

# BT2000



## Custom-Designed Multi-Channel Battery Testing System



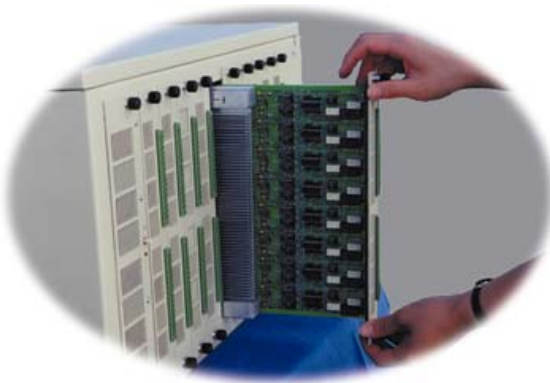
- Battery Testing, Life Cycling
- Material Research
- Electrode Study
- Cell & Battery Pack Testing
- Multiple Current Ranges
- Bipolar Output
- PST/GST Function
- Pulse Function
- Plug & Play System

Custom-designed multi-channel battery testing system, **BT2000**, is an advanced testing equipment for research and development of energy storage or electrochemical devices, such as battery, supercapacitor, and fuel cell. Besides functions commonly used in energy storage device testing; such as charge-discharge, constant current, constant voltage, constant load and constant power; there are special functions to satisfy the unique testing requirements for various devices or cells. It can be applied to battery testing, material research, electrode study, fuel cell testing, supercapacitor R&D, or electrochemical investigation. Each channel performs independently in multiple channel system. The system is also capable of providing fast (sub-millisecond) or slow (sub-second) pulse operation, such as GSM, CDMA, and testing procedures in PNGV. Easy maintenance and preventive safety net guarantee system's reliability. Data conversion to Excel or Access format is provided with Arbin MITS Pro software, which provides the most flexible and comprehensive testing routine.



## Main I/V Channel

- **Programmable control** of current, voltage, load and power; providing constant, linear ramp, staircase and other control profiles, generated by a specified formula.
- **Independent control** for each channel.
- **High accuracy.** 0.1% FSR control and reading accuracy of current or voltage on linear circuitry and 0.5% FSR accuracy on PWM circuitry.
- **Fast current rise time** from 50 $\mu$ s to 2ms on linear circuitry; 10~100ms on PWM circuitry.
- **Optional high and slow speed pulse with synchronized DAQ.** Depending on current/voltage range, pulse function of Arbin software, MITS Pro, can generate high speed (sub-millisecond) bipolar pulses as fast as 500 $\mu$ s and synchronized data sampling on linear circuitry or slow speed (sub-second) pulses up to a stage of 30 minutes on both linear and PWM circuitries.
- **Factory set GSM/CDMA pulse profiles** are included in the software for system with current rate  $\leq 10$ A and voltage  $\leq 15$ V.
- **DC internal resistance.** Online measurement of cell's DC ohmic resistance.
- **Fast data acquisition,** > 40 points/second per PC.
- **Plug and play module** for easy maintenance and expansion.



- **PST/GST functionality** on each channel enables broad electrochemistry studies including material study that employs reference electrodes. Arbin testing system is capable of performing potentiodynamic and galvanodynamic tests such as **cyclic voltammetry (CV)** by voltage ramp.

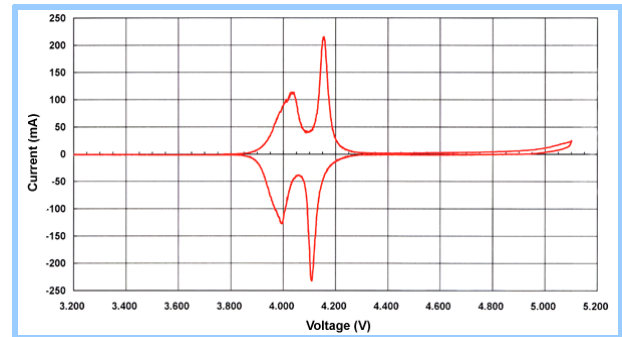


Figure 1. CV of a lithium battery electrode at 50  $\mu$ V/second.

- **Multiple current ranges** on every channel provides high accuracy over a wide, dynamic range.
- **Bipolar current/voltage output** guarantees cross zero linearity and accuracy. It also enables instant cross zero transition with the speed defined by the rise time. One example is the Reverse Charge Technique used in a fast charge application where short discharge pulses are applied during charging.

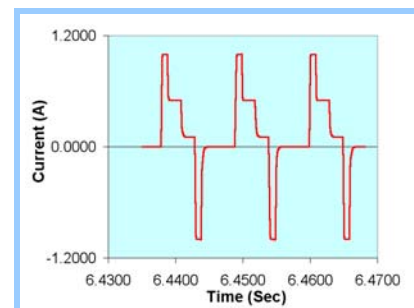


Figure 2. Bipolar pulse.

- **Voltage clamp** to protect from over- or under-charge/discharge.
- **Discharge power supply** is a standard part of BT2000.
- **I/V channel paralleling.** This option allows users to parallel several I/V channels to increase current output.

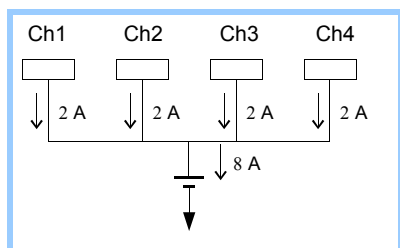


Figure 3. Block diagram for parallel output.

## Optional Auxiliaries

There are many options provided for the BT2000 that enhance the functionality and capability of the system. They are briefly listed as follows:

- **Auxiliary voltage input:** Usually a floating  $\pm 10V$  range with  $10G\Omega$  input impedance, unless specified otherwise.
- **Thermocouple input:** Type T, K, J, E thermocouple inputs can be used. Ice point compensation is internally provided.
- **Thermistor input:** Provides activation signal for the thermistor. Different thermistor types can be specified.
- **Pressure input:** Provides activation signal to the pressure transducer. Can use a variety of sensors.
- **pH meter:** A BNC connector is provided for input from the pH sensor. The input impedance is  $10^{15}\Omega$ .
- **External charge/load adapter:** This option is to test a battery under a specific charger/load or to test the charger/load. It connects the battery under test to an external charger or load. Current, voltage, and other auxiliary measurements are still functional and usable for control which is very useful for evaluating battery and chargers.
- **Smart battery:** The BT2000 reads information from a smart battery and tests the smart battery accordingly.
- **Flow rate input** for reading data from the gas or liquid flow meter into data file.
- **Programmable digital input/output control.** Input control provides external TTL or relay signal to control the testing while output control provides TTL or isolated relay output to trigger external devices such as valves or alarm.

All of the above mentioned auxiliaries, except for external charger and smart battery, can be grouped with main channel(s) to form virtually any combination, 1-to-1, 1-to-many, or many-to-1 mapping.

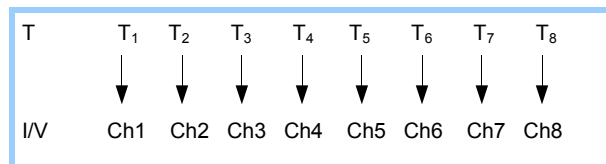


Figure 4. One-to-one mapping.

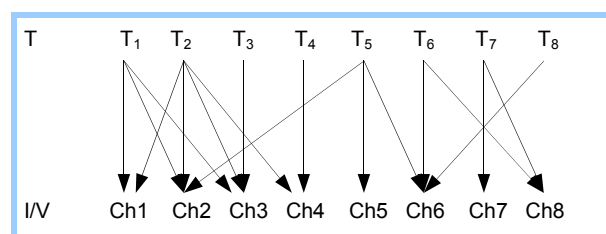


Figure 5. Flexible mapping.

## Optional Attachments

- **AC impedance measurement** to achieve certain accuracy ( $\pm 5\sim 6\%$  of value) of the cell's AC impedance.
- **Auto-calibration fixture and software** allow for automatic calibration of the main I/V channels and auxiliary inputs.
- **Uninterruptible power supply (UPS)** protects against computer shutdown in the event of power failure. Arbin recommends a UPS for the system's protection.
- **Multiple temperature chambers** can be added to the system to provide environmental control around tested cell/battery.
- **Temperature chamber or device controller** to control Arbin temperature chamber or other brands of temperature chamber.
- **Mass flow or metering pump controller** to deliver required flow rate set in the testing schedule and record flow rate data in a data file.
- **Combustible or toxic gas detector and alarm.**
- **Universal battery holder** plugs directly into channel connector or a battery rack.





## Safety Features

The BT2000 hardware and software have many safety provisions to protect it from power failure, circuitry failure, environment failure, or system problems.

- **Current limiting circuitry** prevents current from exceeding maximum current range even when shorted.
- **Watchdog** turns off the system in case of a major hardware failure.
- **Fuses** prevent damage from unexpected shortage or over current.
- **Thermoswitches** prevent over heating from an abnormally large current or breakdown of cooling fans.
- **UPS** (uninterruptible power supplier) prevent data loss or system damage from power failure (optional).
- **Software Safety Limits.** In each schedule, there are safety limits for current, voltage, and temperature for the entire test.
- **Software Step Limits.** For each step, there are limits available for almost every variable or meta variables that can be set for termination of the step or the test.
- **Special safety measure for lithium batteries:** Temperature Cutoff (for systems equipped with temperature input)—this feature comes with each channel. It cuts off cell current immediately when cell temperature passes a specified value.
- **Voltage Clamp:** hardware voltage clamp is available for additional safety protection and to provide smooth current/voltage mode transaction.

## MITS Pro Software

**MITS Pro**, as the operating software, provides the same stable and robust software platform across the entire Arbin product line. Its unique open-ended structure offers full Microsoft compatibility, ease of upgrade, and flexibility. When it applies on BT2000 series of testers, its comprehensive functions and entire capability are fully developed.

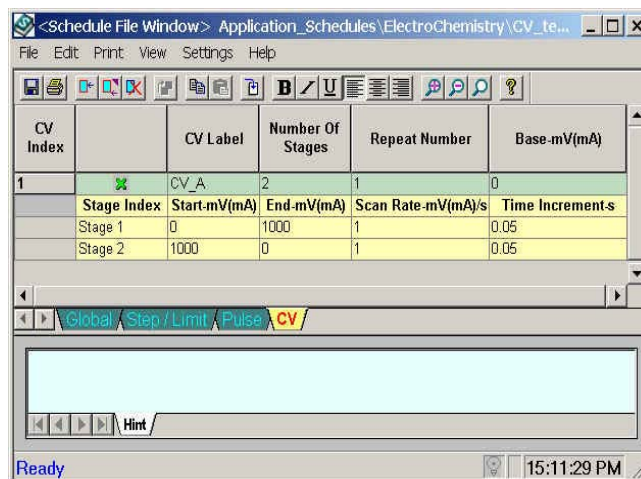
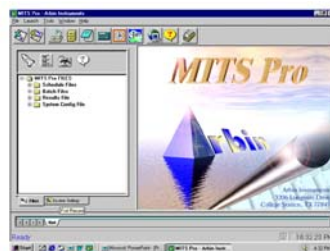


Figure 6. MITS Pro interface for scheduling a CV test.

## General Specifications

TECHNOLOGY	LINEAR	PWM-MOSFET	PWM-IGBT
Current Range per channel	<= 2000 A	<= 400A	<= 500A
Voltage Range per channel	<= 72 V	<= 100V	<= 400V
Power Range per channel	<= 40 kW	<= 40 kW	<= 200 kW
Max Current Ranges per channel	3	3	3
Minimum Rise Time to Full Charge or Full Discharge	20 $\mu$ s ~ 2 ms	~ 10 ms	10 ~ 100 ms
Accuracy	0.02% FSR for V $\leq$ 24V; 0.1% FSR for V > 24V	0.15 ~ 0.25% FSR	0.2 ~ 0.3% FSR
DAQ Speed	100 points/s/PC	100 points/s/PC	100 points/s/PC
Special Features	<ul style="list-style-type: none"> <li>• Low to high current and power.</li> <li>• Low noise.</li> <li>• Fast rise time.</li> </ul>	<ul style="list-style-type: none"> <li>• Medium current, voltage and power.</li> <li>• Compact size.</li> <li>• Regenerative power</li> <li>• Less heat</li> </ul>	<ul style="list-style-type: none"> <li>• High current, power and voltage.</li> <li>• Lower cost per watt.</li> <li>• Regenerative power</li> <li>• Much less heat</li> </ul>