ModuLab®

electrochemistry

Application Guide

DC cell analysis techniques
GSM mobile phone pulse test

John Harper and Brian Sayers
Solartron Analytical, Farnborough, UK.

Demonstration Guide: AGML06

Introduction

This guide demonstrates how to simulate charge / pulse discharge sequences on energy storage devices such as batteries, supercapacitors and fuel cells that are used in mobile phone or satellite communications. Data is typically transferred from mobile phones to the base station in data-packets, and the energy storage device experiences pulsed current load during data transmission. The pulses may be very short in duration, for example GSM (Global System for Mobile Communications) pulses are 577 µs duration (typically up to 2 Amps) with a repeat period of 4.615 ms, with thousands of pulses representing a typical discharge profile. This pulse discharge requirement places a very high demand on test equipment, requiring accurately timed high-speed current pulses, high rate data collection and fast experiment step switching. Analysis of the data can also present problems if the test system does not provide flexible data reduction and analysis facilities. The ModuLab system was designed with fast pulse applications very much in mind and offers a range of features which make this type of test easy to perform. The following demonstration shows the amazing flexibility of the ModuLab system. The same techniques can also be applied to many pulsed current test applications outside of the field of communications.

Key system capabilities used in this demonstration

- High precision pulse generator with up to 1 µs time resolution
- High-speed data capture for detailed pulse analysis (up to 1 MS/s)
- Reduction of data storage requirements using delta-I and different acquisition rates per step
- Exit pulse discharge loop when cell is discharged (cell voltage reduces to under 0.6 V)

Equipment required for this demonstration

- ModuLab electrochemical test system with Booster 2A and HV options (experiment may be run at lower current if ModuLab potentiostat only is available)
- Sealed lead acid battery - e.g. 6 V or 12 V (for example 2.5 Ah)

Connections

- Connect ModuLab to the battery following the connection diagram shown in the software.

Experiment setup

Select "AGML06 GSM Mobile Phone Pulse Test" in the "ModuLab Demonstration Guide" project

Step #	Purpose
Step 1	Charge the cell for the required time while measuring at low data rate
Step 2	Rest the cell after charging.
Step 3	Loop steps 4 and 5 the required number of times to simulate a complete discharge cycle
Step 4	Pulse discharge current from -20 mA to -200 mA using GSM profile. Capture high rate data.
Step 5	As step 4 but uses delta-I acquisition mode to capture minimum and maximum current / voltage per pulse for the next 1000 pulses

Additional test possibilities:

- Loops could be used to repeat the entire sequence for cell lifetime tests
- Impedance analysis can be added after each pulse discharge to investigate cell lifetime
- Analyse anode / cathode performance using auxiliary channels (voltage drop and impedance)
- Higher current pulses can be run by adding external boosters

Notes on setup

This experiment is designed to simulate the charge / discharge profile which is experienced by mobile phone batteries, supercapacitors etc. Usually the cell is charged until it is fully charged using constant current and constant voltage strategies as appropriate for the particular cell (this particular test has been shortened for demonstration purposes). The GSM pulse discharge level would usually be 1 Amp or more, but smaller batteries (e.g. AA rechargeable cell) could be used if the current is reduced to 0.2 A.

GSM pulses are very short duration (less than 1 ms) and they occur when data is being passed between the mobile phone and the base station. Fast data acquisition is needed to accurately capture the pulses (1 MS/s = one sample every 1 µs). However, capturing high rate data for several minutes to simulate phone calls would require a massive amount of data storage capacity in the PC. In order to reduce the data storage requirement, ModuLab provides various modes of operation where the accurately timed high-speed pulses can still be applied to the cell while reducing the data capture. Using techniques such as delta-I allows essential information about pulse amplitude to be captured without having to save all data points to disk (giving the overall discharge curve). Occasionally high rate data capture is used (1 in 1000 pulses for example) to provide detailed pulse analysis at the full data rate (up to 1 MS/s).

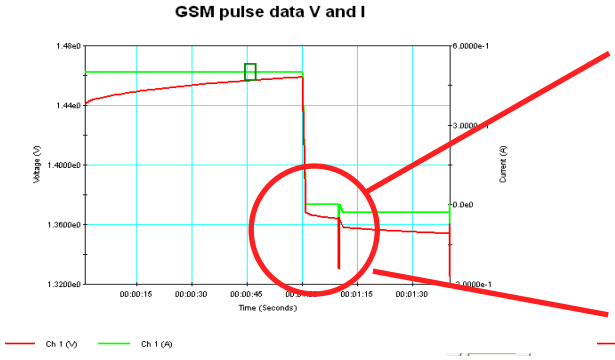

Figure 1: Overview of whole test

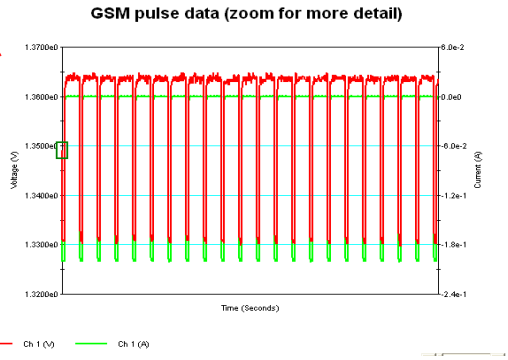

Figure 2: Zoomed pulse display

Data presentation and analysis

An overview of the charge, rest and pulse discharge curve is shown in Figure 1. The user can use the zoom facilities to zoom into the detailed pulse data. Click with the mouse button and hold down while dragging the cursor to select the area of interest. The zoomed data from step 4 is shown in figure 2 which is where the pulses are being captured using the high speed data capture facilities of the system..

Alternatively in the graph set up in the navigation tree, the customer can select data from any individual step in the experiment.

Conclusions

The unequalled flexibility of the ModuLab system is shown to great purpose by this GSM mobile phone demonstration. The ability to instantly switch between high and low data acquisition rate while continuously outputting high speed pulses makes the best use of PC data storage, and allows the user to not have to scroll through millions of data points to find the data that is of real interest. GSM is a very specific application, but the facilities shown here can be applied and adapted to many different applications.

Application Guide

Solartron Analytical's Quality System is approved to BS EN ISO 9001:1994

FM01709

...part of AMETEK® Advanced Measurement Technology

UNIT B1 ARMSTRONG MALL
SOUTHWOOD BUSINESS PARK
FARNBOROUGH, GU14 0NR
UNITED KINGDOM
Phone: +44 (0) 1252 556 800
Fax: +44 (0) 1252 556 899

801 SOUTH ILLINOIS AVENUE
OAK RIDGE
TN 37831-2011
USA
Phone: +1 865 425 1360
Fax: +1 865 425 1334

Visit our website for a complete list of our global offices and authorized agents

solartron.info@ametek.com www.solartronanalytical.com

150508

15/05/2008