Personal UV Dosimeter Badges: Mark II

David “Zim” Sherman

Scienterra Ltd, Oamaru, North Otago, New Zealand. Phone (+64) 3 434 9761. Email info@scienterra.com.

Abstract. A new instrument has been developed for researching personal ultraviolet radiation exposure. The Personal UV Dosimeter Badge: Mark II (“Badge” for short) is designed to allow researchers and school groups to monitor the UV exposure of selected individuals. Improvements to the previous instrument include wireless connectivity, more memory, longer battery life, and a lamp to indicate that the unit is functioning.

UV Dosimeter background

It has been determined that excessive UV radiation exposure is harmful to humans, but the allowable limit is difficult to quantify due to differences among individuals. To allow researchers to collect data about an individual’s personal UV exposure, a device known as a “badge” has been designed to record incident UV radiation, in a small, lightweight, waterproof, unobtrusive package that can be easily worn on a piece of clothing. This allows research subjects to gather data about their own UV exposure. By using many such badges carried by a wide cross-section of the population, an enormous mass of data can be collected.

The need for a newer dosimeter badge

The previous badge design has been highly functional, and it has enabled many important studies. However, there were several shortcomings that required a redesign.

Interaction with the badges has been time consuming because of the need to disassemble each unit in order to communicate with it. Disassembly was frequently required: during testing, configuration, preparation for deployment, and again for data collection. At each stage, there were multiple opportunities for screws to get lost, pins bent, or glue joints broken. Handling the bare circuit board had the potential to cause ESD damage.

Badge circuitry was mounted to the case with glue, using the back of the battery clip as a joining surface. This glue joint often released while the user was inserting the battery.

The stability of the calibration was also a concern. After disassembly and reassembly, there was nothing to ensure that the sensor sat in exactly the same place relative to the radome. The act of calibrating the sensor thus changed the sensor’s calibration.

UV-sensitive phototransistors are wonderfully inexpensive, but woefully inconsistent. Some sensors are ten times more responsive than others of the same batch. The old badge required a specific resistor to be hand-tuned to make up for this variation. Of course, each unit had to be disassembled and reassembled multiple times to accomplish this.

Once running, the old badge gave no indication that it was functional. Often, researchers would collect their badges, only to find that many of them had stopped working early in the study.

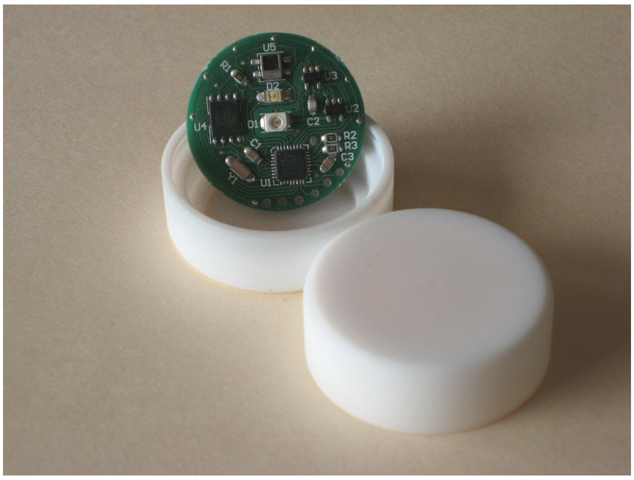

Figure 1. Personal UV dosimeter badges are displayed. Each unit is only 36mm in diameter, and 13mm thick.

Improvements and new features

The new design corrects the problems of its predecessor, and adds a few new features of its own.

To avoid the need to disassemble each unit, new badges use wireless communication. A small integrated circuit handles incoming IR data reception, and a visible light LED serves to transmit data. Both light paths are through the radome. The visible light LED also serves as an indicator for the power-on test, and as a visible heartbeat that shows the badge is still functioning.

The UV measurement circuit has been improved. The new circuit integrates the UV signal over a short period of time, and then samples the integral. This method is inherently good at amplifying small signals, while filtering noise. It also provides an easy way to compensate for inconsistent sensor responsivity, merely by changing the integration time.

Memory was increased to 2MB. The badge stores UV data, plus battery voltage and temperature. The time intervals between measurements are set individually for each parameter. Valid intervals are between 5 seconds and 18 hours. More than a million data values can be stored before the memory is full.

The PTFE housing was modified so that the circuit board is firmly pressed into place by a water-resistant seal. No glue is used, and the battery clip can move freely.

At the time of this writing, battery life has been calculated to be approximately one year, under normal conditions. A very small change to the circuit board will increase the expected battery life threefold. Note that these figures have not been tested.

A built-in clock tells the badge which hours of the day to be active. For example, a badge can be set to activate at seven in the morning, and deactivate after supper. The speed of the visible heartbeat indicates whether it is active.

Configuration and data transfer are done via a wireless cradle, which is connected to a computer via USB and a terminal emulator. Data is transmitted from the badge to the computer at approximately 40,800 baud.

Remaining issues

- Calibration and testing will be conducted this year by NIWA Lauder. Field testing will follow.
- A new circuit board is in process for the cradle. This will improve manufacturability, and also provide other features, such as a battery backup for the time and date.
- One of the IC chips on the badge has become obsolete, and the replacement must be tested for compatibility.
- A graphical user interface (GUI) should be written. It will be easy to integrate with the USB cradle. Custom interfaces are also possible. Please contact Scienterra.

Interested?

For sales and marketing questions, please contact Martin Allen. His email is martin.allen@canterbury.ac.nz.