The Moodlight Tee:
Making Social Energy Visible

Katelyn Guo

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To create expressive wearable technology that makes an invisible feeling visible, helping people communicate their social energy and personal boundaries without having to say a word.

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- Suit That Gives You Confidence

Where connection becomes enchantment and technology supports self-regulation.

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- Social Battery Shirt
- Circadian Glasses


The Moodlight Tee
Deep Breath ©Melanie Weidner 2005 www.ListenForJoy.com

The Moodlight Tee







The **Moodlight Tee** is an interactive wearable tee that makes social energy visible. Breathing and sound sensors estimate changes in the wearer's social activity, which are communicated through an LED battery display on the front of the shirt. As the wearer becomes more socially drained, the battery loses bars and changes from green to yellow to red. The design offers a clear but playful way to communicate social energy and personal boundaries without having to say them out loud.

Why?

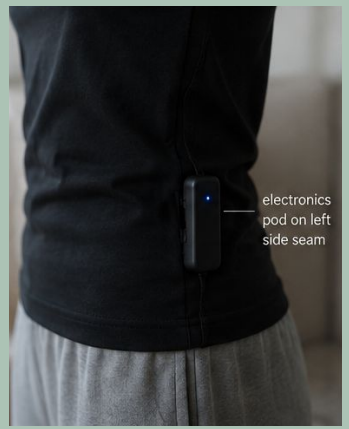
Social energy is often difficult to communicate, especially when someone feels overwhelmed or needs space. The Moodlight Tee makes this invisible feeling visible, creating a simple and playful way for people to express their social capacity and personal boundaries without having to explain them out loud.



How?

The Moodlight Tee combines breathing and sound sensors to estimate changes in the wearer's social activity. This information is processed by a small electronics pod and communicated through an LED battery display on the chest. As the wearer's social energy decreases, the display loses bars and shifts from green to yellow to red.







Ergonomics Study – Sensor Placement

1. Reachability

The electronics pod is placed along the left side seam at waist height, keeping it within comfortable reach while following the natural construction of the shirt. This location allows the wearer to access the pod without placing it in a visually or physically distracting area.

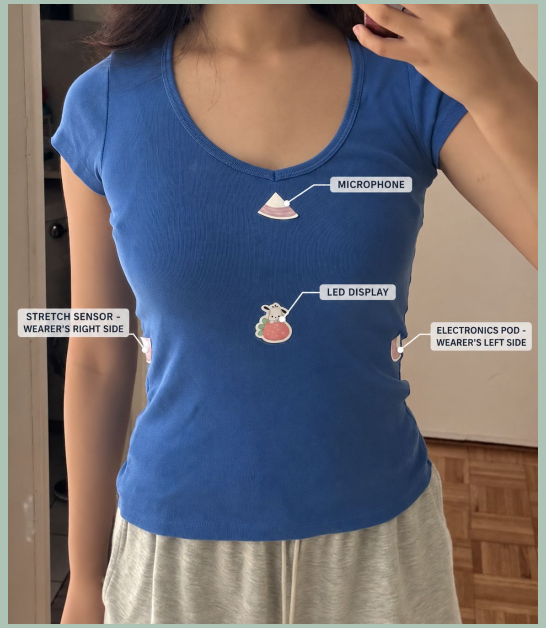
2. Visibility

The sensors, wiring, and electronics pod are positioned along seams or concealed within fabric pockets. Keeping these components hidden allows the Moodlight Tee to maintain the appearance and comfort of an ordinary T-shirt, while the LED battery remains the only intentionally visible part of the system.

3. Body Comfort

The stretch sensor is integrated into the right side seam, allowing it to expand with the wearer's breathing without placing a rigid component directly against the ribs. The microphone sits near the collar inside a small fabric pocket, where it remains close to the mouth without creating a noticeable pressure point.

Further testing is needed to determine whether the stretch sensor performs consistently across different body types, shirt sizes, and breathing patterns.



The stickers represent the placement of the main components.

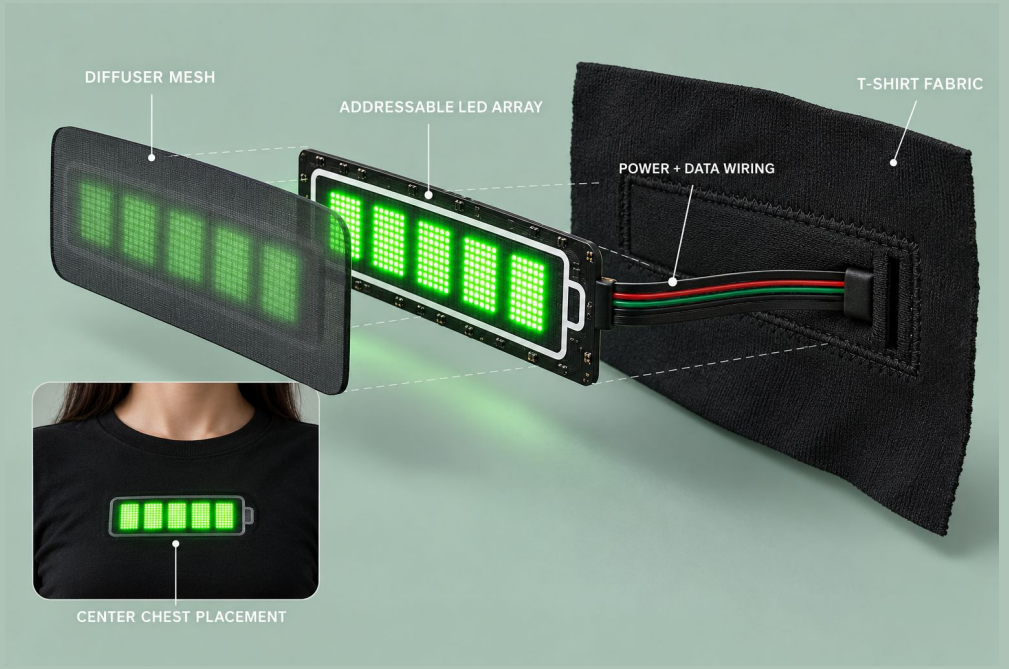
Ergonomics Study – LED Placement

1. **View Angle**

The LED battery is positioned at the center of the chest, making it easy for others to see and understand during social interactions. Although the wearer cannot view the full display from a natural head position, they can quickly check it by looking down.

2. **Discreet**

Because the display communicates personal information in public, it should not feel overly bright or distracting. Adjustable brightness and an on/off setting would allow the wearer to control when their social battery is visible while preserving the shirt's everyday appearance.



Ergonomics Study – Haptic Placement

1. **Sensitivity**

The haptic motor is positioned at the center of the upper back, where the fitted fabric helps maintain consistent contact with the body and improves vibration transmission. This location also keeps the motor away from the ribs and other areas where a rigid component may create discomfort.

Because vibration sensitivity varies between users, the motor's intensity and placement would need to be tested across different body types, shirt fits, and activity levels. The final system should provide noticeable feedback without feeling startling, distracting, or uncomfortable.



Location of the haptic motor

Sensor Configuration

Breathing rate via stretch sensor in the side seam
A resistive stretch sensor or conductive rubber cord sewn into the side seam of the shirt can detect chest/torso expansion from breathing. This actually works well in a t-shirt specifically because the side seam tracks the body closely. Breathing rate and depth are legitimate social stress signals — shallower faster breathing under load, slower deeper breathing at rest.

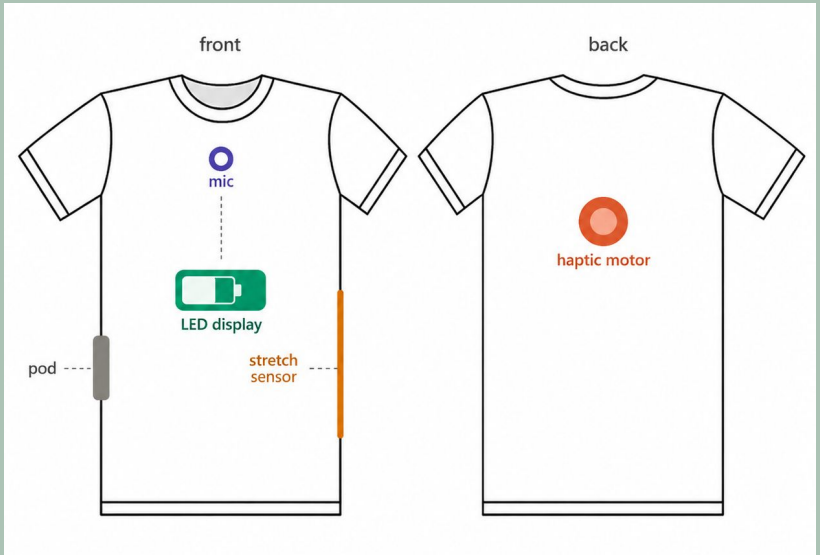
Mic — upper chest, center, below collarbone

Stretch sensor — side seam, lower chest height

Haptic motor — upper back, center, between shoulder blades

LED display — center chest

Electronics pod — left side seam, waist height



Fabric Selections



https://www.amazon.com/EOVEA-Spandex-Stretch-Stretchy-T-Shirt/dp/B0CYWPCLMG/ref=?th=1

Content - 95% Cotton and 5% Spandex
210 GSM
$13.90 / YARD

See product video review for visual of the stretch. This fabric was chosen due to it's breathability, durability, and soft feel while also being heavyweight enough to withstand a small amount of weight of the hardware.

Hardware Components

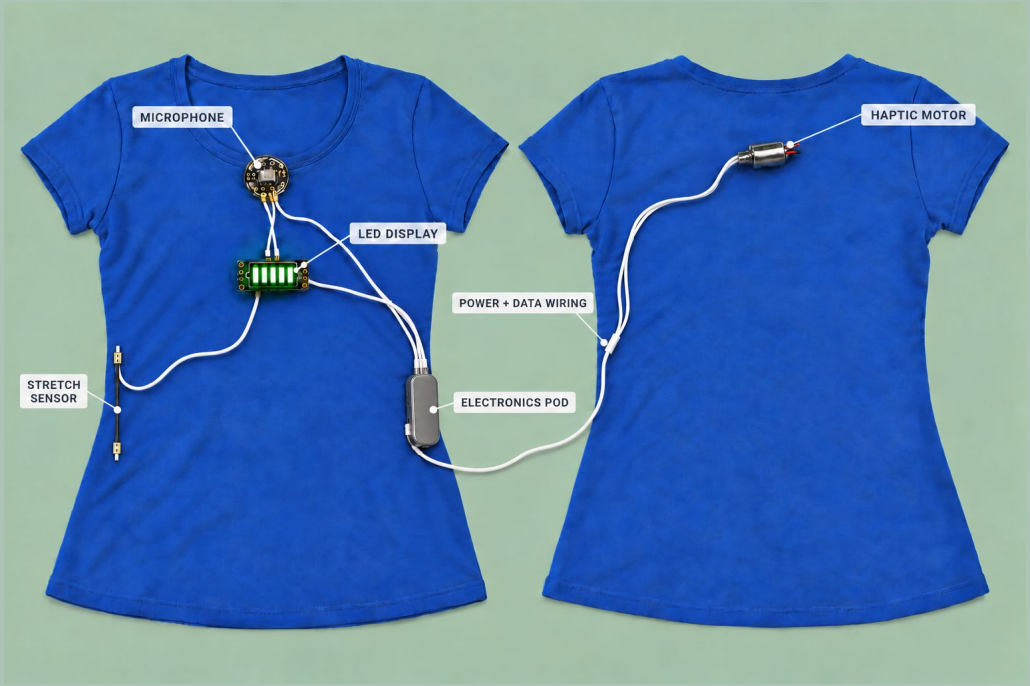


Figure showing components placement on tee

Mic

Mic — INMP441 (upper chest, near collar)

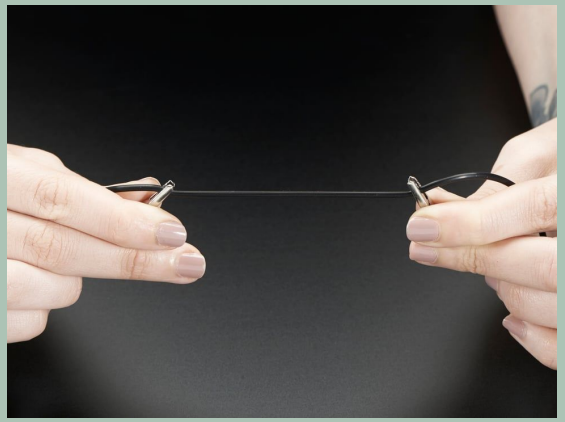


Weight: ~0.5–1g for the bare module
(tiny PCB, roughly 4mm x 5mm sensor + small breakout board)

Fabrication:

- Comes on a small breakout PCB (~10mm x 10mm from common breakout boards like Adafruit's or generic I2S ones)
- Mount inside a small fabric pocket sewn behind the outer shirt layer, with a pinhole (2-3mm) punched or laser-cut through the fabric for sound to pass through
- Secure the PCB with a dab of fabric glue or a small stitched pocket so it doesn't shift
- Wire it with 4 conductor silicone-coated wire (VDD, GND, SCK, WS, SD — actually 5 wires for I2S) routed down the inside of the shirt to the electronics pod
- If going for washability, apply a thin conformal coating spray to the PCB (avoid coating the mic port itself)

Stretch Sensor



Stretch sensor — conductive rubber cord (right side seam)

Weight: Very light — a rubber cord stretch sensor of ~15–20 cm length weighs only a few grams (2-5g depending on gauge)

Fabrication:

- Adafruit-style conductive rubber cord sensors come with stripped/tinned ends for soldering or crimping
- Sew directly into the side seam using a fabric channel — essentially a narrow casing (like elastic waistband construction) that holds the cord against the body without it slipping
- Install with slight pretension (stretch it slightly before securing both ends) so it has range to compress and expand with breathing rather than sitting fully slack
- Seal the wire-to-cord junction with heat shrink tubing plus a dab of silicone sealant, since this is the weak point for both mechanical fatigue and water exposure
- Wire runs along the same side seam channel down to the pod

Haptic Motor

Haptic motor — LRA (upper back, between shoulder blades)



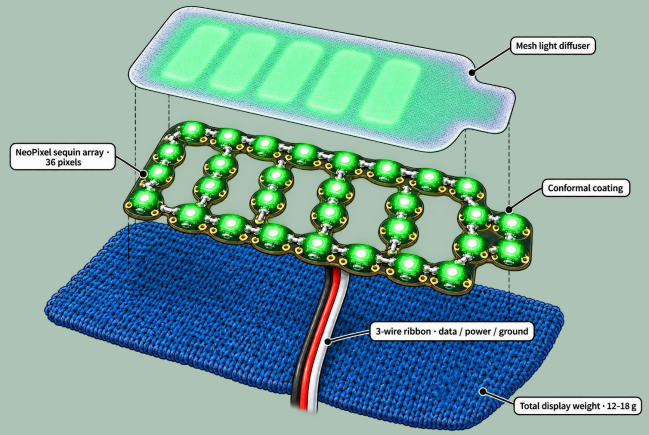
Weight: Small LRAs are typically 1–3g (e.g., common 8mm or 10mm coin-style LRAs used in haptic wearables)

Fabrication:

- Mount the LRA in a small fabric or thin silicone housing sewn to the inside of the back panel — a little pocket that holds it flush against the skin without letting it shift
- If you want it wash-safe, pot the motor in a thin layer of silicone sealant (like Sugru or a 2-part silicone) before sewing it in, leaving just the two wire leads exposed
- The housing should be soft enough not to create a hard pressure point during wear — a thin foam or silicone gasket around the rigid motor body helps
- Wire it with 2-conductor silicone wire back to the DRV2605L driver in the pod

LED Display

LED display — NeoPixel Sequins/strip (center chest)



Weight: Individual NeoPixel sequins are ~0.3g each;
a battery-icon shaped array of ~30-40 pixels totals roughly 9-12g including the small interconnecting wire

Fabrication:

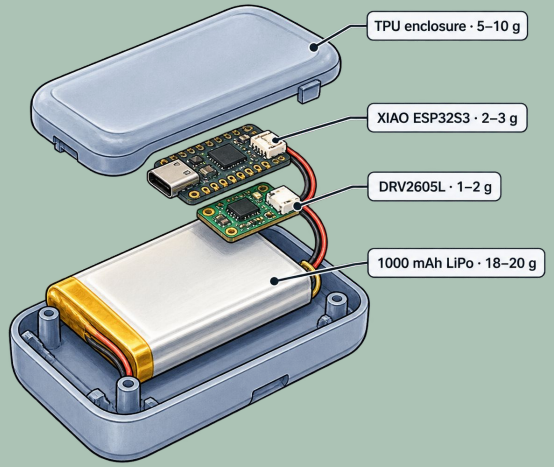
- Adafruit NeoPixel Sequins are designed to be sewn — they have conductive pads meant for stitching with conductive thread or soldering to flexible wire
- Arrange them in the battery icon shape (outline + fill segments) directly on the outer or inner layer of the chest panel, either sewn on top (visible, more fashion-forward) or behind a translucent fabric/mesh panel so the shape glows through without the components themselves being visible
- If sewn on top, use a swatch of sheer or mesh fabric as a light diffuser laminated or stitched over the LEDs for a softer glow rather than pinpoint dots
- Conformal coat each sequin lightly to protect solder points from sweat/moisture
- Data, power, and ground lines run down as a small ribbon of 3 wires to the pod

Electronics Pod

Electronics pod — left side seam, waist height

Weight: This is the heaviest single assembly — roughly 25–40g total:

- XIAO ESP32S3: ~2-3g bare board
- DRV2605L breakout: ~1-2g
- 1000mAh LiPo: ~18-20g (this is most of the weight)
- Small enclosure (TPU printed or small project box): ~5-10g



Fabrication:

- 3D print a custom enclosure in TPU (flexible) or PETG (rigid) sized to snugly hold the ESP32, driver board, and battery stacked or side-by-side
- Include an internal USB-C cutout aligned with the XIAO's port so you can charge without opening the enclosure
- Attach the enclosure to the shirt via 4 conductive snaps (2 for power, 2 for a shared signal/ground bus, or more if each sensor needs its own line) sewn into a reinforced fabric patch at the side seam
- The reinforced patch should use a stiffer interfacing fabric (like a fusible interfacing layer) behind the snaps so repeated snapping doesn't stretch out the shirt fabric over time
- Total pod dimensions realistically land around 5cm x 3cm x 1.5cm depending on battery choice — small enough to sit flat against the waist without being obtrusive under a fitted tee

Appendix

Ideas that didn’t make the cut

Adaptive Calm Tank Top

Theme: Self-regulation

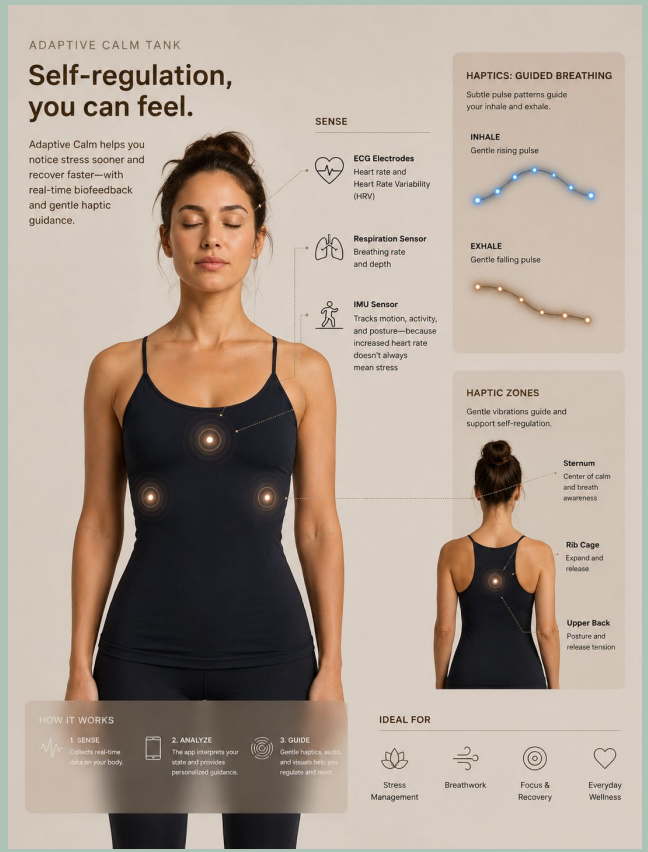
Problem: People don’t realize when they’re stressed until they’re already overwhelmed.

Sense:

- ECG electrodes for heart rate, Heart Rate Variability (HRV)
- Respiration sensor in the band for breathing rate, breathing depth
- IMU to measure motion, activity, posture since increased heart rate doesn’t always mean stress

Haptics:

- On sternum, rib cage, upper back
- Pulse pattern for inhale, another for exhale


ADAPTIVE CALM TANK
Self-regulation, you can feel.
Adaptive Calm helps you notice stress sooner and recover faster—with real-time biofeedback and gentle haptic guidance.
SENSE
ECG Electrodes
Heart rate and Heart Rate Variability (HRV)
Respiration Sensor
Breathing rate and depth
IMU Sensor
Tracks motion, activity, and posture—because increased heart rate doesn't always mean stress
HAPTICS: GUIDED BREATHING
Subtle pulse patterns guide your inhale and exhale.
INHALE
Gentle rising pulse
EXHALE
Gentle falling pulse
HAPTIC ZONES
Gentle vibrations guide and support self-regulation.
Sternum
Center of calm and breath awareness
Rib Cage
Expand and release
Upper Back
Posture and release tension
HOW IT WORKS
1. SENSE
Collects real-time data on your body.
2. ANALYZE
The app interprets your state and provides personalized guidance.
3. GUIDE
Gentle haptics, audio, and visuals help you regulate and reset.
IDEAL FOR
Stress Management
Breathwork
Focus & Recovery
Everyday Wellness



Hug Hoodie

Gentle torso compression, shoulder pressure, like a weighted blanket

- Make it inflatable?

Inflatable Air Bladders (Most Realistic)

How it works:

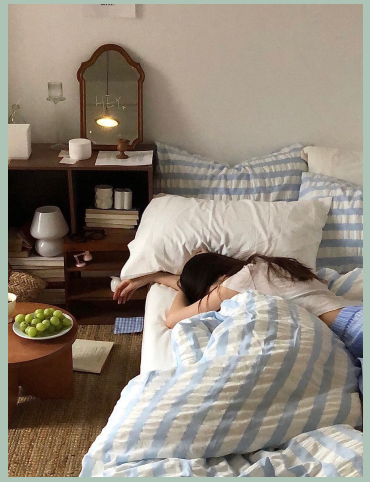
Thin inflatable bladders sewn into:

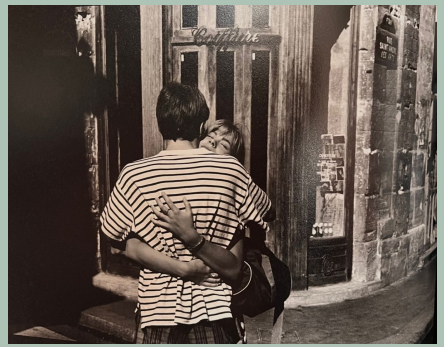
Chest, Upper back, Sides/ribs, Small air pump in pocket

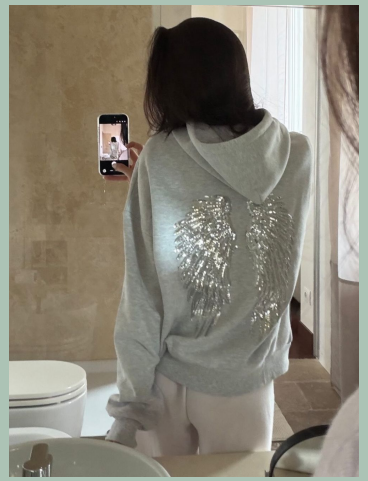
- Solenoid valve controls inflation
- Press button → bladders inflate gently → feels like a hug











Dynamic Jewelry

Transforms like a flower opening petals or whatnot depending on movement or temperature (colors?)





Instead of the HRV detector, use PPG,

MAX30102 — PPG (optical heart rate) sensor, tiny breakout, I2C, sits flat against skin. Gives you HR and a rough HRV proxy. Wrist or sternum placement. Not as clean as a chest strap ECG but no second device needed — it lives on the shirt itself, wired directly to your ESP32.

XIAO ESP32S3 + INMP441 mic + MAX30102 PPG

- Mic handles the social exposure side (talk time, ambient noise)
- MAX30102 handles the physiological arousal side (HR, rough HRV)
- Both are I2C/I2S, both are tiny breakouts, both are well-documented with Arduino libraries
- Total component count is very low — ESP32, mic module, PPG module, haptic driver, one LiPo

Need a waterproof enclosure and make it removable

- Waterproof the LRA motors (haptics)
- Cheap, washable, commercial
- Look into ways to detect heart rate
- Polar products

- Digital Friendship Bracelet
- Family bracelets, glows when they return home, blares when in danger
- GPS Tank Top
- Watch That Always Points North

connection

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- Two Garments That Synchronize Heartbeats
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enchantment

- Dress That Glows So You're Always in the Spotlight
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self-regulation

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