Booya SDR

Booya16 SDR Radio Receiver Description

The Booya16 SDR radio receiver samples RF signals at 16MHz with 14 bits and streams the sampled signal into PC memory continuously in real time. The Booya software demodulates the signals down to baseband at the full bandwidth. The Booya digitizer boards plug into the Cypress USB 2.0 board, included. The Cypress USB 2 board provides the interface to the PC. The Booya SDR includes an active Mini Whip antenna to allow good radio reception in the 0 to 8 MHz band. The BooyaSDR free open source software on the PC provides a fully functioning SDR receiver application demonstrating the full Booya digitizer capability.

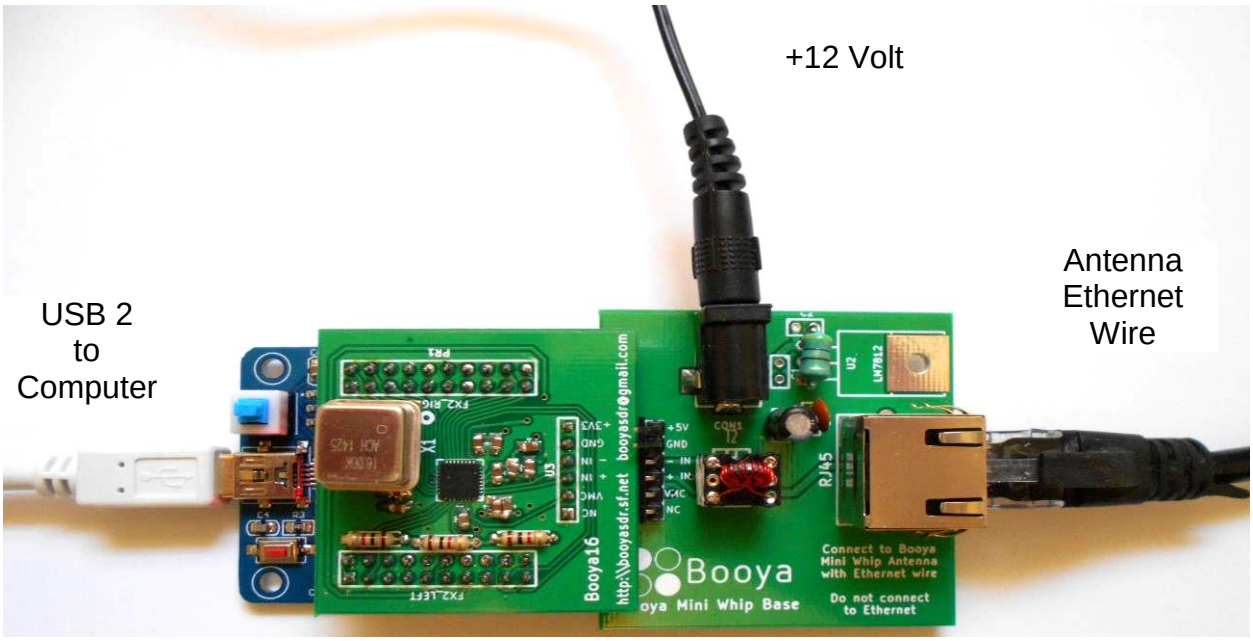

Figure 1. Booya16 SDR Digitizer Assembly

Features
16 MHz 14 bit sampling rate
USB 2 Super Speed realtime input into PC memory

Features (continued)

http://booyasdr.sf.net booyasdr@gmail.com

Booya16 SDR Datasheet

Full speed decimation into 16 kHz bands in PC software
(1024 bands, 16kHz wide, spaced 8kHz apart)
Realtime demodulation of standard radio signals, AM, LSB, USB, CW
Any demodulation possible with software modification
Active Mini Whip antenna

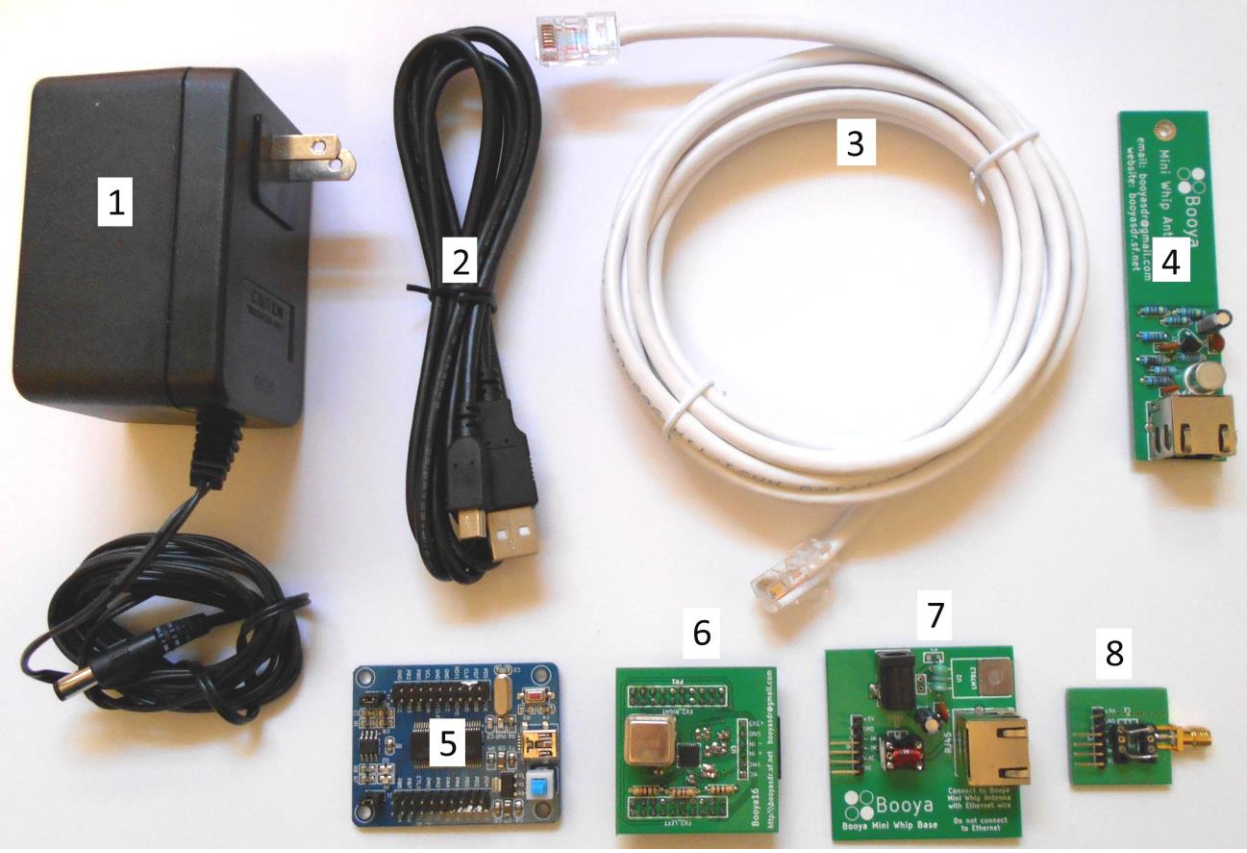

Figure 2. Booya16 SDR Included Hardware

Items Included Hardware:

1. +12 Volt Power Supply
2. USB 2 Cable
3. Ethernet Wire to Active Antenna
4. Active Antenna
5. USB2 Cypress FX2 Interface Board
6. Booya Digitizer Board with LTC2246 A/D Chip and 16 MHz clock
7. Antenna Adapter Board
8. Alternate RF Connector Board

The **Booya16 Digitizer** product includes only items 2,5,6,8 above

Included Software, download from http://booyasdr.sf.net

1. BooyaSDR Windows PC software application

http://booyasdr.sf.net booyasdr@gmail.com

2. Windows Drivers

Required items:

1. Windows PC, Windows 7 or better OS and a dual core PC should be sufficient
2. Internet connection to obtain software

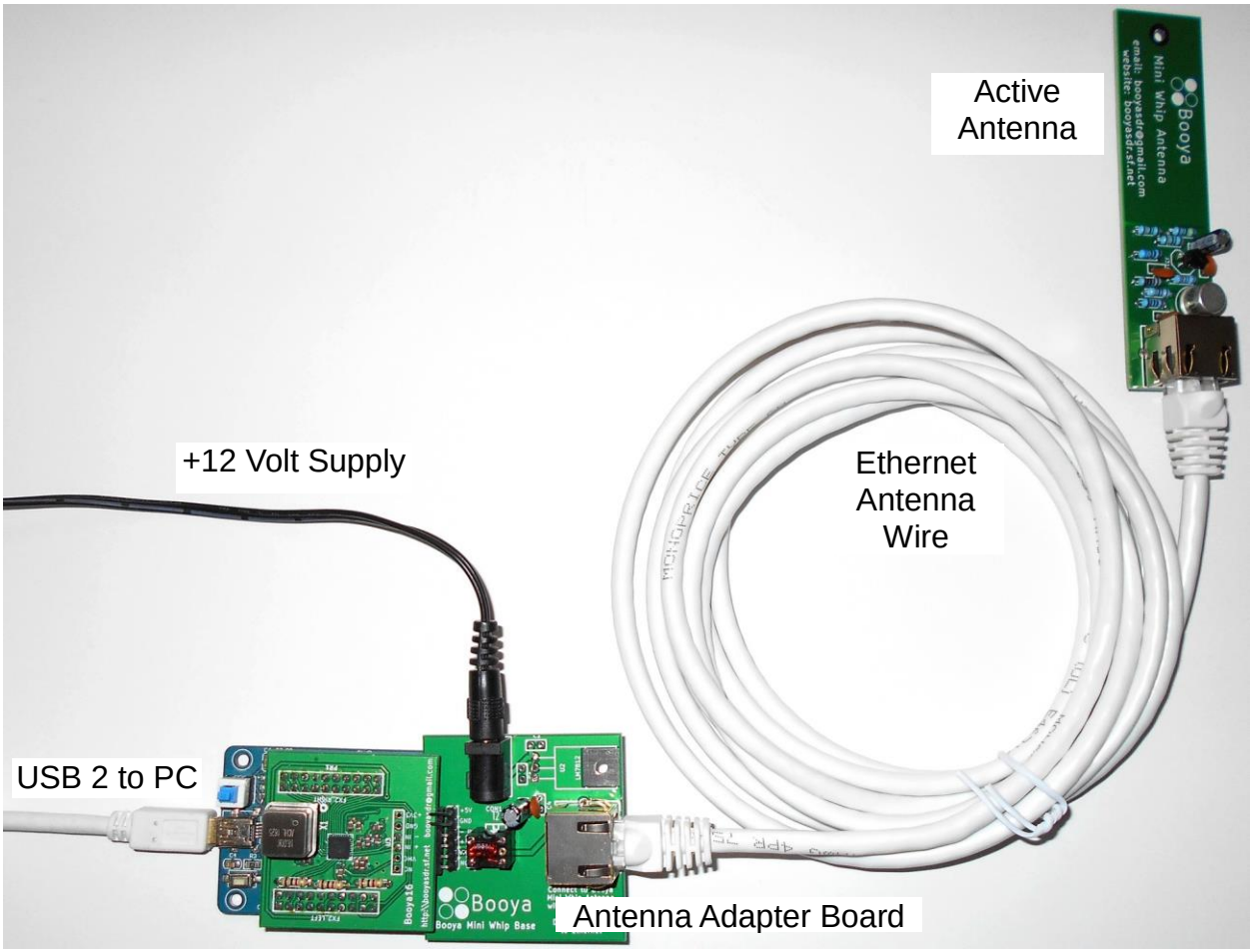

Figure 3. Assembled Booya16 SDR

SDR Hardware Setup Instructions

1. Connect the Booya SDR hardware components as shown in Figure 3
   A. Connect the digitizer board to the FX2 Cypress USB2 interface board if not already connected. Align the white marks to be sure the board is orientated correctly.
   B. Connect the provided USB2 Cable between the FX2 Cypress USB2 board and the PC
   C. Connect the Antenna Adapter Board to the Digitizer Board. Align the 6 pin connectors (Leave power pins bent upward unconnected)
   D. Connect the Ethernet cable between the Antenna Adapter Board and the active antenna

   E. Plug the +12 V power supply into the wall and connect the power cord to the Antenna Adapter Board
   F. Hang the active antenna as high as possible in the room
2. Depress the blue power button on the FX2 board to turn on the red power indicator light
3. Download the latest version of the BooyaBinV1.0.zip software from http://booyasdr.sf.net
4. Unzip the file to a convenient location
5. Install the FX2 driver
   A. Verify the FX2 board is connected to the PC and the red power light is on
   B. Start the zadig_driver_install.exe program by clicking on ../Driver/FX2Driver4Booya16/zadig_driver_install.exe
   C. Select the device in the first white box so that the USB ID is 04b4 8613. If the device does not appear, select the menu item Options->List All Devices
   D. Select libusb-win32 (v1.2.6.0) in the second white box pointed to by the green arrow
   E. Hit the Install WCID Driver button
   F. More zadig instructions are available under ../Driver/FX2Driver4Booy16/Zadig · pbatard_libwdi Wiki · GitHub.htm
6. Click on the Booya16.bat file to start the application. The program should complete its startup routine in a few seconds. The GUI user interface is intended to be self explanatory with a few pointers given under the Help menu. The program can also be started from the command line by changing directory to the bin folder and typing "booyasdr.exe fx2_16".

Troubleshooting

The Booya16 SDR is intended to work out of the box with minimum installation. Please follow the installation instructions above carefully. If you get the message "initFX2 () failed" in the console window, the most likely reason is the board is not connected to the computer over the USB wire. Connect the board and restart the application. The BooyaSDR software must be quit and restarted whenever the board is reconnected or whenever the data stream stops otherwise. There is no facility to restart the data stream from within the application at this time.

Antenna Setup

A 7 ft Ethernet wire is included in this kit, but reception is improve using a longer Ethernet wire antenna connection. A 100 ft wire can be used to put the active antenna out in the yard. The active antenna needs to be protected from the weather if placed outdoors. A small plastic bag and tape work fine to protect the active antenna temporarily. Placing the active antenna remotely on a long wire will normally improve reception substantially by reducing noise pickup from local sources and some studies suggest that the long wire act as part of the antenna increasing signal strength. Please remember not to connect the active antenna or antenna adapter to Ethernet. While Ethernet wire is used, there is no compatibility between the antenna hardware and Ethernet.

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Alternate RF Connector

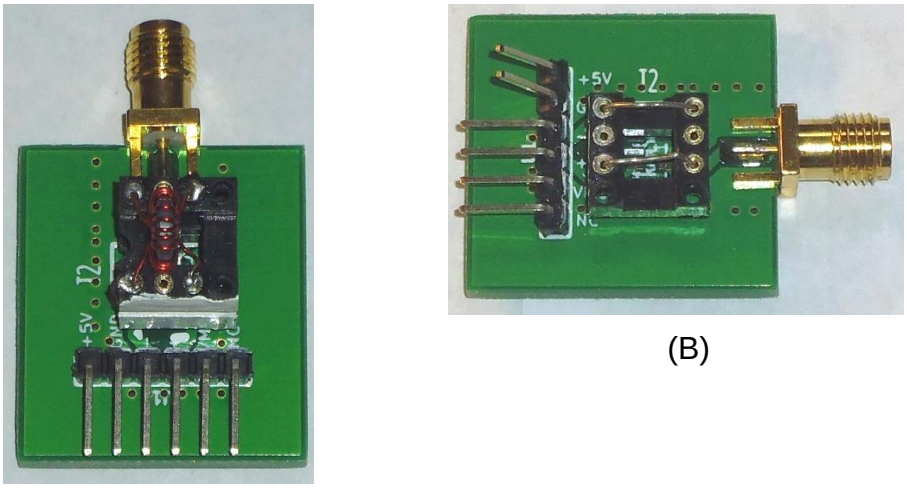


Figure 4. RF Connector, (A) with Stepup Signal Transformer (B) with Straight Through Connection

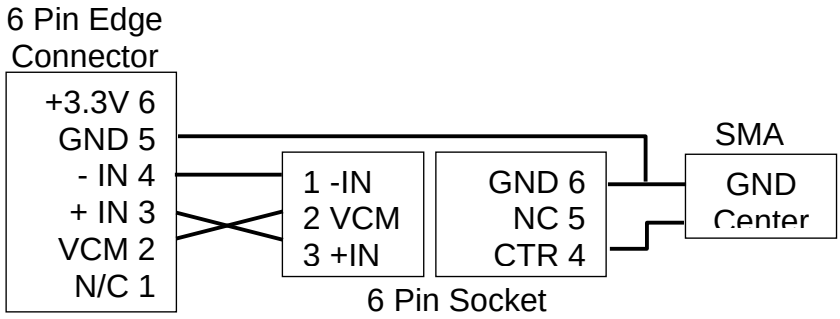


Figure 5. Schematic of the Alternate RF Connector

The RF connector show in Figure 4 is included to provide maximum application flexibility. The RF connector can be used in place of the antenna adapter board to replace the custom ethernet connection with a standard SMA antenna connector. The 6 pin connector is intended to connect to the digitizer in place of the antenna adapter. A schematic for the RF connector is shown in Figure 5.

Configuration (A) has the stepup transformer removed from the antenna adapter board and place on the RF connector board. The stepup transformer has a 64:1 impedance ratio and does a good job of increasing the voltage amplitude of the RF signal to put it in the A/D range. Be sure to align the white mark on the side of the transformer with the white mark on the board to ensure it is connected in the stepup direction.

Configuration (B) has jumpers installed across the input connector to directly connect the SMA input to the A/D input if such a connection is desired. The +3.3V and GND

edge connector pins should normally be bent up out of the way in this configuration to prevent one of the A/D inputs from being grounded.

The digitizer board +3.3V and GND edge connector power output pins are provided in case there is a desire to power some input circuitry. Normally, however, these two pins should be bent up out of the way so that they are not connected. The GND pin in particular will ground one input of the LTC2246 A/D which is intended to be left floating. The middle +IN and –IN pins connect directly to the LTC2246 chip input on the digitizer board. Bending the pins up to disconnect them is not necessary in Configuration (A) since the transformer isolates the A/D input from GND but is needed in Configuration (B) to prevent one of the A/D inputs from being DC grounded.

Experimental Grade Product
While every effort has been made to maximize the product functionality, product improvement is possible. The product does provide high quality basic functionality and is intended to work out of the box with minimum setup. Help is available through the contact information. Facility is provided for the user to upgrade the product as desired. Basic functionality is guaranteed.

Additional Technical Details and Development Setup

Additional technical details are provided in the section to more fully describe the product and to facilitate experimental product modification and development.

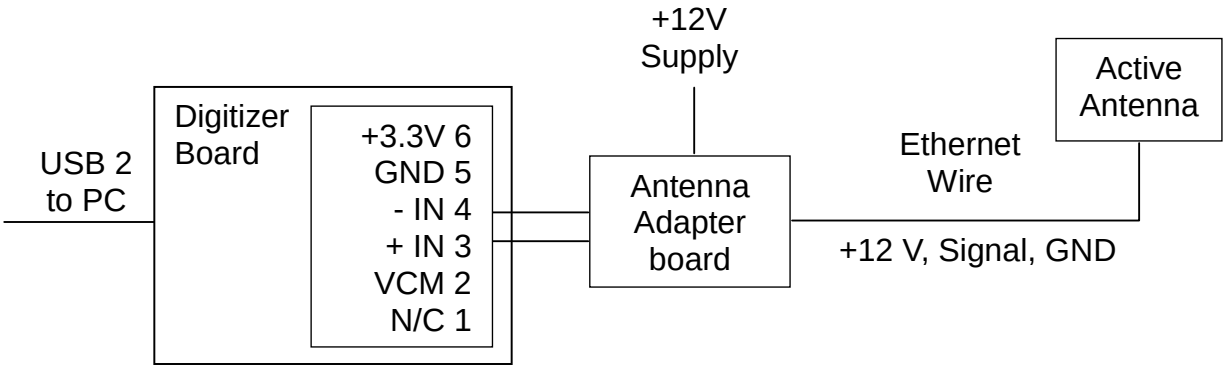


Figure 6. A Schematic Version of the Connections Shown in Figure 3

Active Antenna
The included active antenna is based on the PA0RDT Mini Whip active antenna. While mini-whip performance remains controversial on the internet, it was found through simple experimentation that the active antenna substantially improves receiver performance for signal reception between 0 and 30 MHz. Therefore the additional feature of the active antenna has been included in this product.

Ethernet wire is used to connect the antenna adapter board to the active antenna as the default setup. Optionally an SMA adapter board is included for application flexibility.

While coax is more commonly used in RF work, Ethernet was chosen in this application due to its high quality and high availability.

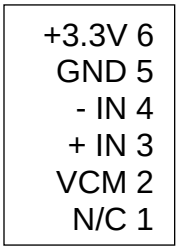
Ethernet Wire to Antenna

Ethernet wire is used to connect the active antenna to the antenna adapter. The signals carried by the Ethernet wire are RF signal down from the antenna, +12 Volt power up to the antenna and GND. The GND wire doubles as both the power ground and the signal ground.

Ethernet Pin	Signal
4	RF signal
3,5,6	GND
1,2	+12V

The table above shows the ethernet connector pin assignment.

Digitizer Board Connector



The diagram above shows the Booya digitizer board input connector.

RF input pins 3 and 4 connect directly to the LTC2246 A/D chip. No input circuitry has been put on the board to maximize user flexibility. VCM pin 2 is the LTC2246 voltage reference output for biasing the center tap of an input transformer. Pins 5 and 6 are GND and +3.3V power to power any user provided input circuitry.

Software Application Development Setup

As this product is intended as a development component, source code is included on the website in the file BooyaSDRSource.zip for modification and development. The following steps will setup your computer for BooyaSDR application software development.

1. Download and unzip BooyaSDRSource.zip and wxWidgets.zip to a convenient location from the link on http://booyasdr.sf.net
2. Download and install Codeblocks 12.11 or later.
3. Open the Source\booyasdr.cbp project by clicking on it or from the File>Open menu in Codeblocks.
4. Tell Codeblocks where wxWidgets is by setting the wx global variable in Codeblocks.
    a. In Codeblocks select Settings>Global Variables to open the Global Variables Editor dialog box
    b. Hit the second from the top New button
    c. Type wx in the box and click Ok
    d. Set the wx variable base to the location of wxWidgets using the "..." button next to base or by typing the path in the blank next to base
    e. Close the dialog
6. The program should now compile. Test the compile by selection the Build>Rebuild menu and look for 0 errors in the Build log box

Firmware Development Setup

The FX3 firmware is provided for full user flexibility. Perform the following step to setup the firmware compiler.

1. Download and install the EZ-USB FX3 SDK v1..3.3 for Windows from http://www.cypress.com/file/139276/download (or for more FX3 firmware information and Linux go to EZ-USB FX3 Software Development Kit | Cypress)
2. Download the latest version of FX3firmwareV0.0.zip from http://booyasdr.sf.net and unzip to a convenient location.
3. Open the Eclipse EZ-USB FX3 SDK and import the slaveFifo project.
4. The firmware may be modified as desired using the SDK instruction.
5. To use the new firmware in the BooyaSDR.exe application, move the new firmware called slavefifo.img from the Debug directory in the firmware project to the BooyaSDR\Bin directory. You may want to make a backup copy the existing slavefifo.img prior to replacing it.

Booya SDR to WebSDR Comparison

The Booya SDR is roughly modeled on the Wide-band WebSDR which provides a 29 MHz bandwidth and can be seen on the web at http://www.websdr.org and http://websdr.ewi.utwente.nl:8901/.

The following table compares the Booya16 SDR and Wide-band WebSDR.

	Booya SDR	Wide-band WebSDR
Operation System	MS Windows	Linux
PC connection	USB 2	Ethernet
Bandwidth	8 MHz	29 MHz
User interface	PC	Web browser

http://booyasdr.sf.net booyasdr@gmail.com

Contact

Please send any questions or comments to booyasdr@gmail.com.

More Booya16 Images

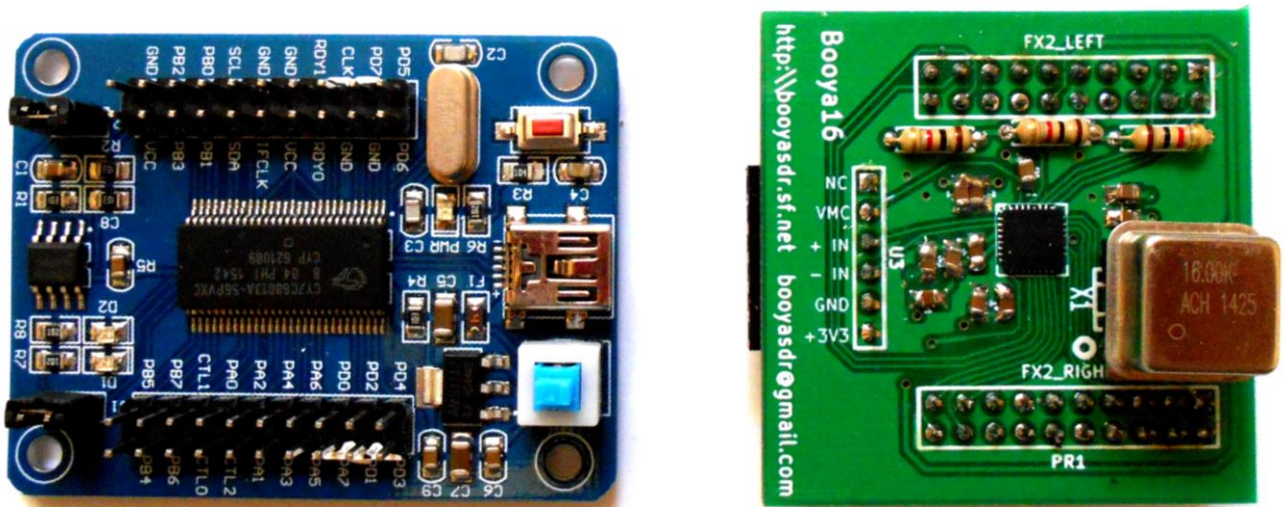


Figure 10. USB2 FX2 Cypress Board Left, Booya16 Digitizer Right

Please send any questions or comments on this product to booyasdr@gmail.com.