TinyFPGA BX

- TFPGA-004

The TinyFPGA BX brings the power and flexibility of custom digital logic designs to the maker community. The BX module allows you to design and implement your own digital logic circuits in a tiny form-factor perfect for breadboards, small spaces, or custom PCBs.

This incredible power allows you to do things that are not possible with traditional microcontrollers. While microcontroller boards have a fixed set of peripheral devices on-board, the TinyFPGA BX modules can implement the exact peripheral devices needed to get the job done. It's not software bit-banging, it's the real deal implemented in digital logic. When the next project has different requirements, reprogram the TinyFPGA BX with a new design suited to the task.

The full potential of programmable logic devices allows for even more ambitious projects than custom microcontroller peripherals: augment a retro-computer with new capabilities, recreate an 8-bit computer from history, or design your own.

If you don't know what the big deal is with custom digital logic, then here's a great way to learn. Place a TinyFPGA BX down on a breadboard and get to work interfacing it with LEDs, switches, rotary encoders, and any other peripheral, sensor, or interface you might like to try. The low cost of the BX and open-source ecosystem make this an excellent way to get started on a new adventure with digital logic.

Whether you are a hobbyist looking to expand your capabilities, a professional prototyping a new product, or a student learning the ropes of digital design, the TinyFPGA BX can help you on your way.

Who Needs It and Why?

Have you ever wanted to use an FPGA in a project, but the available boards were too big or expensive? New to FPGAs and want to learn how to use them? Want to put an FPGA on a PCB you are designing but don't want to worry about power delivery, clocking, configuration flash, or difficult surface mount packages? If you answered "yes" to any of these questions, then the TinyFPGA BX can help!

The TinyFPGA BX is designed for makers and hobbyists. It puts *you* in control by taking care of FPGA support details and getting out of your way. It provides an easy to use component for your projects. It's small enough to fit comfortably on a breadboard for learning or prototyping. When you're ready, you can design a custom PCB incorporating a TinyFPGA BX module.

The TinyFPGA BX module is completely open hardware and open source. If you move beyond the need for through-hole components, you may decide you want to re-use or adapt the design for your own creations.

Description

The TinyFPGA BX is a small FPGA module with all of the components and circuitry required for the FPGA to function taken care of for you. To develop for the board you create a design in your favorite digital design language (Verilog/VHDL, Migen, and Chisel are some popular options). Alternatively, you can use a schematic entry tool like IceStudio. A schematic entry tool allows you to graphically draw a digital circuit to be implemented on the FPGA.

Once you have a design, you can program it onto the TinyFPGA BX module over USB. All the functions your design implements will now be able to interface with the outside world through the module's IO pins.

SPECIFICATIONS

- Height: 1.4 inches, width: 0.7 inches
- Programming interface: USB 2.0 full-speed (12 mbit/sec)
- ICE40LP8K FPGA
- 7,680 four-input look-up-tables
- 128 KBit block RAM
- Phase Locked Loop
- 41 user IO pins
- 8 MBit of SPI Flash
- Onboard 3.3 V (300 mA) and 1.2 V (150 mA) LDO regulators
- Low-Power 16 MHz MEMs Oscillator
- 1.3 mA power when active
- 50 ppm stability.

FEATURES

Small form-factor is breadboard friendly

There's plenty of space on either side for connecting jumpers or components. There is
no smaller FPGA board available with this many logic resources!

Open source bootloader

Forget proprietary and expensive USB interface chips, the TinyFPGA BX implements its
own open source USB bootloader! Upon power-up, USB bootloader is loaded from SPI
flash and becomes active. It appears on the host computer as a virtual serial port
device. The programmer software automatically detects the board and uses the serial
interface to program your design onto the board. Once your design is loaded in the SPI
flash, the board reboots and loads your design without the bootloader. To update your
design just press the reset button and the bootloader will be activated again.

The TinyFPGA Bootloader has features that proprietary chips do not have. In addition to
lowering the cost of the board for users like you, it also contains metadata on the SPI
flash in an open JSON format. This metadata contains:

1. A unique ID for each board. No matter what serial port designation your OS assigns your
   board, you can always be sure you are programming the right one.
2. A human-readable name of the board and FPGA.
3. Information on where to put the user program and optional user data.
4. An update URL for fetching bootloader/firmware updates.

For technical details and source code see the TinyFPGA Bootloader GitHub repository.

High-quality PCB design

The TinyFPGA BX improves upon the previous B2 model in every aspect and the PCB
layout is no exception. In addition to nearly doubling the number of user IOs, the new
PCB layout also an improved PCB layout and power delivery:

1. Four-layer PCB with dedicated ground and power planes
2. Six external ground connections (including the USB connector)

3. Power distribution and decoupling capacitors implemented by the book for all ICs, including bulk capacitance and ferrite bead filtering for the board.
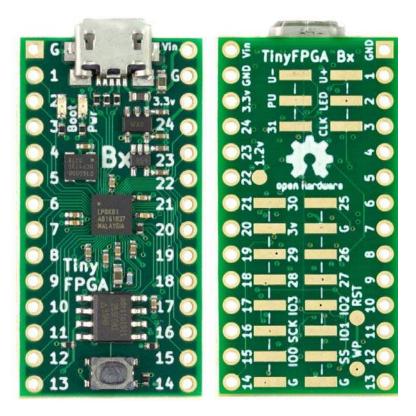
Open source FPGA toolchain support

In addition to the free tools from Lattice for developing with the iCE40 FPGAs, the TinyFPGA BX is also supported by the completely open-source IceStorm FPGA toolchain.

IceStorm has enabled incredible tools like IceStudio to be developed. If you are new to the world of digital logic, IceStudio is a great way to learn and make with FPGAs.

IceStorm currently supports the TinyFPGA B2 and I will be working closely with its creators to implement support for the TinyFPGA BX as well.

If graphical schematic entry is not your thing, you can use your own favorite text editor or try out the APIO-IDE project. APIO-IDE builds on top of PlaformIO-IDE and is a great open-source development environment for FPGAs.

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