

Papilio One (250K, 500K) User's guide



Summary:

The Papilio is a FPGA development board based on the Xilinx Spartan 3E FPGA (datasheet). It has 48 I/O lines, dual channel USB, integrated JTAG programmer, 4 power supplies (1.2v, 2.5v, 3.3v, 5v), and a power connector. It provides everything needed to start learning Digital Electronics. Papilio draws inspiration from the friendly Arduino learning environment. The Arduino has proven that a complicated topic can be packaged into an easy to use format. It is not intended to replace the Arduino. Although there are many similarities, its purpose is an introduction to the entirely different topic of [digital electronics](#). While Arduino pioneered the format for understanding C++ client-level programming, Papilio adopts the same environment for [client-level programming](#) in HDL.

Applications:

Education

The Papilio provides an easy introduction to [FPGA](#), [Digital Electronics](#), and [SOC \(System on a Chip\)](#) design.

Hobbyists

Quickly learn [client-level programming](#) to build your own supercharged parallel processing projects.

Engineers

Get ideas up and running quickly with simple hardware designed for [rapid prototyping](#).

Specifications:

Power

- Four independent power rails at 5V, 3.3V, 2.5V, and 1.2V.
- Power supplied by a power connector or USB.
- DC Input Jack
 - Input Voltage (recommended): 6.5-15V

USB

- Two channel USB connection for JTAG and serial communications implemented with FT2232D.
- EEPROM memory to store configuration settings for FT2232 USB chip.

Spartan 3E FPGA

- 32MHz oscillator that can be used by Xilinx's DCM to generate any required clock speed.
- VTQFP-100 footprint that supports Xilinx XC3S100E, XC3S250E, and XC3S500E parts.
- I/O can be set to support 1.2V, 2.5V, or 3.3V.

SPI Flash

- 4M SPI Flash for design persistence?.

Wings

- 48 bidirectional I/O lines which can be split up as:
 - 1x 32 Bit Wing or
 - 3x 16 Bit Wings or
 - 6x 8 Bit Wings
- .1" spacing for compatibility with bread boards.

Power

The Papilio One can be powered from the USB connector, an external power supply, or a battery. The PWRSELECT jumper controls whether the USB connector or the Power Jack/PWRIN connectors are active.

Power Selection

When the USB connector is selected up to 500mA of current is supplied to the 1.2V, 2.5V, and 3.3V LD1117 voltage regulators. The 5V power rail is supplied directly by the USB port and the 5V LD1117 power regulator is inactive.

When the power jack or battery is selected the 5V LD1117 voltage regulator supplies up to 800mA of current to the 1.2V, 2.5V, and 3.3V LD1117 voltage regulators. The power jack or battery must provide at least 6V in order to generate the desired 5V output.

I/O Bank Power Selection

The VCCO jumper selects the voltage for all of the I/O lines, the options are 1.2V, 2.5V, and 3.3V. The recommended setting is 3.3V since most peripherals operate at 3.3V.

RPAR

The JTAG programming pins on the Spartan 3E always operate at 2.5V while the connected JTAG pins of the FT2232D always operate at 3.3V. This difference in voltage can cause the Spartan 3E to send reverse current back on the 2.5V power rail. The RPAR resistor provides a shunt for this reverse current to be dissipated. The Xilinx application notes recommend the use of RPAR in the case that a voltage regulator cannot handle reverse current. The LD1117 datasheet does not indicate that it can handle reverse current so RPAR was included. Testing has shown that the LD1117 seems to handle the reverse current just fine but boards will be populated with RPAR as a safety precaution. The RPAR resistor consumes 25mA of current so if a battery is being used it is recommended to remove the RPAR resistor to help extend battery life. Please understand that the possible effects of removing the RPAR resistor are the 2.5V rail going higher than 2.5V and possibly damaging the 2.5V voltage regulator. There is an interesting discussion about the need for RPAR [here](#).

Power Jack

- Input: 6-15V DC
- Current: Draws up to 800mA
- Size: 2.1mm
- Polarity: Positive Tip

Memory

The on-board SPI Flash provides 4Mbits of space to store a bitstream that is loaded by the FPGA at start-up. Bitstreams are loaded to SPI Flash using the Papilio Loader?.

Communications

The Papilio One uses a FTDI 2232D USB chip which provides two channels over one USB connection. One of the channels is configured as a simple UART device and shows up as a virtual COM port. The other channel takes advantage of the MPSSE (Multi-Protocol Synchronous Serial Engine) functionality to implement a high speed JTAG channel for programming the Xilinx Spartan 3E.

Drivers

The first time the Papilio One is plugged into the computer it will be necessary to install the FTDI device drivers. Drivers can be downloaded from the FTDI website.

UART

When the Papilio One is plugged into the USB port both channels will be detected and will show up under the Control Panel as a virtual COM port. The second virtual COM port is the UART channel.

JTAG

The Xilinx device is programmed using any application that can support the FT2232D MPSSE JTAG mode. The Papilio Loader is one such application.

JTAG Programming Port

The JTAG programming port is included for use with external JTAG programmers such as the Xilinx JTAG cables. The Xilinx tools such as Impact and the EDK do not support FT2232D based programmers nor does Xilinx provide any method to add support for non-Xilinx programmers. This external port is provided as a means to use the Xilinx tools with the Papilio One. The Xilinx tools can still be used without an Xilinx programmer by generating bitstreams that can be loaded by the Papilio Loader.

TEMPORARY LIMITATION: In order to use the external JTAG port the FT2232D lines that are connected to the JTAG port need to be put into a HIGH-Z state. This has not been tested yet and will probably require a special application.

EEPROM

Custom VID/PID and configuration data can be loaded into the provided EEPROM using the FTDI MProg application.

Misc

Oscillator

The Papilio One has a 32Mhz oscillator that can be converted to any speed desired inside the FPGA using a Digital Clock Manager. The Spartan 3E provides 4 Digital Clock Managers.

LED's

The Papilio One has a power LED, a RX LED, and a TX LED. The power led lights up to indicate that power is being supplied to the board while the RX and TX led's show UART traffic.

Papilio Examples

VGA

[YAVGA](#)

Example of drawing text and graphics to a [VGA Wing](#).

Papilio Kits

[Barcode Genie](#)

Capture Barcodes with the Papilio One. Uses the Arduino core and a custom sketch.

Papilio Arcade

Learn how to implement Pac-Man on the Papilio One.

"Sump" Logic Analyzer

Debug digital logic with the "Sump" Logic Analyzer.

Papilio Cores

Arduino Core

Arduino Core

General

Stepper Core

Core for driving a stepper motor.

Button and LED Core

Core for interfacing buttons and leds. Works with B\\Led Wing?.

Please help us identify, test, and verify cores that we can make available for the Papilio One. There are several excellent Open Source cores at Open Cores. If you have the time and interest in making any of them work with the Papilio One please feel free to start a page in the Playground.

Papilio Tutorials

UART

High Speed UART

Use a Xilinx reference design to implement high speed (3Mb/s) serial communications.

Logic Analyzer

Debug Internal FPGA Logic

Learn how to debug digital logic running inside of the Papilio's FPGA.

Analyze Remote Control Commands

Analyze the IR data sent by an infrared remote control using the "Sump" Logic Analyzer.

Infrared

Infrared Quick Start

Get started with a sketch to decode IR commands.

Analyze Remote Control Commands

Analyze the IR data sent by an infrared remote control using the "Sump" Logic Analyzer.

Soft Processor and Arduino Core

Custom AVR8 Soft Processor

Make a custom AVR8 with just the functionality you need for use with the Arduino IDE.

AVR8 Custom User Core

Make your own peripheral core in VHDL or Verilog to run in the AVR8.

Simulate AVR8

Use simulation to debug your custom user core or to learn about the AVR8 internals.

Run Arduino Sketches

See how to run sketches and move the Arduino core SPI pins on the fly.

Run Bascom BASIC Code

Run Bascom BASIC code on the AVR8 soft processor.

Working with Arduino Core

Make a simple change to the Arduino core in order to move a PWM pin with VHDL.

Clocks

Digital Clock Manager

Create clocks with custom speeds between 2Mhz and 250Mhz.

Xilinx tools

Xilinx ISE Webpack Quick Start

Start learning VHDL with this Quick Start Guide for the Xilinx ISE Webpack software.