be configured. This must be done by using:

- RPI CM4 IO BOARD
- rpiboot software
- Raspberry Pi Imager software (Win32DiskImager)

----THIS PROCEDURE IS UNDER DISCUSSION----

With the following steps the CM4 is configured:

1. Install the RPI CM4 on the RPI CM4 IO BOARD, see Figure 6
2. Place jumper between J2 pin 1 and 2.
3. Connect the IO module micro-USB J11 to PC
4. Connect power 12V DC power to IO-Modules J19.
5. Start rpiboot.exe
6. Start Raspberry Pi images software
7. Power-cycle LOFAR image to the CM4.
8. Run "rpiboot.exe -d c:\LOFAR2\recovery"
9. Remove Pi from RPI CM4 IO BOARD

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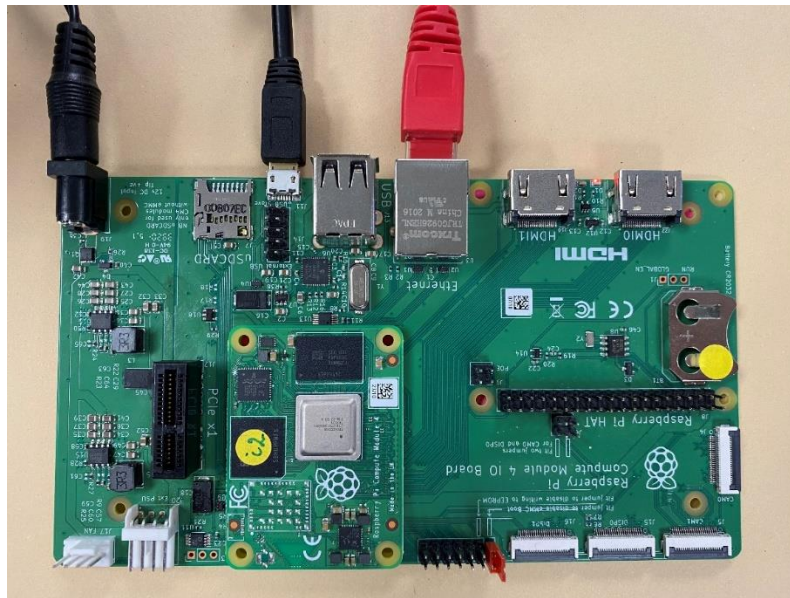


Figure 6 RPI CM4 installed on RPI CM4 IO BOARD with jumper placed and microUSB connected.

3.3 Functional Tests

The purpose of the functional test as described in this section, is to confirm that the board is properly assembled. These tests can also indicate assembly issues such as short- and open circuits as well as missing or misplaced components.

3.3.1 Test equipment and test software

Table 1 summarizes the equipment that is required to test APST.

Table 1 List of test equipment.

Equipment	Part Number	Serial Number	Calibration due date
Digital Multi Meter			
Power supply 5.5 V / 4 A			
10 MHz clock source			
1 Hz source (1 PPS)			

The test software (scripts) will be running in the Test Control Computer (TCC), see Table 2 for an overview of the test software. The TCC combines the functions of the specific APST test. It will be used to set the required test configuration for a certain function or measurement. Functions can be commanded, the corresponding monitoring values and housekeeping parameters of the APST will be monitored and evaluated for correctness by the test control computer. The computer will show a pass/fail on each of the functional test parameters and store the test results in the database.

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Table 2 List of software package on the Test control.

Software package	Version	Location
Windows		
Python		
APSCT_production.py		

3.3.2 Test setup

In Figure 7 the test setup for the APSCT is shown. The APSCT will be tested as single board without test jig. A 10 MHz clock source and 1 Pulse Per Second reference source will be connected to APSCT along with two 5.5V power connection and a ethernet control cable. For this short test no cooling is needed for APSCT

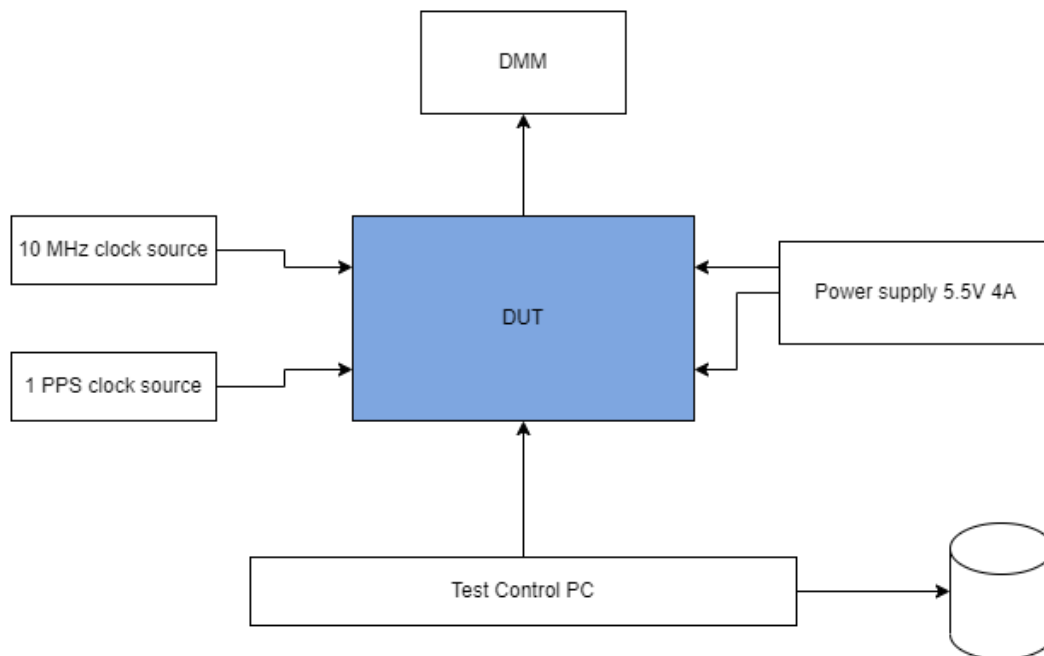


Figure 7 APSCT production test setup.

3.3.3 Power supplies impedance and voltages

The power to the board is connected through two backplane connectors. The power supplies are measured during the functional test. In case a module does not start-up correctly the local power supplies have to be measured as described in 5.1.

3.3.4 Clock and PPS input

Connect the 10 MHz reference clock and 1 PPS (1 Hz) signal to APSCT and check that the flashing red LED's are off.

3.3.5 Monitor and Control

The monitor and control interface, including programming of the EEPROM, is tested by running the python script: APSCT_Production.py. This should be done by performing the following steps:

1. Connect the Ethernet cable to APSCT
2. Power-up APSCT

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3. Run APSCT_production.py
4. Check if run was successfully
5. Upload results.txt into the database.

3.3.6 Signal path

After running the test script LED D1 should be green.

3.4 Summary

In Table 3 an overview steps during the functional test and the test times are shown.

Table 3 Estimated test time.

Item	Est. test time
RPI CM4 configuration	5 min
Install in test system	1 min
Run python script	2 min
Store results	1 min
Sum	9 min

4 Anomalies and procedure variations

During a test, several types of anomalies or deviations may occur. Depending on the type, the anomaly or deviation has to be documented. In the following subsection actions, which have to be taken on the possible anomalies and deviations are described.

4.1 Deviations from the step-by-step procedure

A Procedure Variation (PV) have to be added to the Procedure Variation Sheet in section. The PV shall have a unique number and explain which test step(s) have changed and for what reason. The PV reference must be added at the relevant test step. The PV must be communicated with the customer ASTRON and eventually agreed before proceeding with the tests depending on the impact on the test.

4.2 Software anomalies

Small mistakes in the test software which do not have impact on the overall flow of the test and need not to be discussed with the customer. Persistence malfunction of the software must be communicated with the customer ASTRON such that actions can be taken. Contact information can be found in the PMS [RD.1]

4.3 Production failure

When a test step fails (i.e. the pass/fail criteria = fail) during the test and the failure cannot be corrected by a small change to the test software (see 4.2 above), the following options are possible:

- Failure diagnosis to be performed to pin-point the problem to a replaceable item. The correction on the PCBA has to be stored in the component database.
- When the failure is such that testing has to be stopped and immediate action has to be taken: Inform the customer ASTRON and together will be decided if testing can continue and whether Software Problem Report (SPR) or PV must be raised. Any PV/SPR reference must be added at the relevant test step.

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5 Annexes

5.1 Power supply impedances and voltages

In case a module does not power up correctly, the impedance of the powersupplies have to be measured, using an Ohm meter to determine that here is no short circuit at the power connection. In Table 4 the minimal impedances are shown. In brackets, the typical value is shown. These impedances are measured to ground unless otherwise noted. After the impedances are successfully measured the power supply can be connected and switched on. On the board the local DC powers are made. With the multi meter the voltages have to be measured as well. In Table 4 the locations and boundaries of the voltages are shown.

Table 4 Power supply impedances and voltages.

Power supply	Location	Impedance	Voltage	Automated Monitoring
VIN_P/N (CLK)	P31	>1 M Ω	$\geq$ 5 V	no
VDD_3V3_INPUT	U27	>25 Ω	> 3.28 V	U46-CH0
VDD_3V3_PLL_160MHz	U52	>500 Ω	> 3.28 V	U46-CH1
VDD_3V3_PLL_200MHz	U18	>500 Ω	> 3.28 V	U46-CH2
VDD_3V3_DIST_A	U20	>500 Ω	> 3.28 V	U46-CH3
VDD_3V3_DIST_B	U33	>500 Ω	> 3.28 V	U46-CH4
VDD_3V3_DIST_C	U21	>50 Ω	> 3.28 V	U46-CH5
VDD_3V3_DIST_D	U68	>500 Ω	> 3.28 V	U46-CH6
VDD_3V3_CTRL	U22	>1 k Ω	> 3.28 V	U46-CH7
PWR_IN (CTRL)	P16	>1 M Ω	$\geq$ 5V	No
VDD_3V3	U53	>1 k Ω	> 3.28 V	Reset circuit
VDD_2V5	U35	>1 k Ω	> 2.48 V	I2C
5V_IN	FB1	>1 M Ω	$\geq$ 5V	Pi boot

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5.2 Procedure variations sheets

(to be copied as necessary)

PROCEDURE VARIATION/ ADDITIONAL ACTIVITIES					
Number	Date/ time	Procedure step/ Test phase	Variation description	Test Dir.	PA

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5.3 Test result check list

Step	Operation	Pass/Fail criterion	Observation	P/F
1.	Equipment calibration	Is the all necessary equipment calibrated?	yes / no	
2.	Record Serial number	Is a label with the ASTRON serial number (Sn: APSTC-1-. . .) placed?	yes / no	
3.	PCB checked	Are electrical test done? Is the PCB according IPC-A-600	yes / no yes / no	
4.	Paste Inspection completed successful	Was the Paste Inspection completed successful?	yes / no	
5.	Optical Inspection completed successful	Was the Optical Inspection completed successful?	yes / no	
6.	x-ray inspection	Has x-ray inspection showed good solder connection for the QFN packages.	yes / no	
7.	Visual check of assembled board	Are all components correctly placed?	yes / no	
8.	Instruments setup	• PC running with correct settings? • Clock at 10MHz? • 1 PPS at 1 Hz? • Power supply at 5.5V / 2.5A?	yes / no	
9.	Setting switches placing jumper	Are SW7 and SW8 set to pin 1	yes / no	
10.	Connect power	Are the power LEDs D3 and D16 on?	yes / no	
12.	Clock and PPS input detection	Are LED's D18 and D17 off (non flashing)?	yes / no	
13.	Python scripts	Was the result of running python script APSTC_production.py successful? Is LED D1 Green?	yes / no yes / no	
14.	Disconnect APSTC for test-setup	Is APSTC, without damages, disconnected from the test setup?	yes / no	
15.	Store test results	Are the APSTC test results stored in the database?	yes / no	