

Production Test Procedure

Antenna Processing Subrack Power Unit  
(APSPU)

PCB nr.: 03117

	Organisatie / Organization	Datum / Date
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This publication is part of the project DUPLO (with project number 175.2017.012 of the research programme "Investeringen NWO-groot" which is (partly) financed by the Dutch Research Council (NWO).

Doc.nr.: TPR00020  
Rev: 1.0  
Date: 09-03-2022  
Class.:

Author: G.W. Schoonderbeek	Date of issue: 09-03-2022 Kind of issue: limited	Doc.id : TPR-00020	
	Status: Final Revision: 1.0	File name:TPR00020_APSPU	

## Distribution list:

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Group:	Others:
Gijs Schoonderbeek Sieds Damstra Nico Ebbendorf	

## Document history:

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Revision	Date	Chapter / Page	Modification / Change
0.1	18-01-2022	-	Final
0.2	09-03-2022		Update
1.0	09-03-2022		Final

Author: G.W. Schoonderbeek	Date of issue: 09-03-2022 Kind of issue: limited	Doc.id : TPR-00020	
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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 APSPCT 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
APSPU	Antenna Processing Subrack Power Unit
BOM	Bill Of Material
DMM	Digital multi meter
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
GUI	Graphical User Interface
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
TBC	To be confirmed
TCC	Test Control Computer
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	PMS00046	APSPU Product Manufacturing Specifications	Gijs Schoonderbeek

## 1.5 Test results storage

The results of all inspections, functional and delivery tests should be stored in the ASTRON data-base. 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 including 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 Nancy	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 APSPU. 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 APSPU 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. APSPU 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 contents of the test database shall be carried over to ASTRON after delivery of all products.

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## 2.4 Safety

The following ESD and personnel safety precautions shall be taken:

- The board is EMC sensitive. EMC 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:

<b>Demonstration</b>	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.
<b>Test</b>	Operation of the system, subsystem or a part of the system using instrumentation or other special test equipment to collect data for later analysis.
<b>Analysis</b>	Processing of accumulated data obtained from other qualification methods.
<b>Inspection</b>	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 analyst 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 check 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 past well defined solder joints can be made without spoiling solder (loose solder balls). In Figure 3 an example of SPI is shown.

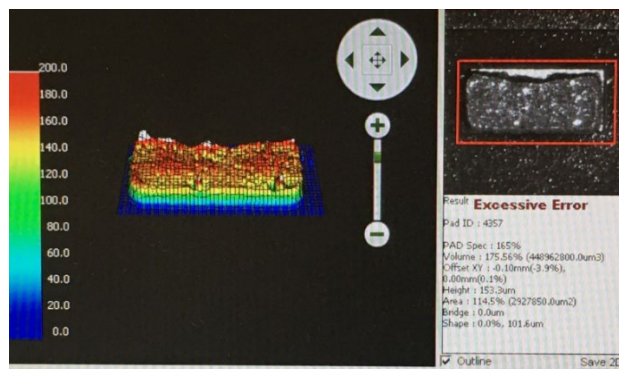


Figure 3 Example of Automated Solder Paste Inspection

#### 3.1.4 Automatic Optical Inspection (AOI)

Automated optical inspection should 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.

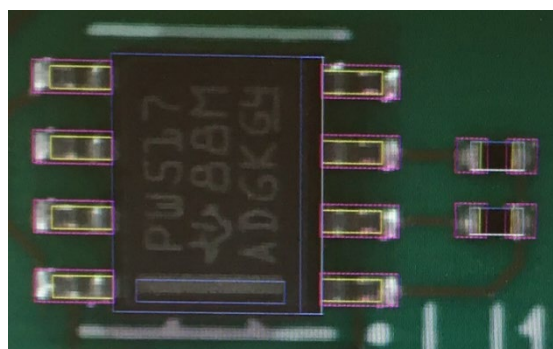


Figure 4 Image of an AOI scan of a SOIC8 package

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## 3.2 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.

### 3.2.1 Test equipment and test software

In Table 1, the equipment to test APSPU is shown.

**Table 1 List of test equipment.**

Equipment	Part Number	Serial Number	Calibration due date
Digital Multi Meter			
Power supply 48 V / 2.5 A			
Control PC			

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 APSPU 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 APSPU 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.

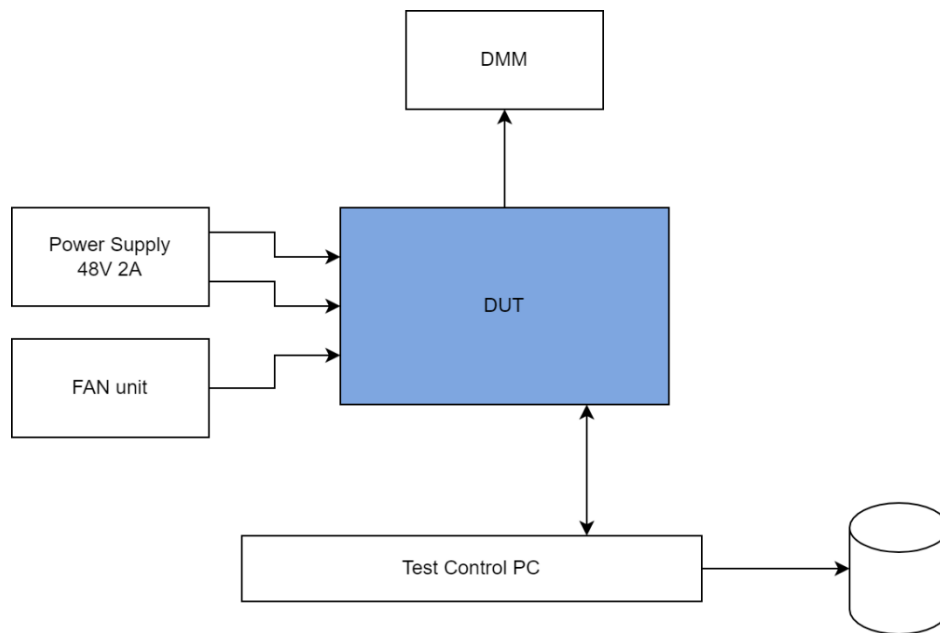
**Table 2 List of software package on the Test control.**

Software package	Version	Location
Windows		
Python		
Flex Power Designer		
APSPU_Production_Check		

### 3.2.2 Test setup

In Figure 5 the test setup for the APSPU is shown.

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**Figure 5 APSPU production test setup.**

### 3.2.3 Power supplies

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.

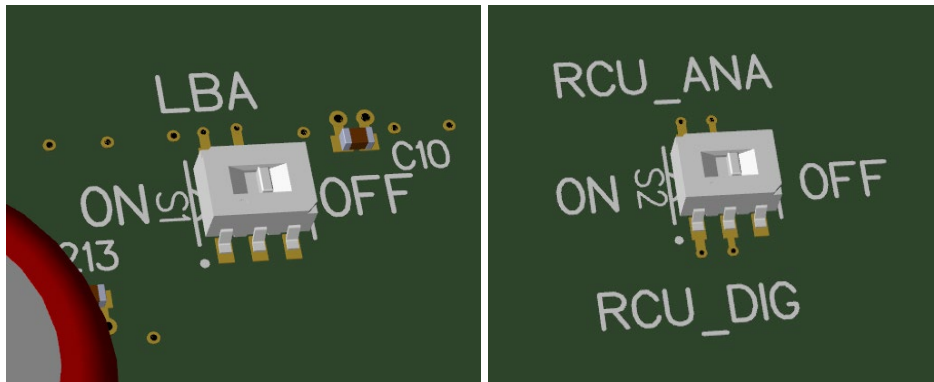
### 3.2.4 Control

#### 3.2.4.1 Programming Power units

Before the test can be done the power unit's need to be programmed. This can be done using Flex Power Designer software. The following steps should be used:

1. Open Flex Power Designer
2. Load APSPU\_xxxx2022.
3. Set dipswitches S1 and S2 in OFF mode
4. Power up board
5. Press write to NVM
6. Check GUI response that programming was successful
7. Power down board
8. Set dipswitches S1 and S2 in ON mode
9. Power up board
10. Continue testing with 3.3.5

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**Figure 6 Dipswitches S1 (left) and S2 (right)**

### 3.2.5 Monitor and Control

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

1. Connect the USB-to-I2C to APSPU
2. Connect power cable to APSPU
3. Power-up APSPU
4. Run APSPU\_production.py
5. Check if run was successfully
6. Upload results.txt into the database.

### 3.3 Summary

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

**Table 3 Estimated test time.**

Item	Test time
Power supplies	1 min.
Program power modules	2 min.
Functional test	2 min.
Store results	1 min.
Sum	6 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.

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## 4.1 Deviations from the step-by-step procedure

A Procedure Variation (PV) have to be added to the Procedure Variation Sheet in section 5.2. 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 []

## 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.

# 5 Annexes

## 5.1 Power supply measurements

In case a module does not power up correctly, the impedance of the powers supplies 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 impedance's are shown. In brackets, the typical value is shown. These impedance's 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 digital multi meter the voltages have to be measured as well. In Table 4 the locations and boundaries of the voltages are shown.

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**Table 4 Power Supply measurements.**

Power supply	Location	Impedance	Voltages
HBA_48V_IN	+ to Pin 1 Connector P1 - to Pin 3 Connector P1	>500 k $\Omega$	>46 V [48.0 V]
ANA_48V_IN	+ to Pin 1 Connector P2 - to Pin 2 Connector P2	>500 k $\Omega$	>46 V [48.0 V]
DIG_48V_IN	+ to Pin 4 Connector P2 - to Pin 5 Connector P2	>500 k $\Omega$	>46 V [48.0 V]
HBA_48V_OUT	+ to Pin 2 Connector J1 - to Pin 2 Connector J1	>500 k $\Omega$	>46 V [48.0 V]
LBA_8V_OUT	TP1	>500 k $\Omega$	>7.7 V [8.0 V]
APSCT_OUT	TP2	>500 k $\Omega$	>5.5 V [5.6 V]
RCU2_A_OUT	TP3	>500 k $\Omega$	>5.5 V [5.6 V]
RCU2_D_OUT	TP4	>500 k $\Omega$	>3.2 V [3.3 V]
UNB2_48V_OUT	+ to Pin 2 Connector J3	>500 k $\Omega$	>46 V [48.0 V]
Local 5V5 (U8)	Fuse F1 pin 1	>1 k $\Omega$	>4.9 V [5.0 V]

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## 5.2 Procedure variations sheets

(to be copied as necessary)

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

### 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: APSPU-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.	Visual check of assembled board	Are all components correctly placed?	yes / no	
8.	Instruments setup	PC running with correct settings? Power supply at 48V / 2.5A?	yes / no	
9.	Setting switches placing jumper	Is dip-switch set in off mode	yes / no	
10.	Connect power	Are the power LEDs D11, D12 and D13 on?	yes / no	
11.	Program DC/DC converters	Are de DC/DC converters programmed?	yes / no	
12.	Setting switches placing jumper	Is dip-switch set in ON mode	yes / no	
14.	Check secondary powers	Are the power LEDs D8, D9 and D10 on?	yes / no	
15.	Python scripts	Was the result of running python script APSPU_production.py successful?	yes / no	
16.	Disconnect APSPU for test-setup	Is APSPU, without damages, disconnected from the test setup?	yes / no	
17.	Store test results	Are the ASPPU test results stored in the database?	yes / no	