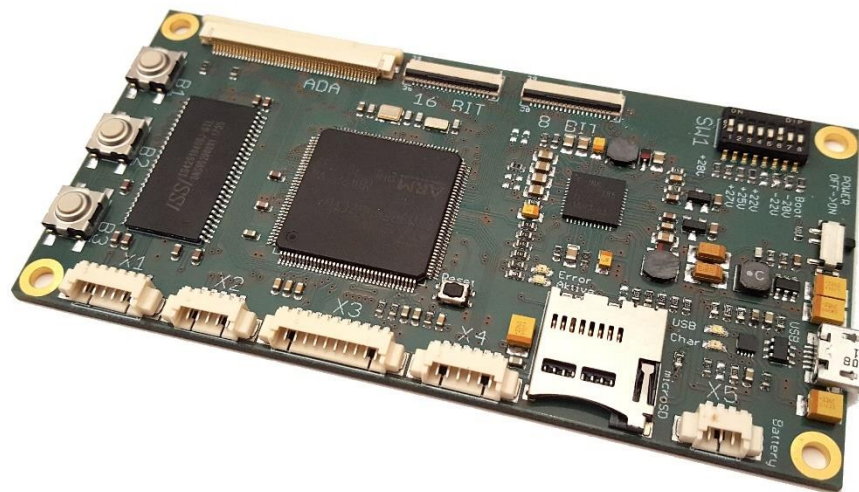


Preliminary Specification



EPD Driver Board

February 2018

Revision History

Rev.	Date	Chapter	Description	by
1.0	20.02.2018	All	First draft	Ryb
1.1	16.03.2018	4.4	Description of the new function	Ryb
1.2	18.04.2018	6.2	Extension	

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1. General description

The Electronic Paper Display (EPD) Driver Board is an advanced controller board to manage EPD displays. It is developed as an easy solution to drive the standard EPD displays. The board supports multiply display choice. Display content can be transferred over USB or presented from the SD memory card. The EPD Driver Board can be driven from battery. The EPD Driver Board's functionality can be extended by customized assembly or firmware configuration.

2. General features

- Supports driving EPD Panels with resolution up to 2200x1650 pixels, 16 colors grey scale and 8-/16-bit interface
- Direct drive EPD by onboard microcontroller without extra graphic or timing controller
- Integrated temperature sensor
- MicroUSB Interface for connecting to PC for data communication
- On board microSD slot
- Open command interface for driving different EPD panels
- Stand alone functionality from battery 3.7V or USB 5V
- Mechanical dimensions 100mmx50mmx5mm with one side assembly
- RoHS compliant

3. System configuration

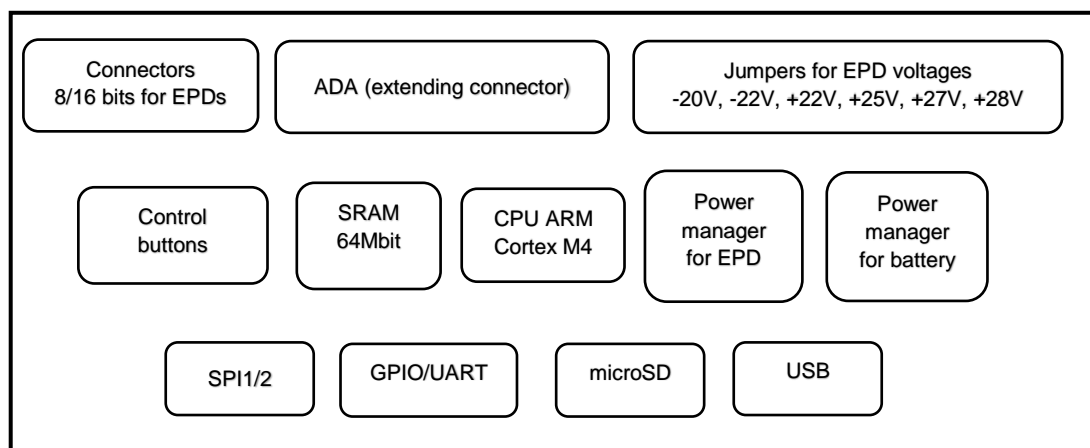


Figure 1: Block diagram of EPD-Driver

4. Settings and functions

4.1. Board overview

The picture below shows the top view of the printed circuit board (PCB).

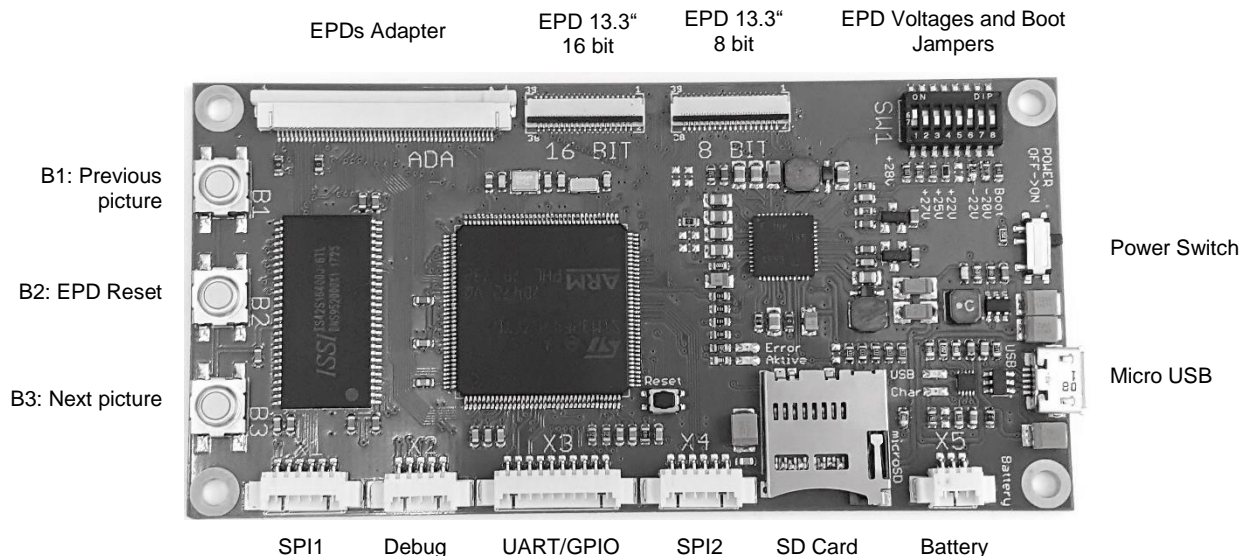


Figure 2: Top View of Typical Board Configuration

SD card

The SD card contains the content information for the EPD display. The information must be saved as separate files in the main folder. The SD card can have a volume up to 32 Gbytes. There are several limitations for the files configuration:

- bmp-files
- Resolution 2200x1650 (smaller pictures will be centered but not scaled, bigger pictures cannot be shown correctly)
- 8 bits per pixel
- Name of the files is no longer as 11 signs

Buttons

- B1 – previous picture
- B2 – clear screen
- B3 – next picture

Power Switch

- Position up – “Off”
- Position down – “On”

Power manager

Power manager is integrated. Battery charging can be realized over USB. To start charging the battery and USB cable must be connected simultaneously. Charging starts automatically and does not influence the board functions.

Approximate charging time for the battery with capacity 300mAh is 3 hours.

Light indication

There are two LEDs indicating the state of the communication with display and flash memory.

LED No.	Color mode	Description
LED Aktive	Green blinking slow	Board is active
	Green blinking quickly	Data is streaming
LED Error	Red on	No flash memory
	Red blinking	Config-file error

Light indication for battery power mode

If the battery manager is used (depended on the assembly version) two LEDs show the USB connection and battery state.

LED No.	Color mode	Description
LED USB	Green constant	USB is connected
LED Charging	Red on	Battery charging
	Red off	Battery is fully charged

4.2. Operation of the EPD-Driver

To start working with the board please follow the next procedure:

1. Put flash memory
2. Connect display to the wished EPD connector
3. Connect battery to the connector X5 or USB
4. Set power switch in the position "ON"
5. Control that LED Display is lightning green and blinking slowly
6. Choose the wished function by means of buttons
7. Set power switch in the position "OFF" after end of work

For battery charge connect battery and USB cable. LED Battery is lightning red. After full charge, the red LED will be off.

4.3. Adjust of config.ini file

The file of configuration allows to set the board's output parameters according to the driving EPD display. The config.ini file is placed in the main folder of SD card. If there is no any config.ini file or any mistake takes place the board shows an error by LED Error lightning.

There are several main settings, which can be critical for the panel usage. The example below describes the configuration for ES133TT3. The comments (#) explain the command lines.

```
## Config File v0.1
## Information file for EPD-Display

#Informational block
HARDWARE_VR=1.0
SOFTWARE_VR=1.1

#Display Size in inch
#Later the multiply choice of panel will be supported
SCREEN_SIZE=13.3

#Display Resolution in Pixel
#According to the datasheet of the panel.
DISPLAY_RES_X=2200
DISPLAY_RES_Y=1650

#Picture mode
#Number of the grades of grey can be defined. It influences the update speed
#Possible settings:
#OFF: monochrome, best application is the text information
#ON: 8 grades of grey in this configuration.
#Later up to 16 grades of grey will be supported.
GRAYSCALE=ON

#Display bus setting
#According to the datasheet of the panel.
BITS_NR=16

#VCOM in Millivolt ( -2.84V *1000 = -2840)
#According to the datasheet of the panel.
#VCOM Value is to find on the Display
VCOM=-2840
```

4.4. USB Data Transfer

The communication between PC and EPD-Driver can be realized via USB virtual COM port. The configuration to use virtual port is: baud rate of 115,200 bps, 8 data bits, no parity, 1 stop bit (8N1) and hardware flow control.

The basic frame structure is as follows (see Table 1):

1. Start byte „0x8A“
2. Two-byte length of the frame
3. One-byte Message ID which specifies the type of message being transmitted
4. Data Counter – is a sequence number of the transmitted date (max: 0x0FFF)
5. Message Data, which can be variable lengths
6. Message Frame Check Sequence (FCS). The FCS is a 16-bit CRC with the least significant byte first.

Table 1: Message Structure

Start Byte "0x8A" (1-byte)	Frame length (2-bytes)	Message ID (1-bytes)	DATA Counter (2-byte)	DATA (Byte 0)	...	DATA (Byte N)	FCS CRC-16 (2-bytes)
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Any transferred frame must confirmed through following acknowledge bytes:

- 0x01 - OK
- 0x02 - FAIL
- 0x03 – BUSY

All transferred data of the interface are hexadecimal "0xXX". The characters in the frame should have an unsigned value.

Table 2: Packet description

Offset	Size	Field	Value hex	Description
0	1	Start Byte	0x8A	Start synchronization byte; always set to 0x8A
1	2	Frame Length	0xFFFF	Specifies number of bytes in the frame
3	1	Message ID	0xFF	Command
4	2	DATA Counter	0xFFFF	Contains the sequence number of the transmitted date (max: 0xFFFF)
6	x	DATA	...	Contains the actual data
6+x	2	FCS CRC-16	0xFFFF	CRC16 Data byte; calculated checksum for the whole frame

There are several different types of messages that may be passed on the data interface. Table 3 presents a syntax of the messages defined in this section, and for which interface types the messages are supported.

Table 3: Message syntax

Message ID	Data	Description
0x01	0x0XXX	Display Resolution Length – number of pixels on the horizontal (x) axis
0x02	0x0XXX	Display Resolution Width – number of pixels on the vertical (y) axis
0x03	0xXXXX	VCOM in Millivolt (<i>unsigned integer</i>)
0x04		Number of the grades of grey level. (<i>8 grades of grey in this configuration</i>)
0x05	0x08 or 0x10	Display data bus (<i>8 or 16 bit</i>)
0x06	0xXX	Display contrast ratio 1 -100 in % (1% - 0xXX, 100% - 0xXX)
0x07	0xXX	Data transfer in RAM (two pixels in one byte)
0x08	0x01	Show the picture from RAM
0x09	0x00	Clear screen

Image transferring

The transfer of the picture takes place in series. For example, the image content can be divided and transferred by string. The transfer must begin with the first pixel and the first line of the image. Each pixel contains 4 bits of information. Therefore, one byte of data should contain 2 pixels. The data counter contains the number of the transmitted string, so the counter must be increased by one, each time a new line is transmitted.

For example, the content of the image with a size of 640 by 480 pixels can be transmitted as follows:

Start Byte	Frame length	Message ID	Data Counter	DATA xxxx xxxx (bits)			FCS
0x8A	0x0148	0x07	0x0000	Pix(1,1)	...	Pix(640,1)	0xXXXX
0x8A	0x0148	0x07	0x0001	Pix(1,2)	...	Pix(640,2)	0xXXXX
0x8A	0x0148	0x07	0x0002	Pix(1,3)	...	Pix(640,3)	0xXXXX
0x8A	0x0148	0x07	0xXXXX
0x8A	0x0148	0x07	0x01DE	Pix(1,479)	...	Pix(640,479)	0xXXXX
0x8A	0x0148	0x07	0x01DF	Pix(1,480)	...	Pix(640,480)	0xXXXX

The next command puts the transferred image from the RAM memory to the display:

Start Byte	Frame length	Message ID	Data Counter	DATA	FCS
0x8A	0x0009	0x08	0x0000	0x01	0xXXXX

4.5. Jumpers for gate voltage setup

Following the specification of an EPD use an assembled DIP switch to set up the requested EPD gate supply voltages.

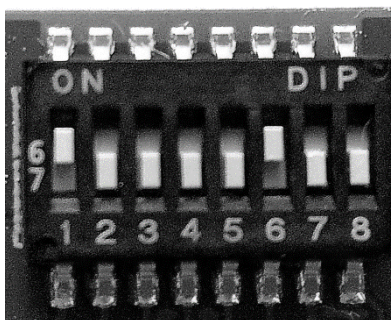


Figure 3: SW1 Jumpers for gate voltage setup

The supported values for the gate supply voltage of EPDs are shown in the table below.

Jumper	Function
1	+28V
2	+27V
3	+25V
4	+22V
5	customized value (optional)
6	-20V
7	-22V
8	Boot

4.6. Firmware update

The firmware of the EPD Driver can be easily updated via USB. There is the recommended flash procedure to follow.

1. Set the switch 8 on the SW1 (see figure 3) in the position "ON"
2. Connect USB cable from host to the board
3. Turn the power on
4. By means of provided software choose a new bin-file to flash and start an update process (please follow the software instructions)
5. After successful update turn the board off
6. Set the switch 8 on the SW1 (see figure 3) in the position "OFF"
7. Restart the board.

5. Electrical characteristics

5.1. Absolute maximum ratings

Parameter	Symbol	Value	Unit
Supply Voltage Range	V_{DD}	-0.3V~4.0V	V
Input Voltage Range	V_{IN}	-0.3 to $V_{DD}+0.3$	V
Operational Temperature Range	T_{OPR}	-10 to +60	°C
Storage Temperature	T_{ST}	-40 to +80	°C

5.2. DC characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage Range	V_{DD}				
USB		4.75	5.0	5.25	V
Battery		3.2	-	3.7	V
Power consumption					
Active mode					mA
Sleep mode					mA
Deep mode					uA
Negative power supply source	V_{NEG}		-15		V
Positive power supply source	V_{POS}		15		V
Negative power supply gate	V_{EE}	-22	-	-20	V
Positive power supply gate	V_{GG}	22	-	28	V
Common connection	V_{COM}	-5.11		0	V

6. Mechanical characteristics

6.1. Connectors pin assignment

Connector	Housing	Mating Part	Function
X1	53261-06 (Molex)	51021-0600 (Molex)	SPI1
X2	53261-05 (Molex)	51021-0500 (Molex)	Debug
X3	53261-10 (Molex)	51021-1000 (Molex)	Serial interface & GPIO
X4	53261-06 (Molex)	51021-0600 (Molex)	SPI2
X5	53261-03 (Molex)	51021-0300 (Molex)	Battery
ADA	5-1734592-0	FFC/FPC,50pins,0.5mm	Extending adapter board
8 BIT	FH39-39S-0.3SHW	39 pins, 0.3 mm.	8 Bits EPDs
16 BIT	FH39-39S-0.3SHW	39 pins, 0.3 mm.	16 Bits EPDs
MicroUSB	47346-0001 (Molex)	Micro USB	Charging, Datatransfer
MicroSD	MEM2051-00-195-00	Micro SD card	Micro SD card

SPI1 Connector X1

Type: 53261-06 (Molex)

Mating Type: 51021-0600 (Molex)

Pin No.	Symbol	Description	Note
1	GND	GND	
2	SPI1_MOSI		
3	SPI1_MISO		
4	SPI1_SCK		
5	SPI1_CS		
6	VCC	3.3V DC	

UART/GPIO Connector X3

Type: 53261-10 (Molex)

Mating Type: 51021-1000 (Molex)

Pin No.	Symbol	Description	Note
1	VCC	3.3V DC	
2	GPIO_1		
3	GPIO_2		
4	EN_BOARD	EPD-Board enable	
5	USART3_TX		
6	USART3_RX		
7	USART3_CK		
8	USART3_CTS		
9	USART3_RTS		
10	GND	GND	

SPI2 Connector X4

Type: 53261-06 (Molex)

Mating Type: 51021-0600 (Molex)

Pin No.	Symbol	Description	Note
1	GND	GND	
2	SPI2_MOSI		
3	SPI2_MISO		
4	SPI2_SCK		
5	SPI2_CS		
6	VCC	3.3V DC	

Battery Connector X5

Type: 53261-0371 (Molex)

Mating Type: 51021-0300 (Molex)

Pin No.	Symbol	Description	Note
1	Vin	3.3V DC	
2	TS		
3	GND	GND	

MicroUSB Connector

Type: 47346-0001 (Molex)

Mating Type: MicroUSB

Pin No.	Symbol	Description	Note
1	VBUS	5V DC	
2	USB_DM		
3	USB_DP		
4	USB_ID		
5	GND	GND	

MicroSD Slot

Type: 49225-0821 (Molex)

Pin No.	Symbol	Description	Note
1	SD_D2		
2	SD_D3		
3	SD_CMD		
4	VCC	3.3V DC	
5	SD_CLK		
6	GND	GND	
7	SD_D0		
8	SD_D1		
9	SD_CD	GND	

EPD Connector 8 bit

Type: FH39-39S-0.3SHW

Pin No.	Symbol	Description	Note
1	VNEG	Negative power supply source driver	-15V
2	VPOS	Positive power supply source driver	+15V
3	VSS	VSS Ground	GND
4	VDD	Digital power supply drivers	
5	XCL	Clock source driver	
6	XLE	Latch enable source driver	
7	XOE	Output enable source driver	
8	VSS	VSS Ground	SHR
9	VSS	VSS Ground	CE1
10	VDD	Digital power supply drivers	CE2
11	STL	Start pulse source driver	SPH
12	D0	Data signal source driver	
13	D1	Data signal source driver	
14	D2	Data signal source driver	
15	D3	Data signal source driver	
16	D4	Data signal source driver	
17	D5	Data signal source driver	
18	D6	Data signal source driver	
19	D7	Data signal source driver	
20	GND	Ground	GND
21	NC	No connection	
22	VCOM	Common connection	
23	VGG	Positive power supply gate driver	
24	VEE	Negative power supply gate driver	
25	NC	No connection	
26	NC	No connection	
27	MODE1	Output mode selection gate driver	MODE2*
28	MODE1	Output mode selection gate driver	MODE1*
29	VSS	VSS Ground	RL*
30	VSS	VSS Ground	
31	VSS	VSS Ground	
32	STV	Start pulse gate driver	SPV
33	CKV	Clock gate driver	CKV
34	BORDER	Border connection	
35	VSS	VSS Ground	UCE*
36	VSS	VSS Ground	UCE*
37	VSS	VSS Ground	NC*
38	VSS	VSS Ground	NC*
39	NC	No connection	

EPD Connector 16 bit
Type: FH39-39S-0.3SHW

Pin No.	Symbol	Description	Note
1	VNEG	Negative power supply source driver	-15V
2	VPOS	Positive power supply source driver	+15V
3	VCOM	Common connection	
4	VSS	VSS Ground	
5	VSS	VSS Ground	
6	CKH	Clock source driver	
7	VSS	VSS Ground	
8	LEH	Latch enable source driver	
9	OEH	Output enable source driver	
10	STH	Start pulse source driver	
11	VSS	VSS Ground	
12	D0	Data signal source driver	
13	D1	Data signal source driver	
14	D2	Data signal source driver	
15	D3	Data signal source driver	
16	D4	Data signal source driver	
17	D5	Data signal source driver	
18	D6	Data signal source driver	
19	D7	Data signal source driver	
20	VSS	VSS Ground	
21	D8	Data signal source driver	
22	D9	Data signal source driver	
23	D10	Data signal source driver	
24	D11	Data signal source driver	
25	D12	Data signal source driver	
26	D13	Data signal source driver	
27	D14	Data signal source driver	
28	D15	Data signal source driver	
29	VSS	VSS Ground	
30	MODE1	Output mode selection gate driver	
31	STV	Start pulse gate driver	
32	CKV	Clock gate driver	
33	BORDER	Border connection	
34	VSS	VSS Ground	
35	VDD	Digital power supply drivers	
36	VSS	VSS Ground	
37	VSS	VSS Ground	
38	VEE	Negative power supply gate driver	
39	VGG	Positive power supply gate driver	

Adapter Connector

Type: FFC/FPC-50pins, 0.5mm / 5-1734592-0

Pin No.	Symbol	Description	Note
1	VNEG	Negative power supply gate driver	
2	NC	NO Connection	
3	VGH	Positive power supply gate driver	
4	Mode2	Output mode selection gate driver	
5	VDD	Digital power supply drivers	
6	Mode1	Output mode selection gate driver	
7	CKV	Clock gate driver	
8	STV	Start pulse gate driver	
9	VSS	Ground	
10	VCOM_TFT	Common voltage	
11	VDD	Digital power supply drivers	
12	VSS	Ground	
13	XCL	Clock source driver	
14	D0	Data signal source driver	
15	D1	Data signal source driver	
16	D2	Data signal source driver	
17	D3	Data signal source driver	
18	D4	Data signal source driver	
19	D5	Data signal source driver	
20	D6	Data signal source driver	
21	D7	Data signal source driver	
22	VSS	Ground	NC*
23	D8	Data signal source driver	
24	D9	Data signal source driver	NC*
25	D10	Data signal source driver	
26	D11	Data signal source driver	
27	D12	Data signal source driver	
28	D13	Data signal source driver	
29	D14	Data signal source driver	
30	D15	Data signal source driver	
31	XSTL	Start pulse source driver	
32	XLE	Latch enable source driver	
33	XOE	Output enable source driver	
34	ISEL	Input data bus width (8 bit or 16 bit)	
35	NC	NO Connection	
36	VPOS	Positive power supply source driver	
37	NC	NO Connection	
38	VNEG	Negative power supply source driver	

Pin No.	Symbol	Description	Note
39	VCOM_FPL	Common Voltage	
40	NC	NO Connection	
41	STV2	Start pulse gate driver 2	
42	G640	Detect IC function	
43	S400	Detect IC function	
44	S320	Detect IC function	
45	NC	NO Connection	
46	G640	Detect IC function	
47	S400/S320	Detect IC function	
48	S320/S400	Detect IC function	
49	G640	Detect IC function	
50	STL2	Data shift start pulse 2	

Button B1

Function “Up” or “Previous picture”.

Button B2

Function “Clear screen”.

Button B3

Function “Down” or “Next picture”.

Button “Reset”

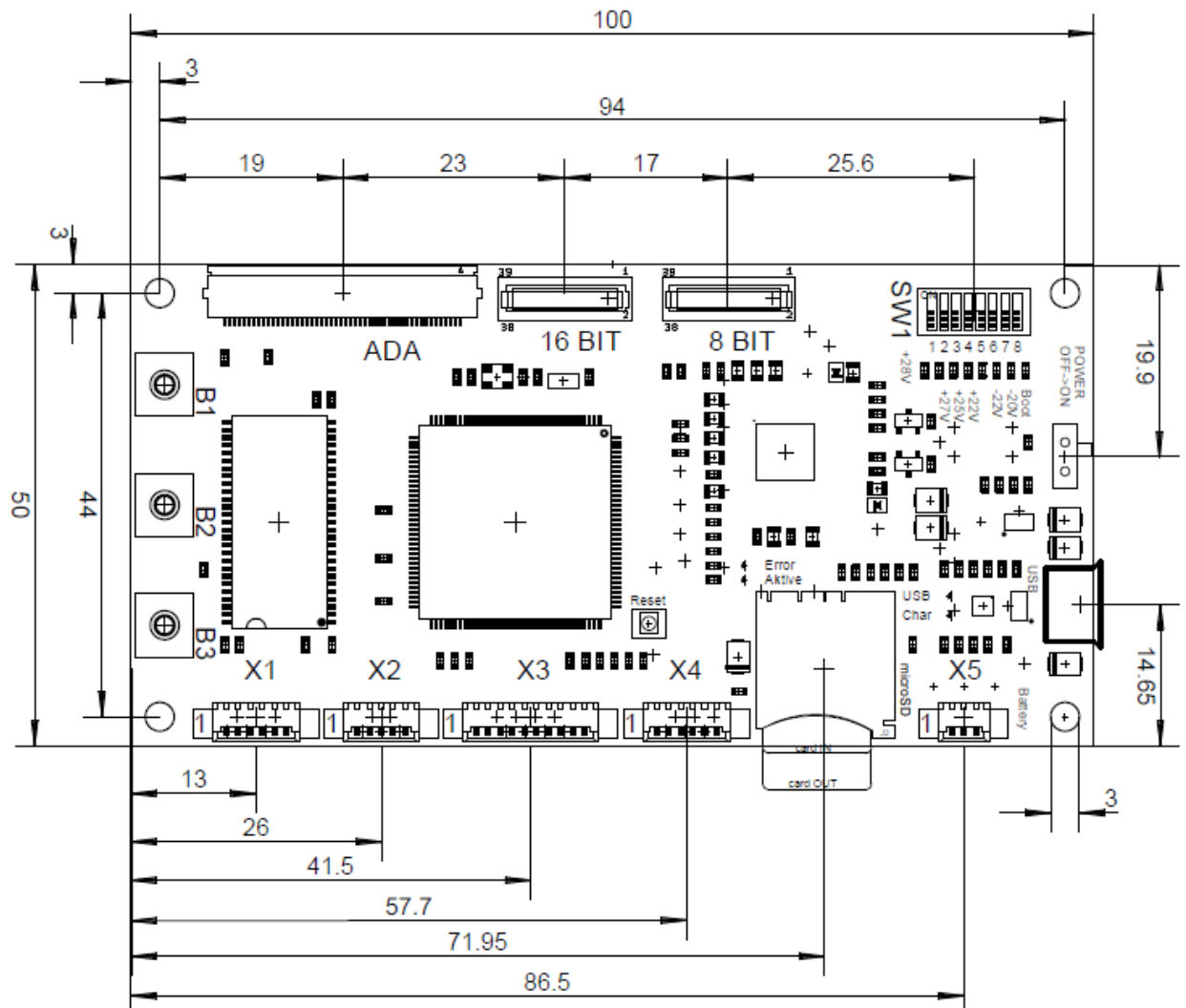
Function of the manual reset for the microcontroller of the board.

Switch “Power”

Power switch for the microcontroller and whole periphery of the board. Battery and USB VCC are not included in the circuit, managed by the switch, and work undependable.

6.2 Physical dimensions

Outline parameters: 100mm (L) x 50mm (W) x 5.2mm (H)



Note that all dimensions are in mm.