ASTRON
Netherlands Institute for Radio Astronomy

UniBoard^2
Measurements for CE

	Organisatie / Organization	Datum / Date
Auteur(s) / Author(s): Gijs Schoonderbeek	ASTRON	24-02-2016
Controle / Checked: Marchel Gerbers	ASTRON	23-03-2016
Goedkeuring / Approval:	ASTRON	
Autorisatie / Authorisation: **Handtekening / Signature**	ASTRON	

Distribution list:

Group:	Others:
Marchel Gerbers Sjouke Zwier Andre Gunst Arpad Szomoru	Ronald Halfwerk

Document history:

Revision	Date	Chapter / Page	Modification / Change
0.1	13-01-2016	-	Creation
0.2	24-02-2016	-	Power measurements
1.0	23-03-2016	-	Update after review Marchel.

Table of contents:

List of figures:

List of tables:

1 Introduction

In this document the measurements on UniBoard^2 are described which have been performed to verify declaration of conformity (CE). The measurements follow the risk analysis described in [RS-2]. This document will start with a description of the equipment under test. After this section the EMI and temperature measurements are described. At the end of the document measurement results are shown which have been done, but not necessary for the CE compliance.

1.1 Reference documents (RD)

Ref.nr.	Document number	Title
RD-1	ICS 33.100.10	EN55022/A1
RD-2	ASTRON-RP-1519	Risk Analysis Report UniBoard^2
RD-3	ASTRON-IS-036	UniBoard^2 Manual

1.2 Abbreviations

CE	Conformité Européenne
CLK	Clock
dBµV	Voltage relative to 1µV RMS
dBµV/m	Electric field strength relative to 1µV per meter.
EMI	Electromagnetic interference
EMC	Electromagnetic compatibility
IR	Infra Red
RD-n	nth document in the list of Reference Documents
RMS	Root Mean Square

2 Equipment under test (EuT)

2.1 Description of EuT

The equipment under test, UniBoard^2 is a universal processing platform, which can be used for digital procession tasks like used for Radio Astronomy application [RD-3]. The board is a development platform for data processing applications. The device will be permanently mounted in a 19” cabinet rack The board will not be installed/used as an unprotected device.
For the measurements UniBoard^2 with the serial number UNIB-???? has been used. The board has an internal clock of 200MHz.

2.2 Classification

Given a data processing board the EN55022/A1 European Standard for Information Technology Equipment (ITE) is taken [RD-1]. The UniBoard^2 is made for 19” rack mount placing the board in Class A ITE.

2.3 Regulations

UniBoard^2 has to comply with the CISPR 22 regulations as defined in [RD-1]. In Table 1 and Table 2 the emission regulations are summarized.

Table 1 Limits for conducted disturbance at telecom ports of class A ITE

CISPR 22 Band	Frequency range MHz	Voltage limit Quasi-peak dBµV/m
B	0.15 to 0.5	97 to 87
B	0.5 to 30	87

Table 2 Limits for radiated disturbance of class A ITE

at a measuring distance of 10m

CISPR 22 BAND	Frequency range MHz	Quasi-peak limit dBµV/m
C	30 to 230	40
D	230 to 1000	47

2.4 Configuration of cable

The equipment has been tested with QSFP+ cables connected in loopback. For power a twisted pair cable has been used. No external clock nor PPS was connected UniBoard^2, the internal 200MHz clock was used instead.

2.5 Clock Frequencies and Distribution

The known frequencies on UniBoard^2 are described in Table 3.

Table 3 Known frequencies on UniBoard^2

ID No	Frequency	Stability	Number	Description
1	~125kHz	fixed	1	Isolated DC/DC converter from 48V to 9.6V
2	200-600kHz	load	8	DDR3 supply for memory
3	~500kHz	fixed	3	Local power supplies up to 12 A
5	~550kHz	fixed	1	Local power supplies up to 20 A
6	~600kHz	fixed	2	Local power supplies up to 6 A
7	25MHz	fixed	1	Transceiver control clock
8	100MHz	fixed	1	DDR reference clock
9	125MHz	fixed	1	Reference clock for 1GbE control interfaces
10	200MHz	fixed	1	System clock supplied external
11	5000MHz	fixed	1	IO data rate
12	644.531MHz	fixed	2	Transceiver reference clock
13	10.3125GHz	fixed	1	10GbE

3 EMI measurements

3.1 Measurement setup

For the first order estimates a measurement with the EMC analyzer with two probe's the 1kHz to 30MHz for band band B, a 30MHz to 1GHz for band C and D is performed. Before the measurement is conducted the correction table is read for the used probe. For this the calibration table as stored on the disk (date) is used. The unit of the Antenna is set to dBµV for the band B and dBµV/m for band C and D. The internal amplifier is enabled and the attenuation set to 0dB In Figure 1 a block diagram of the measurement setup is shown.

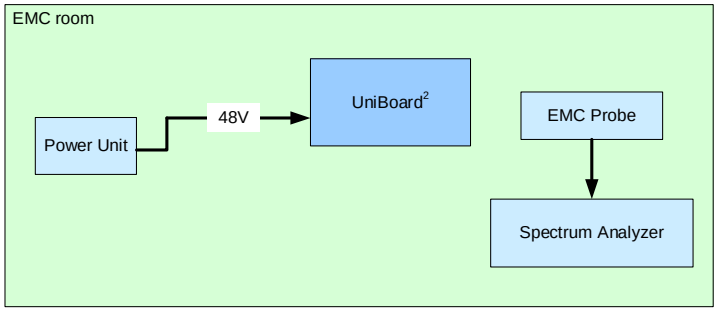

Figure 1 Measurement setup

In Figure 2 an image of the measurement setup is shown.

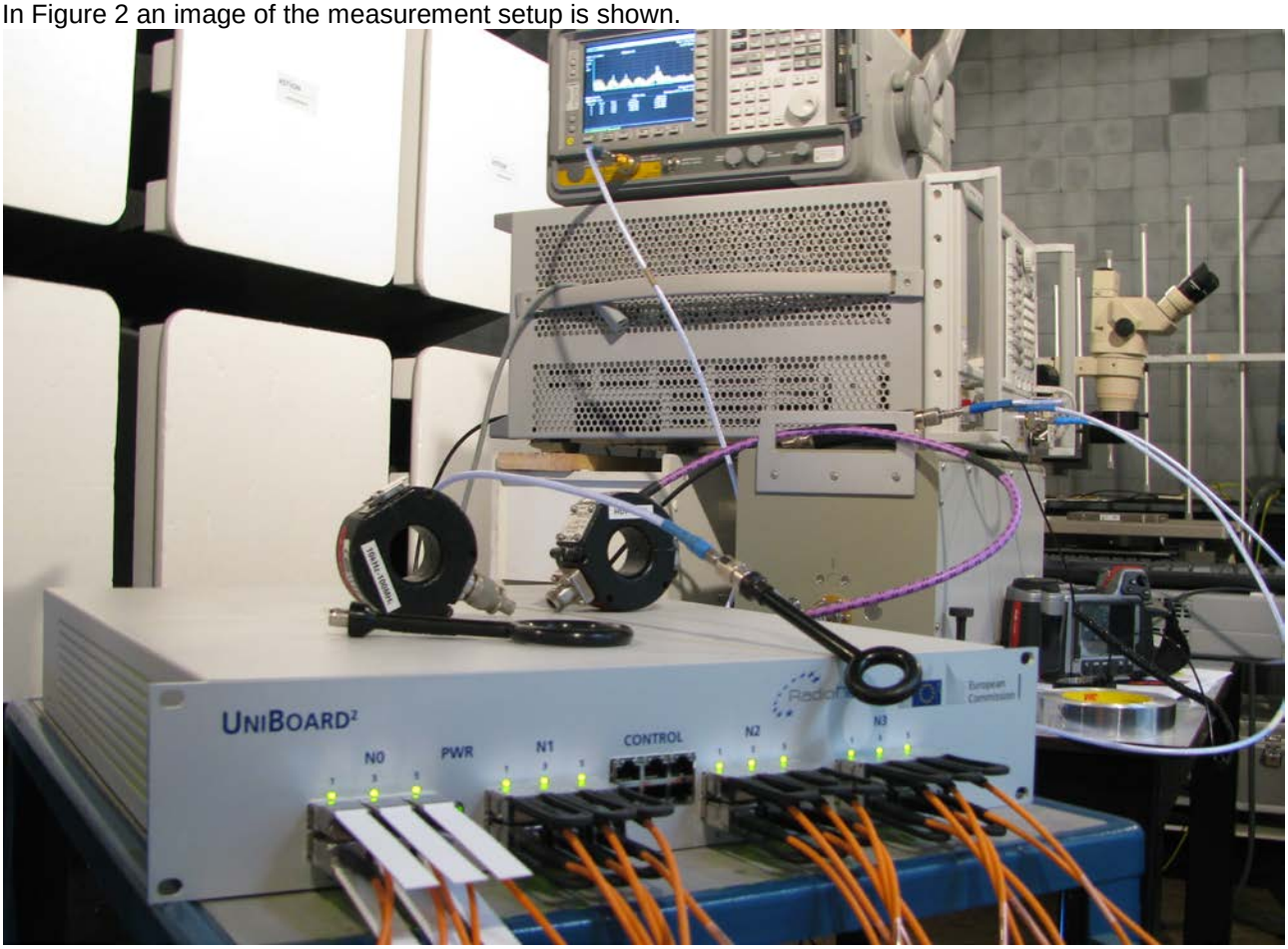

Figure 2 Image of measurement setup

On UniBoard² the default firmware is running. The measurements are started after the FPGA are configures. All connectors are connected with cables. On the power input a shielded cable is assumed.

The equipment which has been used to perform the EMI measurements is shown in Table 4.

Table 4 Used Equipment

Equipment	Manf	Type	Number
Spectrum Analyzer	Agilent	E7405A	ZWO2013
Nearfield H field probe	EMCO	96021-2	ZWO1459
Current Probe 10kHz-100MHz	EATON	91550-1L	ZWO1459
Current Probe 1MHz-1GHz	EATON	94111-2	ZWO1404
Power Supply	TDL-Lambda	GENH60-12.5	ZWO2160
IR camera	FLIR	T335	ZWO2102

3.2 Results of emission measurement

3.3 Band B

The measurement for CISPR band B are performed with the spectrum analyzer in peak detector mode with maximum hold. First a reference measurement is far from UniBoard², the result is shown in blue in Figure 3. With the probe all sides of the UniBoard² are sniffed, the result is shown in yellow in Figure 3.

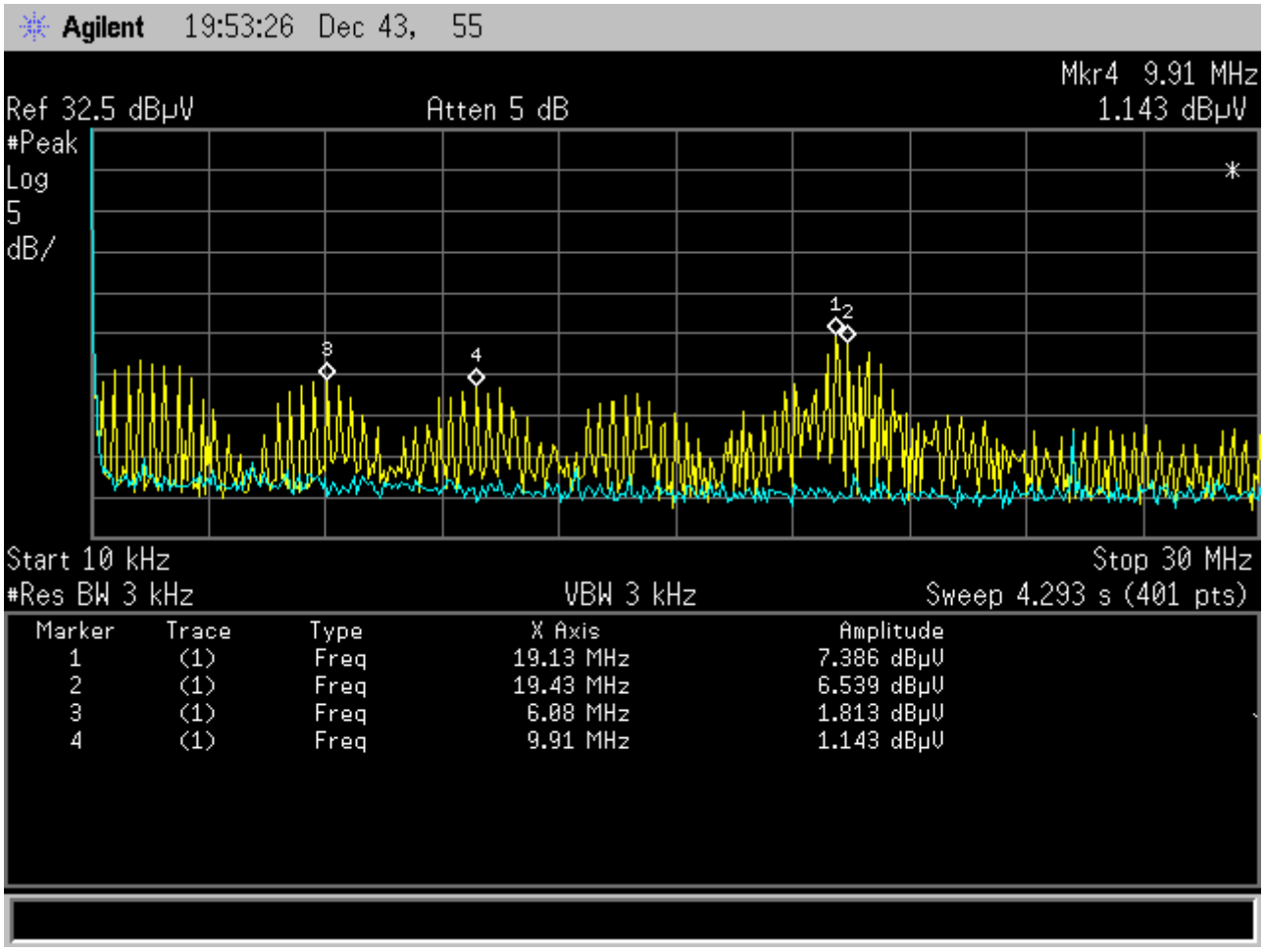

Figure 3 EMI measurement band B

3.4 Band C and D

For compliance testing of the C and D band, an antenna should be used at 30 till 10m distance from the EuT. It was not possible to perform such a measurement. Instead a sniffing measurement is done with a probe (30M-1GHz) held close or touching the housing.
In Figure 4 the measurement result is shown. First a reference measurement is done far from UniBoard^2. Both traces are measured in the max hold modes. All sides of the housing have been sniffed.

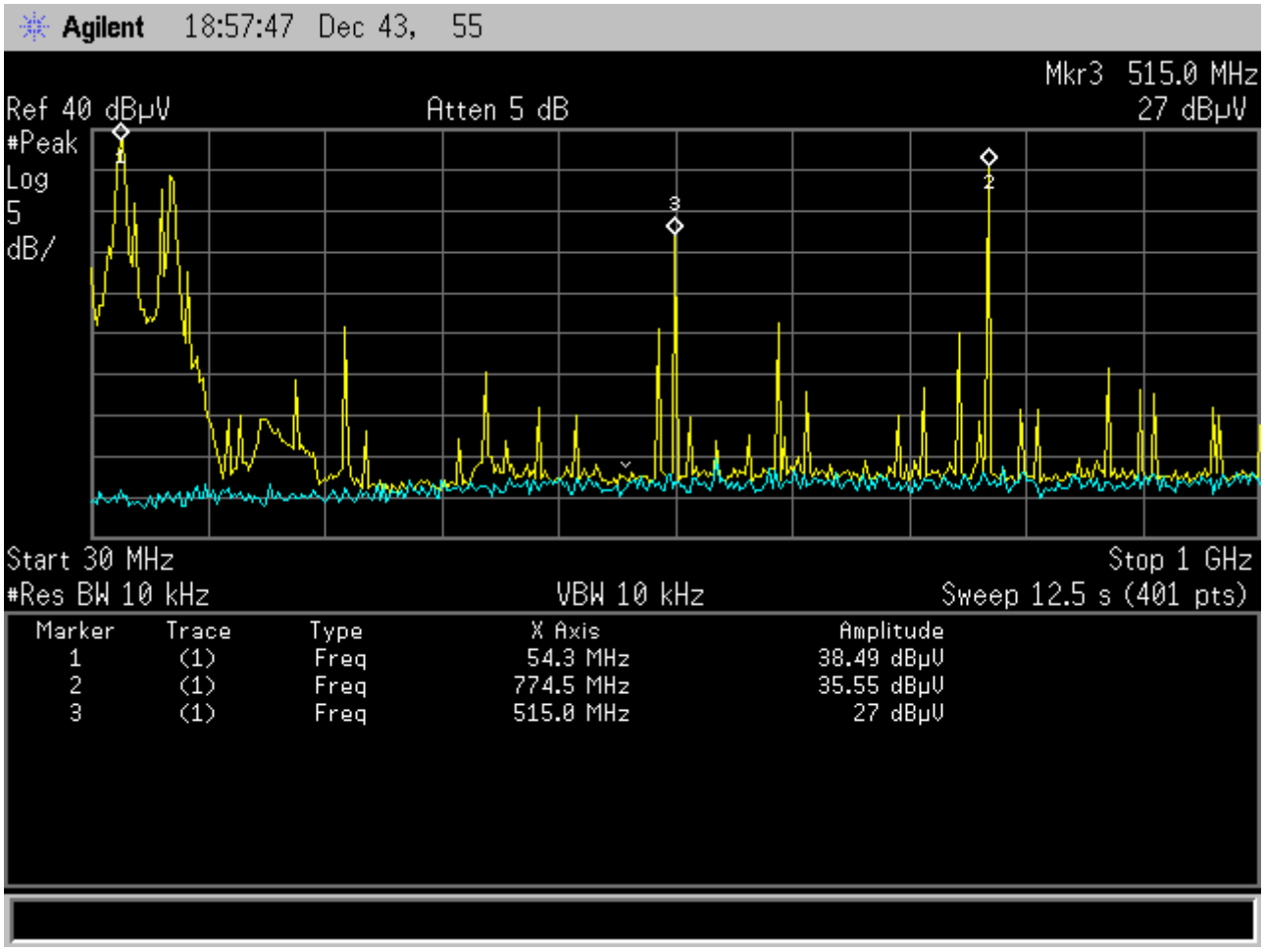

Figure 4 EMI measurement band C and D

From this measurement it can be seen that from a small distance UniBoard^2 first peak at 54MHz is compliant with the Class B ITE (40 dBµV/m). It is expected that from 10m the radiation is reduced even further.

3.5 Conclusion

Even with this sniffing measurement it is expected that that UniBoard^2 is compliant with the emission regulations.

4 Temperature Analysis

4.1 Housing

With an IR temperature camera (FLIR T335 ZWO2102) pictures have been taken to analyze the temperature of UniBoard^2. The results are shown in the Figure 5.

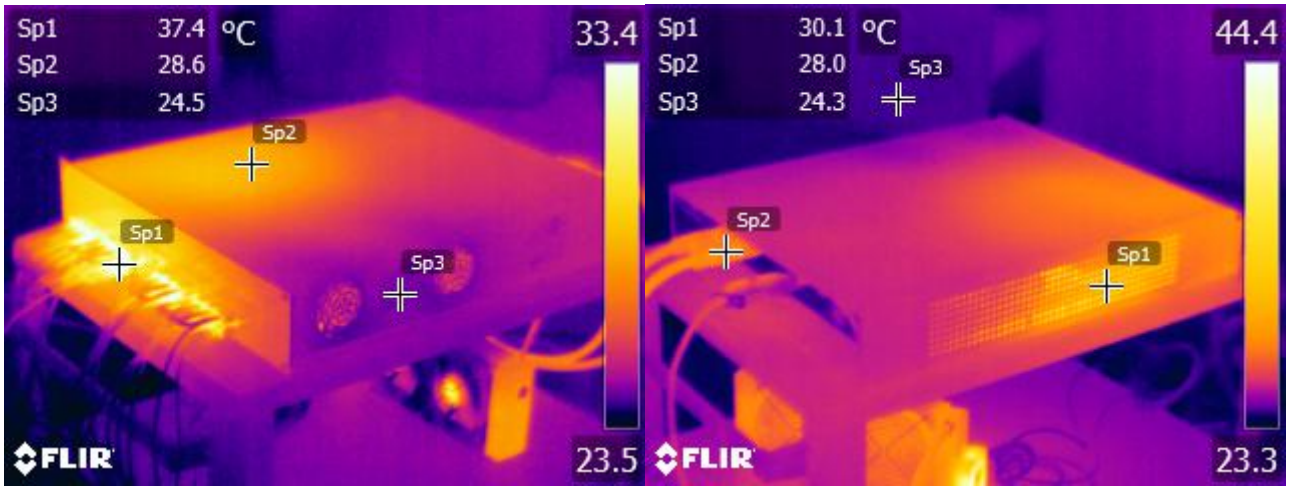

Figure 5 Temperature analysis UniBoard2

From this figures it can be seen that outside of the housing is warm but not exceeding 30°C. The temperature of the QSFP modules can increase to 37°C.

5 Extra measurements

Some extra measurements are performed. These measurements are outside requirements for CE marking, but can be helpful for a better understanding of UniBoard[2].

5.1 EMI

Additional measurements have been done with a current probe on the 48V input lines. In Figure 6 the results is shown.

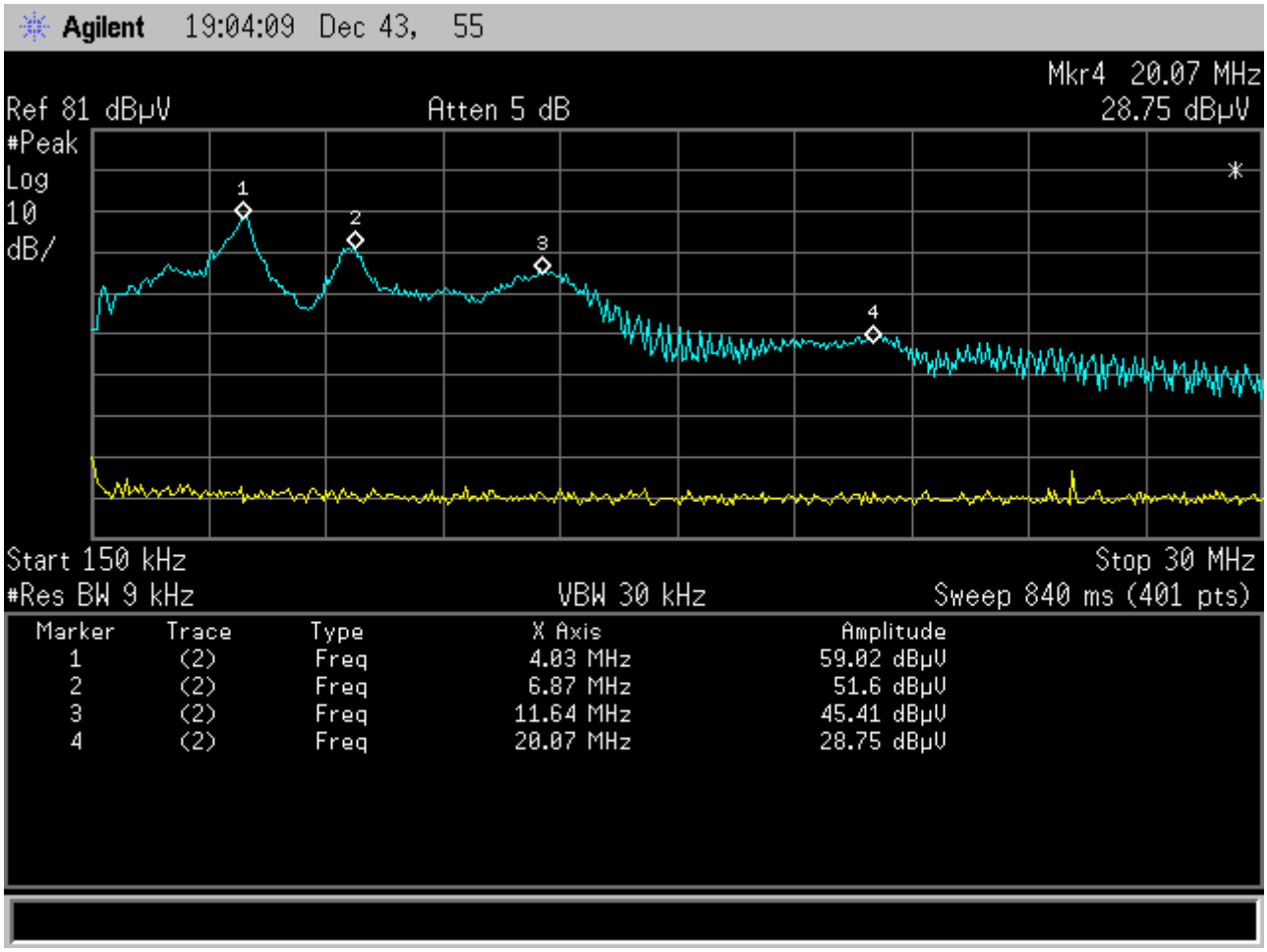

Figure 6 Measurement with clamp around the power input.

In Figure 7the leakage points are shown.

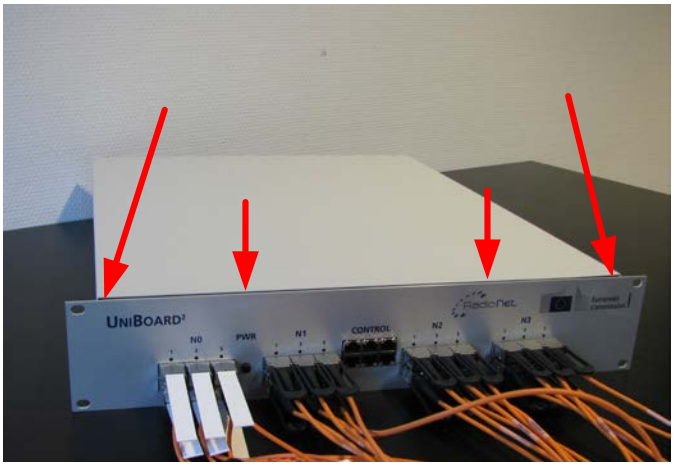

Figure 7 Locations of worst leakage in 150kHz to 30MHz band

5.2 Temperature

In Figure 8 a temperature images of the UniBoard^2 are shown. For this measurement cooling past is used on the water blocks to prevent IR-mirroring of the metal blocks.

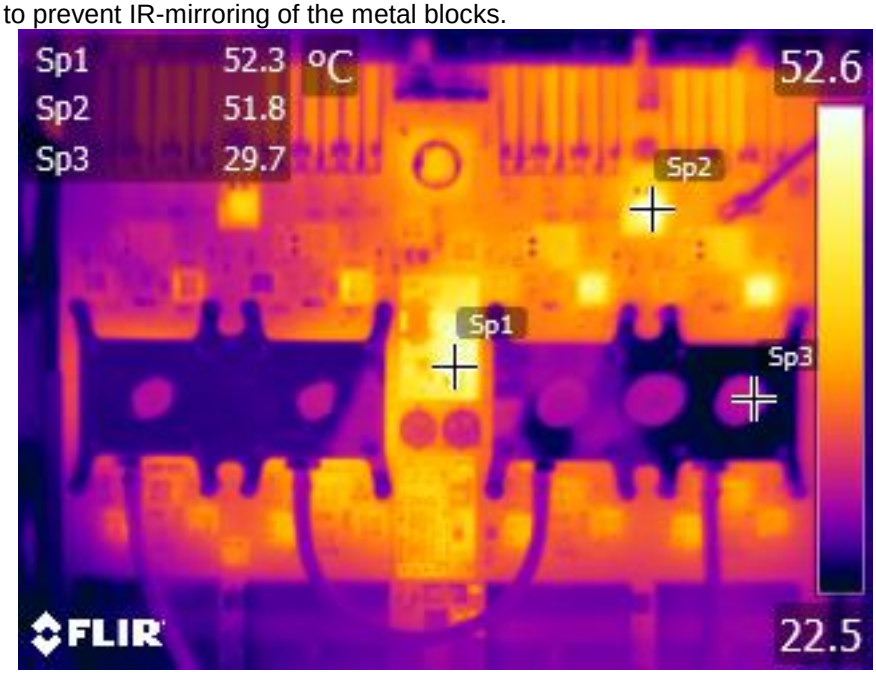

Figure 8 UniBoard^2 with cooling

From this measurement it can be seen the worst temperature is 52°C. The water blocks are 30°C, only a few degrees above ambient temperature.

5.3 Power input

5.3.1 Power consumption

Power consumption of UniBoard^2 is dependent on the firmware image loaded on the FPGA. In Table 5 some power measurements are shown.

Table 5 Power consumption

Design	Power consumption
Stand by	12W
Unconfigured FPGAs	50W (excl. QSFPs)
Memory test design	63W (excl. QSFPs)
Minimal Ethernet design	80W (excl. QSFPs) + 24W QSFPs
All transceivers used	214W (incl. QSFPs)

Max power of the DC/DC converter is 468W, therefore for UniBoard^2 the maximal power is set to 450W.

5.3.2 Inrush current

In Figure 12 the standby inrush current for UniBoard^2 is shown. A large peak is seen in the start, the height is the peak is the current limit setting of the power supply. The peak is probably due to the hold-up capacitors. After the hold-up is charged the expected ramp is seen to power the board.

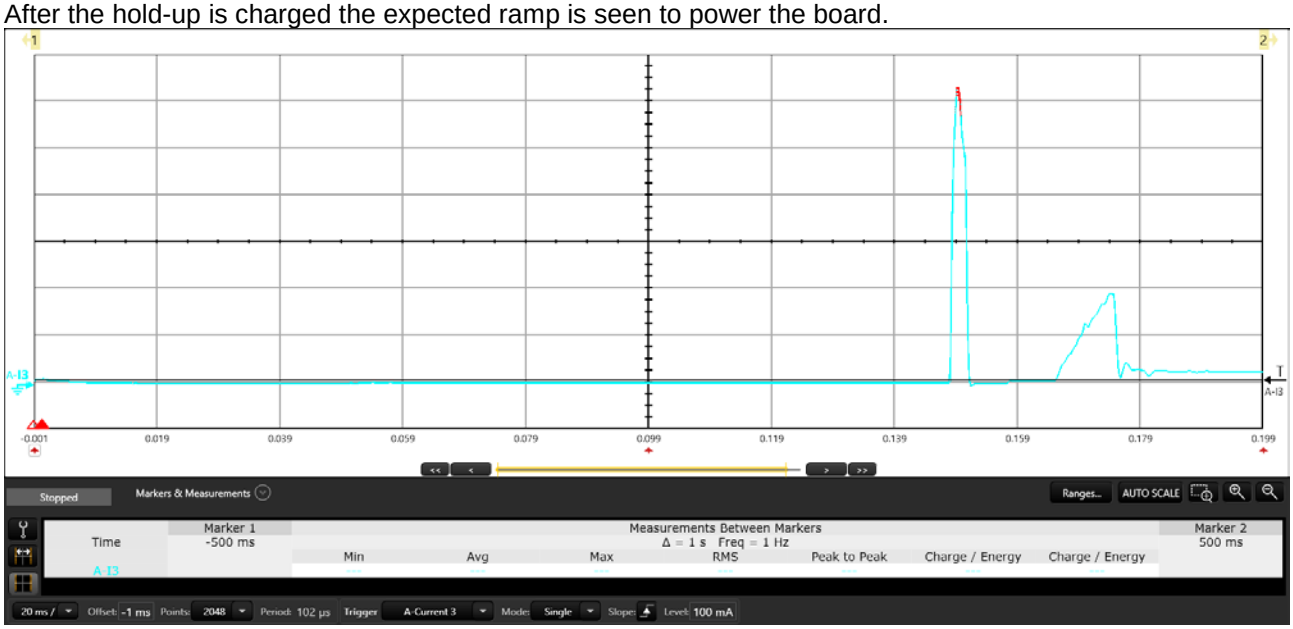

Figure 9 Standby inrush current

The current change from standby to used image (minimal Ethernet design) is shown in Figure 10. In this measurement the sequencing of the FPGA power supplies are clearly visible.

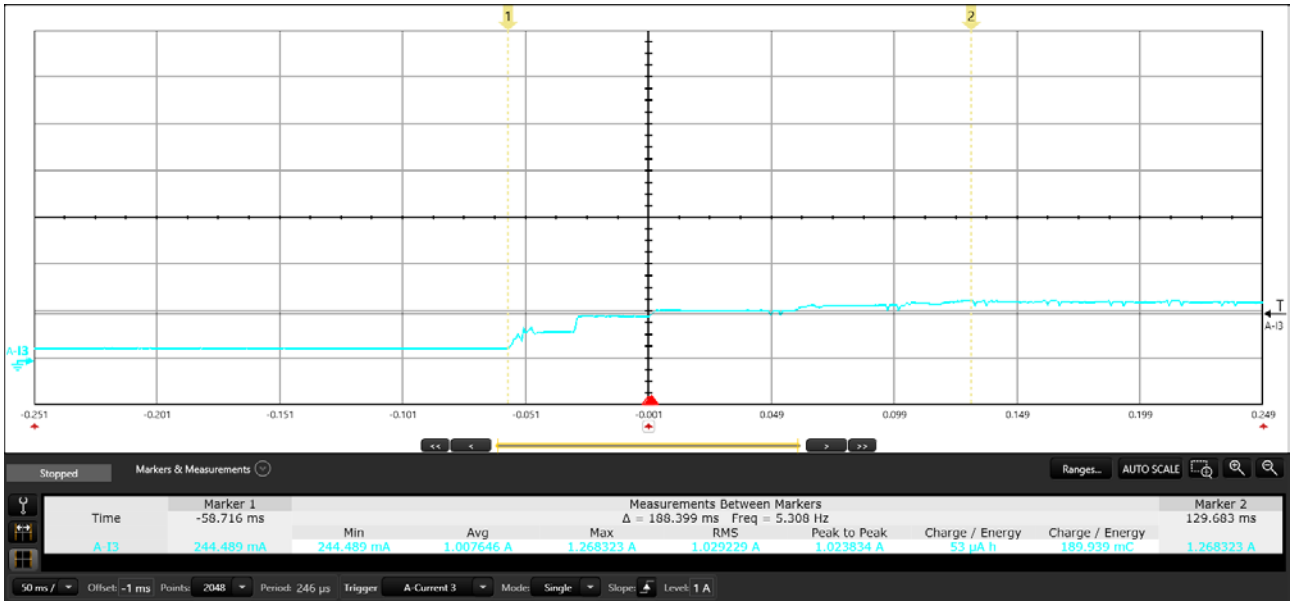

Figure 10 Current change from standby to user image

5.3.3 Current ripple

The ripple on the 48V input current is shown in Figure 11. From this measurement a 100mA peak-to-peak 200MHz ripple can be seen.

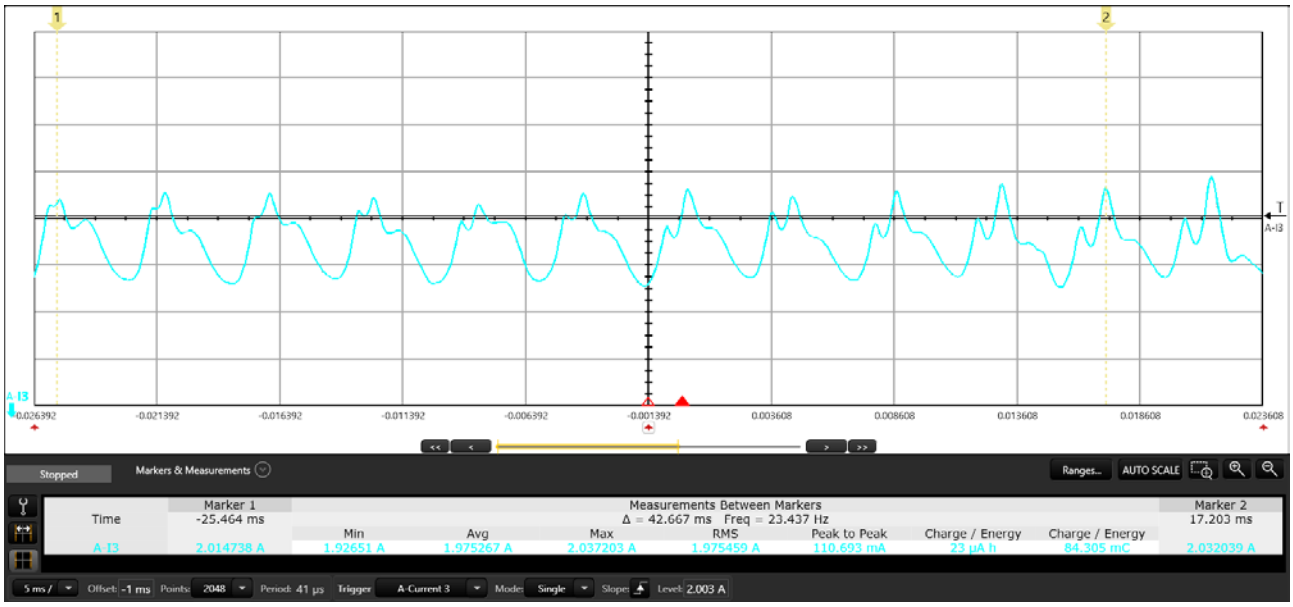

Figure 11 Current ripple on 48V input.

5.3.4 Hold-Up

A shut down sequence should be obeyed for the power supplies of the FPGAs on UniBoard2, first the IO and last the core power supplies. This has consequences on shutting down the board. When the button is used to shut down the board the complete sequence can be followed. When the 48V input power of the board is shutdown while the FPGA are in use, a hold up circuit is used to enable the sequence. In Figure 12 a measurement of the sequence is shown for button shut down and board power down. In green in these measurements the shutdown signal is shown, in pink the 12V bus power supply driving the Point of Load converters and in purple the core supply of the FPGA. From the right figure it can be seen that with a load of

215W of the total board the holdup circuit has enough energy to enable the full sequence, the shutdown of the core is at the same location, the bus power is still 12V.

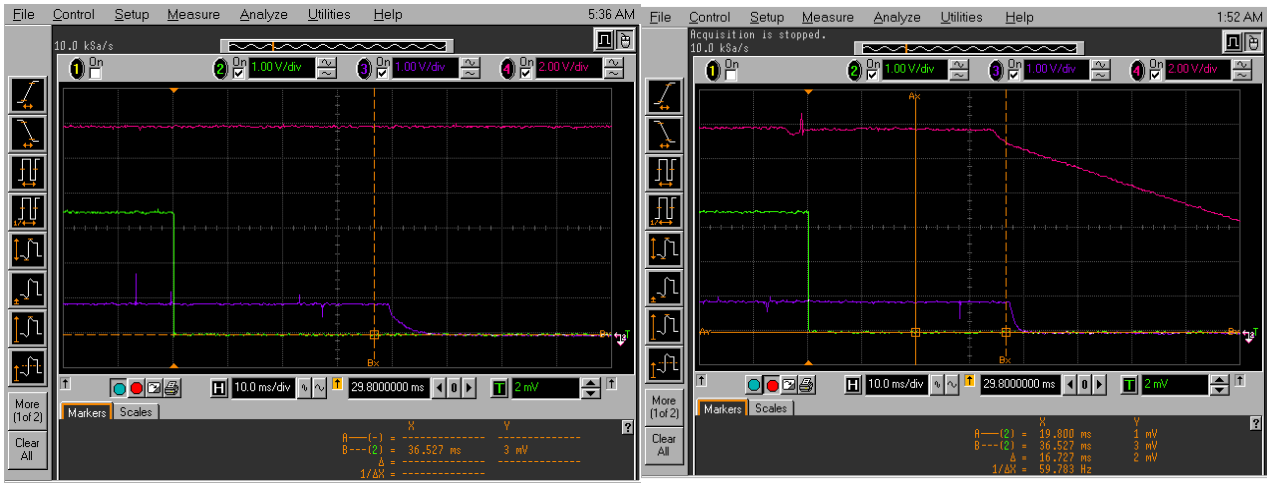

Figure 12 Switch off by button (left) and 48V power off (right)

6 Physical specifications

In table an overview of the size and weight of UniBoard^2 in a box is shown.

Table 6 Physical Specifications

Specification	Value	Unit
Weight	9.9	kg
Height	88	mm
Width	483	mm
Depth	525	mm

In **Error! Reference source not found.** an image of the finger guards on the UniBoard^2 housing is shown.

6.1 Finger guards

Although UniBoard2 uses liquid cooling some fans are needed to cool the power supplies on UniBoard2. The fans are protected for the fingers with finger guards, see Figure 13. All holes are smaller than 4.7mm

Figure 13 Finger guards on UniBoard^2

6.2 Electrical input

Although the power consumption of UniBoard2 is depending on the image load on the FPGA, the maximal power consumption determined the power input of UniBoad2 can be specified as:

Voltage +48V DC
Power: 450W