µPAD 2.0: Microprocessor for Academic Development

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Warning: READ BEFORE PROCEDING

Be Careful with PORTB

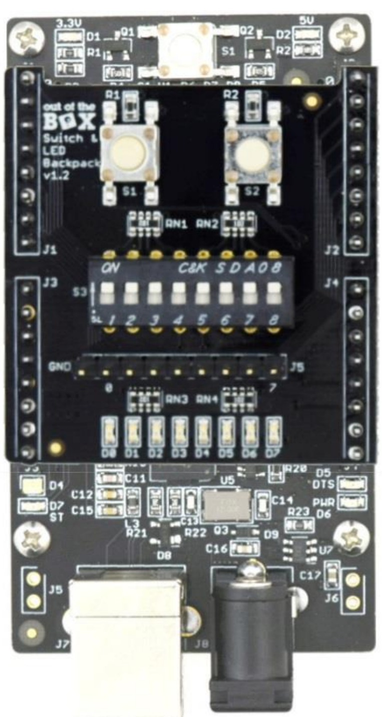
It is possible to damage your μPAD irreparably with poor software. PORTB pins 0 and 1 are reserved for the analog reference and a GND reference respectively. Setting the direction register for PORTB pins 0 or 1 risks destroying the module. Always use care when using PORTB of the μPAD's Xmega.

External Power Considerations

- The μPAD 2.0 is capable of being powered at 12V, but some Backpacks cannot tolerate more than 5V for VIN.
- The μPAD VIN signal is shared on the Backpack connections, the Base Connector, and the barrel jack. The μPAD should only receive power from one source at a time, or a diode should be in line to mitigate multiple supplies being shorted together.

Always Check Backpack Orientation

Backpacks should be connected with their cutout region adjacent to the μPAD's reset button as shown below.



Overview

The µPAD module is ideal for education, prototyping, and system integration. The µPAD contains everything needed to develop an embedded system quickly and easily. The board contains a built-in debugger, supports various powering methods, PC communication, and supports two kinds of mezzanine connections. The first mezzanine connection is referred to as the Backpack Connectors. These connections are likened to that of Arduino shields, which are ideal for prototyping. The other mezzanine connection is known as the Base Connector. This has more signals and utilizes a fine pitch fine pitch connector. The Base Connector makes the µPAD ideally suited as a drop-in embedded system solution.

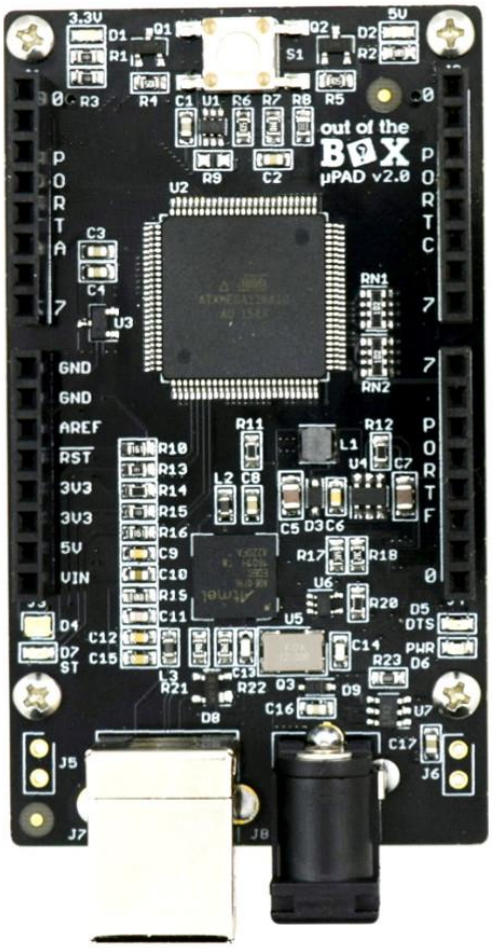
Why Xmega?

The Xmega line of microcontrollers are arguably the best suited platform for learning on the market. The modular design of the Xmega microcontrollers promotes portability of code and the use of higher level languages such as C++. The vast and modern peripheral set, including such features as DMA and the event system, make the Xmega a very powerful yet simple microcontroller. It is this simplicity combined with its capability that make the Xmega such an ideal teaching tool.

Microcontroller Features

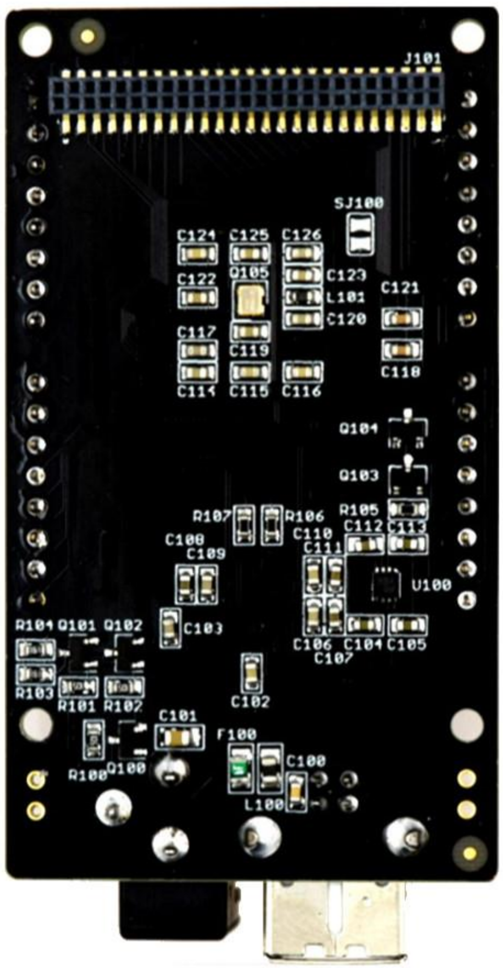
- 128KBytes of in-system self-programable flash
- 8KBytes boot section
- 2KBytes EEPROM
- 8K – internal SRAM
    - External bus interface supporting up to 1Mbytes SRAM
- 4-channel DMA controller
- 8-channel event system
- 8 16-bit timer/counters
    - 4 timer/counters with 4 output compare or input capture channels
    - 4 timer/counters with 2 output compare or input capture channels
    - High resolution extension on all timer/counters
    - Advanced waveform extension (AWeX) on all timer/counters
- 8 USARTs and IrDA support for one USART
- 4 two-wire interfaces with dual address match (I2C and SMBus compatible)
- 4 serial peripheral interfaces (SPIs)
- AES and DES crypto engine
- CRC-16 (CRC-CCITT) and CRC-32 (IEEE® 802.3) generator
- 16-bit real time counter (RTC) with separate oscillator
- 2x 16-channel 12-bit, 2MSPS Analog to Digital Converters
- 2x 2-channel 12-bit, 1MSPS Digital to Analog Converters
- 4 Analog Comparators (ACs) with window compare function, and current sources
- External interrupts on all general-purpose I/O pins
- Programmable watchdog timer with separate on-chip ultra-low power oscillator
- QTouch® library Support
    - Capacitive touch buttons, sliders, and wheels
- Special microcontroller features
    - Power-on reset and programmable brown-out detection
    - Internal and external clock options with PLL and prescaler
    - Programmable multilevel interrupt controller
    - 5 sleep modes
    - PDI (program and Debug interface)
    - Operating frequency of 0-32MHz

Top Layout


3.3V LED
Reset Button
5.0V LED
PORTA Backpack Connector
PORTC Backpack Connector
CTRL Backpack Connector
PORTF Backpack Connector
EDBG Busy LED
RGB LED
EDBG PWR LED
Status LED
USB Connector
VIN Barrel Jack

Bottom Layout

Base Connector



µPAD Features

The µPAD is designed to be a simple yet powerful module ideally suited for learning, prototyping, and a drop-in solution for embedded systems. The µPAD has a built-in debugger, a USB serial port, a flexible power system, various voltage sources, a real-time clock (RTC) oscillator and indicators.

Built-in Debugger with USB Serial Port

The µPAD 2.0 module contains the Microchip EDBG (embedded debugger). With this device, the Xmega microcontroller can be fully debugged and programmed without any external tools. In addition to the debugger functionality the EDBG also supports a USB serial port over the same USB connection. Since the EDBG is set up as a composite USB device, it is therefore possible to use the USB serial port while debugging.

Flexible Power System

To promote modularity, the µPAD can be powered in various ways based on two main sources, USB and an external supply signal VIN. The µPAD favors an external source (VIN), but USB will automatically be selected if VIN is not present.

The VIN signal is available on the two mezzanine connections (Backpack and Base) as well as a barrel jack connector. This allows for Base and Backpack boards to be either powered by the µPAD or for the µPAD to power them.

Voltage Sources

The µPAD has 3.3V and 5.0V voltage regulators, and a 2.5V analog reference. The 3.3V and 5.0V sources are exposed on both mezzanine connections, but the 2.5V reference is only available on the Backpack Connectors.

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 $32768 = 2^{15}$. A 15-bit counter when fed a clock of this frequency will overflow precisely in 1 second intervals.

Indicators

Power Indicators

The µPAD has LED indicators for each of the primary power sources 5V (D2) and 3.3V (D1). The EDBG has its own power indicator (D6) as well. These LEDs should be lit when power is given to the µPAD.

EDBG Busy

When the EDBG Busy LED (D5) is lit, the EDBG is currently being used.

Status LED

The µPAD features a general-purpose status LED (D7) 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 (D4). RGB LEDs are special because they contain three discrete LEDs, each of which displays 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.

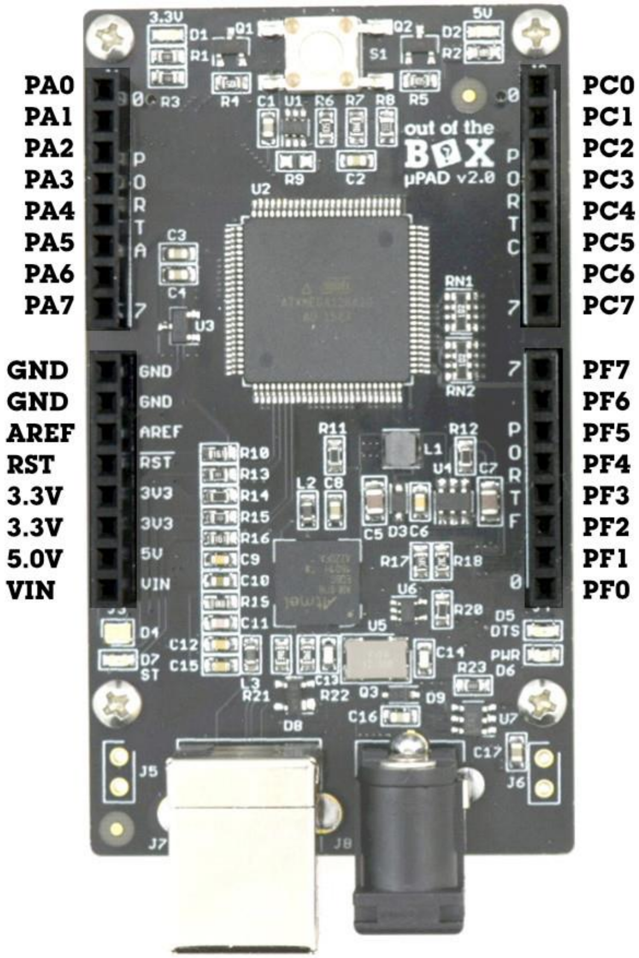
Module Mezzanine Connections

The µPAD has two types of mezzanine connectors each with different use cases. The first type are the Backpack Connectors which are ideally suited for prototyping. The second type is the Base Connector which is intended for integrating the uPAD into an embedded design.

Backpack Connectors

The Backpack Connectors of the µPAD contain an analog port, two digital ports, the Xmega reset signal, and all the power signals available to the µPAD. Since the Backpack Connectors are standard .1” female headers on a .1” grid this interface is ideally suited for prototyping. Any standard proto-board can be connected to the µPAD’s Backpack Connectors.

Backpack Connectors Pinout



Base Connector

The Base Connector of the µPAD is a fine pitch connector mounted on the bottom of the µPAD. This connector contains all of the supply signals with the exception of the analog reference. The Base Connector also has a partial analog port, two standard digital ports, and three additional digital ports (minus 1 pin) that can be used for memory expansion via the Xmega's EBI (External Bus Interface) peripheral.

Using the Base Connector, the µPAD can be easily integrated into an embedded system.

Base Connector Pinout

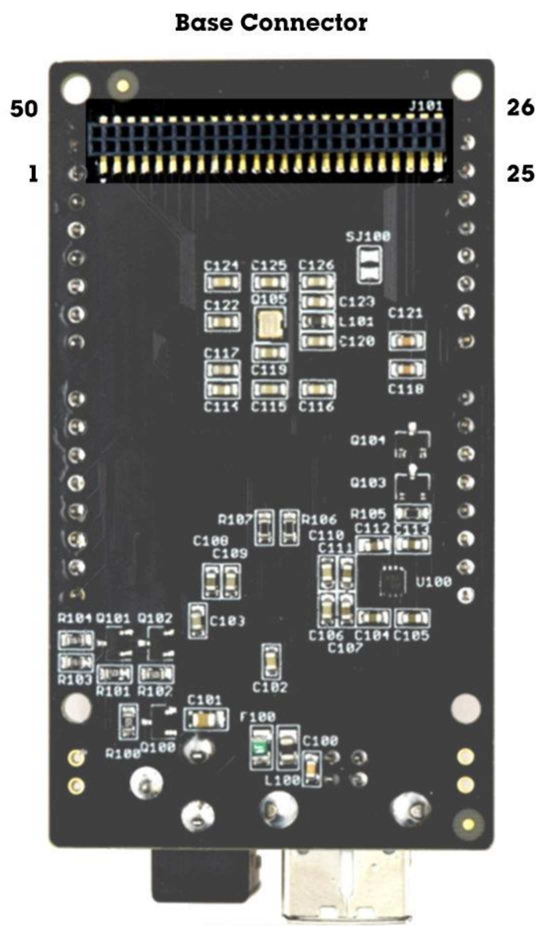


Table 2: Base Connector Signals

Signal	Pin	Function	Signal	Pin	Function
PORTF 7	1	I/O,SCK,TXD1	PORTK 7	26	I/O,A7,A15[1]
PORTF 6	2	I/O.MISO,RXD1	PORTK 6	27	I/O,A6,A14[1]
PORTF 5	3	I/O,MOSI,XCK1,OC1B	PORTK 5	28	I/O,A5,A13[1]
PORTF 4	4	I/O, $\overline{SS}$,OC1A	PORTK 4	29	I/O,A4,A12[1]
PORTF 3	5	I/O,TXD0,OC0D	PORTK 3	30	I/O,A3,A11[1]
PORTF 2	6	I/O,RXD0,OC0C	PORTK 2	31	I/O,A2,A10[1]
PORTF 1	7	I/O,SCL,XCK0,OC0B	PORTK 1	32	I/O,A1,A9[1]
PORTF 0	8	I/O,SDA,OC0A	PORTK 0	33	I/O,A0,A8[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, $\overline{CS3}$,A19
PORTB 3	18	I/O,DAC1,AC,ADC	PORTH 6	43	I/O, $\overline{CS2}$,A18
PORTB 4	19	I/O,TMS,AC,ADC	PORTH 5	44	I/O, $\overline{CS1}$,A17
PORTB 5	20	I/O,TDI,AC,ADC	PORTH 4	45	I/O, $\overline{CS0}$,A16
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.

Electrical Characteristics

Table 3: Absolute Maximum Ratings

Item	Min	Nom	Max	Unit
VIN			12.0[1]	V

1) The µPAD is rated for 12V. However accessory boards connected may not be. Always ensure the VIN voltage applied is within range for any Backpack or Base boards that utilize this signal.

Table 4: General Characteristics

Item	Min	Nom	Max	Unit
3.3V Tolerance		3.3		V
5.0V Tolerance	4.85	5.0	5.15	V
2.5V Ref Tolerance	2.49	2.50	2.51	V
VIN Range	4.5	5.0	12	V
2.5V Rail current		15[1]		mA
3.3V Rail current		1.00		mA
5.0V Rail Current			275	mA
µPAD Idle Current		~125		mA
RTC Oscillator Frequency	-30		30	ppm

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