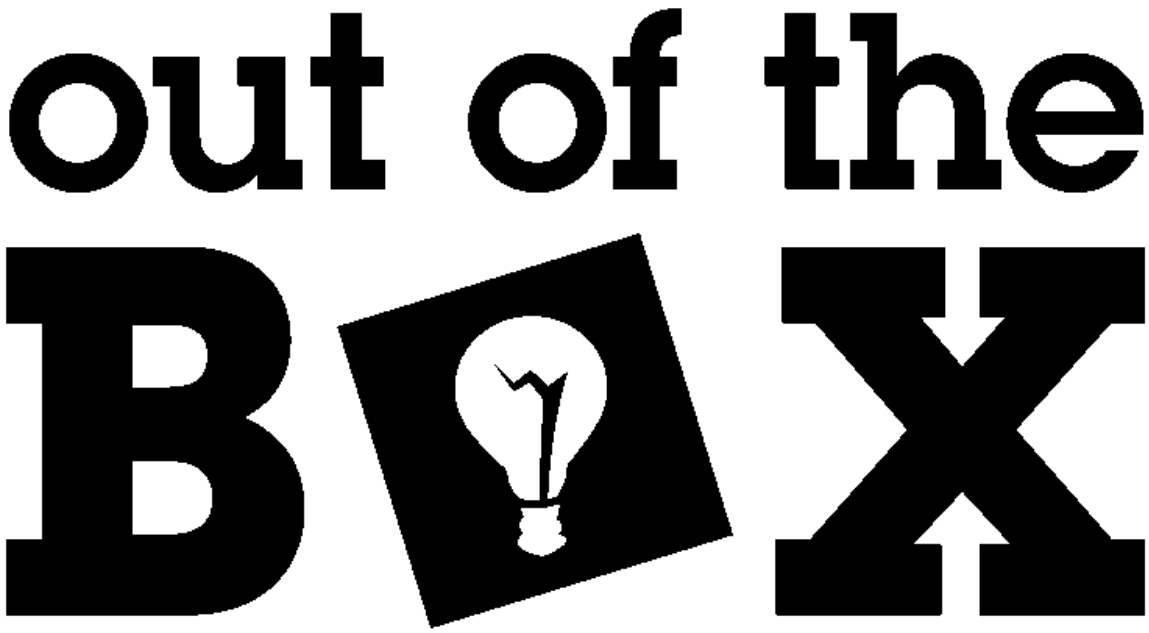

µPAD: Microprocessor for Academic Development version 1.4 Manual

Last Updated May 8, 2017

out of the BOX
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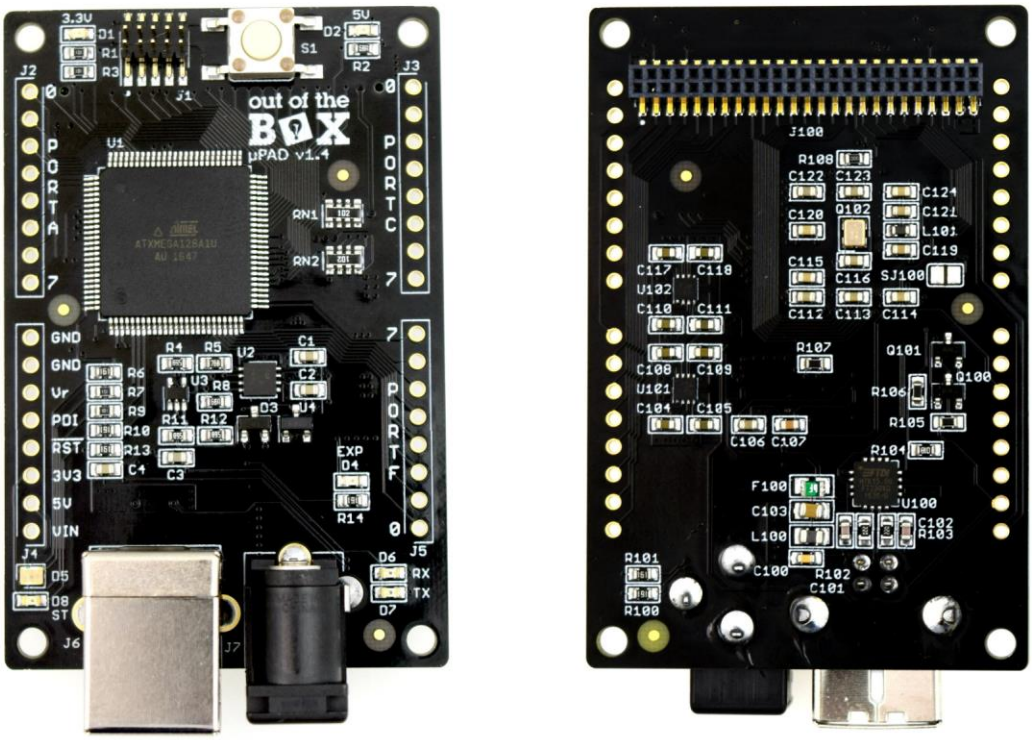

Figure 1: µPAD Top and Bottom

Warning Before Proceeding

1. It is possible to damage your µPAD irreparably through the use of poor software. PORTB 0 and PORTB 1 pins serve special functions. PORTB 0 is the input for the precision 2.5V analog reference, and PORTB 1 is the Circuit GND reference input for differential analog measurements. **If you set the direction register for PORTB pins 0 or 1 you risk destroying your board!** Always use caution when using PORTB of the µPAD's Xmega!!!
2. Use caution when connecting and disconnecting the programmer from J1 pictured in Figure 1. This connector can be sheared off the PCB if handled roughly.
3. **Treat your Atmel ICE programmer's USB connector with the utmost care!** The USB connector of these devices have proven weak, and can be broken off by the slightest rough handling. Do your best not to put strain on or force your USB cable into the device!
4. Ensure that when connecting a Backpack to the µPAD that the orientation is correct. Orientation for reference.

On Board Features

Smart Power Switching

The µPAD was designed to be powered in many ways. The two primary methods are through the USB connector, or via an external power source. If both a USB and external power connection are provided, the external source is switched to automatically.

There are three inlets for external power to the µPAD. The board can be powered via the barrel jack J7 (pictured in Figure 1), the Backpack VIN connection, or the Base connector's VIN signal. Therefore, the µPAD can be self-powered or receive power from an accessory Backpack or Base.

Indicators

Power Indicators

The µPAD has LED indicators for each of the primary power sources 5V (D2) and 3.3V (D1). These LEDs should be lit when power is given to the µPAD.

Status LED

The µPAD features a general-purpose status LED (D8) connected to the PORTD7 pin of the microcontroller.

RGB Indicator

The µPAD features a super bright tri-color, Red Green and Blue (RGB) LED indicator (D5). RGB LEDs are special because they contain three discrete LEDs each of which a primary color of visible light. Using PWM thousands of distinct colors can be created!

Table 1: RGB LED Mapping

Color	Board Pin	PWM
Red	PORTD 0	TCD0: CCA[1]
Green	PORTD 1	TCD0: CCB[1]
Blue	PORTD 4	TCD0: CCC[1]

1) To use TCD0 output compare channels with the RGB LED, use the remap register to select the upper nibble pins for output compare.

External Power (EXP) Indicator

When the µPAD if fed an external power source the EXP LED (D4) will light to indicate the µPAD is being powered externally as opposed to receiving USB power. The external power connection takes precedence over the USB connection. If both sources are present the external source will be selected.

USB Serial Indicators

The USB to serial bridge indicates whenever data is received or transmitted visually via RX (D6) and TX (D7) LEDs. TX in this context refers to data being sent from the µPAD to a USB serial host, and vice versa for RX.

Real Time Clock Oscillator

The µPAD has an external 32.768 KHz Real Time Clock (RTC) Oscillator. This frequency is significant due to the relationship of $32768 = 2^{15}$. This means that a 15-bit counter fed a clock of this frequency will overflow precisely in 1 second intervals.

USB Serial

The µPAD has a dedicated USB to serial bridge, a FT-230X. This device simply pipes UART data to and from USARTD0 over USB.

Mezzanine Connectors

The µPAD is a small development tool designed to interface with external circuitry through two main connections the Backpack connectors and Base connector.

Base Connector

Interface boards utilizing this connector are referred to as a Base. The Base Connector exposes the External Bus Interface (EBI) of the microcontroller as well as port E, F and part of B. Additionally, the Base Connector exposes the 5V and 3.3V supplies and a pass through for the VIN signal. The VIN signal can be used to power the µPAD or as a source depending on the application. Table 3 details the signals attached to the Base Connector.

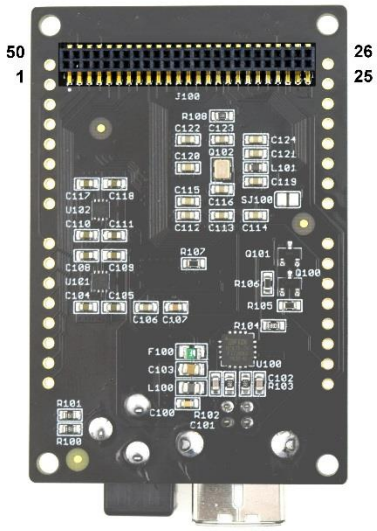

Figure 2: µPAD Base Connector

Table 2: Base Connector Signals

Signal	Pin	Function	Signal	Pin	Function
PORTF 7	1	I/O,SCK,TXD1	PORTK 7	26	I/O,ADD7,ADD15[1]
PORTF 6	2	I/O.MISO,RXD1	PORTK 6	27	I/O,ADD6,ADD14[1]
PORTF 5	3	I/O,MOSI,XCK1,OC1B	PORTK 5	28	I/O,ADD5,ADD13[1]
PORTF 4	4	I/O, $\overline{SS}$,OC1A	PORTK 4	29	I/O,ADD4,ADD12[1]
PORTF 3	5	I/O,TXD0,OC0D	PORTK 3	30	I/O,ADD3,ADD11[1]
PORTF 2	6	I/O,RXD0,OC0C	PORTK 2	31	I/O,ADD2,ADD10[1]
PORTF 1	7	I/O,SCL,XCK0,OC0B	PORTK 1	32	I/O,ADD1,ADD9[1]
PORTF 0	8	I/O,SDA,OC0A	PORTK 0	33	I/O,ADD0,ADD8[1]
PORTE 0	9	I/O,SDA, $\overline{OC0ALS}$,OC0A	PORTJ 7	34	I/O,DATA7
PORTE 1	10	I/O,SCL,XCK0,OC0AHS,OC0B	PORTJ 6	35	I/O,DATA6
PORTE 2	11	I/O,RXD0, $\overline{OC0BLS}$,OC0C	PORTJ 5	36	I/O,DATA5
PORTE 3	12	I/O,TXD0,OCBHS,OC0D	PORTJ 4	37	I/O,DATA4
PORTE 4	13	I/O, $\overline{SS}$,OC1A, $\overline{OC0CLS}$	PORTJ 3	38	I/O,DATA3
PORTE 5	14	I/O,MOSI,XCK1,OC1B,OC0CHS	PORTJ 2	39	I/O,DATA2
PORTE 6	15	I/O,MISO,RXD1, $\overline{OC0DLS}$	PORTJ 1	40	I/O,DATA1
PORTE 7	16	I/O,EVOUT, CLK_{PER}, SCK,TXD1,OC0DHS	PORTJ 0	41	I/O,DATA0
PORTB 2	17	I/O,DAC0,AC,ADC	PORTH 7	42	I/O, $\overline{CS3}$
PORTB 3	18	I/O,DAC1,AC,ADC	PORTH 6	43	I/O, $\overline{CS2}$
PORTB 4	19	I/O,TMS,AC,ADC	PORTH 5	44	I/O, $\overline{CS1}$
PORTB 5	20	I/O,TDI,AC,ADC	PORTH 4	45	I/O, $\overline{CS0}$
PORTB 6	21	I/O,TCK,AC,ADC	PORTH 2	46	I/O,ALE1
PORTB 7	22	I/O,TDO,AC,ADC	PORTH 1	47	I/O, $\overline{RE}$
VIN[2]	23	Power In or Out Connection	PORTH 0	48	I/O, $\overline{WE}$
GND	24	GND Connection	5V	49	5.0V Out
GND	25	GND Connection	3.3V	50	3.3V Out

1) These signals utilize external circuitry based upon ALE (Address Latch Enable)

2) The VIN signal can be a sourced from 3 locations. If sourcing the board use a diode to prevent a power rail conflict.

Backpack Connectors

The Backpack Connectors like the Base Connector are used for expansion. Like the Base Connector, the Backpack Connectors give access to the 5V, 3.3V and VIN power signals. Additionally, the Backpack Connectors expose the PDI programming signals and the 2.5V precision reference. The GPIO ports exposed are A,C and F.

The Backpack Connectors are .1" female headers on a .1" grid. This allows for custom proto-board based Backpacks.

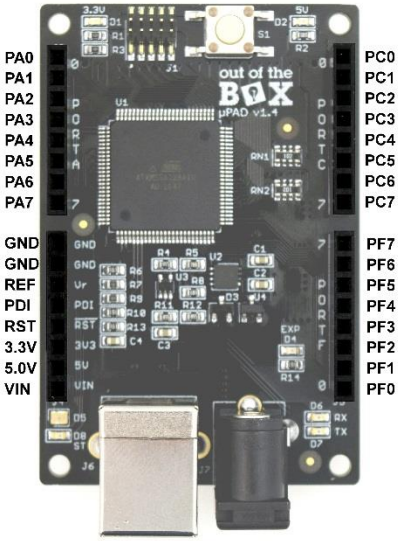

Figure 3: Backpack Connectors

Backpack Orientation

When connecting a Backpack to the µPAD ensure that the orientation is correct. Each Backpack has a recess cut into the top half to give space to the µPAD programming header as well as the reset switch.

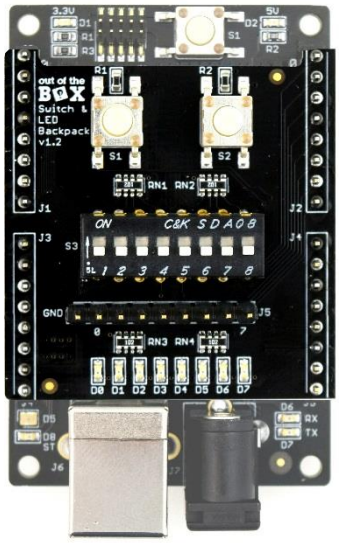

Figure 4: Backpack Orientation

Electrical Characteristics

Table 3: Absolute Maximum Ratings

Item	Min	Nom	Max	Unit
VIN			5.5	V

If VIN receives a power signal beyond this value, failures of the µPAD's components will occur.

Table 4: General Characteristics

Item	Min	Nom	Max	Unit
3.3V Tolerance	3.201	3.3	3.399	V
5.0V Tolerance	4.85	5.0	5.15	V
2.5V Ref Tolerance	2.490	2.50	2.510	V
VIN Range	3.1		5.0	V
2.5V Rail Current[1]		15		mA
3.3V Rail Current			300	mA
5.0V Current			275	mA
µPAD Idle current		~25		mA
RTC Crystal Frequency	-30		30	ppm

1) It is not recommended to power external circuits using the 2.5V reference.

µPAD Power

The µPAD has an involved network of power supplies that serve several purposes

3.3V and 5.0V Supplies

The primary system supplies of the µPAD are the 3.3V and 5.0V rails. These voltage rails are sourced by buck-boost switching regulators. Buck boost meaning that these supplies are able to create their desired voltage outputs when the voltage input to the regulators is either above or below the intended output(s). This principle is why the µPAD can be powered externally by power sources between 3.1 and 5.0V. Such a range allows for power sources such as 3.7V lithium batteries, USB cables, 3x alkaline batteries etc.

Precision Analog Reference

The µPAD has an external 2.5V precision reference for use with analog applications, such as the Xmega's ADCs and DACs. This reference is also accessible via the J4 Backpack connector. Powering external circuits with this supply is not recommended, since the current sourcing capabilities of the 2.5V reference is very small.

Powering the µPAD

The µPAD is designed to be powered via USB and external sources. As for the external sources there are 3 VIN connections present on the board. The first is J7, the barrel jack pictured in Figure 1. The jack is wired center positive, and it accepts 2.1mm ID by 5.5mm OD plugs. The second VIN connection of the µPAD is found on J4 pictured in Figure 1. This connection allows Backpacks to power the µPAD. The last VIN connection is on the Base connector. This connection allows µPAD Bases to power the µPAD. Reference the µPAD schematic for the pinout of the Base connector.

The µPAD features smart and hot swappable power switching. Whenever an external source, with a voltage above the minimum voltage threshold, is connected it will automatically be selected as the preferred power input. Therefore if the system were running on USB power, the board would automatically switch over to external power when an external source was connected. The EXP LED (D4) will light to indicate the presence and use of the external source.

External Power Considerations

Since the µPAD accepts VIN signals from the on-board barrel jack, Backpacks and Bases it is important to ensure no more than one device is sourcing the VIN signal. Failure to do so could cause the µPAD and or the external circuits to be damaged.

Programming the µPAD

The µPAD is designed to be programmed and debugged using the PDI protocol. The program header of the µPAD is J1, and can be viewed in Figure 1. Notice that there is a white dot next to this connector. This dot designates pin one on the program header. When connecting a programmer such as the Atmel ICE, pin 1 of the connector, generally indicated by a red wire, should be positioned next to the dot.

Take care when programming the µPAD that the program header does not get pulled or otherwise stressed in the process. It is possible to tear the surface mount connections off the PCB.

Downloading the FTDI Device Driver

To obtain the device drivers for the FTDI USB device follow this link. Once downloaded the FTDI device will be recognized as a com port. Use the device manager to determine what com port has been assigned to the device.