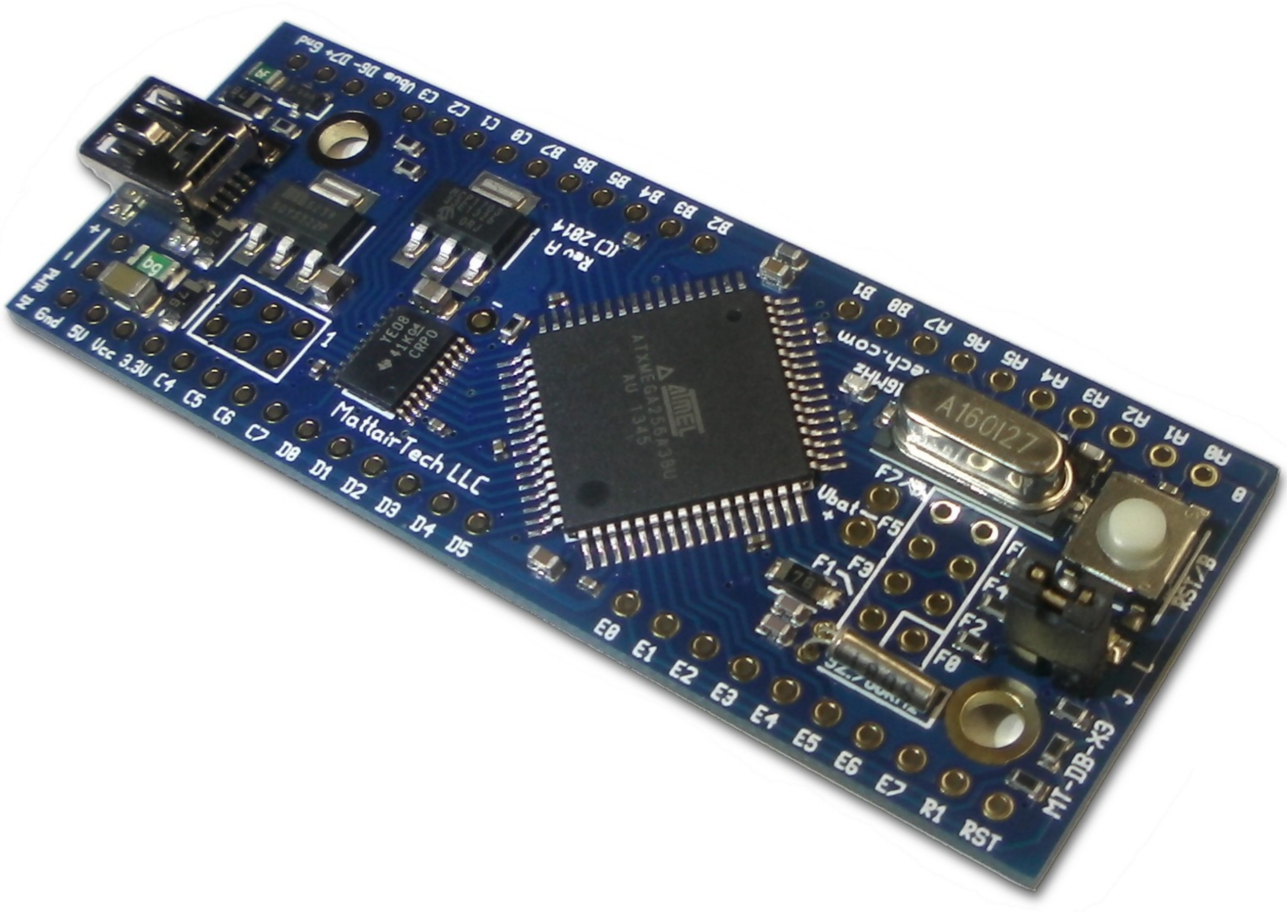
# MT-DB-X3 User Guide



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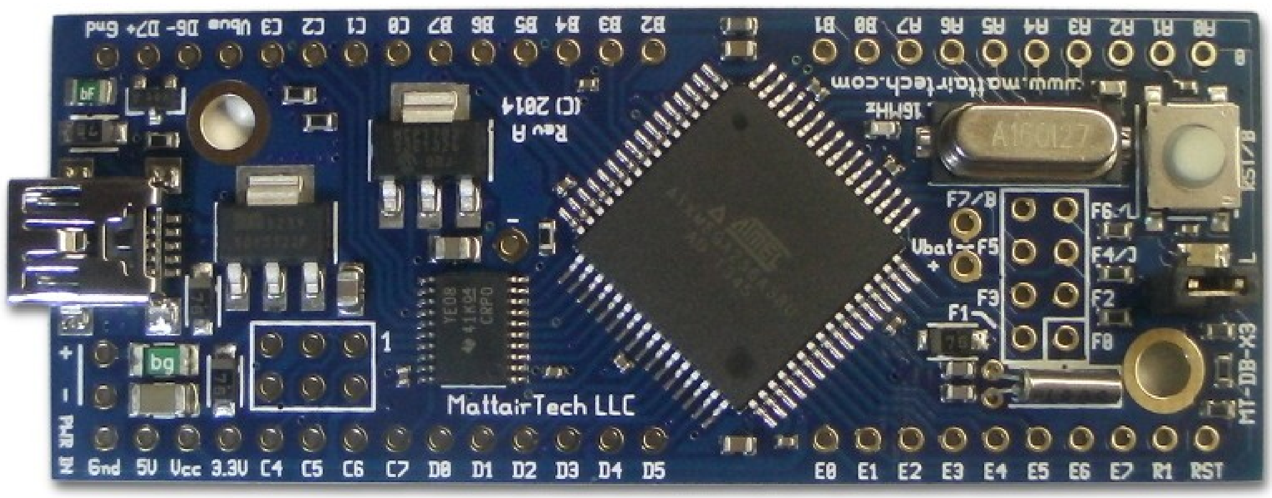
# Overview




### *Introduction*

The MT-DB-X3 is a development board for the 64-pin Atmel AVR XMEGA A3U, A3BU, C3, and D3 microcontrollers. It can be powered from USB, the PWR IN header, or from a 3V coin cell (CR2032 holder optional). The inputs have PTC resettable fuses (500mA) and schottky diodes. Voltage is regulated by the onboard 3.3V, 250mA, extremely low quiescent current (2uA) LDO regulator that supports up to 16V DC input. Optionally, a 5V, 500mA low quiescent current (23uA) LDO regulator can also be installed, which supports up to 24V input. Along with the 5V regulator, an 8-bit auto-direction sensing level shifter is installed, to provide level conversion between XMEGA Vcc and 5V (or 3.3V). Also mounted is a mini USB connector, green LED, 16MHz crystal, 32.768KHz RTC crystal, reset/user button, TWI (I2C) pullups, and a bootloader jumper. A USB DFU bootloader comes pre-installed (except D3). The board has 48 main dual inline header pins with 100 mil pin spacing and 900 mil row spacing which allows for mounting on a perfboard (or barely on a breadboard). There are 8 more pins available on an inboard header (PORT F). The PDI/SPI header can be used with an external programmer, or be reconfigured to be used as a SPI master or slave. There are 36 solder jumpers for configuration flexibility. The pcb measures approx. 2.9” x 1.1” (73mm x 28mm) and 0.062” (1.6mm) thick. There are 2 3mm mounting holes.

## *Board Features*

- **Atmel AVR XMEGA A3U, A3BU, C3, or D3 64-pin microcontroller**
    - A3U, A3BU, and C3 variants support USB device mode
    - 32KB - 384KB FLASH, 4KB - 32KB SRAM, 2KB - 4KB EEPROM
    - 16 12-bit ADC channels (all variants), 2 12-bit DAC channels (A3U and A3BU)
    - 7 USART (6 for A3BU, 3 for D3 and C3), 2 SPI (3 for A3U), and 2 TWI (I2C)
    - 7 16-bit timers (5 for C3 and D3), 16-bit RTC (32-bit for A3BU) with ext. oscillator
- **Onboard 3.3V, 250mA LDO regulator**
    - Up to 16V DC input (reverse-polarity protected)
    - extremely low quiescent current (2.0uA typical), 0.4% output tolerance typical
    - low dropout (525mV typical @ 250mA, 725mV max. @ 250mA)
    - Over-current and over-temperature protection
- **Onboard 5V, 500mA LDO regulator (optional)**
    - Up to 24V DC input (reverse-polarity protected)
    - low quiescent current (23uA @100uA, 75uA @10mA, 0.7mA @100mA)
    - low dropout (350mV @ 500mA)
    - over-current protection, thermal shutdown
- **Auto-direction Sensing Level Shifter (optional)**
    - Converts from Vcc (usually 3.3V) to either 5V or 3.3V
    - 8 independent bi-directional bits connected to Port C (can be bypassed)
    - Low power consumption (4uA max.), 15KV ESD (HBM)
    - Can optionally control output enable (OE) from microcontroller
- **DFU (FLIP) bootloader preinstalled (except D3 variant)**
- **2 PTC resettable fuses (500mA) for PWR IN + and Vbus**
- **PDI/SPI header (PDI by default)**
    - As a PDI header, it is used to program the AVR with an external programmer
    - Header can be converted to a SPI (master or slave) header
    - Can mount the MT-SD MicroSD card slot directly to this header
- **16MHz crystal for main clock (use PLL for higher frequencies)**
- **32.768KHz crystal for 16-bit RTC (32-bit battery-backed with A3BU)**
- **CR2032 coin cell holder (optional) can power Vcc (all variants) or RTC (A3BU only)**
- **Green Status LED (can be disconnected), bootloader jumper**
- **Button configurable for reset or general use (pin F7) with optional debouncing**
- Mini USB connector for communications (except D3) and Vbus power (all variants)
- USB pins routed to header pins (for panel-mount USB connector)
- Ferrite bead and 2 capacitors on analog supply
- **36 solder jumpers on PCB bottom for configuration flexibility**
- All PORT pins routed to headers (except R0; and when using the A3BU, E6 and E7)
- 4 main headers are on 0.1” spacing relative to each other (breadboard/perfboard mounting)
- **Two 3mm mounting holes (~5mm pad)**
- High-quality PCB with gold-plated finish
- Measures approx. 2.9” x 1.1” (73mm x 28mm) and 0.062” (1.6mm) thick

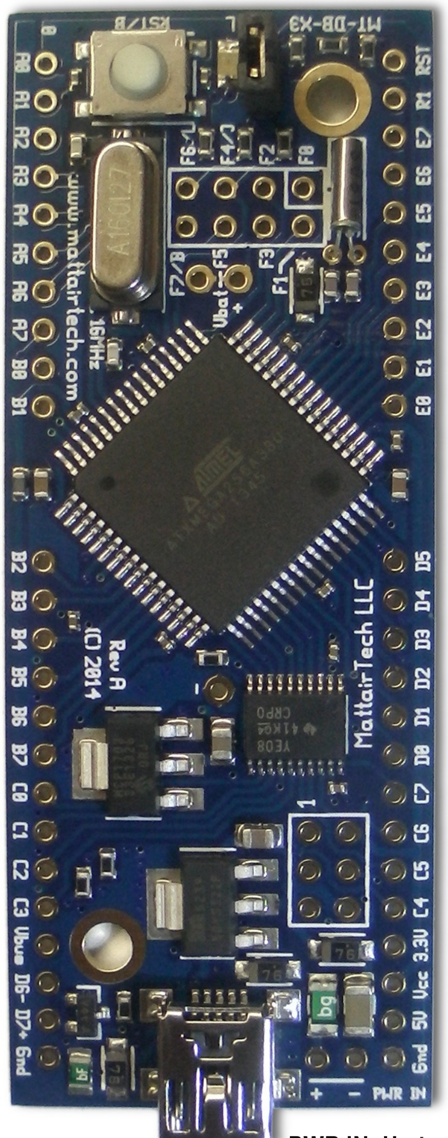
## *ATxmegaXXXa3u Features*

(Consult appropriate datasheet for C3, D3, and A3BU variant features)

- High-performance, low-power Atmel® AVR® XMEGA® 8/16-bit Microcontroller
- Nonvolatile program and data memories
  – 64K - 256KBytes of in-system self-programmable flash
  – 4K - 8KBytes boot section
  – 2K - 4KBytes EEPROM
  – 4K - 16KBytes internal SRAM
- Peripheral features
  – Four-channel DMA controller
  – Eight-channel event system
  – Seven 16-bit timer/counters
  – Four timer/counters with four output compare or input capture channels
  – Three timer/counters with two output compare or input capture channels
  – High resolution extension on all timer/counters
  – Advanced waveform extension (AWeX) on one timer/counter
  – One USB device interface
  – USB 2.0 full speed (12Mbps) and low speed (1.5Mbps) device compliant
  – 32 Endpoints with full configuration flexibility
  – Seven USARTs with IrDA support for one USART
  – Two two-wire interfaces with dual address match (I2C and SMBus compatible)
  – Three 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
  – Two sixteen-channel, 12-bit, 2msps Analog to Digital Converters
  – One two-channel, 12-bit, 1msps Digital to Analog Converter
  – Four Analog Comparators 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
  – Five sleep modes
  – Programming and debug interfaces
  – JTAG (IEEE 1149.1 compliant) interface, including boundary scan
  – PDI (program and debug interface)
- I/O and packages
  – 50 Programmable I/O pins
  – 64-lead TQFP
  – 64-pad QFN
- Operating voltage
  – 1.6 – 3.6V
- Operating frequency
  – 0 – 12MHz from 1.6V
  – 0 – 32MHz from 2.7V

# MT-DB-X3 Hardware

### *Top View / Pinout*



### *Header Pins (Power)*

| Pin | Description |
|---|---|
| **Gnd (2)** | Ground |
| **PWR IN (+ / -)** | Positive and negative (ground) terminals for connection to an external power source or battery. Reverse-polarity protected. It is routed through a PTC resettable fuse (500mA) to a 10uF, 50V ceramic capicitor. In addition to tripping under excessive continuous current, the PTC fuse also controls inrush current due to the low ESR of the ceramic capacitor. Power is then routed through a schottky diode to either the 5V regulator (if present) or the 3.3V regulator input. Jumper J10 is used to select the regulator. Even when the 5V regulator is present, the user may wish to route PWR IN to the 3.3V regulator instead (ie: reduce current consumption if 5V rail not needed). When PWR IN is routed to the 3.3V regulator, the maximum input voltage is 16V DC. If routed to the 5V regulator, PWR IN can be up to 24V DC. Note that the regulator can actually handle 30V, but the PTC fuse limits this to 24V. PWR IN + voltage can be measured on pin B7 by connecting J15 and setting J3 to connect to PWR IN +. J15 will connect B7 to a resistor divider consisting of a 200Kohm (to PWR IN +) and a 20Kohm resistor (to ground). The resistor divider will pull B7 to near ground level when PWR IN + is disconnected. Because of a small leakage current from the schottky diode, a small voltage should be interpreted as PWR IN disconnected. |
| **Vbus** | Vbus is connected directly to the Vbus pin (5V) of the USB connector. It is routed through a PTC resettable fuse (500mA), a schottky diode, and jumper J4 to the 5V power rail, which has a 10uF capacitor. In addition to tripping under excessive continuous current, the PTC fuse also controls inrush current due to the low ESR of the ceramic capacitor. Disconnect J4 if you do not wish Vbus ever to power the 5V rail. Note that because of the voltage drop of the schottky diode, the 5V rail will be less than 5V when Vbus is the only power source. Vbus voltage can be measured on pin B7 by connecting J15 and setting J3 to connect to Vbus. J15 will connect B7 to a resistor divider consisting of a 200Kohm (to Vbus) and a 20Kohm resistor (to ground). The resistor divider will pull B7 to near ground level when Vbus is disconnected. Because of a small leakage current from the schottky diode, a small voltage should be interpreted as Vbus disconnected. |
| **5V** | The 5V pin outputs 5V from either the onboard 5V regulator (if present) or USB Vbus. There is a 10uF capacitor on this rail. The 5V rail can power the high-voltage side of the level shifter (if present). It is also routed through a low-leakage schottky diode to the 3.3V regulator input. If PWR IN + is also routed to the 3.3V regulator input (using J10), then the diode may be reverse-biased, and leak onto the 5V rail. Thus, J5 must be soldered which enables a 47Kohm pulldown to prevent the 5V rail from rising above 5V (see J5 below). If supplying power externally on the 5V pin, disconnect the 5V regulator output with J11, and take care to limit inrush current caused by the ceramic capacitor (see precautions). |
| **Vcc** | This pin is connected to the Vcc and AVcc (through a ferrite bead) pins on the XMEGA, the PDI/SPI header Vcc pin, the reset pullup, and the TWI pullup resistors. There is one 4.7uF capacitor on Vcc and one 4.7uF capacitor on Avcc. Thus, with the six 100nF capacitors, there is a total of 10uF on Vcc. Vcc is normally connected to the 3.3V rail through J1, which in turn is connected to the output of the onboard 3.3V regulator. Note that there is a total of 20uF on Vcc when connected to 3.3V, due to the additional 10uF 3.3V regulator output capacitor. A 3V coin cell (holder optional) can be connected to Vcc through a schottky diode by soldering J28 toward the center of the board. On boards with the level shifter |

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| | installed, Vcc is also connected to the low-voltage side. If supplying power externally on the Vcc pin, disconnect either J24 (if supplying 3.3V) or J1 (any other voltage supported by the XMEGA), and take care to limit inrush current caused by the ceramic capacitor. |
| **3.3V** | 3.3V is connected to the output of the onboard 3.3V regulator. There is a 10uF capacitor on this rail. 3.3V is normally connected to Vcc through J1. It is also routed to J14, which is the voltage selection jumper for the high-voltage side of the level shifter (if present). If supplying power externally on the 3.3V pin, disconnect J24 to disconnect the onboard 3.3V regulator output, and take care to limit inrush current caused by the ceramic capacitor. |
| **Vbat (+ / -)** | An optional 3V CR-2032 coin cell holder can be installed to either the top or bottom of the pcb. The side with 2 pins is positive (+). This pin can be routed through a schottky diode and through J28 to either pin F5 (Vbat, for the battery-backed RTC – use with **ATxmega256a3bu ONLY**) or to Vcc to power the chip itself for low power applications. It is not necessary to disconnect the 3.3V regulator output when using a coin cell. |

| CAUTION |
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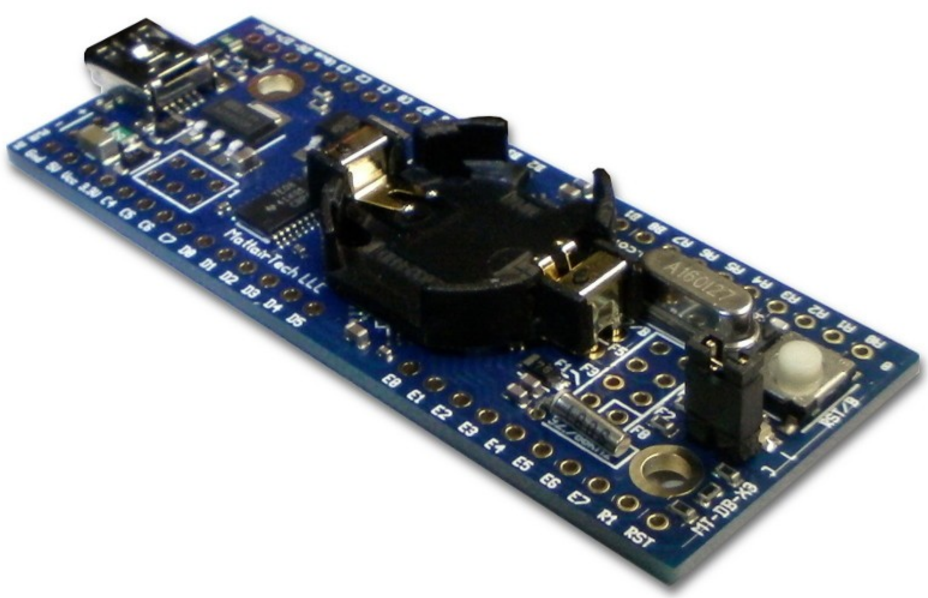
| Higher regulator input voltages mean larger voltage drops and thus higher thermal dissipation for a given amount of current. Be sure to limit current consumption to prevent excessive heat when using higher voltages and/or currents. The regulator will enter thermal shutdown if it gets too hot, but this should be avoided as degradation will occur (true of most regulators). All capacitors are X7R (X5R for the large 1206 PWR IN capacitor), or NP0, so they can deal with the higher temperatures of the regulators. Note that high temperatures will lower the PTC trip and hold currents. |



### *Header Pins (Signal)*

| Pin | Description |
|---|---|
| **A0 -A7** | Port A. These can be used for analog functions (ADC or AC) or for GPIO. Pin A0 can be used as AREF. When used as AREF, connect J34 to enable a 100nF capacitor. |
| **B0 - B7** | Port B. These can be used for analog functions (ADC, AC, or DAC) or for GPIO. JTAG is on pins B4 – B7. Because JTAG is enabled by default, be sure to disable JTAG before using these pins with the ADC or for GPIO. Pin B0 can be used as AREF. When used as AREF, connect J25 to enable a 100nF capacitor. Pin B7 can be connected to the voltage divider for measurement of PWR IN + or Vbus by setting J3 and J15 appropriately. |
| **C0 - C7** | Port C. These can be used for digital functions (TC, USART, TWI, SPI) or for GPIO. Pins C4 – C7 can be connected to the PDI/SPI header by using jumpers J8, J9, J12, and J13. To convert the header to SPI mode, connect J8 and J12, then change J9 and J13 to the alternate positions. Port C can be level-shifted. The auto-direction sensing level shifter and 5V regulator are optional components. When not installed, Port C is directly connected to the header pins via 8 solder jumpers (J16 – J23). When installed, these jumpers are not soldered by default. Instead, port C pins connect to the low-voltage side of the level shifter, which is referenced to Vcc (usually 3.3V). The high-voltage side connects to the header pins (including the ISP/SPI header), and can be referenced to either 5V or 3.3V. Even when the level-shifter is installed, it can be bypassed by setting jumpers J16 – J23 and disabling the outputs by disconnecting J26 completely from both pads. |
| **D0 - D5** | Port D. These can be used for digital functions (TC, USART, SPI) or for GPIO. Pin D5 can optionally be used to control the output enable line (OE) of the level-shifter (if installed). Normally, OE is connected to Vcc through J26, so it is not required to use D5. |
| **D6-, D7+** | These pins are always connected to D6 and D7 of the XMEGA and can be connected to D- and D+ of the USB connector through jumpers J6 and J7 (soldered by default except with the XMEGA D). There is an ESD diode to ground on each pin. These pins, along with the adjacent Vbus and Ground pins can be used for a panel-mount USB connector. |
| **E0 - E5** | Port E. These can be used for digital functions (TC, USART, TWI, SPI) or for GPIO. Pins E0 and E1 have 4.7Kohm pullup resistors for TWI (I2C) than can be enabled by setting J35 and J36. |
| **E6 (TOSC2), E7 (TOSC1)** | Pins E6 and E7 can be used for digital functions (USART, SPI) or for GPIO with all chip variants except for the ATxmega256a3bu. Additionally, these pins can be routed to the 32.768KHz crystal (TOSC1 and TOSC2) instead of the header pins using jumpers J27 and J29. Connection to the crystal is required in the case of the ATxmega256a3bu. |
| **R1** | Pin R1 can be used as EXTCLK (input) or as GPIO by setting J30 appropriately. Otherwise, R1 is routed to the 16MHz crystal (default). |
| **RST** | RST connects to the reset pin of the XMEGA, the reset button (depending on J33), and through J9 to the PDI/SPI header. A 10K pullup resistor is connected to this pin. J9 is used along with other jumpers to set the header to PDI or SPI mode. Note that the XMEGA reset pin is also used as the PDI clock. Thus, the button debouncing capacitor (J32) should be left disconnected when PDI programming is used. |
| **F0 – F3** | Port F. These can be used for digital functions (TC, USART) or for GPIO. |

| | |
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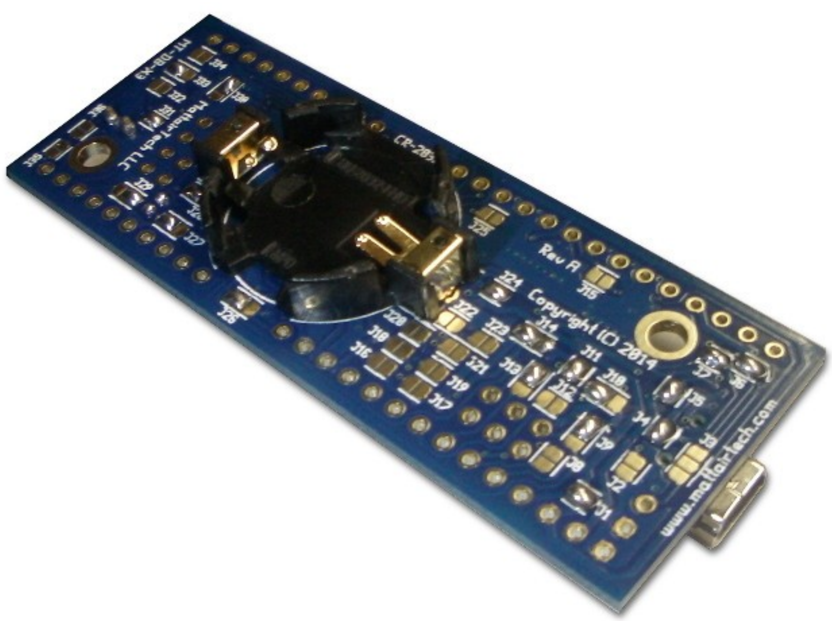
| **F4** / **J** | This pin is connected to the bootloader jumper (though a 249 ohm resistor) and to pin F4 of the XMEGA. The jumper in turn connects to ground. The 249 ohm resistor provides short-circuit protection in case the pin is used as an output and the jumper is installed. Install the jumper to run the USB DFU bootloader (except D variant). Otherwise, the user application is run. |
| **F5** / **Vbat** | This pin is connected to F5 of the XMEGA. Additionally, for the **ATxmega256a3bu ONLY**, this pin can connect to a 3V coin cell for RTC backup power. The optional 3V CR-2032 coin cell holder can be installed to either the top or bottom of the pcb. The side with 2 pins is positive (+). This pin can be routed through a schottky diode and through J28 to either pin F5 (**ATxmega256a3bu ONLY**) or to Vcc to power the chip itself for low power applications. |
| **F6** / **L** | This pin is connected to the green LED (though a 249 ohm resistor and jumper J31) and to pin F6 of the XMEGA. Drive pin F6 high to turn on the LED. Disconnect J31 to disable the LED. |
| **F7** / **B** | This pin may be connected to the button by setting J33 appropriately. When this pin is connected to the button, a debouncing capacitor may also be enabled by soldering J32. A 249ohm resistor is connected in series with the button to eliminate voltage spikes due to the capacitor and to prolong button life. When using the button as reset (default setting), the capacitor should be disconnected to allow for PDI programming. |
| **PDI** / **SPI Header** | This header can be connected to an external PDI programmer/debugger. Alternatively, this header can be used for SPI communications (master or slave). To convert the header to SPI mode, connect J8 and J12, then change J9 and J13 to the alternate positions. This will route 4 header pins to pins C4 – C7 of the XMEGA (there is a SPI peripheral here). Pin C4 can be used as a chip select (or as a slave select if in slave mode). See schematic for pinout information. Note that when using the level-shifter (if present), the SPI pins will be at 5V levels if 5V is selected as the high-voltage. But, the Vcc pin will still be at 3.3V. |



### *Solder Jumpers*

| Jumper | Description |
|---|---|
| **J1: Vcc – 3.3V** | This connects the 3.3V regulator output to Vcc. Open J1 if supplying a regulated voltage (3.6V or less) externally on the Vcc pin, and take care to limit inrush current caused by the ceramic capacitor (see precautions). |
| **J2: USB Shield Ground** | Jumper J2 can be closed to connect the USB shield to ground. The USB specification calls for the USB shield to be grounded on the host side only. However, some prefer to have it grounded, although this could cause the shield to act as an antenna or a ground loop would be formed. An 0603 component (or maybe two 0402) may be soldered on the pads. |
| **J3: Voltage divider input** | Vin or Vbus voltage can be measured on pin B7 by closing J15 and setting J3 toward the PWR IN + (for PWR IN + measurement) or the Vbus (for Vbus measurement) side of the board (refer to printing on top side of pcb). J15 will connect B7 to a resistor divider consisting of a 200Kohm (top) and a 20Kohm resistor (bottom), and J3 connects to PWR IN + or Vbus. The resistor divider will pull B7 to near ground level when PWR IN + or Vbus is disconnected. Because of a small leakage current from the low-leakage schottky diode, a small voltage should be interpreted as PWR IN + or Vbus disconnected. Note that these resistors are only 1% and they are close to the 5V regulator thermal tab, so accuracy is limited. By default, J3 is not soldered at all. |
| **J4: Vbus Power** | Vbus (5V) is routed through a PTC resettable fuse (500mA), a schottky diode, and jumper J4 to the 5V power rail, which has a 10uF capacitor. Open J4 to prevent Vbus from powering the 5V rail. See Vbus above. |
| **J5: 5V Rail Pulldown** | The 3.3V regulator input is connected to the 5V rail through a low-leakage schottky diode. Additionally, PWR IN + can also be routed through a PTC fuse and schottky diode to this input (using J10). In this case, the voltage present on the regulator input (up to 16V) may be higher than the 5V rail, which may or may not even be powered. In this case, the diode will leak a small amount of current onto the 5V rail. To prevent the 5V rail from exceeding 5V, J5 must be closed which enables a 47Kohm pulldown. The amount of leakage is strongly dependent on temperature. The 47Kohm resistor is adequate to consume the amount of current that leaks at 85C with the maximum 16V applied to PWR IN +. Note that in this case, the 5V regulator is not connected and thus will not generate heat, so the close proximity of the diode to the 5V regulator does not matter. The downside of using the pulldown is that it also consumes current when Vbus is feeding the 5V rail. Open J5 to remove the pulldown (ensure that PWR IN + does not exceed 5V). Alternatively, if temperatures can be limited further, solder an 0603 resistor onto the J5 pads to increase the resistance. See the diode datasheet in this case (Rohm RB160M-60 Schottky Barrier Diode). |
| **J6: USB D+ / Pin D7** | The D6- and D7+ pins are connected to pins D6 and D7 of the XMEGA. They are also routed to the D- and D+ pins of the USB connector when |

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| | J6 and J7 are closed. J6 and J7 are open on boards with the XMEGA D variant. The D6- and D7+ pins, along with the adjacent Vbus and Ground pins can be used for a panel-mount USB connector. D6- and D7+ can be used for digital functions with J6 and J7 open. Note that even when these jumpers are open, there is still an ESD diode (with low pin capacitance) to ground on both D6- and D7+. |
| **J7: USB D- / Pin D6** | See J6. |
| **J8: PDI/SPI Selection** | The PDI/SPI header can be connected to an external PDI programmer/debugger. Alternatively, this header can be used for SPI communications (master or slave). The image below shows the PDI configuration, which is the default. To convert the header to SPI mode, close J8 and J12, then change J9 and J13 to the alternate positions. This will route 4 header pins to pins C4 – C7 of the XMEGA (there is a SPI peripheral here). Pin C4 can be used as a chip select (or as a slave select if in slave mode). See schematic for pinout information. Note that when using the level-shifter (if present), the SPI pins will be at 5V levels if 5V is selected as the high-voltage. But, the Vcc pin will still be at 3.3V. |
| **J9: PDI/SPI Selection** | See J8. The image below shows the PDI configuration. |
| **J10: PWR IN Regulator Selection** | PWR IN + can be routed to the input of the 5V regulator (if present) or to the 3.3V regulator input by using J10. When connected to the 5V regulator, the 3.3V regulator instead gets input from the 5V rail. **See PWR IN (+ / -) above.** The image below shows Vin routed to 5V, which is the default on boards with the 5V regulator. On all other boards, J10 will be in the alternate position. |
| **J11: 5V Regulator Output** | The output of the 5V regulator (if present) can be disconnected by opening J11. This allows connection of an external regulator on the 5V pin. In this case, be sure to limit inrush current caused by the 10uF ceramic capacitor. See 5V pin above. |
| **J12: PDI/SPI Selection** | See J8. The image below shows the PDI configuration. |
| **J13: PDI/SPI Selection** | See J8. The image below shows the PDI configuration. |
| **J14: Level Shifter Voltage Selection** | The low-voltage side of the level shifter (if present) is always connected to Vcc (usually 3.3V). The high voltage side can connect to either 5V or 3.3V by using J14. Normally, this will be set to 5V. The 3.3V setting is useful if Vcc is less than 3.3V, or to use the level shifter as a buffer with additional ESD protection. See pins C0-C7 above. The default setting, on boards with the level shifter, is 3.3V (as shown in the image below). Thus, all pins on port C are at 3.3V levels until explicitly set to 5V. Note that the PDI/SPI header (when in SPI configuration) is routed through the level-shifter. |
| **J15: Pin B7 to voltage divider** | See J3. Close to connect B7 to the onboard voltage divider. |
| **J16 - J23: Level Shifter Bypass** | These 8 jumpers, when closed, are used to connect both sides of the level shifter, so that the XMEGA pins are connected directly to the header pins without level shifting. This is the default setting on boards that lack the level shifter. These can also be set on boards with the level |

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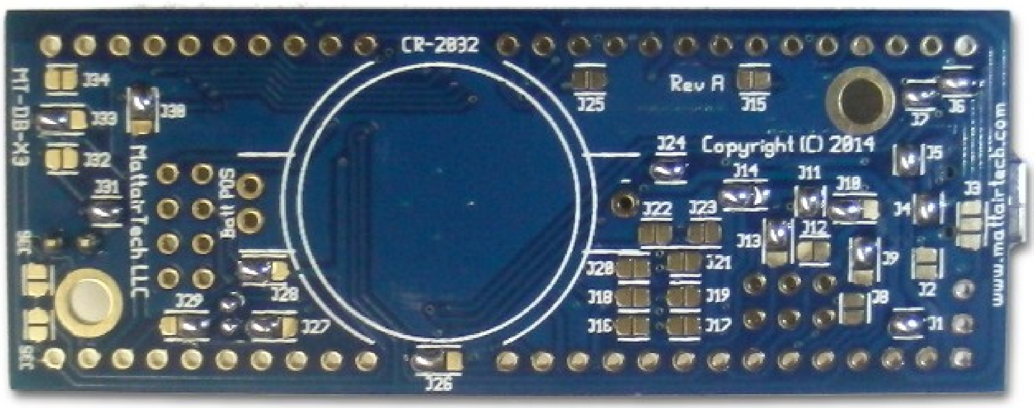
| | shifter in order to bypass it. In this case, also disable the level shifter outputs by disconnecting all three pads of J26. This will allow the output enable (OE) to be pulled low at all times by a pulldown resistor, disabling the outputs (tri-stated). It is safe for the high-voltage side of the level shifter to be unpowered (ie: 5V rail can be absent). See J14 and J26. |
| **J24: 3.3V Regulator Output** | The output of the 3.3V regulator can be disconnected by opening J24. This allows connection of an external regulator on the 3.3V pin. In this case, be sure to limit inrush current caused by the ceramic capacitor(s). See 3.3V pin above. |
| **J25: AREF capacitor** | When using pin B0 as AREF, close J25 to enable a 100nF capacitor from B0 to ground. |
| **J26: Level Shifter OE Control** | This jumper controls the output enable (OE) pin of the optional level shifter. By default, on boards with the level shifter installed, this jumper connects OE to Vcc (as shown in the image below), so the outputs are always enabled. The alternate position connects OE to pin D5 for MCU control. The solder can be removed completely, which will allow the pulldown to pull OE low and thus keep the outputs disabled at all times. |
| **J27: TOSC2 – E6 Selection** | J27 and J29 route XMEGA pins E6 and E7 to either the 32.768KHz crystal or to the header. The crystal must be connected when using the ATxmega256a3bu. The image below shows the jumpers routing both pins E6 and E7 to the crystal. |
| **J28: Coin Cell Power Routing** | An optional 3V CR-2032 coin cell holder can be installed on either the top or bottom of the pcb. The side with 2 pins is positive (+). This pin can be routed through a schottky diode and through J28 to either pin F5 (Vbat, for the battery-backed RTC – use with **ATxmega256a3bu ONLY**) or to Vcc to power the chip itself for low power applications. It is not necessary to disconnect the 3.3V regulator when using a coin cell. The image below shows routing to F5 (**ATxmega256a3bu ONLY**). For all other chips, the jumper will be in the alternate position by default. |
| **J29: TOSC1 – E7 Selection** | See J27 above. |
| **J30: Crystal – EXTCLK Selection** | Pin R1 can be used as EXTCLK (input) or as GPIO by soldering the two pads of J30 nearest the MattairTech printing. In the alternate position, R1 is routed to the 16MHz crystal which is the default as seen below. |
| **J31: LED** | Pcb pin F6/L is connected to the green LED (though a 249 ohm resistor and jumper J31) and to pin F6 of the XMEGA. Drive pin F6 high to turn on the LED. Open J31 to disconnect the LED. |
| **J32: Button debouncing capacitor** | Pin F7/B can be connected to the button by setting J33 appropriately. A debouncing capacitor can be enabled by closing J32. A 249ohm resistor is connected in series with the button to eliminate voltage spikes due to the capacitor and to prolong button life. When using the button as reset (default), J32 must be open to allow for PDI programming. |
| **J33: Button function selection** | Solder the two pads of J33 nearest the “MT-DB-X3” printing to connect the button to the RST line (as shown in the image below). Be sure J32 is open when connected to RST. The alternate position for this jumper |

| | |
|---|---|
| | connects the button to pin F7/B. See J32. |
| **J34: AREF capacitor** | When using pin A0 as AREF, close J34 to enable a 100nF capacitor from A0 to ground. |
| **J35: TWI (I2C) Pullup** | Pins E0 and E1 have a TWI (I2C) peripheral available. Close both J35 and J36 to enable two 4.7Kohm pullup resistors to Vcc. |
| **J36: TWI (I2C) Pullup** | See J35 above. |



# USB DFU Bootloader (A3U, A3BU, and C only)

USB enabled XMEGAs (A3U, A3BU, or C3) come with a USB DFU bootloader pre-installed. The XMEGA D3 does not have onboard USB hardware, so no bootloader is installed. The bootloader is from Atmel. Documentation can be found in AVR1916. Note that the MT-DB-X3 uses a different bootloader activation pin than the Atmel default. The hex files provided by Atmel (from AVR1916.zip) were patched directly to use the MT-DB-X3 boot jumper pin. The patched hex files can be found at http://www.mattairtech.com/software/MT-DB-X3/MT-DB-X3_DFU_Bootloaders_104.zip.

### *Installing FLIP / USB DFU Drivers*

FLIP is a graphical utility for Windows used to load firmware into the XMEGA. FLIP supplies the USB DFU bootloader driver. Download FLIP 3.4.7 or higher from http://www.atmel.com/tools/flip.aspx and install. Older versions may not support the latest XMEGA variants. Once FLIP is installed, the USB DFU drivers can be loaded. Install the boot jumper and power the board (or press reset). This will start the DFU bootloader. Windows will then prompt you for the driver, which is located in the Program Files/Atmel/Flip 3.4.7/usb directory. Point the installer to that directory and install. Once the driver is loaded, the device will appear under Atmel USB Devices in the device manager. No driver is needed for Linux or OS X.

### *Using FLIP*

Install the boot jumper and power the board (or press reset). This will start the DFU bootloader. Now launch the FLIP utility. When it has loaded, click on the chip icon and select your XMEGA variant. Next, click on the USB icon, select USB, then connect. The screen should now show information about your XMEGA variant. Click on the File menu, and open the appropriate hex file. More information will appear about the program. Be sure that erase is checked. The firmware cannot be loaded unless the flash is erased first. Program must be checked. Verify should also be checked. Now click on the Run button in the lower-left of the screen, and the firmware will be quickly loaded into the XMEGA FLASH.

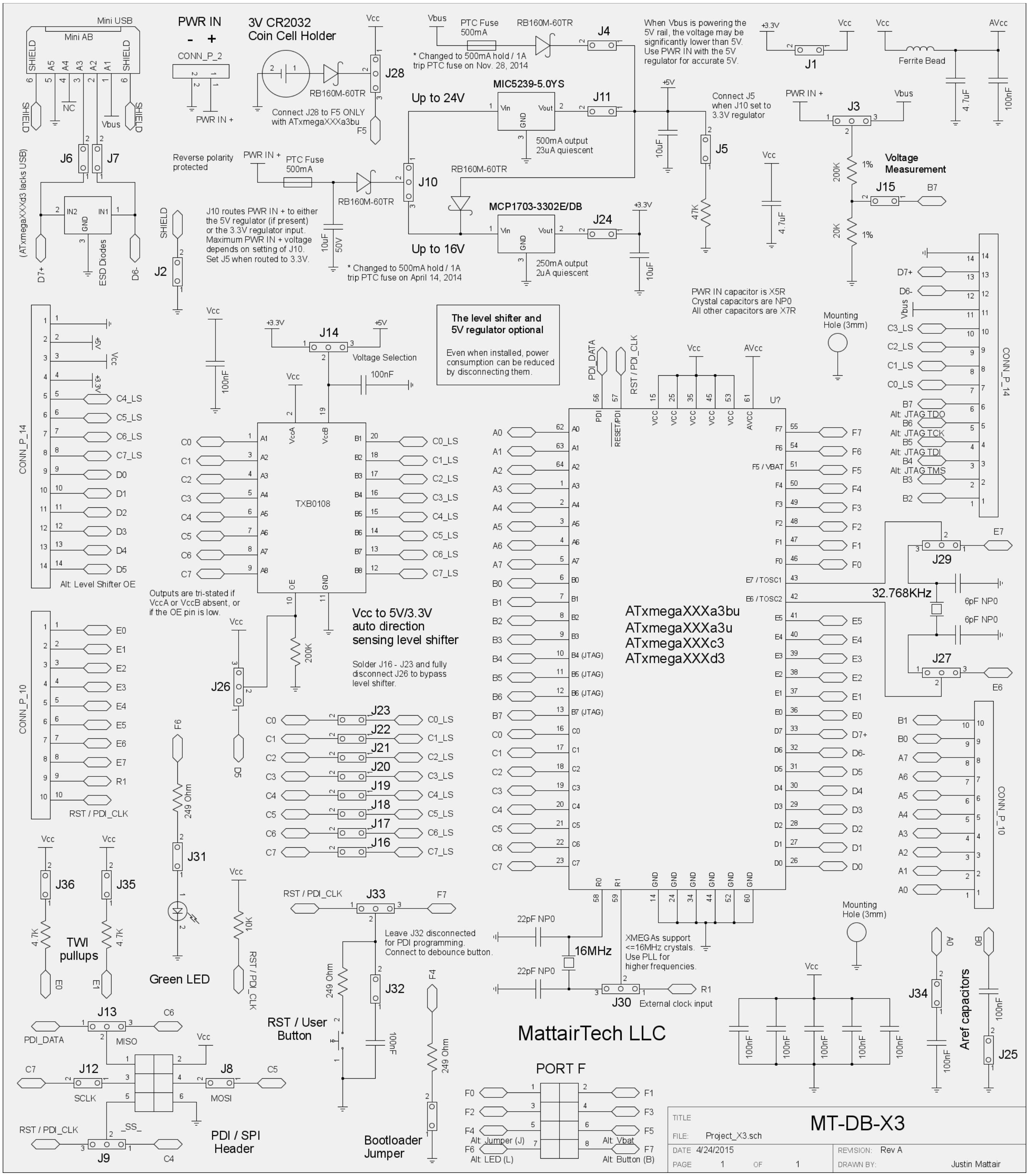
You may also program the EEPROM. If so, click on Select EEPROM at the bottom. Then, click on the File menu and open the appropriate eep file. You will have to change the file filter to allow you to see the eep file. Note that eep files are just hex files but with the eep extension instead of hex. More information will appear about the file when selected. Both Program and Verify should be checked. Click run to program the EEPROM. You can run your application without removing the jumper or pressing reset by unchecking the reset box and pressing the “Start Application” button (lower right).

### *Using dfu-programmer*

dfu-programmer is a Linux command line utility used to program the XMEGA memories. Driver installation is not required. Download version 0.6.2 or higher from http://dfu-programmer.sourceforge.net/ . The following commands can be used (atxmega128a3u shown):

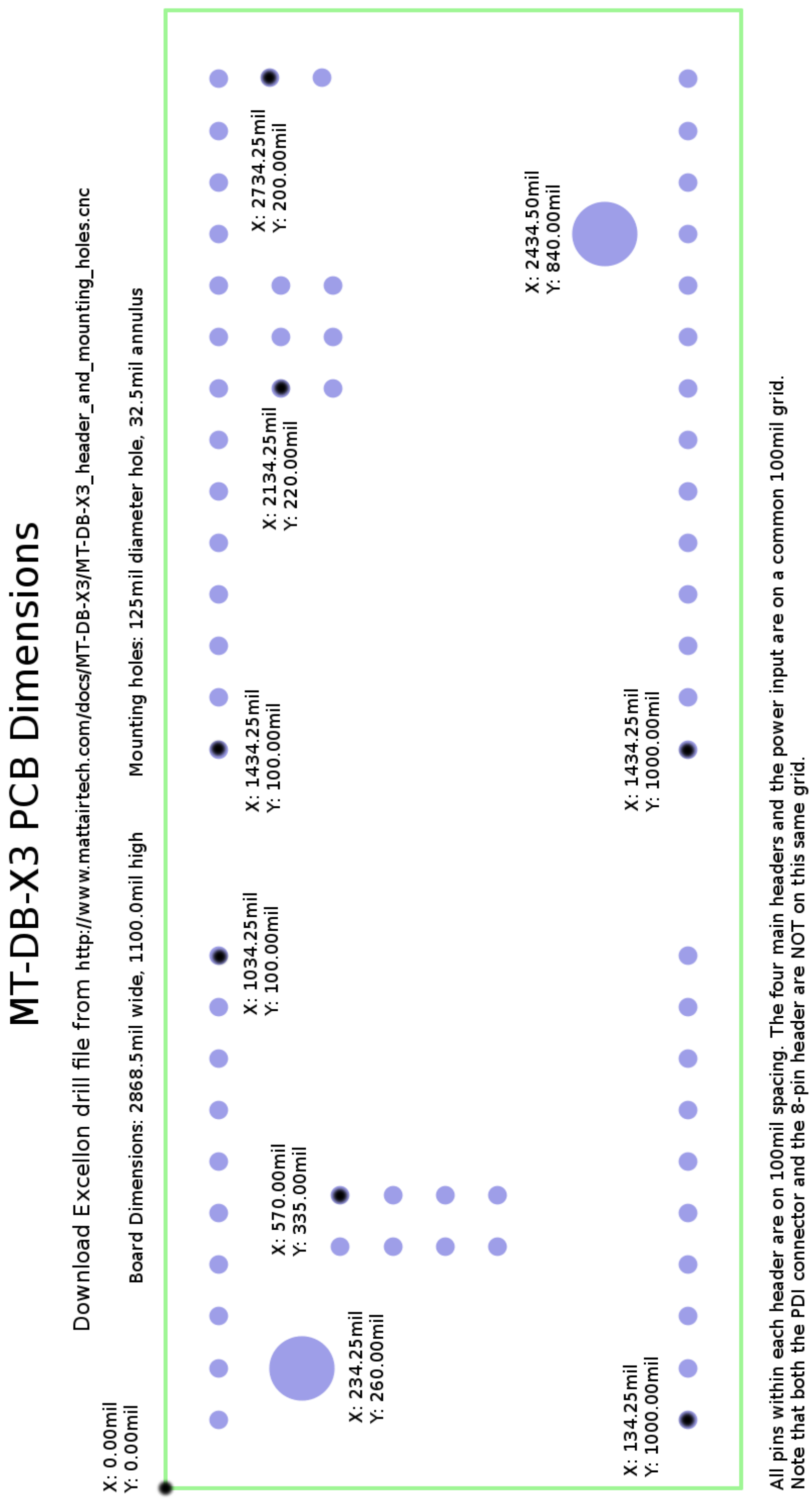
```
dfu-programmer atxmega128a3u erase
dfu-programmer atxmega128a3u flash Blink_128a3u.hex
dfu-programmer atxmega128a3u flash-eeprom YourEep.eep (if applicable)
dfu-programmer atxmega128a3u start (to jump to application section without reset)
```

# Schematic



MattairTech LLC
MT-DB-X3
Project_X3.sch
4/24/2015
Rev A
Justin Mattair
ATxmegaXXXa3bu
ATxmegaXXXa3u
ATxmegaXXXc3
ATxmegaXXXd3
TXB0108
MIC5239-5.0YS
MCP1703-3302E/DB
3V CR2032 Coin Cell Holder
PWR IN
The level shifter and 5V regulator optional
Even when installed, power consumption can be reduced by disconnecting them.
Vcc to 5V/3.3V auto direction sensing level shifter
PDI / SPI Header
Bootloader Jumper
PORT F
Aref capacitors
Green LED
TWI pullups
RST / User Button

# PCB Dimensions



# Fuse and Lock Settings

The bootloaders were pre-installed with the following commands (ATxmega128a3u shown):

```
avrdude -p x128a3u -c avrisp2 -P usb -e
avrdude -p x128a3u -c avrisp2 -P usb -U fuse0:w:0xFF:m -U fuse1:w:0x00:m -U fuse2:w:0xBF:m -U fuse4:w:0xFE:m -U fuse5:w:0xFF:m
avrdude -p x128a3u -c avrisp2 -P usb -U flash:w:"MT-DB-X3-128a3u_104.hex"
```

The Blink program was pre-installed with the following commands (ATxmega128a3u shown):

```
dfu-programmer atxmega128a3u flash Blink_128a3u.hex
dfu-programmer atxmega128a3u reset
```

The lockbits are not set.

# Blink Demo

A demo program comes pre-installed. It simply blinks the LED at 1Hz using the 16MHz crystal as the clock source.
The hex files and source code can be found at http://www.mattairtech.com/software/MT-DB-X3/MT-DB-X3_Blink.zip.

# Troubleshooting / FAQ

- **Are there any alternatives to Atmel Studio?**
  The Atmel Standalone Toolchain (based on GCC) is available for Windows (http://www.atmel.com/tools/atmelavrtoolchainforwindows.aspx) and Linux (http://www.atmel.com/tools/atmelavrtoolchainforlinux.aspx). Atmel is the primary contributer to AVR support in GCC. As such, their own toolchain has the latest support/fixes. I would recommend using only this toolchain. It is more up to date than either the latest stock GCC or the distro builds. WinAVR is very old and does not support XMEGAs at all.

# Support Information

Please check the MattairTech website (http://www.MattairTech.com/) for firmware and software updates. Email me if you have any feature requests, suggestions, or if you have found a bug. If you need support, please contact me (email is best). You can also find support information at the MattairTech website. A support forum is planned. Support for AVRs in general can be found at AVRfreaks (http://www.avrfreaks.net/). There, I monitor the forums section as the user physicist.

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# Acknowledgments

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# Legal

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# Appendix A: Precautions

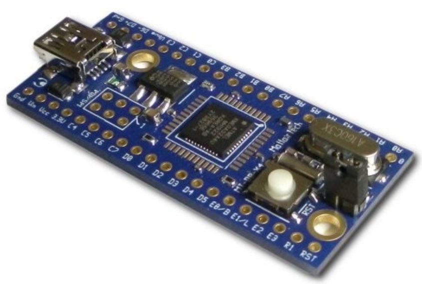
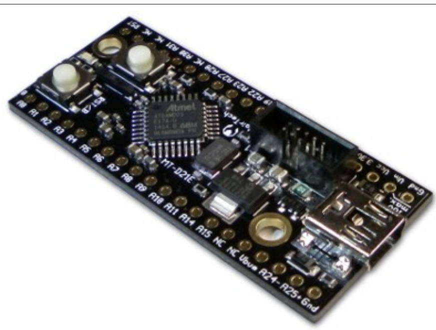
| CAUTION |
|---|
| Do not change power configuration, or solder any jumper while unit is powered. Do not short Vin, Vbus, 3.3V, or ground to each other (ie: solder jumpers on bottom shorting on clipped lead). |

| CAUTION |
|---|
| Higher regulator input voltages mean larger voltage drops and thus higher thermal dissipation for a given amount of current. Be sure to limit current consumption to prevent excessive heat when using higher voltages and/or currents. The regulator will enter thermal shutdown if it gets too hot, but this should be avoided as degradation will occur (true of most regulators). All capacitors are X7R (X5R for the large 1206 PWR IN capacitor), or NP0, so they can deal with the higher temperatures of the regulators. Note that high temperatures will lower the PTC trip and hold currents. |

| CAUTION |
|---|
| Normally, power is supplied from PWR IN, Vbus, or a coin cell.<br>An onboard 3.3V regulator and an optional 5V regulator supply the 3.3V and 5V power rails and Vcc is usually connected to 3.3V.<br>However, it is possible to disconnect the regulator(s) and supply an externally regulated voltage on the 5V, 3.3V, and/or Vcc pins. When doing this, care must be taken to limit inrush current on these pins due to the low ESR of the ceramic capacitors. Failure to do so may cause damaging inductive voltage spikes due to any wire inductance (ie: benchtop power supply leads). Inrush current is normally controlled by the PTC fuses, which have a small series resistance. |

| CAUTION |
|---|
| The MT-DB-X3 contains static sensitive components.<br>Use the usual ESD procedures when handling. |

# Appendix B: Other MattairTech Products

| | |
|---|---|
|  | **ZeptoProg II  AVRISP mkII Programmer**<br>● AVRISPmkII compatible AVR Programmer<br>● Supports all AVRs with ISP, PDI, or TPI<br>● Optional 5V output via headers to target board, with standard jumper and PTC fuse<br>● 4-channel Logic Analyzer<br>● Serial bridge / pattern generator / SPI interface<br>● GPIO / PWM / frequency input & output<br>● Atmel Studio / AVRDUDE support<br>● Target board voltage of 2V to 5.5V via level-shifted pins on two main headers |
|  | **MT-DB-U6  USB AVR development board**<br>● AT90USB646 / AT90USB1286 USB AVR<br>● 64KB/128KB FLASH, 4KB/8KB SRAM<br>● 5V, 500mA LDO regulator (3V-30V input)<br>● Auto power source selection IC (USB/External)<br>● 16MHz and 32.768KHz crystals<br>● Arduino compatible<br>● CDC or DFU bootloader |
|  | **MT-DB-X4  USB AVR XMEGA board**<br>● ATxmega128A4U USB XMEGA AVR<br>● 128KB FLASH, 8KB SRAM, 2KB EEPROM<br>● 3.3V LDO regulator (low quiescent current)<br>● 16MHz and 32.768KHz crystals<br>● LED, boot jumper, PDI header<br>● Reset button, mounting holes<br>● USB DFU bootloader preinstalled |
|  | **MT-D21E USB ARM Cortex M0+ board**<br>● ATSAMD21E17A or ATSAMD21E18A (32-pin)<br>● 128KB/256KB FLASH, 16KB/32KB SRAM<br>● Onboard 3.3V, 250mA LDO regulator (2uA quiescent)<br>● 16MHz and 32.768KHz crystals<br>● USB connector (power by USB or external up to 15V)<br>● Blue LED, 10-pin Cortex header, 2 buttons, I2C pullups<br>● USB Mass Storage Bootloader (no programmer required) |