HP module EVK hardware user guide

- XM112, XB112, LH112

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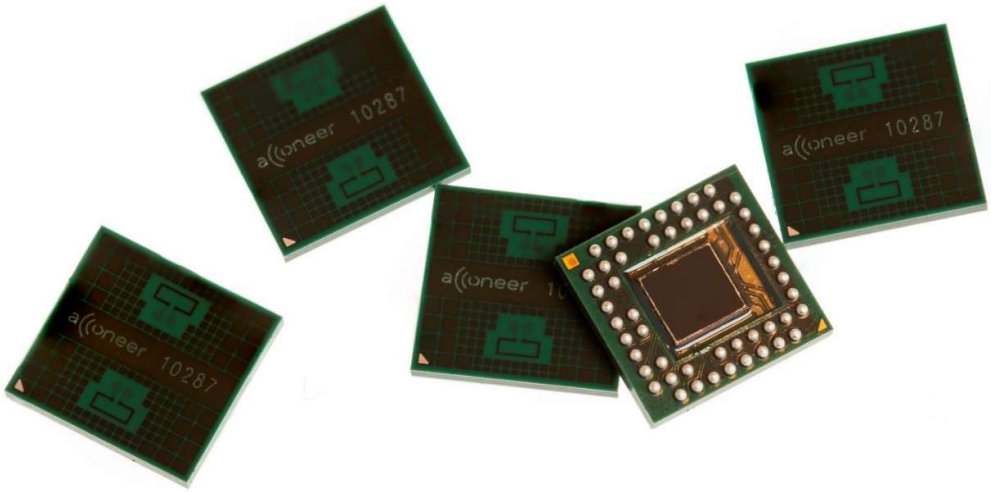
Acconeer AB

Table of Contents

1 Overview of the HP module EVK.

1.1 Introduction

The HP Module Evaluation Kit (The EVK) is a platform for evaluating the HP Module. The module is based on the Acconeer A111 sensor, which is an optimized low-power, high-precision 60 GHz radar in one package solution with integrated Baseband, RF front-end and Antenna. In the HP Module The A111 sensor is integrated together with an M7 processor (Atmel SAME70) which facilitates signal processing for advanced use cases. For an introduction to Acconeer's technology and product offer refer to "Introduction to Acconeer's sensor technology", available at the Acconeer website.



The EVK consists of

- One HP Module featuring A111 and an Atmel SAME70 MCU. The module is not pre-flashed and an XB112 is needed to easily flash it.
- One XB112 breakout board which enables connection to external devices.
- LH112

2 Software for the Module EVK

2.1 Software download

All software is available for download at https://www.acconeer.com/products, more details about the software offer and structure can be found in the document “Introduction to Acconeer’s sensor technology”, available at the Acconeer website.

For the HP Module Acconeer provides two deliveries, a software development kit (SDK) for ATMEL SAME70 and a module software image for XM112. Details about the software offer can be found in the document “Introduction to Acconeer’s sensor technology”, available at the Acconeer website.

2.2 Module software for XM112

The HP Module software enable register-based access to radar functionality from external devices connected to the HP Module. The module software is delivered as an image.

Typical usages of the HP Module software are:

1. Integration of radar functionality in your product to decrease development cost and time to market.
2. Module evaluation and algorithm development in Python together with the “Acconeer Python Exploration Tool” that is available for download on GitHub. https://github.com/acconeer/

The HP Module software provides a rich register-based API that can be accessed over UART, SPI and I2C[1].

The Module software will initially support the following services and detectors:

- Power Bin Service
- Envelope Service
- IQ Data Service
- Distance peak detector with fixed threshold

Support for more detectors is planned for future module software releases.

2.3 SDK for ATMEL SAME70

For users that wish to use the module MCU to implement their own applications and other SW components we also provide an SDK.

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

[1] The I2C support is planned but is not available at the time of writing.

3 The HP Module EVK Hardware

Figure 1 shows the block diagram for the HP Module Evaluation Kit

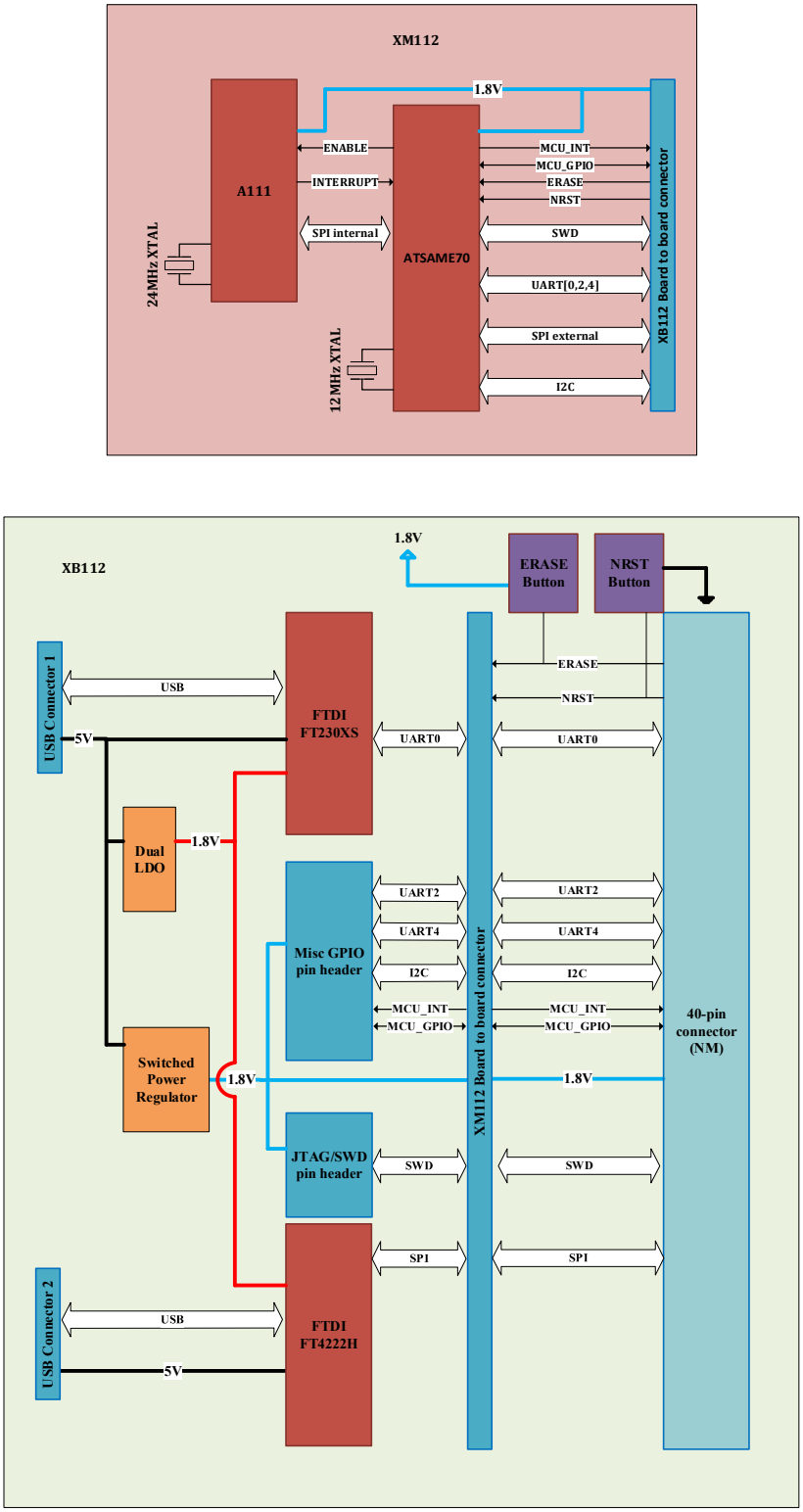


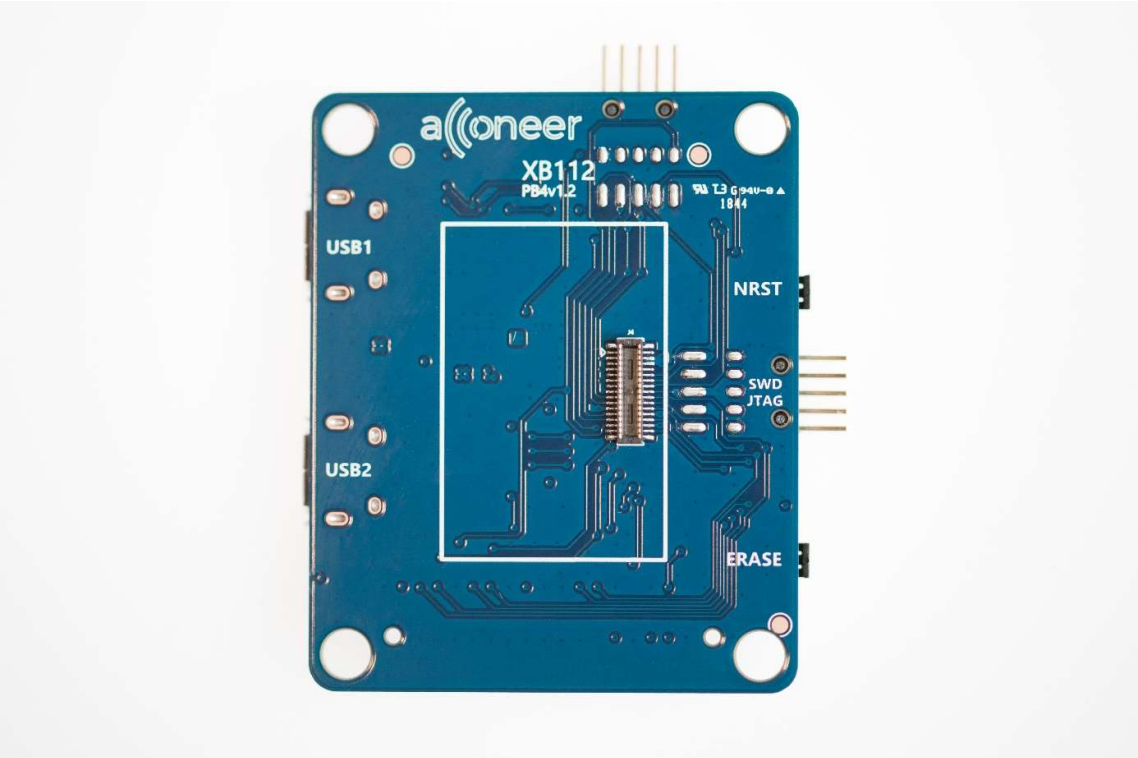
Figure 1 The EVK block diagram.

3.1 XB112 Breakout Board

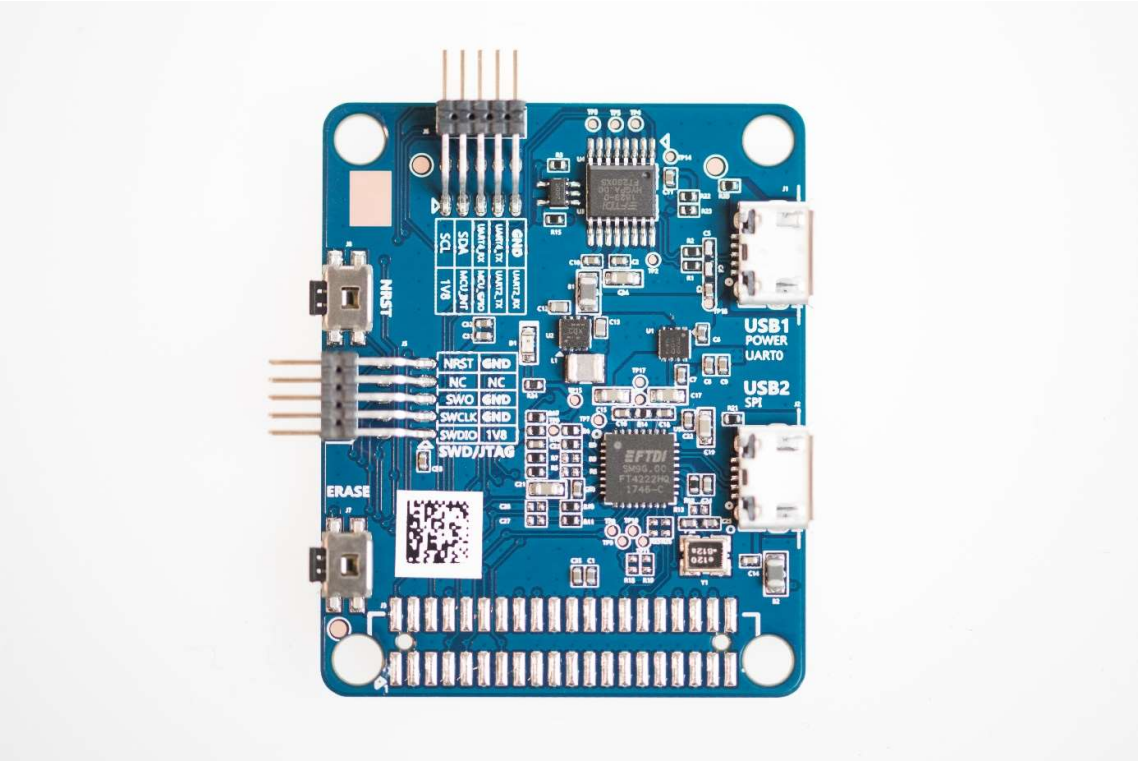
The XB112 is Acconeer's breakout board and part of the Module EVK.

3.1.1 Overview

The XB112 is a breakout-board designed for the XM112 Radar Module. It makes the interfaces from the XM112 radar module accessible for evaluation and debug. It also enables flashing of the XM112 via USB-UART or SWD. The XM112 is connected to the XB112 via a board-to-board connector on the top side of the PCB. Below you will find pictures of both front and back side of the breakout board.



Picture 1 shows the XB112 connector board, front side.



Picture 2 shows the breakout board, XB112, back side.

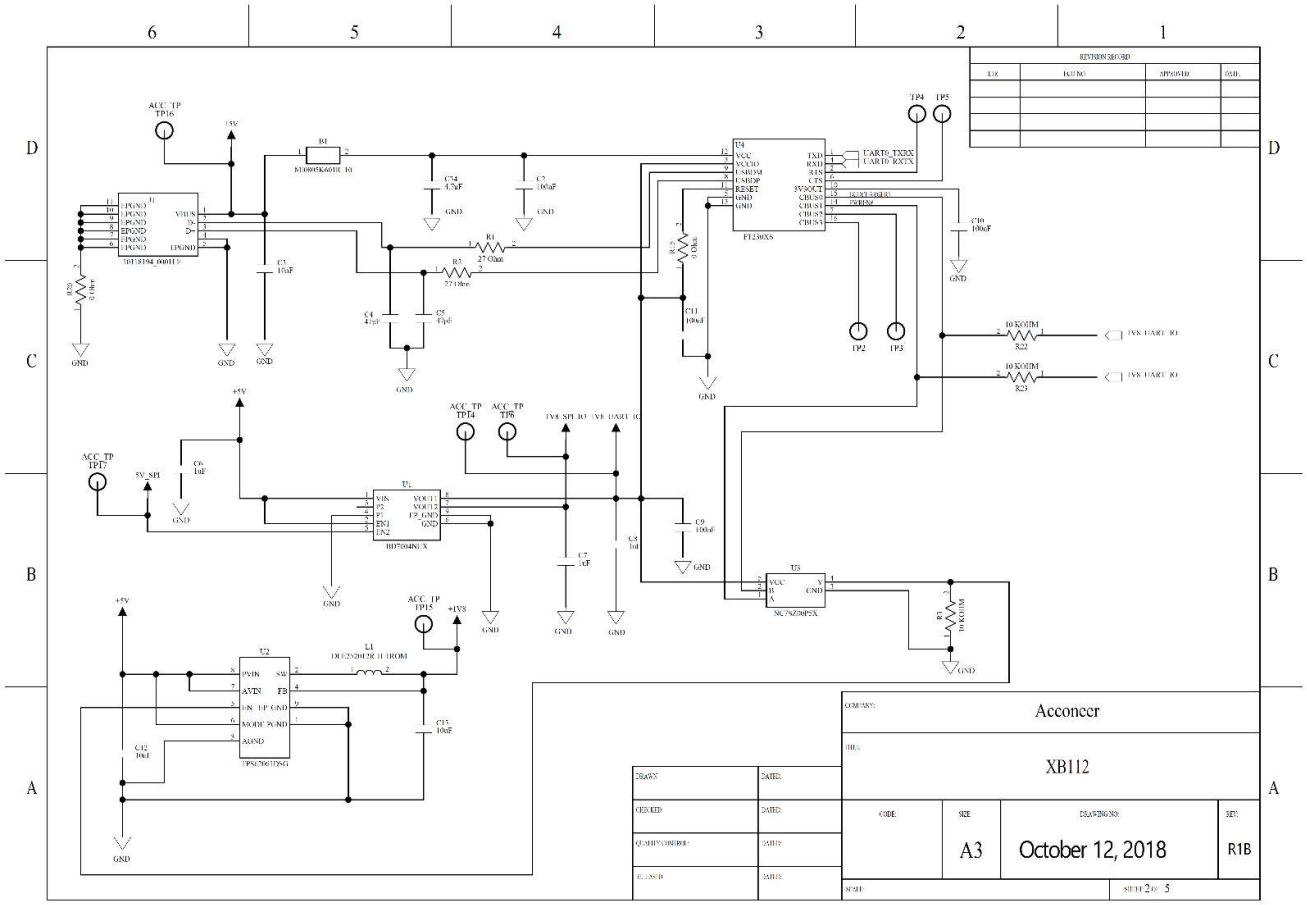
3.1.2 Power

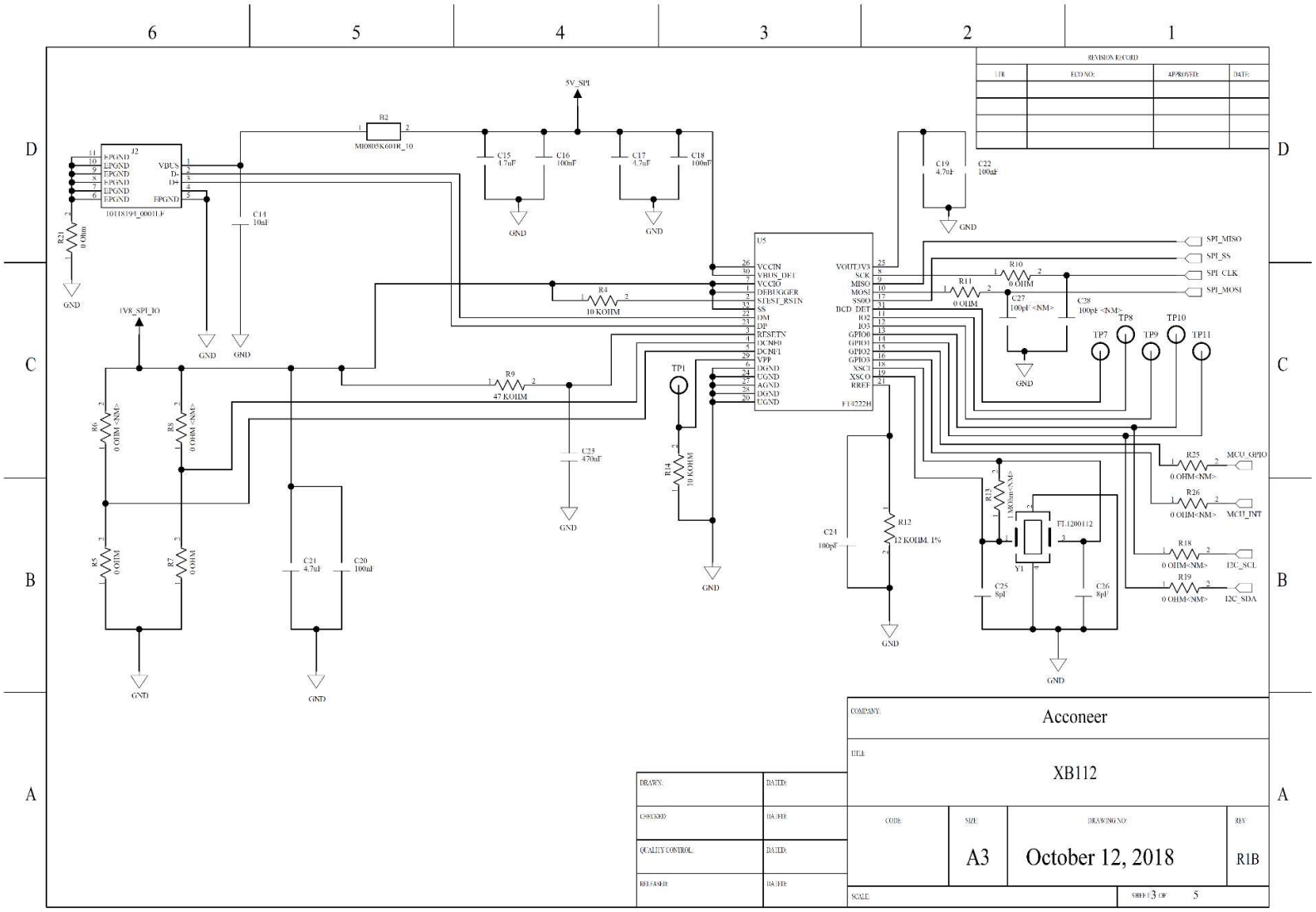
The EVK is powered via the USB connectors on XB112. USB1 powers the USB-UART chip (U4) and the XM112. USB2 powers the USB-SPI chip (U5). If no SPI data is needed, the USB2 can be left unconnected. USB1 must however always be connected. If the USB-UART interface is not used, a dedicated USB charger can be inserted to USB1.

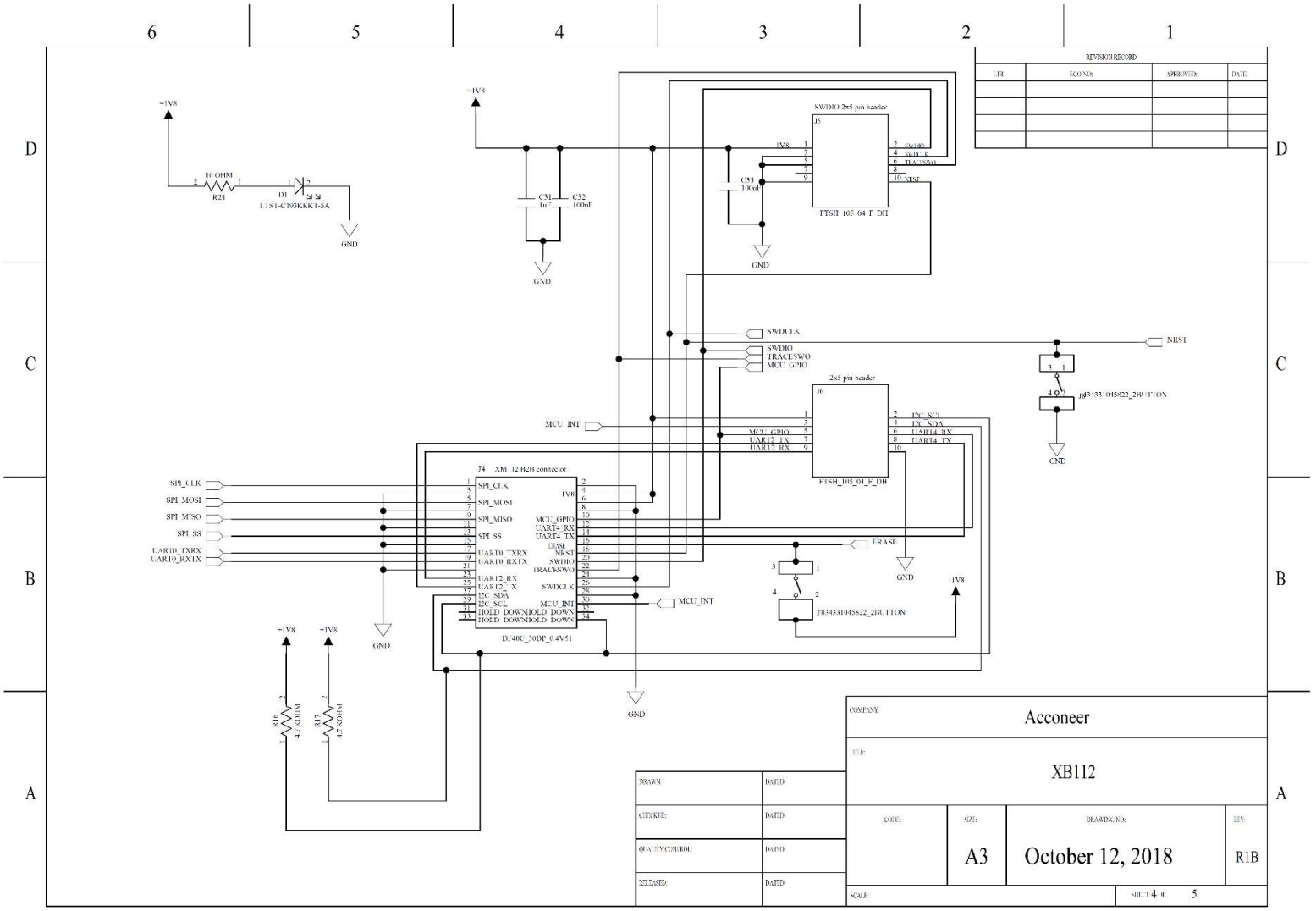
When the power LED on the XB112 is lit, the breakout board and the XM112 radar module (if connected to the board-to-board connector on the top side of XB112) are powered on and ready for use. For details regarding the power management on XB112, refer to the XB112 product brief.

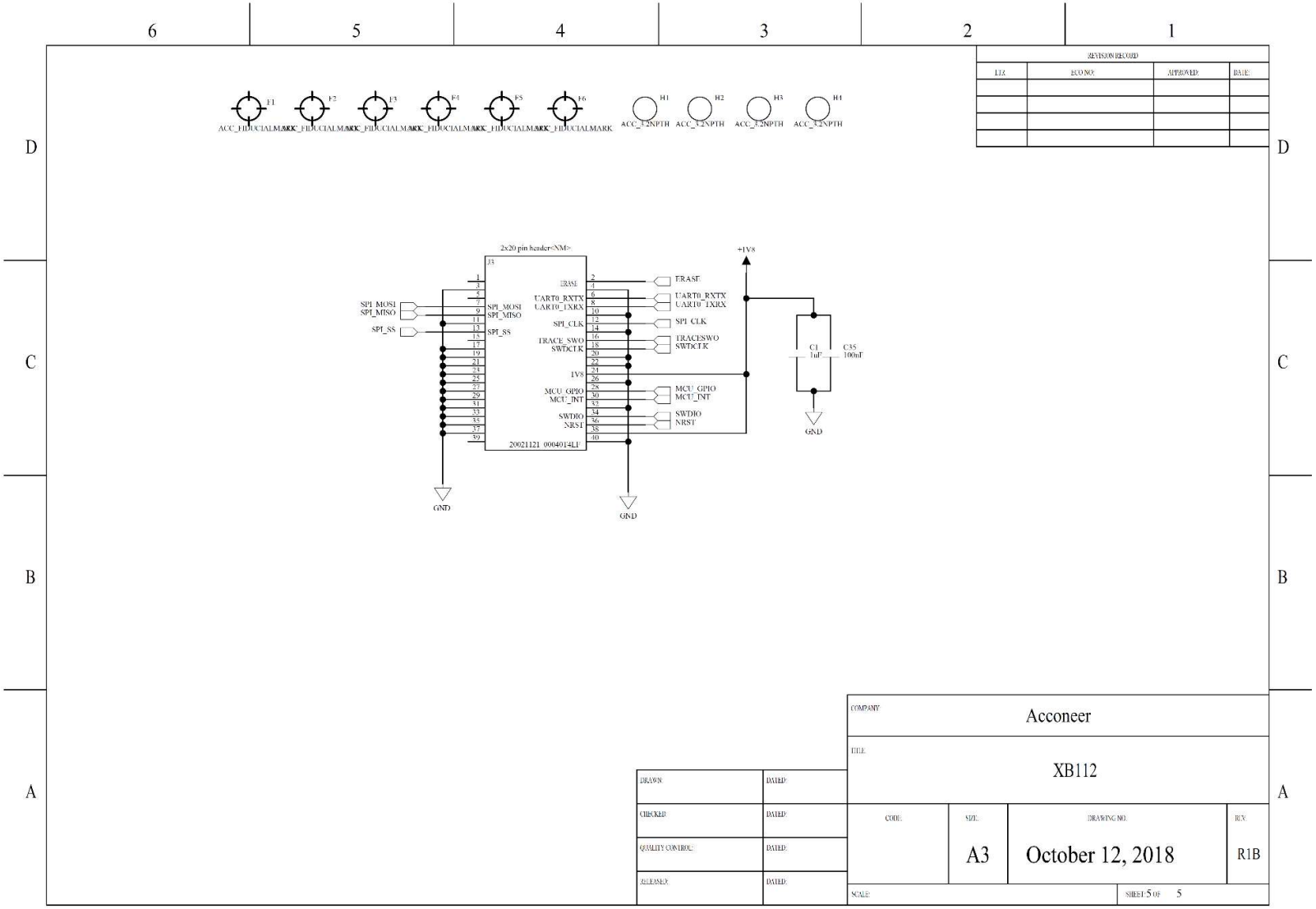
3.1.3 Electrical Schematics

On the following pages, please find the electrical schematics for the XB112.









3.1.4 Bill of Material

Table 1 shows the BOM for the XB112

Table 1 The BOM for the XB112.

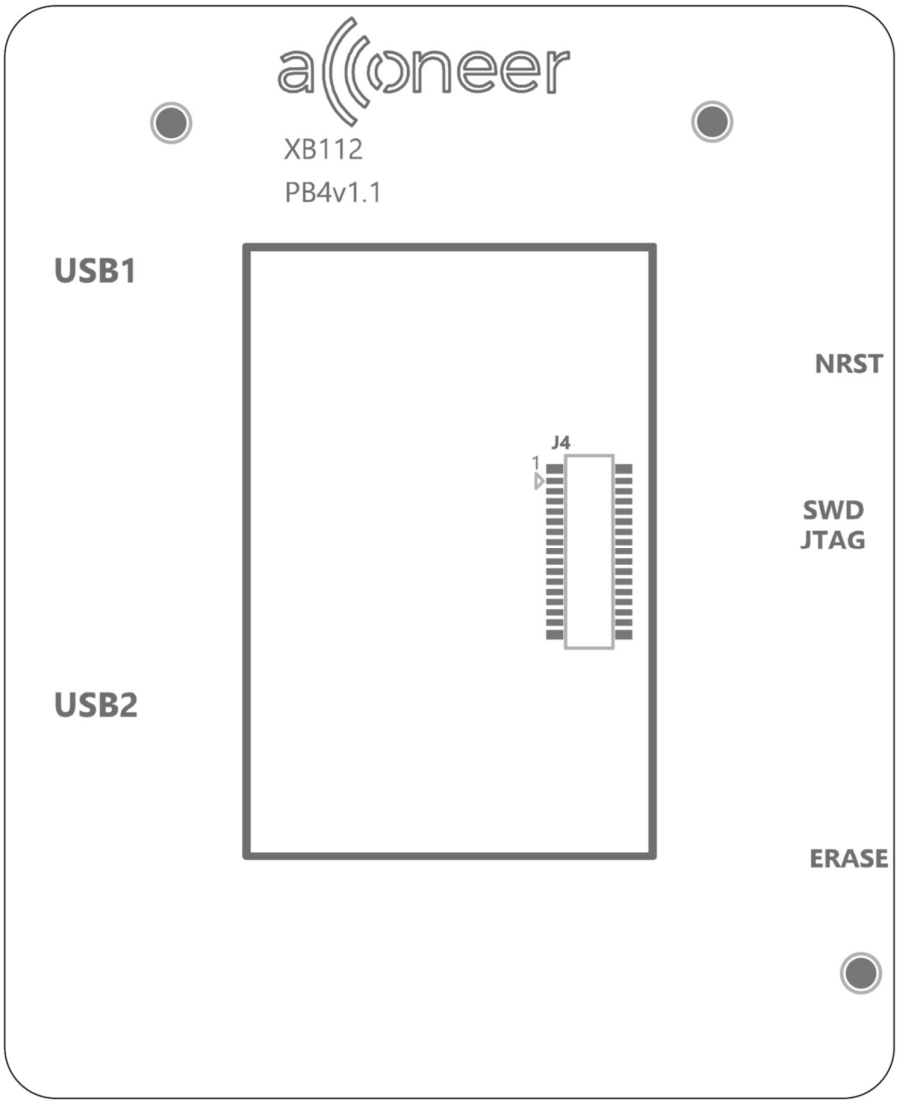
Component Ref.	Specification	QTY	Value	Comment
C2,C9,C10,C11,C16,C18,C20,C22,C32,C33,C35	100/NF/K/50V/X7R/1005	11	100nF	
C24	100/PF/J/10V/NP0,C0G/1005	1	100pF	
C3,C14	10/NF/K/16V/X7R/1005	2	10nF	
C12,C13	10/UF/M/10V/X5R/1005	2	10uF	
C1,C6,C7,C8,C31	1/UF/K/10V/X5R/1005	5	1uF	
C23	470/NF/K/10V/X5R/1005	1	470nF	
C4,C5	47/PF/J/50V/C0G/1005	2	47pF	
C25,C26	8/PF/C/50V/NP0,C0G/1005	2	8pF	
C15,C17,C19,C21,C34	1608 10% 10V X5R 4.7uF	5	4.7uF	
R5,R7,R10,R11,R15,R20,R21	1005 J 0	7	0 Ohm	
R3,R4,R14,R22,R23	1005 F 10K	5	10kOhm	
R12	1005 F 12K	1	12kOhm	Accuracy 1%
R1,R2	1005 F 27	2	27Ohm	
R9	47/KOHM/F/1005	1	47kOhm	
R16,R17	4.7/KOHM/F/1005	2	4.7kOhm	
R24	10/OHM/F/1005	1	10 Ohm	
J1,J2	10118194-0001LF/Micro B USB 2.0 Receptacle	2	N/A	Manufacturer: Amphenol
U1	BD7004NUX/Dual output 5V to 1.8V LDO	1	N/A	Manufacturer: Rohm
J4	DF40C-30DP-0.4V51/XM112 30 pin B2B connector plug	1	N/A	Manufacturer: Hirose
L1	DFE252012R-H-1ROM=p2	1	1uH	
Y1	FL1200112/CRYSTAL_12MHz	1	N/A	

U4	FT230XS-R/USB to UART bridge	1	N/A	
U5	FT4222H/USB to SPI bridge	1	N/A	
J5,J6	FTSH_105_04_F_DH/SWD Connector, Right angle 2x5 pin header	2	N/A	Manufacturer: Samtech
J7,J8	SWITCH TACTILE SPST-NO 0.05A 12 434331045822	2	N/A	Manufacturer: Wurth Electronics
B1,B2	MI0805K601R_10/Ferrite Bead	2	N/A	
U3	NC7SZ00P5X/NAND gate	1	N/A	
U2	TPS62061DSGR	1	N/A	
D1	LTST-C193KRKT-5A/LED RED	1	N/A	

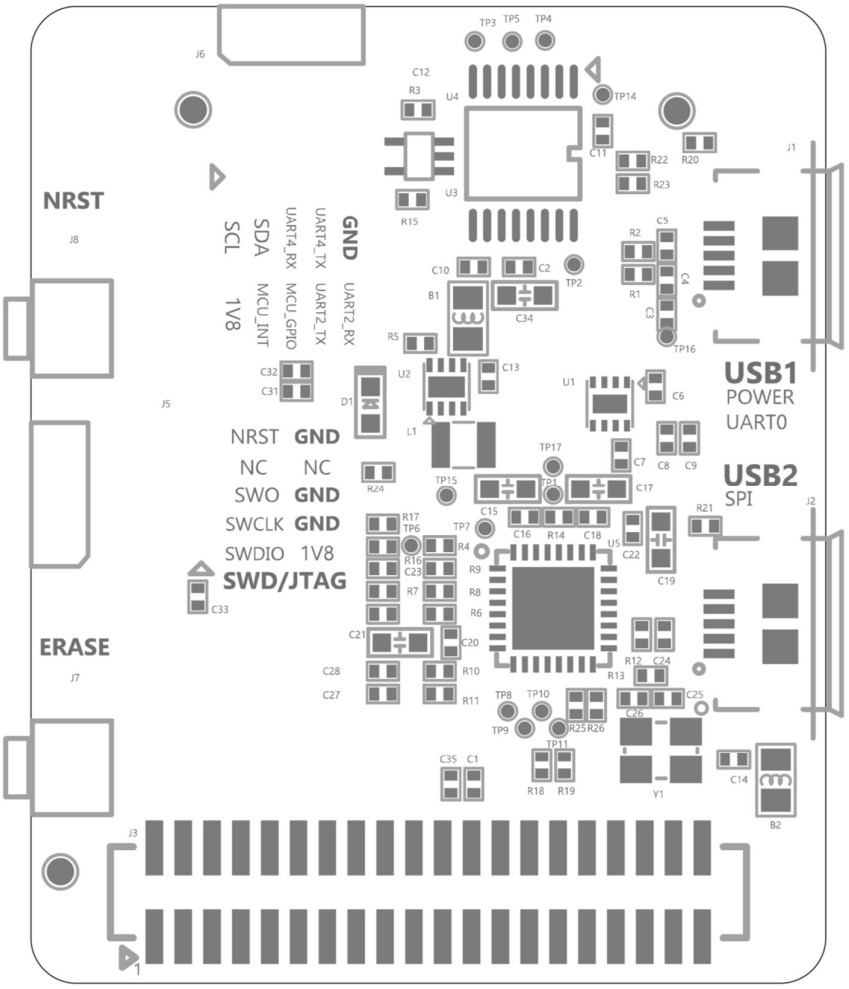
3.1.5 Component Placement Drawing

The component placement drawing of XB112 is found below.

Top Side:



Bottom Side:



3.1.6 Pinning/Connectors

3.1.6.1 USB1 (J1)

USB1 is used as power supply for the XB112 and the XM112. It is also used for flashing and communicating over UART. USB1 is connected to the FTDI chip FT230XS which converts the UART interface from XM112 into USB signals. The pinout of USB1 is shown in

.

Table 2. The pinout of J1.

Pin Number	Signal
1	VBUS
2	D-
3	D+
4	ID (GND)
5	GND

3.1.6.2 USB2 (J2)

USB2 is used for high speed data read out from the module SPI interface. It is converted to USB via the FTDI chip FT4222H. The pinout of USB2 is shown in Table 3.

Table 3. The pinout of J2.

Pin Number	Signal
1	VBUS
2	D-
3	D+
4	ID (GND)
5	GND

3.1.6.3 2x20 pin header (J3)

The 2x20 pin header (1.27mm pitch) is not mounted. The reason is that it is intended for Acconeer internal use only. All the interfaces available in the 2x20 pin header are also available in the other connectors. The pinout of the 2x20 pin header is shown in Table 4.

Table 4. The pinout of J3.

Pin Number	Signal	Pin Number	Signal
1	NC	2	ERASE
3	GND	4	GND
5	NC	6	UART0_RX_TX
7	SPI_MOSI	8	UART0_TXRX
9	SPI_MISO	10	GND
11	GND	12	SPI_CLK
13	SPI_SS	14	GND
15	NC	16	TRACESWO
17	GND	18	SWDCLK
19	GND	20	GND
21	GND	22	GND
23	GND	24	1V8
25	GND	26	GND
27	GND	28	MCU_GPIO
29	GND	30	MCU_INT
31	GND	32	GND
33	GND	34	SWDIO
35	GND	36	NRST
37	GND	38	1V8

3.1.6.4 30 pin board-to-board connector (J4)

The 30-pin board-to-board connector is intended to connect the XM112 to the XB112. The pinout is found in Table 5.

Table 5. The pinout of J4.

Pin Number	Signal	Pin Number	Signal
1	SPI_CLK	2	GND
3	GND	4	1V8
5	SPI_MOSI	6	1V8
7	GND	8	GND
9	SPI_MISO	10	MCU_GPIO
11	GND	12	UART4_TXRX[2]
13	SPI_SS	14	UART4_RXTX[2]
15	GND	16	ERASE
17	UART0_TXRX[2]	18	NRST (SWD_NRST)
19	UART0_RXTX[2]	20	SWDIO
21	GND	22	TRACESWO
23	UART2_TXRX[2]	24	GND
25	UART2_RXTX[2]	26	SWDCLK
27	I2C_SDA	28	GND
29	I2C_SCL	30	MCU_INT

3.1.6.5 2x5 JTAG/SWD pin header (J5)

The 2x5 JTAG/SWD pin header (1.27mm pitch) contains the signals needed for flashing the XM112 MCU via the SWD interface. The pinout matches that of the Cortex 10-pin JTAG/SWD Connector and is found in Table 6.

Table 6. The pinout of J5.

Pin Number	Signal	Pin Number	Signal
1	1.8V	2	SWDIO
3	GND	4	SWDCLK
5	GND	6	TRACESWO
7	NC	8	NC
9	GND	10	NRST

[2] The first two letters in the part of the signal name that is following the "_" character indicate the direction of the UART on the external host. The last two letters of the signal name that is following the "_" character indicate the direction of the UART on the XM112 MCU.

3.1.6.6 2x5 pin header (J6)

The 2x5 pin header (1.27mm pitch) contains miscellaneous 1.8V signals from the XM112. The pinout is found in Table 7.

Table 7. The pinout of J6.

Pin Number	Signal	Pin Number	Signal
1	1.8V	2	I2C_SCL
3	MCU_INT	4	I2C_SDA
5	MCU_GPIO	6	UART4_TXRX[2]
7	UART2_RXTX[2]	8	UART4_RXTX[2]
9	UART2_TXRX[2]	10	GND

3.1.7 Buttons

There are two buttons on the XB112. J7 controls the signal “ERASE” from XM112 and J8 controls “NRST” from the XM112. In Table 8 the state of the buttons and the corresponding signal states are listed.

Table 8. The states of the buttons J7 and J8.

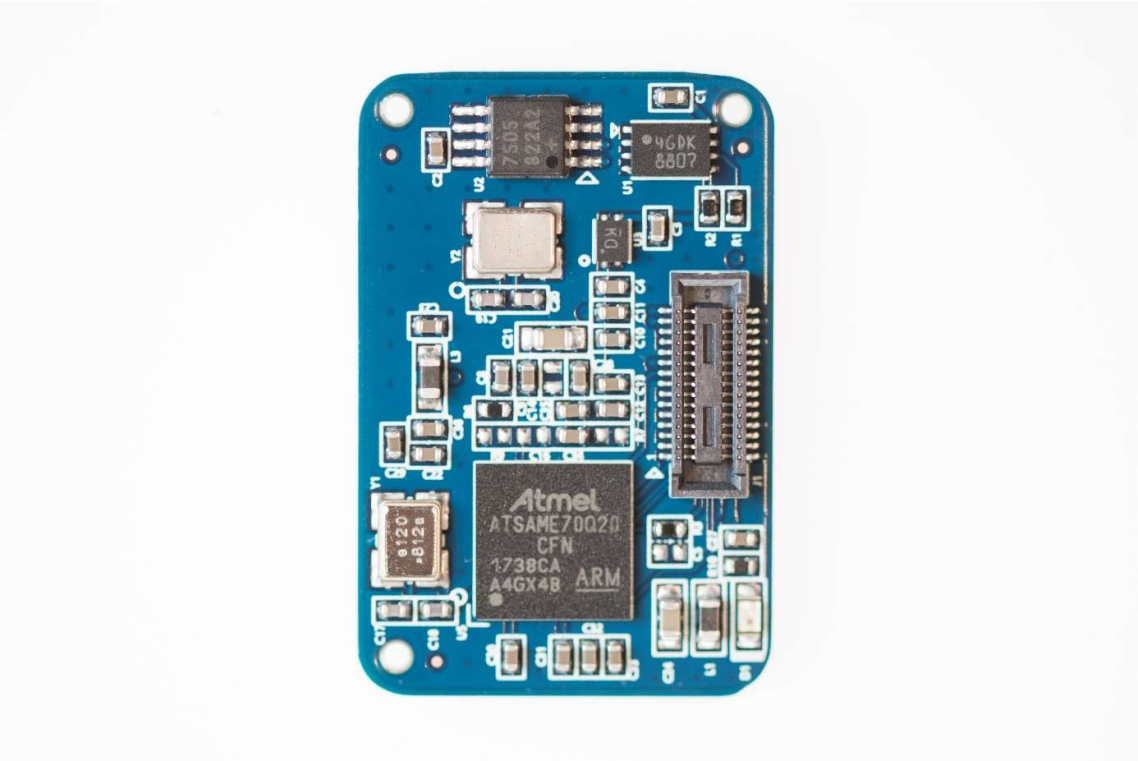
Button	Open (default)	Closed
J7	ERASE=0	ERASE=1
J8	NRST=1	NRST=0

3.2 HP Module

3.2.1 Overview

The picture below shows the HP Module top side and Picture X shows the bottom side.

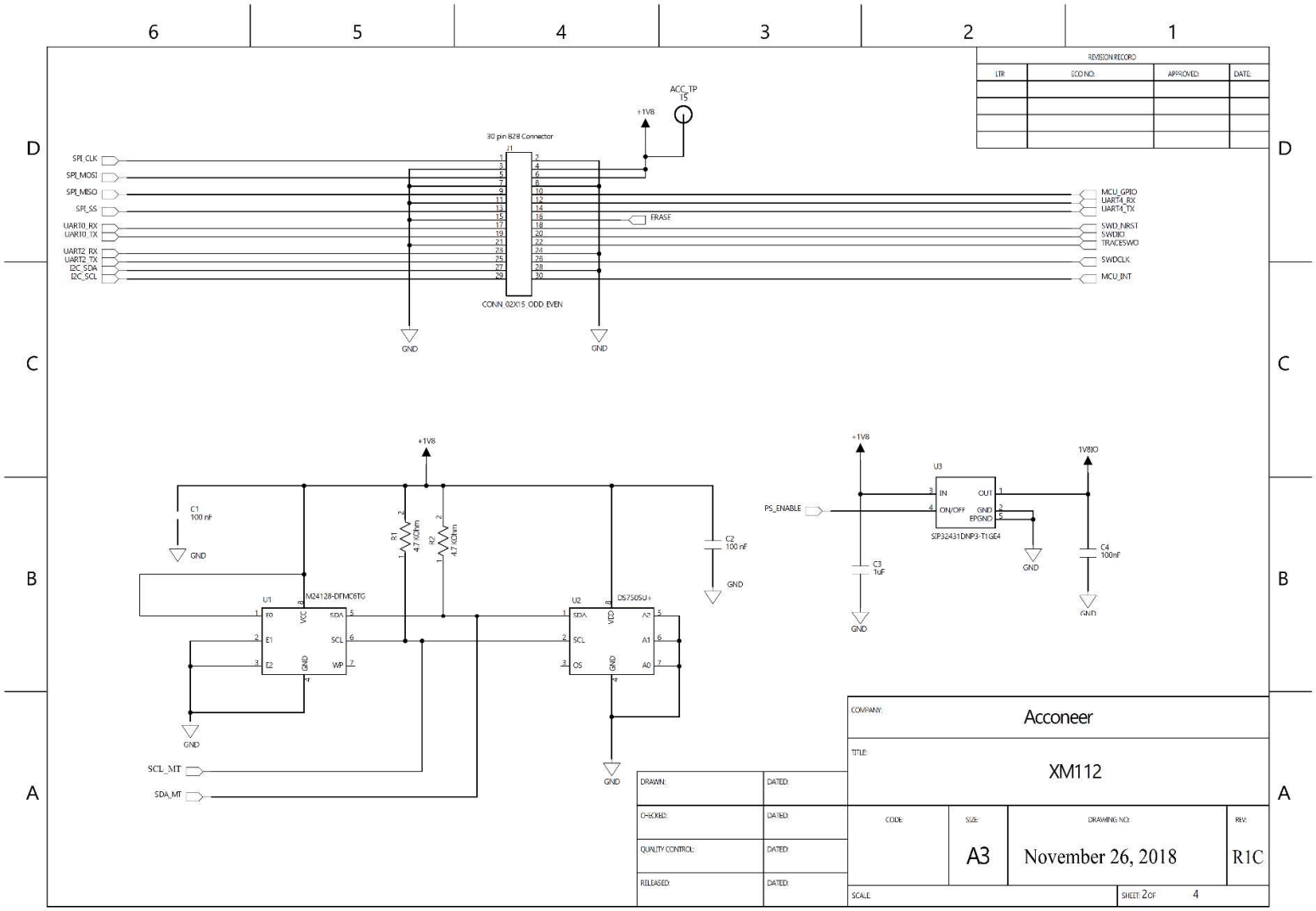
Picture 1 shows the HP Module, front side.

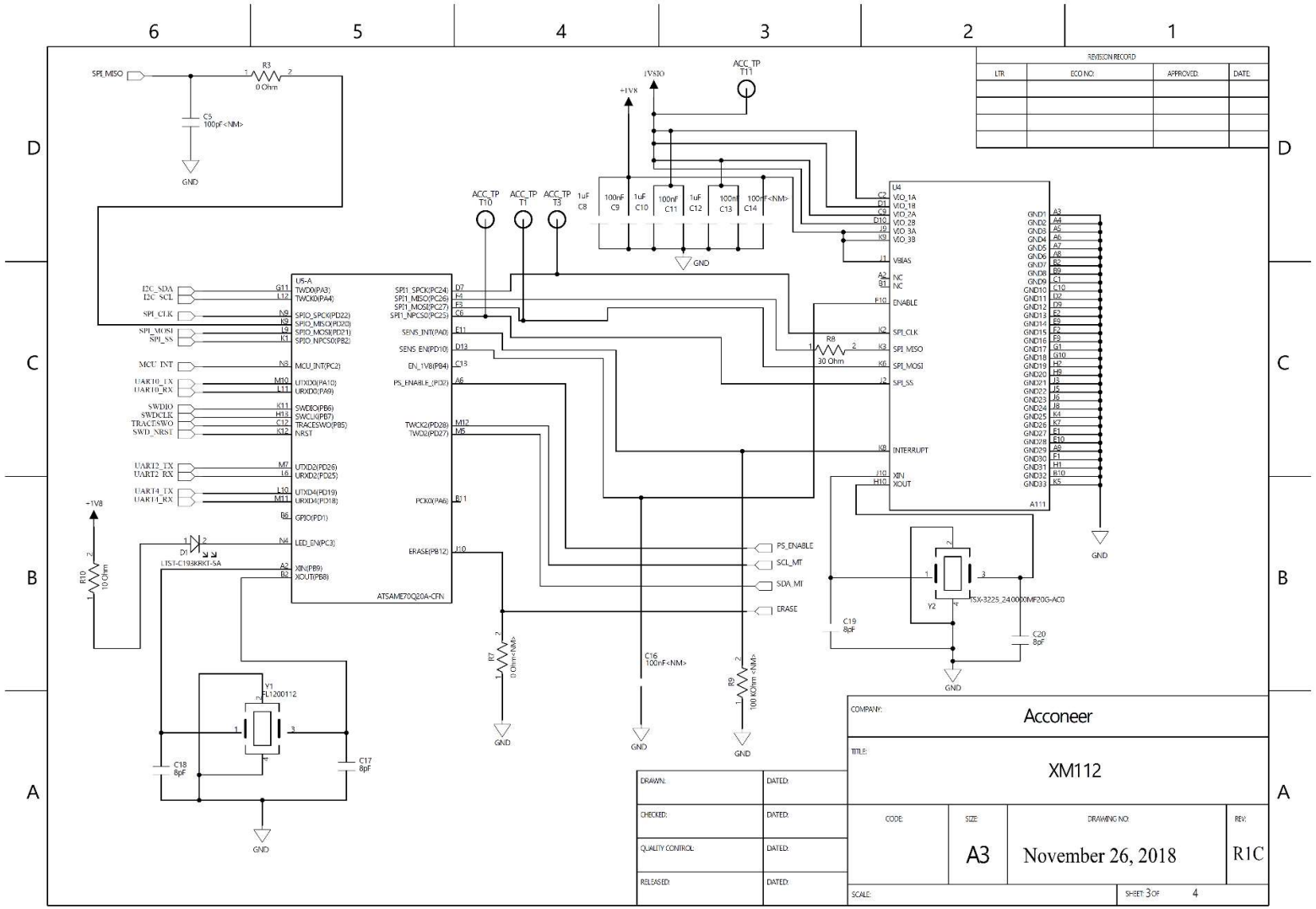


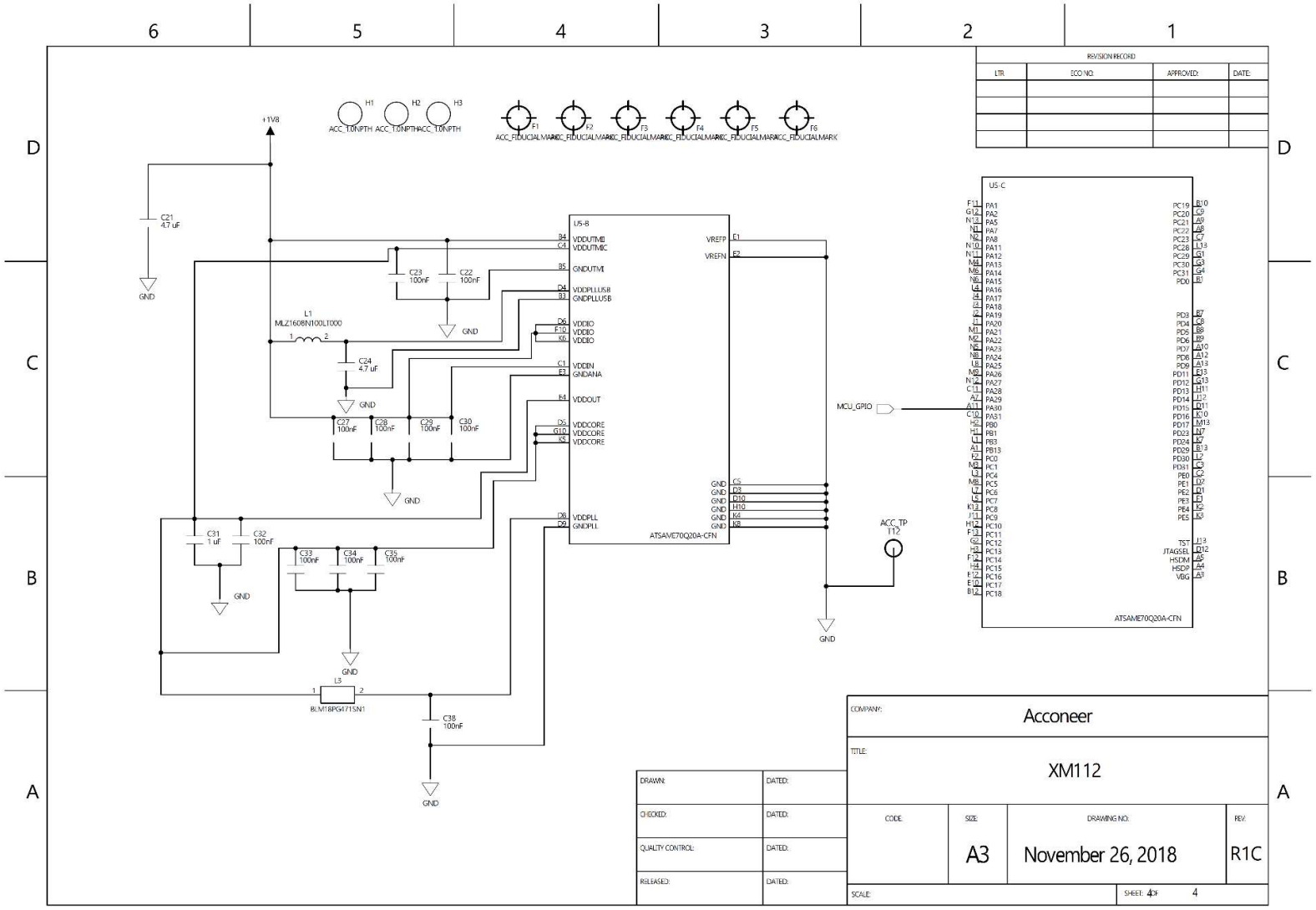
Picture 2 shows the HP Module, back side.

3.2.2 Electrical Schematics

Please find the electrical schematics of the XM112 below.







3.2.3 Bill of Material

Table 9 shows the BOM for the XM112.

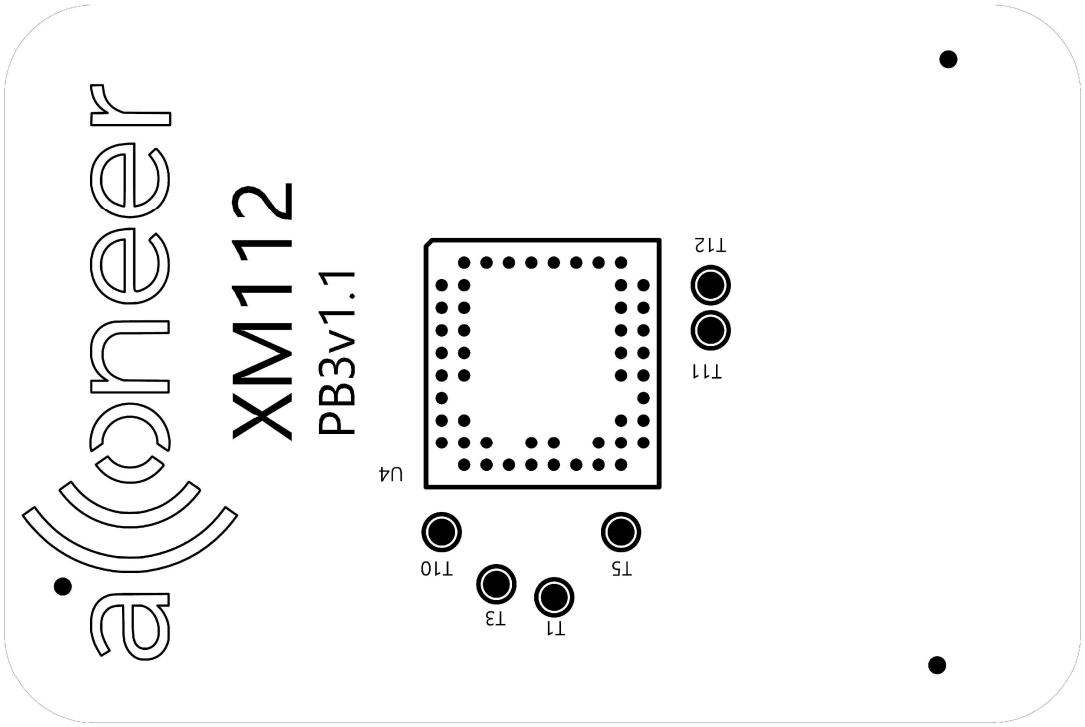
Table 9 The BOM for XM112

Component Ref.	Specification	QTY	Value	Comment
C3,C8,C10,C12,C31	1/UF/K/10V/X5R/1005	5	1uF	
C1,C2,C4,C9,C11,C13, C22,C23,C27C28,C29, C30,C32,C33,C34,C35 ,C38	100/NF/K/50V/X7R/1005	17	100nF	
C17,C18,C19,C20	8/PF/C/50V/NP0,C0G/1005	4	8pF	
C21,C24	1608 10% 10V X5R 4.7uF	2	4.7uF	
R3	1005 J 0	1	0 Ohm	
R10	10/OHM/F/1005	1	10 Ohm	
R8	30/OHM/F/1005	1	30 Ohm	
R1,R2	1005 F 4.7K	2	4.7kOhm	
U4	A111 R2D	1	N/A	
U5	ATSAME70Q20A-CFN	1	N/A	
U2	DS7505U+	1	N/A	
U1	M24128-DFMC6TG	1	N/A	
U3	SIP32431DNP3-T1GE4	1	N/A	
J1	DF40C-30DS-0.4V51/30-pin B2B connector receptacle	1	N/A	Manufacturer: Hirose
Y1	FL1200112/CRYSTAL_12MHz	1	12 MHz	
Y2	TSX-3225 24.0000MF20G-AC0	1	24 MHz	
D1	LTST-C193KRKT-5A	1	N/A	LED RED
L3	BLM18PG471SN1	1	N/A	Ferrite Bead
L1	MLZ1608N100LT000	1	10uH	

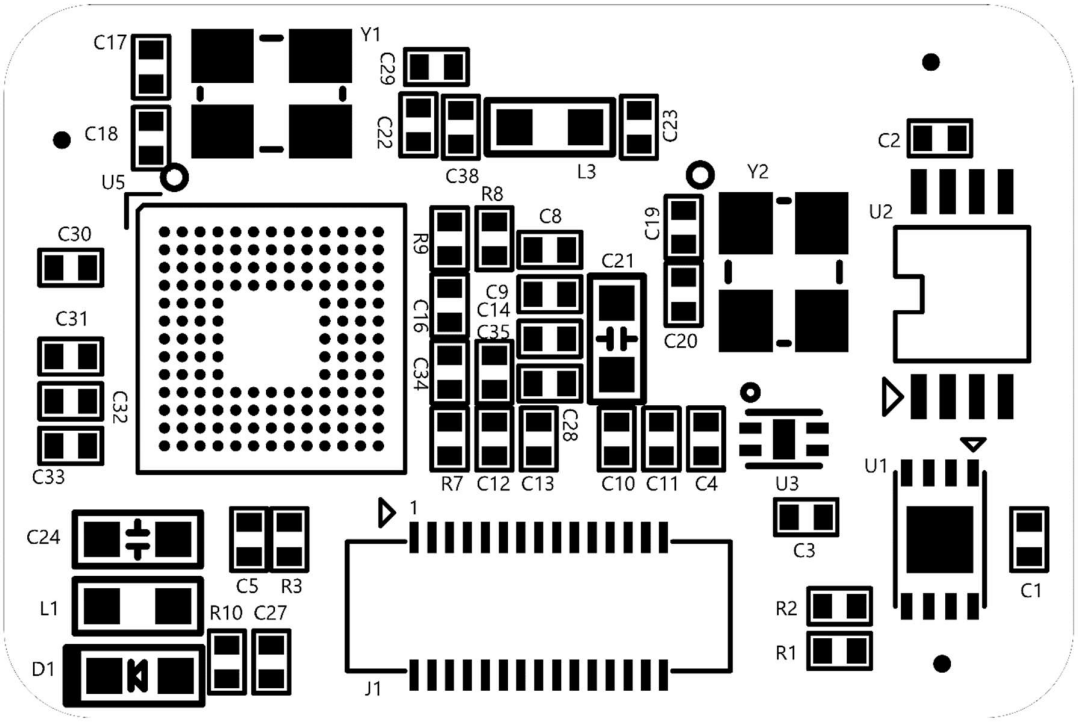
3.2.4 Component Placement Drawing

The component placement drawing of XM112 is found below.

Top side



Bottom side:



3.2.5 Pinning

4 shows the pinout of the XM112 connector J1.

Table 10 The pinout of the XM112 connector J1.

Pin Number	Signal	Pin Number	Signal
1	SPI_CLK	2	GND
3	GND	4	1V8
5	SPI_MOSI	6	1V8
7	GND	8	GND
9	SPI_MISO	10	MCU_GPIO
11	GND	12	UART4_TXRX[2]
13	SPI_SS	14	UART4_RXTX[2]
15	GND	16	ERASE
17	UART0_TXRX[3]	18	SWD_NRST (NRST)
19	UART0_RXTX[2]	20	SWDIO
21	GND	22	TRACESWO
23	UART2_TXRX[2]	24	GND
25	UART2_RXTX[2]	26	SWDCLK
27	I2C_SDA	28	GND
29	I2C_SCL	30	MCU_INT

[3] The first two letters in the part of the signal name that is following the "_" character indicate the direction of the UART on the external host. The last two letters of the signal name that is following the "_" character indicate the direction of the UART on the XM112 MCU.

3.3 Lens Evaluation Kit LH112

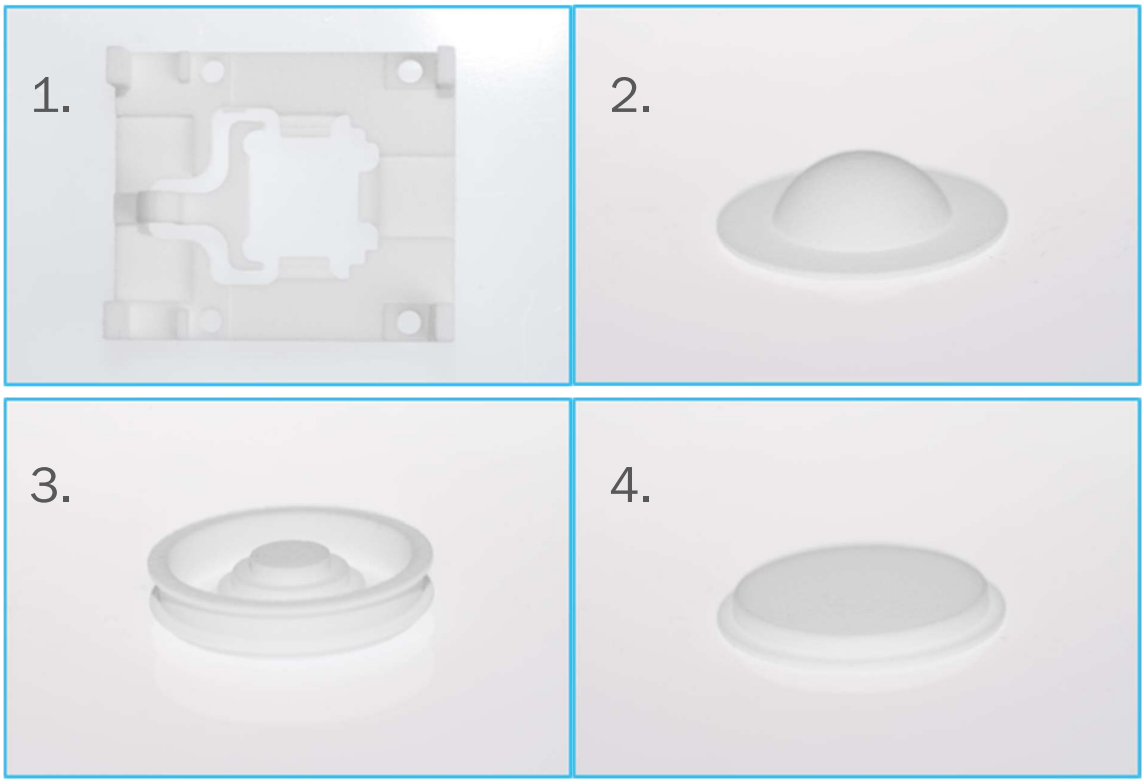
3.3.1 Overview

The LH112 lens evaluation kit is an accessory for the XM112/XB112 evaluation kit. The lenses can be used to increase sensor performance. The lenses increase signal strength by focusing the beam width of the radiated EM-waves and thereby concentrating the emitted power. The lens kit is sold separately from XM112 and XB112.

3.3.2 Contents and assembly

The LH112 lens kit is delivered including four parts. The included items are (as shown in picture below):

1. Lens and PCB holder
2. HBL Lens (Hyperbolic Lens)
3. FZP Lens (Fresnel Zone Plate)
4. Flat cover

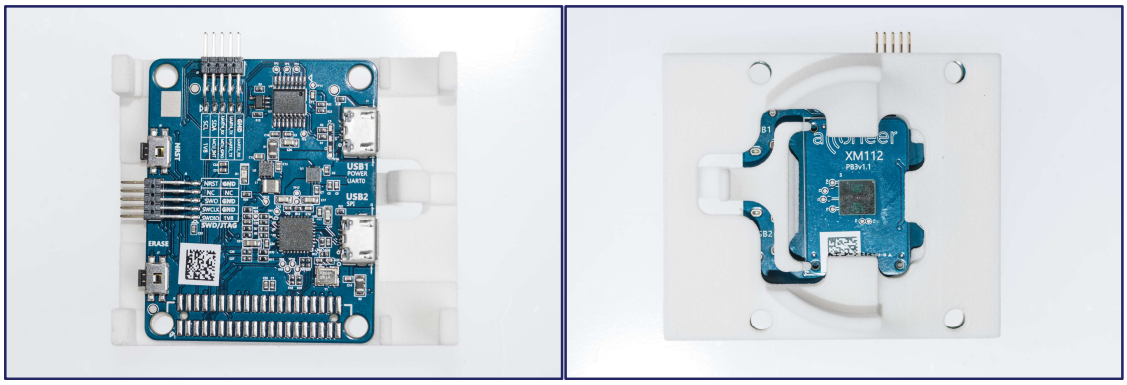


The XM112/XB112 can be mounted directly in the lens and PCB holder. It is recommended to fasten the PCB to the holder using screws in order to make sure it is positioned correctly. The exact sensor position in relation to the lens will be important for optimal performance. Screws and bolts that match the design can be found on www.digikey.com. Part numbers provided below:

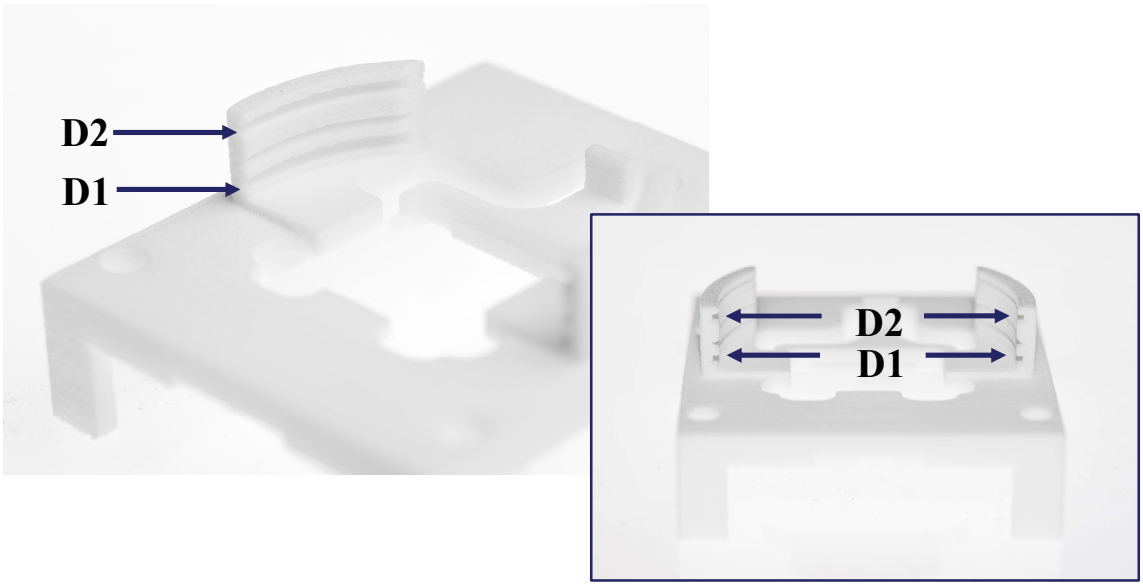
Screw: H560-ND

Bolt: RPC1742-ND

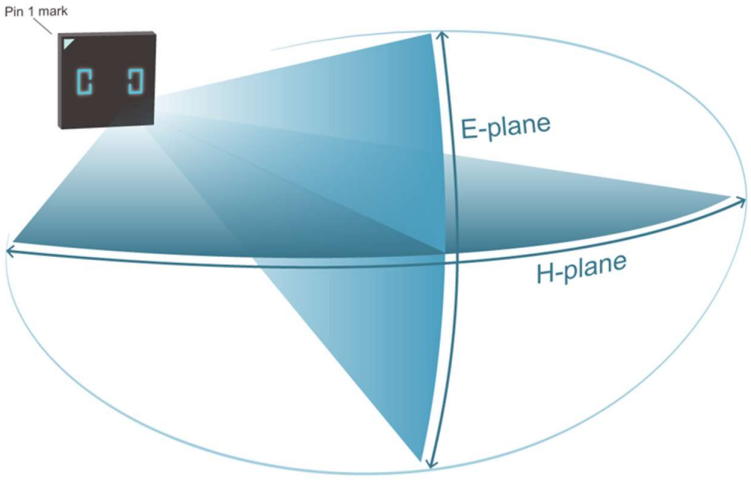
The pictures below show XM112/XB112 mounted in the PCB holder from below and above:



Both lenses can be fitted in the holder in two different positions, D1 or D2. The cover is only used in the D1 position. The two positions will give you slightly different performance. Performance results can be found in the next section. The pictures below show the difference between positions D1 and D2:



3.3.3 Lens Performance



The transmitted electromagnetic waves from the Acconeer sensor has different divergence for the E-plane and H-plane. When mounted in front of the sensor the lenses affect the signal strength as well as the spread of the signal.

The expected performance for maximum gain and half power beam width (HPBW) can be found in the table below.

	Max Gain. (dB_{FS}*)		**HPBW-E (degree)**		**HPBW-H (degree)**	
Free Space	0		55		80	
Cover	-0.15		55		80	
Lens Position	D1	D2	D1	D2	D1	D2
HBL	5.8	10	22	17	33	15
FZP	5.7	9.1	20	12	27	12

* The dB_{FS} gain is the radar loop gain (Tx + Rx gain) relative to a free-space measurement.

4 Flashing of XM112 via USB-UART Interface

This section describes how to update the software in the HP Module by using the USB-UART interface on XB112.

4.1 Updating the Software

4.1.1 Install Tools

In order to update the software on the HP Module it is recommended to use the BOSSA application. The application along with instructions are available at http://www.shumatech.com/web/products/bossa. The application is available for Linux, Windows and Apple Mac OS X and version 1.9 or later is supported.

4.1.2 Upgrade Procedure

Step 1: The SAM E70 CPU have a ROM boot loader that is used during the software update. In order to enter this boot mode the internal flash must be erased with the following sequence:

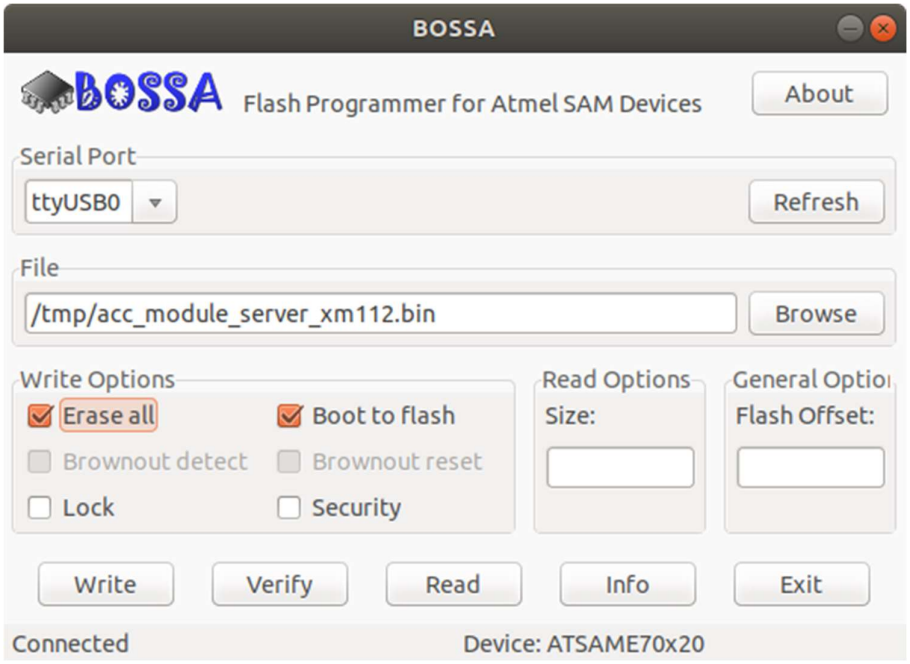
1. Connect the XB112 together with XM112 to your PC with a micro USB cable to the "USB1/Power/UART0" connector
2. Press and hold the "ERASE" button on the XB112.
3. Press the "NRST" button on XB112 (still holding the "ERASE" button)
4. Release the "NRST" button
5. Release the "ERASE" button

The internal flash of the SAM E70 is now erased and the ROM boot code is executing.

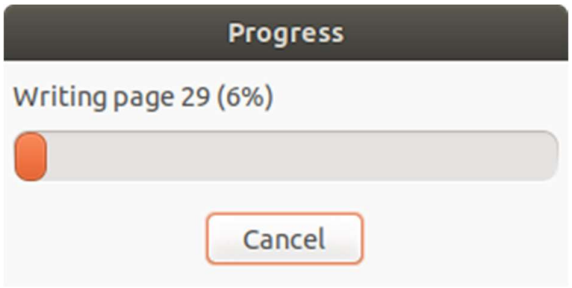
Step 2: Start the BOSSA application.

IT IS VERY IMPORTANT TO NOT START THE BOSSA APPLICATION UNTIL THE INTERNAL FLASH OF SAM E70 HAS BEEN ERASED.

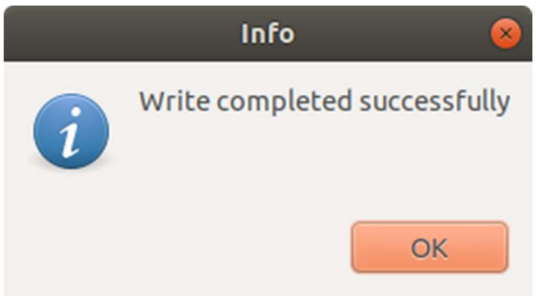
1. Select correct port, e.g. "/dev/ttyUSB0" if running on Linux or "COM6" if running on Windows. If the BOSSA application doesn't find the SAME70 on XM112, try closing BOSSA, then redo Step 1 and Step 2.
2. Press "Browse" and select the new firmware file
3. Make sure that "Erase all" and "Boot to flash" is selected
4. Press "Write"



A progress dialog is shown showing the current progress:



When the flash is completed a new dialog is shown:



Press “OK” and exit the BOSSA application. In order to start the new software, press the “NRST” button on XB112.

5 Safety

5.1 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.

6 Regulatory Information

Acconeer have no plans to certify the XM112/XB112 EVK, it is only for evaluation purposes.

Regulatory Compliance for XM112: Refer to XM112 datasheet.

Regulatory Compliance for A111: Refer to A111 datasheet.

7 Revision History

Date	Revision	Changes
2018-12-19	1.0	Original version
2021-05-03	1.1	
2022-08-25	1.2	ISO14001 updates. Updated chapter “Regulatory Information”.

8 Disclaimer

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