Flow Battery Testing Solutions

Arbin's Flow Battery Testing System is the result of more than 20 years of research and experience in the battery and fuel cell testing industry. Designed specifically for Flow Battery applications, Arbin's FBTS was created to integrate with a customer's existing Flow Battery System or with a new start-up.

Each FBTS unit has programmable electronic modules for charge/discharge control, and options for mass flow control, temperature measurement and/or control, pressure monitoring, and a host of safety features. Additionally, the design engineers at Arbin are able to customize your FBTS to control or interact with a variety of external hardware.

With products ranging from small-scale research testing up to high-powered industrial applications, Arbin's engineers will work with customers to identify the ideal system specifications for every application. Clients in many of the world's top research and industrial organizations have recognized Arbin's FBTS as the system capable of meeting the challenges of any flow battery application.

	Research Applications	Industrial Applications
Voltage Range	Below 25V *	Up to 800V
Current Ranges	As low as 10µA	Up to 4000A
Current & Voltage Accuracy	Linear: 0.02% of Full Scale Range	Linear: 0.05% of Full Scale Range Regenerative: 0.1% of Full Scale Range
	* Reverse polarity available on request	

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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Electronic Power Supply Features

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.

Sample Standard Systems		
Application	**Voltage**	**Current**
Research	(-5) to 5V	10A
Research	0 to 5V	50 A
Industrial	100V	200A
Industrial	10V	1000A

- Low voltage and reverse polarity available for research scale testing and high-voltage systems for industrial applications
- Current capability ranges from micro-amp level up to thousands of amps
- Multiple current ranges allowing higher accuracy across total current range
- Potentiostatic/Galvanostatic charge/discharge or discharge-only circuitry
- True Bipolar Circuitry for no switching time between charge and discharge
- Hardware-based Voltage Clamp

External Hardware Incorporation

Users may use their own pumps or Arbin can recommend a suitable third-party pump for each application. In order to give an accurate pump recommendation, Arbin agents will need to know:

- ✓ Application
- ✓ Flow Rate
- ✓ Pressure Requirements
- ✓ Media

- For applications ≤ 3Lpm, 0-10V control, Arbin recommends a KNF pump.
- For applications > 3Lpm, Arbin recommends an AC inverter from Leeson to handle motor speed
- Please check chemical resistance of any pump before choosing

Arbin's team of engineers have developed systems for clients around the world. Their knowledge and experience will be valuable tools in building a testing system that will meet your needs. Consult your Sales Engineer for help in designing your system.

Applications ≤ 3Lpm

Applications > 3Lpm
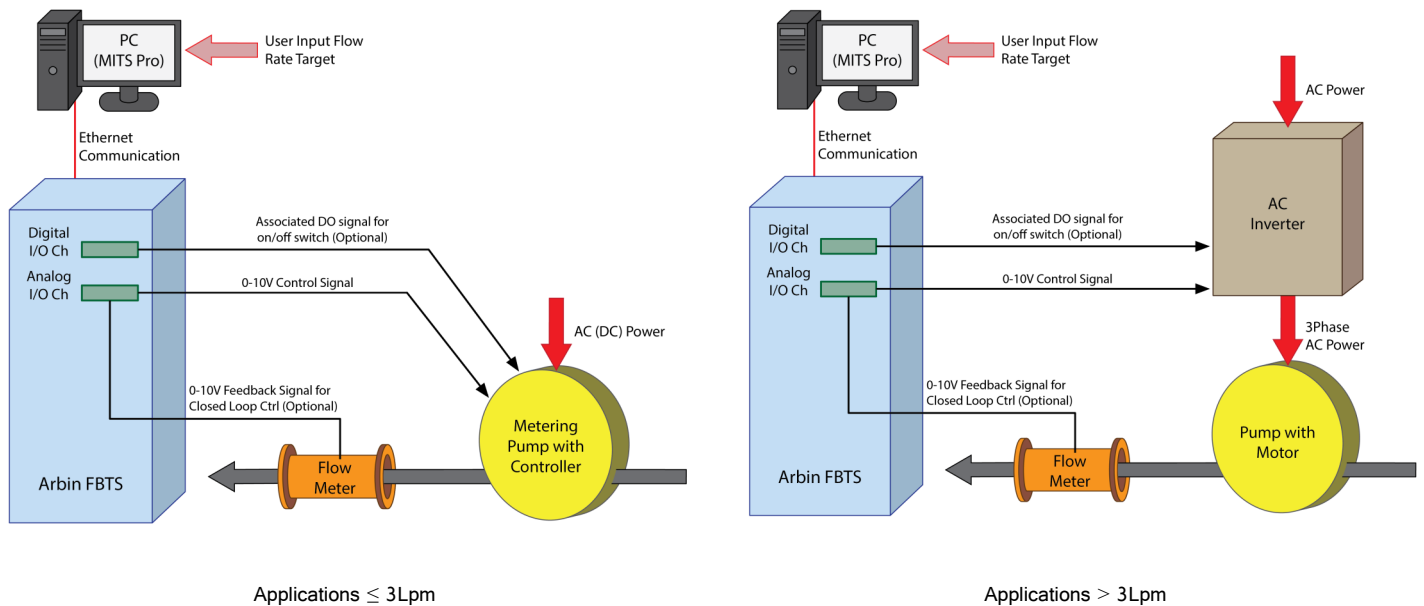
Custom Features

Pump & Flow Meter Control

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.

Digital I/O

The Digital Input/Output module can be used to communicate with third party hardware directly or in conjunction with a 24V DC source. The Digital I/O module sends and receives a simple digital on/off signal that is available in TTL and Relay.

DC Power Supply Module

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

Auxiliary Voltage Inputs may be 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. The software allows multiple auxiliary channels to be mapped to a single main channel, or however required by the user.

Temperature Measurement

Users may gather temperature data for any point in the set by 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.

Pressure Input

Pressure Inputs measure and record 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.

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Custom Features
### *(continued)*

Heater/Fan Controller

The Heater/Fan Controller offers integrated temperature measurement and power output control applying PID technology. This unit uses Type K thermocouple inputs to provide temperature feedback measurements and provides PWM style heating/cooling power source to control the heater or fan.

Temperature Chamber Interface

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

Mass Flow Rate Interface

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.
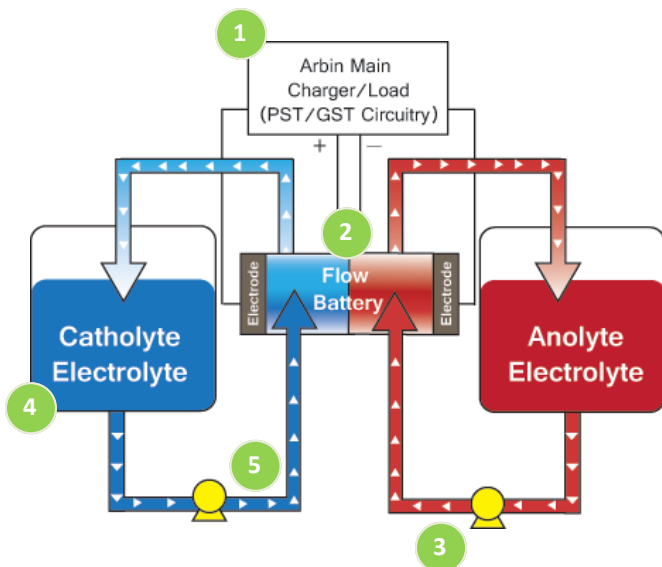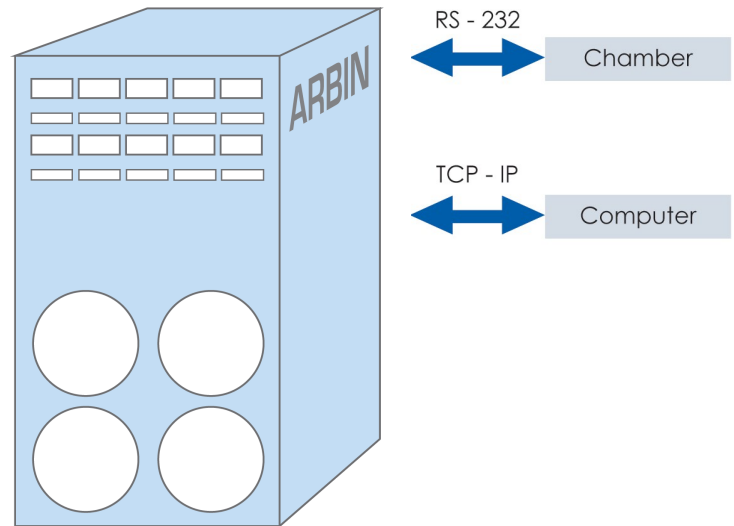
Sample options for Flow Battery Testing System (FBTS):

1. Multiple channel electronic modules with charging/discharging
2. Auxiliary voltage measurement allowing users to monitor individual cell voltages
3. Pump or mass flow controller to start, stop, and regulate flow rates of the pump
4. Heater controller to control the temperature of the liquid. If a cooling requirement is needed, a chiller can be integrated.
5. Other measurements such as: temperature and pressure at the inlet and outlet of the flow battery.

Software Features

Arbin's latest Mits Pro software has been designed for flow battery applications by modifying our standard Mits Pro battery testing software and combining appropriate aspects of our fuel cell software. Mits Pro is the most comprehensive testing software solution available in the marketplace today. Over the past decade, it has been the front end of Arbin's BT2000, MSTAT, SCTS, EVTS, and FCTS product lines, and now our FBTS line of products. This has allowed Arbin to refine 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, whether simple or highly complex, all with a user-friendly interface. The interface presents an intuitive Windows-friendly format and allows users to conduct tests, monitor real-time data, and perform data analysis. In addition to Mits Pro, Arbin provides Data Watcher software and the Data Pro Excel add-in.

- Independent testing of multiple devices

- Integrated control of third party equipment such as temperature chamber, pumps, flow meters, heaters, etc.

- 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

Software Features

- Data Watcher allows quick and simple real-time 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.
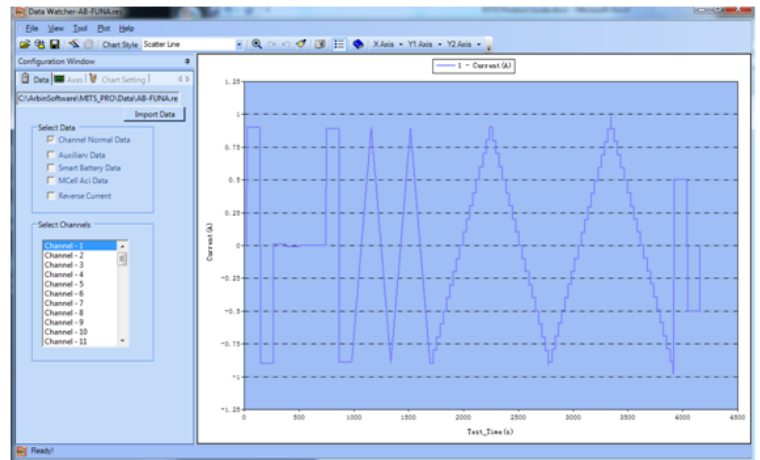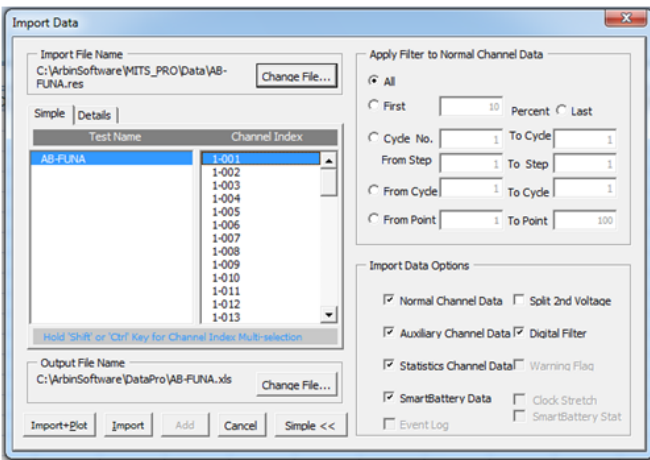
- For a more in-depth data analysis report, Arbin has created an Excel Macro that will allow for simple importation of the test result file. The results file will contain all the information gathered to allow for easy manipulation of the data. Arbin's Data Pro Macro allows users to view, plot, and analyze 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.

Arbin's Data Watcher and Data Pro Excel Macro are provided free as a part of the MITS Pro suite of software. Data Watcher and Data Pro Macro can be loaded on any PC in order to view result files from saved test schedules allowing users to analyze data outside the laboratory. When used in combination with Microsoft Excel and Arbin's Data Pro Macro, Data Watcher provides MITS Pro users with unmatched data monitoring and analysis abilities.

Safety Features

All Arbin test stations are designed and manufactured based on industry regulations and arrive CE certified. The Arbin system includes an array of safety features that protect the user, the devices under test, and the test station.

■ The system itself is secure internally to protect from unintentional misuse. The system is equipped with an emergency stop button and multiple levels of fusing are provided inside the system for protections at the channel/board and power supply level. Arbin's Watchdog circuit monitors the machine's internal communication between the PC and onboard microcontrollers and will stop all tests if there is a failure that poses a risk. A light tower array is used to visually alert the user to potential problems and the PC can be programmed to sound an audible alarm.
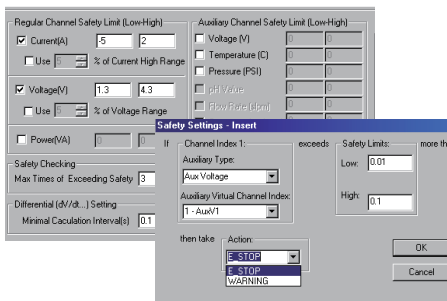
■ The user is able to implement safety limits in the software for current, voltage, total power, as well as temperature or other auxiliary readings. These values can be programmed to send the system into a rest state for a period of time, or simply stop the test and disconnect the charge/discharge circuitry. There are separate limits available for each test schedule as a whole, and individual steps within the test schedule.

■ A Redundant Safety System can be provided to independently monitor the devices under test, and can disconnect the device if a safety setting has been exceeded. Safety is the highest priority when testing high power devices, and Arbin's Redundant Safety System provides an additional safety system, independent of the Arbin hardware and software, to ensure a safe testing environment. The system has the ability to monitor current, voltage, and temperature. If any user-defined safety settings are reached, the device under test will be disconnected from the Arbin test channel. A hardware interlock can also be provided with this system to completely power off the Arbin test station.
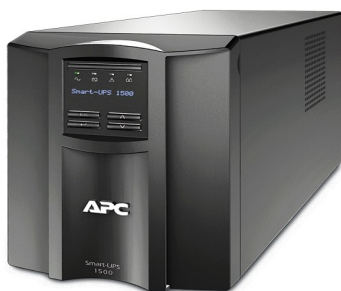
■ The reliability of testing can be increased even further by adding a smart UPS to the controlling PC. This will allow tests to automatically resume after a brief power failure if they are in a safe condition and permits user intervention in the process. There is provision for the user to intervene if desired before the channels resume. This is an essential component for any user with an unreliable power source unless the entire facility is on backup power.

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 fo r 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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