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Evaluation of FastCAP Ultracapacitors in Geothermal Environments

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Introduction

FastCAP Systems has developed innovative technical solutions to power downhole tools while operating at extremely high-temperature (HT). The operating temperature limit of the developed system has been pushed as high as 250°C (in some cases up to 300°C). In order to advance the readiness level of this technology (TRL) from TRL3 to TRL6, a programmed plan of laboratory tests and an integrative field demonstration is required. The goal of this project is to iteratively test and qualify HT energy storage devices (ultracapacitors) and electronic systems designed and manufactured by FastCAP Systems using resources at Sandia National Laboratories. Components will undergo two primary types of tests: temperature and vibration/shock, which can also be performed simultaneously. Parts can also be tested in Sandia's High Operating Temperature (HOT) Drilling Facility. Beyond bench-scale and intermediate scale testing, partnerships within the geothermal industry will be sought to facilitate a full field scale test to advance the technology readiness level to a TRL7. FastCAP Systems will perform design improvements to prototypes in between tests in order to optimize performance of the ultracapacitors and electronic systems.

Department of Energy Small Business Voucher Pilot

The Department of Energy Small Business Voucher Pilot Program (SBVPP) is a program designed to enhance key small business innovations through the expertise and capabilities of the national labs.

FastCAP Systems is a small business that has developed a technology that could enable a step-change in power systems for high temperature geothermal tools. The Geothermal Technologies Office funded this FastCAP SBVPP to enable TRL advancement of their technology through Sandia's unique capabilities and resources. Sandia has a long history of geothermal tool engineering and relevant extreme environment part evaluations.

FastCAP and Sandia National Laboratories have a proven track record of successful collaboration on the evaluation of high-temperature power storage capacitors. FastCAP is an industry leader in the development of ultracapacitors while Sandia National Laboratories (SNL) has the experience and capability to test these components as a third-party, impartial laboratory. The SBVPP allows FastCAP to gain access to the technical expertise at a Sandia to help them advance their technology and ultimately the field of geothermal energy.

Laboratory Bench Scale

Laboratory Intermediate Scale

Experimental Plan

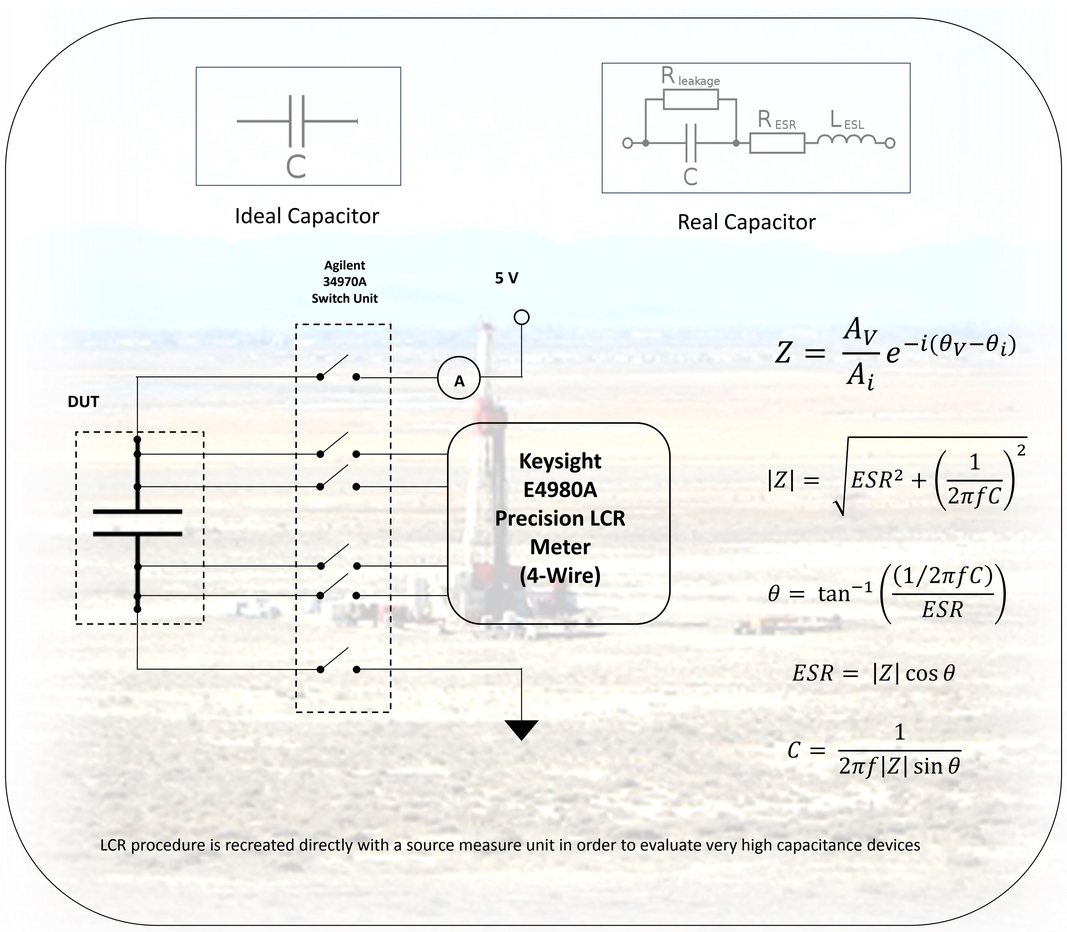
The experimental plan will be carried out in two-phases during FY18

Phase One: Lifetime performance of ultracapacitors at high temperature

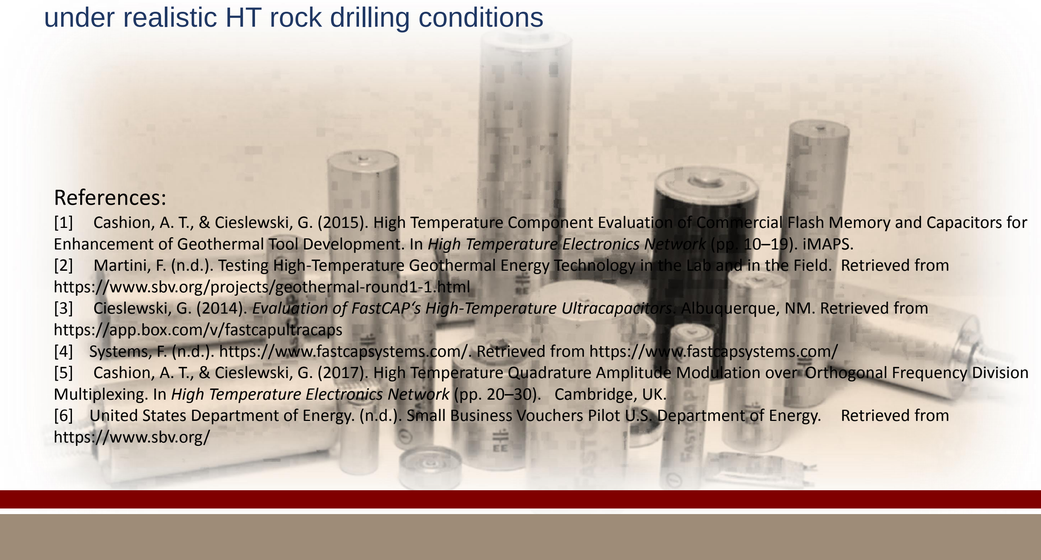
- Temperature range - 200°C to 350°C.
  - The typical temperature range encountered in geothermal drilling applications is 90°C to 350°C. These tests are focused higher end of this range.
- Time Period - maximum 1500hrs.
- Ultracapacitor system:
  - Form factor - primarily ultracapacitors in the size of AA and D sized battery cells (corresponding to a total volume of 7.9cc and 55.4cc respectively)
  - Power requirements - maximum operating voltage of 5V and current up to 20A.
  - Testing on each cell will end when cell reaches end-of-life (predetermined increase in ESR or decrease in capacitance) or maximum time period elapses.

Phase Two: Lifetime performance of the ultracapacitors at high temperature and simultaneous mechanical vibration to simulate drilling or emplacement conditions

- All conditions from phase one apply to phase two.
- Vibration - 10Grms to 60Grms at frequencies up to 50Hz.
- Shock - 500Gpk to 2000Gpk..
- Finally, testing will be performed on Sandia's laboratory high temperature drill rig under realistic HT rock drilling conditions



LCR procedure is recreated directly with a source measure unit in order to evaluate very high capacitance devices



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