Flow Battery Testing Solutions

Arbin was founded over 20 years ago as a manufacturer of battery testing equipment and added our fuel cell product line in 1997. Our experience and expertise from these two industries have allowed us to create a new product designed for Flow Battery applications that is able to integrate with a customer's existing Flow Battery System or with a new start-up.

We are able to provide programmable electronic modules for charge/discharge control, mass flow control, temperature measurement and/or control, pressure, monitoring, and more; all with a myriad of safety features. Arbin's design engineers are able to customize the FBTS to work with a variety of external hardware that can control or simply interact with by using a digital relay signal.

Our products range from small-scale research testing up to high powered industrial applications. Arbin's design engineers will work with customers' engineers to meet any unique requirements. Over the past few years, Arbin has developed a great product and have been successful in meeting all challenges in the industry. Arbin has already provided multiple Flow Battery Systems to many of the world's top research and commercial organizations in this field.

FBTS Capability

Voltage Range	0 - 800V
Current Ranges	Up to 4,000A
Current & Voltage Accuracy	Linear: 0.05% of Full Scale Range Regenerative: 0.1% of Full Scale Range

Arbin's FBTS is intended to provide a complete testing solution for use in R&D testing that requires advanced test schedules and protocols.
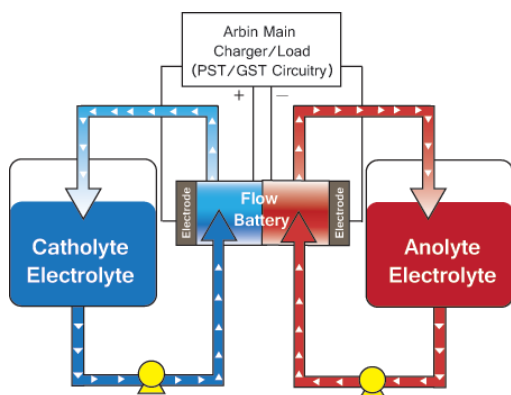
Key Features

Integrated Control of the Complete Flow Battery System

- Compatible with Third Party Hardware
- Potentiostatic/Galvanostatic Functionality
- Modular Plug & Play Design
- Automatic Device Simulation

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FBTS

Flow Battery Options

Arbin Main
Charger/Load
(PST/GST Circuitry)

Catholyte Electrolyte

Electrode

Flow Battery

Electrode

Anolyte Electrolyte

- Main Current and Voltage charger and load (Electronic I/V) for testing flow battery stack. The system can have multiple channels and ahs full potentiostatic/galvanostatic (pst/gst) control

- Auxiliary Voltage Measurement which allows users to monitor individual cell voltages

- Valve, pump and mass flow controller integration to start, stop, and adjust flow rates; Integration of third party device such as temperature/humidity chamber, furnace, oven and etc via RS232

- Heater/Fan controller with power supply to control the temperature of media or battery

- Other measurements such as: temperature or pressure at the inlet and outlet of the flow battery

- Safety alarm and hardware interlock

Arbin Instruments' electronic circuitry is a completely programmable and automatic power supply that works directly with Arbin's MITS Pro Software. Through the software, the user can control the current and voltage applied and drawn from the flow battery in any number of profile types.

- Current capability ranges from micro-amp level up to 1000's of amps

- Voltage capability ranges from below 0V up to 700V

- Automatic and programmable control for the entire system

- Potentiostatic/Galvanostatic charge/discharge circuitry or discharge-only option

- True Bipolar Circuitry allows for no switching time between charge and discharge

- Hardware-based Voltage Clamp

- Modular plug and play, compact design

- Multiple Current Ranges

Electronic Power Supply Features

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Customizable Features

■ The Analog Input/Output module option is designed to measure and control Flow Rate or Pressure or any devices that can output 0(2)-10V as feedback signal and input 0-10V as control signal. The Analog I/O board offers control with closed loop (PID) or open loop communication depending on the application. There are 8 channel inputs for measurement and 8 channel outputs for control per module.

■ The Digital Input/Output module sends and receives a simple digital on/off signal that is available in TTL and Relay. There are 8 channel inputs and 8 channels output per module. These can be used to communicate with third party hardware directly or in conjunction with a 24V DC source as stated below.

■ The DC power supply module offers ability to turn on/off solenoid valves, pumps or other devices with a 24V DC power supply. The channels of this module are associated one-to-one with Digital Output channels and provide an on/off 24V DC power source.

■ Auxiliary Voltage Input is typically used to measure each cell voltage in a multi-cell battery or to measure the reference electrode voltage in a three electrode setup. The value of voltage can be recorded in the results file or used to further control the experiment. Auxiliary Voltage boards come in groups of 8 channels. The software allows multiple auxiliary channels to be mapped to a single main channel, or however required by the user.

More Custom Features

Voltage Range	(-5V) to 5V	(-10V) to 10V
Accuracy	10mV	20mV
Input Impedance	16M Ohm	16M Ohm

■ Temperature Measurement is used to measure the temperature of any point in the set using either our thermocouple module (E, J, K or T) or our thermistor module. The value of temperature can be recorded in the results file and/or used to further control the experiment. Minimum order quantity: 8 Channels of thermocouples or 16 channels of thermistors per module.

■ Pressure Input works in the same way as the temperature option however, it measures the pressure inside the cell using a pressure transducer. The transducer used with this option uses an operating supply voltage of 5V DC and output voltage of 0-100mV. The cell must have an opening to insert the transducer. There are 8 channels per module.

Customizable Features

- The Heater/Fan Controller offers integrated temperature measurement and power output control applying PID technology. This unit uses Type K thermocouple input to provide temperature feedback measurements and provides PWM style heating/cooling power source to control the heater or fan. There are 4 Heating/Cooling channels or 8 Heating channels per module.

- The MFRI module allows users to set mass flow rates from Arbin's MITS Pro Software. The user needs to specify gas type and maximum flow rate when ordering. There can be up to 4 Mass Flow Controllers per module.

- The Multiple Temperature Chamber Interface option (MTCI) allows the system to communicate with a temperature chamber controller during testing. The MTCI module tells the chamber controller what temperature set-point to use during each test step, allowing the user to program complex automatic temperature profiles in their tests. Consult your Sales Engineer for a full list of supported chambers and MTCI specifications

RS - 232

MTCI Module
in Arbin System

Chamber

TCP - IP

Computer
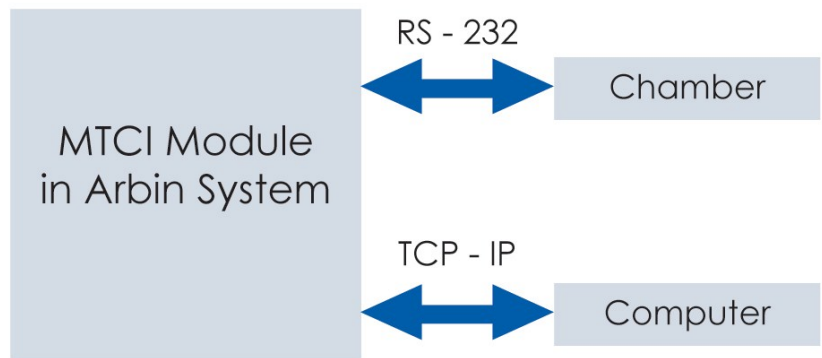
- The UPS option is designed to support the PC and detect a power outage to the Arbin testing system. It will allow a test to resume automatically if power returns within a user-defined time period, or shut down the PC if power is not returned. The Universal Power Supply helps prevent file corruption from a sudden loss of power. The UPS option includes a 1500VA Smart UPS and proprietary cable to allow control by the Arbin Software.

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Software Features

Arbin's MITS Pro Software is the most comprehensive battery testing software solution available in the marketplace today. Over the past decade, MITS Pro has been the front end of the Arbin test stations of the BT-2000, MSTAT, SCTS, and EVTS systems. This has allowed Arbin to refine and simplify the software and user interface for improved stability and ease of use.

The power of MITS Pro comes from its capacity to create and implement tests from simple to complex all with a user-friendly interface. MITS Pro 5.0 software for Flow Battery applications is a modified version of Arbin's standard battery MITS Pro Testing Software. User-interface is presented in a an intuitive and Windows-friendly format. MITS Pro 5.0 is simple to use but has extremely powerful and flexible applications. Using the same software, you can write new test schedules, implement test regimes, as well as monitor and view real-time data.

MITS Pro 5.0 for FBTS

- Independent testing of multiple devices
- Boolean control of test parameters such as temperature, flow rate, and pressure Stoichiometric flow rate control associated with current.
- PID Technology is applied on all temperature and pressure control channels
- Software allows the user to control a test using variables rather than concrete control values (Example, instead of using 4.2V for control, the system can use "Last Step Maximum Voltage" as the control type of the following step.
- "On the Fly" modification of test parameters in real time without pausing or stopping a test; benefits include being able to increase the number of cycles, fix a typo, add steps, adjust data logging, etc.
- A vast library of variables, conditions, and formula conditions are available
- Integrate control of third party equipment such as temperature/ humidity chamber, furnace, or oven.

FBTS

Software Features

■ Data Watcher allows quick and simple plotting of your test results file. Using data watcher, the user can do simple or complex plotting to determine whether or not the battery is reacting as expected. If a data point falls outside of expectations, the user can double click on the graph and the list of data points will appear as well as the cycle count and step number the test is in. If modifications are required to the test schedule, the user can open the specified test schedule in MITS Pro, make the modification and continue testing with no interruption.
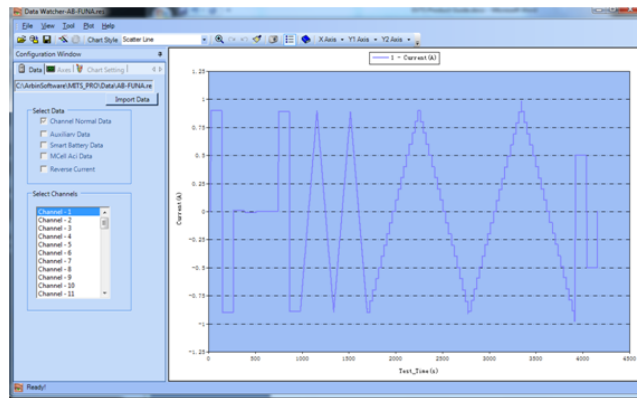
■ Data Pro Software is an add-on for Microsoft Office Excel designed for analyzing test results. Users can view data in table formation and customized graphic views. This software provides a user-friendly interface for Excel's analysis capability and maintains the full power of Microsoft's software and flexibility.

Safety Features

Arbin has implemented a number of new hardware and software safety features to prevent damage on the device being tested, and the test station. Arbin's FBTS incorporates multiple layers of safety at the module, and overall system level. These safety features listed below work together to make the FBTS extremely safe to operate and increases the robustness of the system. The Charger/Load Module incorporates the following safety features:

- Over/Under Current Alarm
- Over/Under Voltage Alarm
- Fuses, Circuit Breakers, and Thermo-switches
- Thermal Protection Devices
- Over temperature, over pressure, or flow rate alarm
- User intervention for safety override
- Hardware interlock alarm input (optional)
- Alarm tower with signal lights (optional)
- Emergency shutoff switch (optional)

About Arbin

Arbin Instruments is one of the fastest growing manufacturers of energy-related testing equipment. Combining the global talents of electrochemists, electronic and software engineers, customer support staff, Arbin Instruments has revolutionized the automated testing instrumentation market. We offer standard and customized testing solutions for a wide variety of energy-storage devices such as batteries, supercapacitors, and fuel cells.

Arbin's focus is exceptional quality, performance and reliability. Our instruments provide scientists and engineers a tool for performing R&D, quality control, production, and characterization in various markets including Hybrid Electric Vehicles, medical, telecommunications, military, alternative energy, space, and consumer products.

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