ULTRA LOW-COST COMPUTERS

03/19/2016

TCF ’41, 2016, V1.0, March 19, 2016
TCF ‘41 Feedback, V1.1, March 31, 2016

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ULTRA LOW-COST COMPUTERS

02/18/2018

<= $5.00 COMPUTERS

- **Amazon Wireless Dash Button**
  Single-Click Ordering Button
- **ESP8266 & NodeMCU MODULE**
  Arduino IDE & Libraries
- **Raspberry Pi Zero**
  Low Cost Only if USB Hub & Connectors are Not Needed

Why the Interest in The Dash?

CLEVER WIRELESS SINGLE PUSH BUTTON

- **FOR <$5.00 (Free with Rebate), you get:**
- **Complete Wireless (WiFi) Solution with Processor, Touch Switch, WiFi chip, battery**

[5], "There Are Now More Than 100 Branded Amazon Dash Buttons," 04/02/2016

- **Go to** www.amazon.com/dashbuttonsetup **on your Smartphone Browser**
- **Unique Ultrasonic Audio Link allows Communications with Smartphone**

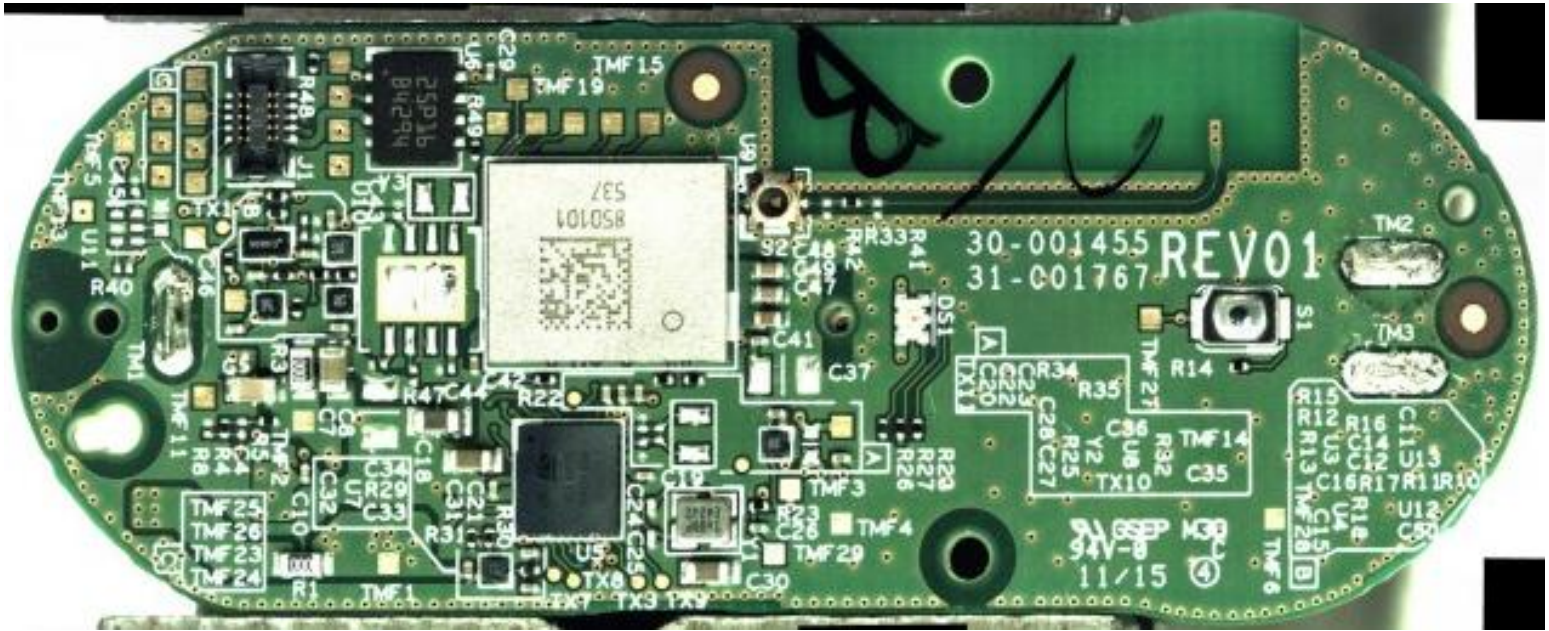
Why the Interest?

CLEVER WIRELESS SINGLE PUSH BUTTON

- **Reverse Engineering**

Amazon Dash Design [1]

- Broadcom BCM943362WCD4 WICED module reference design
- Broadcom BCM43362 Wi-Fi module
- ST STM32F205 microcontroller in a WLCSP
- InvenSense INMP441 microphone,
- Micron M25P16 16Mbit serial Flash memory
- Energizer Ultimate Lithium AAA battery



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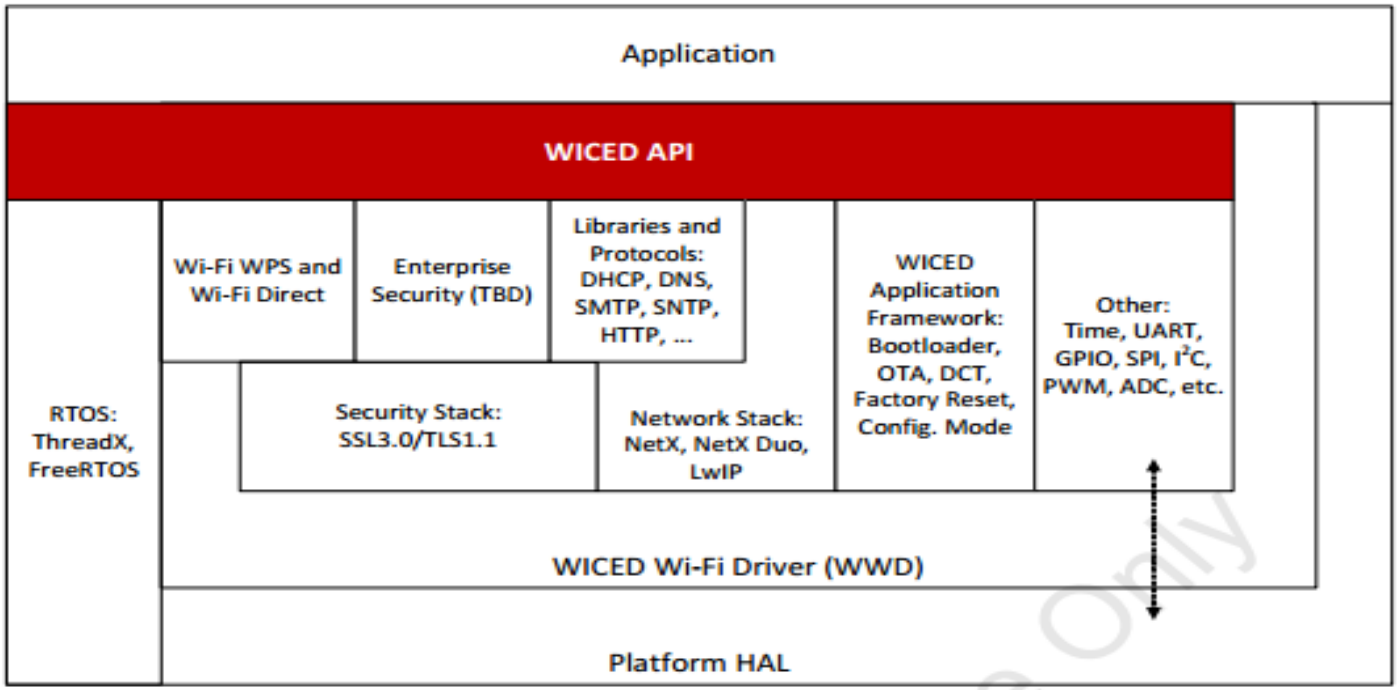
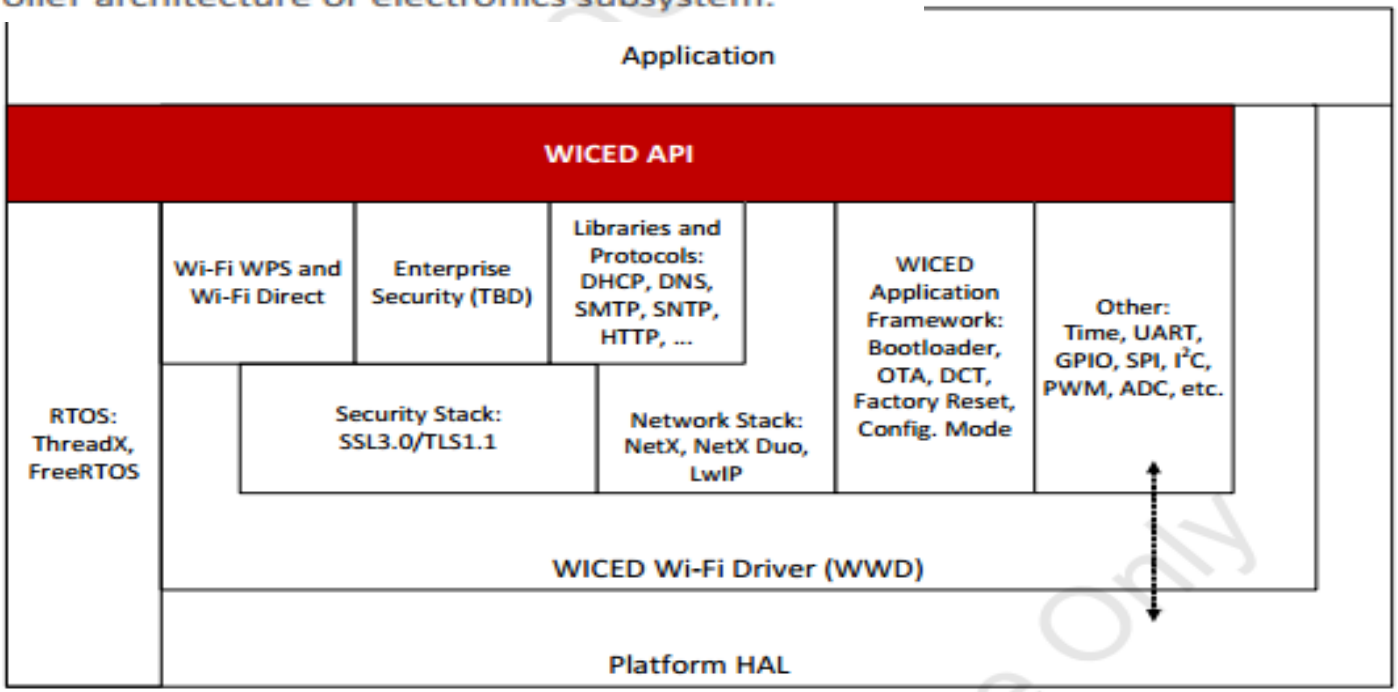


WICED™ Software Stack and API

Why the Interest?

Overview

The WICED™ Wi-Fi architecture features the Broadcom® BCM43362 wireless LAN MAC/baseband/radio, along with a 32-bit embedded processor, a unique 'self-hosted' Wi-Fi networking library, and a software application stack that allows manufacturers to easily integrate Wi-Fi connectivity into any MCU-based consumer product. WICED-based modules enable the addition of secure and interoperable Wi-Fi connectivity via a simple serial port, using a basic command set that does not require any significant changes in a product's microcontroller architecture or electronics subsystem.



WICED™ Software Stack and API

ESP8266EX [3]

TINY $2.00 WiFi/CPU/Antenna MODULE

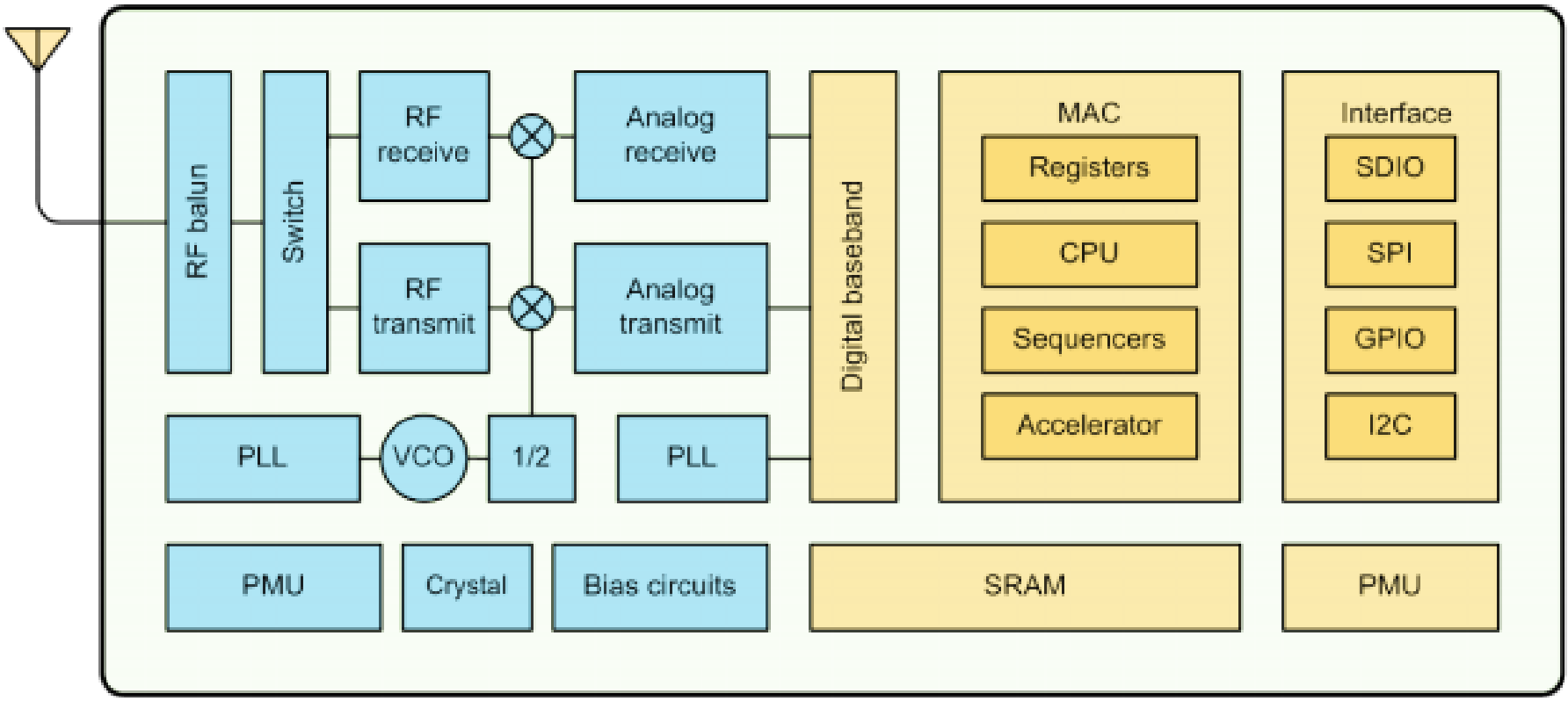
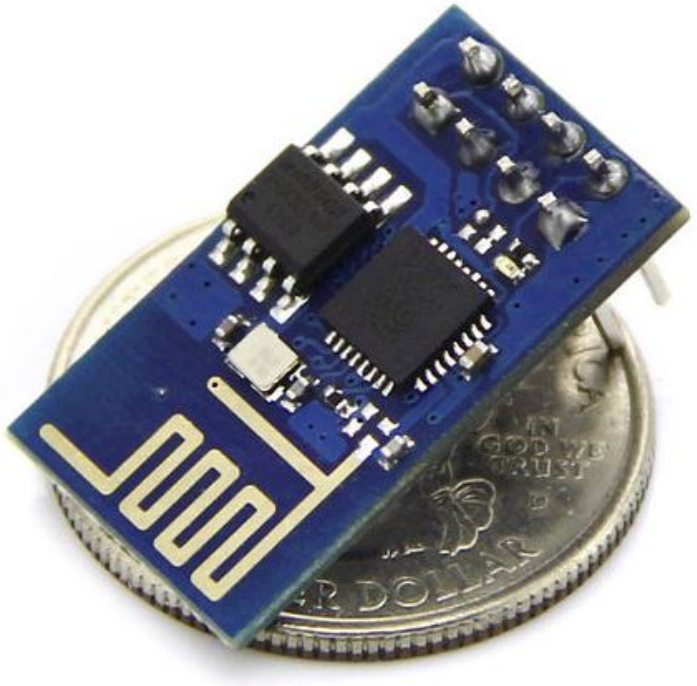


Figure 1 ESP8266EX Block Diagram

ESP8266EX

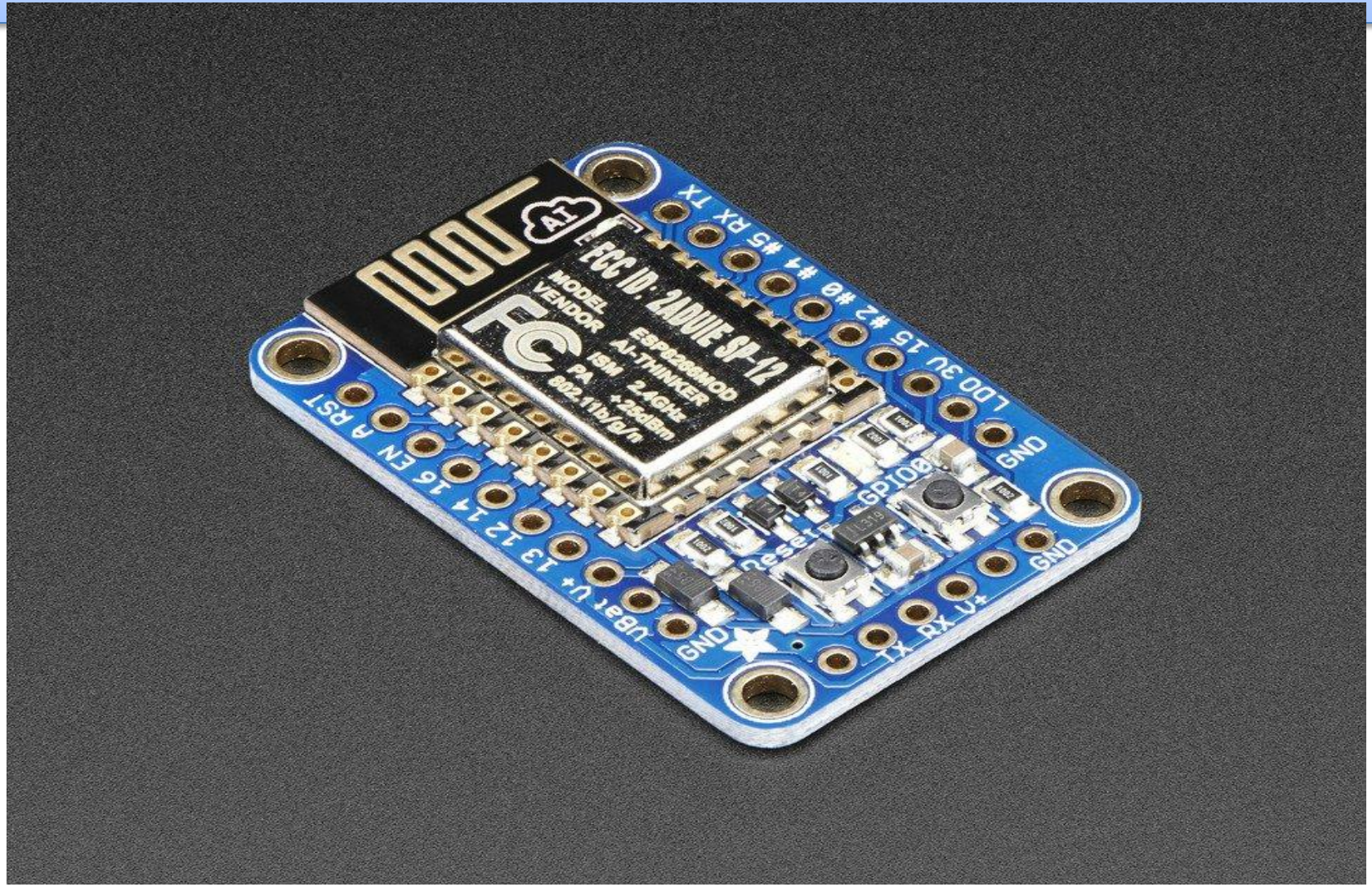
SPECIFICATIONS: TINY $2.00 (was $3.00 6 months ago!) MODULE

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC • Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- Supports antenna diversity
- WiFi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO • STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4s guard interval
- Deep sleep power < 5uA
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- +20 dBm output power in 802.11b mode
- Operating temperature range -40C ~ 125C
- FCC, CE, TELEC, WiFi Alliance, and SRRC certified



ESP8266EX

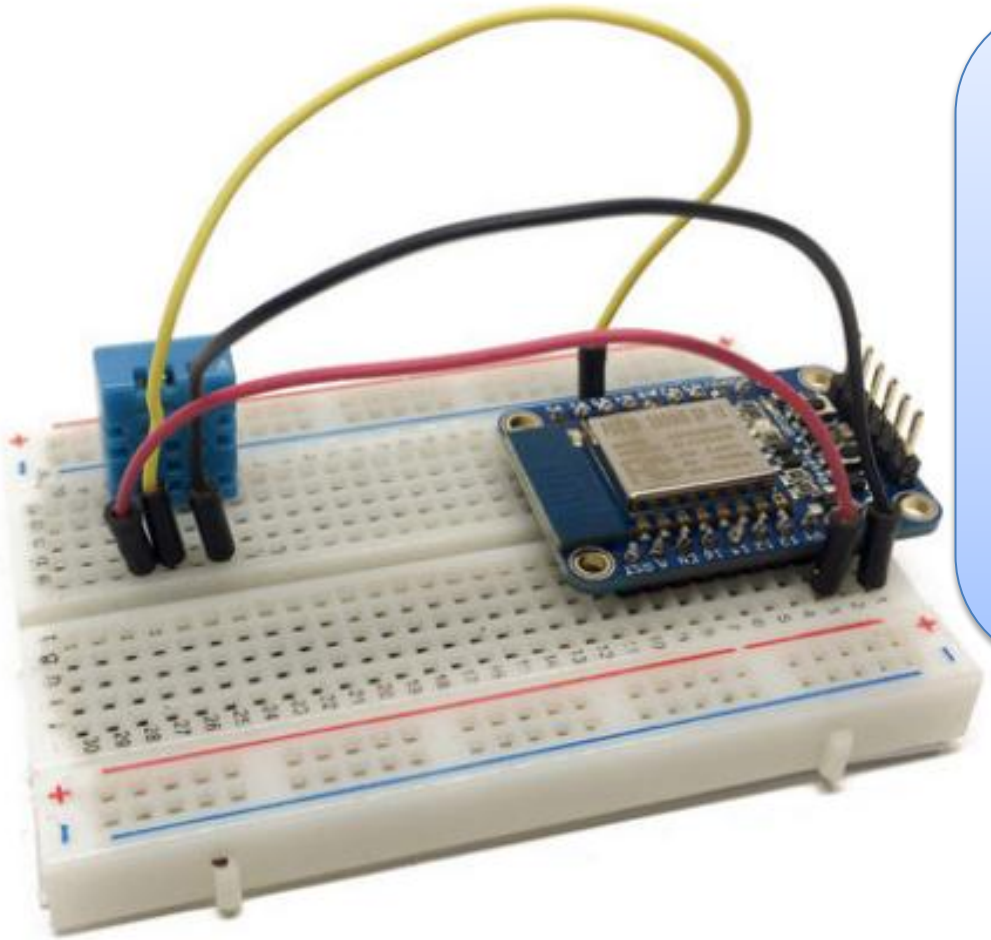
Adafruit HUZZAH ESP8266 Breakout



https://www.adafruit.com/product/2471

ESP8266EX PROJECT

Home Automation in the Cloud - esp8266 and Adafruit I/O Introduction
DHT11/DHT22 Temperature / Humidity



SOFTWARE REQUIREMENTS –

Latest Arduino IDE
https://www.arduino.cc/en/main/softwar e (http://adafru.it/fGz)
Adafruit MQTT library
(http://adafru.it/fp6) DHT sensor library (http://adafru.it/aJX)
Adafruit IO Portal Account
http://io.adafruit.com/
(http://adafru.it/fH9)

https://learn.adafruit.com/home-automation-in-the-cloud-with-the-esp8266-and-adafruit-io/introduction

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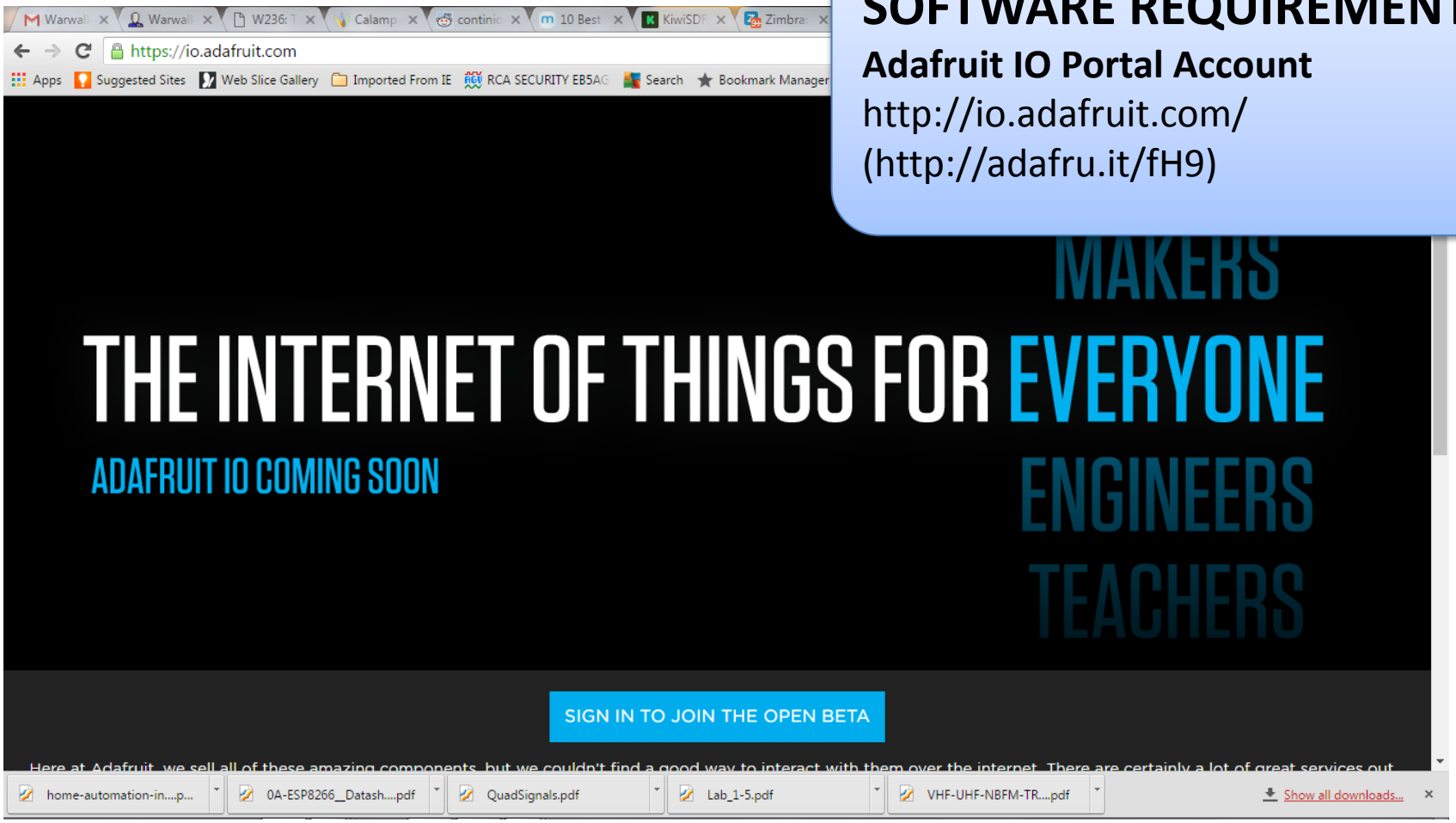

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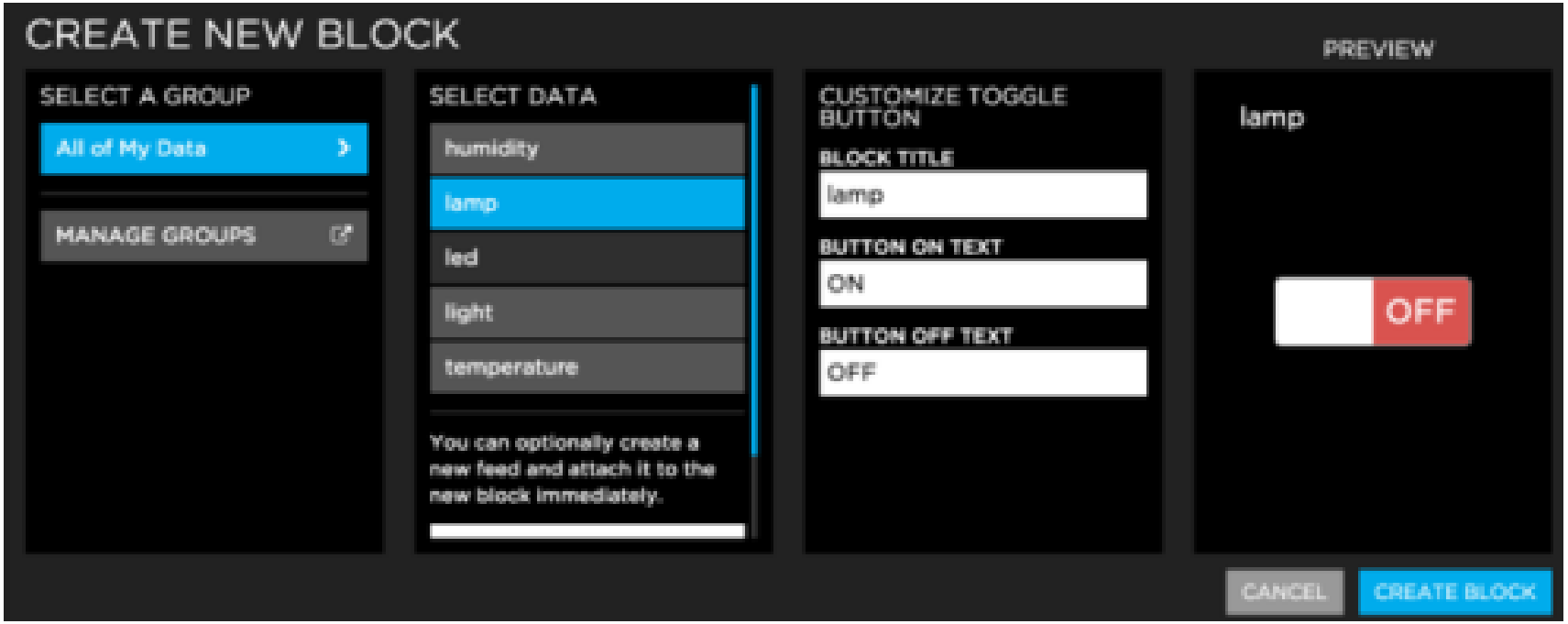

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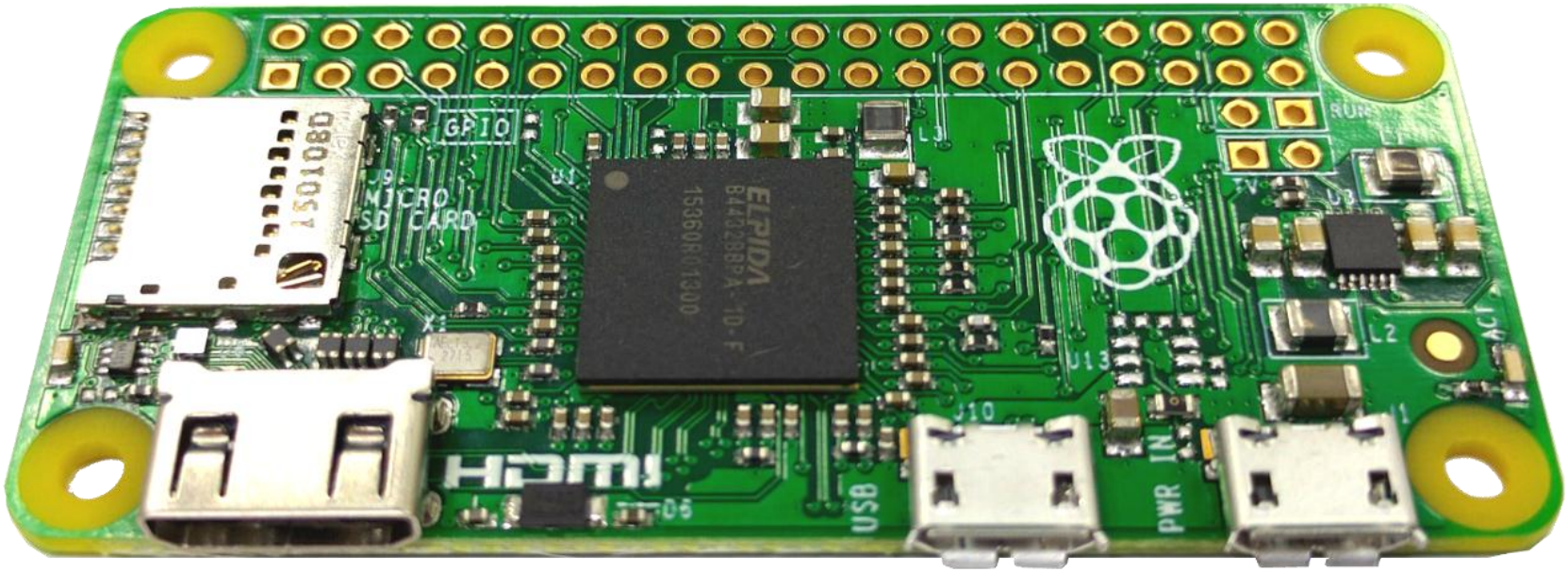
ESP8266 CONCLUSION

- EXCELLENT ARDUINO-COMPATIBLE PLATFORM
- BREAKTHROUGH PRICE/PERFORMANCE/SIZE
- REMOTE TEMPERATURE, HUMIDITY, IMAGE SENSORS BUILT AND TESTED
- SMALL ENOUGH TO EMBED IN WEARABLES
- EXAMPLE OF RAPID IoT ADOPTATION

RASPBERRY PI ZERO, $5.00 [4]

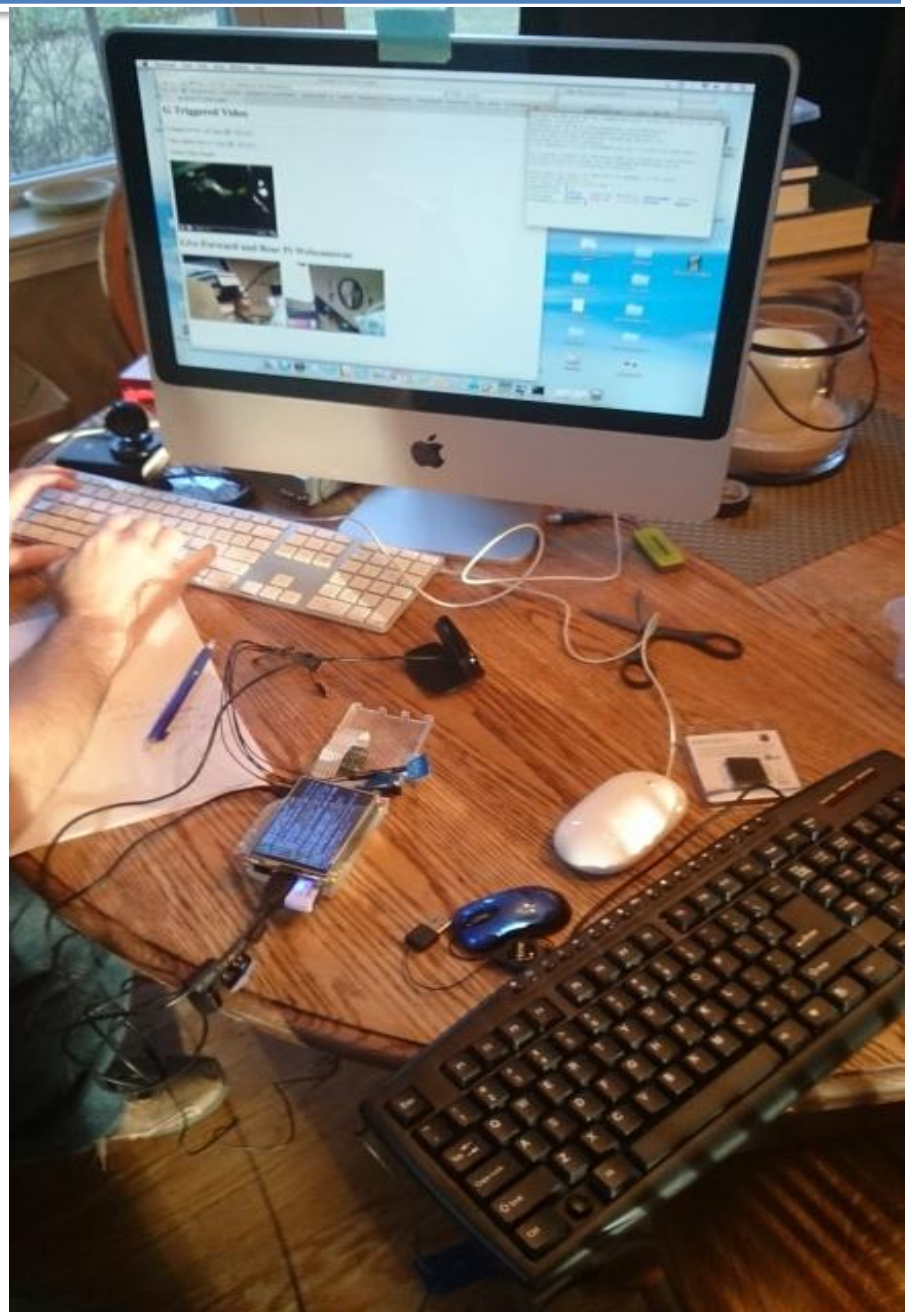
CPU: Broadcom BCM2835, which operated at 1GHz (Equiv to Overclocked Pi B)
RAM: 512MB
Power: 5V, supplied via micro USB connector, drawing 160mA (even when connected to an HD display).
Dimensions: 65mm x 30mm x 5mm
Video & Audio: 1080P HD video output. Audio output via mini-HDMI connector.
Storage: MicroSD card.
Operating System: Linux, installed via NOOBS.



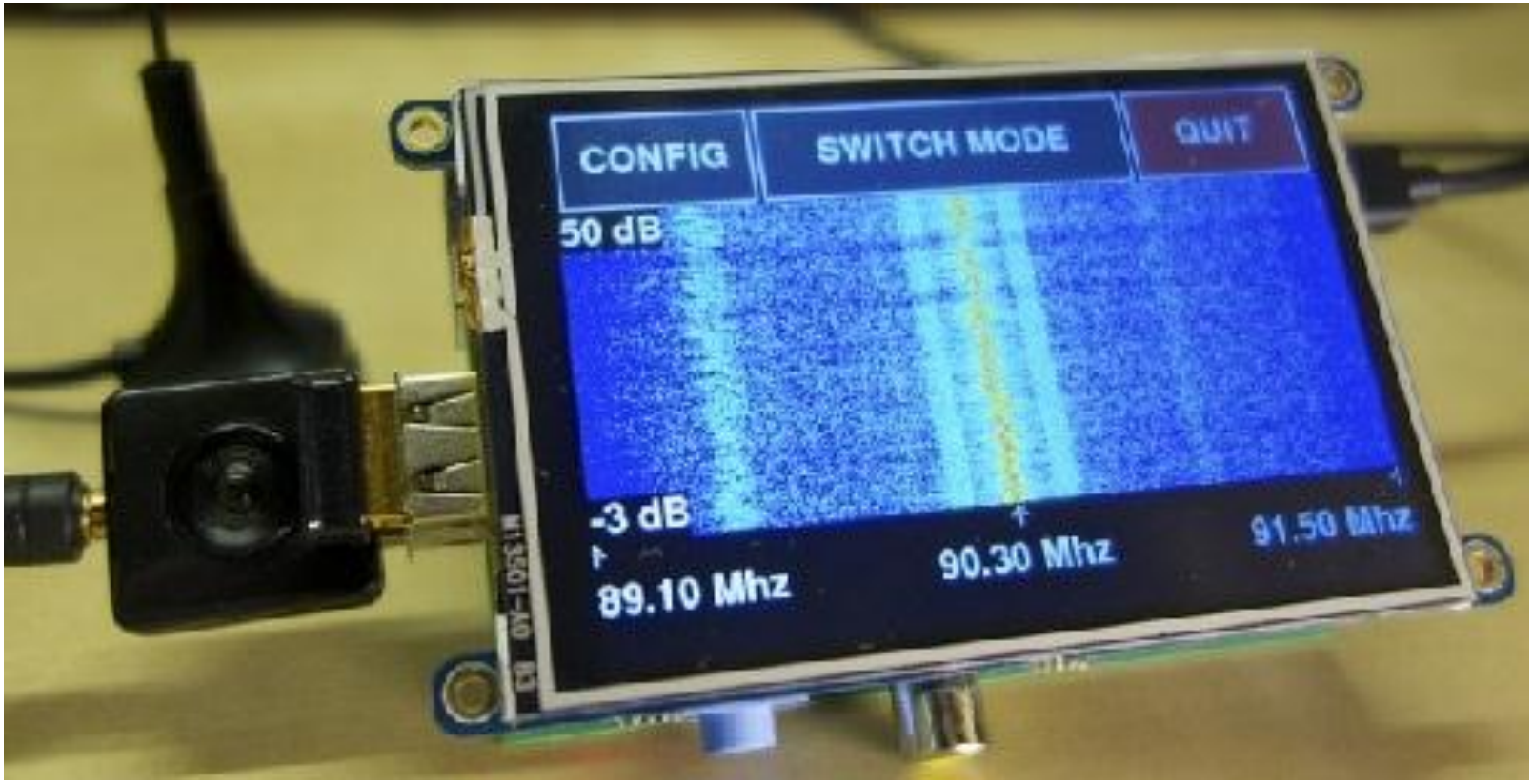
RASPBERRY PI ZERO, $5.00 [4]

MicroSD Card Slot: The Pi Zero gets its storage space from a MicroSD card (PLUS OS)
Mini HDMI: Video output for the Pi Zero is by way of a mini-HDMI connector.
Micro USB: You'll notice there are two micro USB connectors on the Pi Zero. One is for data (the connector on the left, if the MicroSD card slot is on the left), and one is for pwr.
GPIO: The Pi Zero has the same 40 pin General Purpose Input/Output connections as the Model A+, B+ and RPi2, but the connector pins are unpopulated. So if you want to use the GPIO, you'll either have to solder the required pins in place, or solder your connections directly to the Pi Zero.
RUN Mode Pins: There are two unpopulated RUN mode pins, which can be used to connect a reset button to the Pi Zero. Again, you'll either have to add the pins yourself, or solder a button straight to the board.
Composite Video: An RCA composited video output via two pins

APPLICATION 1: ZERO CAMERA (USB Port)



APPLICATION 2 – SPECTRUM ANALYZER



https://learn.adafruit.com/freq-show-raspberry-pi-rtl-sdr-scanner/overview

PI ZERO CONCLUSION

- SMALL ENOUGH TO EMBED IN WEARABLES
- GREAT PRICE & EXISTING PI COMPATIBILITY
- COST EVOLUTION OF THE PI FAMILY
- BE AWARE OF EXTERNAL CONNECTIVITY REQUIREMENTS & PROJECT TOTAL COST
- IoT EMBEDDED PYTHON-COMPATIBLE PLATFORM

REFERENCES

[1] Mathew Petroff, “Amazon Dash Button Teardown”
https://mpetroff.net/2015/05/amazon-dash-button-teardown/

[2] Broadcom, *et al*., , “bcm943362wcd4”
https://www.broadcom.com/products/wireless-connectivity/wireless-lan/bcm943362wcd4

[3] Adafruit, *et al*., , “ESP8266 Specifications Manual”
https://www.adafruit.com/images/product-files/2471/0A-ESP8266__Datasheet__EN_v4.3.pdf

[3] Adafruit, *et al*., ,“Home Automation in the Cloud with the ESP8266”
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[4] Overview of the Raspberry Pi Zero
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[5] There Are Now More Than 100 Branded Amazon Dash Buttons, 04/02/16
http://socialmediaweek.org/blog/2016/04/branded-dash-buttons-amazon/

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