Sensor Watch

A hackable ARM Cortex M0+ upgrade for a classic Casio wristwatch

Oddly Specific Objects
Mobile Devices
Microchip

$112,267 raised
of $10,000 goal

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$35 - $39

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Recent Updates

- Announcing the Sensor Watch Pro Campaign Pre-launch — Jul 30, 2024
- Sensor Watch Lite shipping soon — check your shipping details! — Aug 31, 2023
- Opening a New Chapter & Closing the Books on the Original Sensor Watch — Apr 18, 2023
- All Boards Shipping, Lessons Learned, and a Fork in the Road for Sensor Watch — Dec 08, 2022

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You'll be notified about news and stock updates for this project.

Sensor Watch is a bridge between eras. It takes an iconic 30-year-old design from a golden age of digital watches, and pairs it with a modern, powerful microcontroller. This small circuit board, less than an inch in diameter, replaces the original quartz movement in a Casio F-91W or A158W watch to put the capabilities of an ultra-low-power ARM Cortex M0+ microcontroller on your wrist.

Sensor Watch Lite is everything you loved about Sensor Watch, streamlined into one simple board.

Sensor Watch is not like most smart watches. It makes a different set of engineering tradeoffs, to achieve a different set of goals:

- Instead of a high-resolution TFT LCD, Sensor Watch repurposes the monochrome segment LCD on the Casio F-91W and A158W. This gives it an always-on display that consumes mere microamperes of power.
- By avoiding power hungry features like Wi-Fi and Bluetooth, Sensor Watch can run for over a year on a single 100 mAh coin cell, eliminating the need for frequent recharging.
- The lack of an external charging port, coupled with reuse of the famously water resistant F-91W and A158W enclosures, makes this a hackable wristwatch that you can wear while surfing or swimming.

What Can It Do?

The community Sensor Watch firmware (called Movement) comes pre-loaded on every Sensor Watch Lite board, and includes useful features for timekeeping and keeping tabs on the sun and moon:

- The **Clock** face allows Sensor Watch to function like, y'know, *a watch*, displaying the time and date.
- The **World Clock** face allows you add a time display for any number of time zones around the world.
- The **Sunrise/Sunset** face displays the next sunrise and sunset times for your location.
- The **Moon Phase** face displays the current phase of the moon, and lets you play the month forward to see moon phases in the future.
- The **Timer** Face allows you to time events up to 40 days long with one-second resolution.

But this is just the beginning. Several alternate firmware images offer additional features:

- The **Backpacker** firmware adds a digital thermometer and a temperature logger, which lets you track overnight low temperatures outside your tent.
- The **Stargazer** firmware adds an astronomy watch face, capable of calculating right ascension, declination, altitude and azimuth for the sun, the moon and all the planets.
- The **Athlete** firmware adds a countdown timer and exercise counter, as well as an old-school pulsometer complication scaled for 30 beats.

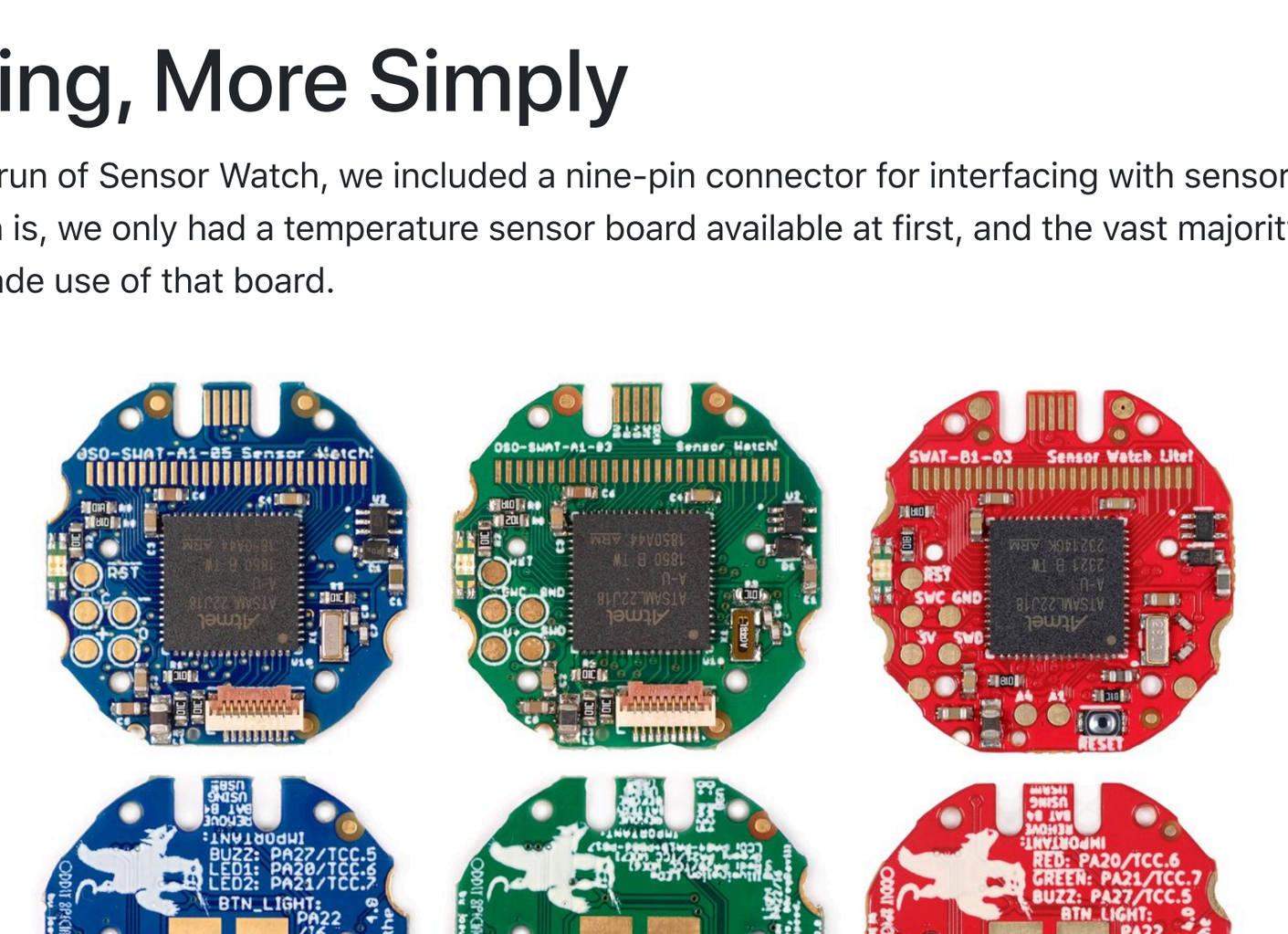
You can also build your own firmware to take advantage of even more watch faces:

- There's a TOTP generator for carrying around two-factor auth codes
- A tachymeter for computing average speed based on distance and travel time
- A beat time clock for showing decimal time according to the Swatch Internet Time system
- There's even a tarot complication, which uses the SAM L22's hardware random number generator to give you a reading on your wrist
- And many more!

More importantly: Sensor Watch is open source and easily hackable, which means you can write the apps that make sense for YOU. Do you want a watch face that can predict satellite passes? A transit face programmed with train arrivals for your nearest subway station? An astrology face that can tell you if Mercury is in retrograde? These are all watch faces that you could write for Sensor Watch.

Sensing, More Simply

For the first run of Sensor Watch, we included a nine-pin connector for interfacing with sensor boards. But the truth is, we only had a temperature sensor board available at first, and the vast majority of folks only ever made use of that board.



For Sensor Watch Lite, we're bringing that temperature sensor onto the Sensor Watch board itself, and dispensing with the complexity of the nine-pin connector. This allows us to hit an affordable price point. The old setup ran you $40: $36 for the main board plus $4 for the temperature sensor, whereas the new board with integrated temperature sensor is just $39!

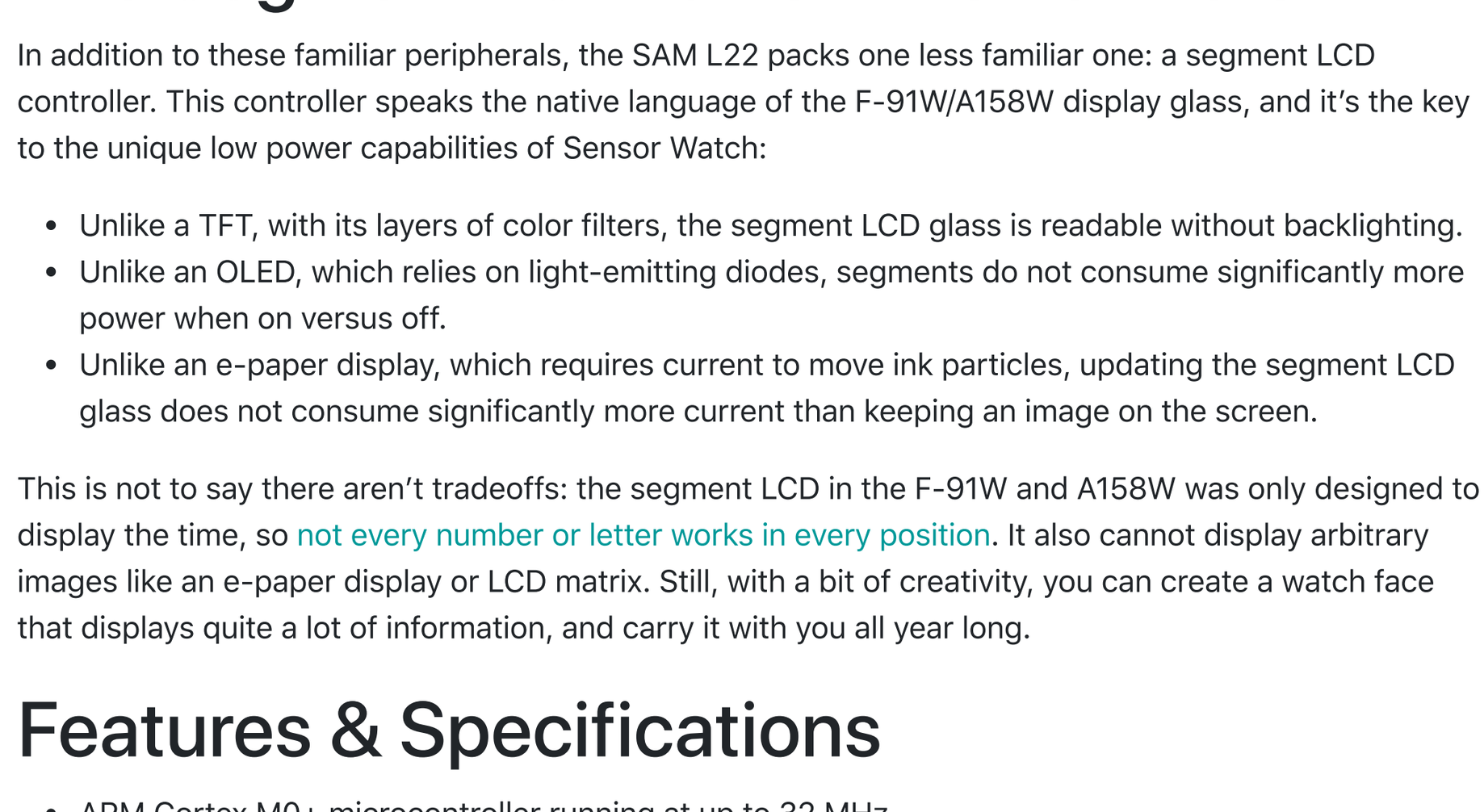
We're also breaking out two test points from the nine-pin connector, pins A1 and A4. You can use these pads as analog inputs, digital IO (with PWM), or a UART for serial commiunications. Pin A4 can even wake from the ultra-low-power BACKUP mode.

The Microchip SAM L22: Big Power in a Small Package

The SAM L22 microcontroller at the heart of Sensor Watch is an ARM Cortex M0+ chip with 256 KB of Flash and 32 KB of RAM, running at up to 32 MHz. It's similar in many ways to the SAM D21 you'd find in a Feather M0 or Arduino Zero, with many of the same versatile peripherals:

- An integrated USB peripheral and UF2 bootloader let you plug the board into your computer and program it by dragging firmware onto it, just like a thumb drive.
- The real-time clock peripheral, paired with a 32.768 KHz crystal, allow for accurate timekeeping and configurable wake-up options.
  - Moreover: its frequency correction function, paired with the onboard temperature sensor, allow us to make this a temperature compensated crystal oscillator, entirely in software!
- The integrated 12-bit ADC, with oversampling to 16 bits of resolution, lets you read the temperature as well as analog values from pads A1 and A4.
- The SERCOM peripheral lets you interface with UART-oriented devices on pads A1 and A4.
- Four timer/counter peripherals allow for versatile use cases like pulse-width modulation, frequency counting and configurable periodic callbacks. This is in addition to the TCC peripheral that drives the red/green backlight and piezo buzzer [1].

[1] *The piezo buzzer is the only piece that requires soldering. You will need to remove a metal piece from your donor F-91W or A158W and solder it to the Sensor Watch board. If you don't feel comfortable doing this, all other features of Sensor Watch will function identically; the watch just won't beep.*



The Segment LCD: a Low-Power Hero

In addition to these familiar peripherals, the SAM L22 packs one less familiar one: a segment LCD controller. This controller speaks the native language of the F-91W/A158W display glass, and it's the key to the unique low power capabilities of Sensor Watch:

- Unlike a TFT, with its layers of color filters, the segment LCD glass is readable without backlighting.
- Unlike an OLED, which relies on light-emitting diodes, segments do not consume significantly more power when on versus off.
- Unlike an e-paper display, which requires current to move ink particles, updating the segment LCD glass does not consume significantly more current than keeping an image on the screen.

This is not to say there aren't tradeoffs: the segment LCD in the F-91W and A158W was only designed to display the time, so not every number or letter works in every position. It also cannot display arbitrary images like an e-paper display or LCD matrix. Still, with a bit of creativity, you can create a watch face that displays quite a lot of information, and carry it with you all year long.

Features & Specifications

- ARM Cortex M0+ microcontroller running at up to 32 MHz
- 256 KB of on-chip Flash, with up to 8 KB EEPROM emulation area
- 32 KB of RAM with full retention in low-power standby mode
- 32.768 kHz crystal for real-time clock functionality with alarm support
- Red & green PWM'able LED backlight
- Temperature sensor
- On-board USB Micro B connector
- Reset button with double-tap UF2 bootloader
- Controller for ten digit segment LCD, plus five indicator segments
- Edge-plated contacts for three interrupt-capable buttons
- Connection pad for piezo buzzer (requires light soldering)
- Open Source

The A1 and A4 test points offer some additional functionality:

- Two interrupt-capable digital inputs, with internal pull-up or pull-down resistors
- Two digital outputs with PWM capabilities
- Two analog inputs
- One UART TX/RX pair
- One external wake input that can wake from the ultra-low-power BACKUP mode

Comparisons

	Sensor Watch	Watchy	PineTime	BangleJS
Manufacturer	Oddly Specific Objects	SQFMI	Pine64	Espruino
Sensors	12-bit ADC and exposed I²C pins, for more on 9-pin connector	Accelerometer	Accelerometer + Heart Rate	Accelerometer + Magnetometer + Heart Rate + GPS
Programming Interface	Built-in USB	Built-in USB	External pogo pins	Bluetooth
Watch Size (in case)	34.5 mm × 37.5 mm	44 × 49 mm	37.5 × 40 mm	50 × 50 mm
Thickness (in case)	8.5 mm	15 mm	11 mm	17 mm
Battery Life	1 Year (estimated)	2-7 days	1 Week	1 Week
Design Files Available	Yes	Yes	Schematic Only	No
Display	Low-power 72-segment LCD	1.54" 200x200 E-Ink	1.3" 240x240 LCD	1.3" 240x240 LCD
Buttons	3	4	1	3
Water Resistance	30 meters	No	1 meter	10 meters
Connectivity	Minimal	Wi-Fi + Bluetooth	Bluetooth	Bluetooth
Price	~$58 [2]	$59	$27	$95

[2] *$39 Sensor Watch Lite board + the cost of an F-91W*

Support & Documentation

- Sensor Watch GitHub Repository
- Sensor Watch Documentation
- Low-Level Watch Library Documentation
- Watch Interface Guidelines
- Sensor Watch Discord
- README for Movement, the community Sensor Watch firmware

And please feel free to reach out using using the *Ask a technical question* link below!

In the Press

boingboing

Boing Boing

"Casio's famed F-91W watch, beloved of terrorists, is the frequent subject of ingenious modifications, including a full smartwatch conversion. Now you can purchase a kit board you can swap in yourself to give the zillion-selling timepiece superpowers."

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Ask a Question

Ask Crowd Supply about an order | Ask Oddly Specific Objects a technical question | Submit a field report about how you used this project

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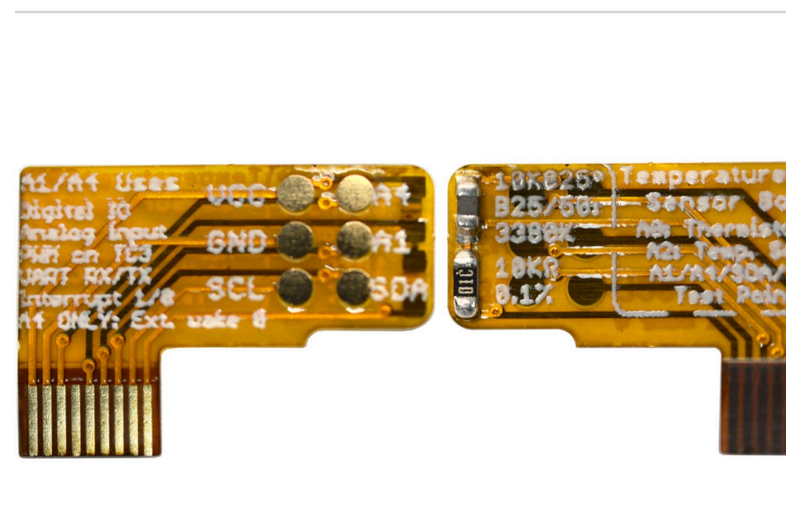
Sold and shipped by Crowd Supply.



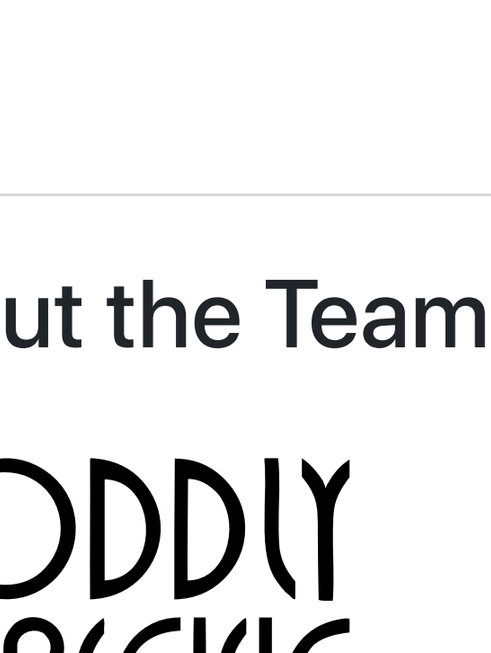
Sensor Watch Lite

A Cortex M0+ board swap for the Casio F-91W wristwatch with a built-in temperature sensor

$39 $8 US Shipping / $18 Worldwide

In stock

Add to Cart



Sensor Watch

One circuit board to swap into a Casio F-91W or A158W wristwatch.

$35 $8 US Shipping / $18 Worldwide

No longer available

No Longer Available

Temperature + GPIO Sensor Board for the Original Sensor Watch

A sensor board—for the original Sensor Watch—with a thermistor temperature sensor and six test points that break out the I²C bus, two GPIO pins, 3 V power, and ground.

$4 $8 US Shipping / $18 Worldwide

No longer available

No Longer Available

About the Team

ODDLY SPECIFIC OBJECTS

Oddly Specific Objects

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We create comprehensible open source designs that democratize the knowledge required to create useful technology. Read: we make stuff, then we tell you how we did it so that you can do it too.

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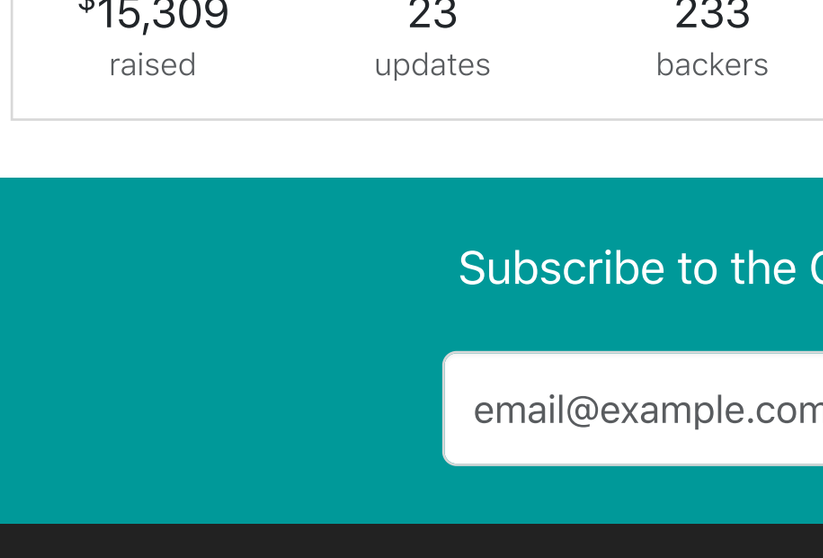
See Also

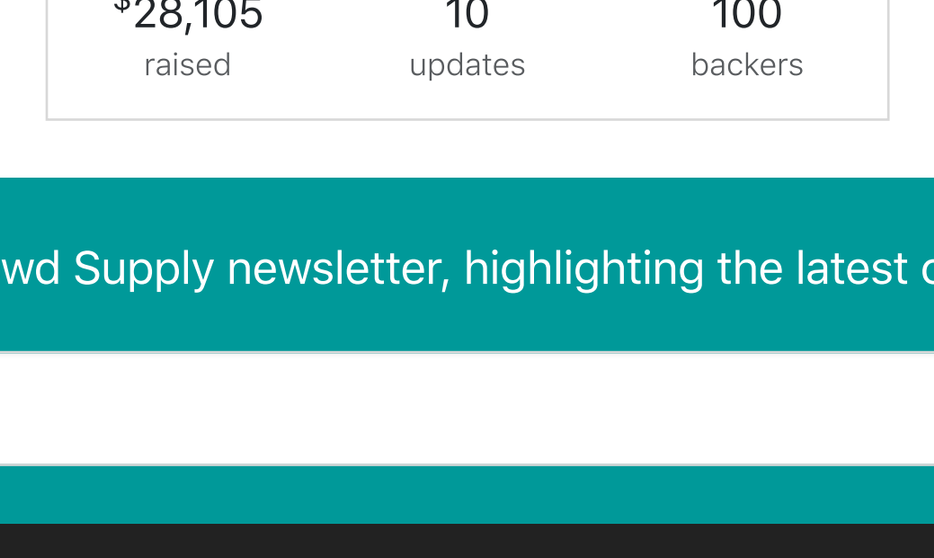


ANAVI Macro Pad 8

Open source, programmable, eight-key keypad with backlighting, underlighting, and OLED screen

Funded! In Stock

$15,309 raised | 23 updates | 233 backers

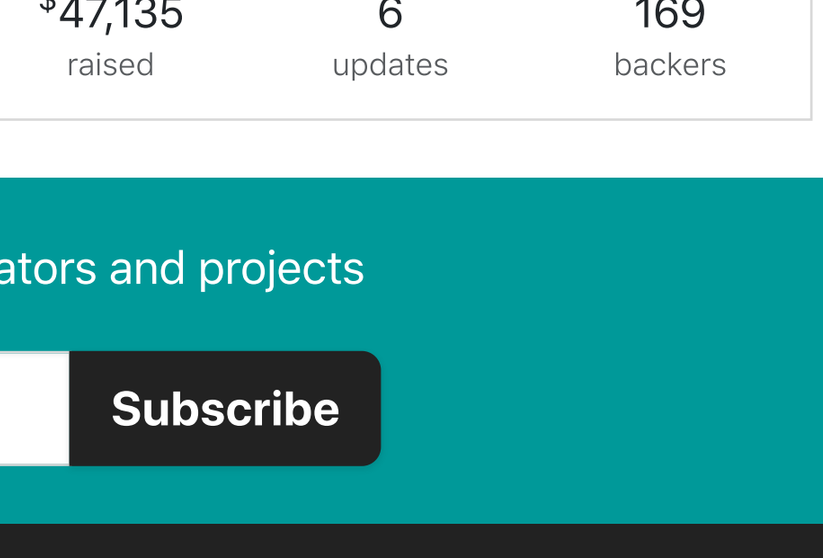


Haxophone

A hackable electronic saxophone with mechanical keys

187% Funded! In Stock

$28,105 raised | 10 updates | 100 backers



PhyWhisper-USB

A hardware-based USB 2.0 monitor & trigger platform, controlled from Python

Funded! In Stock

$47,135 raised | 6 updates | 169 backers

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