

NRF52 BLUETOOTH LOW ENERGY LINUX DEVELOPMENT STACK

TRENT @LATHIAT LLOYD

WWW.LATHIAT.NET/TALKS



PROJECT

NEW HOUSE

DATE

2015

CLIENT

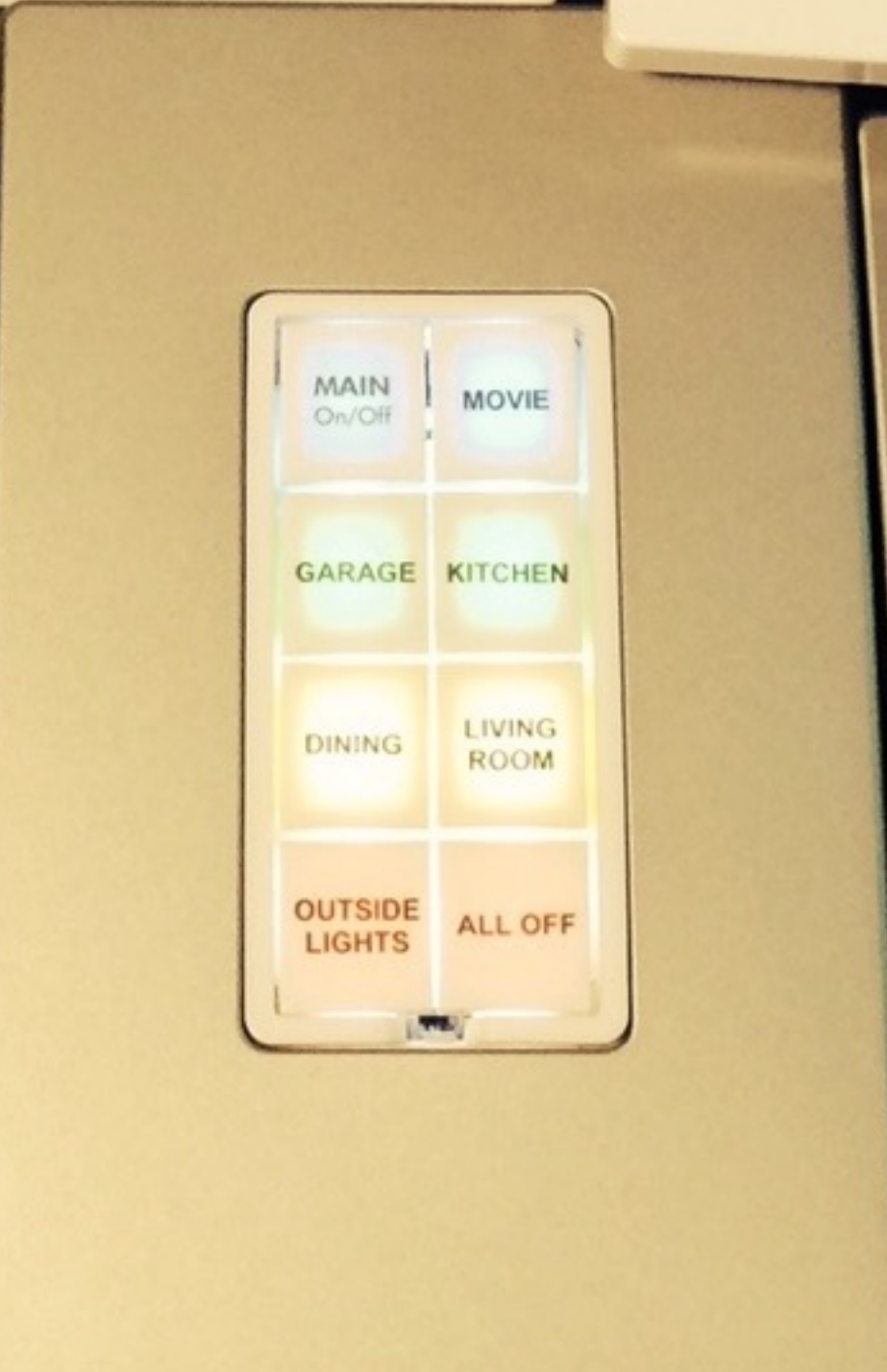
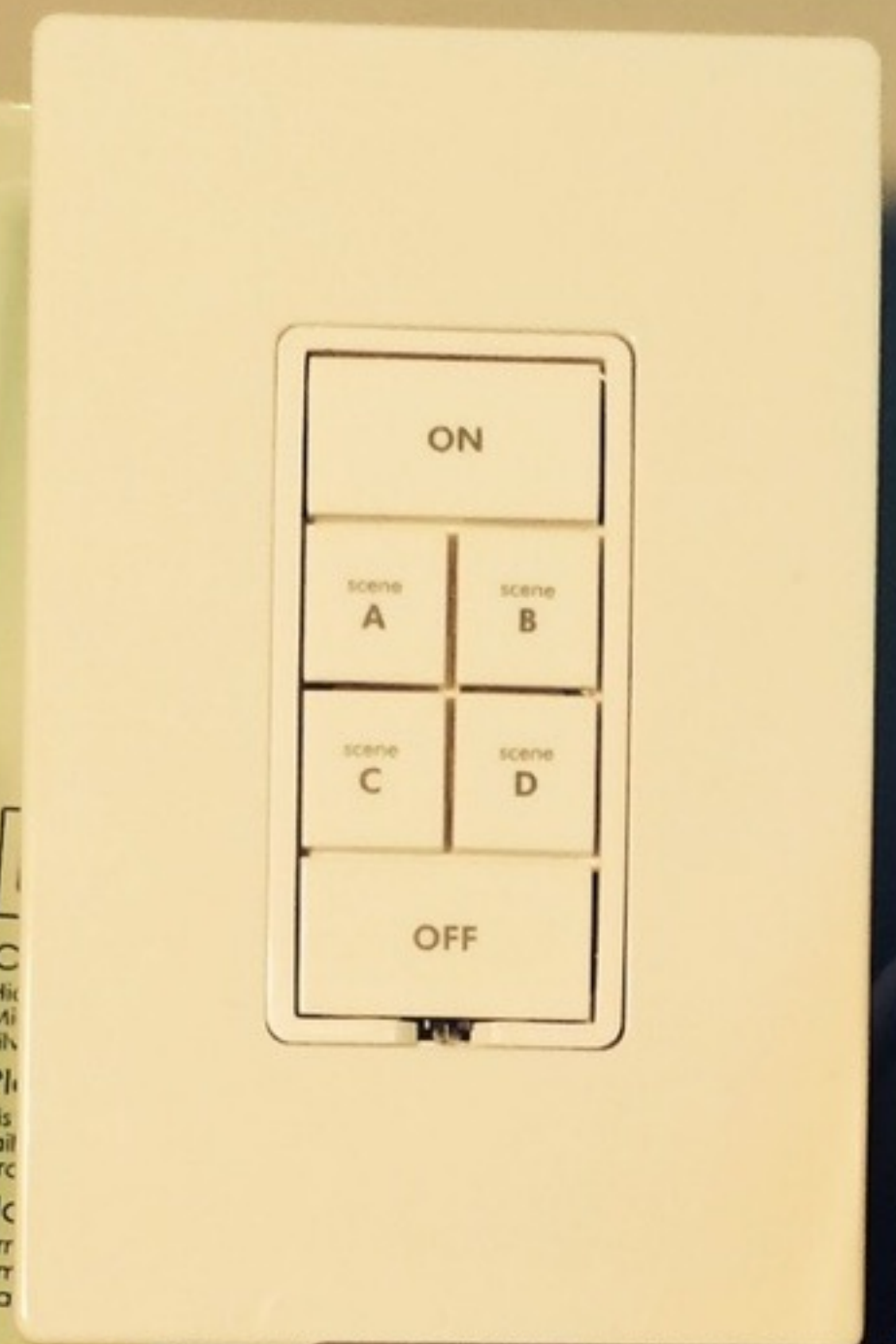
ME

INSTEON
 Keypad Dimmer Switch (Dual-Band)
 6 Button, White Model: 2334-232

100-277VAC, 50/60Hz; 600 Watts

ETL Intertek
 8 13922 01317 7

INSTEON.COM Protected under U.S. and foreign patents Made in China



MAIN
On/Off

MOVIE

GARAGE

KITCHEN

DINING

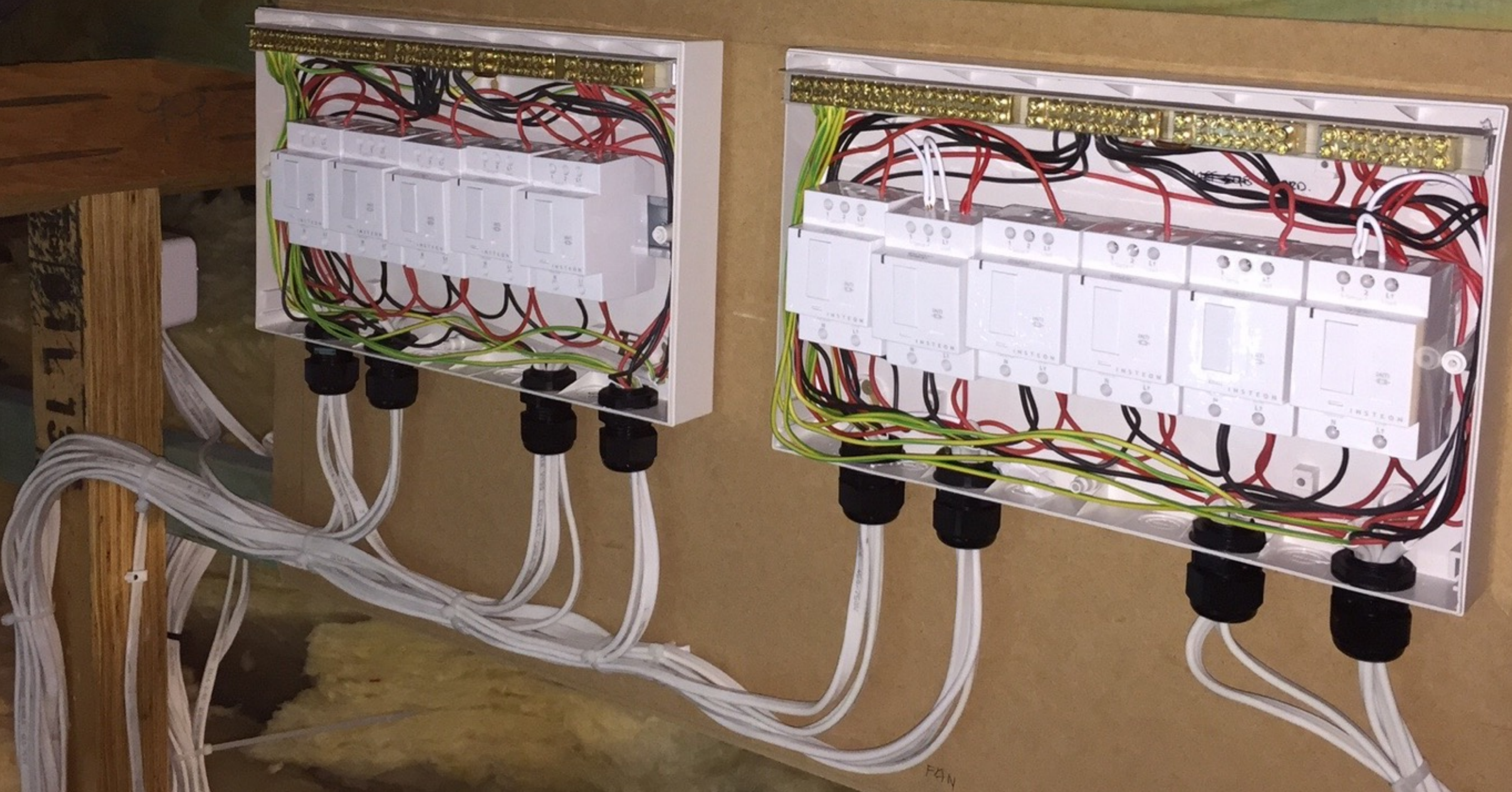
**LIVING
ROOM**

**OUTSIDE
LIGHTS**

ALL OFF







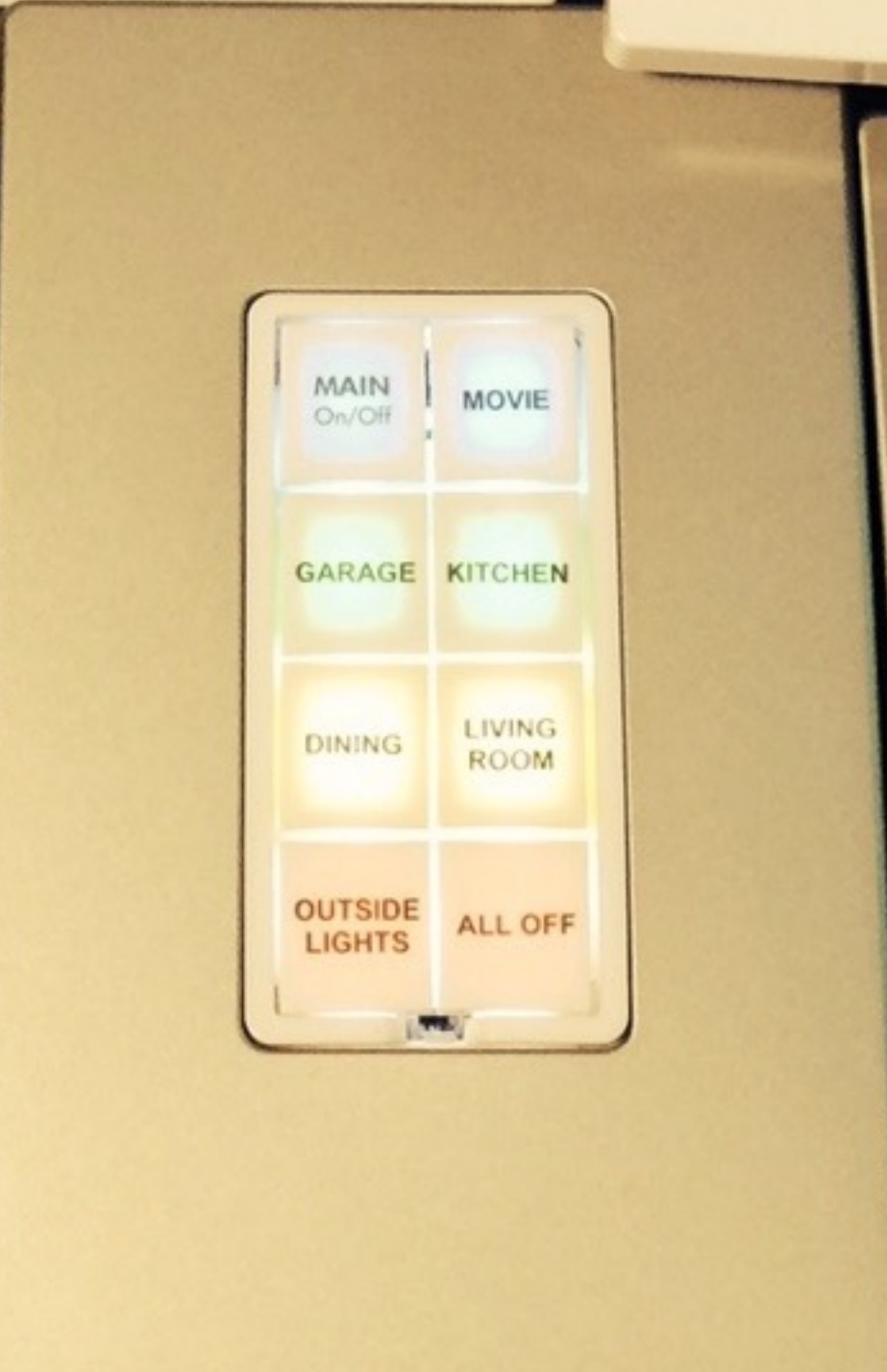
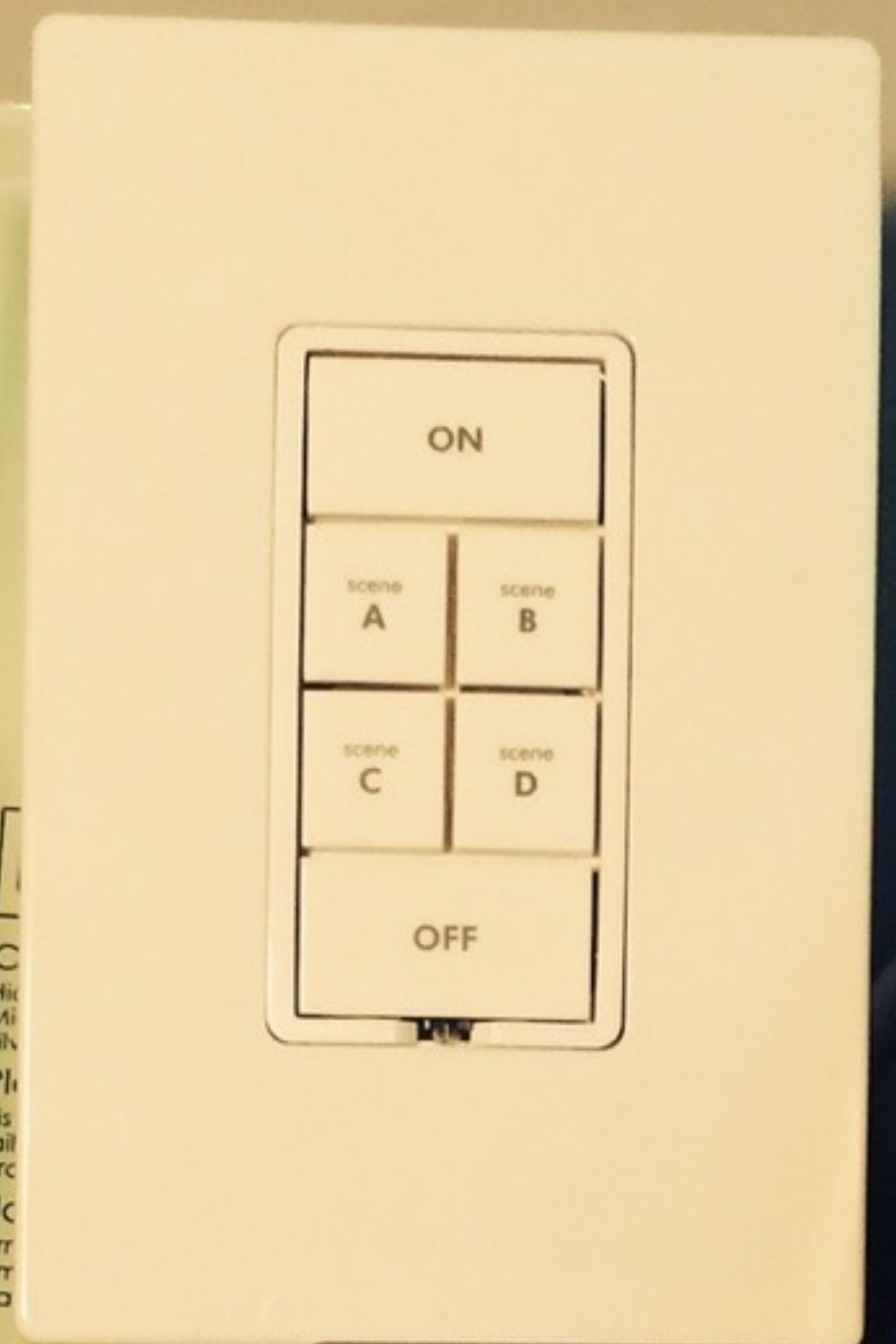


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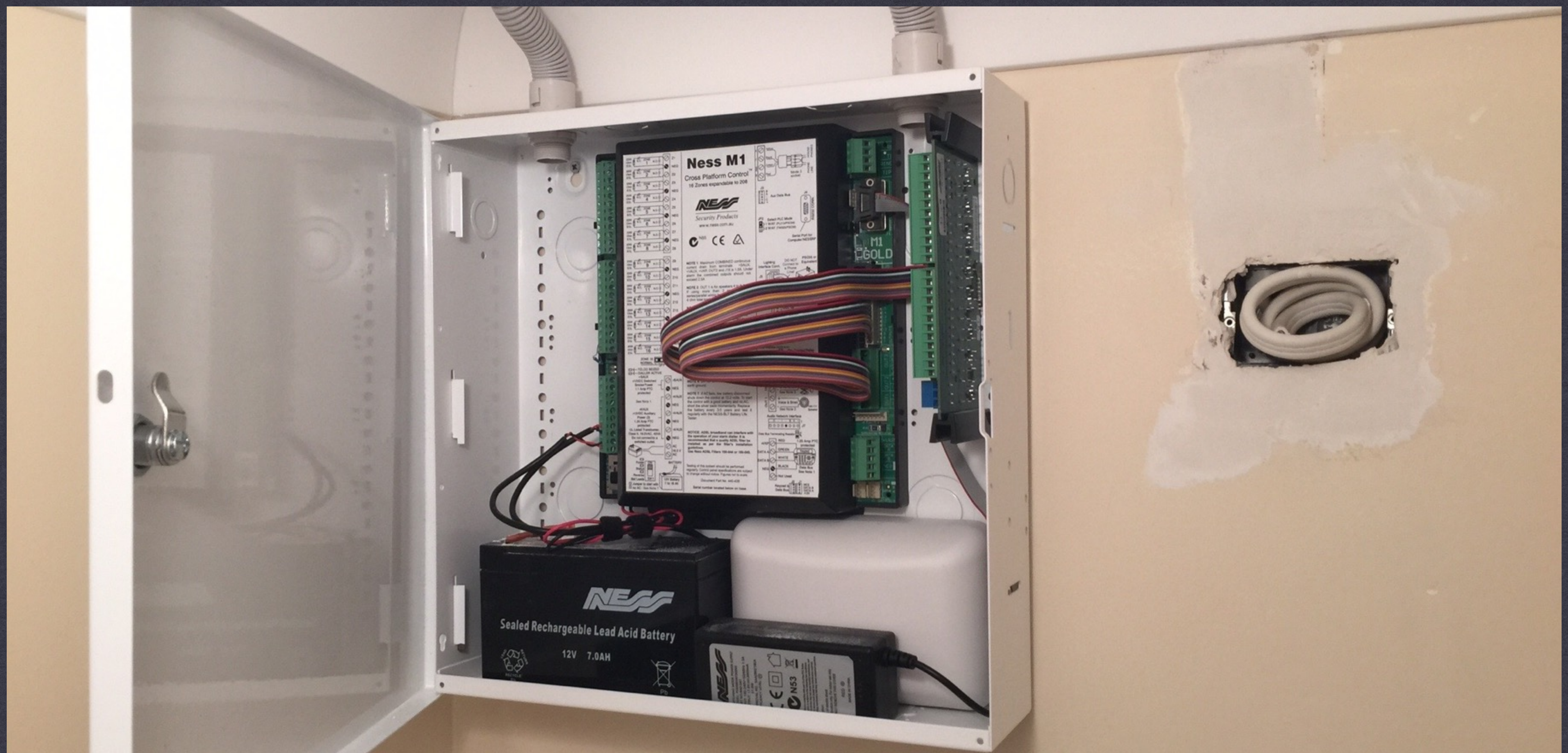




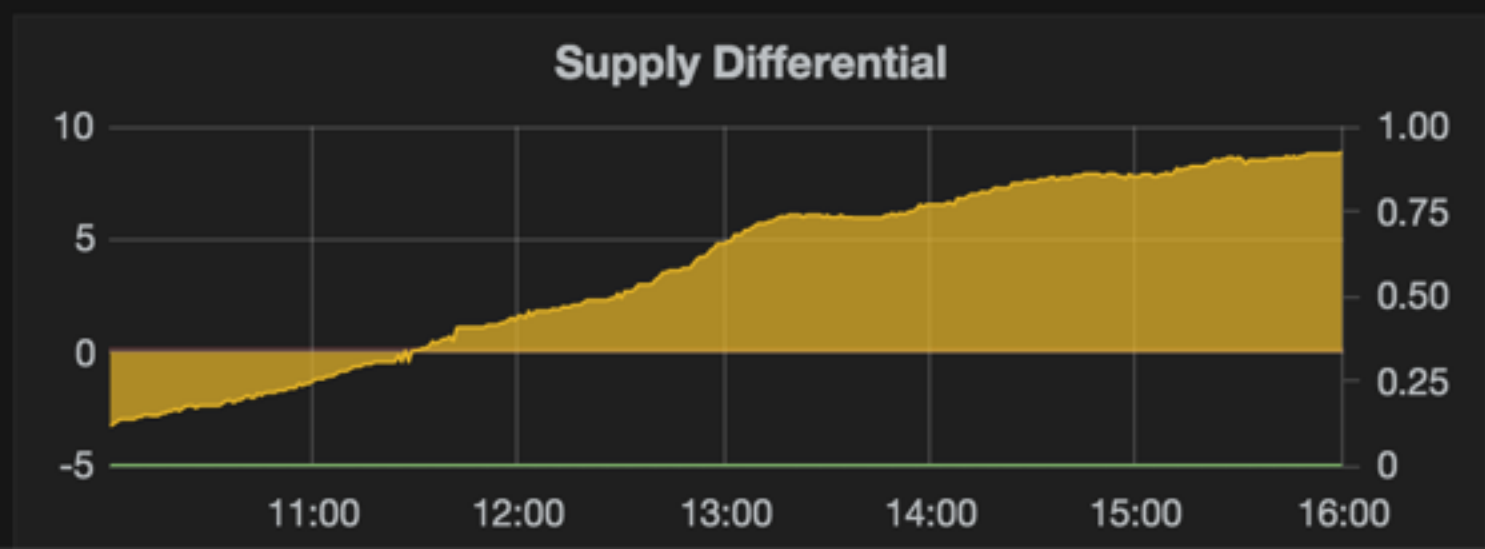
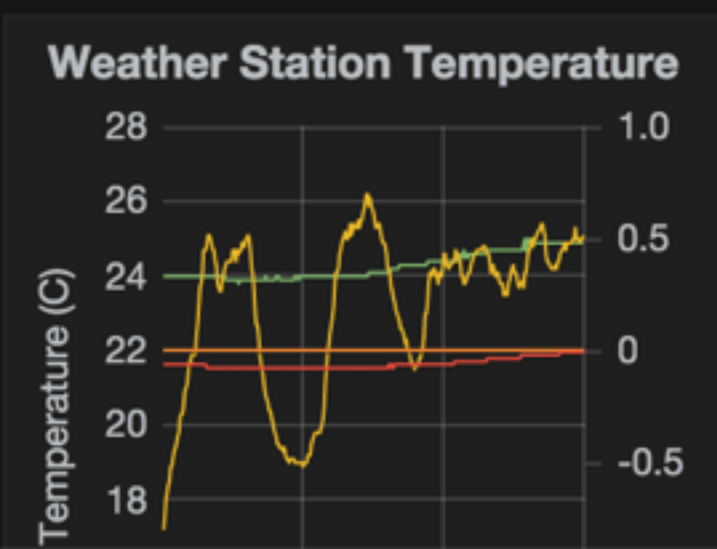
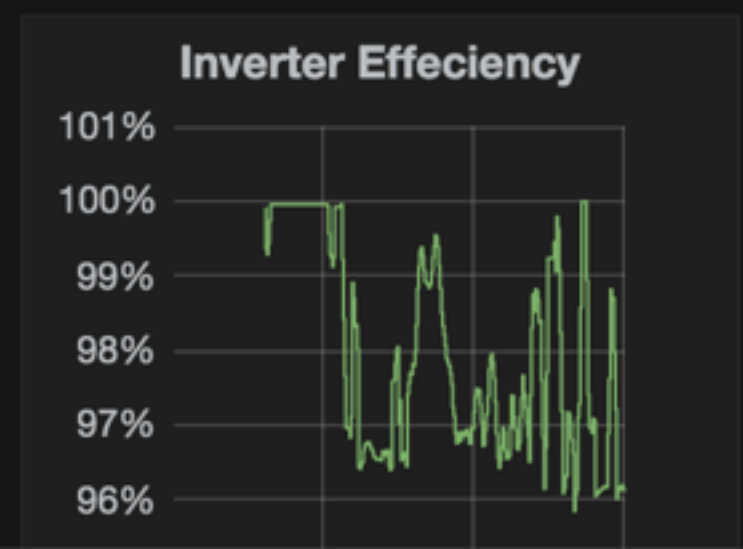
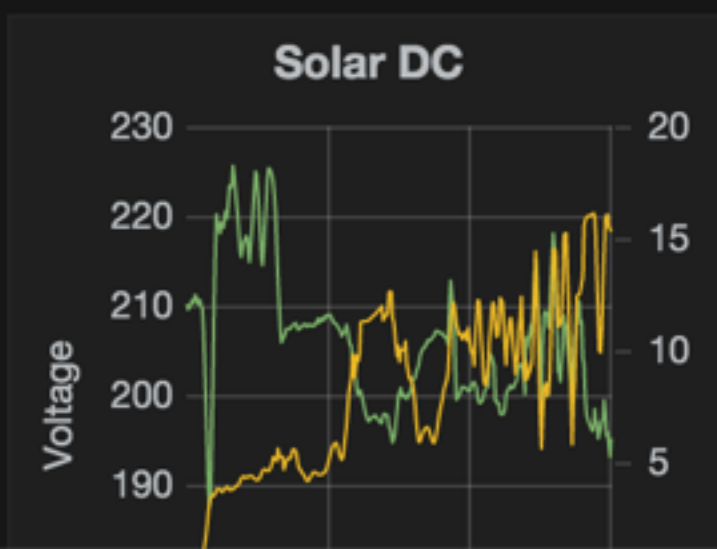
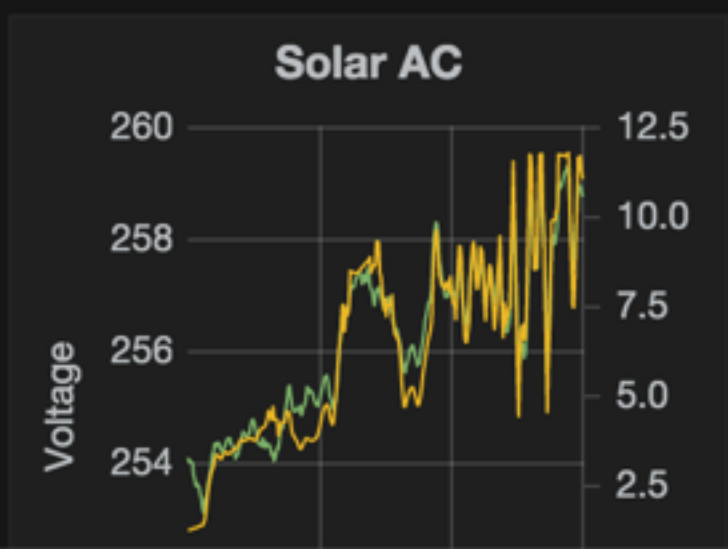
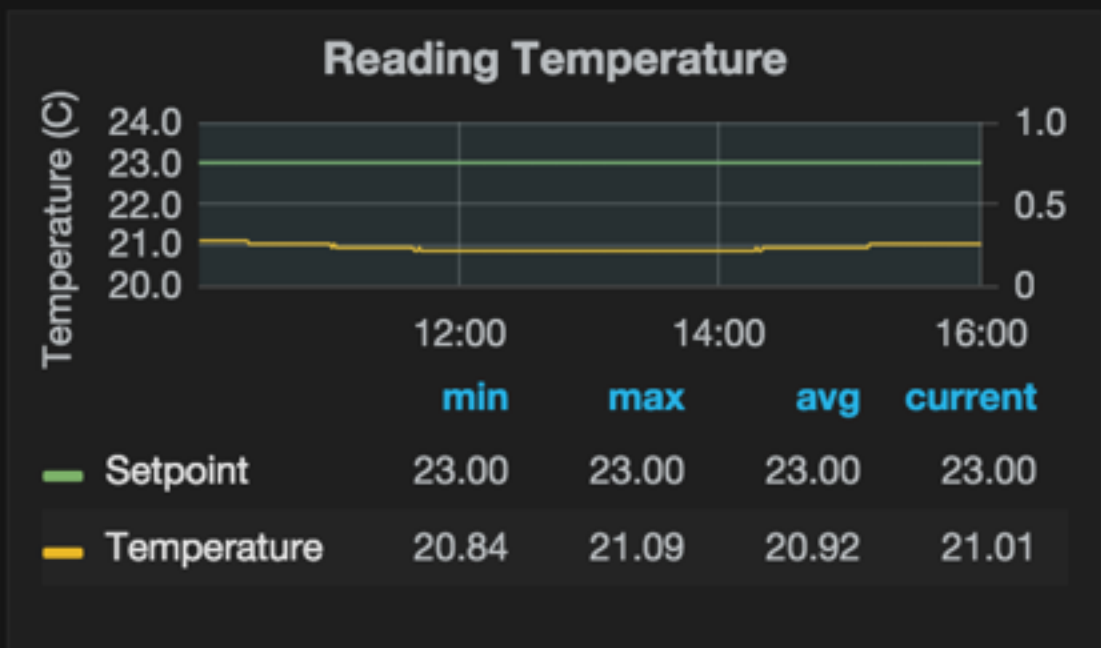
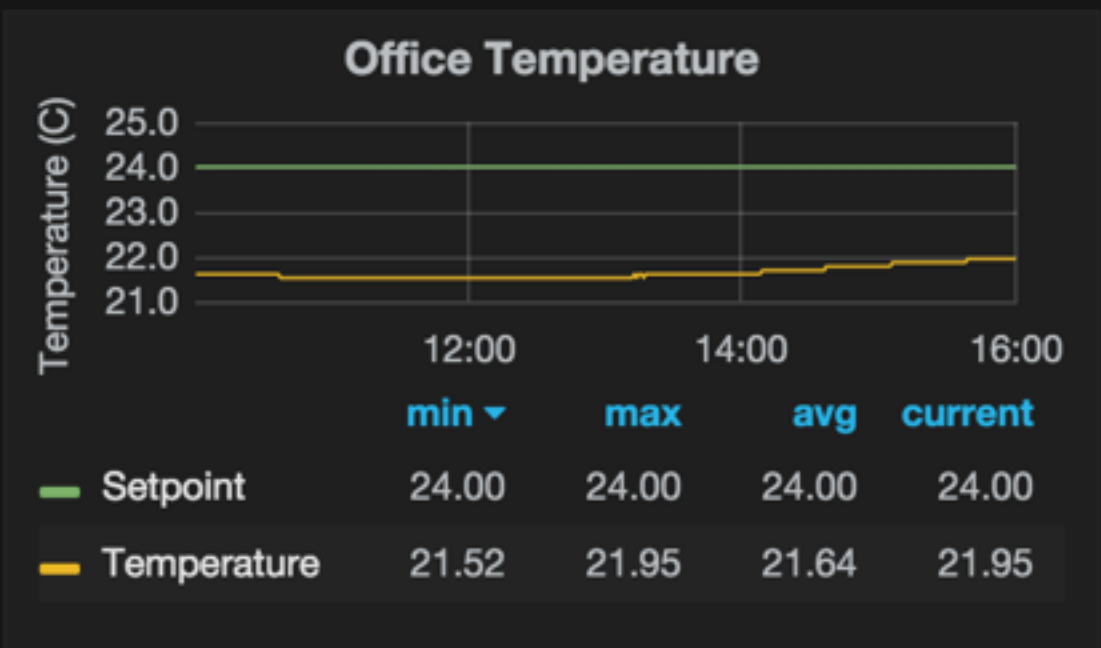
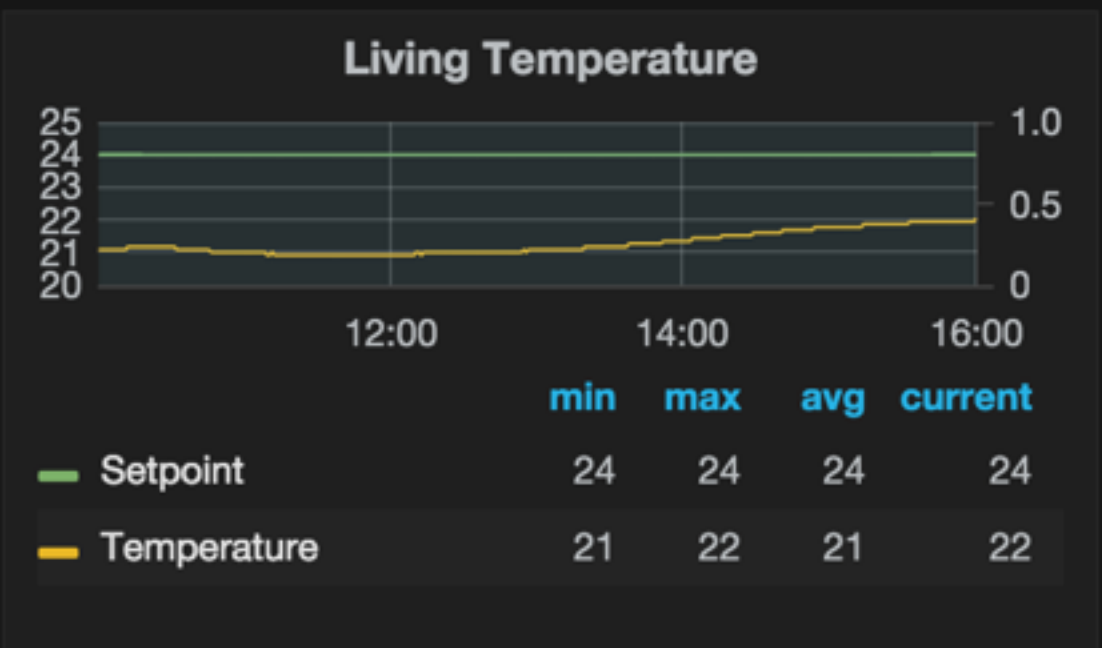
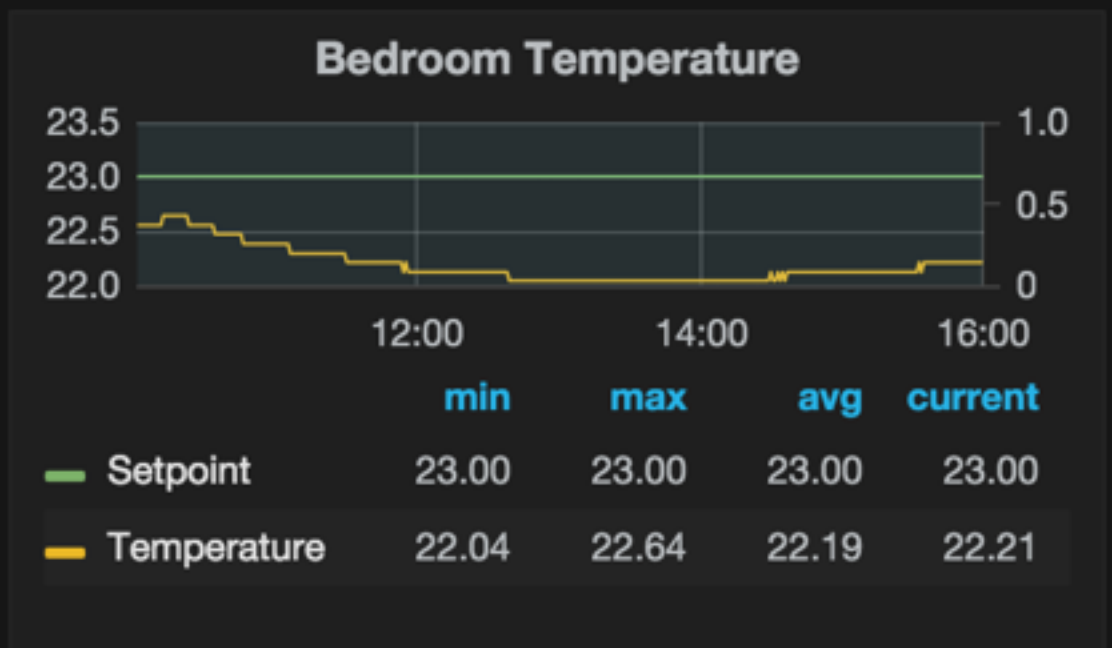
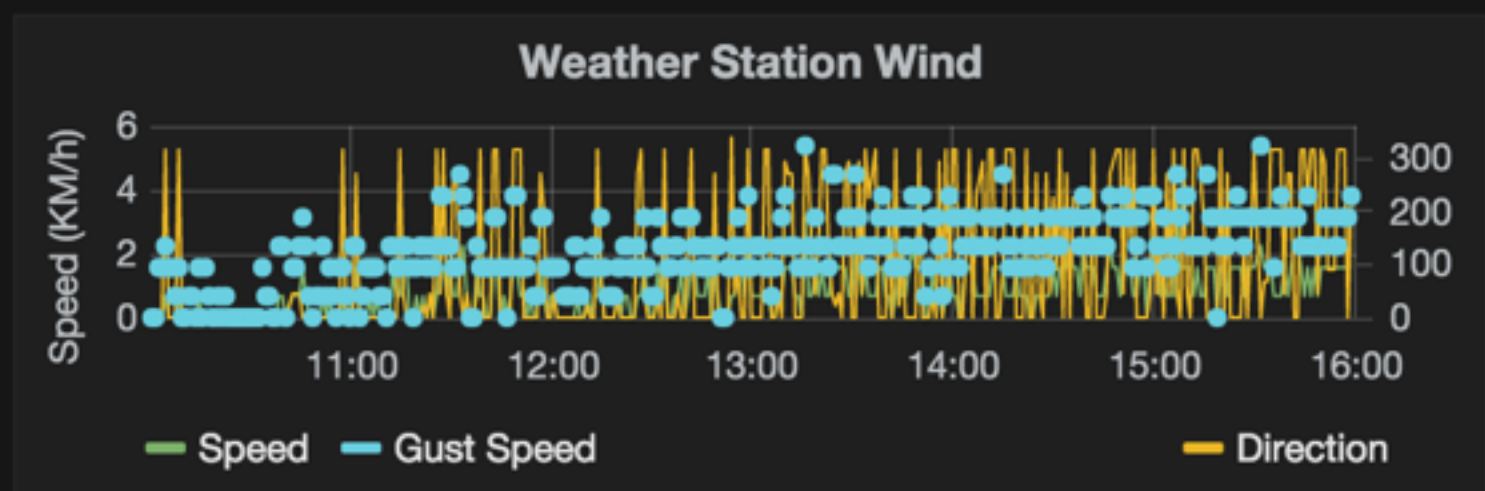
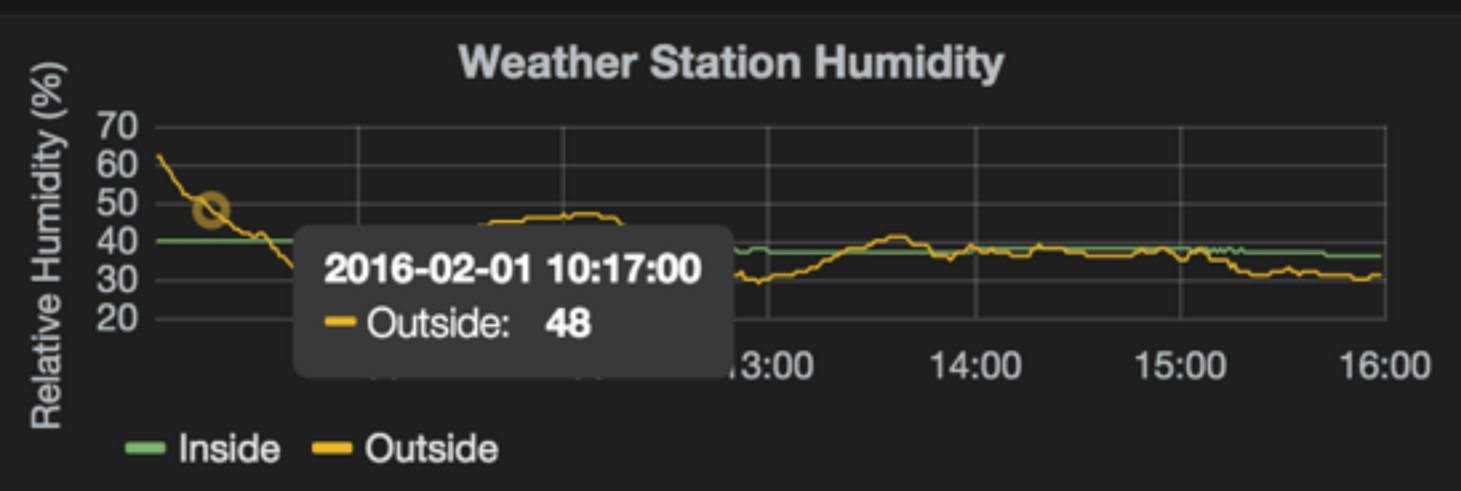
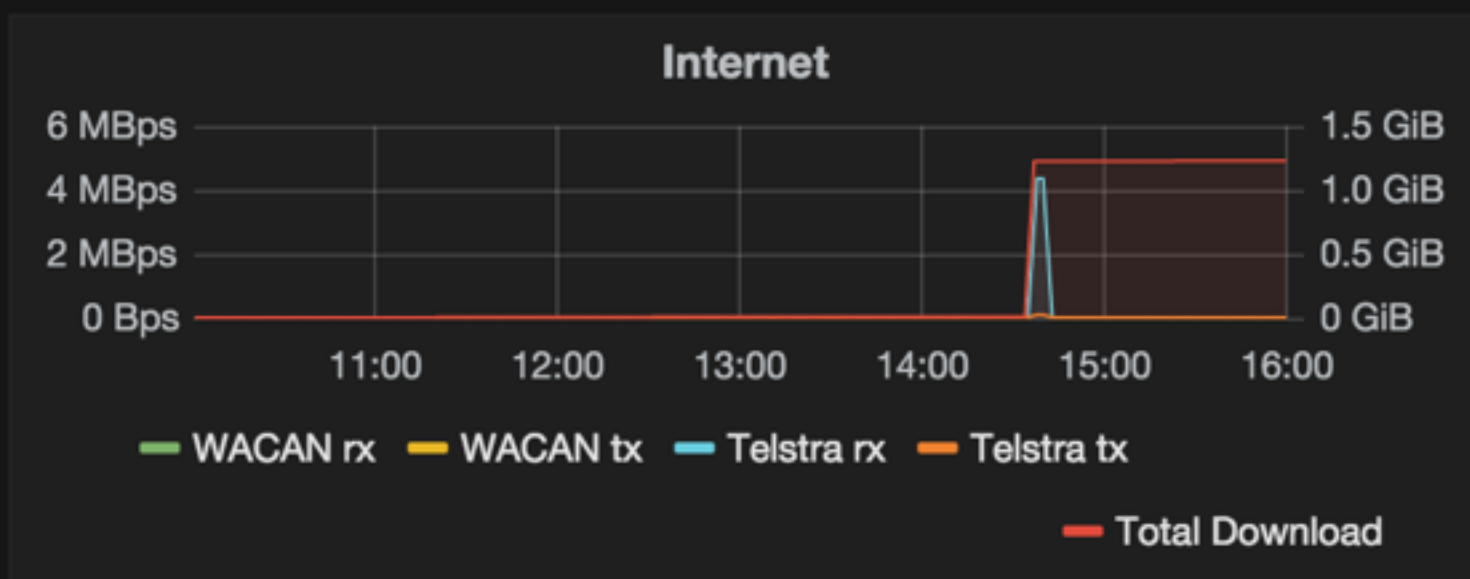
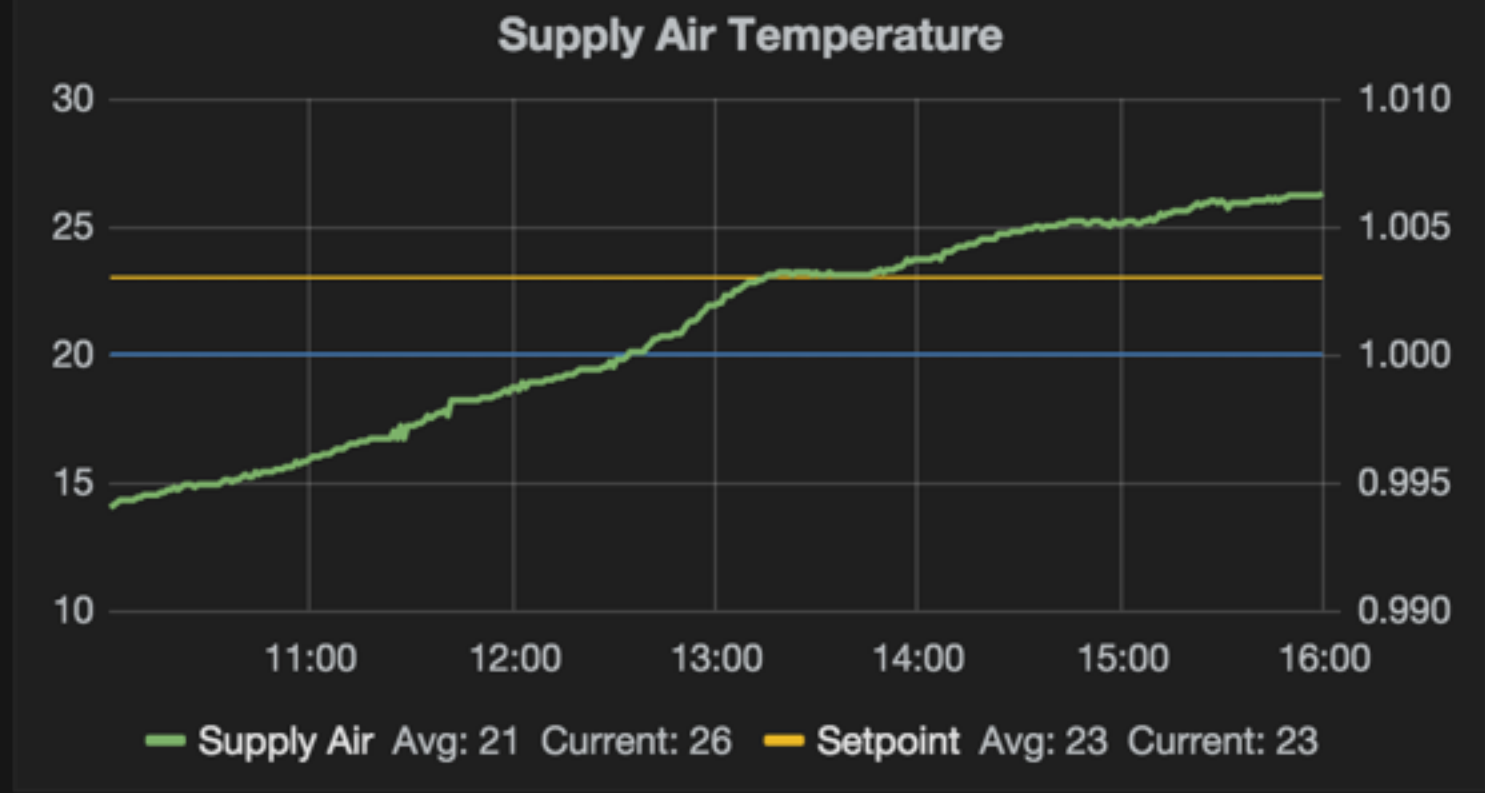
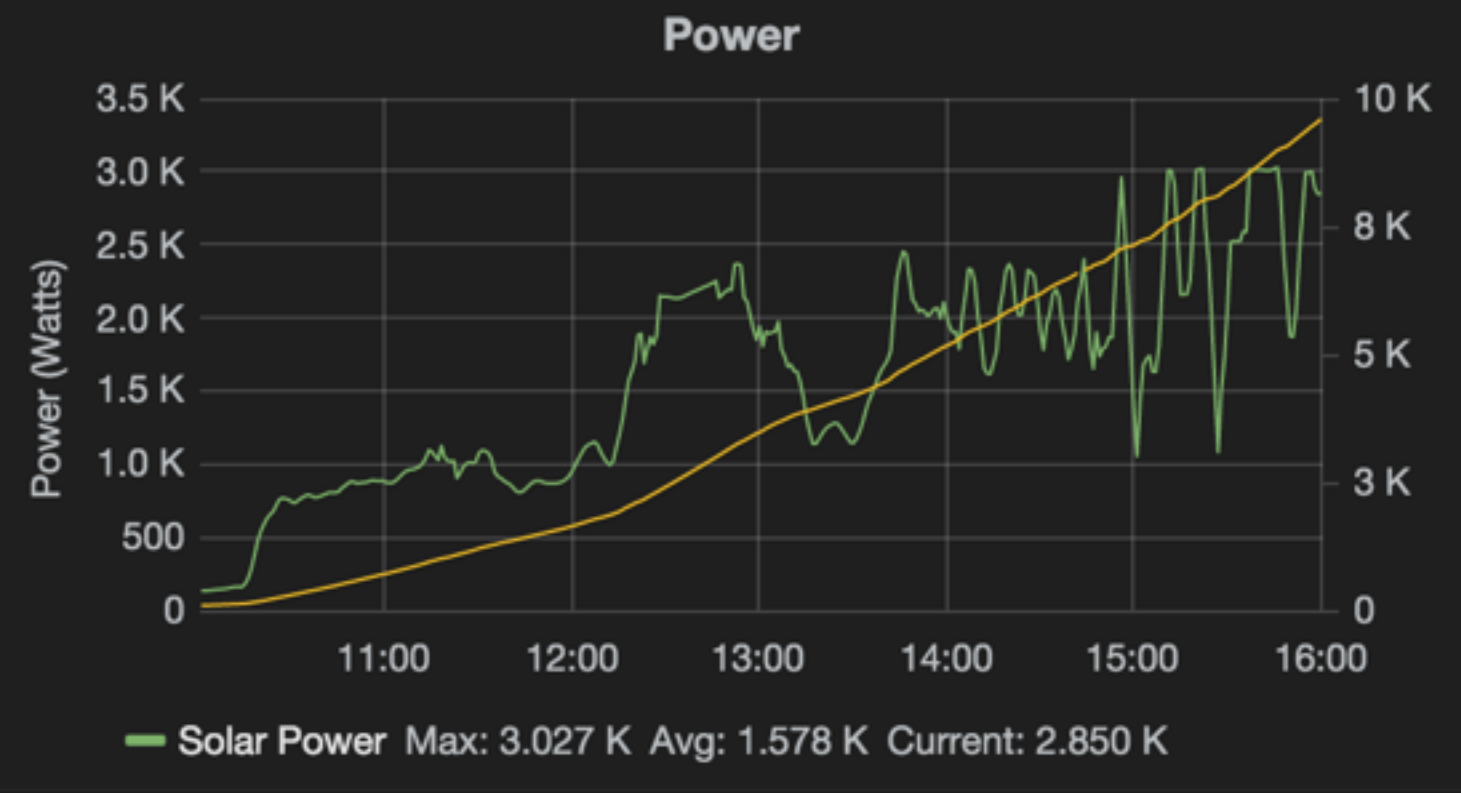
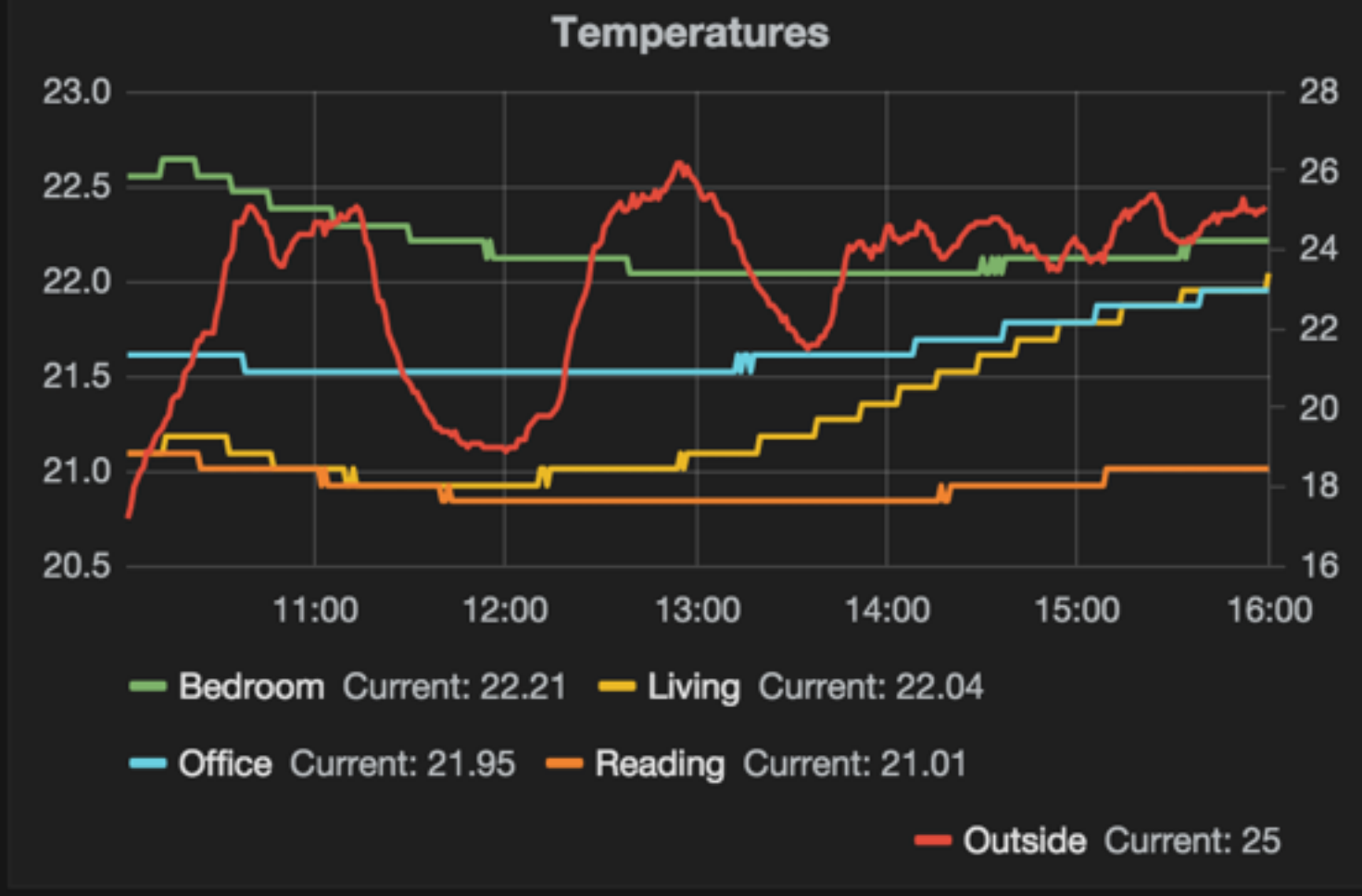
AIR CONDITIONING

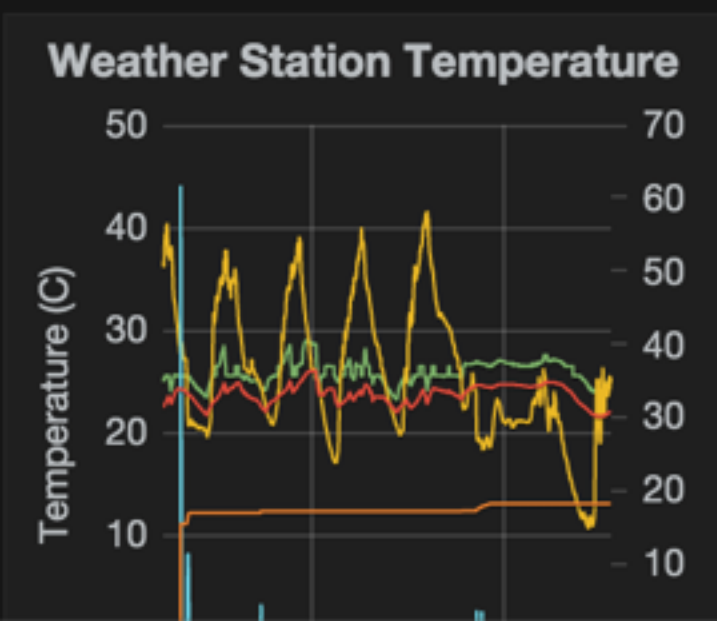
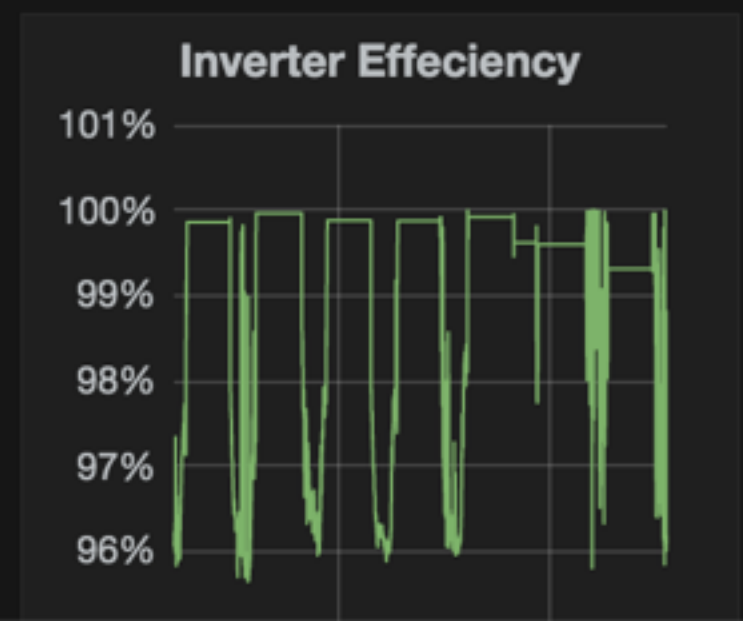
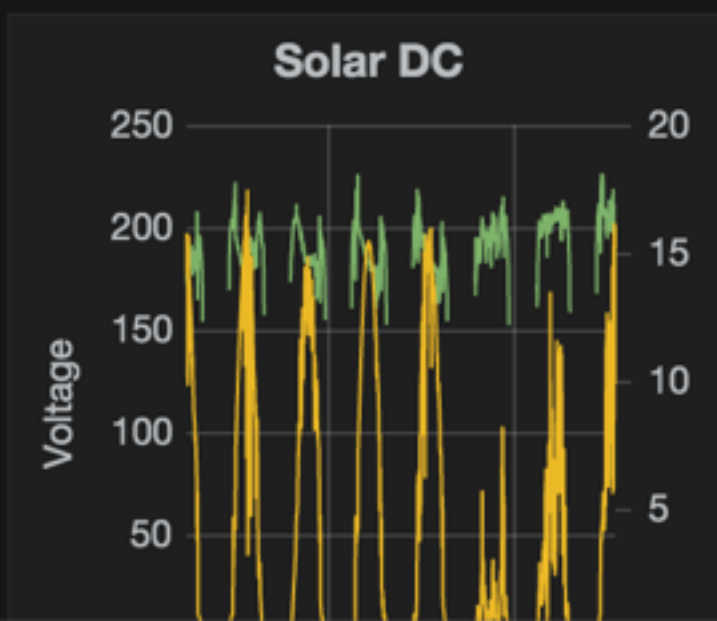
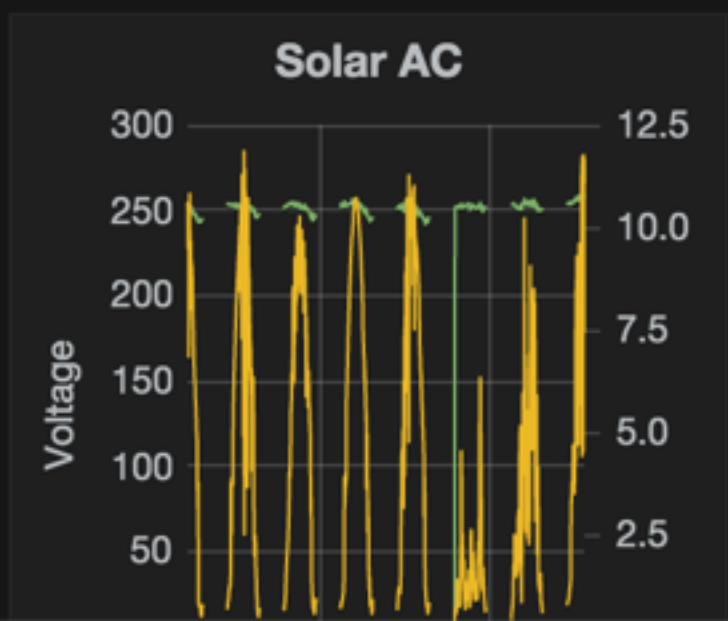
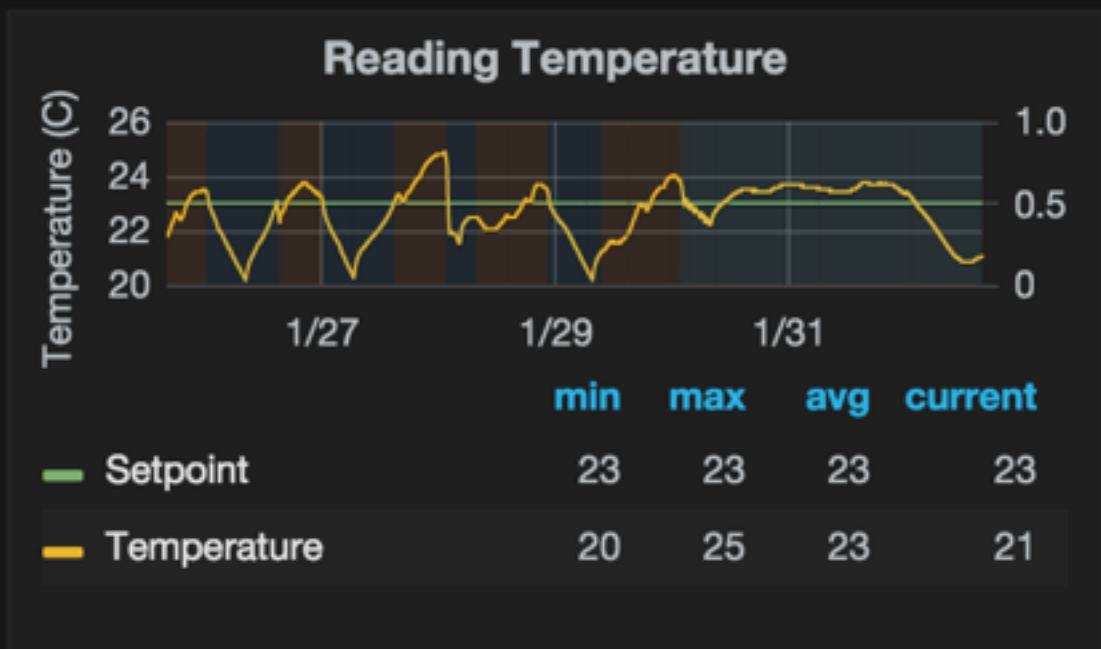
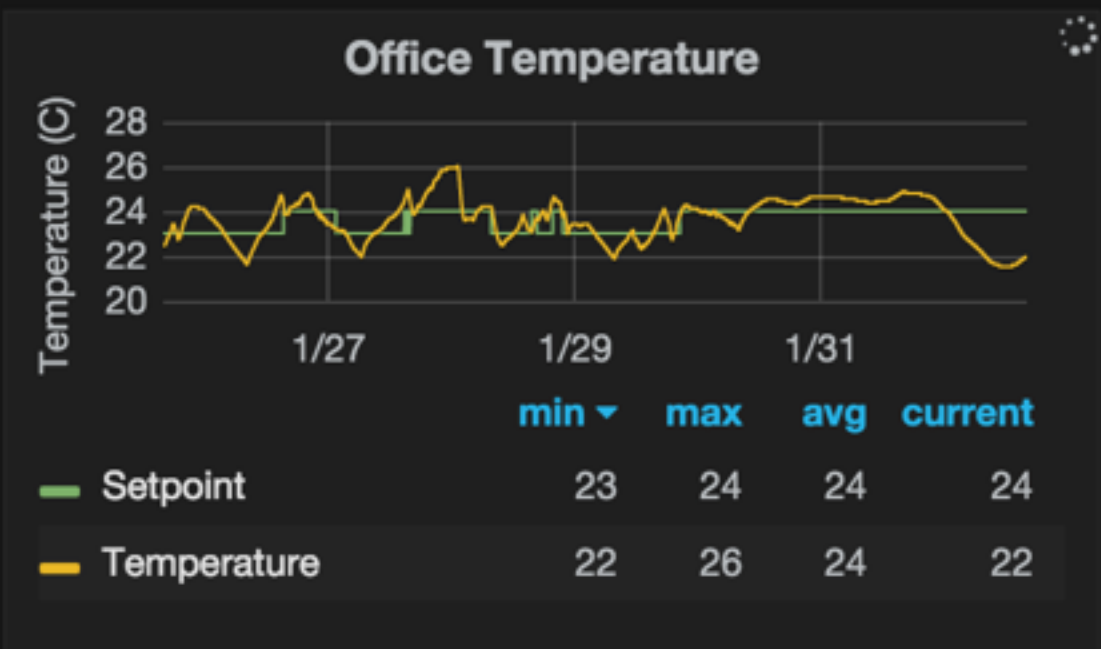
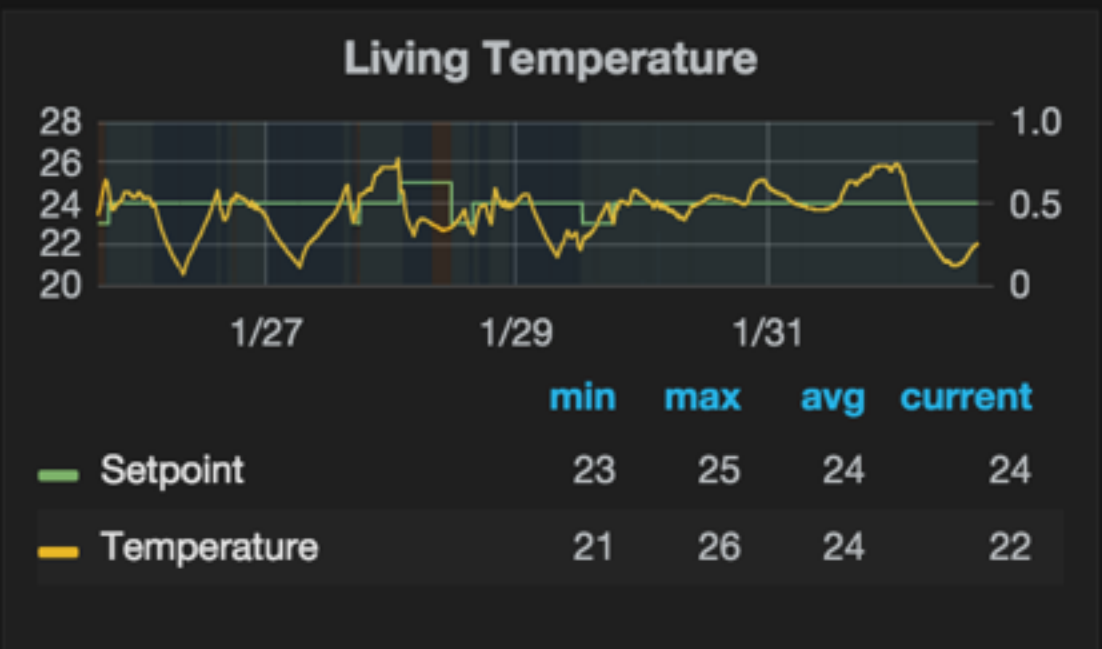
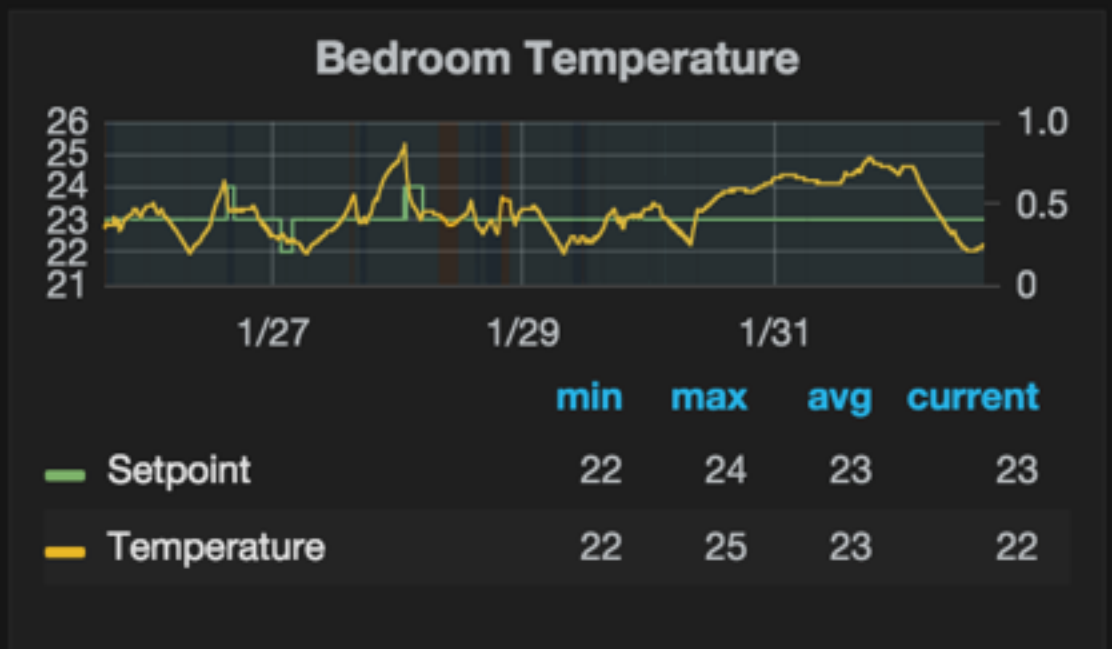
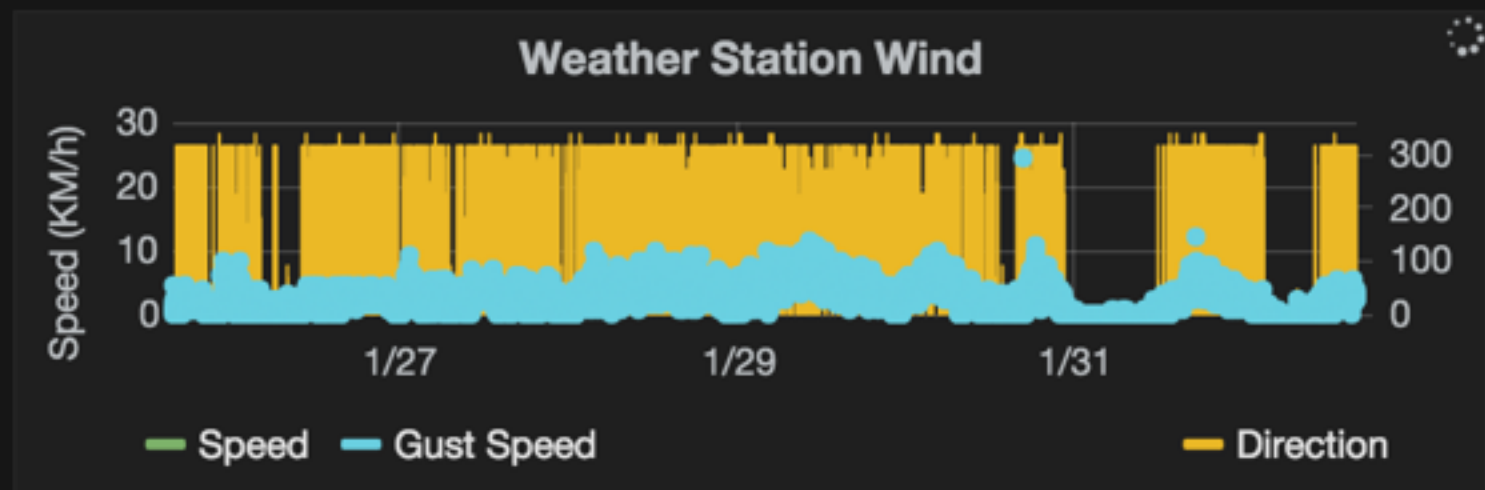
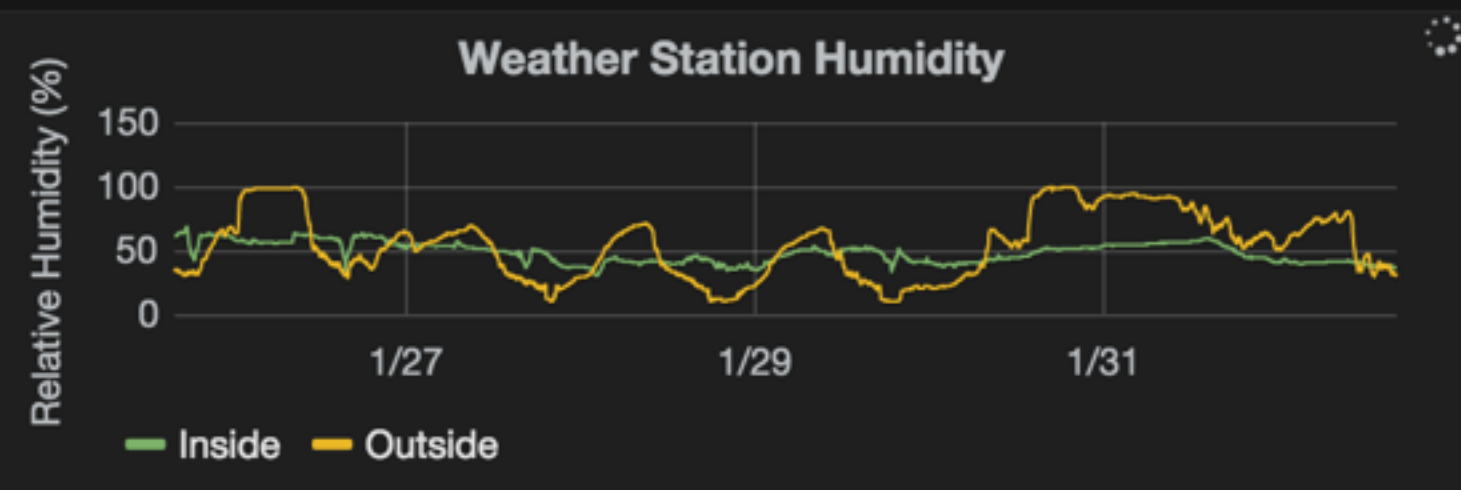
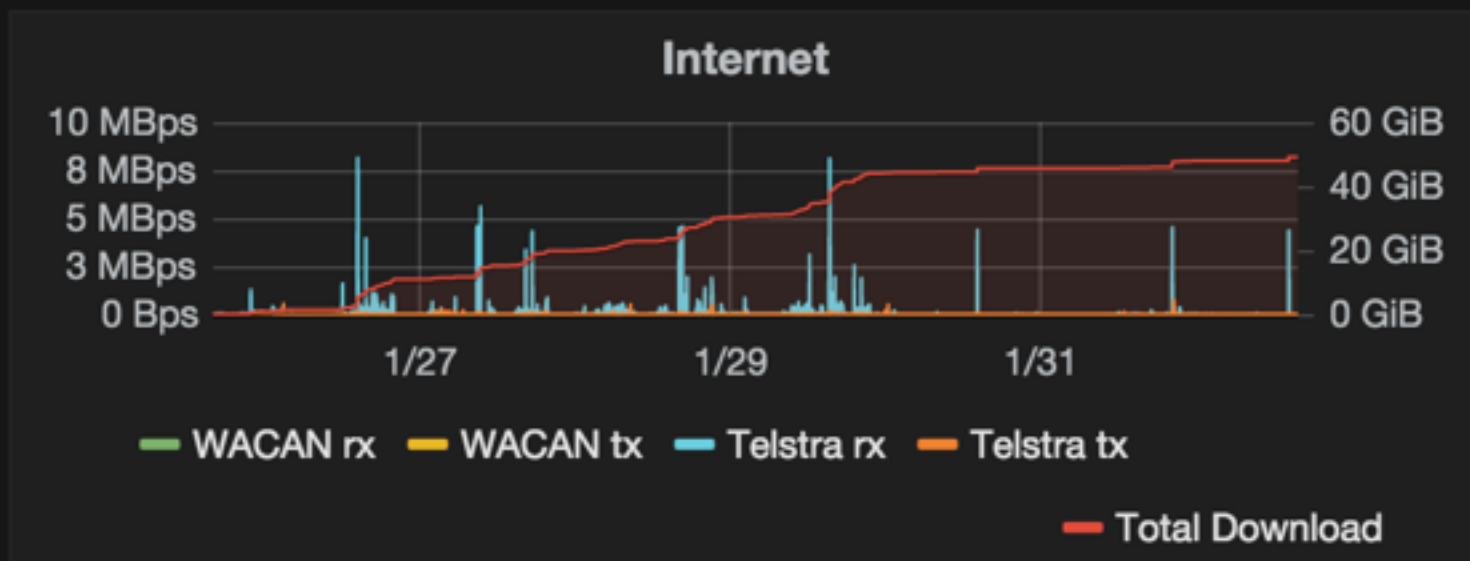
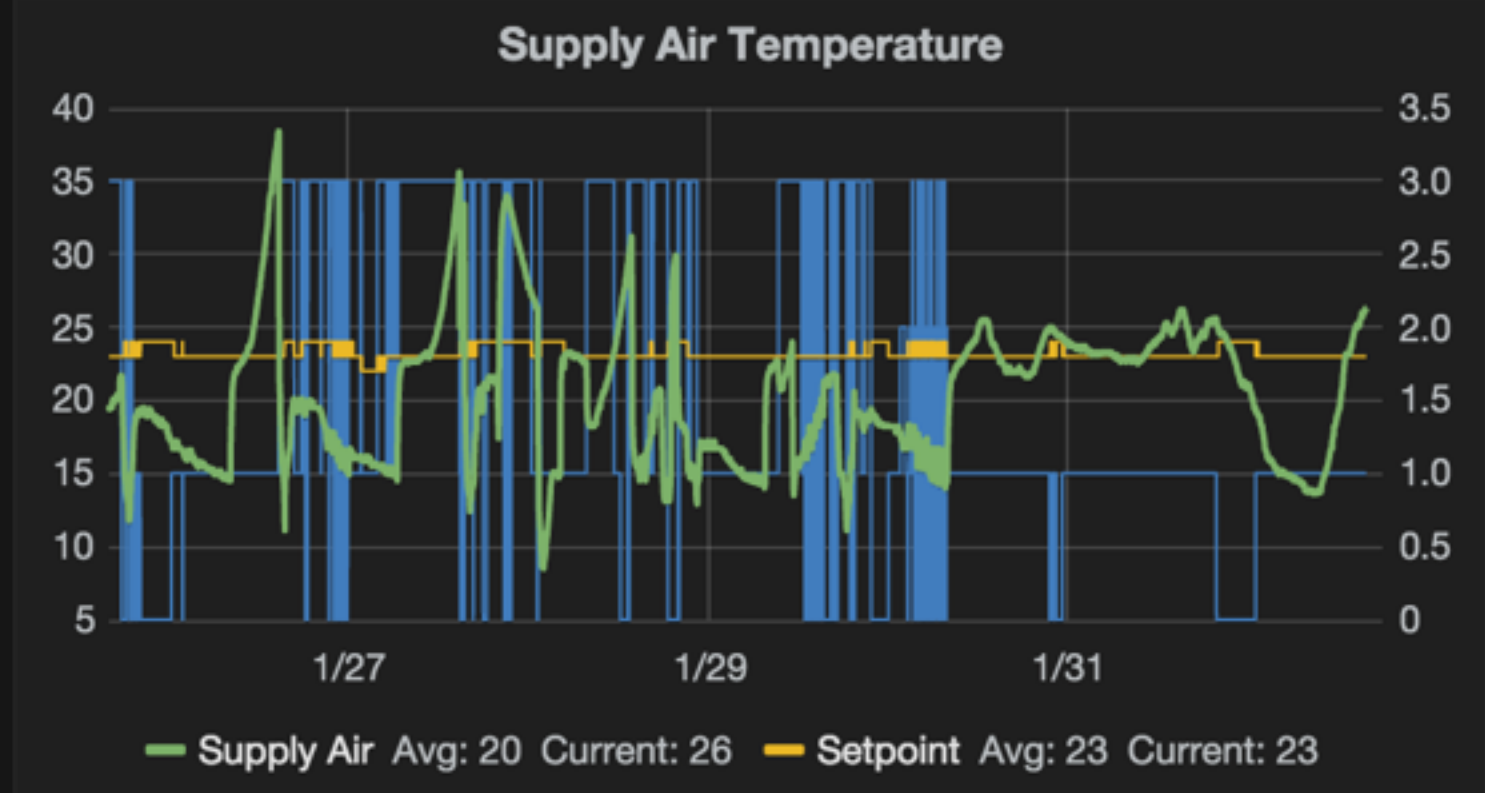
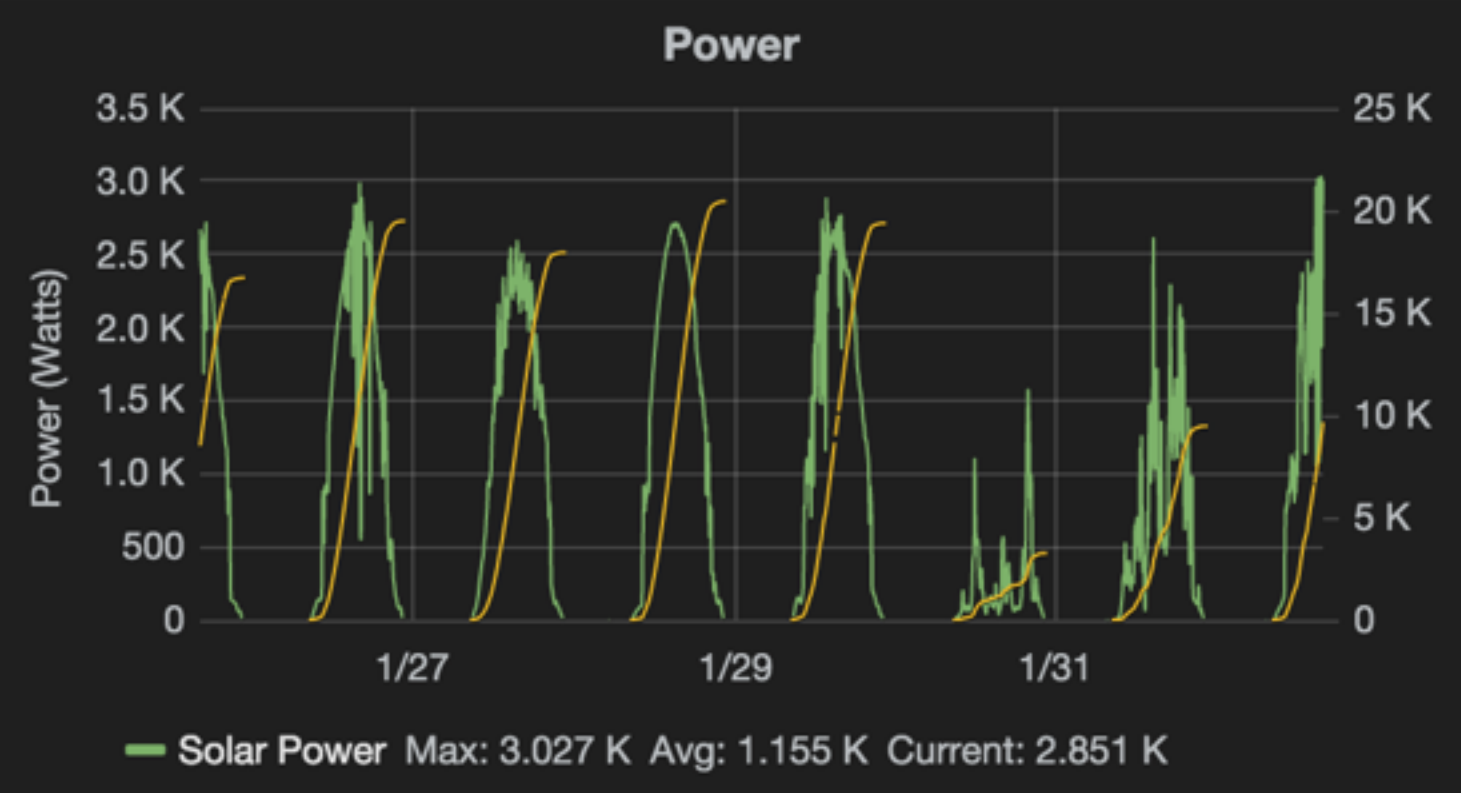
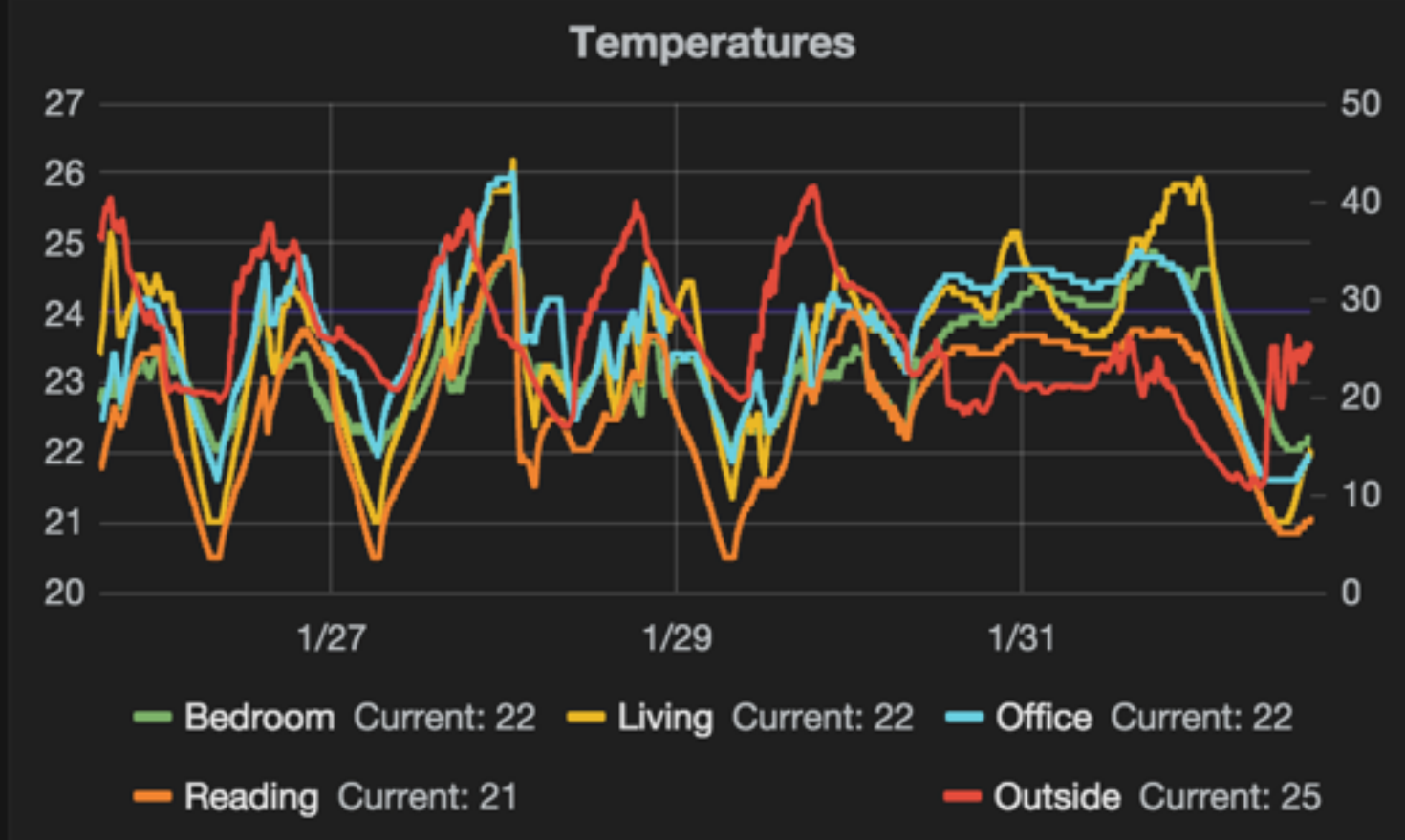


AIR CONDITIONING



ALARM





IMPORT/EXPORT

000

000720
000720

1Wh/imp

SCROLL

volts
volts blue ϕ
line 2

Power
Light
Wires
LOT 92
BRISTOL
BALDIVIS

INSTALLATION
CERTIFICATE
AS PER CLAUSE 41.5(1) OF THE BUILDING CODE OF AUSTRALIA

EM1000
IMPORT/EXPORT
westernpower
0200484083
Lands+Gyr E150 2014
NMI 14/2/22 Class1
10-100A N10943
1P 2W 230V/240V 50Hz

935 BRISTLEBIRD
BALDIVIS

Before installation

CLIPSAL SOLID STATE DEVICES
IF MEGGER TESTING INSTALLATION
LOW READING MAY BE
OBTAINED
SOLID STATE DEVICES ARE LOCATED
IN THE FOLLOWING CIRCUITS:

NORMAL
SUPPLY
MAIN
SWITCH

MAIN RCD1
SWITCH N1
LIGHTS ON N1
RCD IN N2
RCD2 N2

D
A
S
T
NS

WARNING
DUAL SUPPLY
ISOLATE BOTH NORMAL AND SOLAR
SUPPLIES BEFORE WORKING ON
THIS SWITCHBOARD

SOLAR ARRAY
ON ROOF
MPPT1 MPPT2
PV Array Open Circuit Voltage(STC)
PV Array Short Circuit Current(STC)

INVERTER LOCATED AT
side of House
rear

TERMITE PROTECTION NOTICE

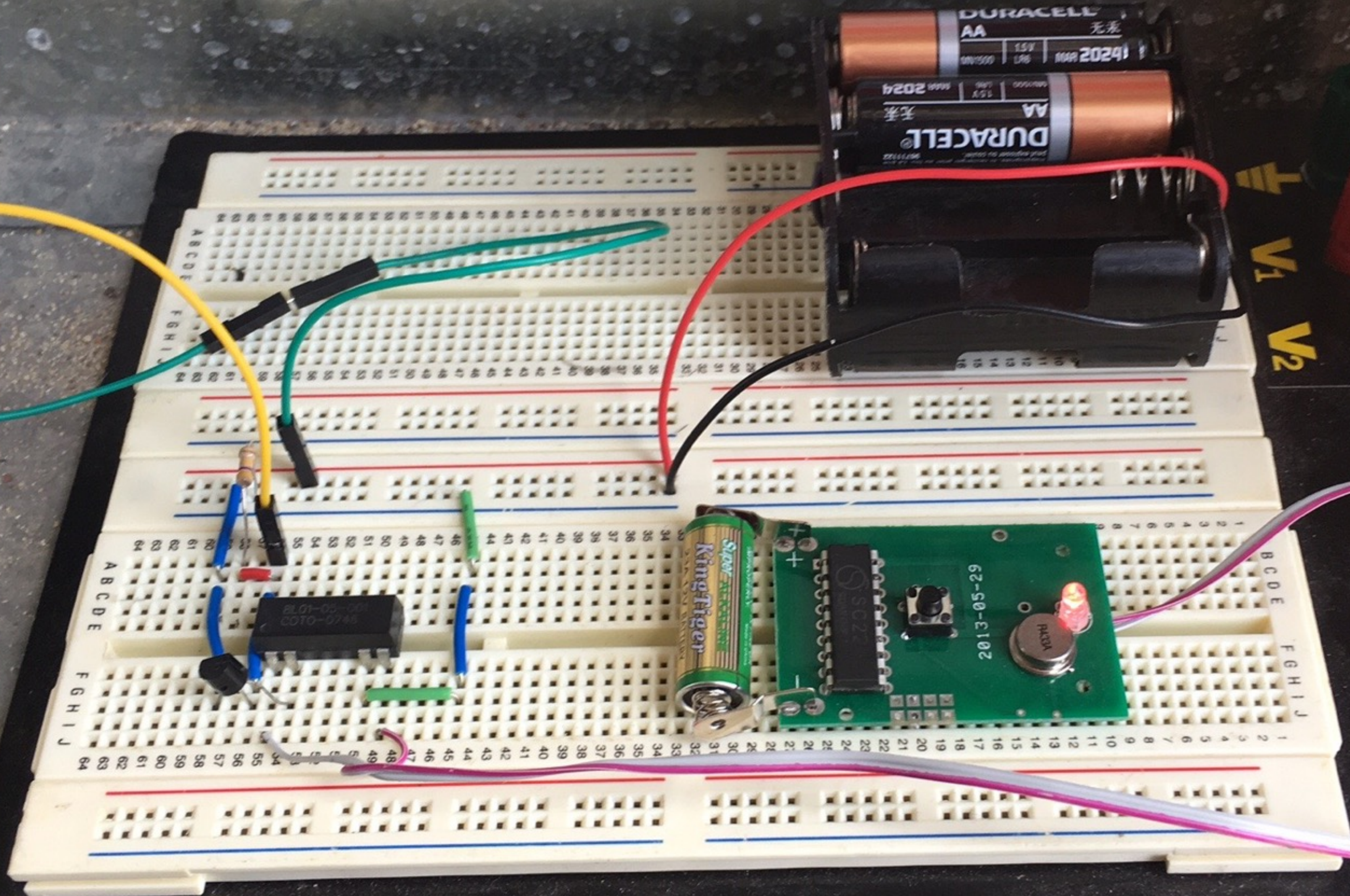
PEST MANAGEMENT SERVICE LOG

Date	Inspector	Property	Address	Phone	Notes
09-10-18					
16-01-19					

FAVSTAN INTEGRATED BREAD-BOARD

2N7-85-27

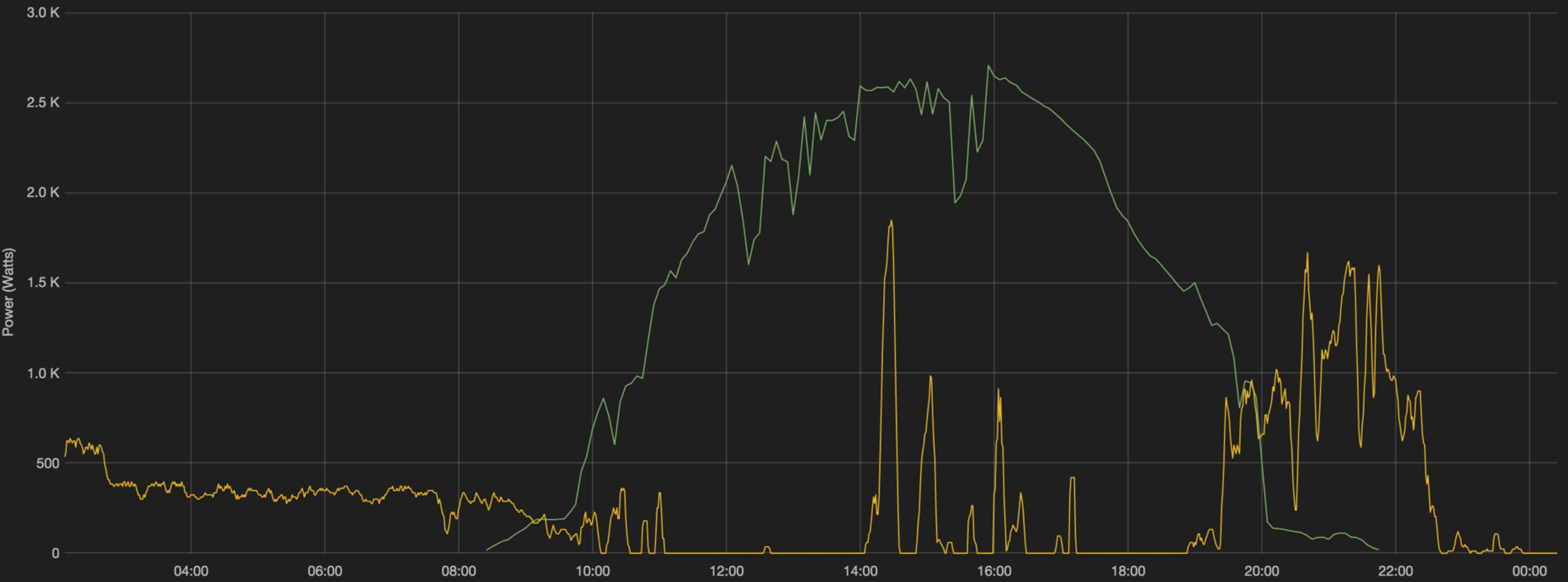
INVERTER LOCATED AT
side of House
rear



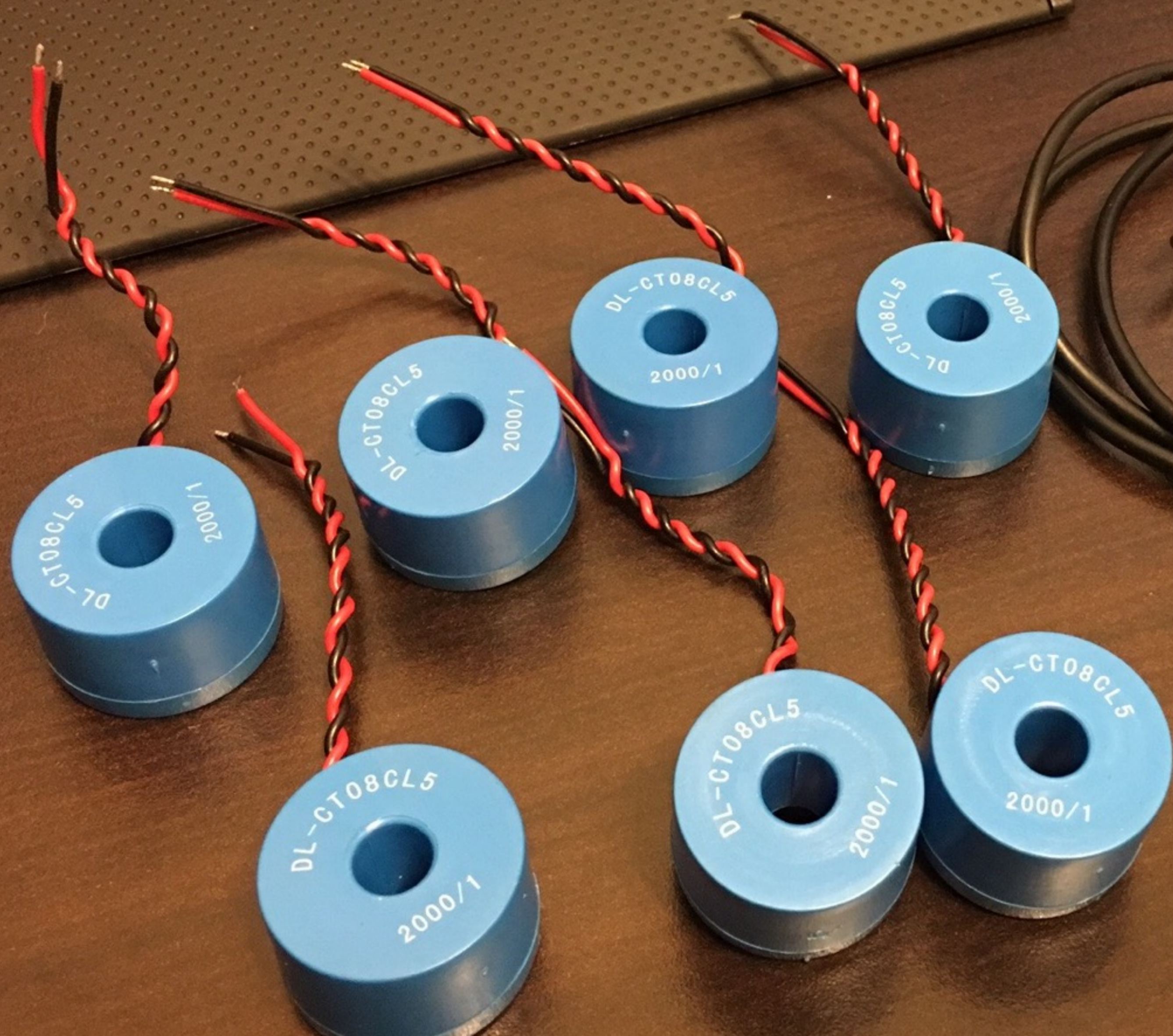
V1
V2

FAYSTAR
INTEGRATED
BREAD-BOARD

Power



— Solar Power Max: 2.706 K Avg: 1.482 K Current: — Import Power Max: 1.848 K Avg: 292 Current: 0



Store: **Waveshare Electronics CO.,Ltd.**

Open: **4 year(s)**



Top-rated Seller

2444

99.5% Positive feedback

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BLE4.0 Bluetooth NRF51822 Module 2.4G Wireless Communication Module Transmitter Receiver Development Evaluation Kit

★★★★★ **4.9** (18 votes) | **13** orders

Price: **US \$15.88** / piece
Bulk Price

Shipping: **US \$3.16** to Australia via China Post Registered Air Mail
Estimated Delivery Time: 15-45 days (ships out within 2 business days)

Quantity: piece (951 pieces available)

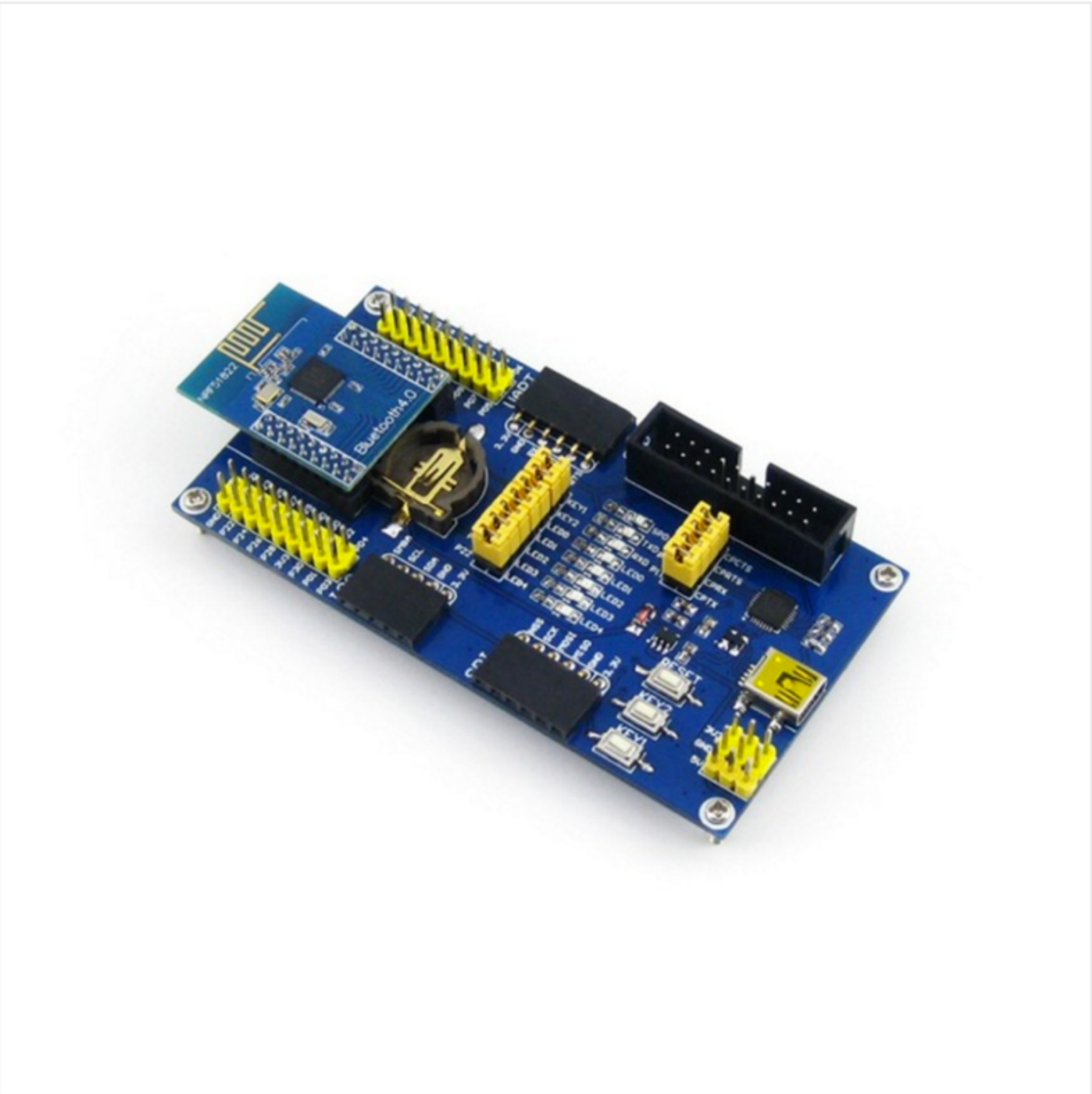
Total Price: **US \$19.04**

Buy Now **Add to Cart**

📖 Add to Wish List (22 Adds)

Return Policy: Returns accepted if product not as described, buyer pays return shipping fee; or keep the product & agree refund with seller. [View details](#)

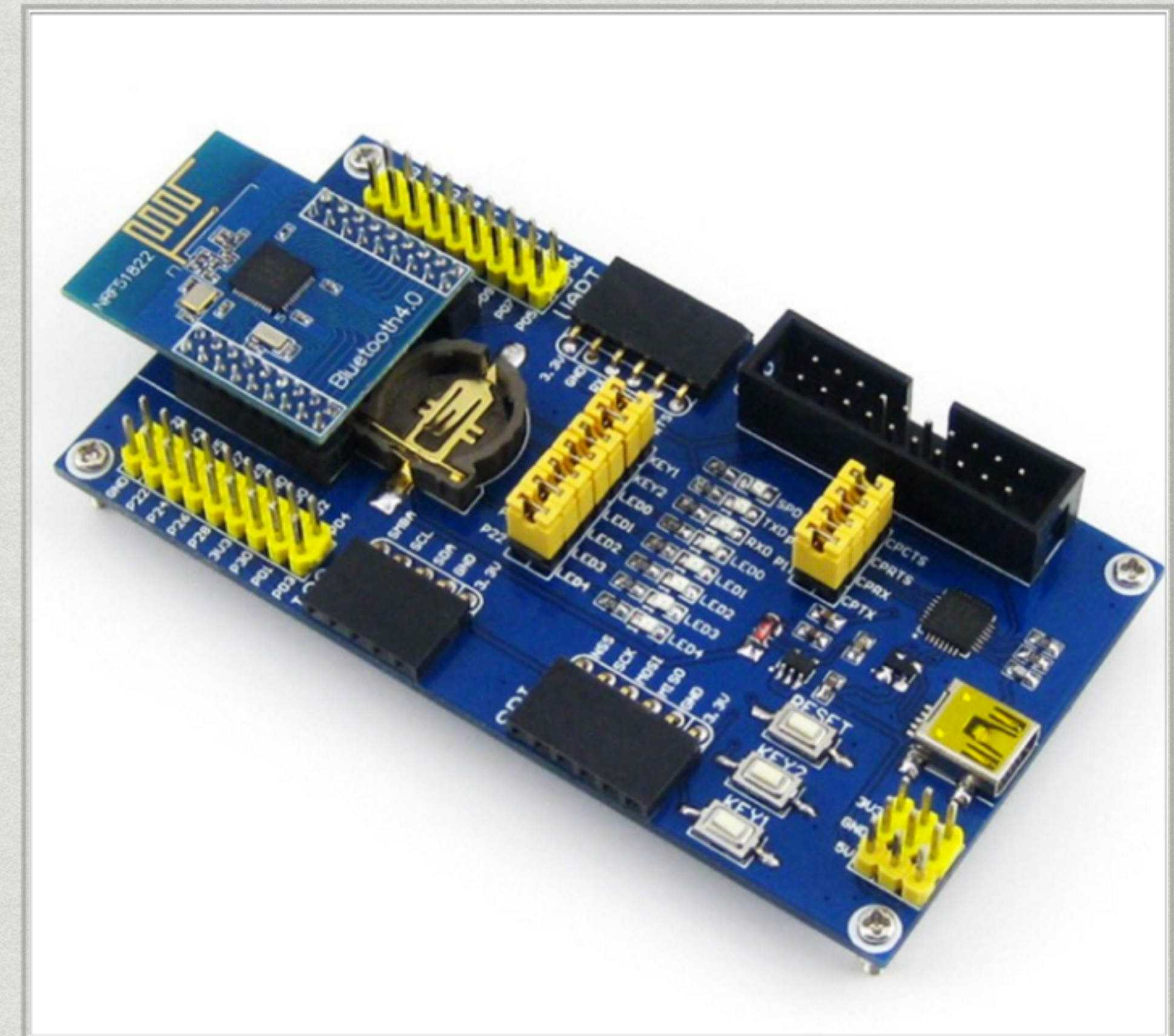
Seller Guarantees: On-time Delivery **60 days**



🔍 Mouse over to zoom in

Nordic NRF51

- * Bluetooth Low Energy 4 “Bluetooth Smart”
- * ARM Cortex M0
- * Very Low Power - 600nA - 2.6 μ A @ 3V
- * 256KB Flash
- * 32KB RAM
- * 3 Timers, 4PWM, 31 GPIO, 8x 10bit ADC
- * Official SDK has gcc Makefile



```
lathiat@ubuntu:~/src/nrf5/examples$ ls *
```

```
ble_peripheral:
```

```
ble_app_alert_notification  ble_app_cts_c          ble_app_hrs_freertos  ble_app_rscs
ble_app_ancs_c              ble_app_gls           ble_app_hrs_rtx
ble_app_template
ble_app_beacon              ble_app_hids_keyboard ble_app_hts           ble_app_uart
ble_app_bps                 ble_app_hids_mouse   ble_app_proximity
experimental_ble_app_blinky ble_app_cscs          ble_app_hrs
ble_app_pwr_profiling
```

```
peripheral:
```

```
adc_simple      bsp      i2s      pin_change_int  qdec      rng
spi             timer    uart
blinky          clock    led_softblink  ppi         radio      rtc
spis            uicr_config
blinky_freertos flashwrite  low_power_pwm  pwm_driver    radio_test  saadc
temperature     twi_master_with_twis_slave  wdt
blinky_rtx      gpiote    lpcomp      pwm_library    ram_retention  simple_timer
template_project twi_sensor
```

```
lathiat@ubuntu:~/src/nrf5/examples/peripheral/uart/pca10040/armgcc$ make
rm -rf _build
echo Makefile
Makefile
mkdir _build
Compiling file: system_nrf52.c
Compiling file: main.c
Compiling file: app_error.c
Compiling file: app_fifo.c
Compiling file: app_util_platform.c
Compiling file: nrf_assert.c
Compiling file: retarget.c
Compiling file: app_uart_fifo.c
Compiling file: nrf_delay.c
Compiling file: nrf_drv_common.c
Compiling file: nrf_drv_uart.c
Compiling file: gcc_startup_nrf52.s
Linking target: nrf52832_xxaa.out
make[1]: Entering directory '/home/lathiat/src/nrf5/examples/peripheral/uart/pca10040/armgcc'
Preparing: nrf52832_xxaa.bin
Preparing: nrf52832_xxaa.hex
```

text	data	bss	dec	hex	filename
9432	112	528	10072	2758	_build/nrf52832_xxaa.out

```
make[1]: Leaving directory '/home/lathiat/src/nrf5/examples/peripheral/uart/pca10040/armgcc'
```

See an Error?



Enlarge

Mouser Part #: 943-8.08.00
Manufacturer Part #: J-Link BASE
Manufacturer: Segger Microcontroller
Description: Emulators / Simulators J-LINK

- Page 238, Mouser Online Catalog
- Page 238, PDF Catalog Page
- J-Link BASE Datasheet

Images are for reference only
See Product Specifications

Add to Compare List

Share | Email | Twitter | Google+ | 0

Specifications	Documents (2)	My Notes
Manufacturer:	Segger Microcontroller	<input checked="" type="checkbox"/>
Product Category:	Emulators / Simulators	<input checked="" type="checkbox"/>
RoHS:	Details	
Product:	JTAG Emulator	

Real Time Availability

Stock:	110 Can Ship Immediately
On Order:	86 View Delivery Dates
Factory Lead-Time:	3 Weeks

Enter Quantity:

<input type="text"/>	<input type="button" value="Buy"/>	Minimum: 1
		Multiples: 1

Pricing (AUD)

1:	\$604.80
----	----------

Segger Microcontroller Newest Products

J-Link Ultra+

Offering high speed, ease of use, fast & free flash loaders, unlimited flash breakpoints, & compatibility w/ all tool-chains.



[Learn More](#)

J-Link and J-Link EDU

USB-powered JTAG emulators designed to communicate at high speed with large number of ARM cores.



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[Enlarge](#)

Mouser Part #: 943-8.08.90
Manufacturer Part #: J-Link EDU
Manufacturer: [Segger Microcontroller](#)
Description: Emulators / Simulators J-LINK EDU

[Learn more about Segger Microcontroller J-Link EDU](#)

- [Page 238, Mouser Online Catalog](#)
- [Page 238, PDF Catalog Page](#)
- [J-Link EDU Datasheet](#)

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Specifications

Features

Product Comments

Documents (3)

My Notes

Manufacturer: Segger Microcontroller

Product Category: Emulators / Simulators

RoHS: [Details](#)

Real Time Availability

Stock: 209 Can Ship Immediately

On Order: 0

Factory Lead-Time: 5 Weeks

Enter Quantity:

[Buy](#) Minimum: 1
Multiples: 1

Pricing (AUD)

1: \$96.00

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Segger Microcontroller Newest Products

J-Link Ultra+

Offering high speed, ease of use, fast & free flash loaders, unlimited flash breakpoints, & compatibility w/ all tool-chains.



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J-Link and J-Link EDU

USB-powered JTAG emulators designed to communicate at high speed with large number of ARM cores.



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Open OCD

- * Flashing, GDB Remote Debug
- * JTAG, SWD, etc
- * Many hardware interfaces
- * Many target hardwarees



The screenshot shows the Open On-Chip Debugger (OpenOCD) documentation website. At the top, there is a blue header with the text "Open On-Chip Debugger" and "Free and Open On-Chip Debugging, In-System Programming and Boundary-Scan Testing". Below the header is a search bar. The main content area is titled "Documentation" and contains the following text:

The OpenOCD User's Guide is maintained along with the sources in the official git repository ([openocd.texti](#)). During the normal build and install process the Texinfo document is processed and installed in the common location to be viewed [locally](#) with an Info browser of your choice. The README files are usually copied to `/usr/share/doc/openocd-<version>/` directory by a distro package manager.

In case you do not have OpenOCD installed, you can also view the generated documentation from our web-server but pay attention to use a matching version.

Latest release
[README](#), [README.OSX](#), [README.Windows](#)

[HTML](#)
[PDF](#)
[Developer's Guide](#)

Git master branch
[README](#), [README.OSX](#), [README.Windows](#)

[HTML](#)
[PDF](#)
[Developer's Guide](#)

Thesis
The [Open On-Chip Debugger](#) was created as part of a Diploma Thesis

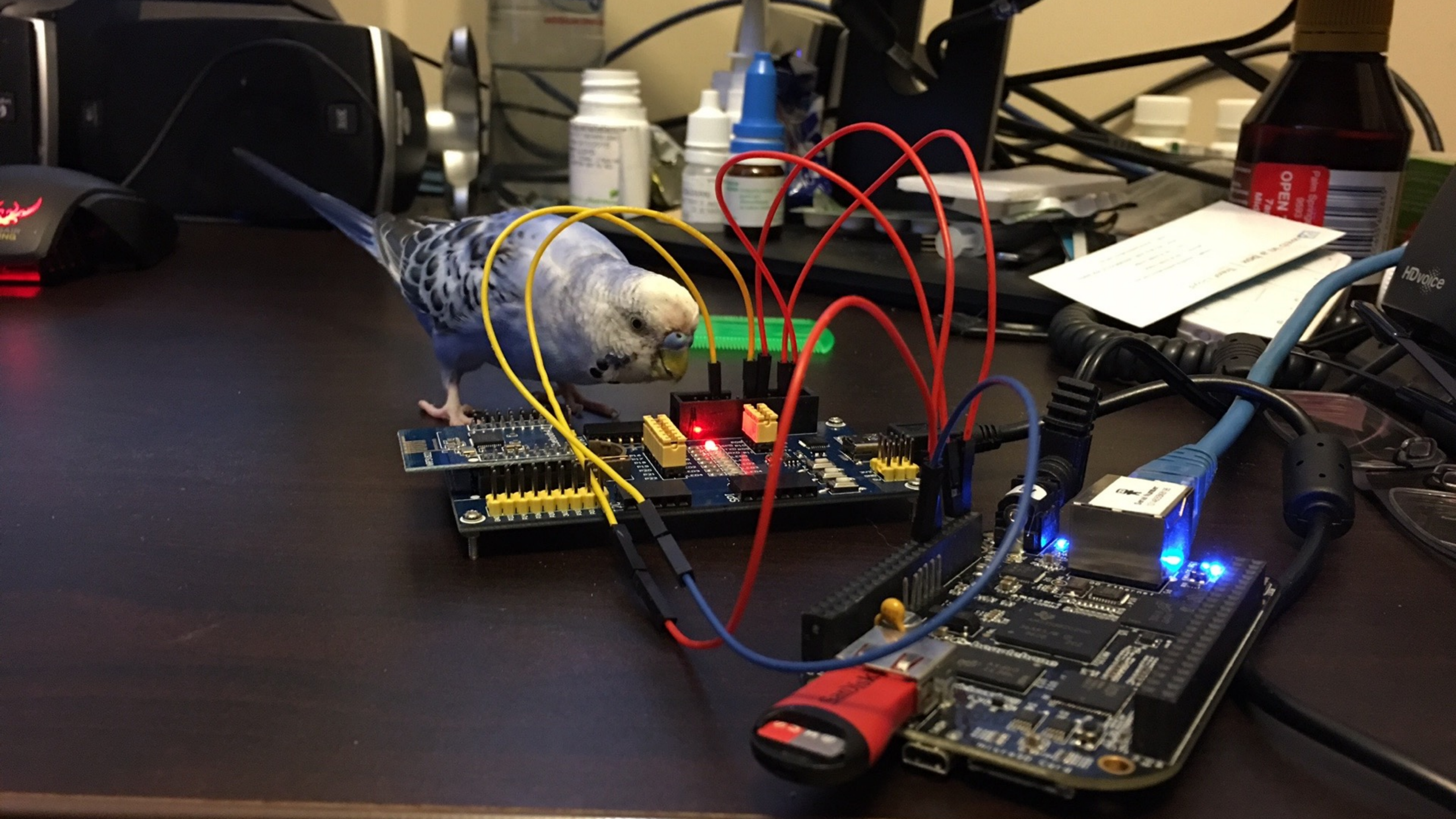
On the right side of the page, there are two sections: "Pages" and "Archives". The "Pages" section lists links to various pages: About, Bug Tracker, Discussion, Mailing Lists, Forum, IRC, Documentation, Donations, Getting OpenOCD, Repository, and Supported JTAG interfaces. The "Archives" section lists a list of months and years from May 2015 down to February 2008.

```
interface sysfsgpio
transport select swd
```

```
sysfsgpio_jtag_nums 69 66 27 67
sysfsgpio_swd_nums 69 66
```

```
sysfsgpio_trst_num 47
sysfsgpio_srst_num 45
```

```
reset_config trst_and_srst srst_push_pull
```

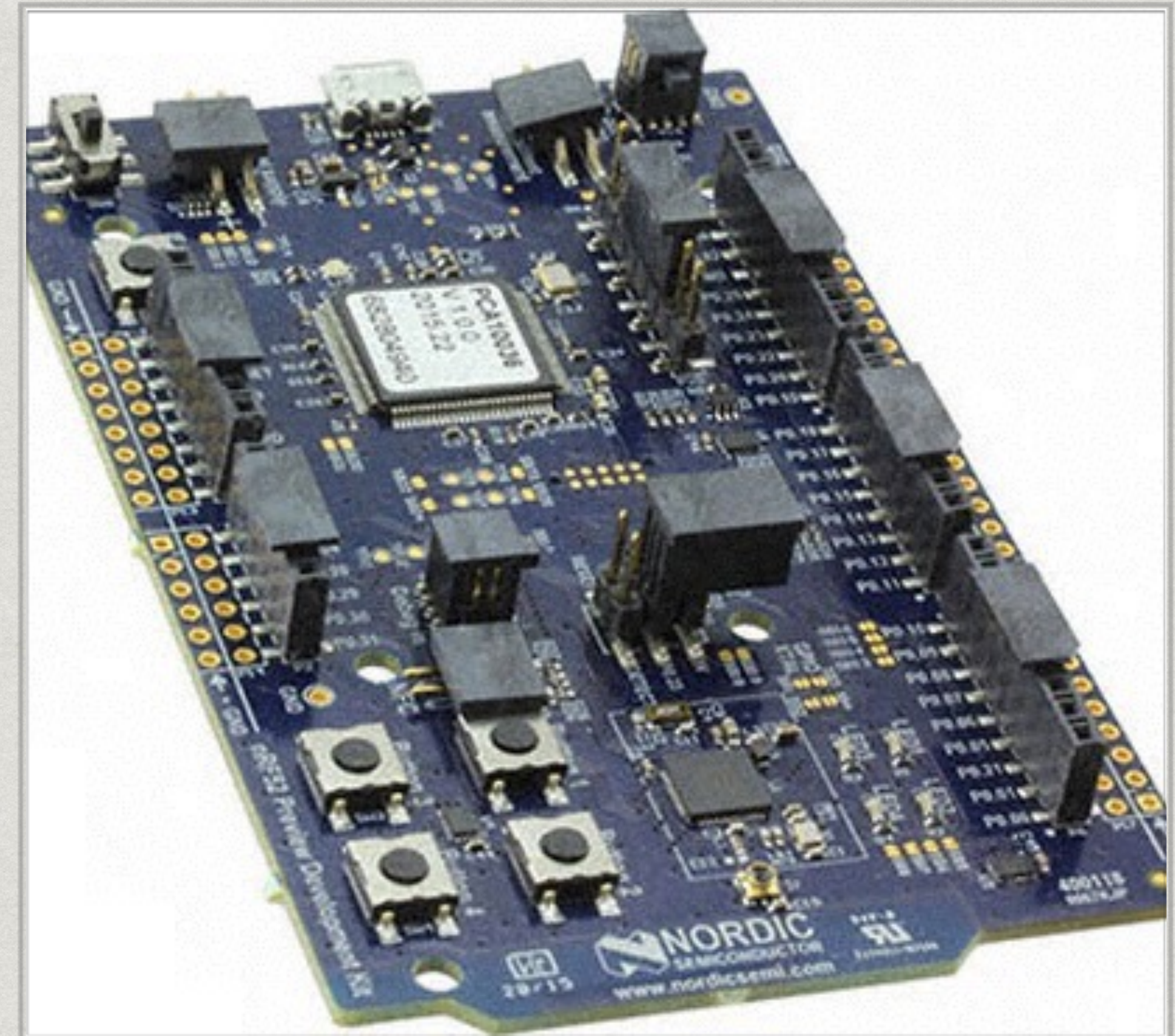


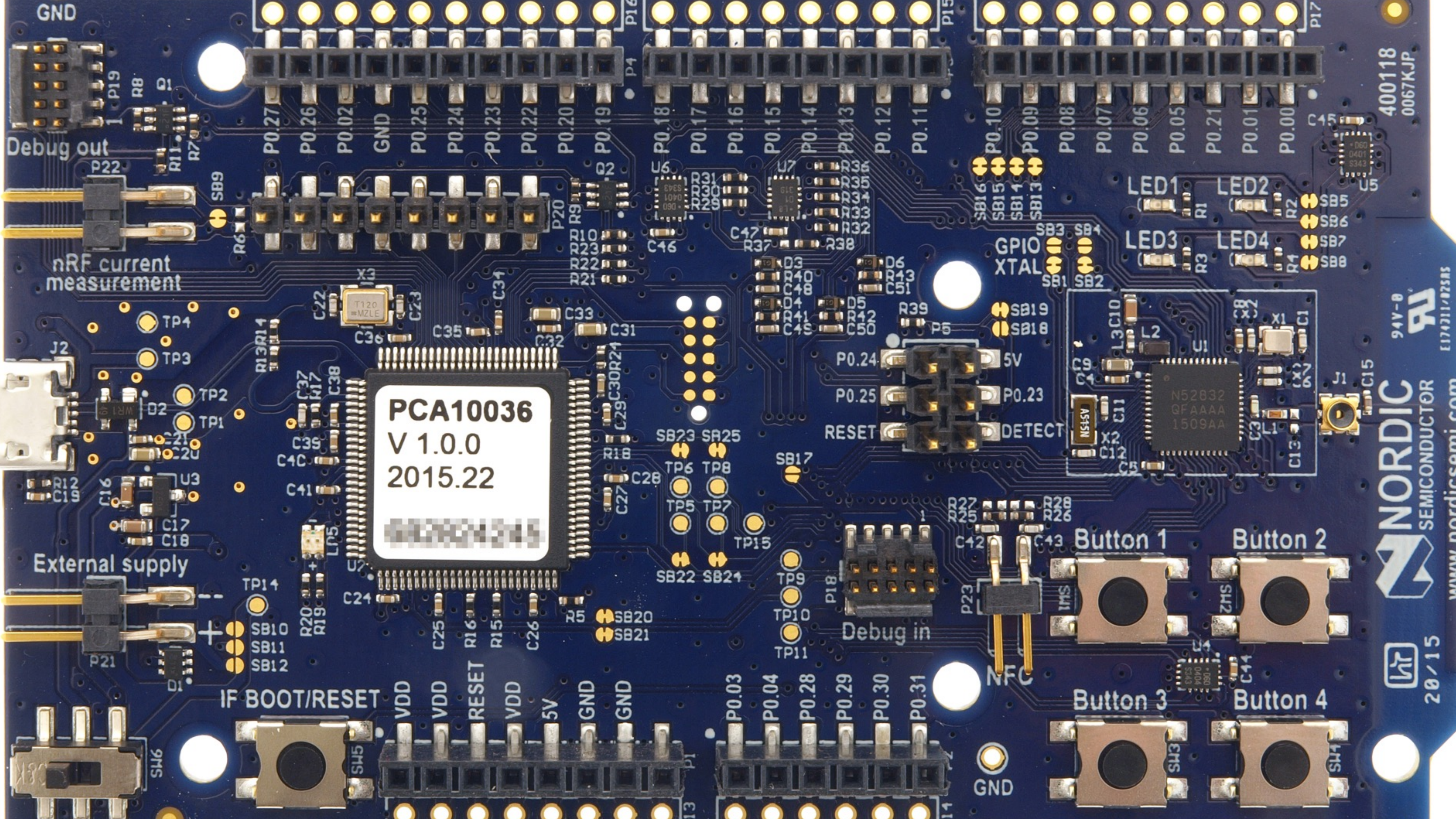
```
$ openocd -f openocd.cfg
Open On-Chip Debugger 0.10.0-dev-00149-g8229d52 (2015-12-22-08:50)
Licensed under GNU GPL v2
For bug reports, read
  http://openocd.org/doc/doxygen/bugs.html
adapter speed: 10000 kHz
cortex_m reset_config sysresetreq

Info : nrf51.cpu: hardware has 6 breakpoints, 4 watchpoints
```

Nordic NRF52

- * Bluetooth Low Energy 4 “Bluetooth Smart”
- * 32-bit ARM Cortex M4F
- * 1.7-3.6V - 1 year+ operation on button cell
- * 512kB Flash, 64kB RAM
- * IPv6 over BLE support - MQTT with TLS
- * CoAP, LWM2M, UDP, TCP, ICMP, DNS, TFTP
- * \$120 Official Development Board - includes J-Link “On Board”
- * Official SDK has gcc Makefile





PCA10036
V 1.0.0
2015.22

U1: N52832
QFAAAA
1509AA

L3: C10
L2
X1
C1
C9
C4
C11
C12
C5
X2
C3
L1

NORDIC
SEMICONDUCTOR

20/15

94V-0
E174711-02585

400118
0067KJP

GND P19 P17 P15 P14 P13 P12 P11 P10 P09 P08 P07 P06 P05 P04 P03 P02 P01 P00

Debug out P22 P20 P19 P18 P17 P16 P15 P14 P13 P12 P11 P10 P09 P08 P07 P06 P05 P04 P03 P02 P01 P00

nRF current measurement TP4 TP3 TP2 TP1 SB9 SB8 SB7 SB6 SB5 SB4 SB3 SB2 SB1 SB19 SB18

External supply J2 TP4 TP3 TP2 TP1 SB23 SB25 SB17 SB22 SB24 TP6 TP8 TP5 TP7 TP15 TP9 TP10 TP11

IF BOOT/RESET VDD VDD RESET VDD 5V GND GND P18 P23 P22 P21 P20 P19 P18 P17 P16 P15 P14 P13 P12 P11 P10 P09 P08 P07 P06 P05 P04 P03 P02 P01 P00

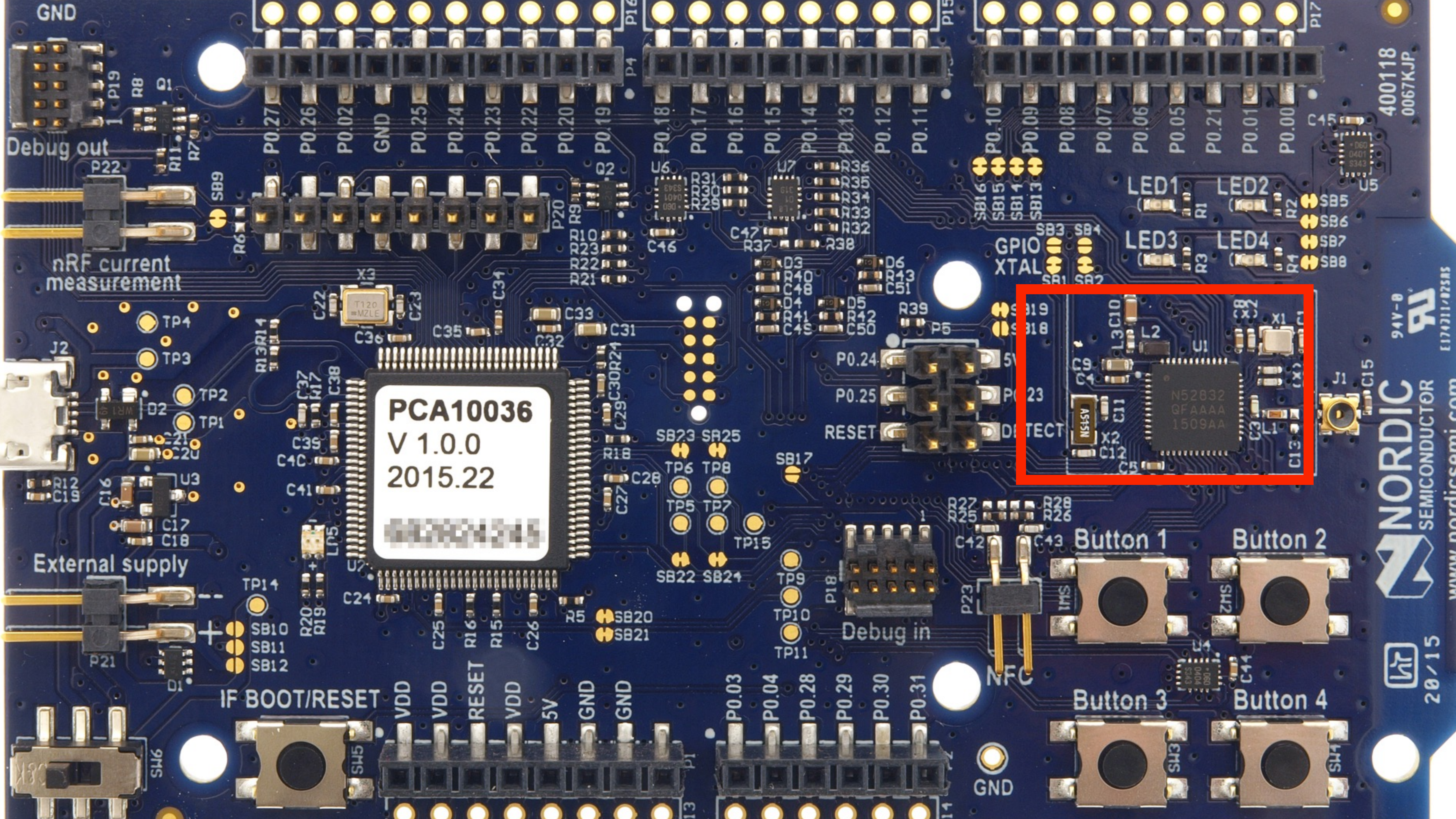
Debug in P18 P23 P22 P21 P20 P19 P18 P17 P16 P15 P14 P13 P12 P11 P10 P09 P08 P07 P06 P05 P04 P03 P02 P01 P00

Button 1 Button 2 Button 3 Button 4

GPIO XTAL SB19 SB18 SB23 SB25 SB17 SB22 SB24 TP6 TP8 TP5 TP7 TP15 TP9 TP10 TP11

LED1 LED2 LED3 LED4 SB5 SB6 SB7 SB8

GND P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29 P30 P31



PCA10036
V 1.0.0
2015.22

Power regulation section components:

- U1: N52832 QFAAAA 1509AA (LDO)
- X2: AS15N (Capacitor)
- L2, L3: Inductors
- C1, C2, C3, C4, C5, C9, C10, C11, C12, C13: Capacitors
- R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100: Resistors
- U2, U3, U4, U5, U6, U7: Other ICs
- X1, X3: Crystals

NORDIC
SEMICONDUCTOR

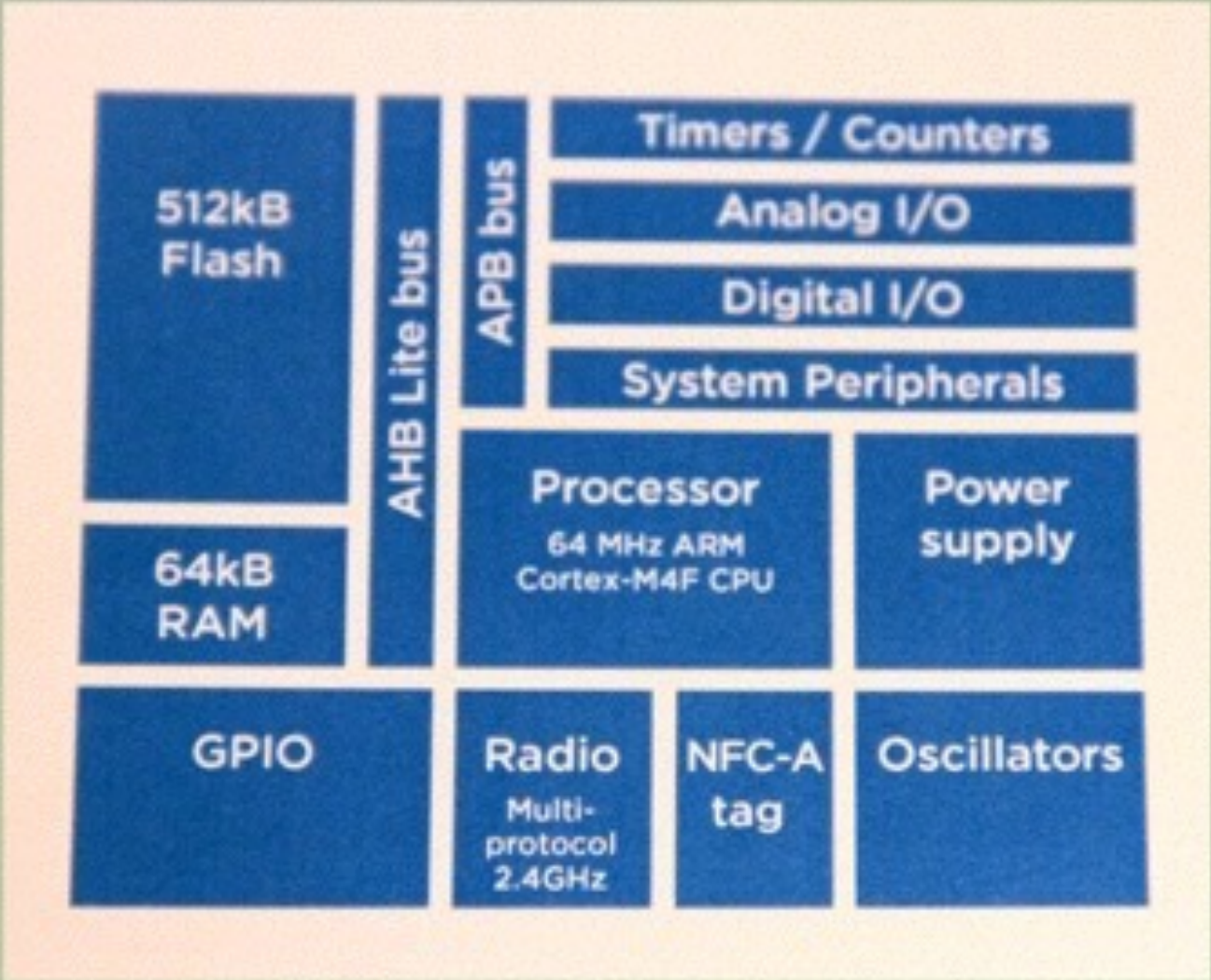
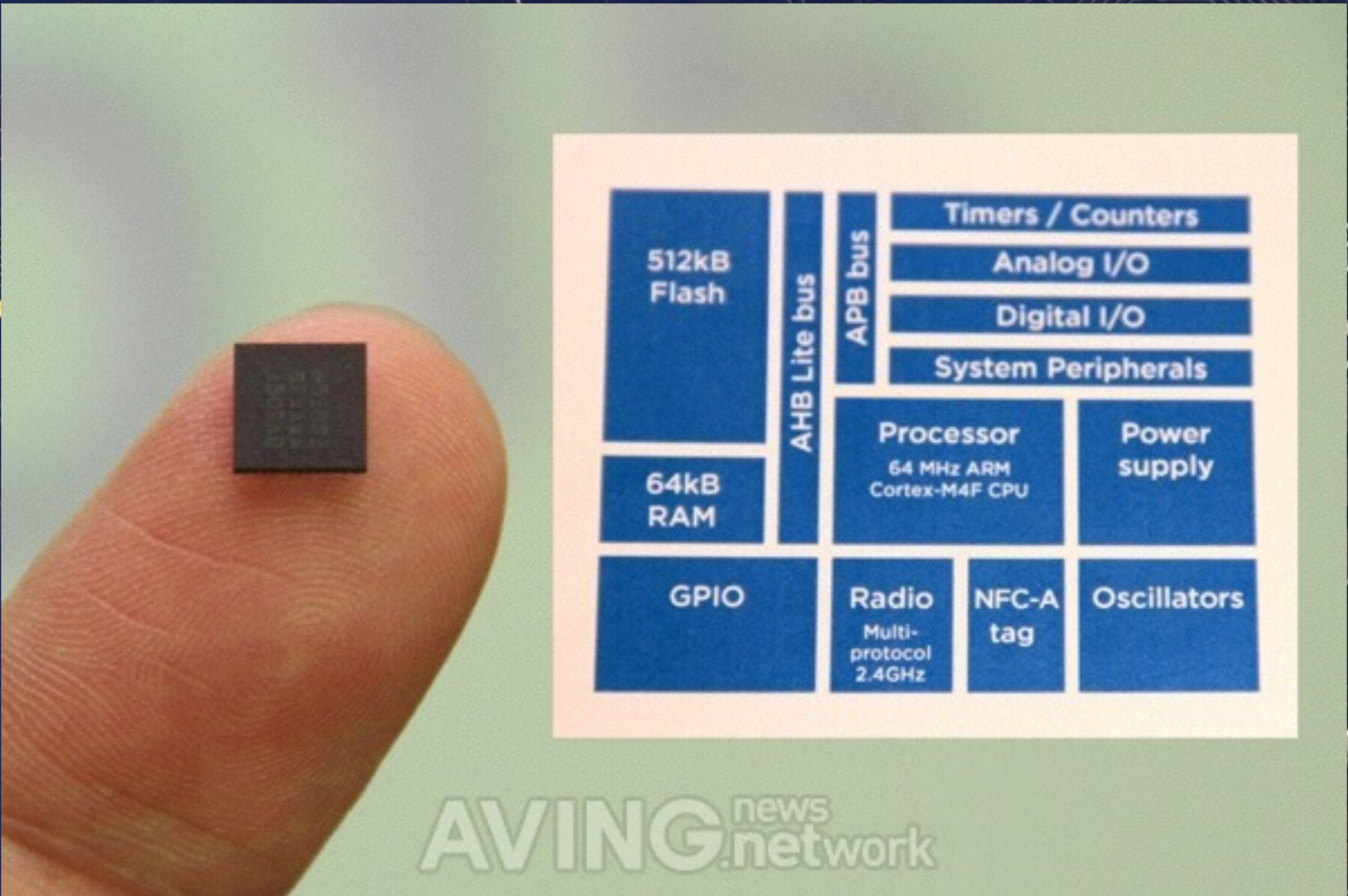
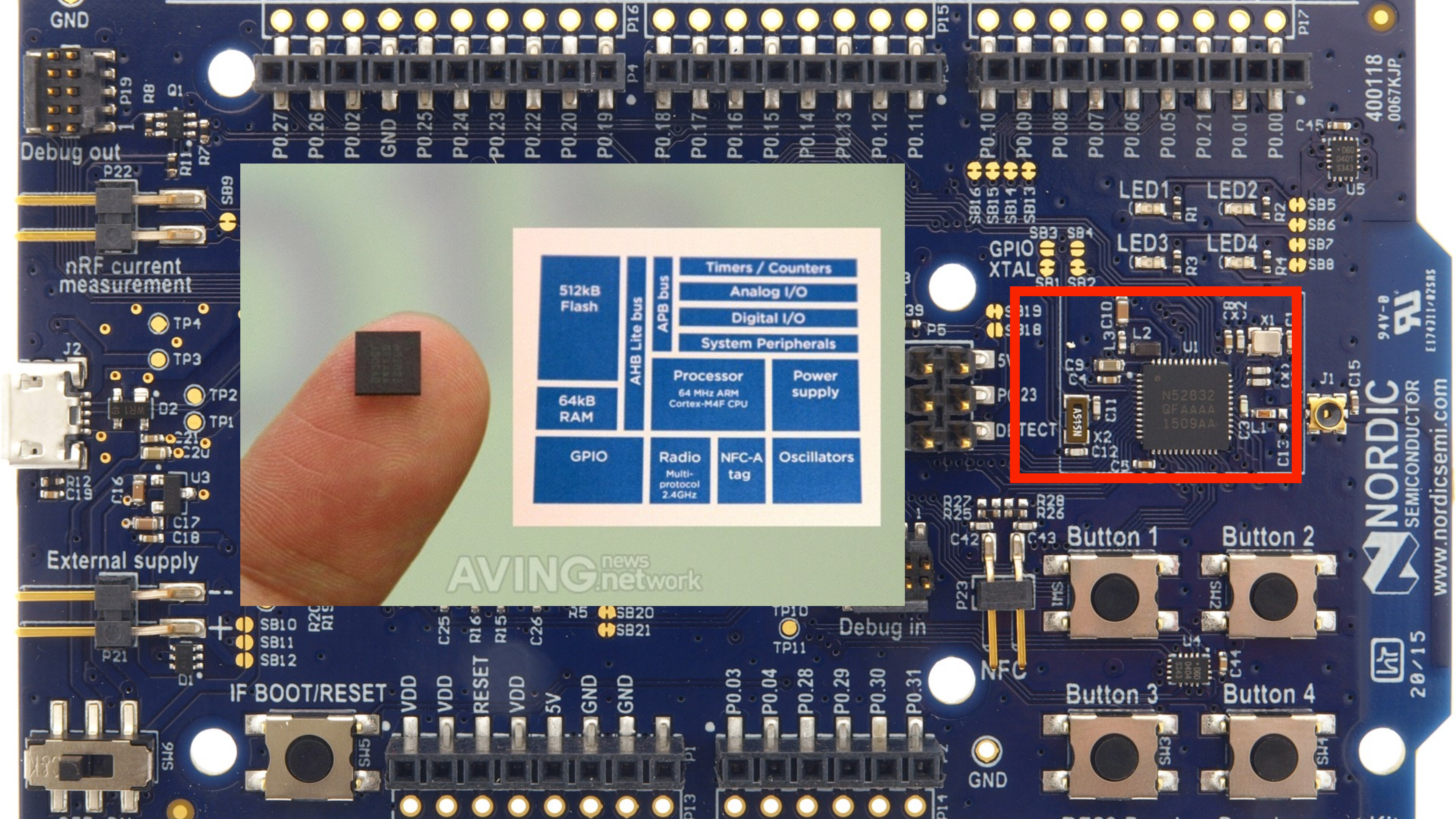
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Labels on the PCB:

- Debug out (P19)
- nRF current measurement (P22)
- External supply (P21)
- IF BOOT/RESET
- VDD
- RESET
- 5V
- GND
- Debug in (P18)
- NFC
- Button 1, Button 2, Button 3, Button 4
- LED1, LED2, LED3, LED4
- GPIO
- XTAL
- RESET
- DETECT
- SW5, SW6, SW3, SW4
- TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP14
- SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11, SB12, SB13, SB14, SB15, SB16, SB17, SB18, SB19, SB20, SB21, SB22, SB23, SB24, SB25
- C1 through C50
- R1 through R100
- U1 through U7
- X1, X2, X3
- L1, L2, L3
- P0.00 through P0.31
- P1.0 through P1.7
- P2.0 through P2.9
- P3.0 through P3.1
- P4.0 through P4.1
- P5.0 through P5.1
- P6.0 through P6.1
- P7.0 through P7.1
- P8.0 through P8.1
- P9.0 through P9.1
- P10.0 through P10.1
- P11.0 through P11.1
- P12.0 through P12.1
- P13.0 through P13.1
- P14.0 through P14.1
- P15.0 through P15.1
- P16.0 through P16.1
- P17.0 through P17.1
- P18.0 through P18.1
- P19.0 through P19.1
- P20.0 through P20.1
- P21.0 through P21.1
- P22.0 through P22.1
- P23.0 through P23.1
- P24.0 through P24.1
- P25.0 through P25.1
- P26.0 through P26.1
- P27.0 through P27.1
- P28.0 through P28.1
- P29.0 through P29.1
- P30.0 through P30.1
- P31.0 through P31.1
- J1, J2
- SW5, SW6
- TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP14
- SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11, SB12, SB13, SB14, SB15, SB16, SB17, SB18, SB19, SB20, SB21, SB22, SB23, SB24, SB25
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- P2.0 through P2.9
- P3.0 through P3.1
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- U1, U2, U3, U4, U5, U6, U7
- X1, X2, X3
- L1, L2, L3



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GND

Debug out

nRF current measurement

External supply

IF BOOT/RESET

Debug in

Button 1

Button 2

Button 3

Button 4

LED1

LED2

LED3

LED4

N52832
QFAAAA
1509AA

AVING news network

```
$ openocd -f openocd.cfg
Open On-Chip Debugger 0.10.0-dev-00149-g8229d52 (2015-12-22-08:50)
Licensed under GNU GPL v2
For bug reports, read
  http://openocd.org/doc/doxygen/bugs.html
adapter speed: 10000 kHz
cortex_m reset_config sysresetreq

Info : nrf52.cpu: hardware has 6 breakpoints, 4 watchpoints
```

```
> telnet localhost 4444
```

```
Trying 127.0.0.1...
```

```
Connected to localhost.
```

```
Escape character is '^]'.  
Open On-Chip Debugger
```

```
> help
```

```
bp
```

```
cpu
```

```
debug_level
```

```
drscan
```

```
dump_image
```

```
exit
```

```
fast
```

```
list or set breakpoint [<address> <length> [hw]]
```

```
<name> - prints out target options and a comment  
on CPU which matches name
```

```
adjust debug level <0-3>
```

```
execute DR scan <device> <num_bits> <value>
```

```
<num_bits1> <value2> ...
```

```
dump_image <file> <address> <size>
```

```
exit telnet session
```

```
fast <enable/disable> - place at beginning of
```

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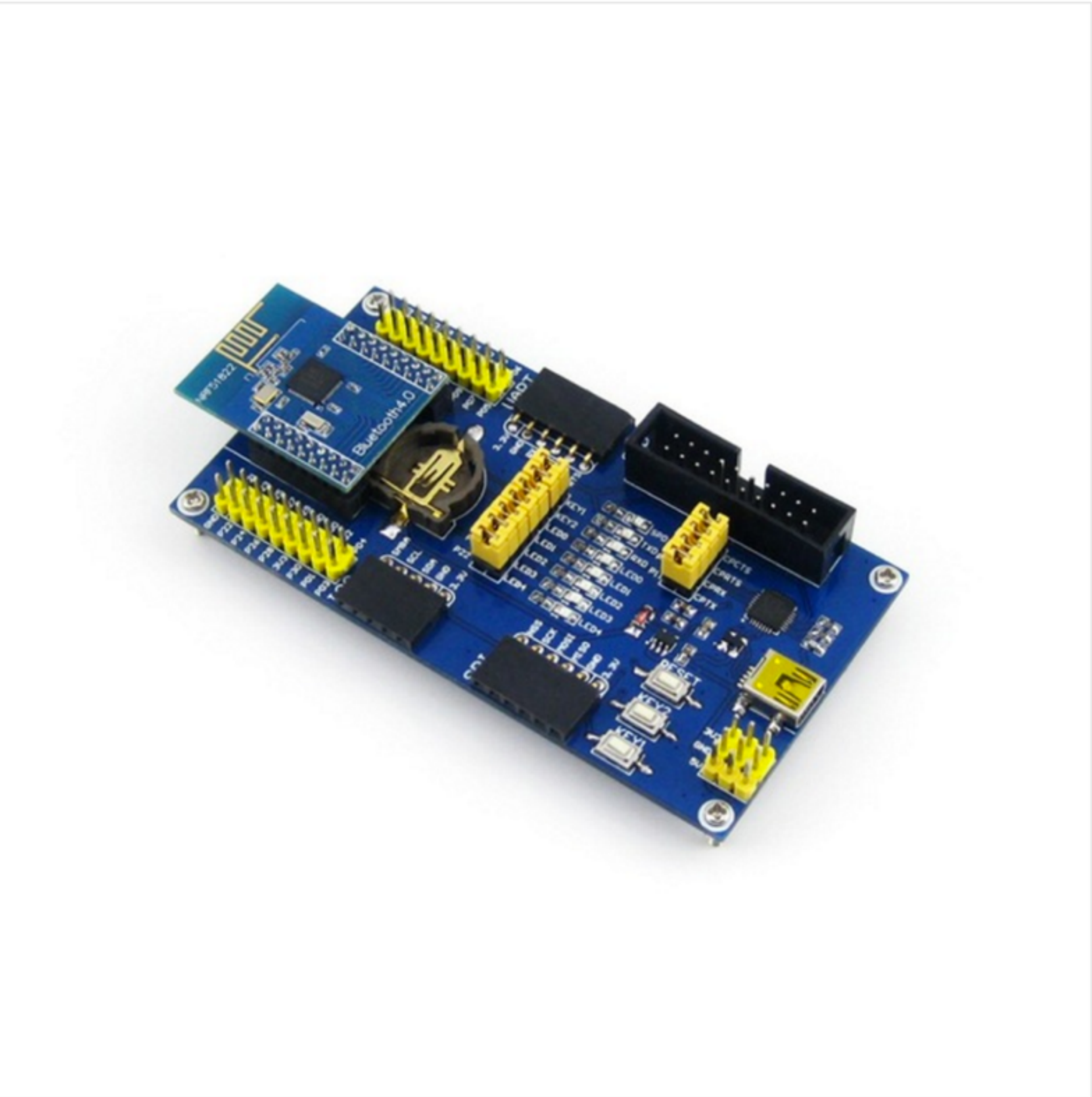
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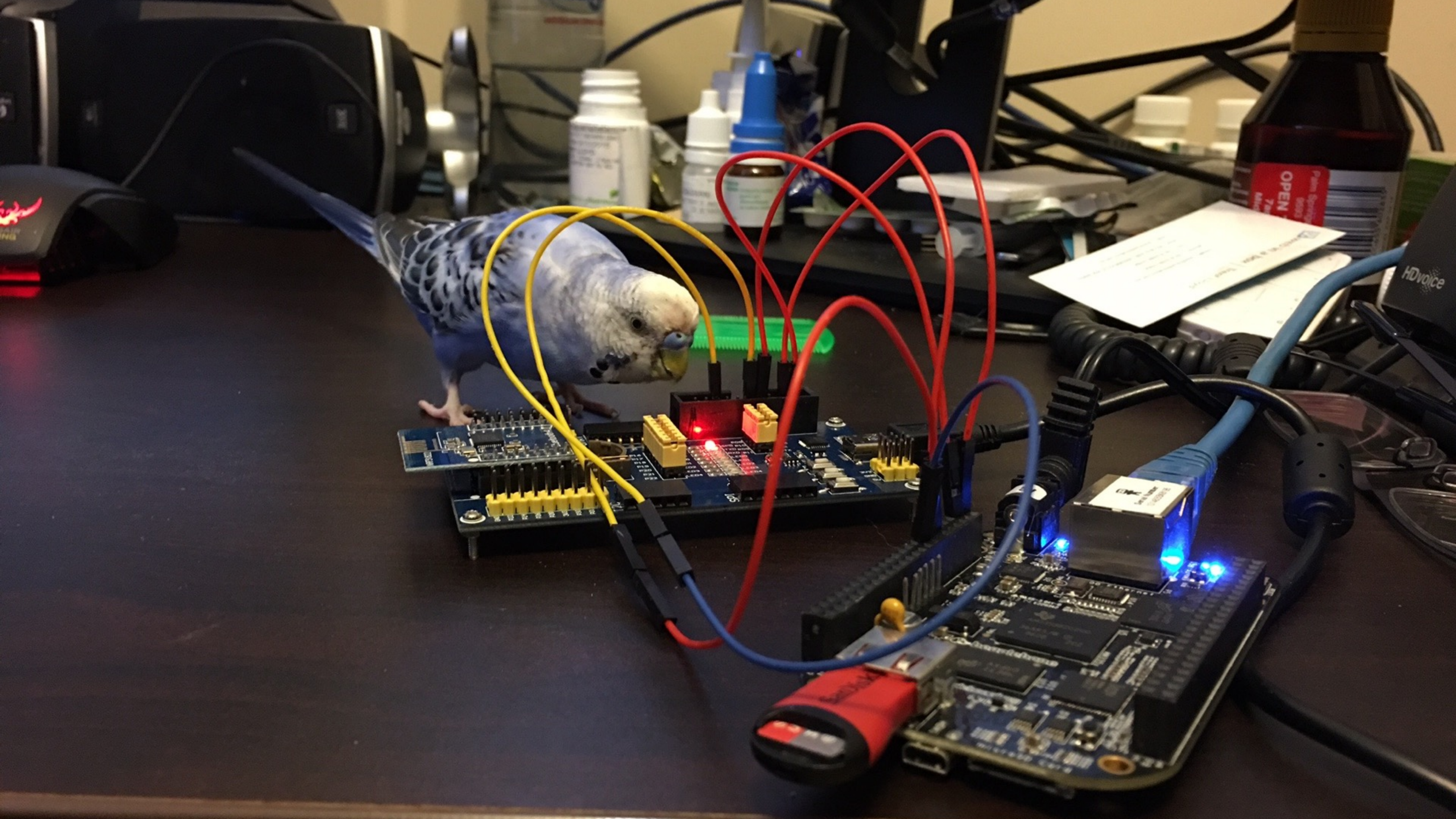
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Starting point and shared code for Nordic nRF5x BLE platforms.

95 commits

3 branches

0 releases

3 contributors

Branch: master

New pull request

New file

Find file

HTTPS

https://github.com/lab11/



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bradjc	create interrupt test app	Latest commit 2e46a37 a day ago
advertisement	add code to change advertisements	15 days ago
apps	create interrupt test app	a day ago
devices	added folders and readmes	7 months ago
lib	Remove mistakenly left macro definition	a day ago
make	create interrupt test app	a day ago
nrf51-pure-gcc-setup @ 3552fc8	update submodule	2 months ago
peripherals	added led	7 months ago
sdk	create interrupt test app	a day ago
services	added folders and readmes	7 months ago
softdevice	S130 softdevice	3 months ago

NRF5X-BASE

[HTTPS://GITHUB.COM/LAB11/NRF5X-BASE](https://github.com/lab11/nrf5x-base)

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emonTx V3

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Hardware

[Technical wiki emonTx V3.2](#)[Technical wiki emonTx V3.4](#)

Firmware

[emonTx GitHub repo](#)

The emontx V3 is the latest generation of the emonTx Low Power Wireless Energy Monitoring Node designed for monitoring AC electrical power on 1 to 4 separate (household/building) circuits using non-invasive clip on CT sensors and an AC-AC Voltage adaptor to provide a voltage signal for Real Power calculations.

Using the ATmega328 microcontroller, the emonTx V3 runs standard Arduino sketches. Customised code is uploaded via the Arduino IDE and a [USB to UART cable](#).

Data from the emonTx V3 is transmitted via a 433/868Mhz radio to an emonBase web-connected base-station (we recommend a [Raspberry Pi with an RFM12Pi](#)) which then posts the data to an emoncms server (e.g. emoncms.org) for logging, processing and graphing.

Features

- Apparent Power, Real Power* and AC RMS voltage readings*
- Microcontroller: ATmega 328 with Arduino Uno bootloader. Compatible with Arduino IDE
- RF Radio: HopeRF RFM69CW 433/868Mhz

Site Map

- Overview
- ▼ Hardware
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 - ▶ emonTx V2
 - emonTx V3
 - emonTx Shield SMT
 - emonTx Shield
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Username: *

Password: *

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- [Request new password](#)

OPEN ENERGY MONITOR

[HTTP://OPENENERGYMONITOR.ORG/](http://openenergymonitor.org/)

NRF5x Resources

- * <https://www.nordicsemi.com/eng>
- * <http://floe.butterbrot.org/matrix/hacking/nrf/>
- * <https://github.com/lab11/nrf5x-base>
- * <http://openocd.org/>
- * <http://openenergymonitor.org/>
- * <http://electronut.in/blebot/>

<http://lathiat.net/talks>

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