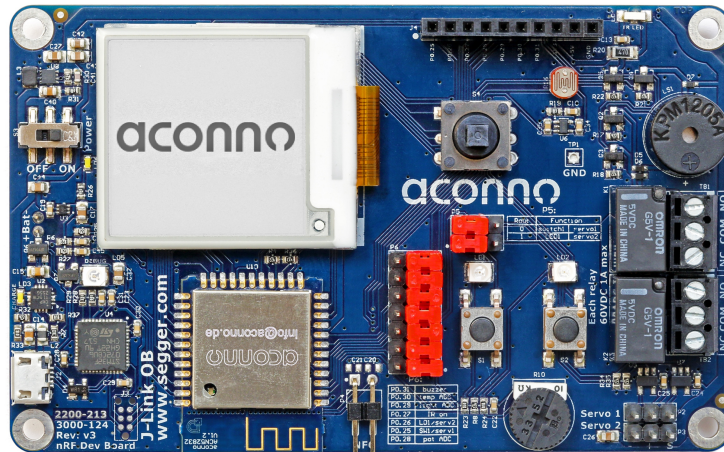**M A N U A L**

ACD52832

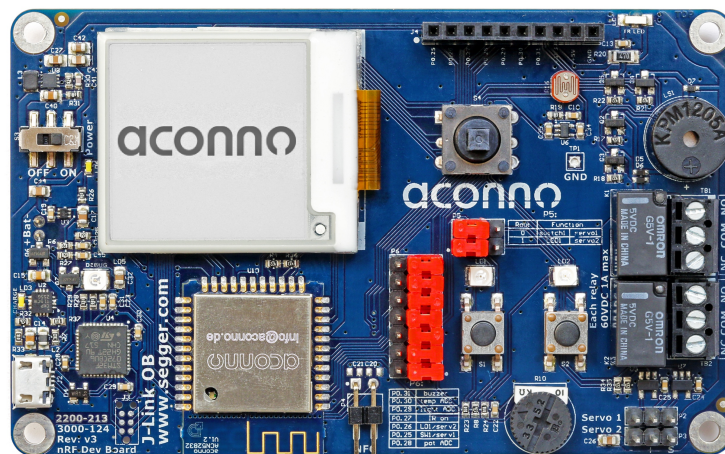Development Kit for Bluetooth Smart, ANT and 2.4 GHz applications

MA:DE IN GERMANY

aconno™

ACD52832

Development Kit for Bluetooth Smart, ANT and 2.4 GHz applications

The aconno ACD52832 brings the speed and the simplicity of software development to hardware and IoT. Our development board and our module are designed to support you starting from the first prototype until the production. It empowers you to create smart, connected Bluetooth devices.

Table of Contents

1. Introduction

Thank you for choosing the ACD52832 development board from aconno! We believe it is the most feature complete Bluetooth smart development board out there.
This document is a user's guide for the aconno ACD52832 starting with a general overview and a list of the board's features.
We hope you enjoy developing with it as much as we enjoyed developing it!

1.1. Purpose of the Board

The ACD52832 is as a development board for the aconno ACN52832 Bluetooth Low Energy module which incorporates the highly powerful and energy efficient Nordic Semiconductor nRF52832 SoC. To give the makers of tomorrow an ultimate development platform for future IoT devices, various on-board sensors, input devices and a graphical HiRes electronic paper display are supplied with the board.

1.2. Features of the Board

- ACN52832 2.4 GHz module, featuring the Nordic Semiconductor nRF52832 SoC.
- 9 degrees of freedom inertial module which contains a 3D accelerometer, a 3D gyroscope and a 3D magnetometer
- Graphical high resolution electronic paper display with 200x200 pixels resolution and 184 dpi pixel density
- Integrated Texas Instruments USB Li-Ion battery charger with up to 1.5A charging current and automatically battery - USB power supply changeover.
- Temperature sensor with temperature range between -40°C and 125°C with ± 4°C accuracy
- Light sensitive sensor
- IR-emitter
- Piezo buzzer
- Digital joystick
- Two LEDs
- Two push buttons
- Potentiometer for ADC values
- Pin-header with seven I/O –ports
- Two potential free relay outputs
- Two PWM controlled servo outputs

2. Getting started

This section helps you setting up the ACD5282 development board for the first time. Here you can find the hardware and software required to operate the board. Moreover it shows the procedure to power up the board and the description of the default board behavior.
Please consider first the electrostatic warning to avoid damaging the board.

2.1 Electrostatic warning

The ACD52832 board is shipped in a protective anti-static package. The board must not be exposed to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the component pins or any other metallic elements.

2.2 Requirements

In order to power up the ACD52832 board, only the supplied USB cable and a PC/ Mac with the proper software are required.
Optionally you can connect a Li-Ion or a Li-Po battery to start the charging process immediately after connecting the ACD52832 board to a PC/ Mac.

2.3 Powering up the ACD52832 board for the first time

1. Connect the ACD52832 board through the supplied USB cable with a PC or Mac and turn on the power switch.

2. Two new USB devices should appear: The J-Link programming interface and a mass storage device called "J-Link"
The mass storage device called "J-Link" is used as a drag & drop target for instant programming with a corresponding *.hex file. The other device serves as a programming interface for IDE Software such as ARM Keil. In order to use the second device, drivers are required for the Segger J-Link device. These are delivered with most of the available IDEs. Otherwise, the operating system will automatically search for drivers.

3. Upon initial powering, the board's white LED "LD6", next to the the power switch, will turn on and the green debug LED will start and keep flashing. After the drivers are installed, the debug LED will remain lit. A flashing debug LED means that the board was not recognized by the PC/Mac.

2.4 Programming the ACD52832 board

Since the ACD52832 board incorporates a genuine Segger J-Link debugging device with drag & drop programming functionality, there are two ways of programming the ACD52832: Using drag & drop without an IDE or within an IDE.

Without an IDE you can create your firmware e.g. using the mbed online developing tool. After you created the *.hex file, simple put it on to the "J-Link" called mass storage device.
During the programming process, the J-Link device will shortly disappear. When it shows up again, the programming process is finished and your board is ready to go.
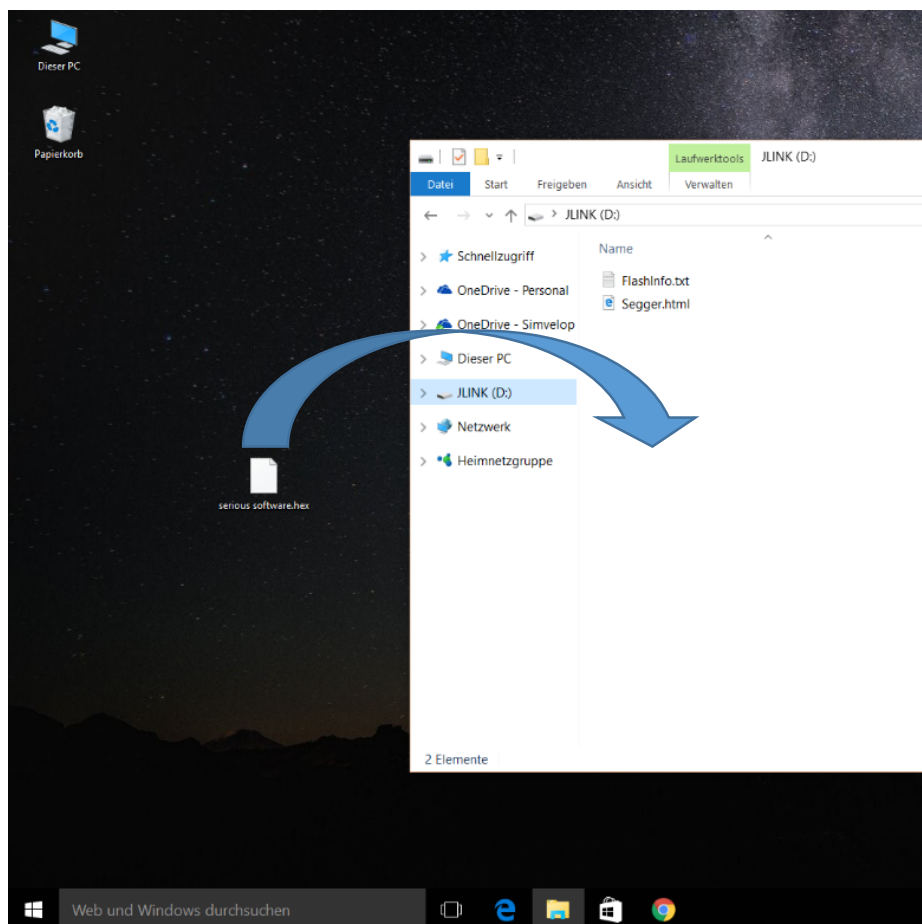

Picture 1: Programming with drag & drop

Programming with an IDE depends very much on which one you are using. aconno recommends the usage of the ARM Keil development platform since it has a broad support base among the different development and maker platforms.

In Keil the ACD52832 is automatically recognised. The only thing you have to do is to choose the J-Link device from the available programming standards.

Go to "Options for Target" window and choose the "debug" card.
Once there, choose the "use:" List button and select the "J-Link / J-Trace Cortex" entry.
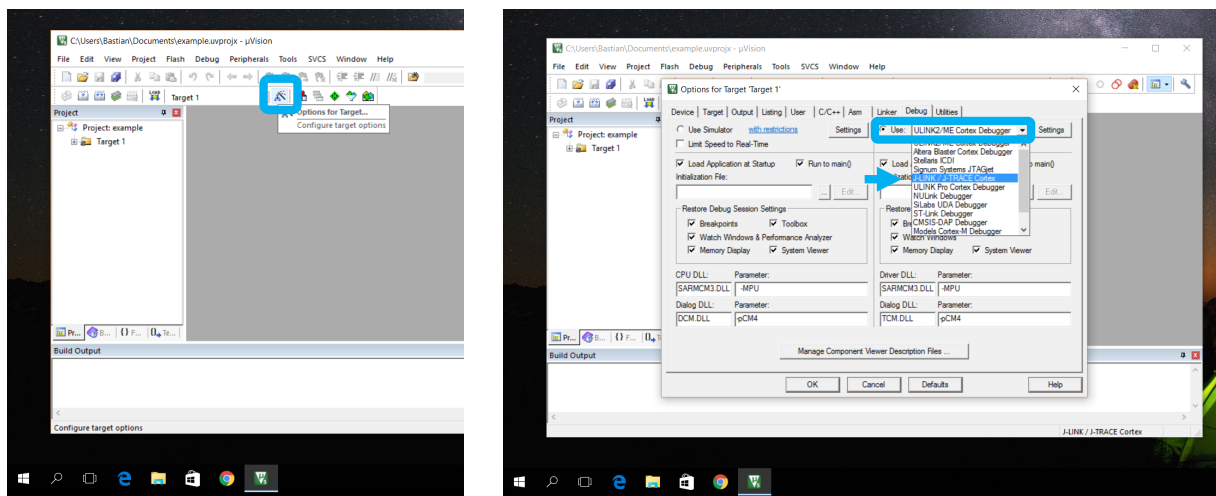

Picture 2: Selection within an IDE

That's it. You are now ready to go and program your ACD52832 board!
You can test if the connection of the J-Link programmer is stable. Simply click on the "Settings" Button on the right side of the "Use:" select bar.

Here you can see and change various settings like connection speeds. You can e.g. reset states. What you should see is a serial number in the "Serial" field.
If you don't see a number, please check your USB connection and drivers.

Close the Window and start to explore the ACD52832. If you have your program, just click on the "Load" icon and your program will be automatically downloaded to the board.
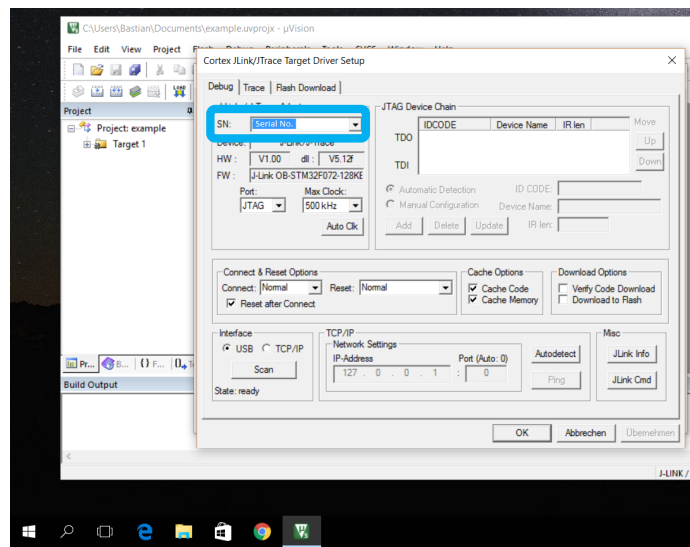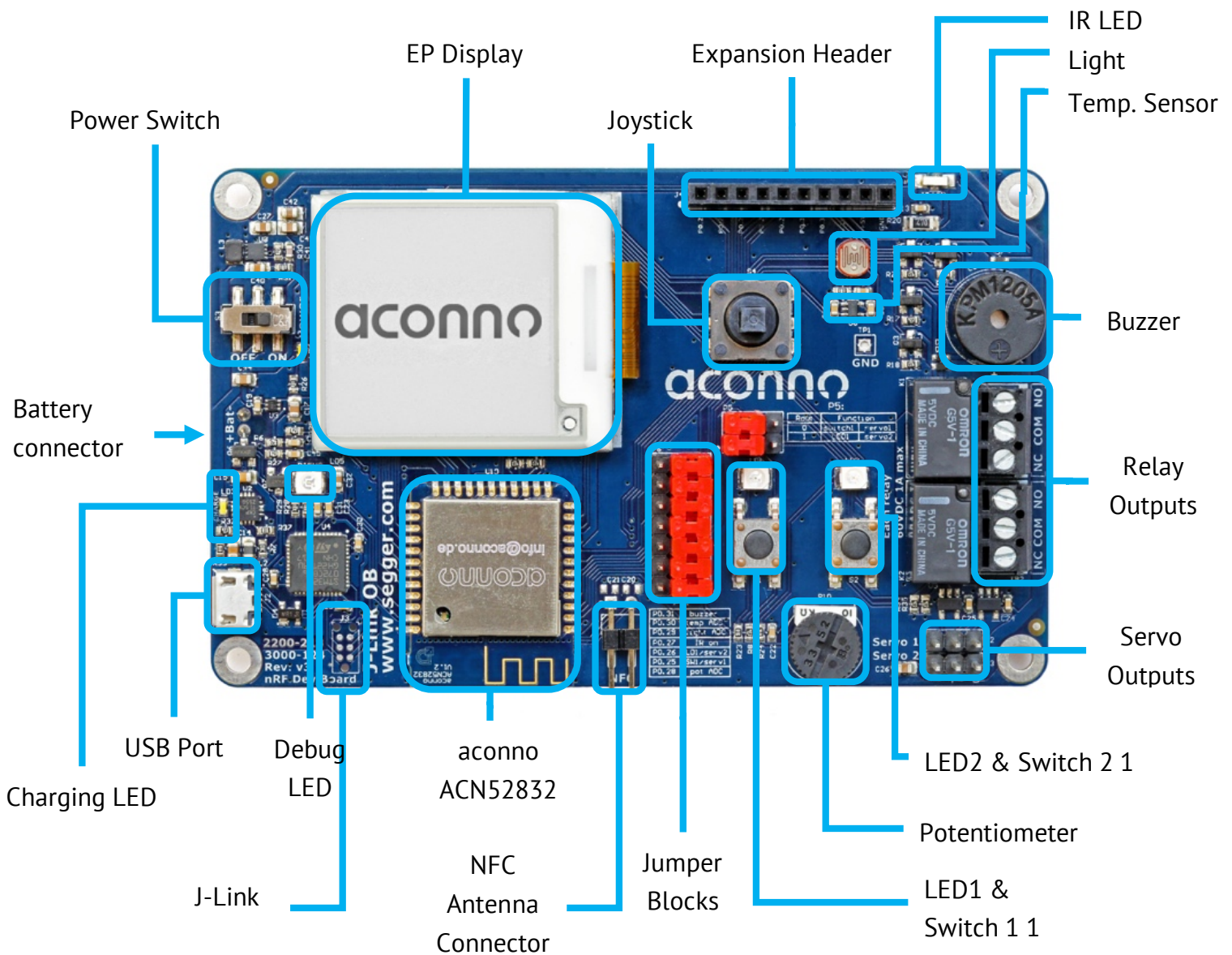

Picture 3: Settings of the J-Link programmer

3. The Board – overview

Here we show the main components of the board. Please note that the descriptions below do not necessarily match with the actual terms, which you can find and check on the aconno ACD52832 board itself.

## 3.1 Overview of the board

3.2 The ACN52832 Bluetooth Smart Module

The heart of the ACD52832 board is the ACN52832 module, which incorporates the highly integrated nRF52832 SoC from Nordic Semiconductor. It is equipped with an ARM Cortex M4F processing core and a 2.4 GHz radio module and is fully compatible with the Bluetooth Smart (former BLE) standard. Its capabilities are tailored for the upcoming demands of sophisticated IoT devices where small size, low power, application performance and radio-range are essential.

Features of the ACN52832 module:

- 32-bit ARM© Cortex™ M4F high performance 64 MHz processor core
- 512kB flash
- 64 kB RAM
- 2.4 GHz RF module with Bluetooth Smart and ANT+ compatibility
- Up to 32 GPIOs with flexible module pin mapping
- On-board RGB LED
- Programmable peripherals for CPU-less operation
- SPI / UART / TWI (I2C)
- 200 ksps 12-bit ADC
- Low power comparator
- I2S and PDM peripherals for audio
- Quadrature demodulator

- -20 dBm to +4 dBm output power
- Ultra-low power consumption
- Temperature Range: -40°C to +85°C
- Wide supply voltage range: 1.7V to 3.6V
- NFC-A Tag for OOB Bluetooth Smart pairing and "wakeup on field"
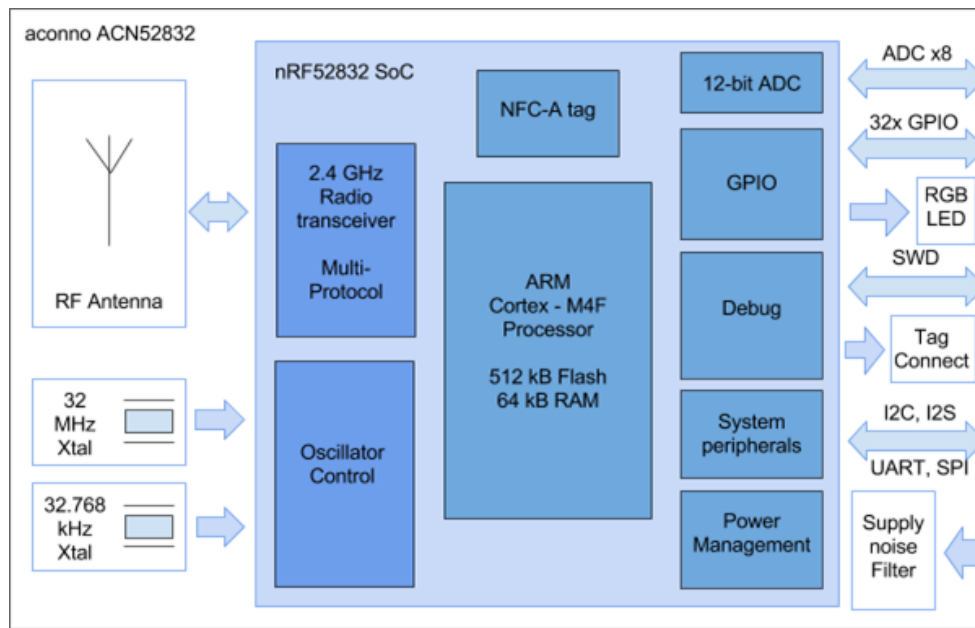
Picture 2: Inside the ACN52832

4. Connection pinout – peripherals and jumper description

The following chapter describes the jumper header and expansion header pinouts and their functions.
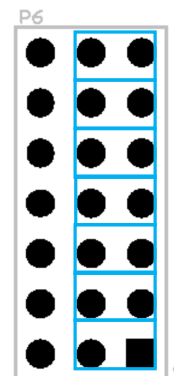
4.1. Jumper Blocks

The ACD52832 is equipped with various jumper blocks to give the developer total control of the board features. In order to use the on-board devices and expansion pin headers correctly, we recommend that the developer acquires a good understanding of jumper blocks first.

Jumper block P6

The P6 jumper block gives you the choice to either use an on-board component (i.e. the readout of the light sensor) or an expansion header pin on a certain controller pin. The jumper in the position left connects the corresponding on-board device, in the position right it routes the controller pin to the expansion header J4.
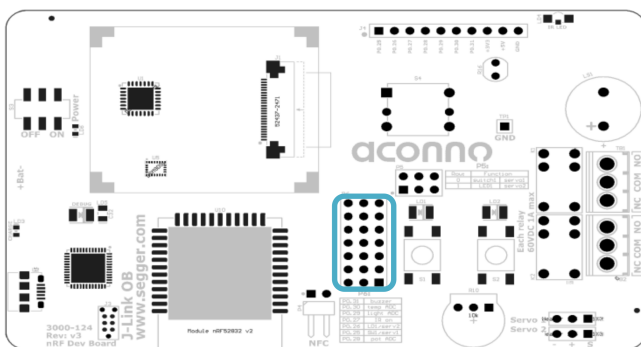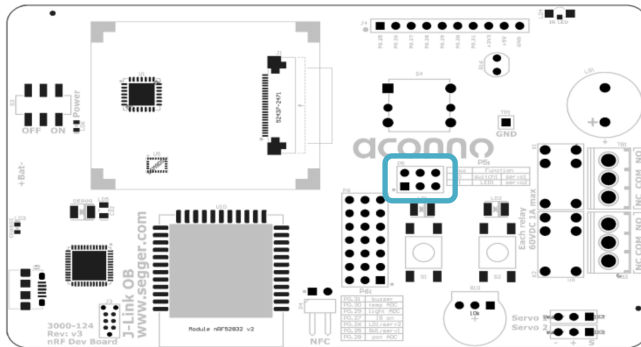

Picture 3: Position on the board
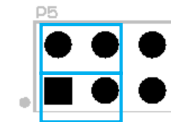

Picture 4: Jumper block P6

	left position	right position
nRF52823 Pin	Exp. Header Pin	on Board dev.
DIG3 / P0.31	7	Buzzer
AIN5 / P0.29	5	Light Sensor
AIN6 / P0.30	6	Temp Sensor
DIG2 / P0.27	3	IR Emitter
DIG1 / P0.26	2	LED1 / Servo 2
DIG0 / P0.25	1	SW1 / Servo 1
AIN4 / P0.28	4	ADC Pot

Jumper block P5

The jumper block P5 determines the usage of the controller pins P0.25 and P0.26 if these were selected through jumper block P6 for internal usage. It is possible to use pin P0.25 as source for the Servo 1 output or as input for the switch SW1. For pin P0.26 the choice is between a source for Servo 2 or LED2.
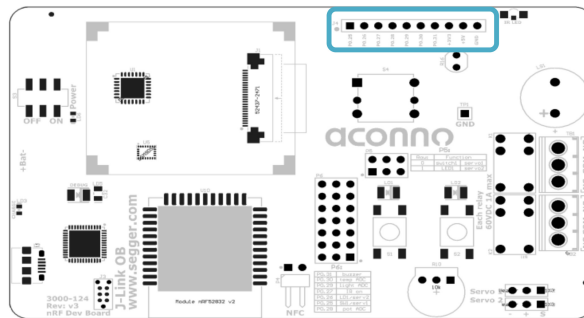

Picture 5: Position on the board

Picture 6: Jumper block P5

nRF52823 Pin	left position	right position
DIG0 / P0.25	SW1	Servo 1
DIG1 / P0.26	LED1	Servo 2

4.2. Expansion Header

The expansion header is intended to expose the GPIOs of the ACN52832 module to external circuits. Supply voltages and a ground connection are also available at this header.


Picture 7: Position on the board

Controller Pin	Header Pin
DIG0 / P0.25	1
DIG1 / P0.26	2
DIG2/ P0.27	3
AIN4 / P0.28	4
AIN5 / P0.29	5
AIN6 / P0.30	6
DIG3 / P0.31	7
+3.3V	8
+5.0V	9
GND	10

5: On-Board Features

The ACD52832 incorporates a variety of on-board features in order to speed up the development process of devices which make use of the aconno ACN52832 module. In the following subchapters each device will be described with corresponding ACN52832 module connections and requirements.

The connections of the ACN52832 module are shown below. The ACN52832 is supplied through the +3.3V rail of the board and has direct connections to the I²C-, EPD, battery sense- and J-Link debug devices. The NFC-pins are connected to a 2.54 mm header and allow the connection of an NFC field coil. There are pads on the board near to the connector to equip 0603 capacitors according to the used field coil.

Note: The pull up resistors for the I²C bus are 4.7 kOhm resistors which are supplied also through the +3.3V rail.
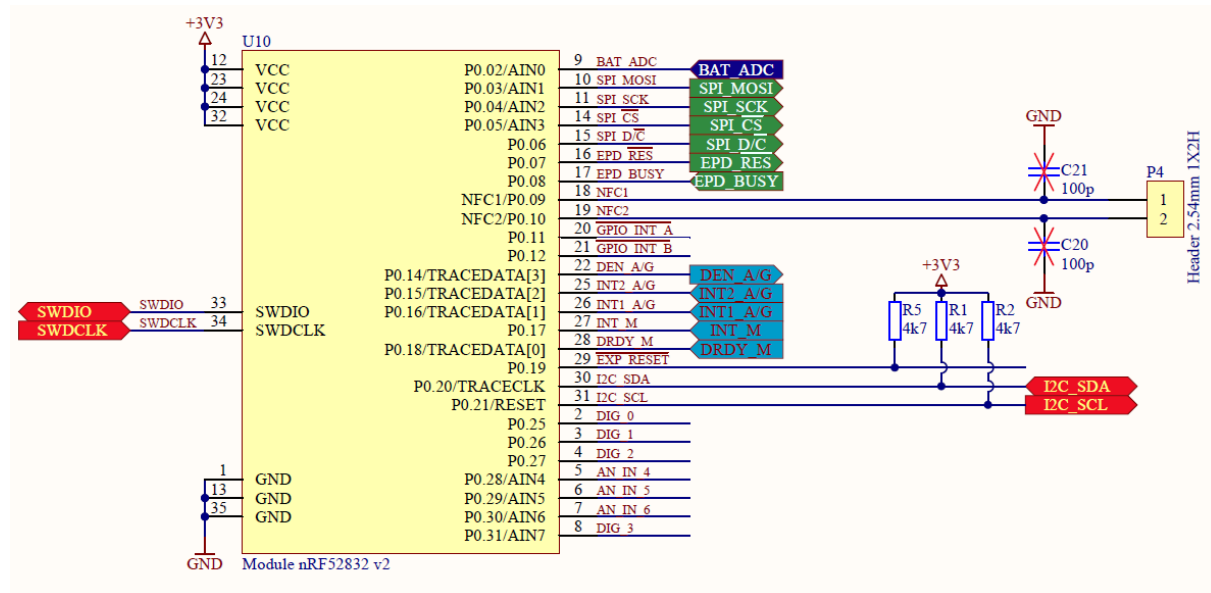
Picture 8: ACN52832 Connections

5.1. Inertial Module

The ACD52832 incorporates a highly integrated iNEMO inertial module by STMicroelectronics. It allows the measurement of acceleration, angular moving rate and magnetic field strength in all three dimensions.

The measurement range is selectable and depends on your application:

±2 /   ±4 /   ±6 /   ±8 g linear acceleration full scale
±4 /   ±8 /   ±12 /   ±16 gauss magnetic field strength full scale
±245 /   ±500 /   ±2000   dps angular rate full scale

The communication between the nRF52832 and the inertial module is realised through the I²C interface and various interrupt lines which can also be configured through the I²C bus.
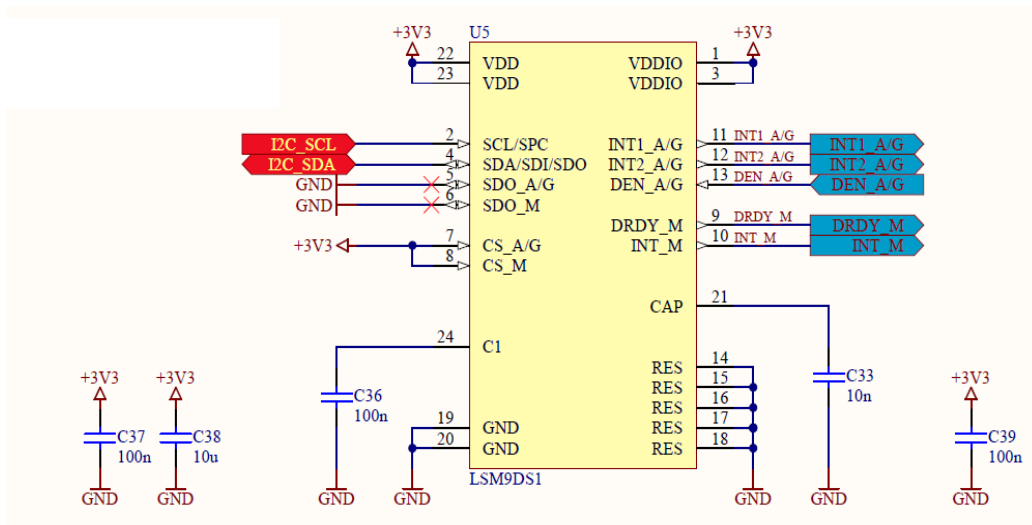
Gyroscope / accelerometer address: 1101 010
Magnetometer address: 0011 100

For more information see the component manufacturer's datasheet: http://www.st.com/resource/en/datasheet/lsm9ds0.pdf
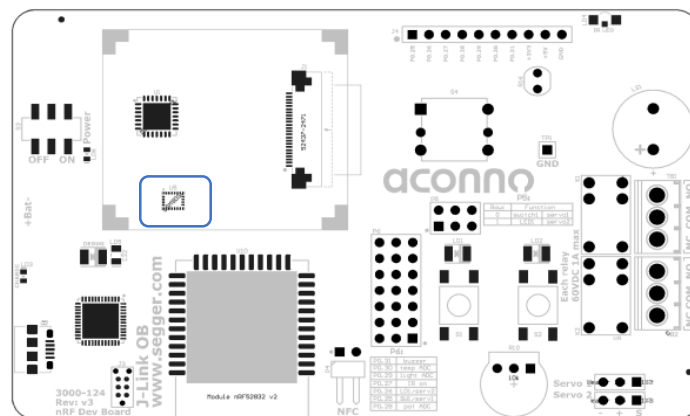
Picture 4: Position on the board

*Picture 5: Inertial module circuit*

5.2. EP Display

The ACD52832 features a graphical HiRes, easy to use, 1.54 inch electronic paper display with nearly no power consumption.

No power supply is needed to display screen content. The screen content is maintained even in case of a power loss.

Power is only needed to refresh the screen content. The resolution is 200 x 200 pixels at a density of 184 dpi. It also features high contrast, ultra-wide viewing angle and high reflectance.
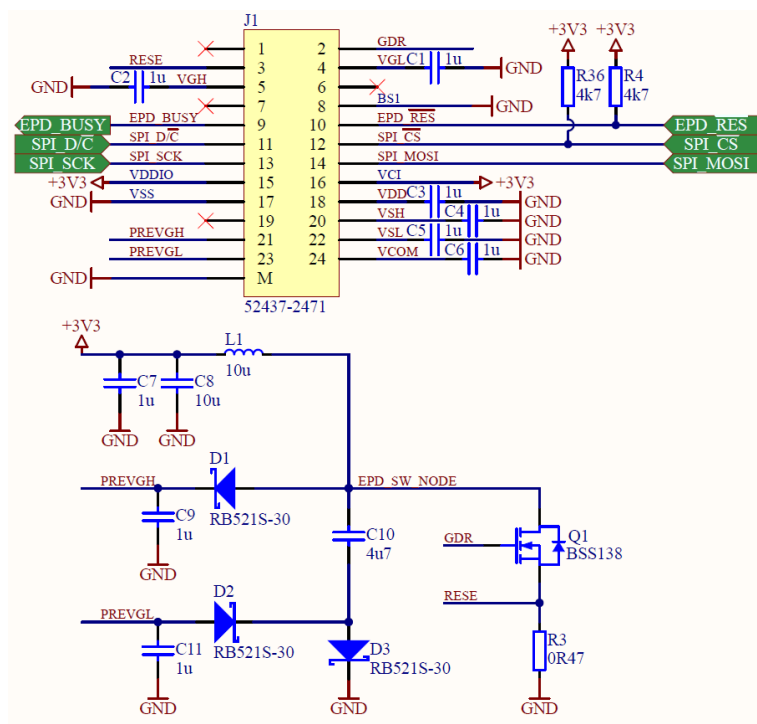

Picture 7: Electronic paper Display
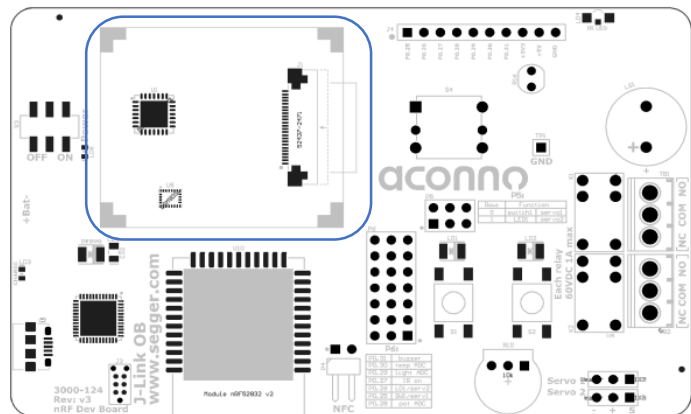
Picture 6: Position on the board

The control of the display is directly realised through the SPI Bus and the nRF52832 controller.

Picture 8: EPD circuit

Controller pin	Display pin
AIN1 / P0.03	SPI_MOSI
AIN2 / P0.04	SPI_SCK
AIN3 / P0.05	SPI_CS
P0.06	SPI_D/C
P0.07	EPD_RES
P0.08	EPD_BUSY

5.3. Temperature Sensor

To provide environmental information, the ACD52832 is equipped with an active thermistor IC. It delivers an analogue voltage which linearly rises with a rising temperature. The readout is, when selected through the P6 jumper block, done by the AIN6 pin of the nRF52823 controller.

The output voltage can be calculated using the following formula:

$$V_{Out} = 500\ mV + \ 10\frac{mV}{°C} * T_A$$

Where T_A is the ambient temperature and V_{OUT} the output voltage.
For more information, refer to the manufacturer's data sheet:
http://ww1.microchip.com/downloads/en/DeviceDoc/20001942G.pdf
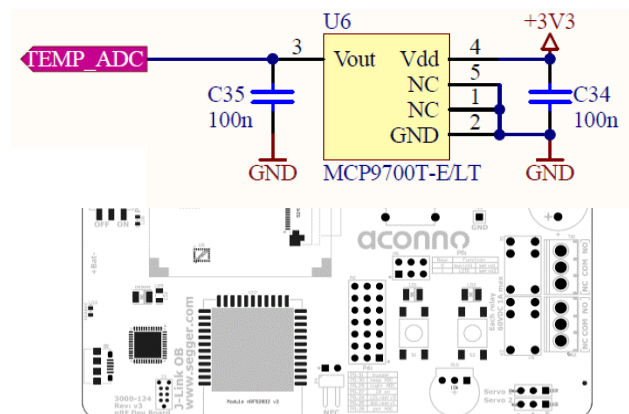
Picture 9: Position on the board

5.4. Light Sensitive Sensor

To determine the amount of light in its environment, the ACD52832 is equipped with a Light Dependent Resistor (LDR). At complete darkness, the circuit provides about 140 mV; if the LDR is illuminated, the voltage rises to about 1,25 V. The read out is available when selected through jumper block P6, at nRF52832 pin AIN5.
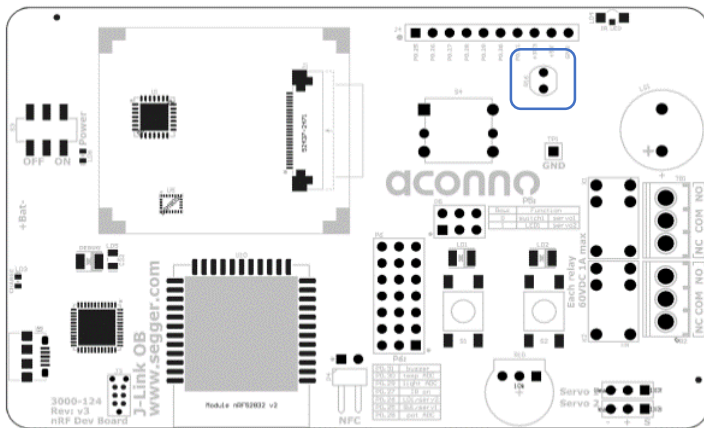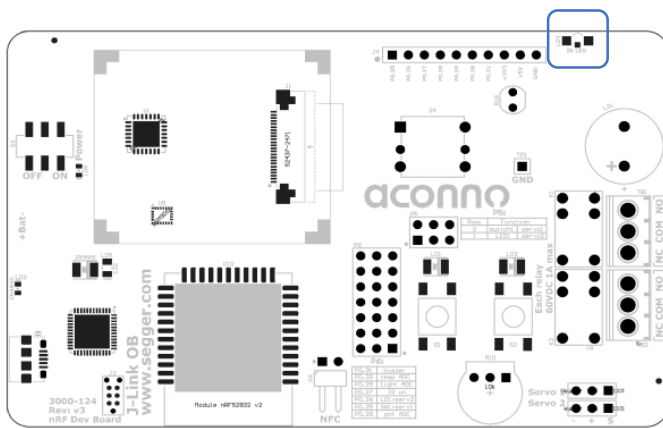

Picture 11: Position on the board
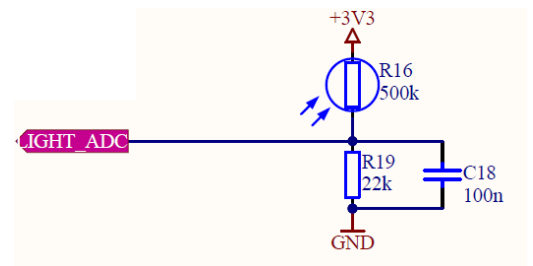
Picture 10: LDR circuit

5.5. IR-Emitter

To enable communication with IR controlled devices (i.e. televisions or receivers), the ACD52832 is equipped with a 940 nm high power, high speed, side emitting GaAlAs IR LED. By the use of a discrete output stage, the LED can be driven with high power, enabling it to reach high distances with ease. It can be driven, when selected through jumper block P6, directly by the DIG2 pin of the nRF52832. For more information, see manufacturer's data sheet: http://www.vishay.com/docs/84170/vsmb10940.pdf

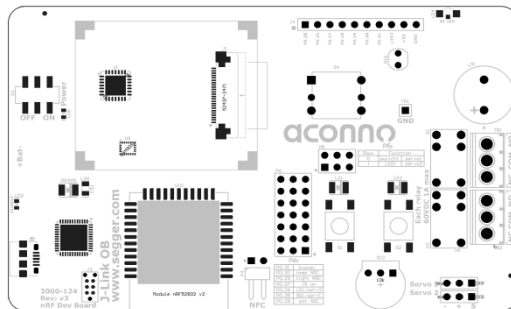*Picture 13: Position on the board*
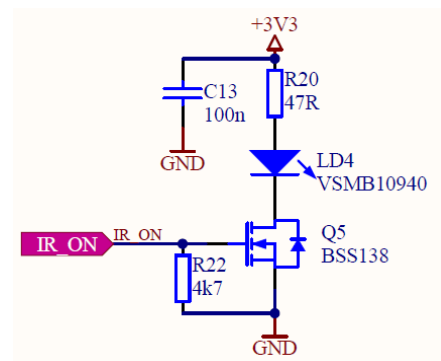

Picture 12: IR emitter circuit

5.6. PWM-Servo Outputs

Two high speed driver stages were implemented in order to enable the ACD52832 to drive RC-Servos, This allows the developer to use high speed, high power RC-Servos for mechanical development.

Please note that the two servo outputs must be selected through jumper blocks P5 and P6 to function properly. If both servo outputs are enabled, it is not possible to use SW1 and LED1.


Picture 19: Position on the board
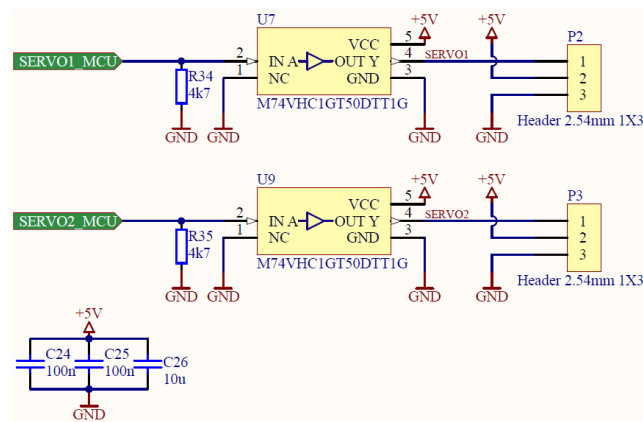
Picture 14: Servo drive circuit

Controller pin	Servo output
DIG0 / P0.25	Servo 1
DIG1 / P0.26	Servo 2

Detailed below are the PWM waveforms of the servo output. Since there are two output buffers, each for one servo channel, there is no need for an additional driving stage. The servos can be directly connected to the board.
The signal has an amplitude of 5V and a period time of 20 milliseconds, which means the output works with 50 frames per second.

The servo responds to the applied on-time of the signal. With an on-time of 0,5 milliseconds, the servo drives to its farthest counter clock wise point of action. If the signal increases its length, the servo keeps moving clockwise. With 1.45ms it is in its default middle position. With 2.4 milliseconds it will move to its farthest clock wise point of action. In the diagram below its moving angle is displayed with 0° in the middle of its action radius.
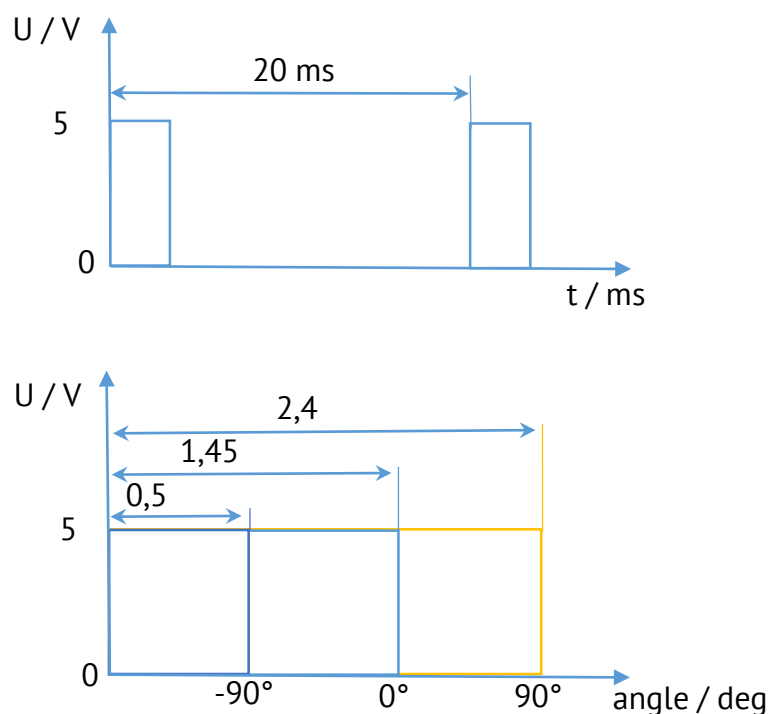
*Picture 15: PWM waveforms for the servo control*

5.7. User Interfaces

The user interfaces (except SW1 and LED1) are realised through an MCP23017 I²C port-expander by Microchip Technology Inc. TheSw1 and LED1 devices are connected directly to the nRF52832 Soc. This ensures a tiny user interface even if the I²C bus is not used or initialised. Also the two relay outputs are driven through this IC. To ensure a near real time tracking of events that occur at this controller, two interrupt lines exist, connecting the nRF52832 controller and the I²C expander. Their function can be easily configured through the I²C bus. For more information, refer to the manufacturer's data sheet: http://ww1.microchip.com/downloads/en/DeviceDoc/20001952C.pdf
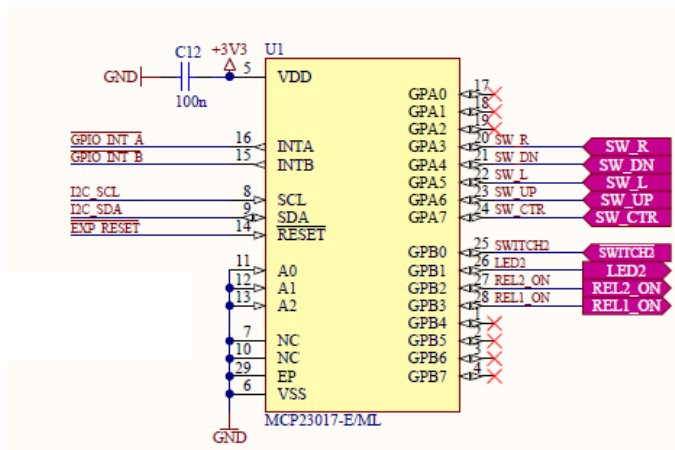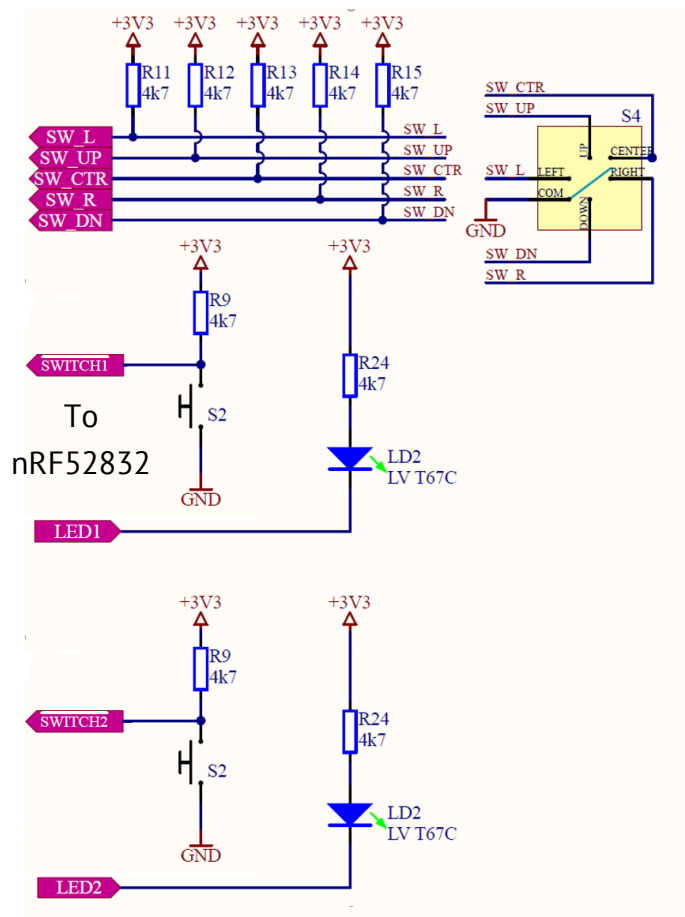

Picture 16: I²C expander circuit

I²C address: 0100 000

The user interface devices are connected as follows:
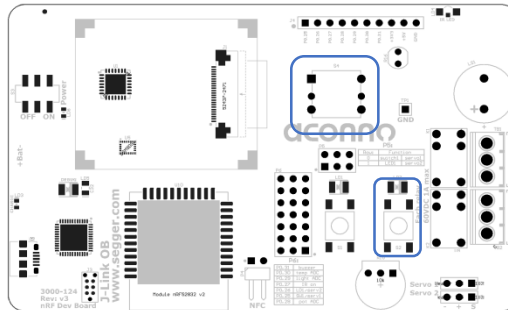
*Picture 18: Position on the board*

Picture 17: User interface circuit

5.8. ADC Potentiometer

The ACD52832 features a classical potentiometer as user input device. It is also useful to evaluate the nRF52832 ADC capabilities. The readout is possible, if the potentiometer input was selected through the P6 jumper block, at nRF52832 pin AIN4.
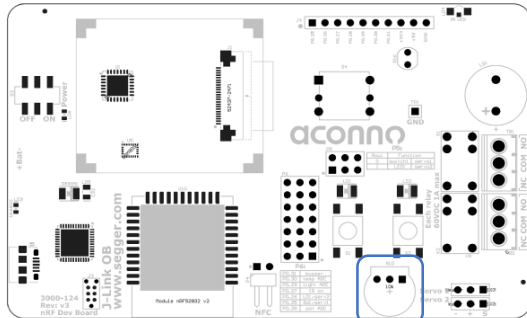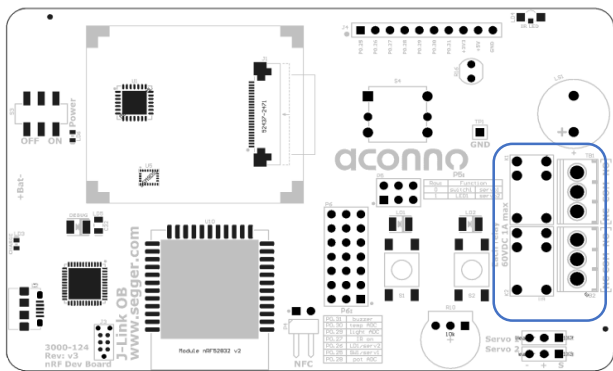

Picture 20: Position on the board
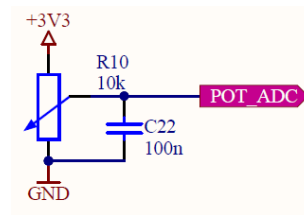
Picture 19: ADC Pot circuit
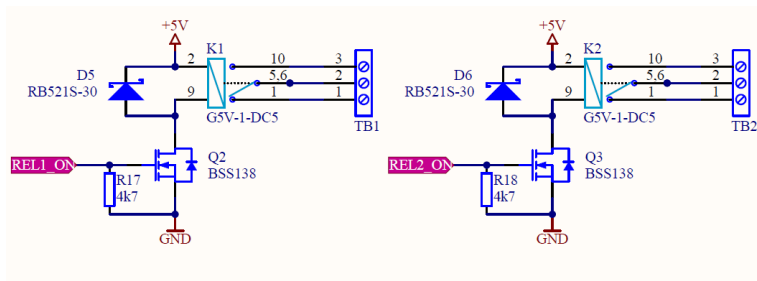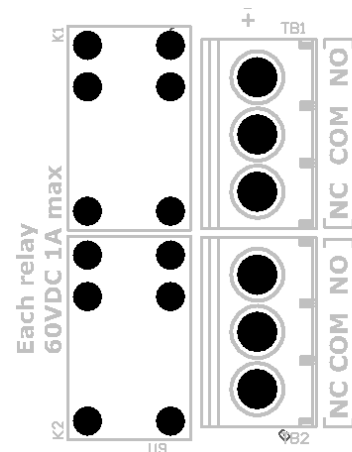
5.9. Relay Outputs

Two relay outputs allow switching external circuitry without the need of a certain reference potential. The relays can drive each 125 VAC / 60 VDC @ 1Amp. Their control is realised through the MCP23017 I²C expander IC at the following ports:
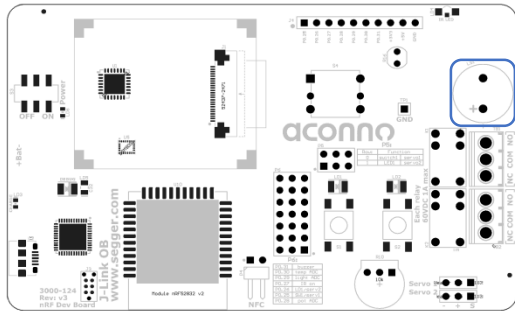
Relay 1 : GPB3
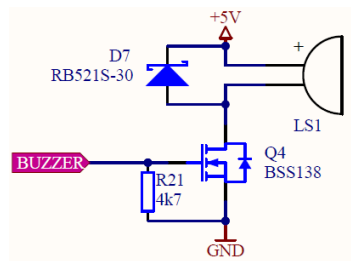Relay 2 : GPB2

Picture 21: Position on the board

Picture 22: Relay drive circuit

5.10. Buzzer

To provide acoustical feedback, the ACD52832 is equipped with a magneto-acoustical buzzer. Its resonance frequency is around 2.4 kHz. It can be directly driven, when selected through jumper block P6, by the nRF52832 DIG3 pin.

*Picture 24: Position on the board*

Picture 23: Buzzer circuit

5.11. Segger J-Link OB programmer

The aconno ACD52832 board features a Segger J-Link OB programming and debugging device. It manages the USB communication at the USB port and delivers debugging information's and controls the programming process of the ACN52832 module.
Please note that::

- The Segger J-Link device will only start up when the supply voltage is stable. A faulty battery or to high input voltage ripple will deactivate the device.
- The output ports, which are connecting the J-Link programmer with the ACN52832 board are only 3,3V tolerant. In normal cases, this is not worth mentioning. But if you apply 5V to these pins both devices, the J-Link Programmer and the ACN52832 could suffer permanent damage.
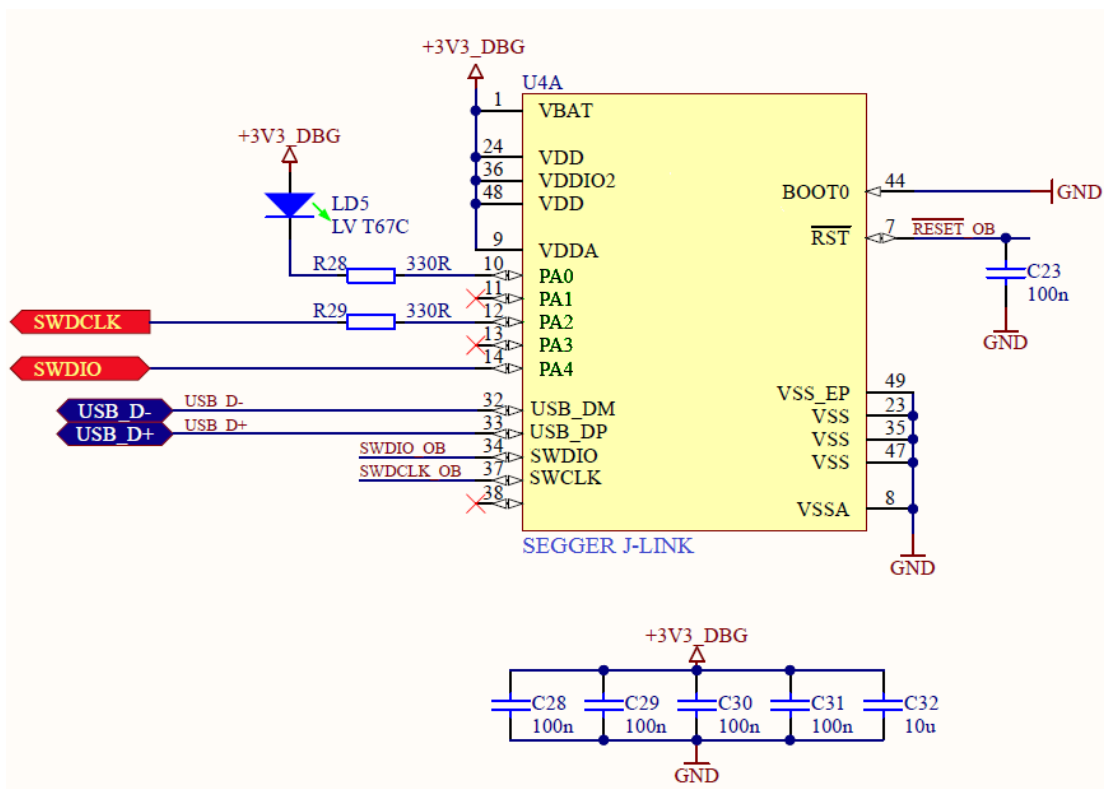
*Picture 25: J-Link programming device*

5.12. Power Supply and Battery Charger

The ACD52832 provides a Texas Instruments BQ24072RGTR Li-Ion and Li-Po charging controller with integrated USB – battery power change over functionality. This function will automatically change the power supply of the board from USB to battery if the USB connection is lost. The maximum charging current is set to 500 mA to ensure USB compliance. The actual battery voltage can be measured though the AIN0 pin of the nRF52832 controller. The maximum measurable voltage is 2.1V.
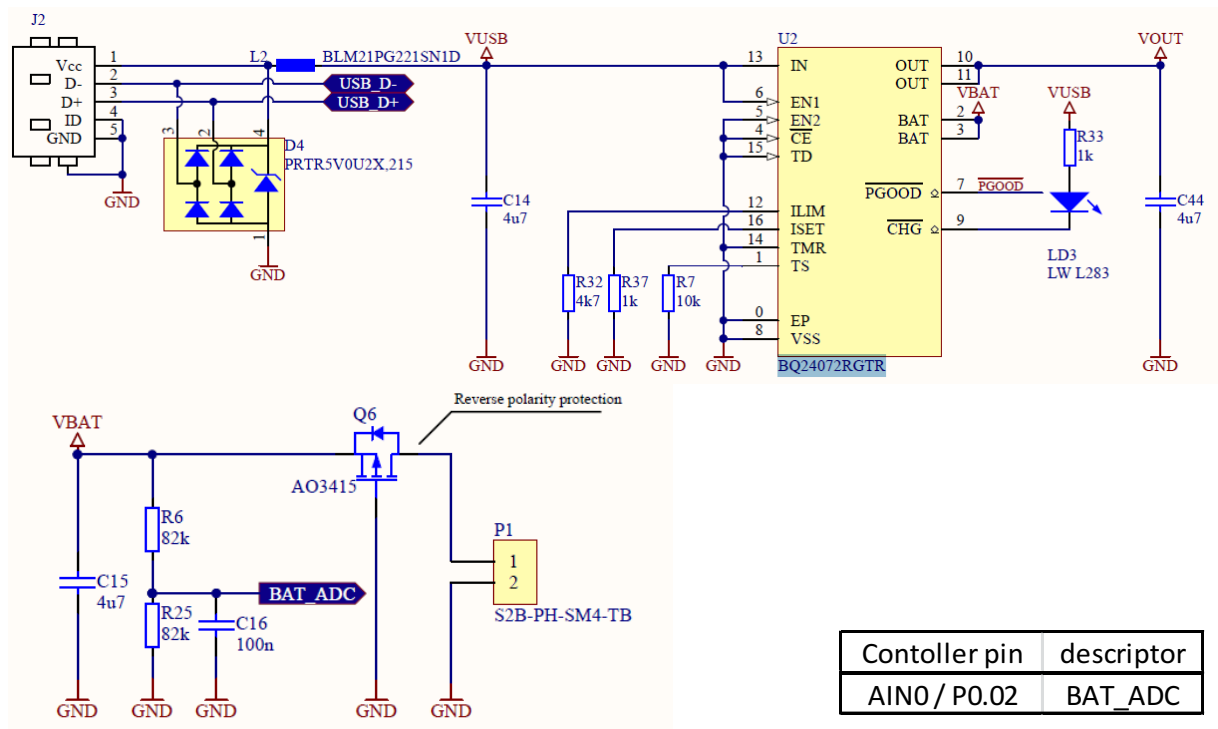
Picture 26: Charging circuit

Contoller pin	descriptor
AIN0 / P0.02	BAT_ADC

The power supply circuit of the ACD52832 consists of two main parts: A step-up regulator which provides constant +5V for on-board devices, independent of the actual battery voltage. In a second stage, +3.3V are supplied through a LDO from the regulated +5V rail. Note: The +3.3V_DBG connection supplies the Segger J-Link programming and debugging device. This device is first powered up when the charging controller confirms a stable power supply.
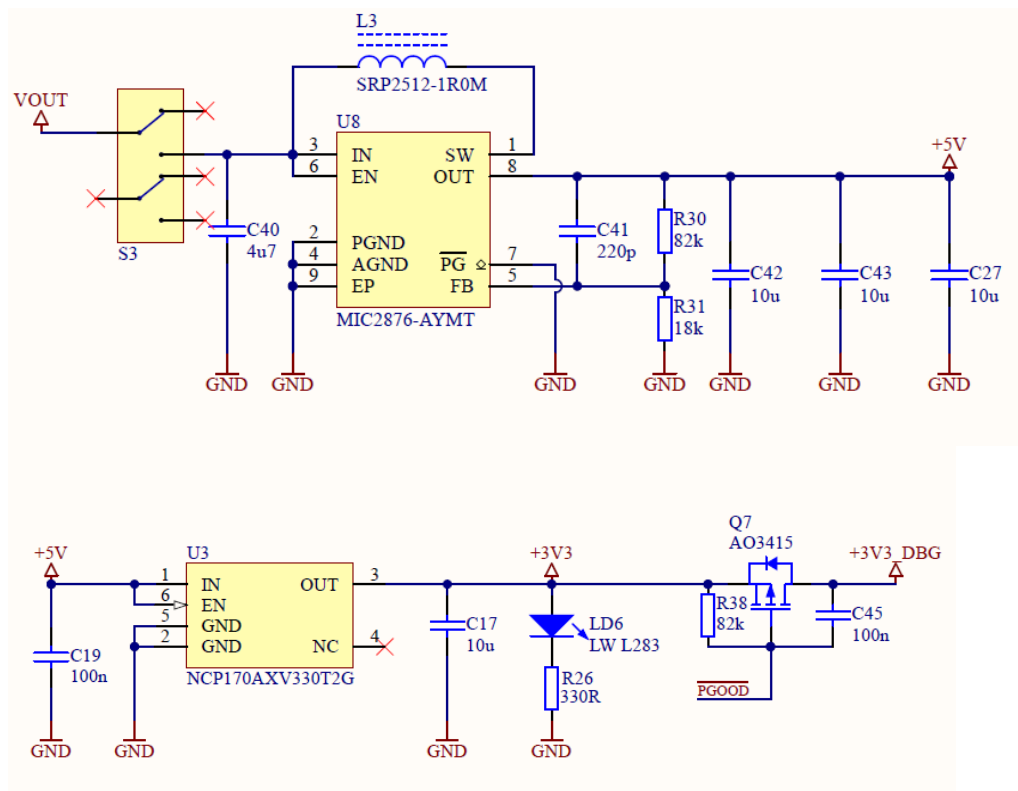
Picture 27: power supply circuit

6. Mechanical Dimensions

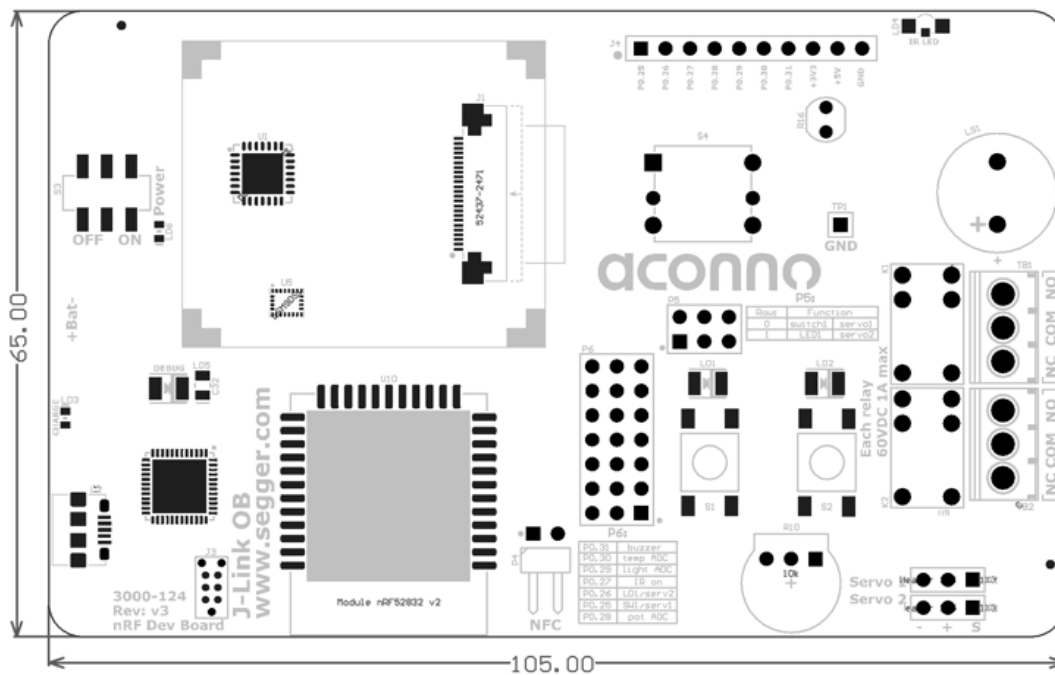Note that all dimensions are expressed in millimeters.

Figure 32: Mechanical Dimensions in mm

The three highest elements on the board in order from the tallest to the shortest one are: Joystick S4 - 10.5mm over the pcb; the relays K1 and K2 – 10.1mm; buzzer LS1 – 9.00mm.
Note that the above measure does not include the pcb.

7. Revision History

In this chapter you will find the current and previous version of the document you are reading. Also the website for your device is listed. Be sure to check it after your purchase for the latest available updates and examples.

Revision	Changes	Modified page #
A	Initial Release	All
04.08.2016		

8. Contact Information

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