XE121 Evaluation Board Product Brief

XE121 Evaluation Board Product Brief

Proprietary and Confidential

Author: Acconeer

Version 1.0: 2022-07-06

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1. Introduction

The A121 EVK is an evaluation kit designed to evaluate the Acconeer A121 pulsed coherent radar sensor. The kit consists of three boards: the XC120, XE121 and XS121. The XC120 board carries a cortex M7 MCU which is to be flashed with a software dedicated to stream data from the A121 radar sensor to Acconeer's "Exploration Tool" via USB HS 2.0[1]. The XC120 is intended to be used with the exploration server for streaming radar sensor data only and after flashing, no further configuration by the user is expected. The XE121 features an on board A121 pulsed coherent radar sensor and the possibility to add up to four additional A121 radar sensors via FFC (Flat Flexible Cable) to the XS121 radar satellite boards. This document focuses on the XE121 board. For details on XC120 and XS121 refer to the respective product briefs. For details on how to use the XC120, XE121 and XS121, refer to the A121 EVK Hardware User Guide available on the Acconeer Developer page: https://developer.acconeer.com/

Below a system overview is shown:

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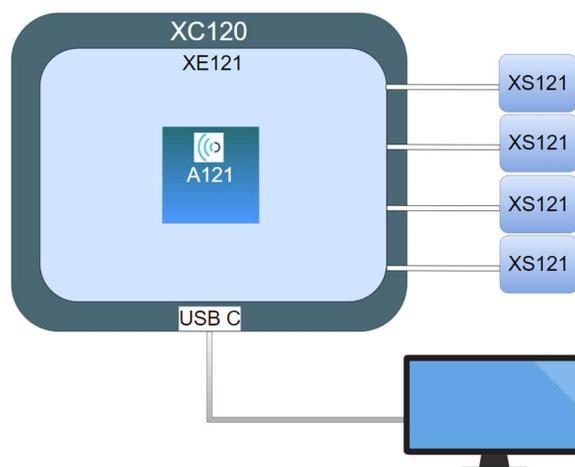
[1] Acconeer's "Exploration Tool" is supported by Linux and Windows OS.

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2. XE121 Evaluation Board.

2.1 Overview

The XE121 Evaluation Board is part of the Acconeer A121 Evaluation Kit and is intended to be used together with the XC120, a Raspberry Pi or STM Nucleo-64 or STM Nucleo-144 development boards. XE121 is equipped with 1 fixed A121 pulsed coherent radar sensor as well as 4 FFC (Flat Flexible Cable) connectors to which XS121 satellite boards can be connected. The flex cable solution enables a wide variety of use cases involving multiple radar sensors. It also facilitates proof of concepts since the radar sensor board placement is not limited by the size of the evaluation board. It is not possible to run the XE121 without one of these "MCU boards" since the XE121 is not equipped with an MCU for control and communication of the A121 pulsed coherent radar sensor.

The purpose of the XE121 is to be able to evaluate the A121 pulsed coherent radar sensor. This can be done in three different ways:

The most straight-forward and optimized way to evaluate the A121 radar sensor is to connect the XE121 to the XC120 Connector board which enables evaluation of the radar sensor using the Acconeer "Exploration Tool"[2]. Connecting the XE121 to the XC120 gives you the highest data streaming rate thanks to the USB HS 2.0 connection on the XC120 and the high SPI speed that is possible to achieve when using the XC120 in combination with XE121.

If you prefer, you can connect the XE121 to a Raspberry Pi, using the "Software Development Kit for Raspberry Pi". The rate at which you can retrieve data from the A121 is in this case limited by the Raspberry Pi SPI interface speed.

Another option is to connect XE121 directly to an STM Nucleo-64 or Nucleo-144 development board featuring the MCU of your choice. The main reason for making XE121 compatible with the STM Nucleo development boards is to facilitate SW development, there is no support for this configuration in Acconeer "Exploration Tool". Acconeer provides a SW integration guideline "STM32CubeIDE User Guide" to help you get started. Refer to the Acconeer Developer page for the different SW guides and downloads: https://developer.acconeer.com/

The XE121 is compatible with the Acconeer LH120 lens kit.

In Picture 1 the block diagram of XE121 is shown:

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[2] Available for download on github: https://github.com/acconeer/acconeer-python-exploration
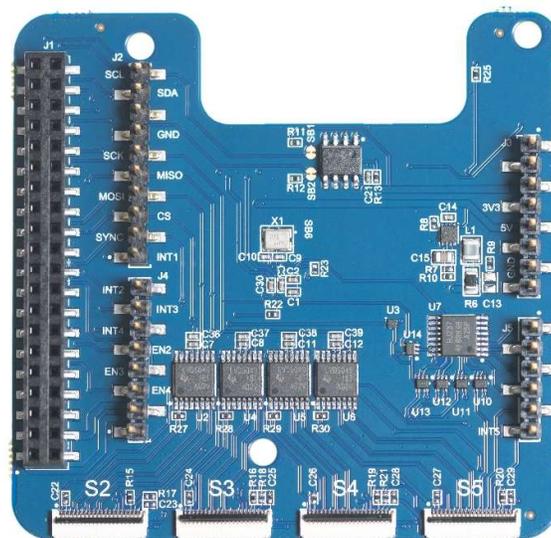
2022-07-06
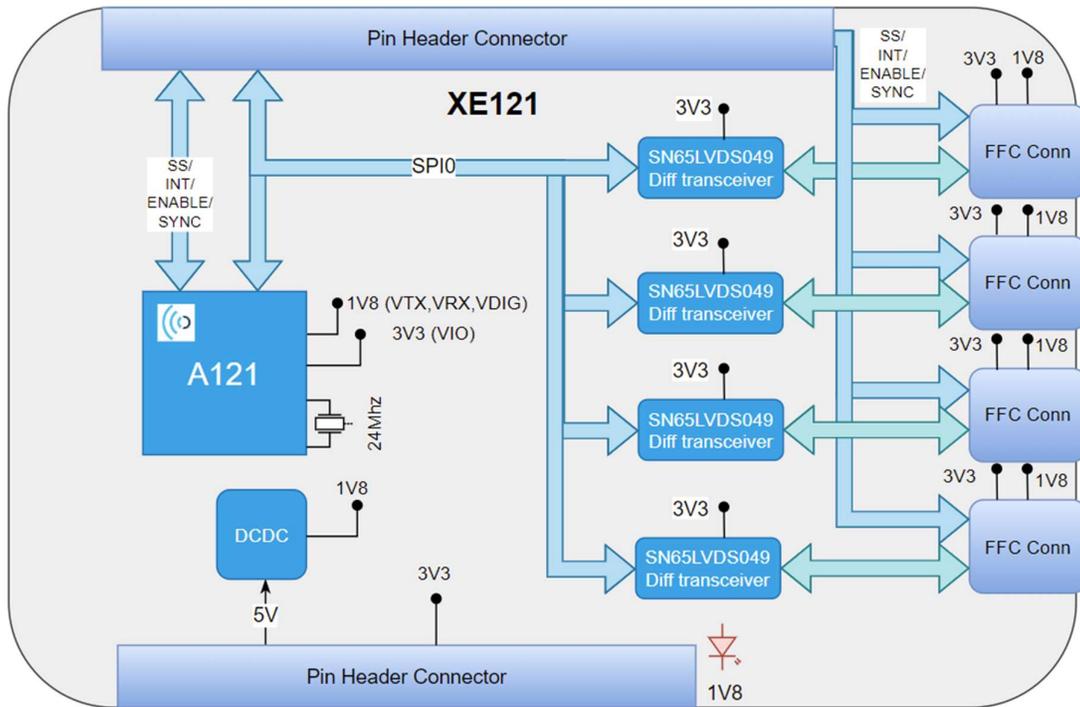
Picture 1. The blockdiagram of XE121.

In the pictures below, the XE121 is shown as well as how to connect it to XC120, XS121, Raspberry Pi and STM Nucleo development boards.

2022-07-06
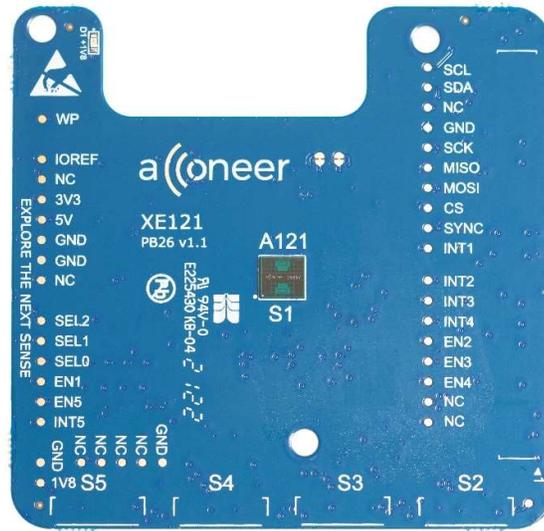
Picture 2. XE121, front side.

Picture 3. XE121 reverse side.

Picture 4. XE121 connected to XC120 and four XS121.

Picture 5. XE121 connected to Raspberry Pi.

2022-07-06

Picture 6. XE121 connected to an STM Nucleo Development Board.

2.2   Power

The XE121 evaluation board is powered from either XC120, Nucleo Development board or Raspberry Pi. There is a power regulator on the XE121 that generates the 1.8V needed for the A121 radar sensor. When the power LED D1 is lit, the board is powered on and ready for use. Depending on your use case, if you connect more than 1 XS121 to your XE121 and run simultaneous radar measurements on them, the power delivered from XC120 powered via USB connector (or Nucleo and Raspberry Pi powered via USB connector) may not be enough. In this case an external power supply is needed. The XC120 has such an option. Refer to XC120 Product Brief fore details: https://developer.acconeer.com/

For details how to use the Nucleo development board and the Raspberry Pi with external power supply, refer to official product information.

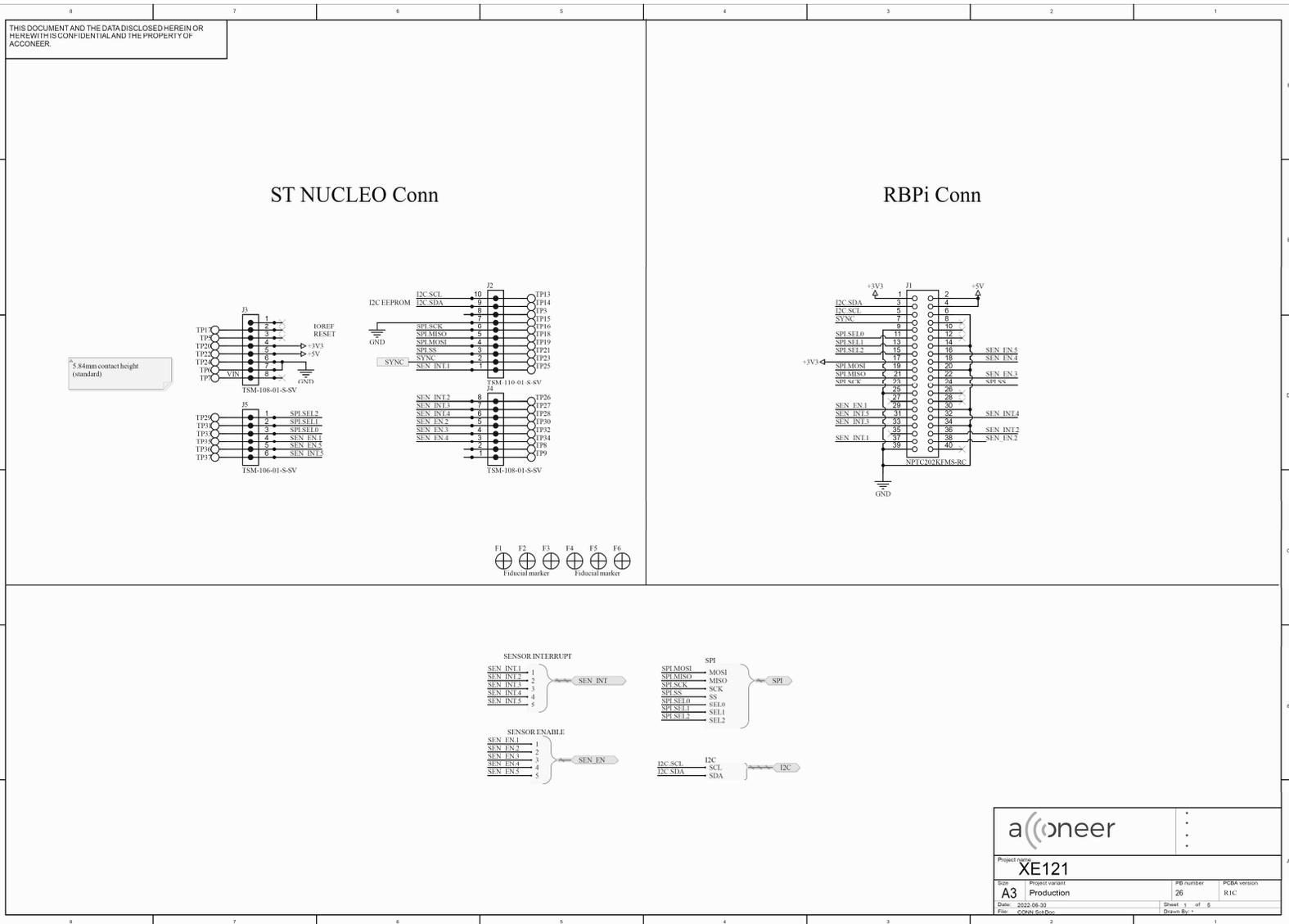https://www.st.com/content/st_com/en.html

https://www.raspberrypi.com/documentation/computers/raspberry-pi.html - power-supply
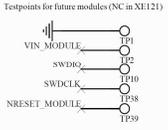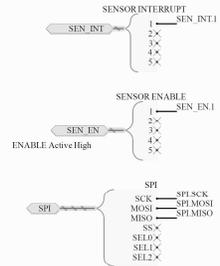
2022-07-06
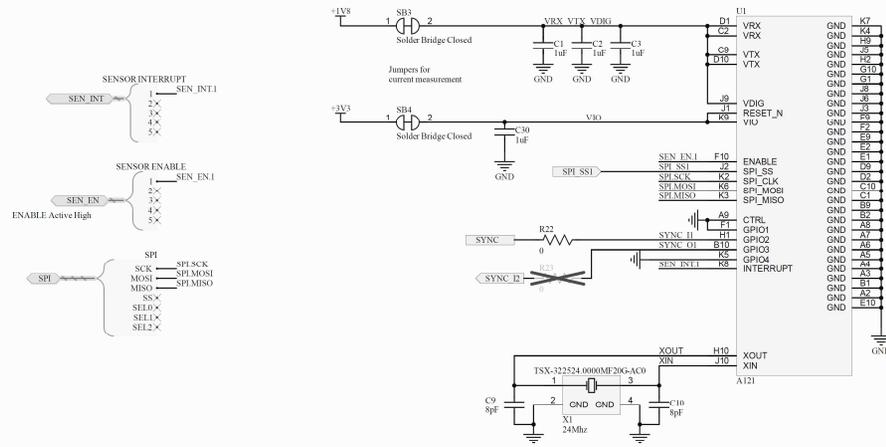
2.3   Electrical Schematics

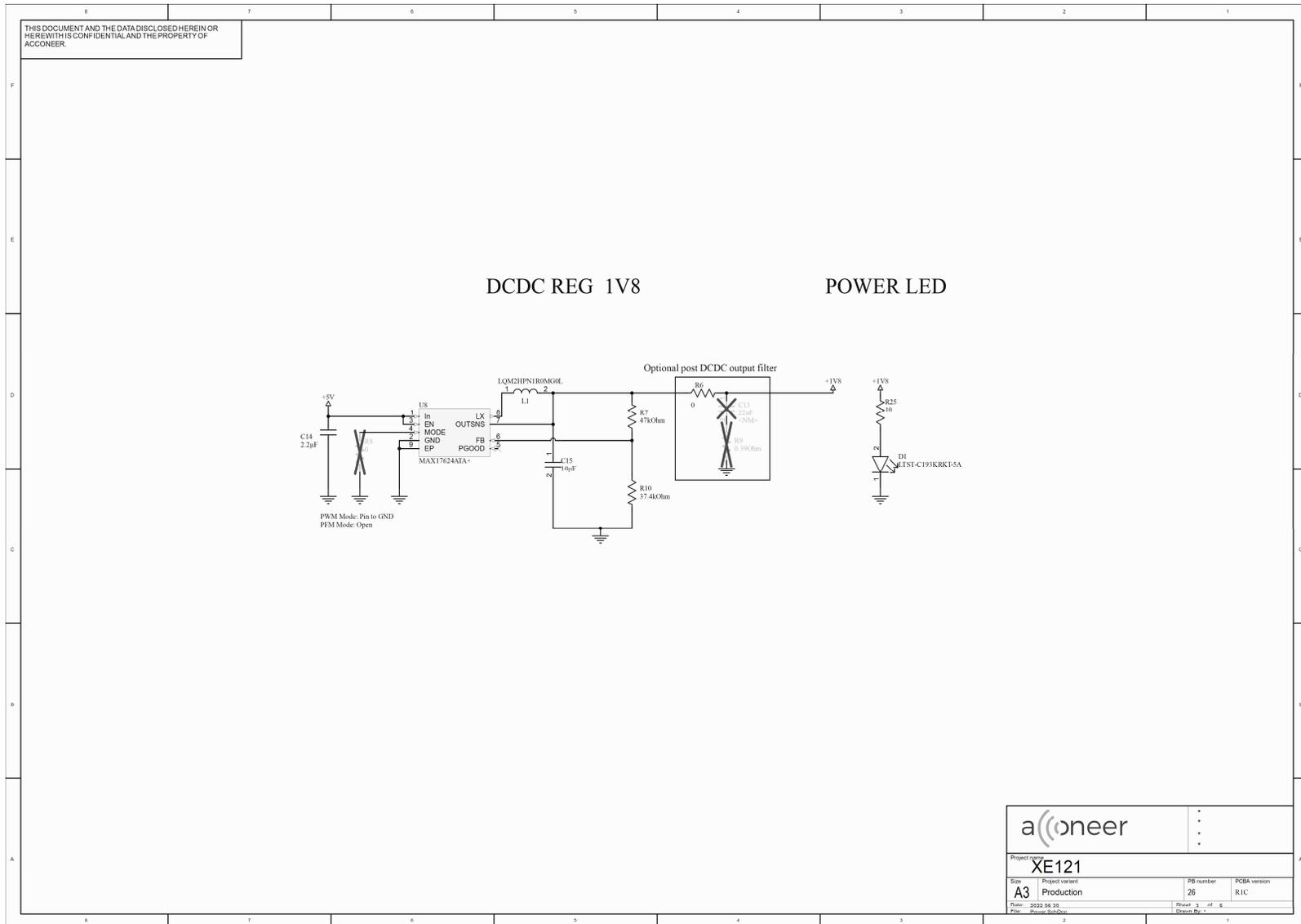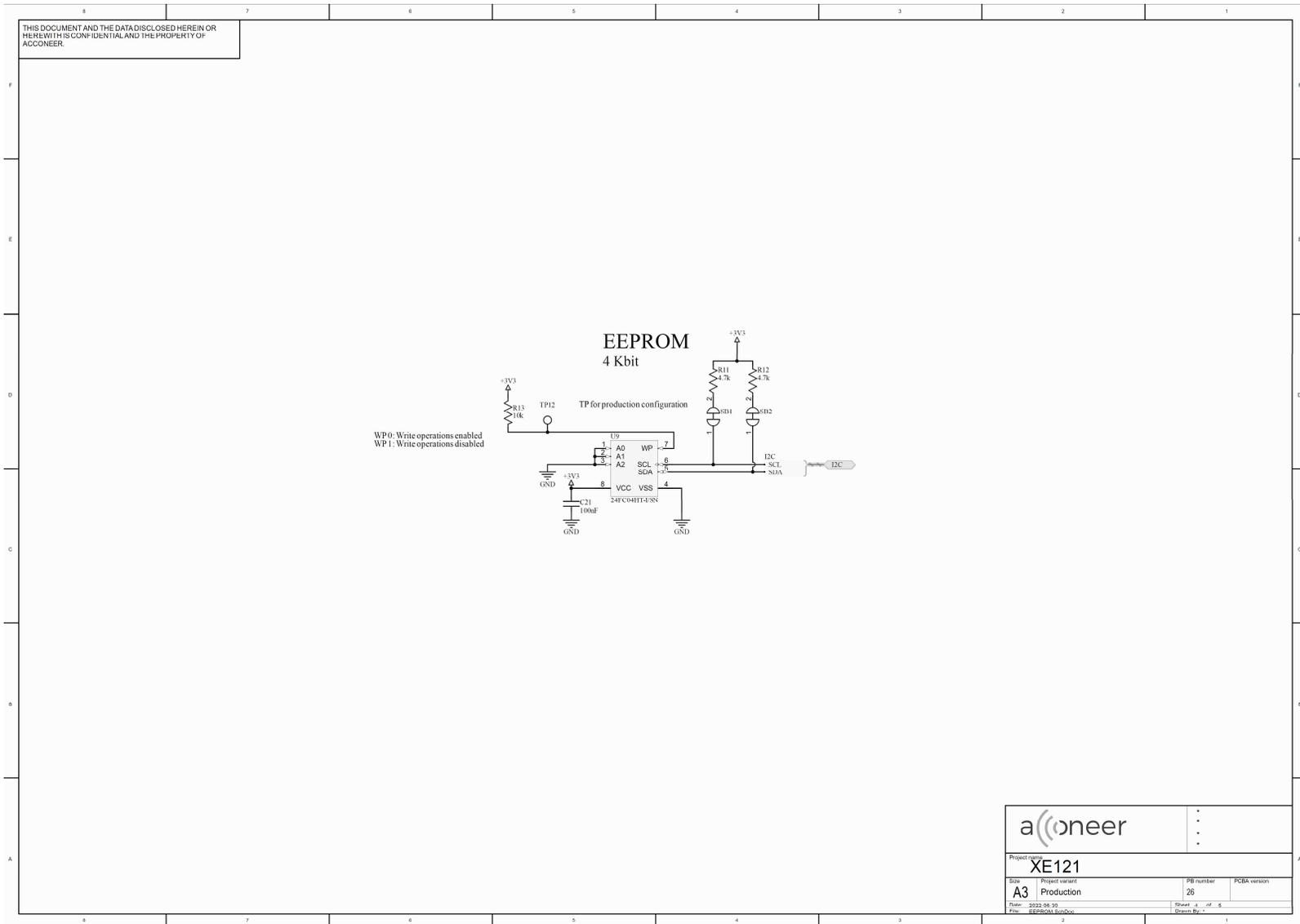On the following pages, please find the electrical schematics for the XE121:

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ST NUCLEO Conn

RBPi Conn

5.84mm contact height (standard)

I2C EEPROM

GND

SYNC

J3
TP1
TP5
TP20
TP23
TP22
TP10
TP7
IOREF
RESET
+3V3
+5V
VIN
GND
TSM-108-01-S-SV

J5
TP29
TP5
TP3
TP8
TP36
TP3
SPI.SEL2
SPI.SEL1
SPI.SEL0
SEN_EN.3
SEN_EN.5
SEN_INT.5
TSM-106-01-S-SV

J2
I2C.SCL
I2C.SDA
SPI.SCK
SPI.MISO
SPI.MOSI
SPI.SS
SYNC
SEN_INT.1
TP13
TP14
TP3
TP15
TP16
TP18
TP19
TP21
TP23
TP25
TSM-110-01-S-SV

J4
SEN_INT.2
SEN_INT.3
SEN_INT.4
SEN_EN.2
SEN_EN.3
SEN_EN.4
TP26
TP27
TP28
TP30
TP32
TP34
TP8
TP9
TSM-108-01-S-SV

J1
+3V3
+5V
I2C.SDA
I2C.SCL
SYNC
SPI.SEL0
SPI.SEL1
SPI.SEL2
SPI.MOSI
SPI.MISO
SPI.SCK
SEN_EN.1
SEN_INT.5
SEN_INT.3
SEN_INT.1
SEN_EN.5
SEN_EN.4
SEN_EN.3
SPI.SS
SEN_INT.4
SEN_INT.2
SEN_EN.2
+3V3
GND
NPTC202KFMS-RC

F1 F2 F3 F4 F5 F6
Fiducial marker   Fiducial marker

SENSOR INTERRUPT
SEN_INT.1
SEN_INT.2
SEN_INT.3
SEN_INT.4
SEN_INT.5
SEN_INT

SPI
SPI.MOSI   MOSI
SPI.MISO   MISO
SPI.SCK   SCK
SPI.SS   SS
SPI.SEL0   SEL0
SPI.SEL1   SEL1
SPI.SEL2   SEL2
SPI

SENSOR ENABLE
SEN_EN.1
SEN_EN.2
SEN_EN.3
SEN_EN.4
SEN_EN.5
SEN_EN

I2C
I2C.SCL   SCL
I2C.SDA   SDA
I2C

Project name
XE121

Size	Project variant	PB number	PCBA version
A3	Production	26	R1C

Date: 2022-06-30   Sheet 1 of 5
File: CONN.SchDoc   Drawn By: *

2022-07-06

On Board Sensor

SENSOR INTERRUPT
SEN_INT — SEN_INT.1

SENSOR ENABLE
SEN_EN — SEN_EN.1
ENABLE Active High

SPI
SCK — SPI.SCK
MOSI — SPI.MOSI
MISO — SPI.MISO
SS
SEL0
SEL1
SEL2

Jumpers for current measurement

Solder Bridge Closed

Testpoints for future modules (NC in XE121)

VIN_MODULE — TP1
SWDIO — TP2
SWDCLK — TP10
NRESET_MODULE — TP38
TP39

Size	Project variant	PB number	PCBA version
A3	Production	26	R1C

Project name: XE121

Date: 2022-06-30
File: A121.SchDoc
Sheet 2 of 6
Drawn By: *

2022-07-06

DCDC REG 1V8

POWER LED

Optional post DCDC output filter

LQM2HPN1R0MG0L
L1

U8
+5V

1	In	LX	8
3	EN	OUTSNS	7
4	MODE		
2	GND	FB	6
9	EP	PGOOD	5

MAX17624ATA+

C14
2.2µF

R7
47kOhm

C15
10µF

R10
37.4kOhm

R6
0

C13
2.2uF
<NM>

R9
0.39Ohm

+1V8

+1V8

R25
10

D1
LTST-C193KRKT-5A

PWM Mode: Pin to GND
PFM Mode: Open

acconeer

Project name
XE121

Size	Project variant		PB number	PCBA version
A3	Production		26	R1C

| Date: | 2022-06-20 | Sheet | 3 | of | 6 |
| File: | Power_SchDoc | Drawn By: | | | |

2022-07-06

EEPROM
4 Kbit

+3V3

R11
4.7k

R12
4.7k

+3V3

R13
10k

TP12

TP for production configuration

SD1

SD2

WP 0: Write operations enabled
WP 1: Write operations disabled

U9

1 A0   WP 7
2 A1
3 A2   SCL 6
        SDA 5

GND

+3V3

8 VCC VSS 4

C21
100nF

24FC04HT-I/SN

GND

I2C
SCL
SDA

I2C

GND

Project name
XE121

Size	Project variant	PB number	PCBA version
A3	Production	26	

Date: 2022-06-20
File: EEPROM.SchDoc
Sheet 4 of 6
Drawn By: -

2022-07-06

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S2

S3

S4

S5

Use with a 100 ohm FFC cable

ACTIVE HIGH / ACTIVE LOW table (SPI SS, SPI SEL, SPI SEL H, SPI SEL 2, SPI EN H, SPI EN 2, SPI EN 3, SPI EN 4, SPI EN 5, SPI SS H, SPI SS 2, SPI SS 3, SPI SS 4, SPI SS 5)

SENSOR INTERRUPT
SEN_INT
SEN_INT.2
SEN_INT.3
SEN_INT.4
SEN_INT.5

SENSOR ENABLE
SEN_EN
SEN_EN.2
SEN_EN.3
SEN_EN.4
SEN_EN.5
ENABLE Active High

SPI
SCK — SPI.SCK
MOSI — SPI.MOSI
MISO — SPI.MISO
SS — SPI.SS
SEL2
SEL1
SEL0

SPI SEL2
SPI SEL1
SPI SEL0

SPLEN5
SPLEN4
SPLEN3
SPLEN2
SPLEN1

SPLEN Active High
Enables the LVDs and SS

SS Active Low

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Project name: XE121

Size	Project variant	PB number	PCBA version
A3	Production	26	R1C

Date: 2022-06-30   Sheet 5 of 5
File: SatelliteConn.SchDoc   Drawn By:

2022-07-06

2.4   Bill of Material

Table 1 shows the BOM for the XE121

Table 1. The BOM for XE121

Designator	Name	Qty	Value	Voltage rating	Tolerance	Manufacturer
C1, C2, C3, C30	Capacitor 1uF, metric 1005	4	1uF	10V	10%	
C7, C8, C11, C12, C21	Capacitor 100nF, metric 1005	5	100nF	10V	10%	
C9, C10	Capacitor 8 pF, metric 1005	2	8pF	10V	1%	
C14	Capacitor 2.2uF, metric 1005	1	2.2µF	10V	10%	
C15	Capacitor 10uF, metric 2012	1	10µF	10V	10%	
C36, C37, C38, C39	Capacitor 10nF, metric 1005	4	10nF	10V	10%	
D1	LTST-C193KRKT-5A	1				Vishay Lite-on
J1	NPTC202KFMS-RC	1				Sullins
J2	TSM-110-01-S-SV	1				Samtec
J3, J4	TSM-108-01-S-SV	2				Samtec
J5	TSM-106-01-S-SV	1				Samtec
J6, J7, J8, J9	503480-2000	4				Molex
L1	LQM2HPN1R0MG0L	1				Murata
R6	Resistor 0 Ohm, metric 2012	1	0 Ohm		1%	
R7	Resistor 47 kOhm, metric 1005	1	47kOhm		1%	
R15, R16, R19, R20, R22	Resistor 0 Ohm, metric 1005	5	0		1%	
R10	Resistor 37.4 kOhm, metric 1005	1	37.4kOhm		1%	
R11, R12	Resistor 4.7 kOhm, metric 1005	2	4.7k		1%	
R13	Resistor 10 kOhm, metric 1005	1	10k		1%	
R25	Resistor 10 Ohm, metric 1005	1	10		1%	
R27, R28, R29, R30	Resistor 100 Ohm, metric 1005	4	100		1%	
U1	A121	1				Acconeer
U2, U4, U5, U6	SN65LVDS049PWR	4				TI
U3	SN74LVC1G04DSFR	1				TI
U7	CD74HC237PWT	1				TI
U8	MAX17624ATA+	1				Maxim
U9	24FC04HT-I/SN	1				Microchip
U10, U11, U12, U13, U14	SN74AHC1G00DRLR	5				TI
X1	TSX-322524.0000MF20G-AC0	1				Epson

2022-07-06

2.5   Pinning

Table 2 shows the pinout of XE121 connectors to XC120 and ST Nucleo development boards:

Table 2. Pinout of XE121 connectors to XC120 and ST Nucleo development boards.

Pin	XC120 (J6)	XE121 (J2)	ST Nucleo	Description
10	I2C1.SCL	I2C.SCL	D15	Used for EEPROM on the XE121
9	I2C1.SDA	I2C.SDA	D14	Used for EEPROM on the XE121
8	NC	NC	AVDD	
7	GND	GND	GND	
6	SPI3.SCK	SPI.SCK.CON	D13	SPI interface for communication with sensor on XE121 and XS121
5	SPI3.MISO	SPI.MISO.CON	D12	SPI interface for communication with sensor on XE121 and XS121
4	SPI3.MOSI	SPI.MOSI.CON	D11	SPI interface for communication with sensor on XE121 and XS121
3	SPI3.SS	SPI.SS	D10	SPI interface for communication with sensor on XE121 and XS121
2	SYNC	SYNC	D9	Signal for sensor synchronization
1	SEN_INT.1	SEN_INT.1	D8	XE121 sensor Interrupt signal
Pin	**XC120 (J7)**	**XE121(J4)**	**ST Nucleo**	**Description**
8	SEN_INT.2	SEN_INT.2	D7	XS121 sensor interrupt signal
7	SEN_INT.3	SEN_INT.3	D6	XS121 sensor interrupt signal
6	SEN_INT.4	SEN_INT.4	D5	XS121 sensor interrupt signal
5	SEN_EN.2	SEN_EN.2	D4	XS121 sensor enable signal
4	SEN_EN.3	SEN_EN.3	D3	XS121 sensor enable signal
3	SEN_EN.4	SEN_EN.4	D2	XS121 sensor enable signal
2	UART4_TX	NC	D1	Not used on XE121
1	UART4_RX	NC	D0	Not used on XE121
Pin	**XC120 (J8)**	**XE121(J3)**	**ST Nucleo**	**Description**
1	NC	NC	NC	Not used on XE121
2	+3V3	NC	IOREF	Not used on XE121
3	PE3	NC	RESET	Not used on XE121
4	+3V3	+3V3	+3V3	
5	+5V	+5V	+5V	
6	GND	GND	GND	
7	GND	GND	GND	
8	VIN	NC	VIN	Not used on XE121
Pin	**XC120 (J9)**	**XE121(J5)**	**ST Nucleo**	**Description**
1	SPI3.SEL2/UART4 CTS	SPI.SEL2	A0	SPI selection for LVDS enable and SPI SS
2	SPI3.SEL1/UART4 RTS	SPI.SEL1	A1	SPI selection for LVDS enable and SPI SS
3	SPI3.SEL0	SPI.SEL0	A2	SPI selection for LVDS enable and SPI SS
4	SEN_EN.1/DUART6 TX	SEN_EN.1	A3	XE121 sensor enable signal
5	SEN_EN.5/DUART6 RX	SEN_EN.5	A4	XS121 sensor enable signal
6	SEN_INT.5	SEN_INT.5	A5	XS121 sensor interrupt signal

Table 3 shows the pinout of XE121 connector to Raspberry Pi:

Table 3. The pinout of XE121 connector to Raspberry Pi.

Pin	XE121	Raspberry Pi	Description
1	+3V3	3V3	
2	+5V	5V Power	
3	I2C.SDA	GPIO 2 (I2C1 SDA)	Used for EEPROM on the XE121
4	+5V	5V Power	
5	I2C.SCL	GPIO 3 (I2C1 SCL)	Used for EEPROM on the XE121
6	GND	GND	
7	SYNC	GPIO 4 (GPCLK0)	Signal for sensor synchronization
8	NC	GPIO 14 (UART TX)	Not used on XE121
9	GND	GND	
10	NC	GPIO 15 (UART RX)	Not used on XE121
11	SPI.SEL0	GPIO 17	SPI selection for LVDS enable and SPI SS
12	NC	GPIO 18 (PCM CLK)	Not used on XE121
13	SPI.SEL1	GPIO 27	SPI selection for LVDS enable and SPI SS
14	GND	GND	
15	SPI.SEL2	GPIO 22	SPI selection for LVDS enable and SPI SS
16	SEN_EN.5	GPIO23	XS121 sensor enable signal
17	+3V3	+3V3	
18	SEN_EN.4	GPIO 24	XS121 sensor enable signal
19	SPI.MOSI.CON	GPIO 10 (SPI0 MOSI)	SPI interface for communication with sensor on XE121 and XS121
20	GND	GND	
21	SPI.MISO.CON	GPIO 9 (SPI0 MISO)	SPI interface for communication with sensor on XE121 and XS121
22	SEN_EN.3	GPIO 25	XS121 sensor enable signal
23	SPI.SCK.CON	GPIO 11 (SPI0 SCK)	SPI interface for communication with sensor on XE121 and XS121
24	SPI.SS	GPIO 8 (SPI0 CE0)	SPI interface for communication with sensor on XE121 and XS121
25	GND	GND	
26	NC	GPIO 7 (SPIO0 CE1)	Not used on XE121
27	NC	GPIO 0 (EEPROM SDA)	Not used on XE121
28	NC	GPIO1 (EEPROM SCL)	Not used on XE121
29	SEN_EN.1	GPIO 5	XE121 sensor enable signal
30	GND	GND	
31	SEN_INT.5	GPIO 6	XS121 sensor interrupt signal
32	SEN_INT.4	GPIO 12 (PWM0)	XS121 sensor interrupt signal
33	SEN_INT.3	GPIO 13 (PWM1)	XS121 sensor interrupt signal
34	GND	GND	
35	NC	GPIO 19 (PCM FS)	Not used on XE121
36	SEN_INT.2	GPIO 16	XS121 sensor interrupt signal
37	SEN_INT.1	GPIO 26	XE121 sensor Interrupt signal
38	SEN_EN.2	GPIO 20 (PCM DIN)	XS121 sensor enable signal
39	GND	GND	
40	NC	GPIO 21 (PCM DOUT)	Not used on XE121

3. Revision History

Date	Version	Changes
2022-07-06	1.0	Original Version

2022-07-06

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