Pierre Auger Observatory

Surface Detector Electronics Upgrade

UUB Pre Prototype Production Report

UUB Model version: SDE-002-002-IE00

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Table of Content

ACRONYMS

ADC	Analog to Digital Converter
BGA	Ball Grid Array
BOM	Bill Of Material
CR	Configurational Requirement
DC	Direct Current
ER	Environmental Requirement
FPGA	Full Programmable Gate Array
FR	Functional Requirements
GPS	Global Positioning System
ICD	Interfaces Control Document
IR	Interface Requirements
n/a	non applicable
OR	Operational Requirements
PBS	Product Breakdown Structure
PCB	printed Circuit Board
PR	Physical Requirements
QR	Quality Requirements
SDE	Surface Detector Electronics
SR	Support Requirements
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
UB	Unified Board
UUB	Upgraded Unified Board
UHE	Ultra High Energy
UHECR	Ultra High Energy Cosmic Ray
VM	Verification Matrix

DOCUMENT CHANGE RECORD

Issue	Revision	Issue Date	Changes Approved by	Modified Pages Numbers, Change Explanations and Status
21	A	09/11/16	E. Lagorio	First version
21	B	08/02/17	E. LAgorio	6.3 forgotten

1 GLOBAL MODIFICATIONS:

This document describes all the retro-fitting action on the boards after their manufacturing. This manufacturing must be made with SDE-002-002-IE00-VA01 13 April 2016 BOM version.

Below find the location of the modifications on the UUB board, TOP and BOTTOM sides. All modifications are specifically described.

1.1 TOP side modifications:

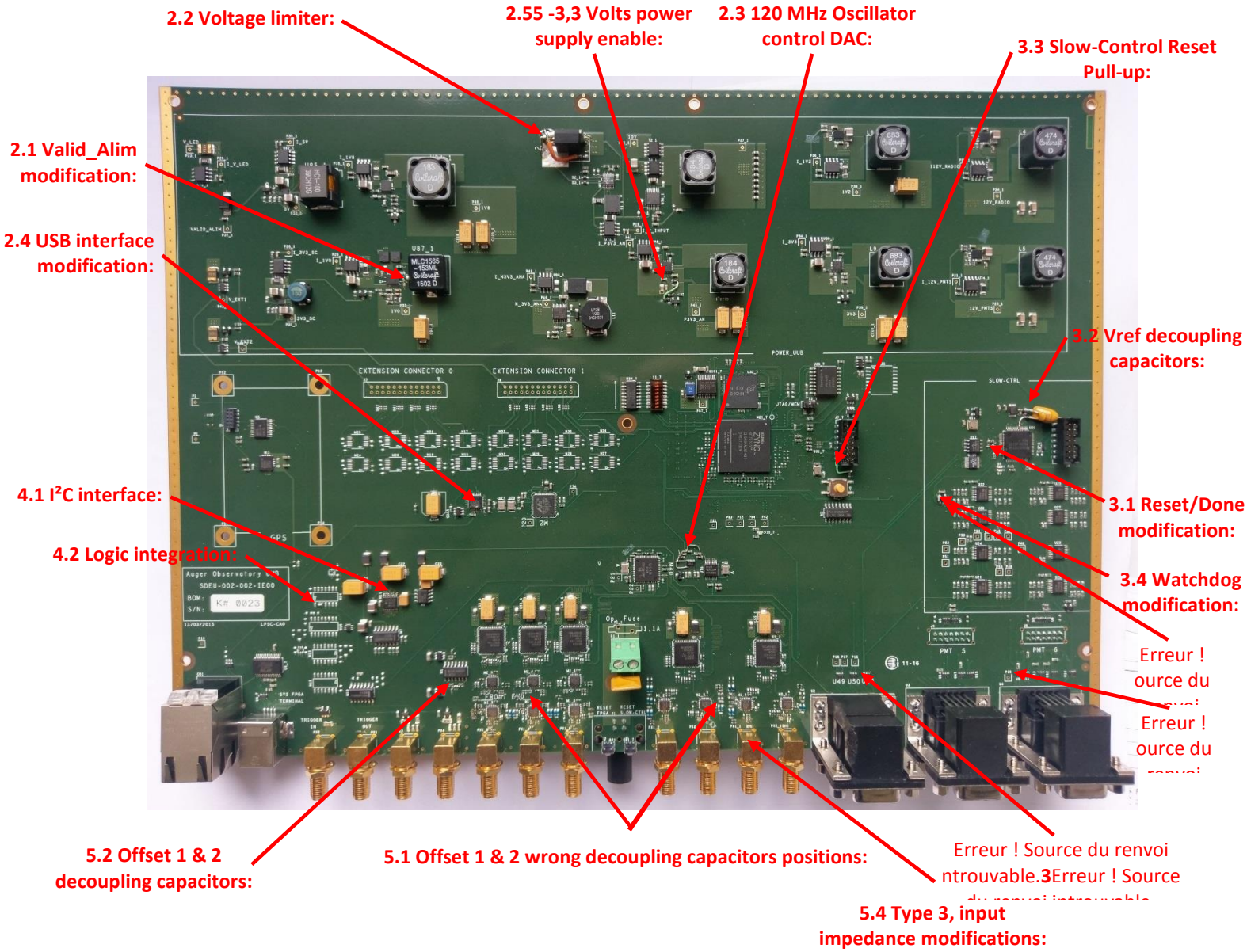

Figure 1: TOP side Modifications.

1.2 BOTTOM side modifications:

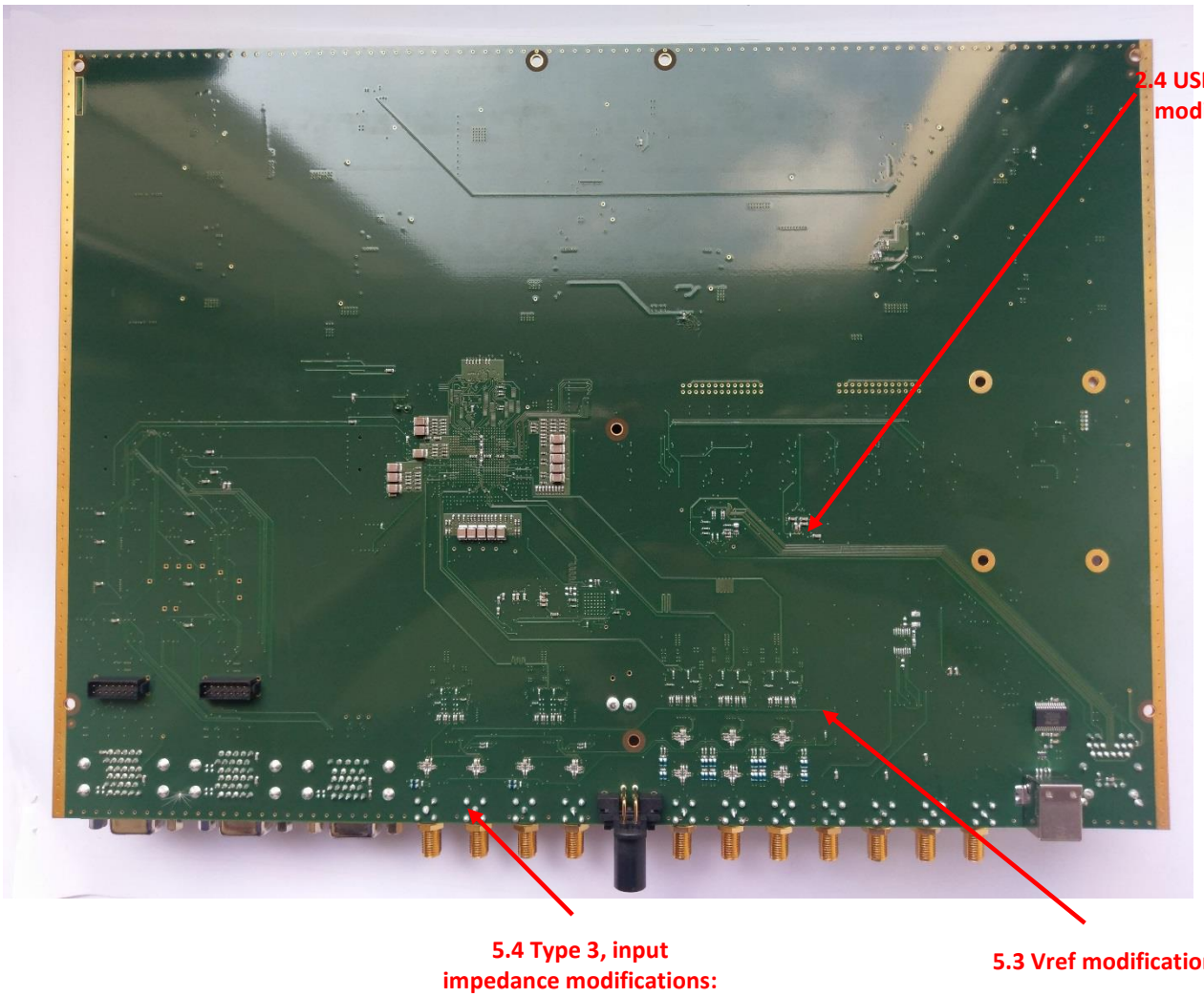

Figure 2: BOTTOM side Modifications.

2 WP5 MODIFICATIONS:

2.1 Valid_Alim modification:

The Valid_Alim is generated by 1 Volt DC/DC converter, from its “power good” pin.
R100_1 is removed.
A 1,5 K Ohms 1 % resistor, 0603 package must be added between VDD (U86_1 pin 10) and PGOOD (U86_1 pin 11).

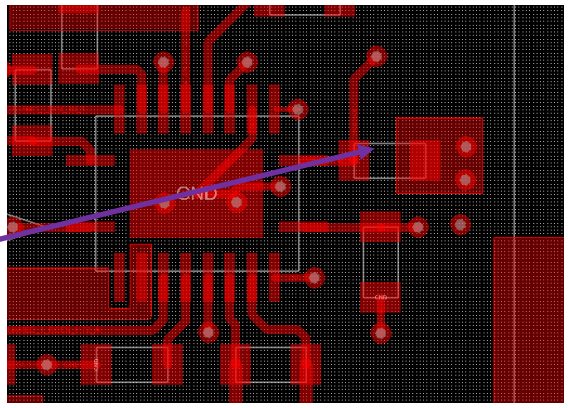

Figure 3: R100 removed

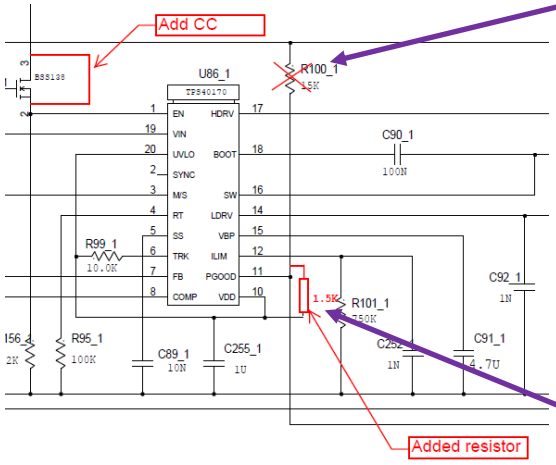

Figure 4: Valid_Alim modification in schematic (page 11)

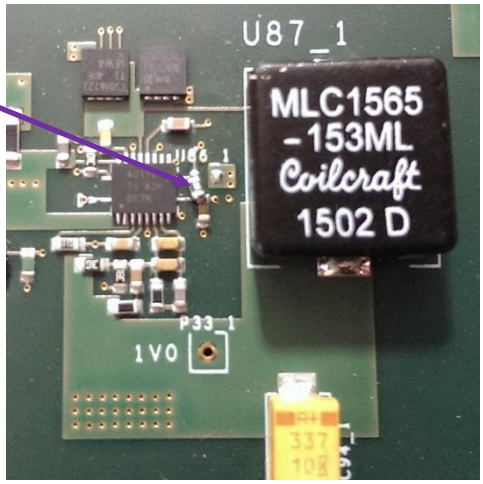

Figure 5: 1,5 k Ohms resistor, and 0603 package added.

The added components:

- R1_X, 1.5 KOhms 1% 0603 (available in UUB BOM, ref.: RES-068)

Number of operation: 1

2.2 Voltage limiter:

Wrong footprint for Q4_1 transistor. Pins 2 & 3 must be swapped.

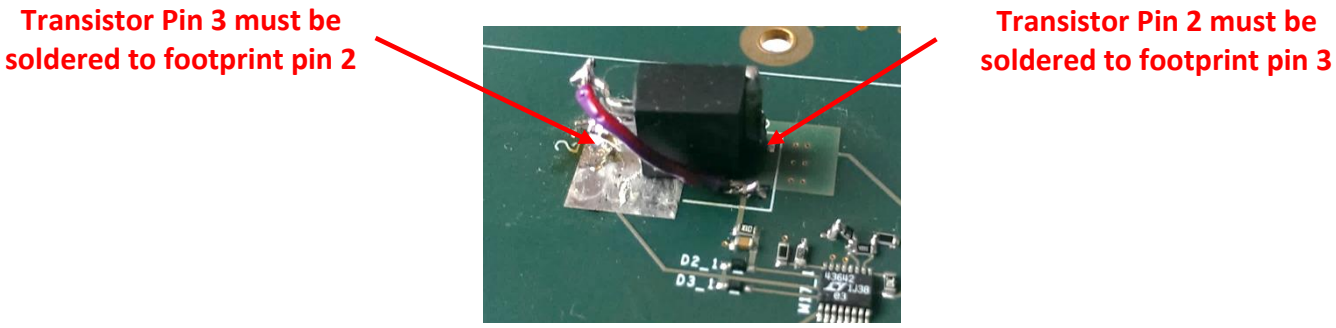

Figure 6: Pin 2 &3 Swap connection.

The connection between transistor pin 1 to the footprint must be made by a wire.

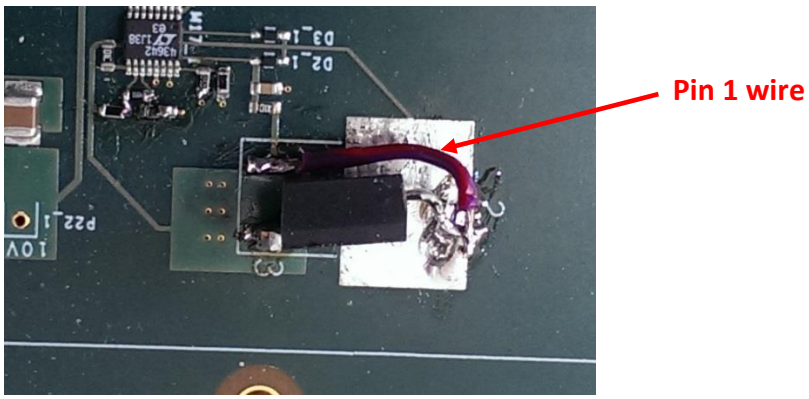

Figure 7: Pin 1 wire connection.

Number of operation: 1

2.3 120 MHz Oscillator control DAC:

DAC7551 IOVDD pin must be connected to 3,3 Volt (1,8 volt previously) power supply and the pull-up resistors R382, R383, R384, R385 & R386 too.

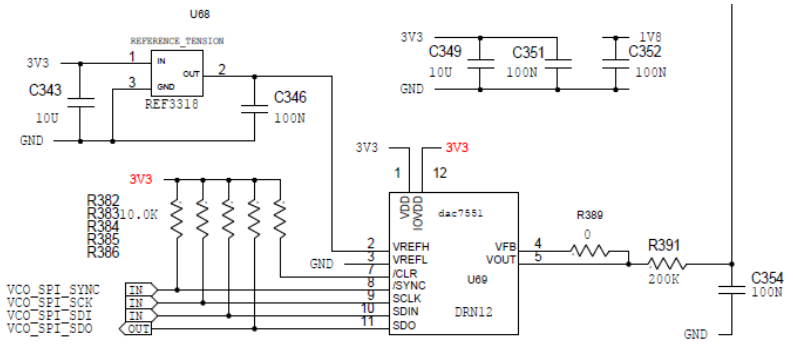

Figure 8: DAC7551 Power supply modifications (Schematic page 6).

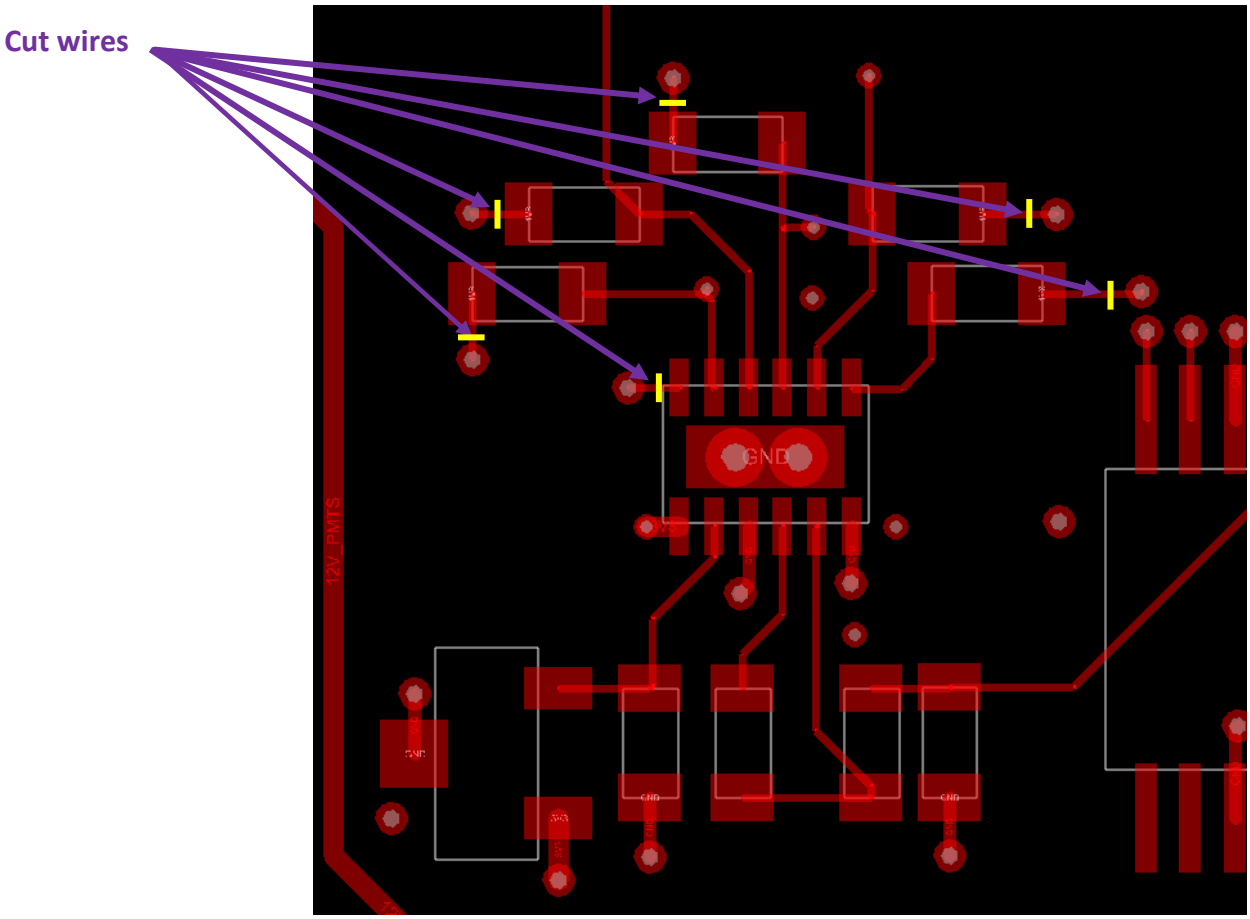

Figure 9: Cut DAC7551 1,8 Volts Power supply wires.

3,3 Volts power supply modifications. Add wire between U69 pin 12 and resistor R382, R383, R384, R385 & R386

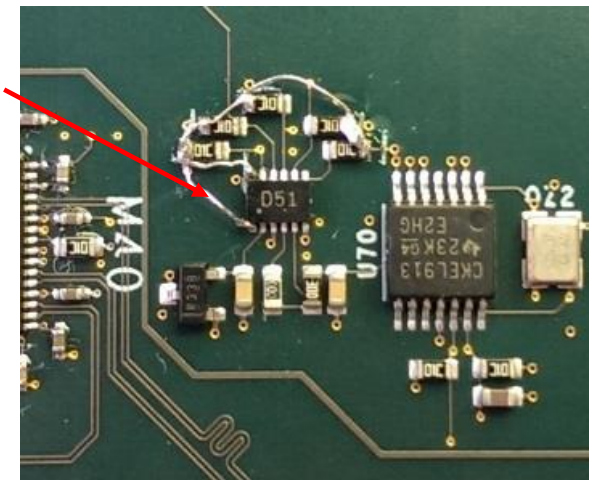

Figure 10: DAC7551 Power supply modifications on UUB

Number of operation: 8

2.4 USB interface modification:

U36 pin 20 must be disconnected from 3,3 Volts and connected to U36 pin 23.

U36 pin 23 must be disconnected from 1,8 Volts and connected to 3,3 Volts.

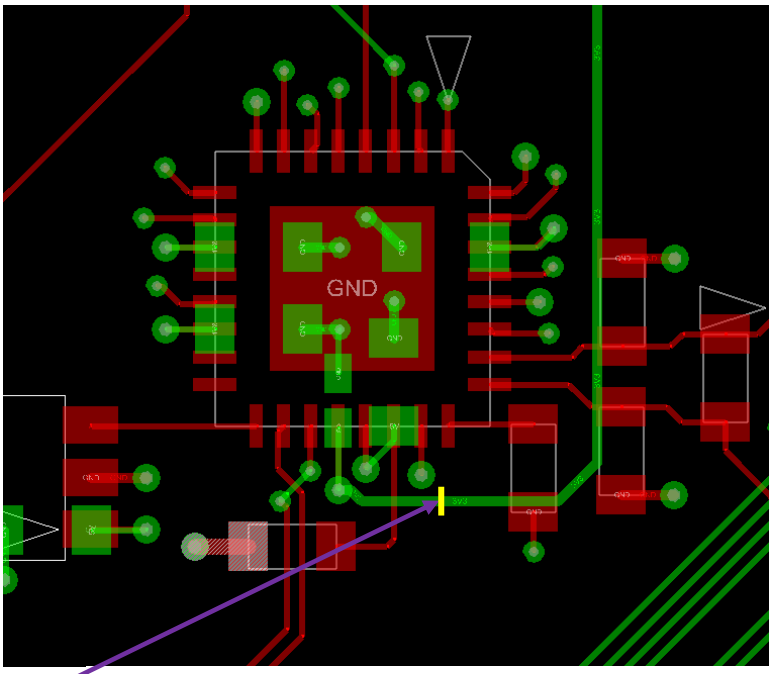

Figure 11: 3,3 Volts wire cut.

Cut wires

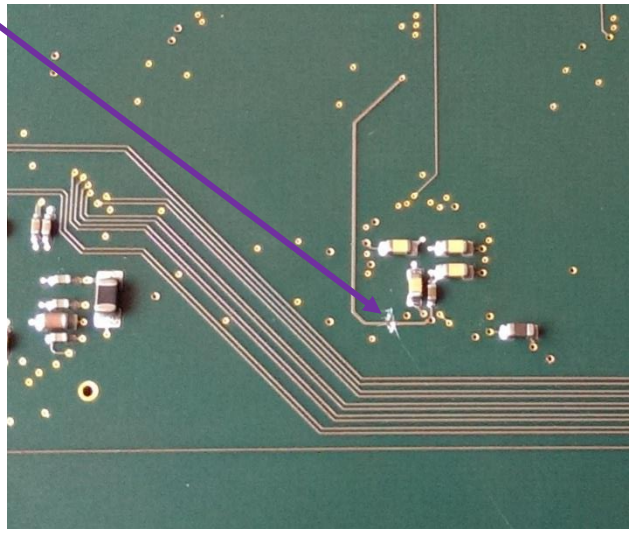

Figure 12: 3,3 Volts wire cut on bottom side.

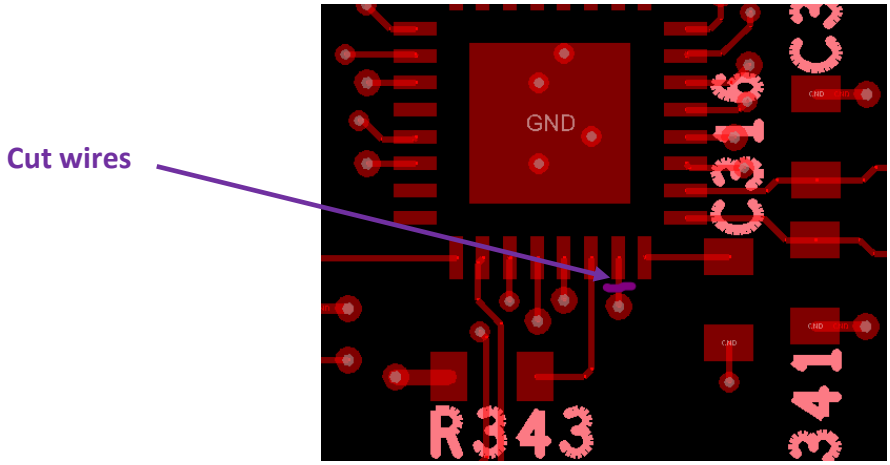

Figure 13: 1,8 Volts wire cut.

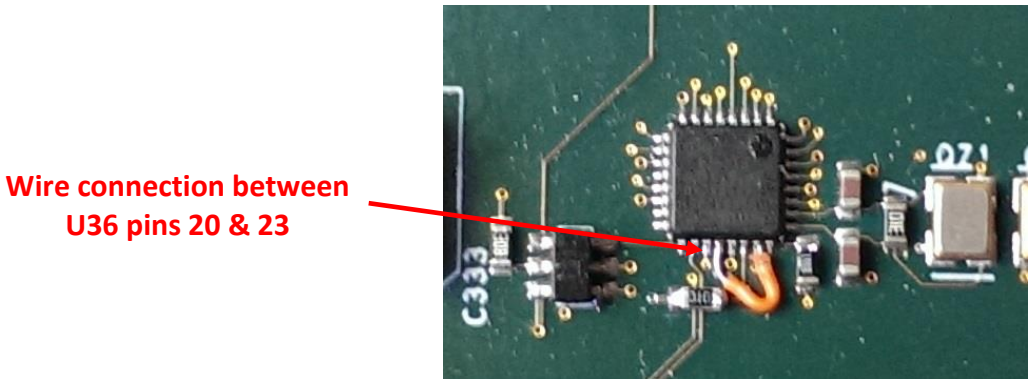

Figure 14: U36, pins 20 & 23 wire connection.

Number of operation: 3

2.5 -3,3 Volts power supply enable:

For the SDE-002-002-IE00 UUB board only, the +/- 3,3 Volts Enable will be send from the Slow-Control micro-controller (3,3Volts) to U97_1 +3,3V DC/DC pin15 (EN) and U18_1 -3,3V DC/DC pin 15 (/SHDN). The +3,3V DC/DC output will enable the -3,3V DC/DC enable.

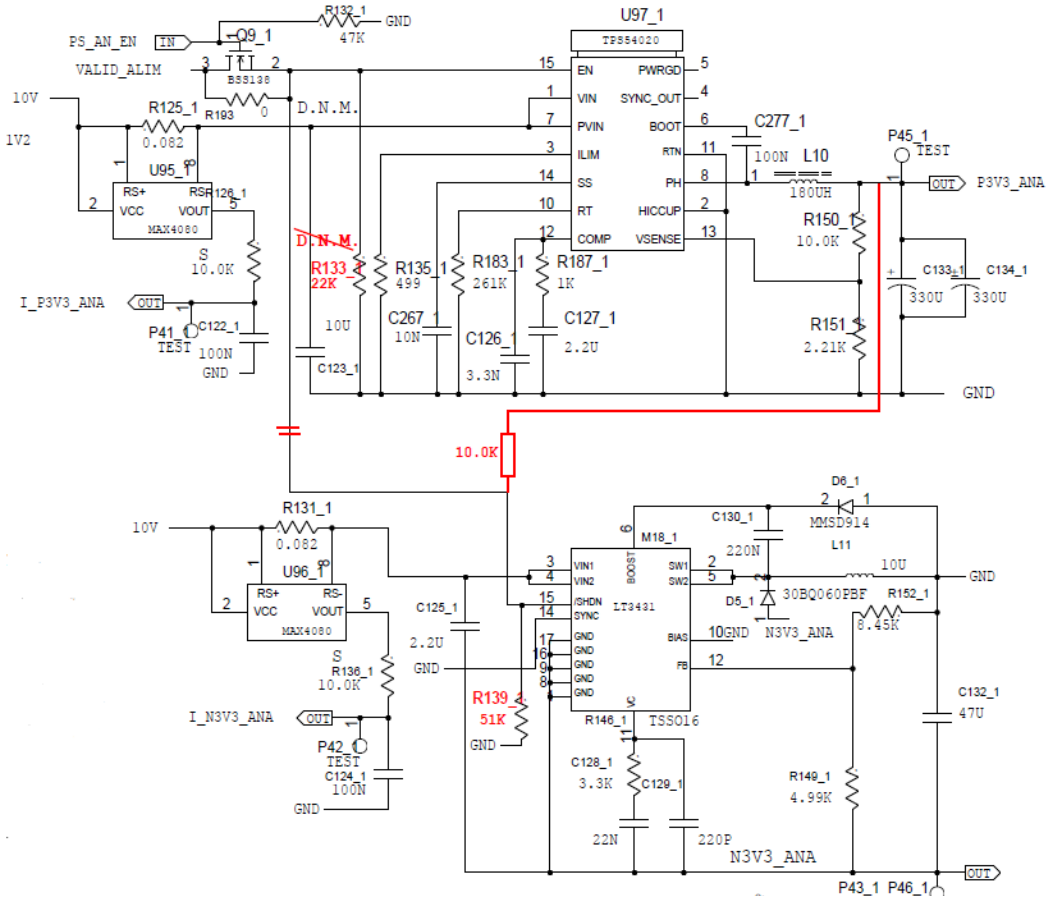

Figure 15: +/- 3,3 Volts Enable modification (Schematic page 10).

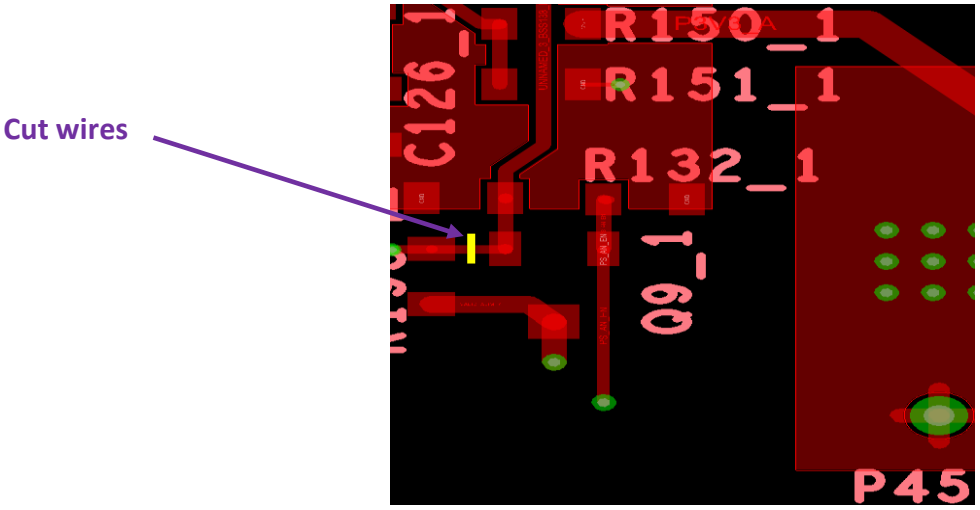

Figure 16: Wire cut.

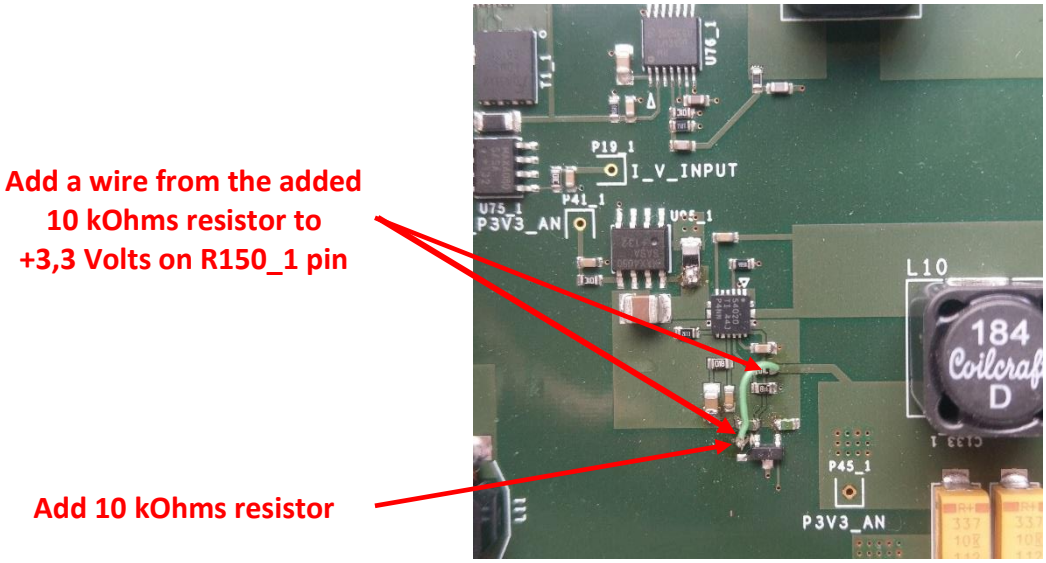

Figure 17: Top side modifications.

The added components:

- R2_X, 10 KOhms 1% 0603 (available in UUB BOM, ref.: RES-017)

Number of operation: 5

3 SLOW-CONTROL MODIFICATIONS (WP4):

3.1 Reset/Done modification:

4,7 kOhms 1% and 0603 package Pull-up resistor must be added between 3V3_SLOW_CTRL and U20 pin 23 (schematic page 12).

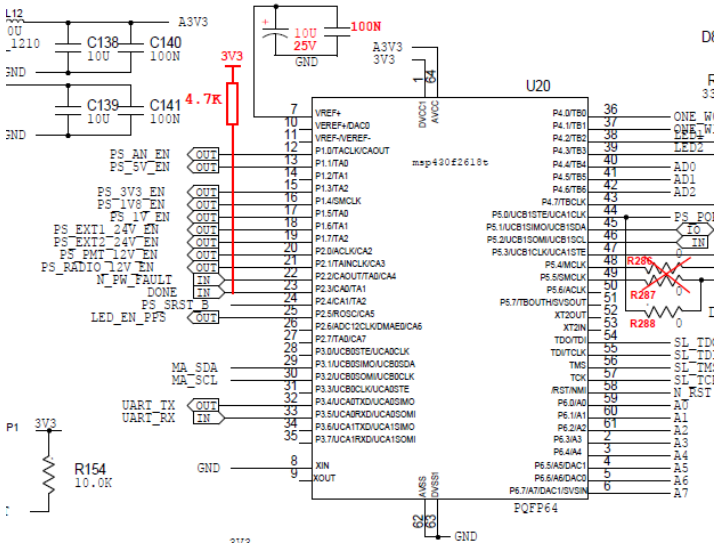

Figure 18: Slow-Control RESET configuration resistors (Schematic page 12).

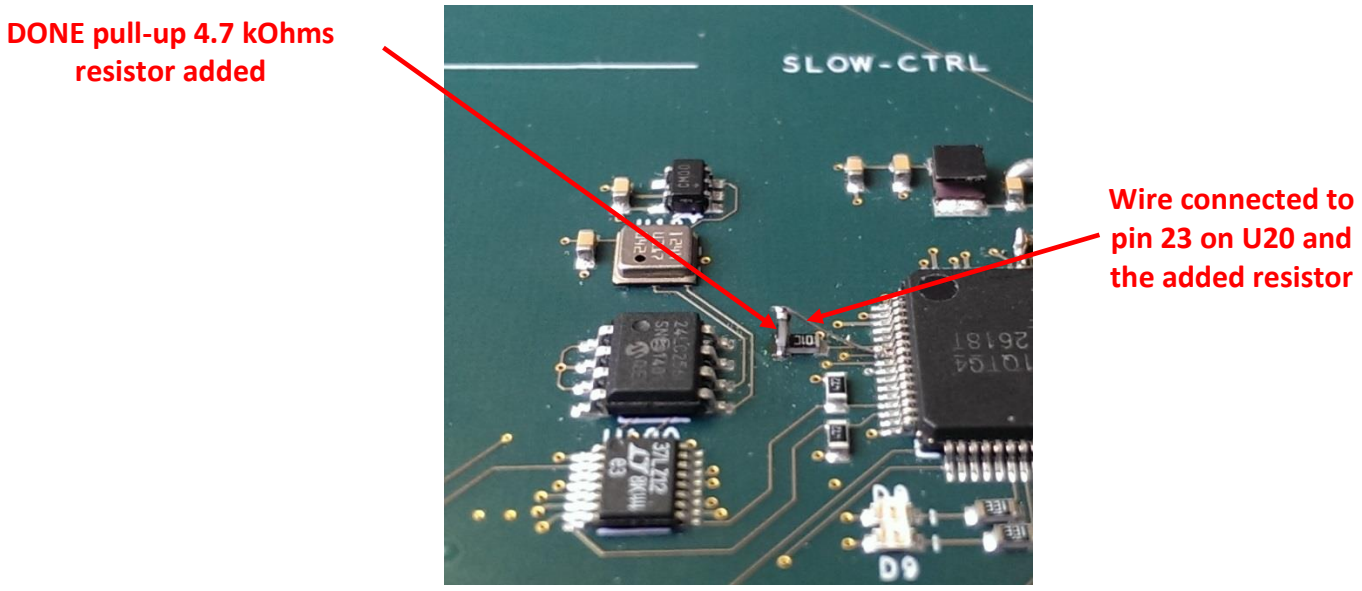

Figure 19: Slow-Control RESET & DONE configuration resistors on board.

The added components:

- R3_X, 4,7 KOhms 1% 0603 (available in UUB BOM, ref.: RES-043)

Number of operation: 2

3.2 Vref decoupling capacitors:

Connect 10 µF 25 Volts and 100nF capacitors in parallel to U20 pin 7 and C138 & C140 ground pins.
Be careful to 10µF polarity connected to U20 pin 7.

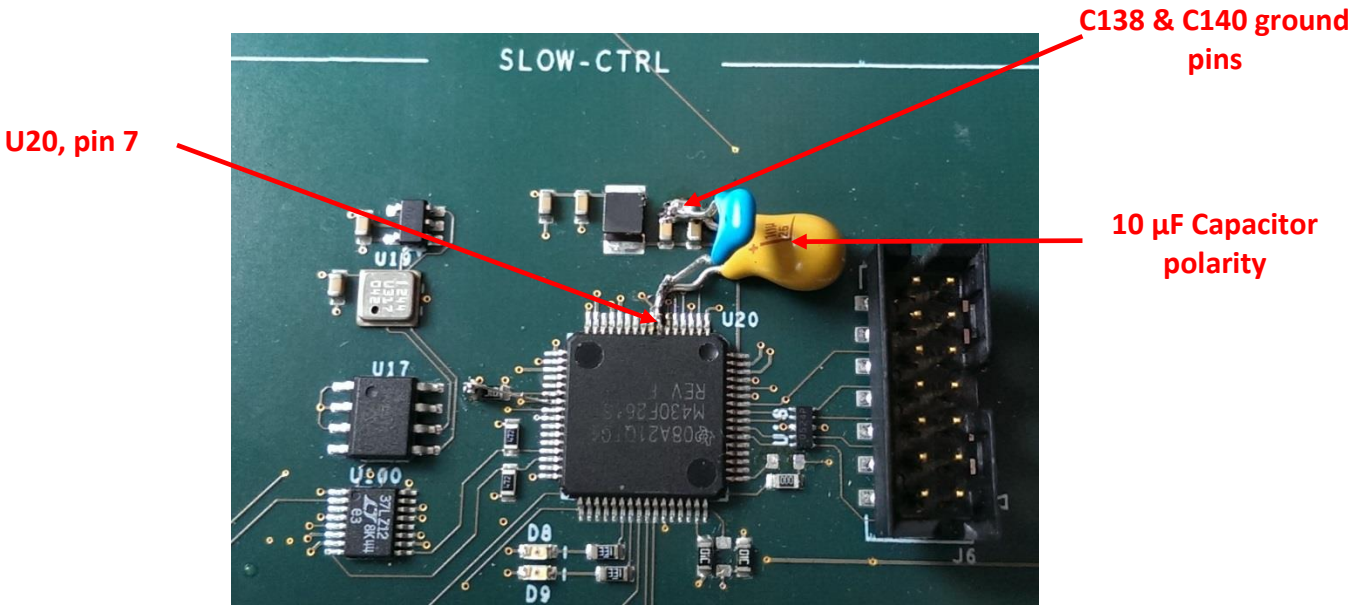

Figure 20: Vref decoupling capacitors.

The added components:

- C2_X capacitor: 10 µF 35 Volts trad — ref.: KEMET T350G106K035AT.
- C1_X capacitor: 100 nF 50 Volts trad — ref.: VISHAY K104K15X7RF53L2.

Number of operation: 2

3.3 Slow-Control Reset Pull-up:

3,3 Volts is missing on Slow-Control Reset Pull-up R297_7 resistor. One pin is unconnected. It must be connected to 3,3 Volts power supply.

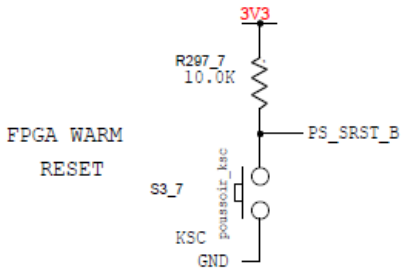

Figure 21: R297_7 pull_up resistor power supply on (Schematic page 12).

A wire must be connected from R297_7 resistor pin to the J7_7 connector pin 2 (3,3 Volts) (NCR n° 2-49).

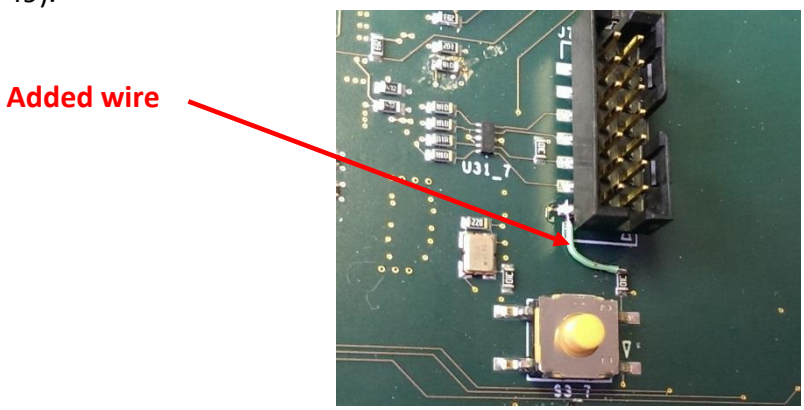

Figure 22: 3,3 Volts connection to 3,3 volts power suplly.

Number of operation: 1

3.4 Watchdog modification:

A pull-up resistor is missing in the schematic. A 10 kOhms resistor must be added between 1 and 5 pins for M34 components (NCR n° 2-22).

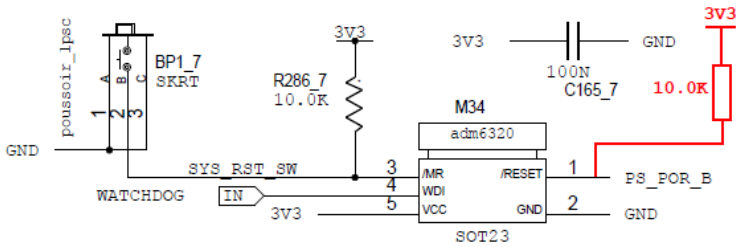

Figure 23: Pull-up resistor added on watchdog output (Schematic page 12).

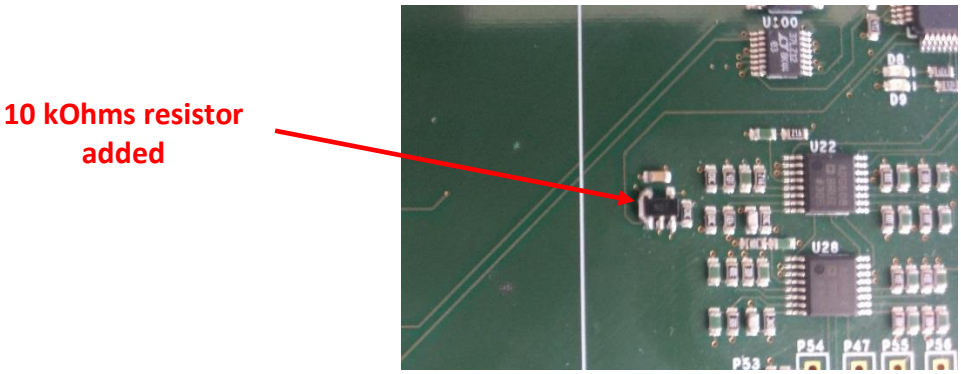

Figure 24: Watchdog 10 kOhms resistor pull-up on board.

The added components:

- R4_X, 10 KOhms 1% 0603 (available in UUB BOM, ref.: RES-017)

Number of operation: 1

4 LED-CONTROLER (WP6):

4.1 I²C interface:

Error in the schematic, SCL & SDA pins must be swapped. The AD5316 must be soldered pins 2 & 3 swapped.

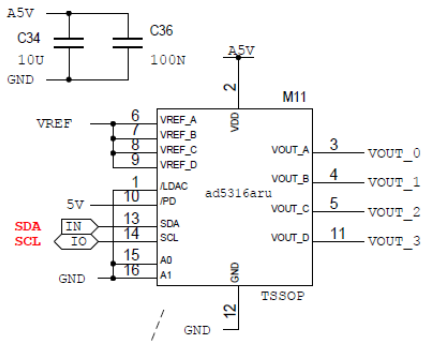

Figure 25: SCL & SDA wires must be swapped (Schematic page 7).

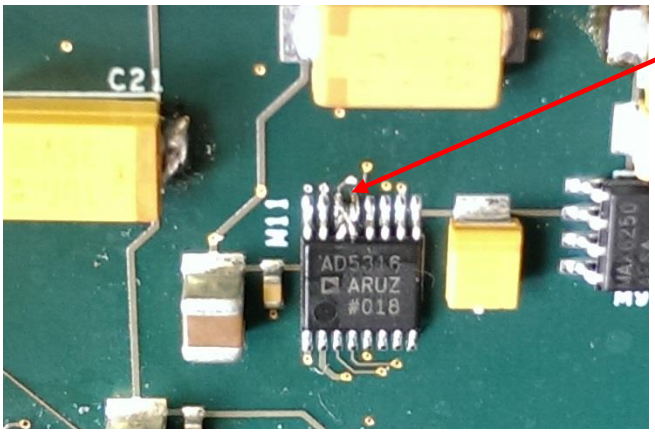

Figure 26: SCL & SDA wires must be swapped on board

Number of operation: 2

4.2 Logic integration:

A short-cut must be made between M14 pins 2 and 3.

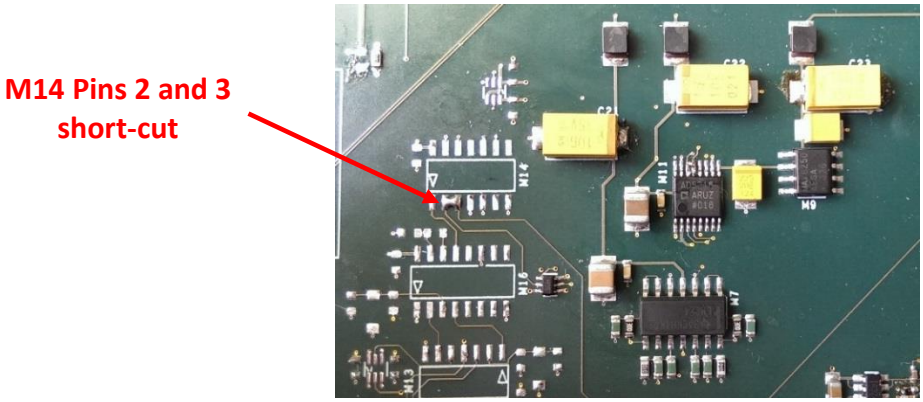

Figure 27: SCL & SDA wires must be swapped on board

Number of operation: 1

5 FRONT-END (WP1):

5.1 Offset 1 & 2 wrong decoupling capacitors positions:

Offset 1 & 2 decoupling capacitors are in the wrong position in the schematic. These capacitors are: C5_1, C8_1, C5_2, C8_2, C5_3, C8_3, C5_4, C8_4, C5_5 & C8_5.

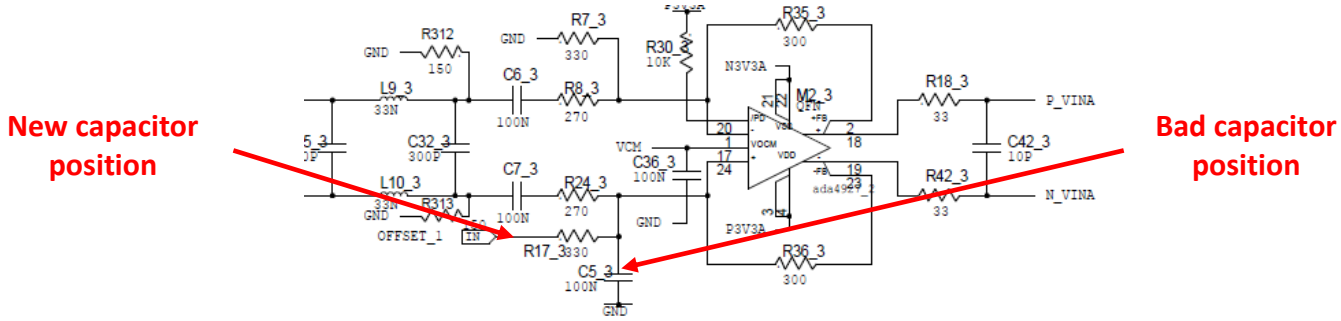

Figure 28: OFFSET_1 C5_3 decoupling capacitors in wrong place (Schematic page 18).

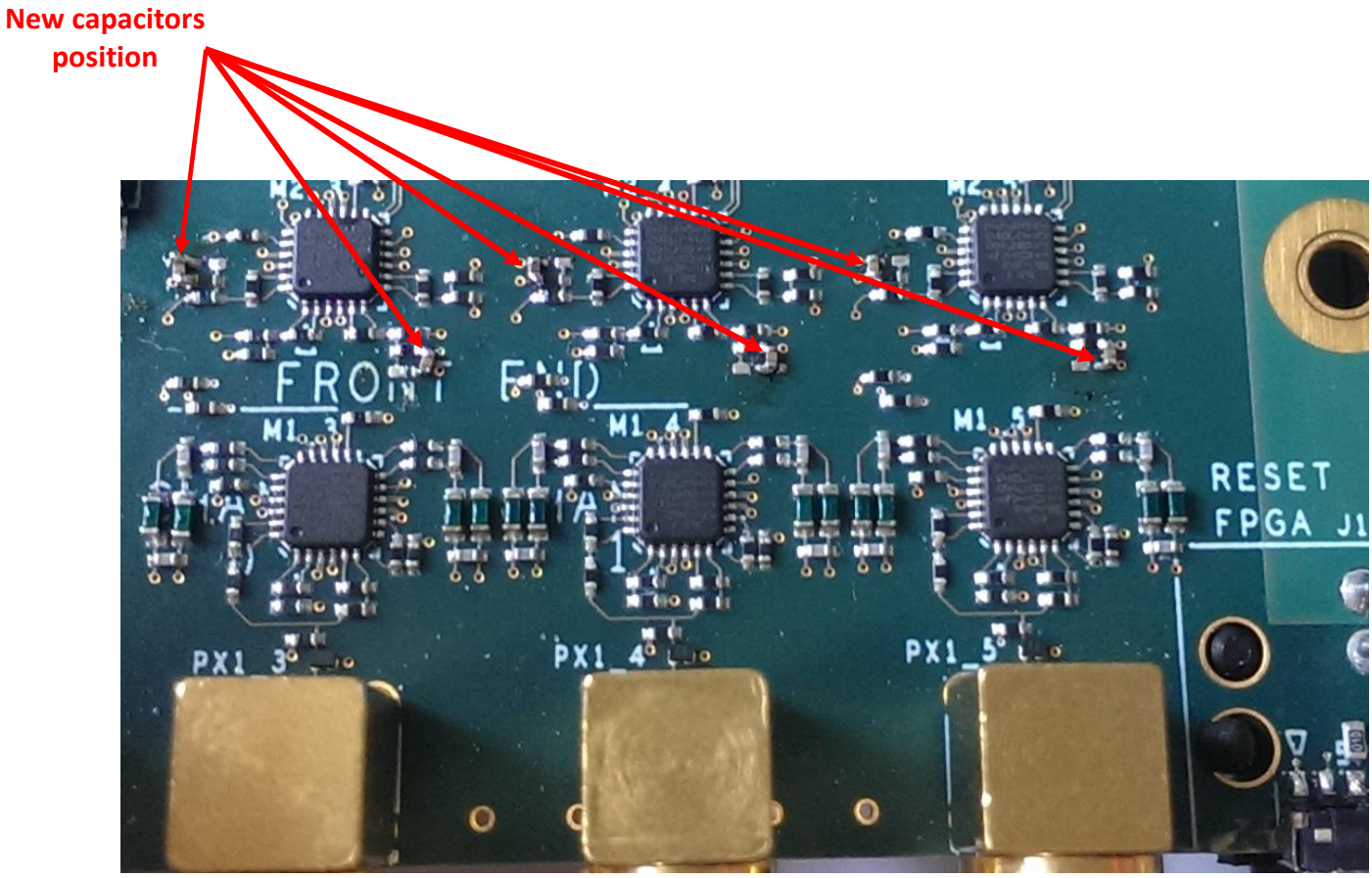

Figure 29: OFFSET_1 & OFFSET_2 C5_3, C8_3, C5_4, C8_4, C5_5 & C8_5 decoupling on board.

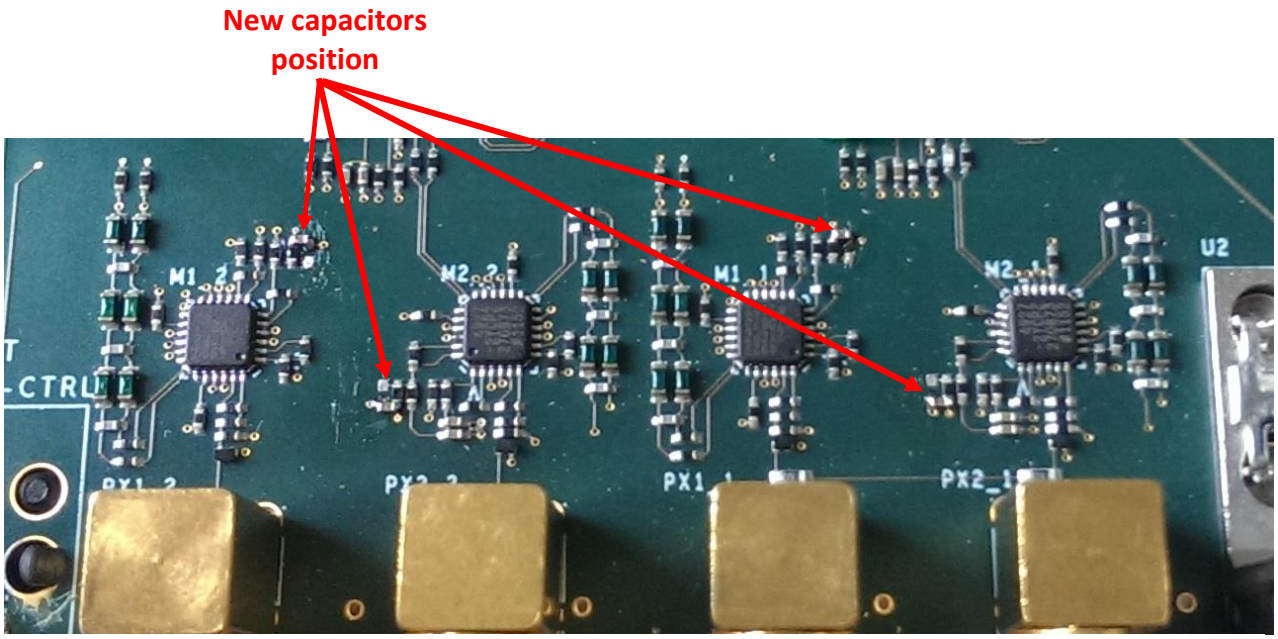

Figure 30: OFFSET_1 & OFFSET_2 C5_1, C8_1, C5_2 & C8_2 decoupling on board.

The added components:

- C5_1,C8_1,C5_2,C8_2,C5_3,C8_3,C5_4,C8_4,C5_5,C8_5, 100 nF 10V 10% 0402 (available in UUB BOM, ref.: CAP-004)

Number of operation: 10

5.2 Offset 1 & 2 decoupling capacitors:

4 Tantalum or ceramic decoupling capacitors must be soldered on board on each OFFSET signal. 2 on amplifier Offset outputs. The 2 others must be close the ADCs.

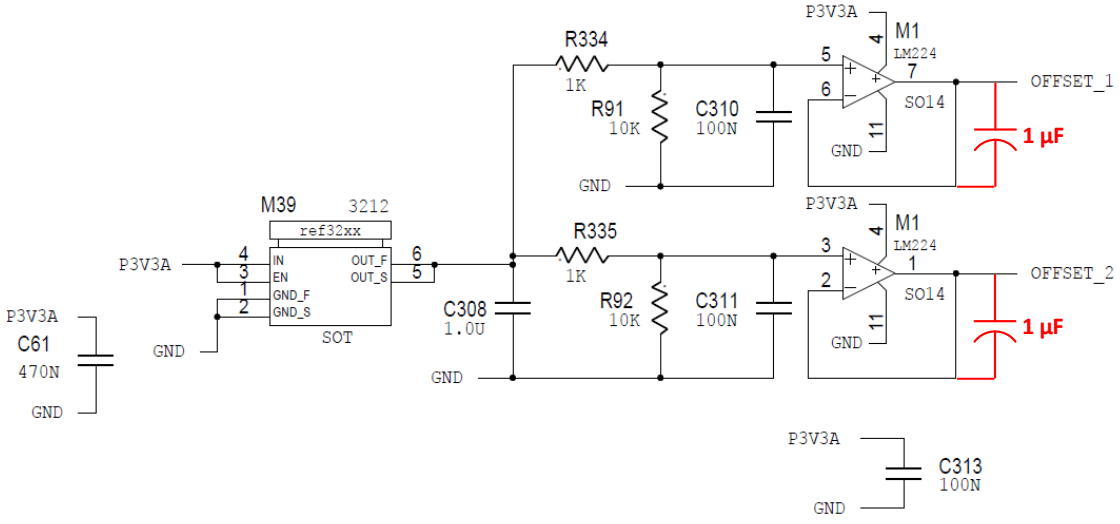

Figure 31: OFFSET_1 & OFFSET_2 amplifiers decoupling (Schematic page 15).

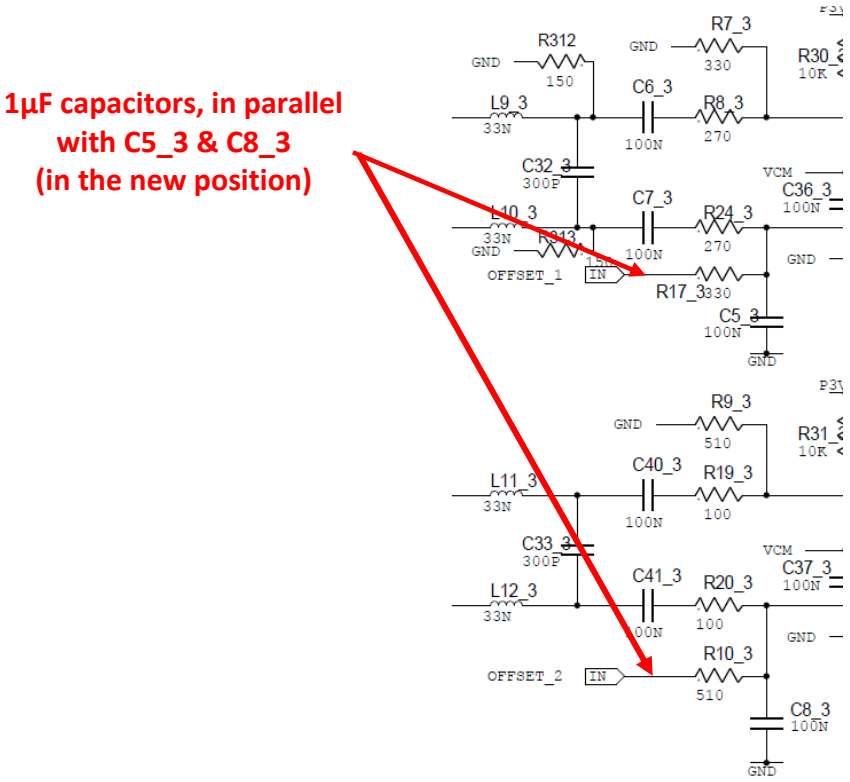

Figure 32: OFFSET_1 & OFFSET_2 decoupling close ADC (Schematic page 18).

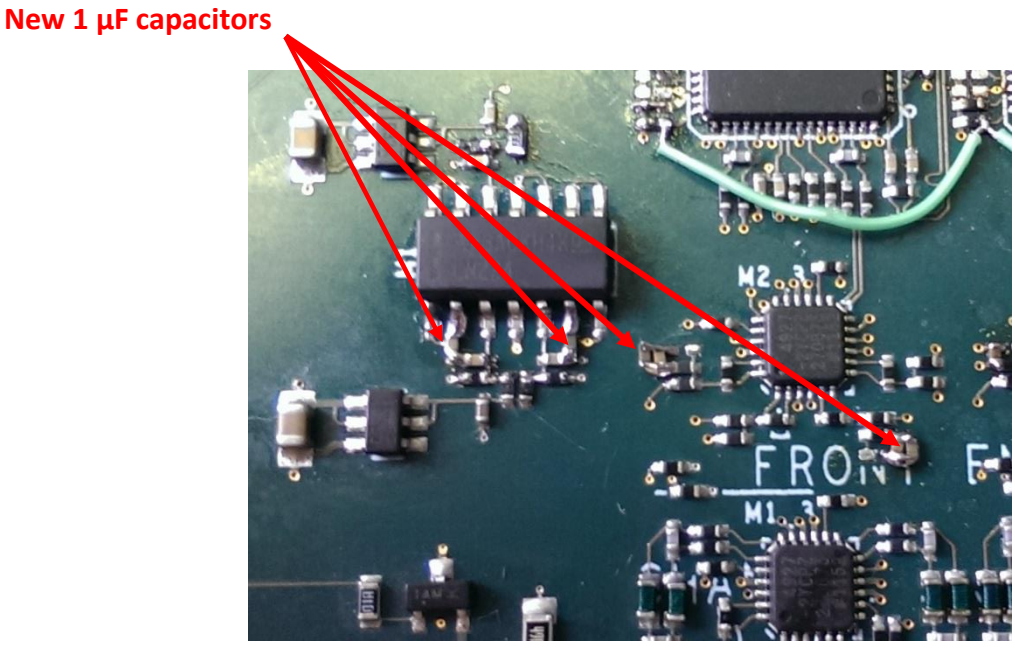

Figure 33: OFFSET_1 & OFFSET_2 amplifier decoupling and close ADC on board.

The added components:

- C3_X, C4_X, C5_X and C6_X, 1 µF 16 V 0402 (available in UUB BOM, ref.: CAP-012)

Be careful with the capacitor's polarity, it is a Tantalum technology.
Number of operation: 4

5.3 Vref modifications:

Vref wire provides 1 Volt to all ADCs. A wire cut must be made just after the M1 output pin.

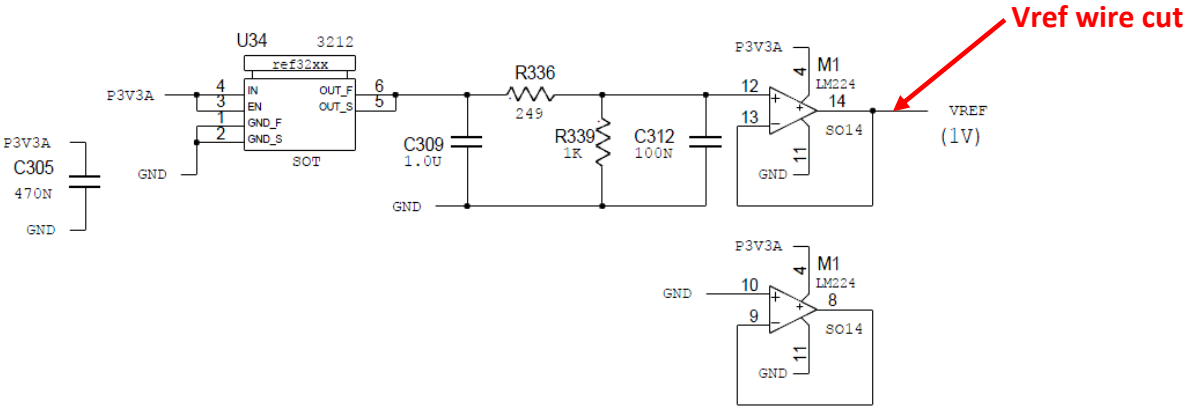

Figure 34: Disconnected Vref provided by M1 amplifier (Schematic page 15).

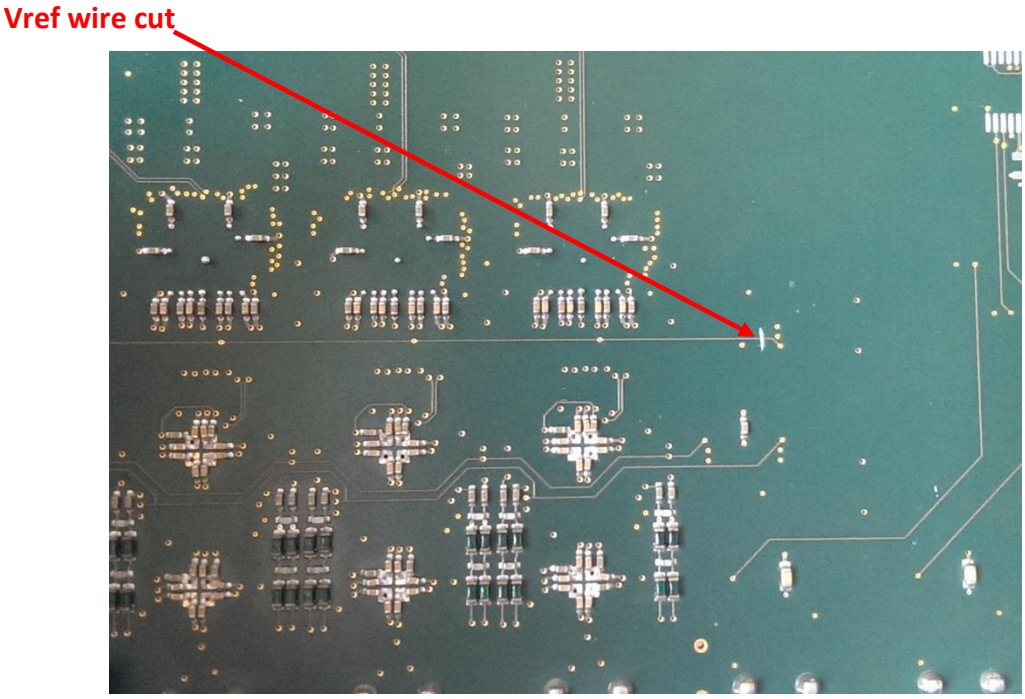

Figure 35: Vref Disconnected cut on board.

Number of operation: 1

5.4 Type 3, input impedance modifications:

For SSD detector the type 3 front-end design must be implanted with a type1 Bill Of Material. For the impedance adaptation a wire must be cut and a resistor 200 Ohms and 51 Ohms 0603 package added.

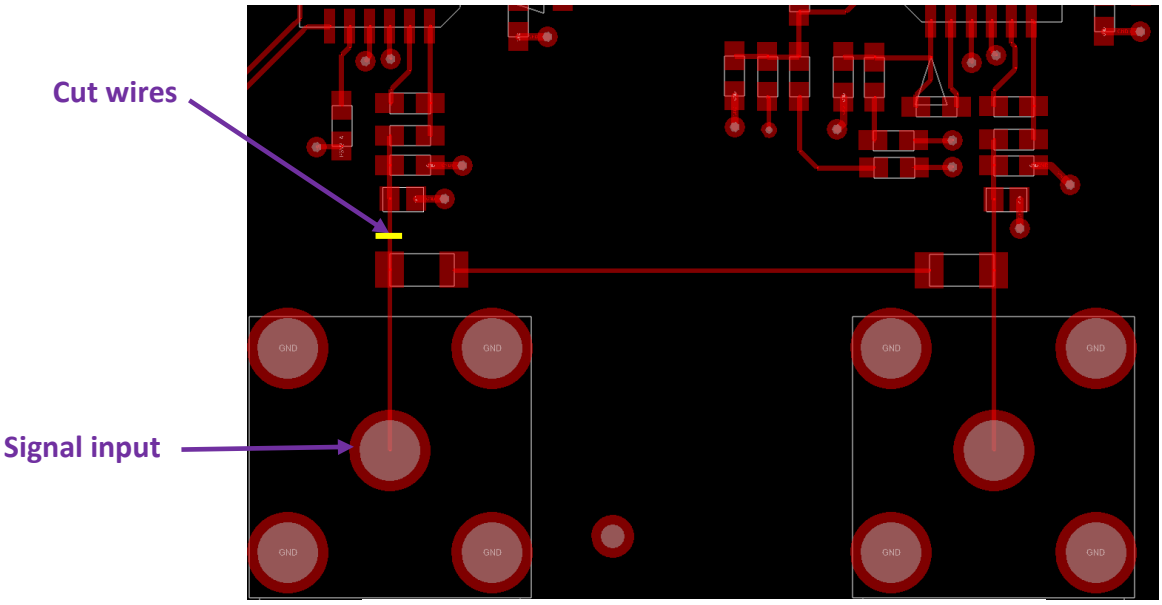

Figure 36: SSD analog input Wire Cut.

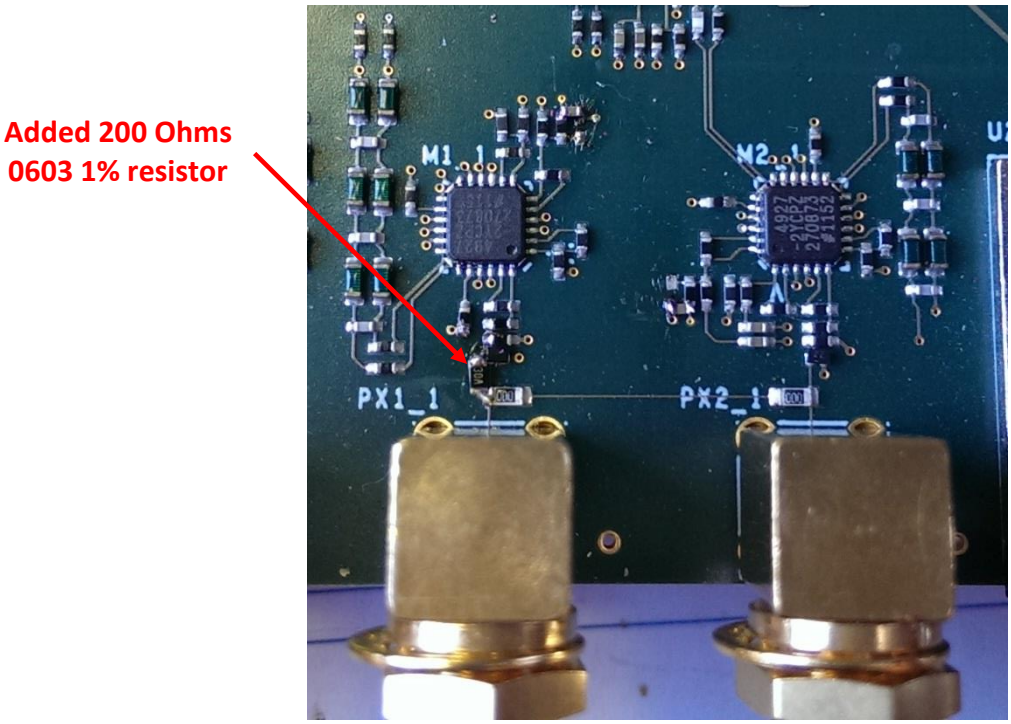

Figure 37: 200 Ohms resistor added.

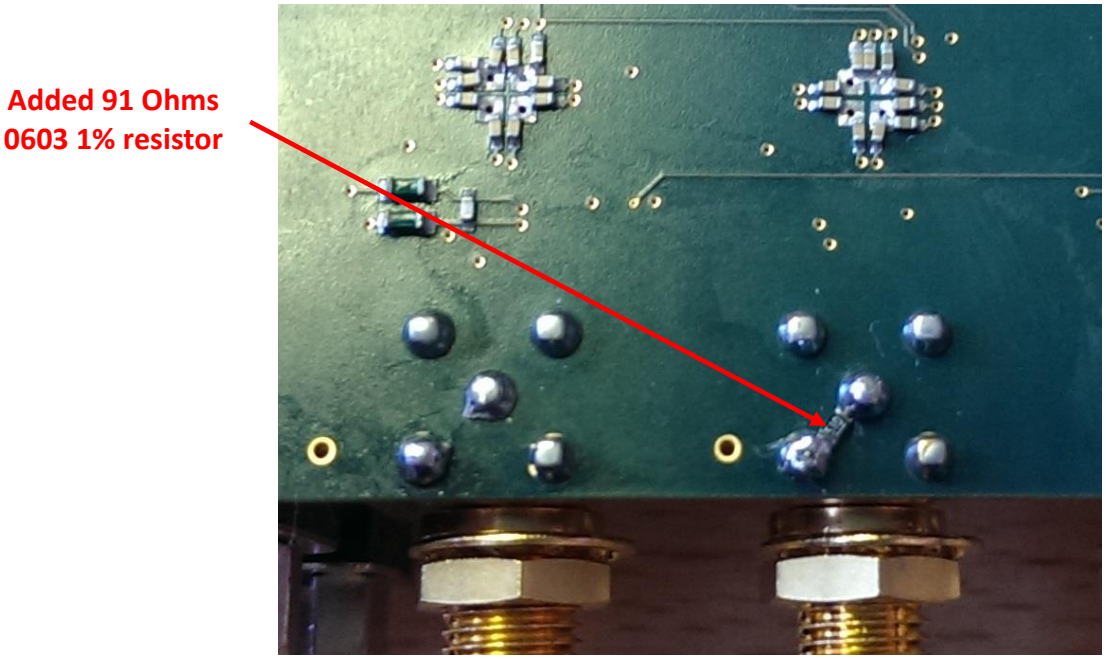

Figure 38: 91 Ohms resistor added.

The added components:

- R5_X, 91 Ohms 1% 0603 (available in UUB BOM, ref.: RES-121)
- R6_X, 200 Ohms 1% 0603 (available in UUB BOM, ref.: RES-112)

Number of operation: 3

6 ENGINEERING ARRAY MODIFICATIONS:

During the Engineering Array, several modifications have been made in the electronic UUB design.

6.1 Watchdog modification:

During the JTAG download, the FPGA could sent signal to watchdog configuration pin. This generate a system Reset and the JTAG download is stopped.

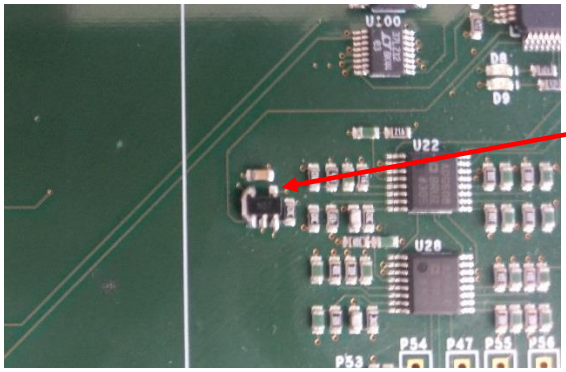

Figure 39: Watchdog Input pin in UP position.

6.2 TRIGGER in modification:

The input 50 Ohms R29 resistor must be removed, but kept on board. There is too many attenuation on the signal.

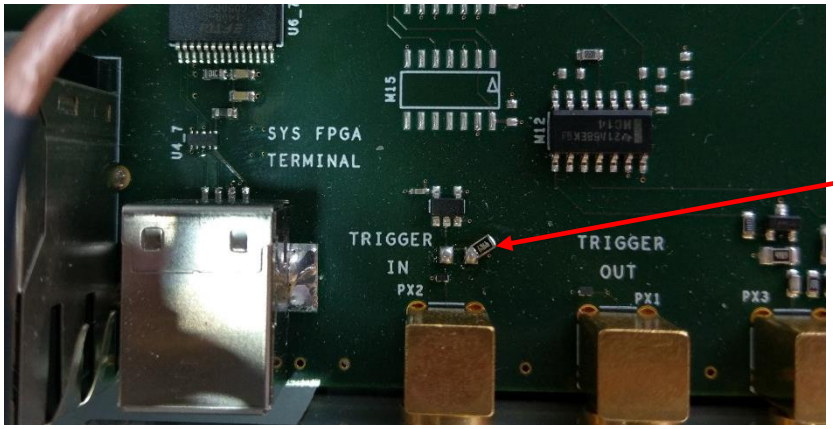

Figure 40: R29 resistors removed on top side.

Number of operation: 2

6.3 "RADIO Reset" modification:

The "RADIO Reset" was managed by FPGA, but now it must be managed by the Slow-Control. It's already managed the UUB's Reset.

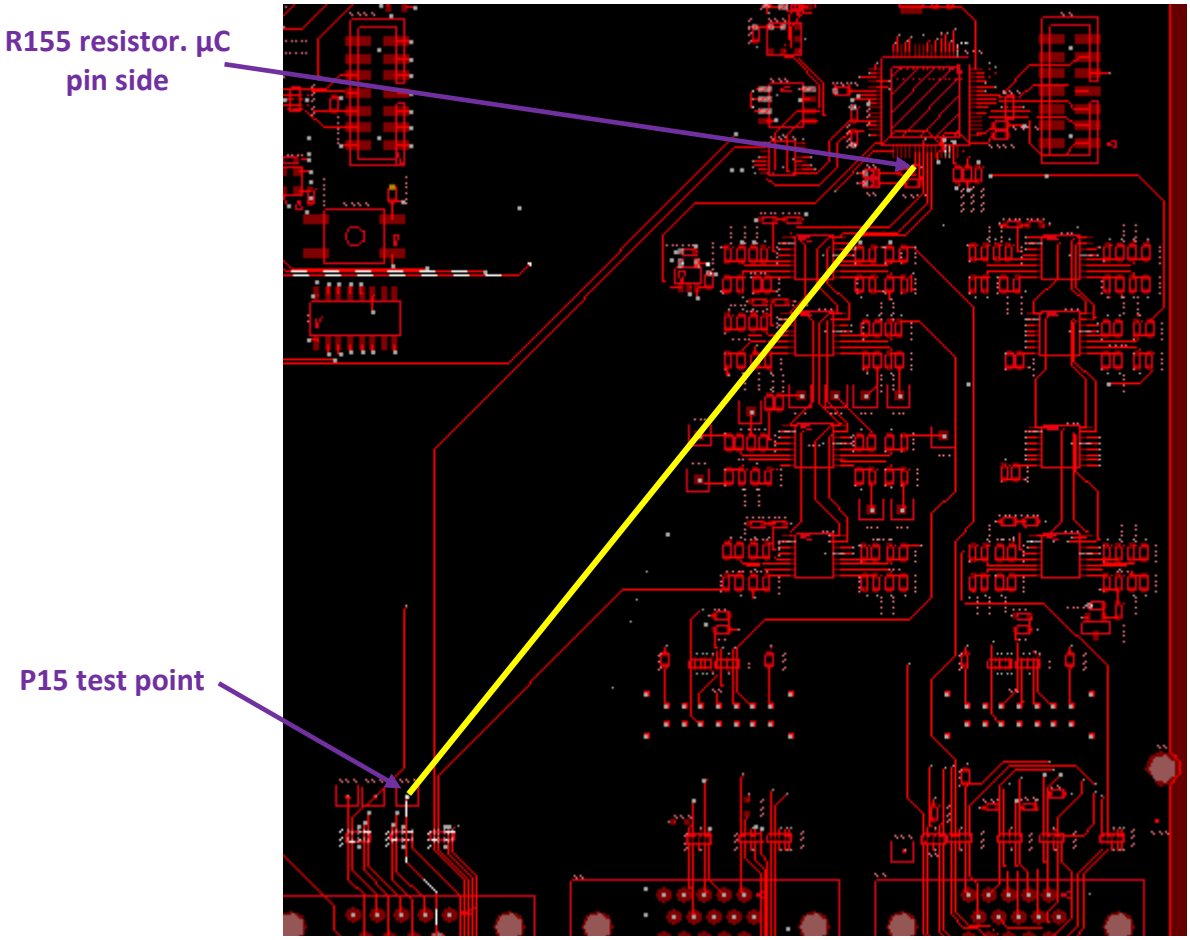

Figure 41: "RADIO Reset" Wire connection between P15 test point and R155resistor.

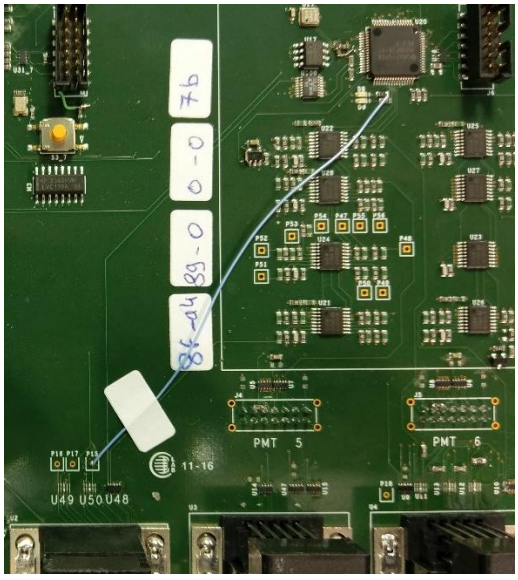

Figure 42: "RADIO Reset" Wire on top side.

6.4 Slow-control ESD protection and Temperature sensor power supply modification (WP4 & 5):

The RCLAMP0524J.TCT ESD component modifies signals for PMT and Tank devices. Wires must be cut, R13, R14, R19, R20 & R21 resistors and U11, U12 & U13 must be removed (made in BOM).

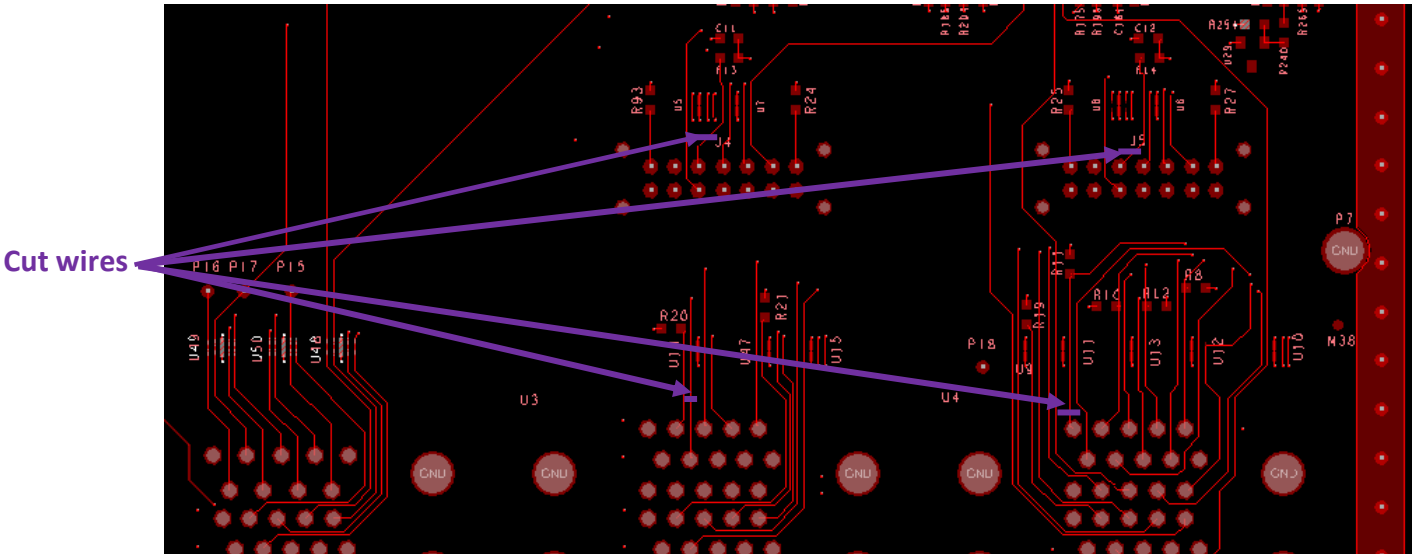

Figure 43: Cut wires and removed resistors.

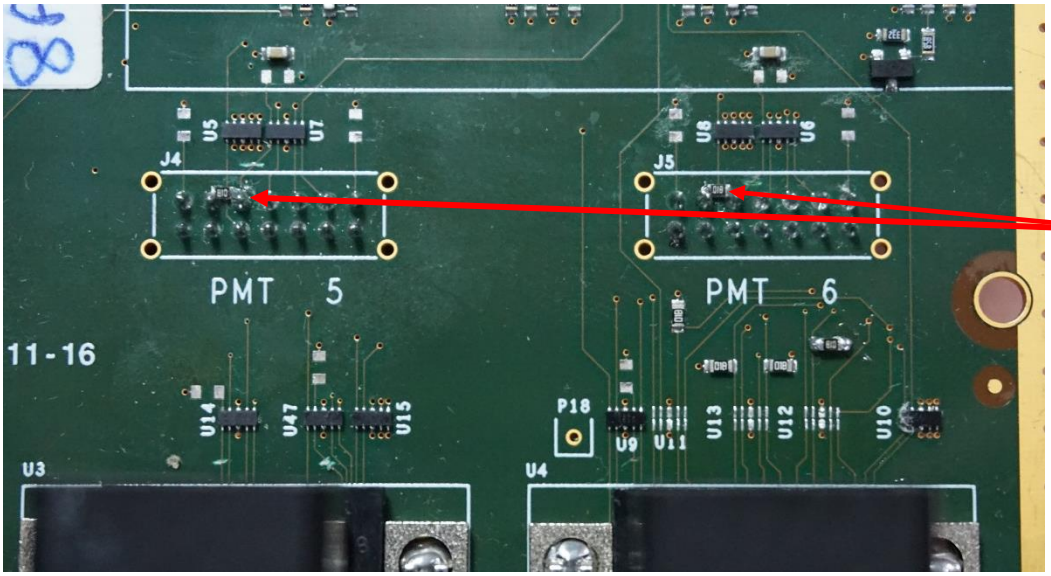

Figure 44: R7_X & R8_X added resistors on top side.

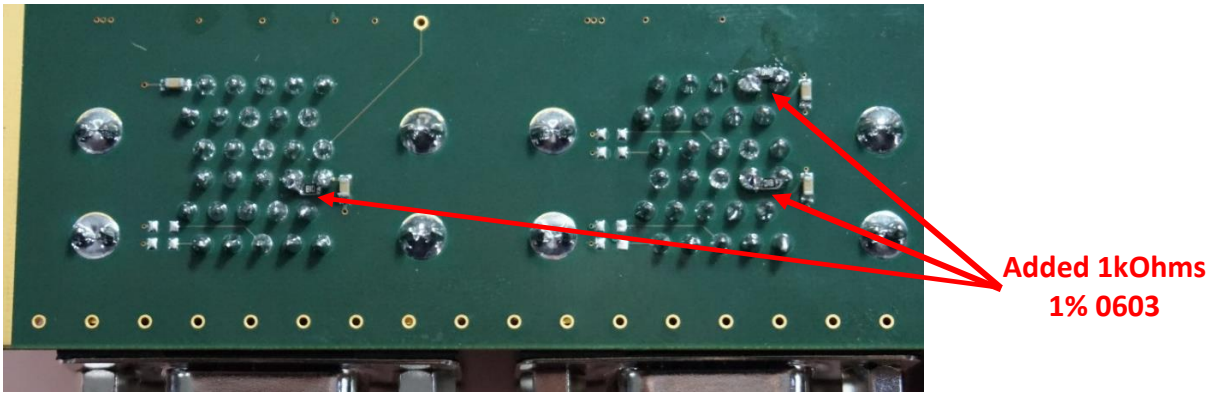

Figure 45: R9_X, R10_X & R11_X resistors added on bottom side.

The added components:

- R7_X, R8_X, R9_X, R10_X and R11_X, 1 kOhms 1% 0603 (available in UUB BOM, ref.: RES-014)

Number of operation: 9

7 MATERIAL:

7.1 Bill Of Material:

Auger ID Ref.	*Component reference*	*Description*	*Design reference*	*Qty*	*Manufacturer 1*	*Manufacturer 1 Part number*	*Manufacturer 2*	*Manufacturer 2 Part number*	*Manufacturer 3*	*Manufacturer 3 Part number*	*Manufacturer …*	*Manufacturer … Part number*	*Work Package in charge*
IC-046	*AD5316ARU_TSSOP16*	*AD5316 Quad 10 bits DAC, I²C, TSSOP 16 pins package -40° to +105°C*	*M11*	*1*	*Analog Devices*	*AD5316ARUZ*	-	-	-	-			*WP7*
TRA-007	TRANSISTOR_FDB3632_D2PAK	FDB3632 100V N-Channel PowerTrench MOSFET transistor 80A 9mOhms , D2PACK 3 pins package -55°C to +175°C	Q4_1	1	Fairchild	FDB3632							WP5
CAP-004	CAPA-100N,C402S10V10%	Capacitor 100 nF 10V ±10% X5R 0402 ceramic -55°C to +85°C	C5_1,C8_1,C5_2,C8_2,C5_3,C8_3,C5_4,C8_4,C5_5,C8_5	10	AVX	0402ZD104KAT2A	MURATA	GRM155R61A104KA01D	KEMET	C0402C104K8PACTU			WP1, WP5
CAP-069	CAPA-100N,CER50V10%	Capacitor 100 nF 50V ±10% X7R TRAD 2,54 mm ceramic -55°C to +125°C	C1_X	1	VISHAY	K104K15X7RF53L2							WP4
CPL-011	CPOL-1U,TAN35V	Capacitor 10 µF 35V ±20% TRAD 2,54 mm Tantalum -55°C to +105°C	C2_X	1	KEMET	T350G106K035AT							WP4
CPL-012	CPOL-10U,0402S16V10%	Capacitor 10 µF 16V ±20% 0402 Tantalum -55°C to +125°C	C3_X,C4_X,C5_X,C6_X	4	VISHAY	TMCJ1C105MTRF							WP1
RES-014	RGEN-1.00K,S100MW1%	Resistor 1 Kohm ±1% 100mW E24 series 0603 package, -55°C to +125°C	R7_X, R8_X, R9_X, R10_X, R11_X	5	TE Connectivity	1622866-1	YAGEO	RC0603FR-071KL					WP1, WP5, WP7
RES-017	RGEN-10.0K,S100MW1%	Resistor 10 Kohm ±1% 100mW E24 series 0603 package, -55°C to +125°C	R2_X,R4_X	2	YAGEO	RC0603FR-0710KL	BOURNS	CR0603-FX-1002ELF					WP4, WP5, WP7
RES-043	RGEN-4.70K,S100MW1%	Resistor 4,7 kohm ±1% 100mW E24 series 0603 package, -55°C to +125°C	R3_X	1	YAGEO	RC0603FR-074K7L	BOURNS	CR0603-FX-4701ELF	Rohm Semiconductor	MCR03FZPFX4701			WP4, WP5
RES-068	RGEN-1.5k,S100MW1%	Resistor 1.5 kohm ±1% 100mW E24 series 0603 package, -55°C to +125°C	R1_X	1	Bourns	CR0603-FX-1501ELF	VISHAY	CRCW06031K50FKEA	YAGEO	RC0603FR-071K5L			WP4
RES-112	RGEN-200,S100MW1%	Resistor 200 ohm ±1% 100mW E24 series 0603 package, -55°C to +125°C	R6_X	1	YAGEO	RC0603FR-07200RL	VISHAY	CRCW0603200RFKEA	PANASONIC	ERJ-3EKF2000V			WP1, WP4
RES-121	RGEN-91,S63MW1%	Resistor 91 ohm ±1% 100mW E96 series 0603 package, -55°C to +125°C	R5_X	1	YAGEO	RC0603FR-0791RL	VISHAY	CRCW060391R0FKEA	PANASONIC	ERJ-3EKF91R0V			WP1