

# iCalm: Measuring Electrodermal Activity in Almost Any Setting

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## Abstract

*The iCalm sensor is a wireless, wearable, washable wristband that can measure electrodermal activity and physical activity in almost any natural setting. This platform has many applications including health monitoring for outpatients, communication of affective information for people who are non-speaking or otherwise interested in sharing this information, education for individuals who want to learn about their own internal physiological changes during daily life, and customer experience data gathering in mobile situations.*

## 1. Introduction

Electrodermal activity (EDA) is an indicator of sympathetic nervous system arousal, approximating one of the two main dimensions of emotion – the arousal dimension. The EDA signal can describe the degree of a person's excitement or anxiousness, as well as pick up on arousal changes related to anticipation, pain, and many other feelings that may be of interest [1]. Many factors can play into a person's arousal: location, time of day, task, familiarity with environment, etc. In a typical lab setting, many of these factors are not natural, making the person's arousal dependent on the altered environment. iCalm measures electrodermal activity in a small, comfortable, and mobile form-factor wirelessly, allowing for measurements to be made outside of a lab setting. This capability is essential for learning about emotion in natural human activity.

Because typical EDA measurements are taken while the participant is attached to a computer, long term EDA patterns have not been well studied. The iCalm sensor is comfortable enough to wear for days or weeks, continuously, providing new information about arousal

and its patterns on a long term basis. Over two thousand hours of data have already been collected from participants in our experiments.

A variety of people can benefit from learning more about their EDA and how it changes with daily activities. We have been working primarily with autistic children, many of whom have difficulty understanding their own emotional state [2], and have also branched out to a larger group of children with sensory processing disorders [3], where emotion regulation is often a part of the targeted treatment.

Traditional EDA sensors involve uncomfortable electrodes, sticky gel, and cumbersome wires that are poorly tolerated by children with hypersensitivities and/or active lifestyles. iCalm's form-factor was designed to provide a comfortable alternative that could be better tolerated by these groups.

## 2. Technical Description

iCalm consists of five parts: a wireless chipset, two dry electrodes, a wristband, a wireless reader, and software.

The chipset is a combination of a wireless transmitter and sensor module. Electrodermal activity, 3-axis motion, and on-chip temperature are measured. A 3.7v rechargeable lithium battery powers the device for over 24 hours of use. With about a 30 meter range, the device transmits signals using a modified Zigbee protocol. In addition to a wireless sensor, another chip can store the information in the wristband locally.

The sampling frequency of iCalm ranges from 2 Hz (wireless transmission) to 32 Hz (logging). The data can be received on a computer via typical serial communication.

The electrodes are attached to the wristband and make contact with the skin. The wristband is stretchy and can be placed in many locations, including palms, wrists, legs, and the sole of the foot. When the dry electrodes are attached, a 15-minute acclimation period is usually needed before a moisture barrier is established and readings can be considered meaningful.

In another iteration of our wireless sensor module, we have incorporated a three-color LED to provide biofeedback to the user. Receiving the wireless signals, the LED chip changes colors based on the user's fluctuating arousal levels.

### 3. iCalm Demo

Four wireless sensors will be available for attendees to try themselves. A laptop will display the participants' current arousal. In addition, two mini-laptops will provide 5 min demos that encourage participants to modulate their own arousal. A poster will also be provided showing previous measurements made with the iCalm sensors, including how we envision using this technology to help children with arousal regulation problems.

### 4. Storyboard

1. An explanation of potential uses and how arousal is specifically measured will be provided.
2. The participant can slip on his or her own iCalm sensor and use the sensor freely. For example, he or she can try clapping their hands and seeing how their body reacts to sudden noise, or see how it changes when talking to different people.
3. The participant will also be invited to work with a computer demo. He or she will be asked to choose the "calming" or "exciting" demo. During the calming demo, various breathing exercises will be introduced- breathing through one nostril, deep breaths, and mental breathing. During the exciting demo, various arousing tasks will be given- subtracting 7 quickly from a large number, finding words in a word search, etc. At the end of the exciting demo, a scary image will suddenly appear along with a scream. Each of these sessions will last no longer than 5 minutes. The demos are designed specifically to modulate the participant's arousal level and have been previously tested with visitors in our lab.
4. During the entire session, the participant's EDA will be recorded along with specific events. This data will be shown back to the user in real-time, and upon

request, the session will be emailed to the participant.

Our goals throughout this demo will be to: (1) Help the participant see how easy it is becoming to measure arousal from EDA while people interact naturally with each other and with computers, software agents, and robots; and (2) Learn more about this physiological dimension of emotion while having fun trying out a new technology.

A video demo of iCalm can be found online at <http://affect.media.mit.edu/projects.php?id=2145>.

### 5. Conclusions

iCalm provides a comfortable, wearable way to measure arousal in natural settings. With its ability to measure for long periods and its comfortable form factor, iCalm allows for the measurement of arousal in new settings. Children with autism can now easily record and/or communicate their arousal during a therapy session or in a classroom. Workers at call centers can monitor their personal stress levels for an entire day. Medical patients can monitor their arousal across a multiple-day intervention. iCalm opens up new avenues of research by providing a novel tool for measuring and understanding arousal.

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### References

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