Entry+ module EVK hardware user guide

- XE123/124

Entry+ module EVK hardware user guide
- XE123/124

Author: Acconeer

Version 1.1: 2022-10-18

Acconeer AB

Table of Contents

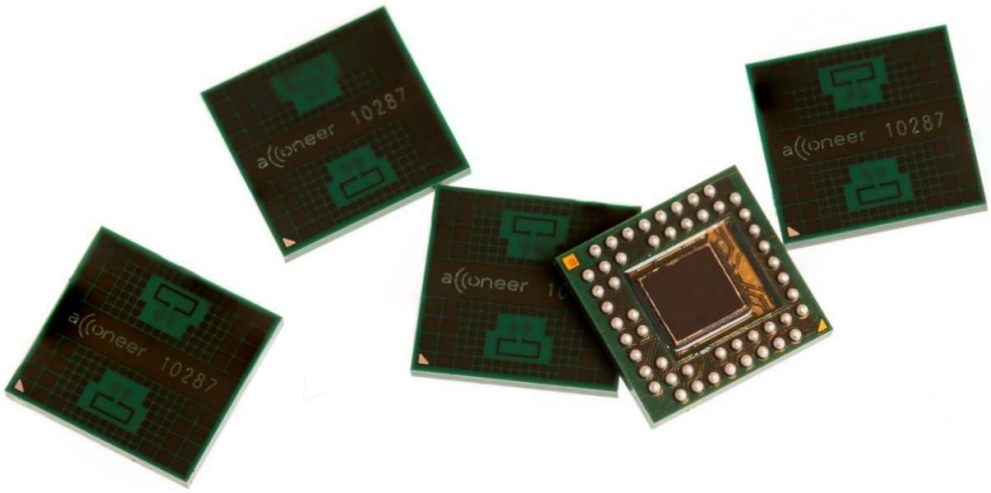
1. Overview of the XE123/124 Entry+ Module Evaluation Kit

1.1. Introduction

The XE123/124 Entry+ Module Evaluation Kit (The EVK) is a development platform targeting straight-forward use cases where small size, low cost and low power is key.

The EVK features Acconeer's XM123 or XM124 Entry+ module, including the A111 radar sensor. The A111 radar sensor is an optimized low-power, high-precision 60 GHz radar with antenna in package (AiP) and integrated baseband. Together with the ARM® Cortex®-M4 STM32L431 MCU, the XM123/124 Entry module becomes a cost- and size-optimized low-power radar sensor.

The A111 is based on pulsed coherent radar technology (PCR). It has leading-edge patented sensor technology with pico-second time resolution. The A111 sets a new benchmark as far as power consumption and distance accuracy are concerned and it comes fully integrated in a small package of 29 mm^2.



The A111 can measure absolute distance with mm accuracy up to a range of 2 m with a continuous sweep update frequency of up to 600 Hz. With the use of a dielectric lens the range can be significantly longer.

The A111, 60 GHz radar is not compromised by natural sources of interference such as noise, dust, color, direct or indirect light.

The EVK consists of:

- 1 XE123/124 Evaluation board with an XM123 or XM124 Entry module soldered onto it.

The XE123/124 is compatible with Acconeer LH132 lens kit (LH132 is also compatible with evaluation kit XE132). LH132 is sold separately.

1.2. Getting Started

A Quick Installation Guide is available at https://youtu.be/PTcQ0FpRz7E

This short instruction video will ensure a smooth setup and installation. As an alternative you can also find a guide in pdf-format at https://developer.acconeer.com.

2. Software for the EVK

2.1. SW download

The SW is available for download at https://developer.acconeer.com. Here you will find both a Software Development Kit and a Module Server version. SW User Guides can be downloaded at the same site.

2.2. SW API Description

The Acconeer SW comes with an API (Application Programming Interface). Acconeer provides several service-oriented example and reference applications, as well as customer guidelines for application development when utilizing the API. All APIs provided by Acconeer are documented.

Unzip the SW zip file downloaded from Acconeer's download site. In the file structure, please locate /doc folder from where API documentation in HTML format is found at doc/html/index.html.

3. The EVK Hardware

In Figure 1 the block-diagram of the XE123/124 is shown. Figure 2 shows the XM123/124 block-diagram.

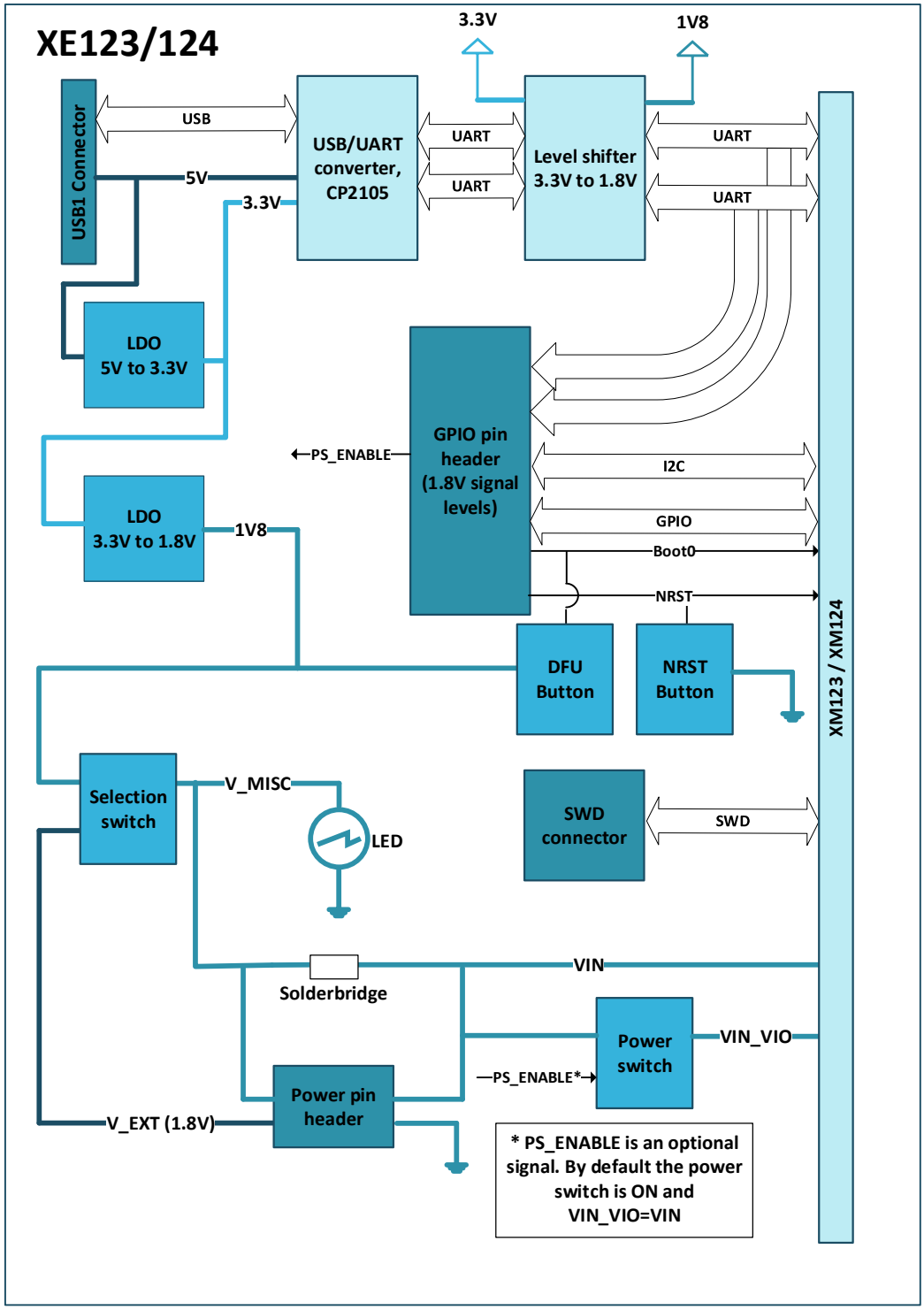


Figure 1 The block-diagram of the XE123/124.

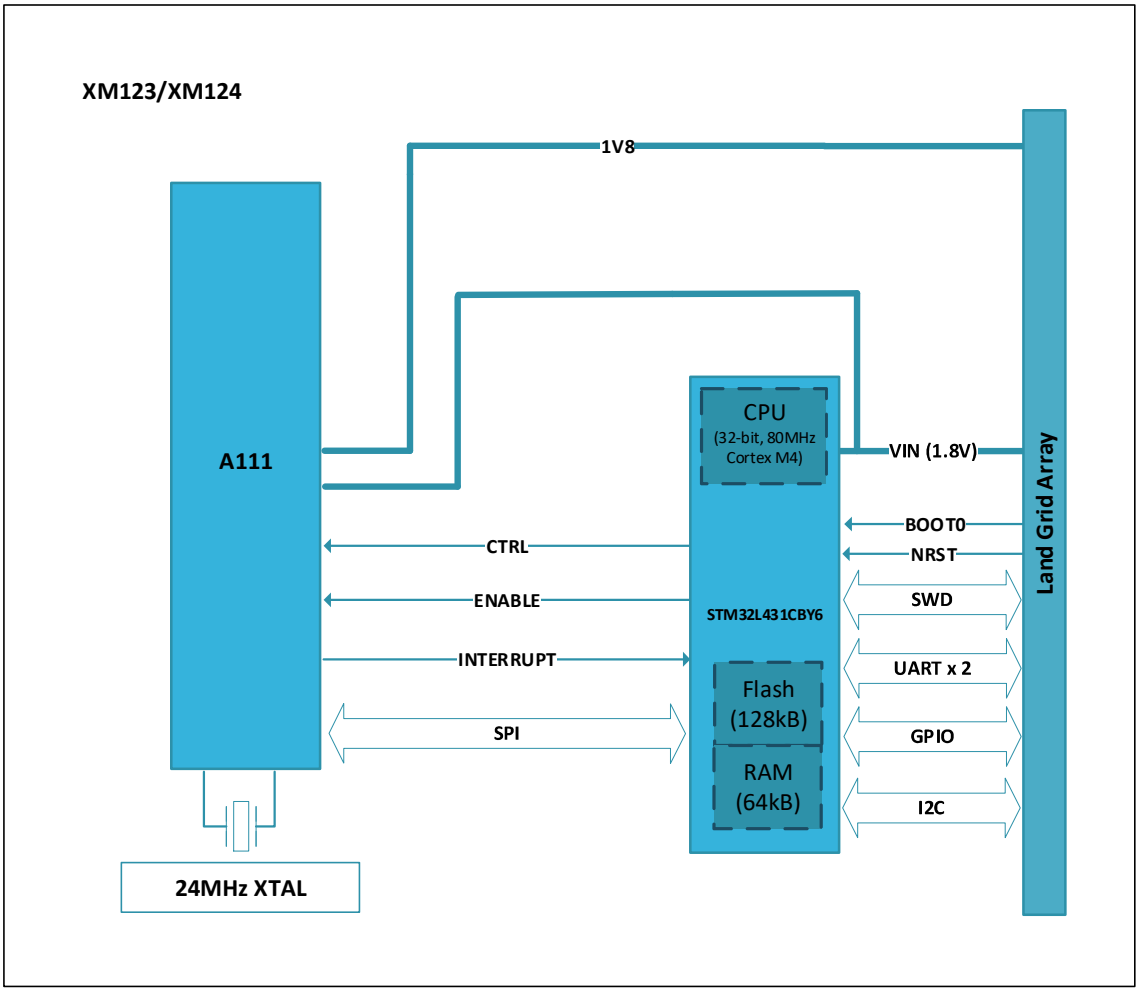
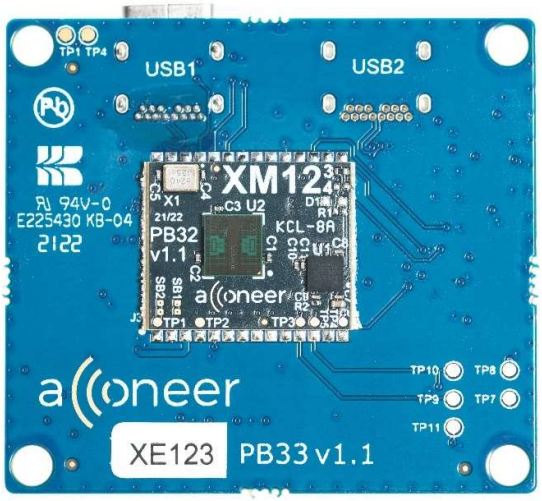


Figure 2. The block-diagram of XM123/124.

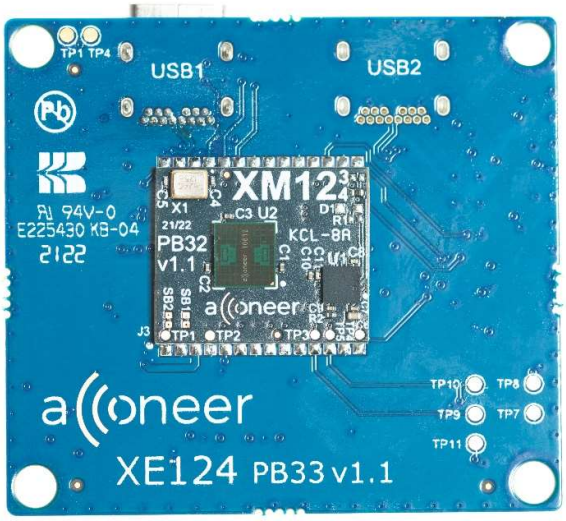
3.1. XE123/124 Evaluation Board

3.1.1. Overview

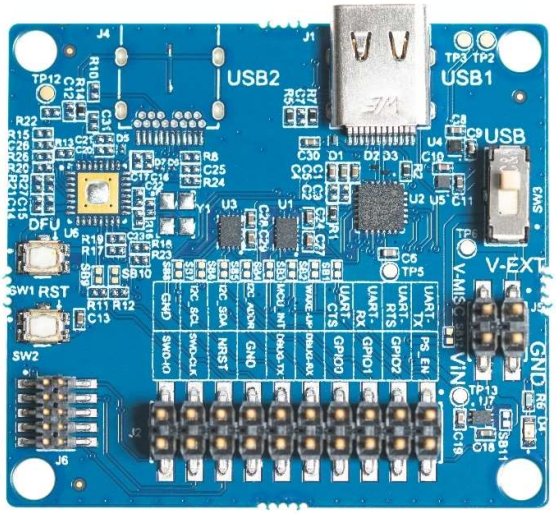
The XE123/124 is an evaluation board including the XM123 or XM124 Entry+ module. It makes the interfaces from the XM123/124 module accessible for evaluation and debug. It also enables flashing of the XM123/124 via USB-UART or SW-DP. The XM123/124 Entry module is included in the XE123/124 Evaluation board. In Picture 1 and Picture 2 you will find the XE123 and XE124 front sides where the XM123 and XM124 is mounted. Picture 3 shows the back side of XE123/XE124.



Picture 1. The XE123 top side where XM123 is mounted.



Picture 2. The XE124 front side with XM124 mounted.



Picture 3. The XE123/XE124 back side.

3.1.2. Power

In the text below, the reference designators refer to the Electrical Schematic of XE123/XE124 in chapter 3.1.4.

The XE123/124 is powered via the USB connector J1 and/or via the pin header J5. The USB 5V power domain supplies the USB-UART chip (U2). If the USB-UART interface is not used, a dedicated USB charger can be used.

The XM123/XM124 module mounted on the XE123/124 can be powered either from a 1.8V LDO (U5) which is supplied from the USB 5V power domain or from “V_EXT” in the J5 pin header. V_EXT should be 1.8V.

The power source for XM123/XM124 is determined by the setting of the switch “SW3”. When the LED D4 on the XE123/124 is lit, the XM123/XM124 is powered

It should be noted that regardless of if “V_EXT” or “1.8V” is used to power XM123/XM124, the LED D4 will consume power since it is connected to “V_MISC”. If one wants to measure only the current consumed by XM123/XM124, power should be supplied to XE123/124 via the pin “VIN” (pin 4 in pin header J5). In this case, the solder-bridge “SB12” should be cut. This way, all components on XE123/XE124 are supplied from the 1.8V LDO, but XM123/XM124 is supplied from the external power supply. D4 will not indicate if XM123/XM124 is powered after SB12 has been cut.

The intention of the power pin header J5 is that it can be used both for supplying power to XM123/XM124 and for measuring current over a measurement resistor. SB12 is a short-circuited solder-bridge, but the customer can change it to a low-value measurement resistor with high accuracy to perform very accurate measurements of the XM123/XM124 current. See Table 2 for the pin assignment of pin header J5.

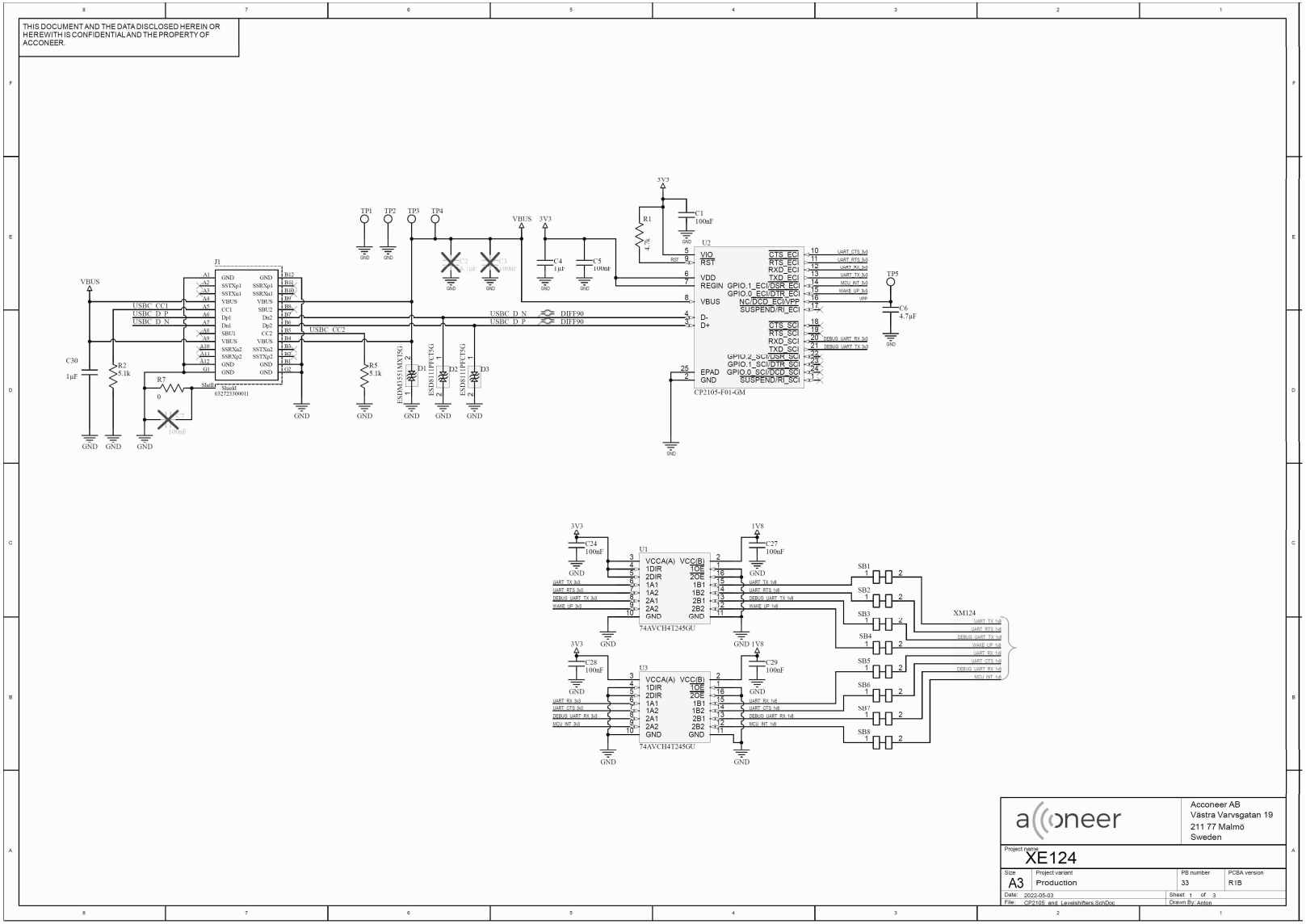
To minimize the current consumption of the XM123/XM124 module, the voltage to “1V8” (VIN_VIO) can be turned off when the A111 radar sensor is disabled (ENABLE=0). To do this, the power switch U7 must be controlled by a GPIO of your choice from XM123/XM124. If a GPIO on pin header J2 is connected to the signal “PS_EN” (PIN 2 on J2), and solder bridge “SB11” is cut, the power switch ON/OFF state is controlled by this GPIO. The SW to do this is not provided by Acconeer and must be implemented by the customer. By default, the power switch U7 is always on.

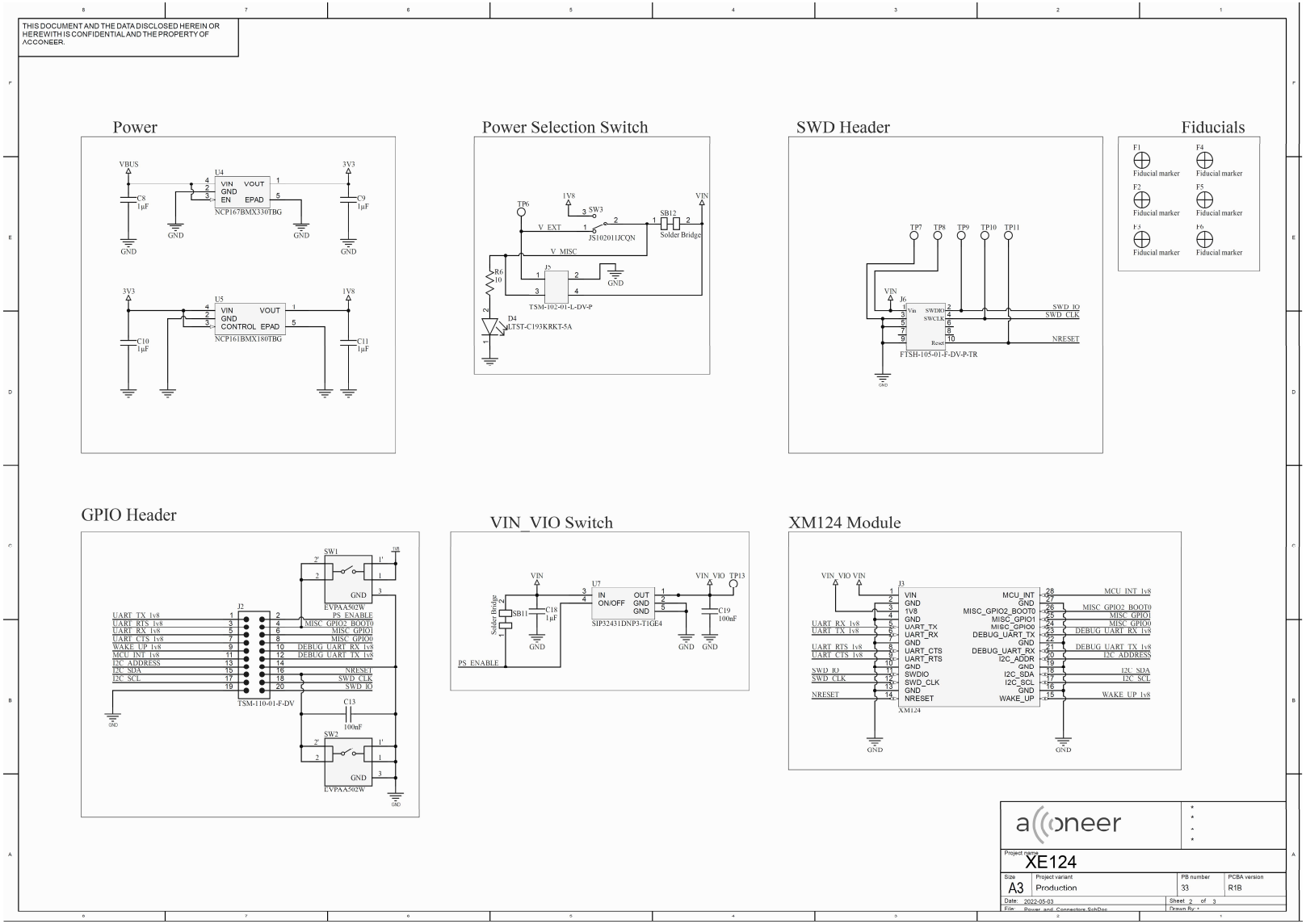
3.1.3. Not Mounted Components

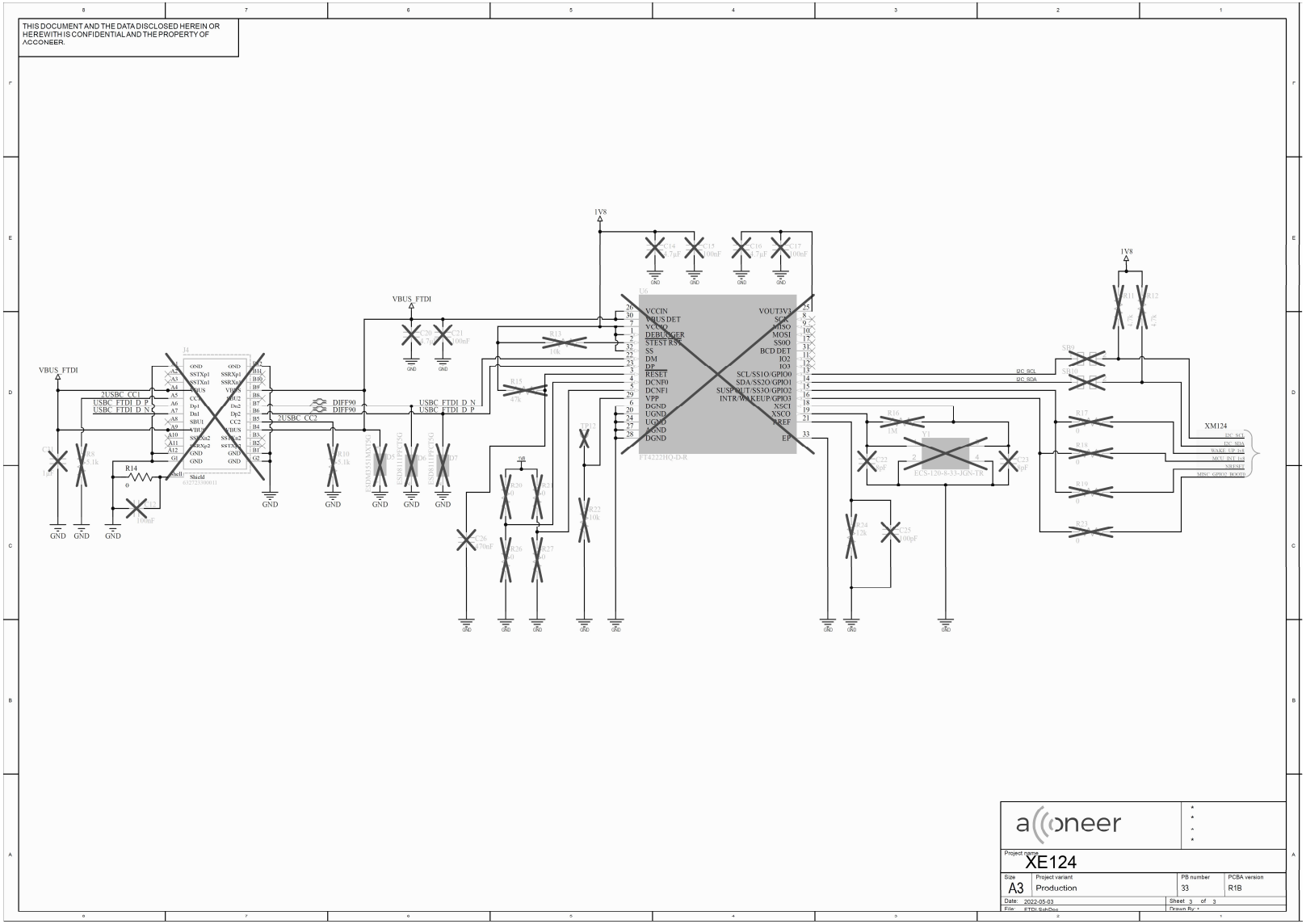
As can be seen in the schematic in chapter 3.1.4, USB connector J4 and several other components are “No Mount”. These components are related to the FTDI I2C-USB bridge chip FT4222H which can be mounted on the PCB. It was added for internal Acconeer use, but customers are of course free to mount these components if they wish. The I2C interface is also accessible in pin header J2. Refer to Table 4.

3.1.4. Electrical Schematics

On the following pages, please find the Electrical Schematics for XE123/124:







3.1.5. Bill of Material

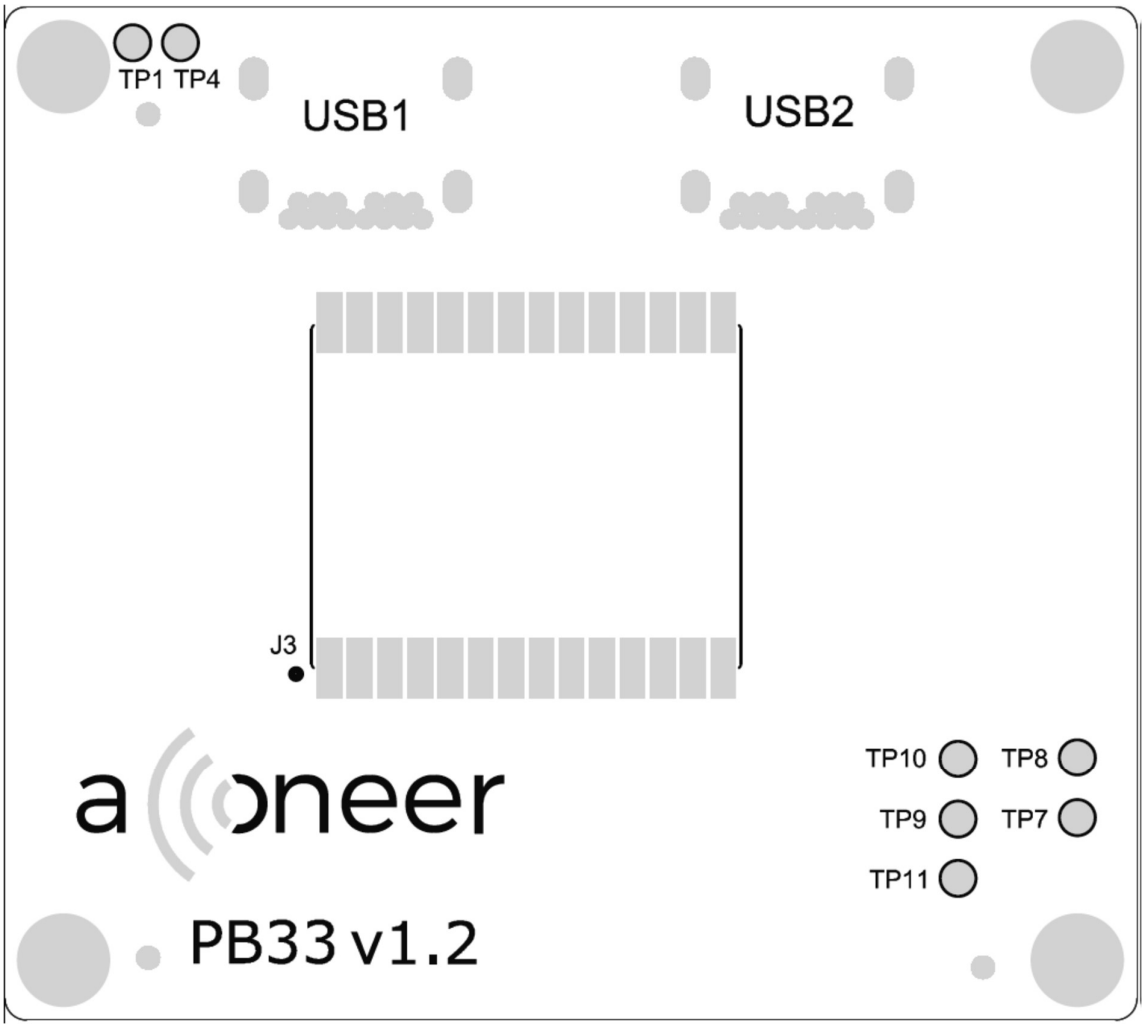
Table 1 shows the BOM for the XE123/124

Table 1 The BOM for the XE123/124.

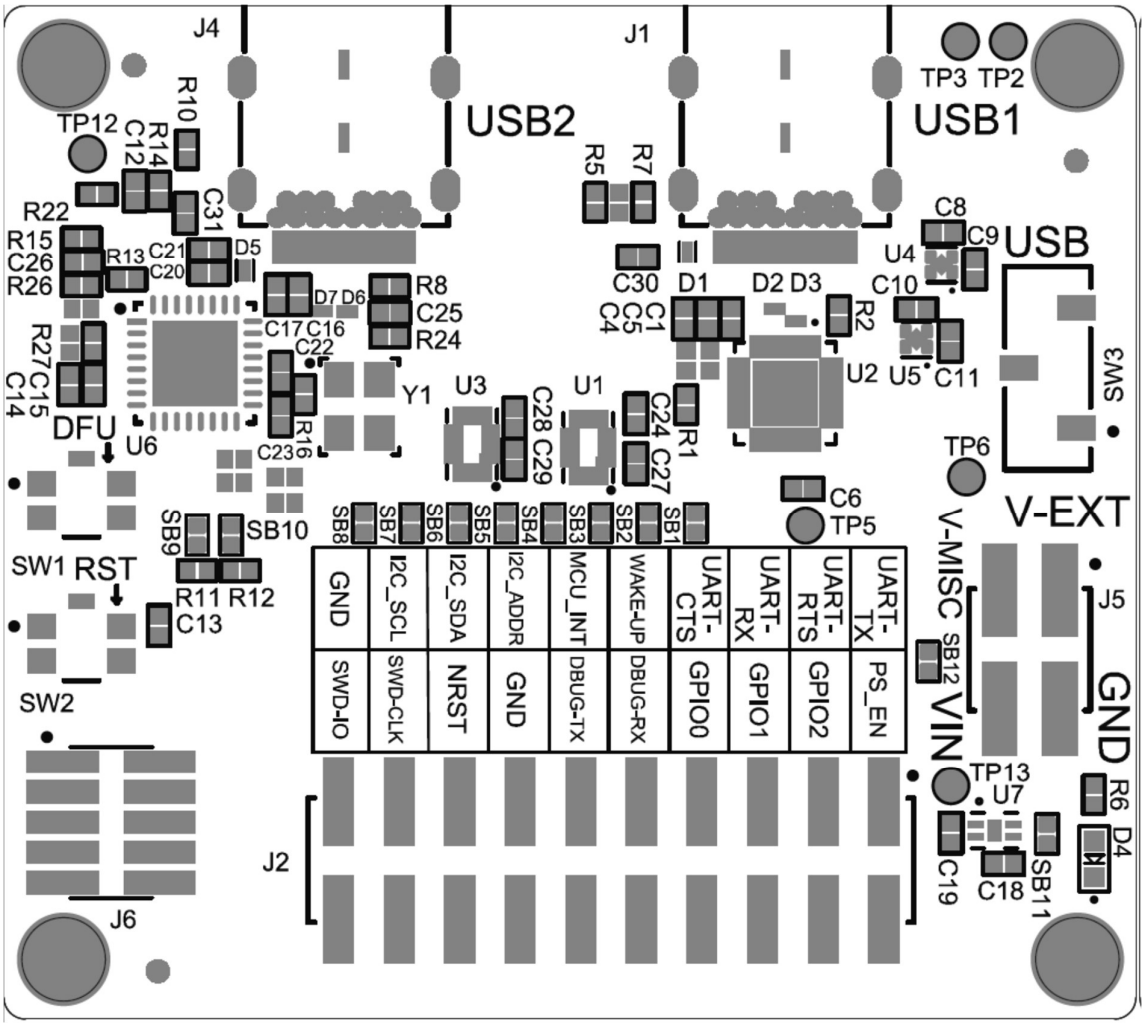
Designator	Name	Qty	Value	Tolerance	Voltage rating	Manufacturer
C4, C8, C9, C10, C11, C18, C30	Capacitor 1uF, metric 1005	7	1µF	20%	10V	
C6	Capacitor 4.7uF, metric 1005	1	4.7µF	20%	10V	
C1, C5, C13, C19, C24, C27, C28, C29	Capacitor 100nF, metric 1005	8	100nF	20%	10V	
R7, R14	Resistor 0 Ohm, metric 1005	2	0	1%		
R1	Resistor 4.7 kOhm, metric 1005	1	4.7k	1%		
R2, R5	Resistor 5.1 KOhm, metric 1005	2	5.1k	1%		
R6	Resistor 10 Ohm, metric 1005	1	10	1%		
U1, U3	74AVCH4T245GU	2				NXP Semiconductors
J1	632723300011	1				Wurth Electronics
U2	CP2105-F01-GM	1				Silicon Labs
D2, D3	ESD8111PFCT5G	2				ON Semiconductor
D1	ESDM3551MXT5G	1				ON Semiconductor
SW1, SW2	EVPAA502W	2				Panasonic
J6	FTSH-105-01-F-DV-P-TR	1				Samtec
SW3	JS102011JCQN	1				ITT C&K
D4	LTST-C193KRKT-5A	1				Vishay Lite-On
U5	NCP161BMX180TBG	1				ON Semiconductor
U4	NCP167BMX330TBG	1				ON Semiconductor
U7	SIP32431DNP3-T1GE4	1				Vishay Siliconix
J5	TSM-102-01-L-DV-P	1				Samtec
J2	TSM-110-01-F-DV	1				Samtec
J3	XM124 or XM123	1				

3.1.6. Component Placement Drawing

In Picture 4 and Picture 5 the component placement drawing of XE123/XE124, top and bottom side, are found:



Picture 4. The component placement of XE123/XE124 top side.



Picture 5. The component placement of XE123/XE124 bottom side.

3.1.7. Connectors

3.1.7.1. Power pin header (J5)

The power pin header J5 provides the possibility to supply the XM123/XM124 module with power from an external power supply. In Table 2, the pin assignment of J5 is shown:

Table 2. The pin assignment of the power pin header J5.

Pin Number	Signal	Pin Number	Signal
1	V_EXT	2	GND
3	V_MISC	4	VIN

3.1.7.2. 2x5 JTAG/SWD pin header (J6)

The 2x5 JTAG/SWD pin header (1.27mm pitch) contains the signals needed for flashing the XM123/XM124 MCU via the SWD interface. The pinout matches that of the Cortex 10-pin JTAG/SWD Connector and is found in Table 3.

Table 3. The pinout of J6.

Pin Number	Signal	Pin Number	Signal
1	VIN	2	SWD_IO
3	GND	4	SWD_CLK
5	GND	6	NC (no TRACESWO available)
7	NC	8	NC
9	GND	10	NRESET

3.1.7.3. 2x10 pin header (J2)

The 2x10 pin header (2.54mm pitch) contains miscellaneous GPIOs from the XM123/XM124. The pinout is found in Table 4.

Table 4. The pinout of J2.

Pin Number	Signal	Pin Number	Signal
1	UART_TX_1V8[1]	2	PS_ENABLE
3	UART_RTS_1V8[2]	4	MISC_GPIO2_BOOT0
5	UART_RX_1V8[3]	6	MISC_GPIO1
7	UART_CTS_1V8[4]	8	MISC_GPIO0
9	WAKE_UP_1V8	10	DEBUG_UART_RX_1V8[3]
11	MCU_INT_1V8	12	DEBUG_UART_TX_1V8[1]
13	I2C_ADDRESS	14	GND
15	I2C_SDA	16	NRESET
17	I2C_SCL	18	SWD_CLK
19	GND	20	SWD_IO

3.1.7.4. Switches and buttons

There is one switch on XE123/124. SW3 determines if XM123/XM124 is powered from the 1.8V LDO (U5) on XE123/124 or from an external power supply via pin header J5 (V_EXT).

[1] This signal is connected to RX on XM123/XM124. If external UART device is connected, this pin should be connected to TX of external device.
[2] This signal is connected to CTS on XM123/XM124. If external UART device is connected, this pin should be connected to RTS of external device.
[3] This signal is connected to TX on XM123/XM124. If external UART device is connected, this pin should be connected to RX of external device.
[4] This signal is connected to RTS on XM123/XM124. If external UART device is connected, this pin should be connected to CTS of external device.

There are two buttons on the XE124. SW1 controls the signal “BOOT0” connected to XM124 and SW2 controls “NRESET” connected to the XM124. In Table 5 the state of the buttons and the corresponding signal states are listed.

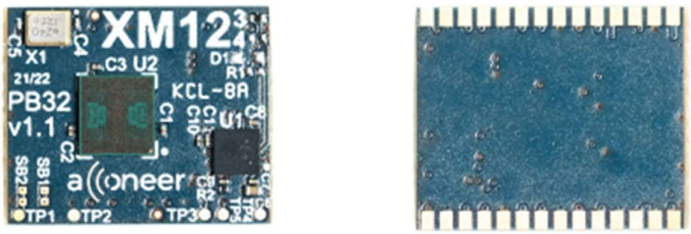
Table 5. The states of the buttons SW1 and SW2.

Button	Open (default)	Closed
SW1	BOOT0=0	BOOT0=1
SW2	NRST=1	NRST=0

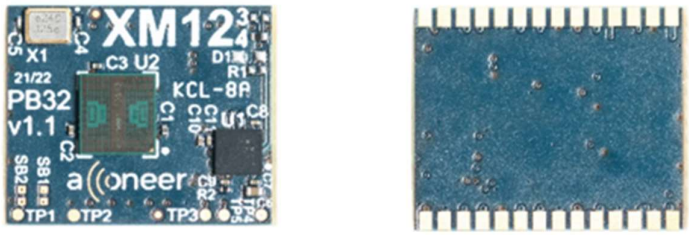
3.2. XM123/XM124 Entry Module

3.2.1. Overview

The XM123 or XM124 Entry Module is included in the XE123/124 design and soldered on the top side of the XE123/XE124 via a Land Grid Array pattern on the bottom side of the PCB. In Picture 6 below the top and bottom side of XM123 is shown. In Picture 7 the top and bottom side of XM124 is shown.



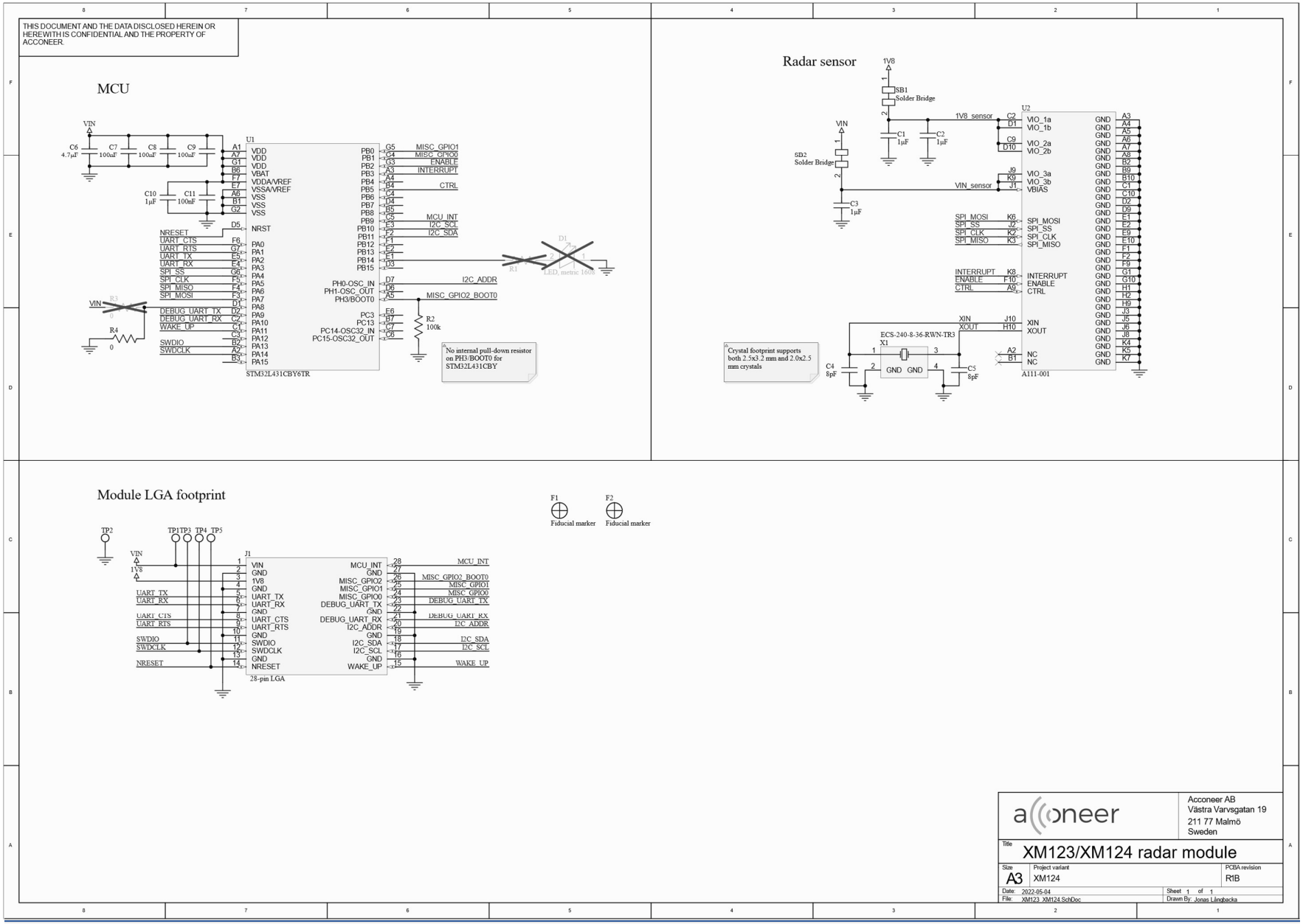
Picture 6. The top and bottom side of XM123.



Picture 7. The top and bottom side of XM124.

Electrical Schemaics

On the following pages, please find the Electrical Schematics for XM123/XM124:



3.2.2. Bill of Material

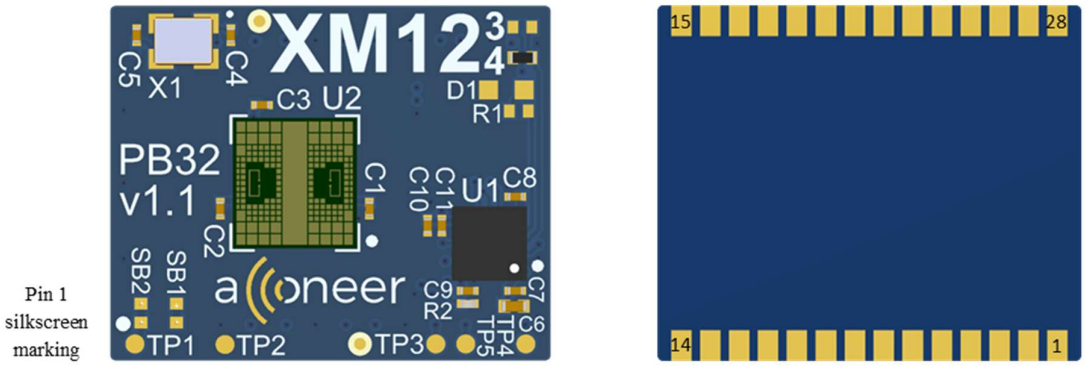
Table 6 shows the BOM for the XM123/XM124.

Table 6. The BOM For XM123/XM124.

Designator	Name	Qty	Value	Comment
C1, C2, C3, C10	Capacitor 1 uF, metric 0603	4	1 µF	
C4, C5	Capacitor 8 pF, metric 0603	2	8 pF	
C6	Capacitor 4.7uF, metric 1005	1	4.7 µF	
C7, C8, C9, C11	Capacitor 100nF, metric 1005	4	100 nF	
R2	Resistor 100 kOhm, metric 0603	1	100 kOhm	
R4	Resistor 0 Ohm, metric 1005	1	0 Ohm	
U1	MCU STM32L431CBY6 32-bit WLCSP49	1		ST Microelectronics: STM32L431CBY6
U2	Radar Sensor 60 GHz A111	1		Acconeer AB: A111
X1	Crystal 24MHz 9 pF 4-Pin SMD	1	24 MHz	ECS-240-8-36-RWN-TR3

3.2.3. Land Grid Array

Picture 8 shows the XM123/XM124 module front and back side pin markings. Table 7 shows the module pinout.



Picture 8. The pin marking of XM123/XM124.

Table 7. XM123/XM124 LGA pinout.

Pin Number	Signal	Comment
1	VIN	1.8 V input voltage
2	Ground	
3	1V8	1.8 V input voltage
4	Ground	

5	UART_TX	Connect to UART_RX on host side. Leave Not Connected if unused.
6	UART_RX	Connect to UART_TX on host side. Leave Not Connected if unused.
7	Ground	
8	UART_CTS	Connect to UART_RTS on host side. Leave Not Connected if unused.
9	UART_RTS	Connect to UART_CTS on host side. Leave Not Connected if unused.
10	Ground	
11	SWD_IO	Leave Not Connected if unused.
12	SWD_CLK	Leave Not Connected if unused.
13	Ground	
14	NRESET	Reset. Leave Not Connected if unused.
15	WAKE_UP	Could be used by host to wake up XM123/XM124 MCU. Leave Not Connected if unused.
16	Ground	
17	I2C_SCL	Leave Not Connected if unused.
18	I2C_SDA	Leave Not Connected if unused.
19	Ground	
20	I2C_ADDRESS	For configuration of I2C address. Leave Not Connected if unused.
21	DEBUG_UART_RX	Connect to UART_TX on host side. Leave Not Connected if unused.
22	Ground	
23	DEBUG_UART_TX	Connect to UART_RX on host side. Leave Not Connected if unused.
24	MISC_GPIO0	Leave Not Connected if unused.
25	MISC_GPIO1	Leave Not Connected if unused.
26	MISC_GPIO2_BOOT0	Pulling BOOT0 high during boot of module will start the embedded boot loader. Leave Not Connected if unused.
27	Ground	
28	MCU_INT	Could be used to send interrupt from MCU to host. Leave Not Connected if unused.

4. Safety

4.1. Electrostatic precautions

Please take electrostatic precautions, including using ground straps, when using the EVK or any of its components. An electrostatic discharge could damage the device.

5. Regulatory Information

For regulatory compliance of XM123/XM124, refer to XM123/XM124 datasheet:

https://developer.acconeer.com.

Independent of XM123/XM124 regulatory status it is the user's responsibility to ensure that any regulatory requirements, applicable to any region, are followed in the region the device is being used.

Regulatory Compliance for A111, refer to A111 datasheet:

https://developer.acconeer.com/download/a111-datasheet-pdf/

Independent of A111 regulatory status it is the user's responsibility to ensure that any regulatory requirements, applicable to any region, are followed in the region the device is being used.

6. Revision History

Date	Revision	Changes
2022-07-06	1.0	Original version

7. Disclaimer

The information herein is believed to be correct as of the date issued. Acconeer AB ("**Acconeer**") will not be responsible for damages of any nature resulting from the use or reliance upon the information contained herein. Acconeer makes no warranties, expressed or implied, of merchantability or fitness for a particular purpose or course of performance or usage of trade. Therefore, it is the user's responsibility to thoroughly test the product in their particular application to determine its performance, efficacy and safety. Users should obtain the latest relevant information before placing orders.

Unless Acconeer has explicitly designated an individual Acconeer product as meeting the requirement of a particular industry standard, Acconeer is not responsible for any failure to meet such industry standard requirements.

Unless explicitly stated herein this document Acconeer has not performed any regulatory conformity test. It is the user's responsibility to assure that necessary regulatory conditions are met and approvals have been obtained when using the product. Regardless of whether the product has passed any conformity test, this document does not constitute any regulatory approval of the user's product or application using Acconeer's product.

Nothing contained herein is to be considered as permission or a recommendation to infringe any patent or any other intellectual property right. No license, express or implied, to any intellectual property right is granted by Acconeer herein.

Acconeer reserves the right to at any time correct, change, amend, enhance, modify, and improve this document and/or Acconeer products without notice.

This document supersedes and replaces all information supplied prior to the publication hereof.

Acconeer AB
Västra Varvsgatan 19
211 77 Malmö
Sweden

www.acconeer.com
info@acconeer.com
+46 10 218 92 00