

Project Rabbit

A Fast, Portable Chlorine Generator Cell Tester
ELECOMP Capstone Design Project 2017-2018

Sponsoring Company:

Hayward Pool Products
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<https://www.hayward.com>



OmniLogic iPad app controlling water features

The HAYWARD Team won 1st Prize at ELECOMP Summit May 2017

See: [Capstone Summit Event](#) and [Winning Project Overview](#)

Company Overview:

HAYWARD is the world's largest manufacturer of swimming pool equipment. We design and manufacture pumps, filters, gas heaters, heat pumps, cleaners, chemical automation systems, control automation systems, and LED lighting systems.



Hayward manufactures several hundred thousand of [AquaRite](#) chlorine generator systems and "salt cells". These apply DC current to Ruthenium coated Titanium plates to generate chlorine gas in an electrolysis reaction.

Technical Directors:

We are the same technical directors that lead last year's first place team! Most meetings can be on-campus, and specialized lab work at Hayward's facility is in nearby North Kingstown.



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Project Motivation:

Create a battery operated, fast and portable salt-cell tester for thousands of field techs

Servicers of our AquaRite Salt Chlorine generation system use a storefront diagnostic tool to determine if the generator cell has worn out. Our current tool is too expensive, too bulky, too easy to misinterpret, and thus is only used by a fraction of the servicers that diagnose and make warranty claims. As such, expensive misdiagnosis is common.

Our capstone team will use water conductivity sensing, test signal generating circuits, impedance measurement, and software to produce a new method that is full-proof, portable and less expensive.

This innovation will allow us to widely deploy thousands of the tester saving possibly 15% of our total warranty claims.



Anticipated Best Outcome:

By Christmas: Determine algorithm, circuits and demonstrate a breadboard of the test.

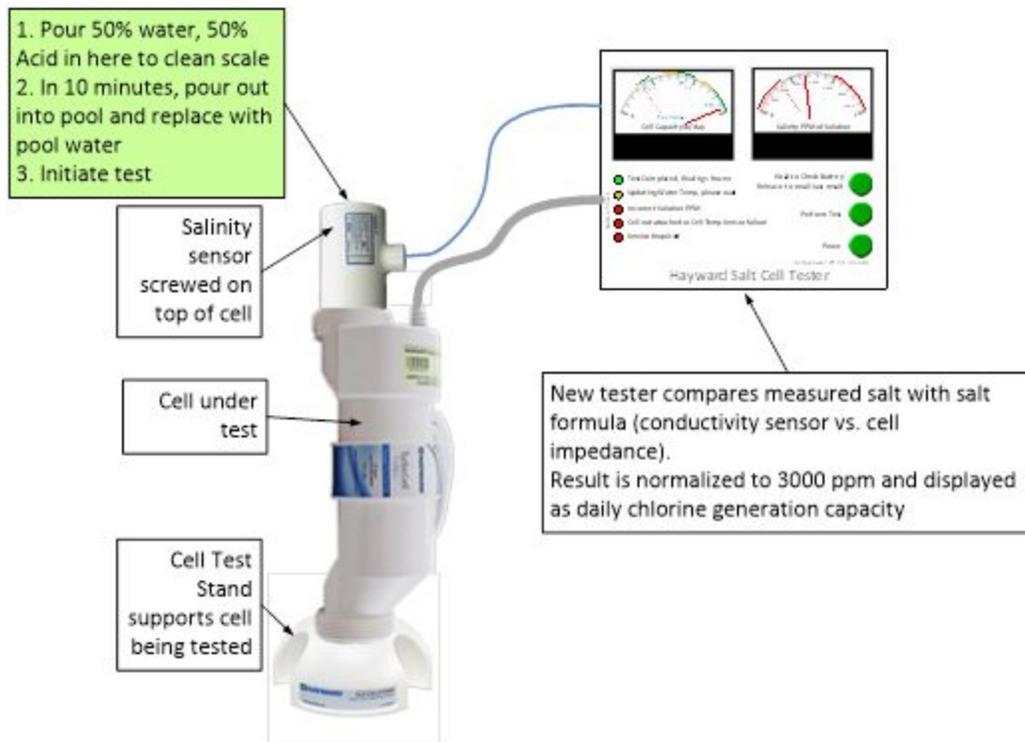
By April 2018: Build 10 working, verified testers with a custom PCB that are ready to deploy in a beta trial.

The unit should:

- Be battery operated with accessory AC power source
- Operate from freezing to hot temperatures, 5C to 40C ambient
- Have a simple user interface to initiate the test and obtain a numeric result along with a pass-fail indication.
- Record test dates and results in internal memory
- Allow testing of our different capacities
- Allow display of test solution salinity, impedance measured, model being tested, and pass/fail.
- \$30 target cost @ 1000 quantity



Possible Configuration:





Project Details:

Hardware Tasks:

- Experimentally develop a new rapid-test protocol that defines what test solution concentration, signal and measurement timing. Digital storage scopes, voltage and current probes will be used to test various new and worn generator cells, using various concentrations of saline water. Comparison of scaled and cleaned cells will also be conducted. Testing can be done either at Hayward North Kingstown or URI.
- Prototype and validate an impedance measurement circuit that includes voltage and current sensing using op-amps and ADC inputs of the microcontroller
- Generate and a short, high power test signal possibly using a charge pump, energy storage capacitors, FET switches, etc.
- Choose an off-the-shelf housing to fit processor and interface boards.
- Develop needed readouts and buttons to provide an intuitive user experience.
- Capture the new circuit in PCB CAD, route and develop a custom circuit board to interface the sensing and generation circuits to the processor.

Firmware Tasks:

- Choose a suitable microprocessor board such as Arduino, Raspberry Pi, BeagleBone etc. based on needed capability, cost, learning curve, and availability of support.
- Flowchart and develop code to initiate the test and get and record results.
- Determine use cases and propose complement of buttons, readouts and indicators for an intuitive tester that needs no training or instructions. Storyboard the UI through the test sequence and verify ease of use using internal Hayward provided customers who use the current system.

Composition of Team:

1 Computer Engineer and 3 Electrical Engineers

Skills Required:

- OpAmp, junction and FET transistor theory
- Operation of signal generators, programmable power supplies, scopes, etc
- Ability to develop a software architecture concept and code the application

Anticipated Best Outcome's Impact on Company's Business:

An Alpha-level test system that can be shipped to several beta testers next summer for final validation. This long-desired tester has never made it to our project list, and it is the #1 wish of the Product Manager.

Broader Implications of the Best Outcome on the Company's Industry:

Reduces illicit and costly warranty replacements of still-working chlorine generator cells, and helps owners debug inability to maintain chlorine levels in their pools. It could save Hayward up to \$500k annually.



*A fast, compact design that
is friendly, easily replicated
and deployed.*