Trigger Box

Specification

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Document history

Version	Date	Comment	Author
1.0	2018-12-18	Initial release	Bengt Ragnemalm
1.1	2019-02-27	New data formats	Bengt Ragnemalm
1.2	2019-04-05	More detailed descriptions	Bengt Ragnemalm

Table of Contents

1 Specification 4

1.1 Picture from design meeting between Sarah and Bengt 2018-12-18 4

2 Physical 4

3 Software 4

3.1 Data format 4

3.2 Commands 5

3.2.1 Command time-out 5

3.2.2 Digital Trigger 5

3.2.3 Analogue Trigger 5

3.2.4 Cancel Trigger 5

4 Hardware 6

4.1 Power 6

4.2 Parts 6

4.3 Connections 6

4.4 Schematics 7

4.4.1 Arduino MKR Zero 7

4.4.2 PmodUSBUART 8

4.4.3 PmodRS232 8

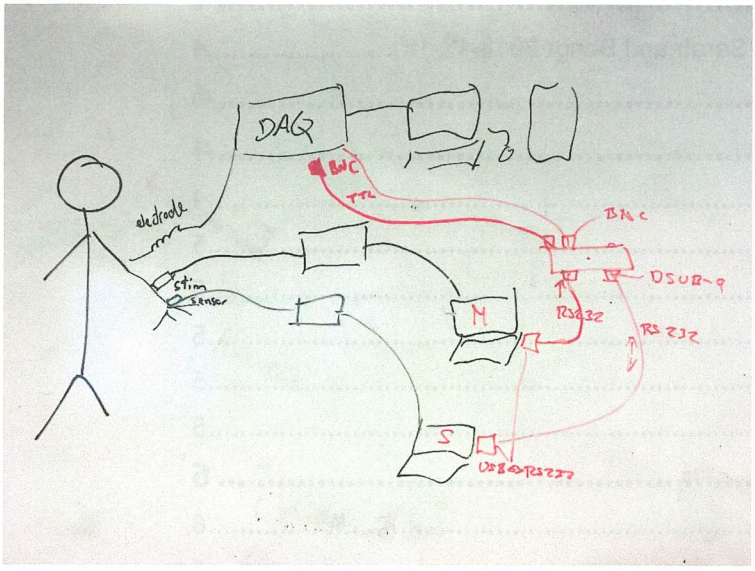
4.4.4 PmodDA4 8

5 Programming 9

5.1 Connection of debugger 9

1 Specification

1.1 Picture from design meeting between Sarah and Bengt 2018-12-18



2 Physical

Connections:

Digital

Nr 1. USB input/output. Converted to RS232 inside the box.

Also used for power. 5 V, < 100 mA.

Nr 2. RS232 output. DSUB-9, female.

Analogue outputs:

Nr 3-5. BNC, 5 psc. Current limited with 1 k ohm resistors.

Reset push button

3 Software

3.1 Data format

For simplicity, most command uses the same length and data format as below. Each rectangle represents one 8 bit byte.

Byte nr:	0	1	2	3	4	5
Purpose:	Start	Commandn nr	Param 1	Param 2	Param 3	Param 4

Start character = 'S'. In case of failure in the data transmission there is a command time-out of 500 ms after the command handler is reset.

Baud rate is 1200. There is no hardware handshaking.

3.2 Commands

Command input must be done on connector 1.

Output can be on any of the analog or digital outputs. Sending a level on a digital output will have no effect.

Note: Unused parameters must always be filled up with zeroes as the command handler always expects 4 parameters.

Parameters for command 01-03 are all 8 bits integers.

3.2.1 Command time-out

In case of failure there is a time-out of 2 seconds for commands.

3.2.2 Digital Trigger

This command will send out one byte to one of the digital outputs. The time from receiving the command to sending out the trigger is set by the parameters.

Format:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Start character	Param 1	Param 2	Param 3	Param 4	Param 5
	Command nr	Output	Byte to send	X = Time MSB. Time = X * 10 ms). X is 16 bits splitted on parameter 4 and 5.	X = Time LSB
'S'	1	3-7	0-255 [1]	Param 4 & 5 = 0-65535 [2]	

[1] A single character can also be used.
[2] If time is set to 0 the output will be on forever.

3.2.3 Analogue Trigger

This command will send out an analogue trigger signal to one of analogue outputs. The trigger will be active from receiving the command until the time set by the parameters.

Format:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Start character	Param 1	Param 2	Param 3	Param 4	Param 5
	Command nr	Output	Output level. Output voltage = value/10	X = Time MSB. Time = X * 10 ms). X is 16 bits splitted on parameter 4 and 5.	X = Time LSB
'S'	2	~~1-7~~ 3-7	0-50	Param 4 & 5 = 0-65535 [1]	

[1] If time is set to 0 the output will be on forever.

3.2.4 Cancel Trigger

This command will cancel a previously activated trigger.

Format:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Start character	Param 1	Param 2	Param 3	Param 4	Param 5
	Command nr	Output	Not used	Not used	Not used
'S'	3	1-7	0	0	0

4 Hardware

4.1 Power

All circuit boards except PmodDA4 use +3.3V to power the internal circuitry. The +3.3V power is delivered from the external USB supply through the PmodUSBUART.

+5V is used to power the PmodDA4 to get 5V output capability. This power is picked up directly at the PmodUSBUART board at C6, inner side closest to USB connector.

PmodDA4 is supplied with VCC = +5 V and is patched to modify the DAC reference to VCC. PmodDA4 has only inputs and is therefore fully compatible with +3.3V without any level shifters.

4.2 Parts

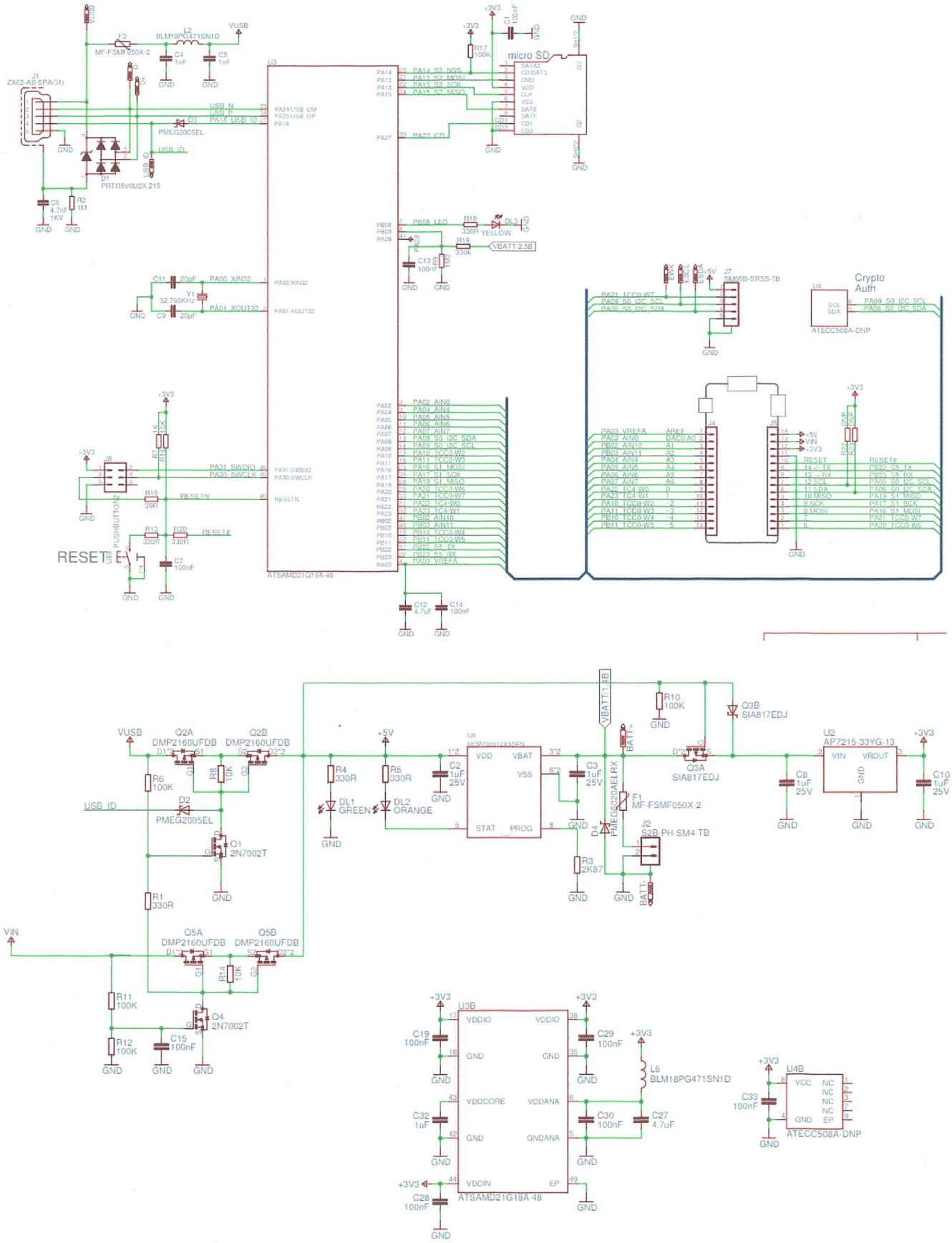
CPU board:	Arduino MKR Zero Microcontroller chip: ATSAMD21G18A
USB to serial UART interface	PmodUSBUART USB to to UART converter chip: FT232RQ Jumper set to pos VCC-SYS3V3 Jumper between J2-1 and J2-4
RS232 interface	PmodRS232 RS232 to UART converter chip: ADM3232E Jumpers set to: JP1 Open JP2 closed
Analogue output interface	PmodDA4. Eight channel analogue outputs DAC chip: AD5628 The board is patched to output 0-5 V by means of a connection between C1+ and IC1 pin 7

4.3 Connections

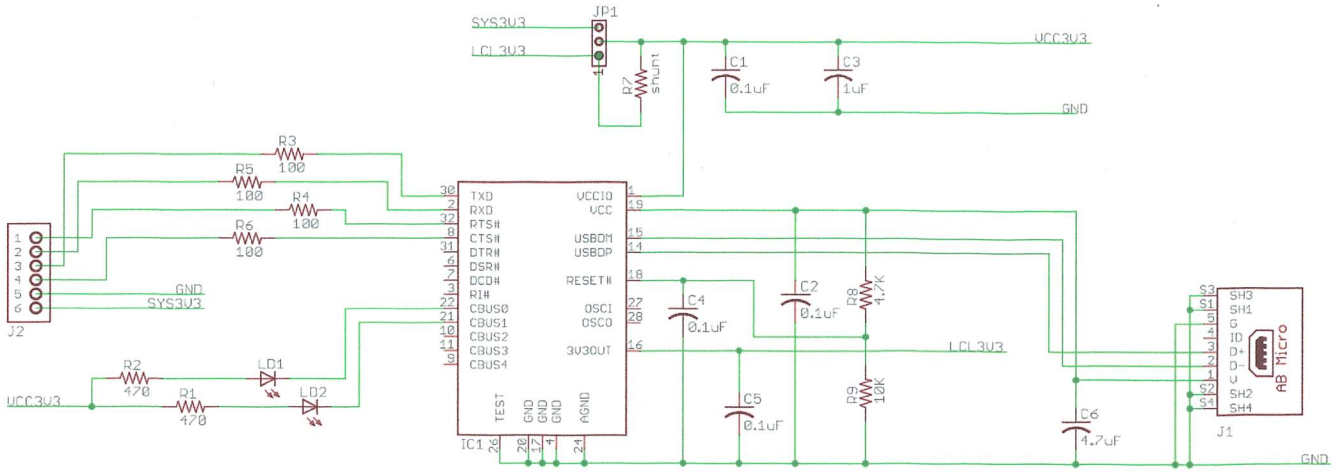
Arduino MKR Zero	PmodUSBUART	PmodRS232	PmodDA4	BNC out
VCC	J2-6	J1-6		
GND	J2-5	J1-5	J2-5	Common GND
	C6+ (USB +5V)		J2-6	
TX (out) [USART 5]	J2-2 (RX, in)			
RX (in) [USART 5]	J2-3 (TX, out)			
A5 (out) [USART 0]		J1-4 (RX, in)		
A6 (in) [USART 0]		J1-3 (TX, out)		
SCK			J2-4 (SCLK)	
MOSI			J2-2 (DIN)	
7 (I/O PA21)			J2-1 (SYNC)	
			Out 0	3
			Out 1	4
			Out 2	5
			Out 3	6
			Out 4	7

4.4 Schematics

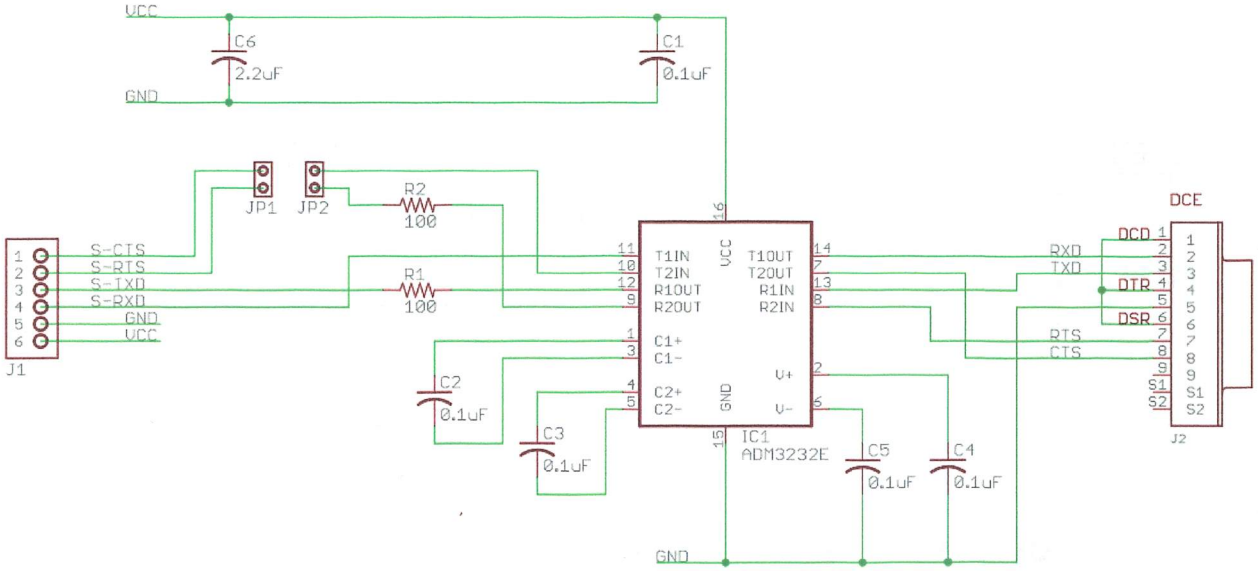
4.4.1 Arduino MKR Zero



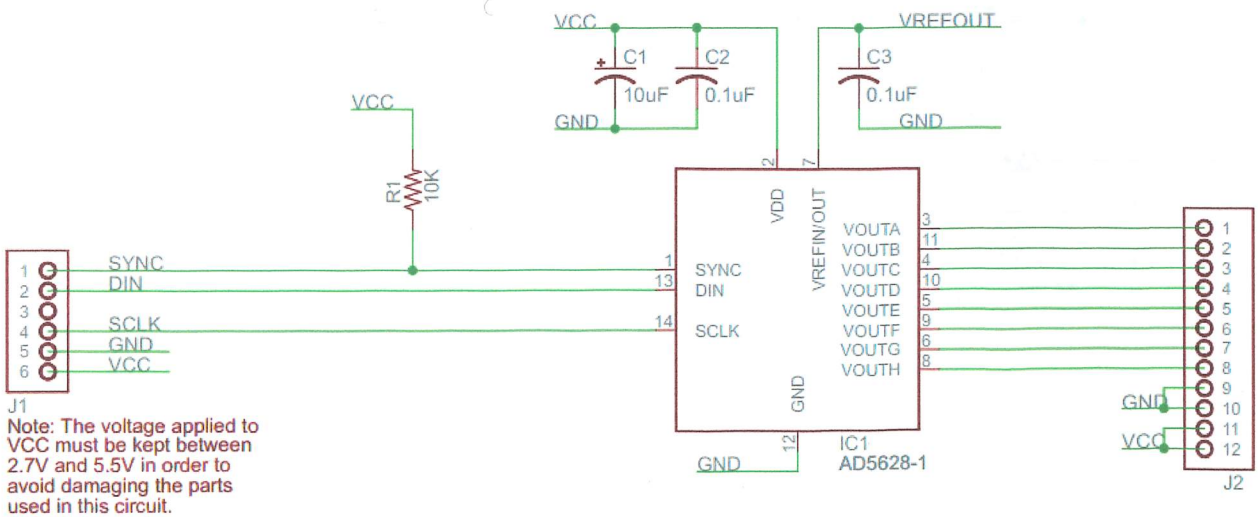
4.4.2 PmodUSBUART



4.4.3 PmodRS232



4.4.4 PmodDA4

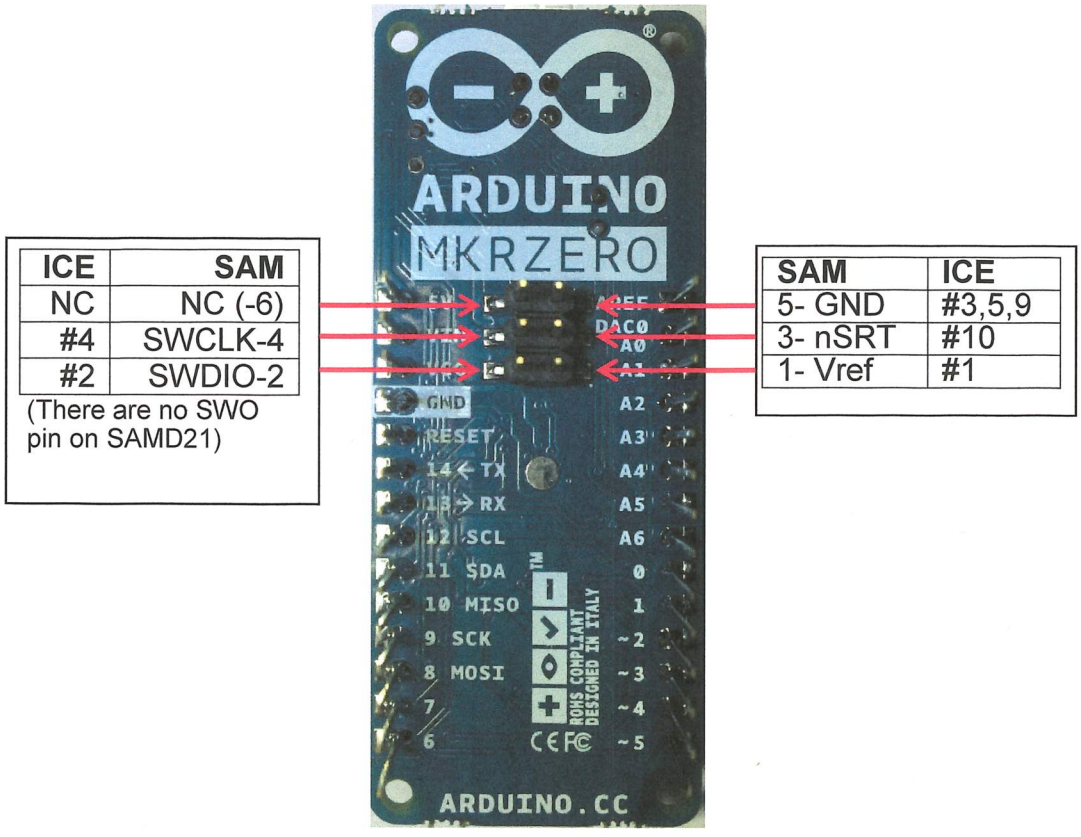


Note: The voltage applied to VCC must be kept between 2.7V and 5.5V in order to avoid damaging the parts used in this circuit.

5 Programming

Arduino MKR Zero is not using the Arduino bootloader or programming interface. All Arduino related code on the board has been erased. (The bootloader is still intact but not intended to be used). Instead it is programmed and debugged directly over the JTAG interface of the back of the board. An Atmel-ICE has been used for debugging/programming but there are other compatible debuggers.

5.1 Connection of debugger

Table 3-8. Atmel-ICE SWD Pin Mapping

Name	AVR port pin	SAM port pin	Description
SWDCLK	1	4	Serial Wire Debug Clock.
SWDIO	5	2	Serial Wire Debug Data Input/Output.
SWO	3	6	Serial Wire Output (optional- not implemented on all devices).
nSRST	6	10	Reset.
VTG	4	1	Target voltage reference.
GND	2, 10	3, 5, 9	Ground.