Battery Charge/Discharge Cycler

Principle & Application

May, 2022

WonATech

Designing the Solutions for Electrochemistry

Potentiostat/Galvanostat| Battery test system | Impedance Analyser | Fuel cell test system

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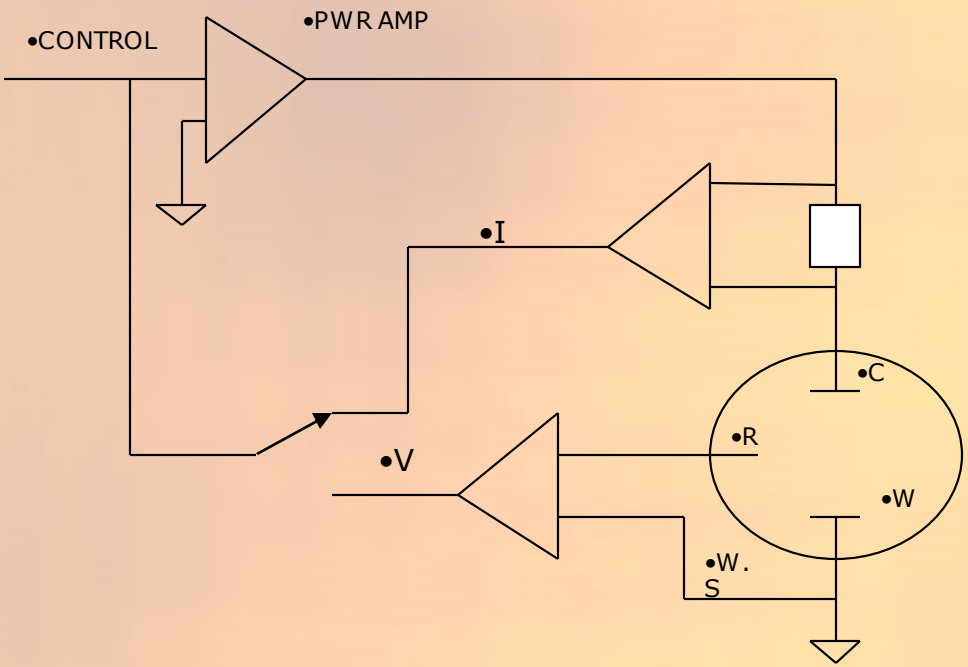
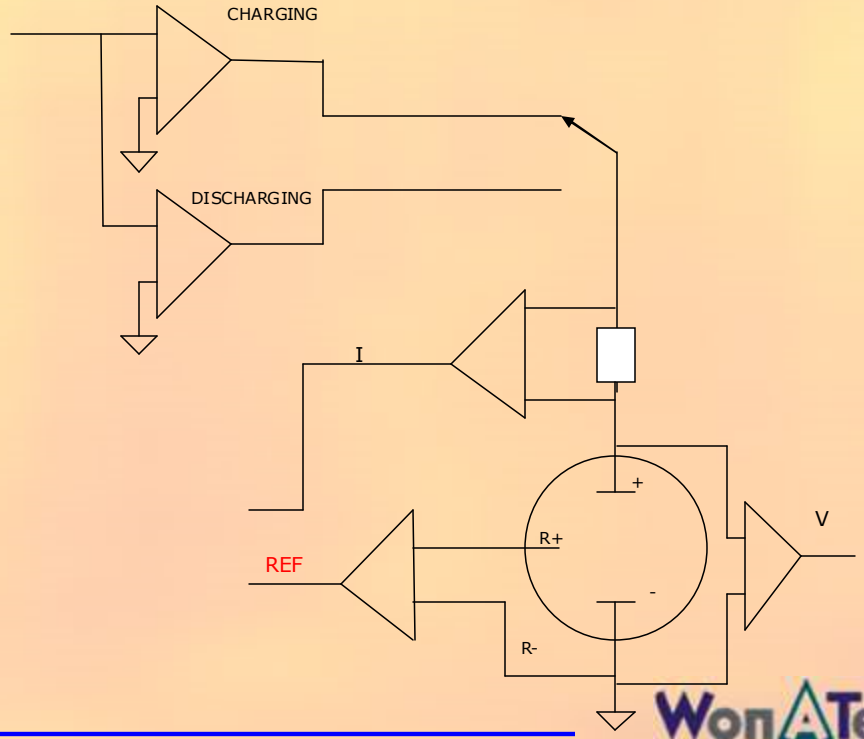
Circuit Difference

- Potentiostat/Galvanostat type
  - Bipolar Linear Circuit
  - Analog Feedback (V&I)
  - Reference (Control & Measurement)



- Power Supply type
  - Charge/Discharge Circuit Switching Unipolar
  - Digital Feedback
  - Reference (Measurement Only)



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0 volt or Negative volt control

- Minus power is needed.
- Half cell control/CV might be needed.
- Electronic load discharging => Over 0V
  - Min. load resistance + Cable/ConnectorR=RL
  - Discharging current: Id
  - Discharging minimum voltage: Em=RL*Id.
    - e.g. Discharging current: 10Amp, RL=0.01Ohm
    - Minimum voltage = 100mV

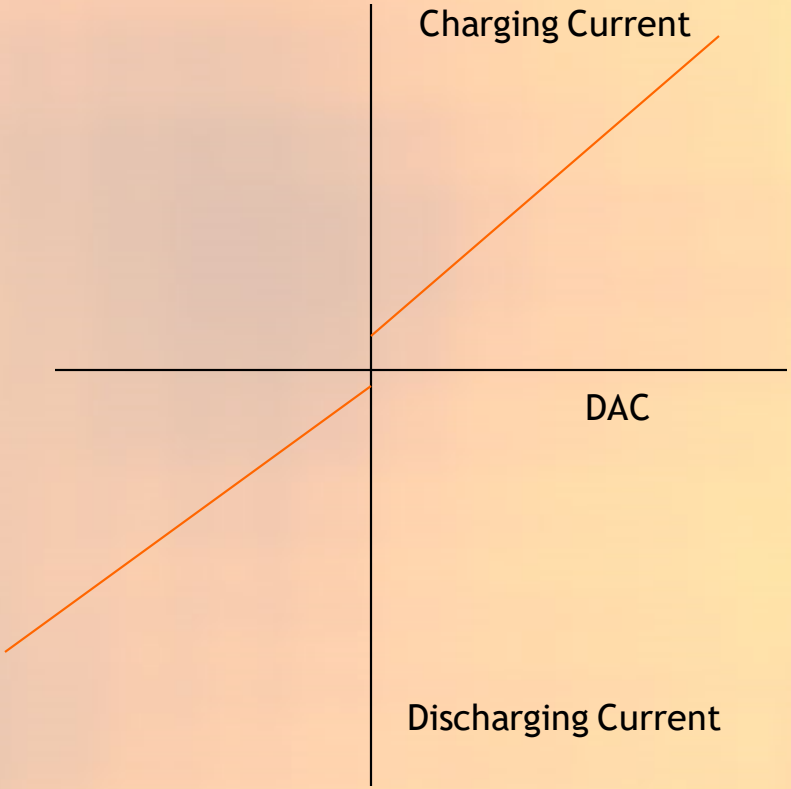
Weak Point Comparison

- Potentiostat/Galvanostat
  - Relatively Expensive
  - Hard To Make Design For Large Power

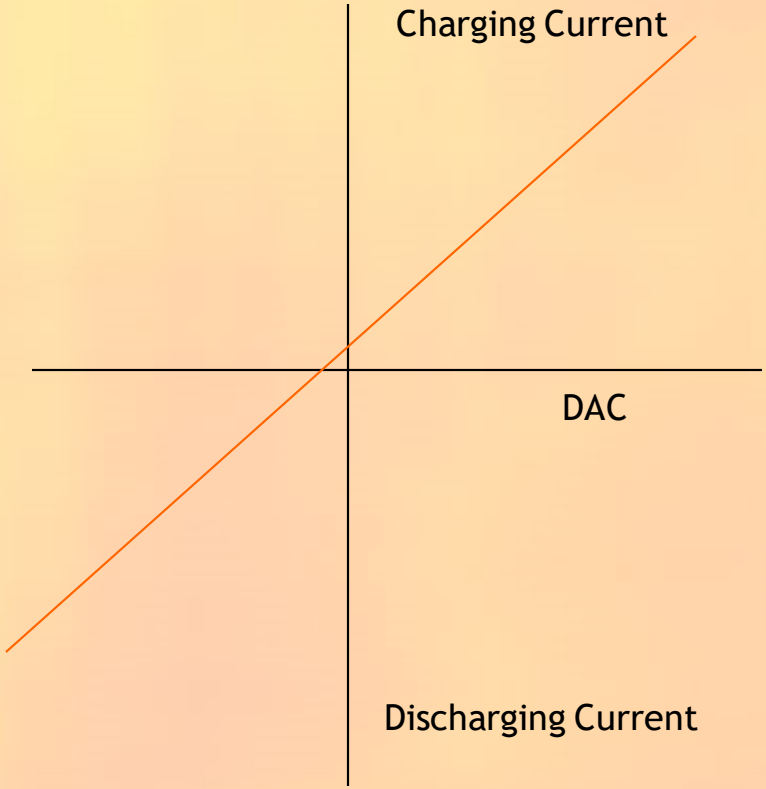
- Power Supply
  - Hard To Maintain Constant Voltage
  - Unavailable For Electrochemical Experiment (3 Electrode Configuration)
  - Big Error Margin For Low Current
  - Deadtime On Polarity Switching (Charging/Discharging)
  - Slower Slew Rate

Bipolar Linearity

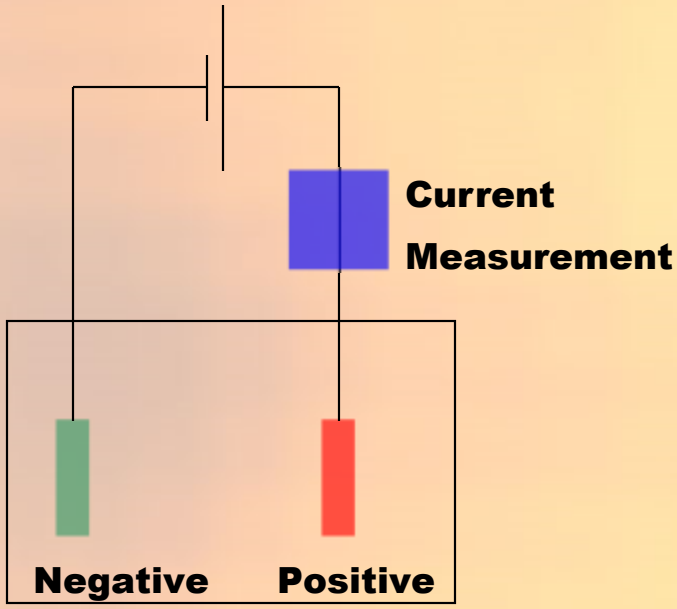
- Power Supply Type



- Potentiostat/Galvanostat Type



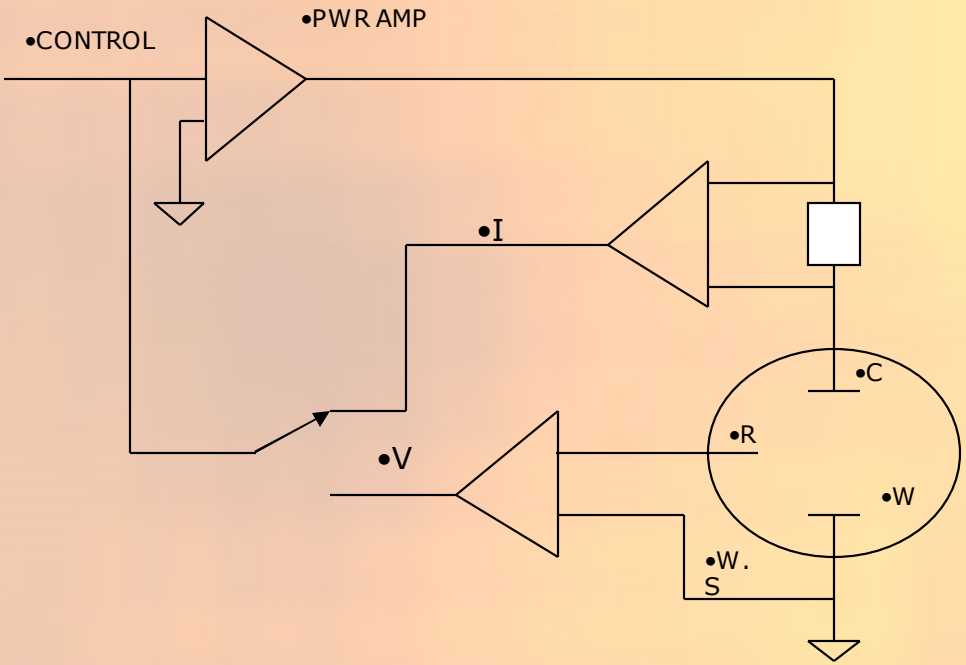
What Is 2-Electrode System?



- Potential Difference
- How To Connect To Potentiostat
- Working + W.S. → Negative(cycler mode)
- Counter + Ref. → Positive (cycler mode)

What Is 3-Electrode System?

- The Function Of Working, Reference, Counter(Auxiliary) Electrode



- Working (Test) Electrode
- Reference Electrode
- Counter (Auxiliary) Electrode

3 Probe & 4 Probe

3 Probe Type

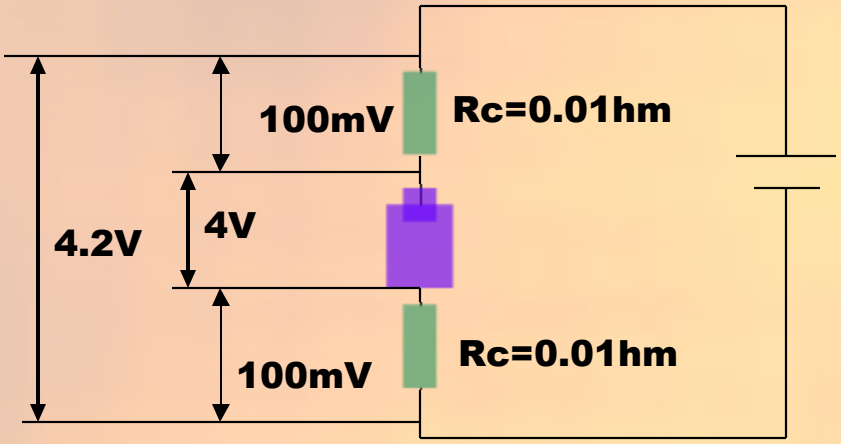
- Working, Reference, Counter
- For Low Current Experiment
- I/E Converter
- Input Impedance
- Current Sensing → Working Electrode

4 Probe Type

- Working, Working Sense, Reference, Counter
- For High Current Experiment
- Instrumentation Amp
- Current Sensing → Working Or Counter Electrode

4 Kelvin Probe Type

- 2 Probe For current flowing
- 2 probe For Voltage Measurement
- Ohmic Drop (Cable Resistance:Rc, Flowing current: If)

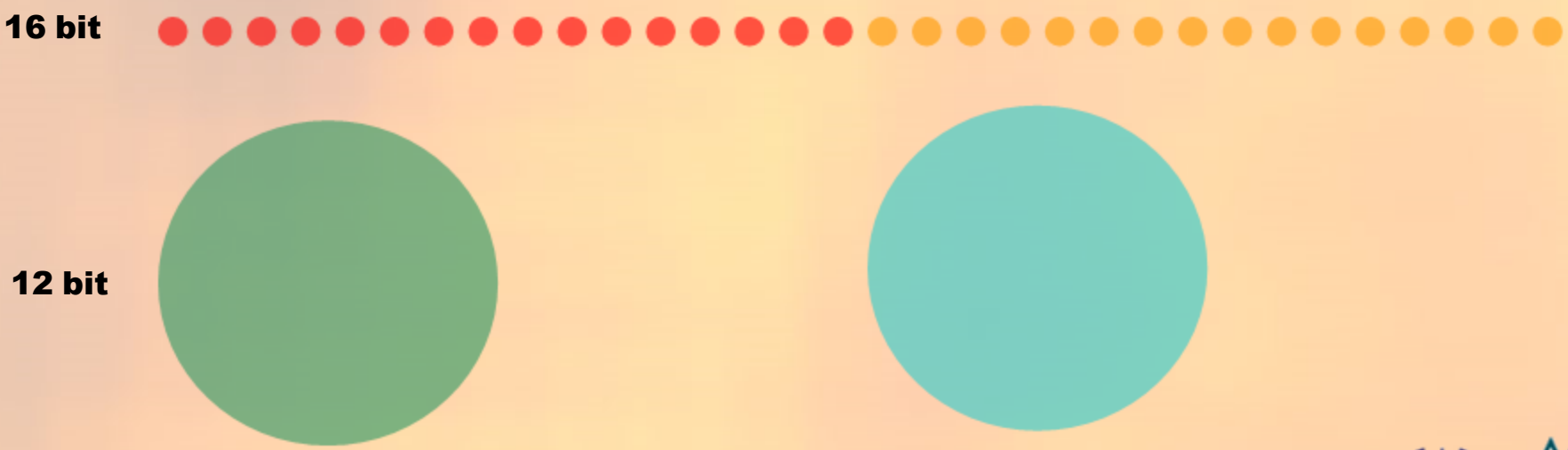


Auxiliary(Temp,Pressure etc.) Voltage

- Voltage In Potentiostat = Working vs. Reference Electrode
- Auxiliary Voltage = Counter vs. Reference Electrode
  Or Counter vs. Working Electrode
- External Signal Input

Multi-Current Range & Resolution

- F.S (Full Scale)
- Resolution (ADC, DAC)
- 16 bit vs. 12 bit → 16 Times Precise
- e.g. +/-5V: 0.15mV(16bit) 2.44mV(12bit)

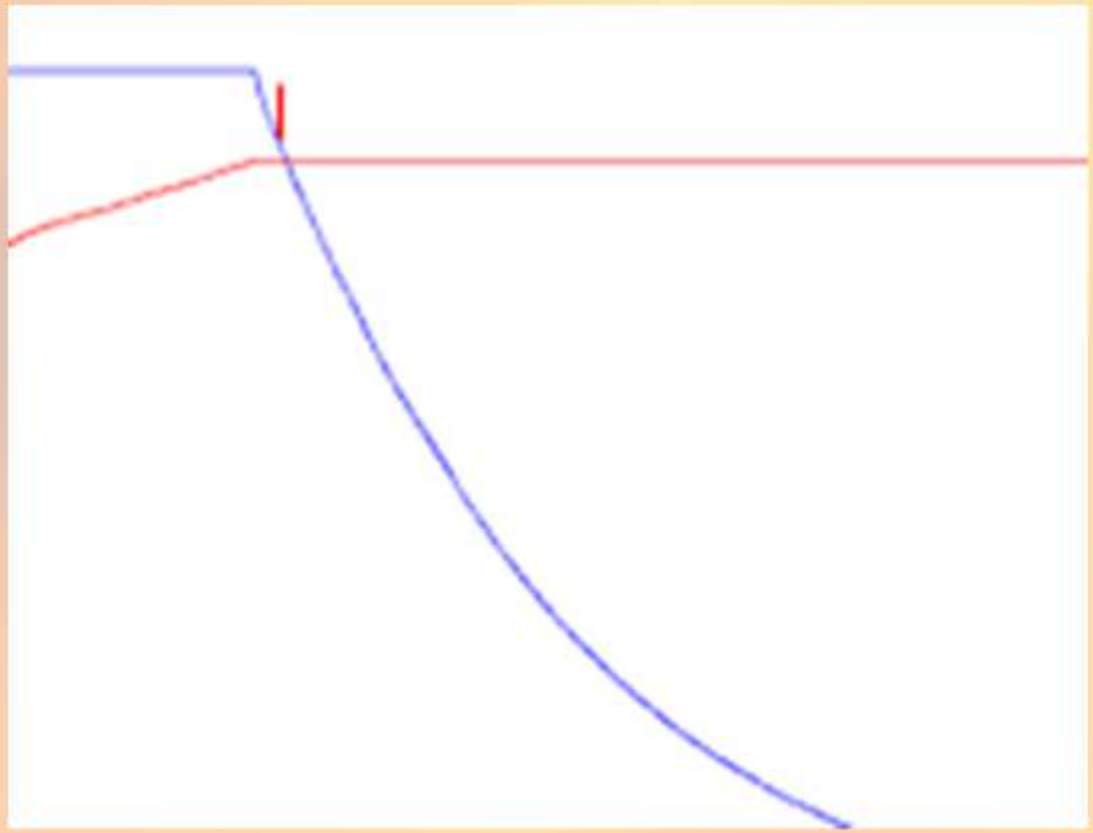


Resolution Comparison

- **Green dot: 12bit**
- **Blue dot: 16 bit**

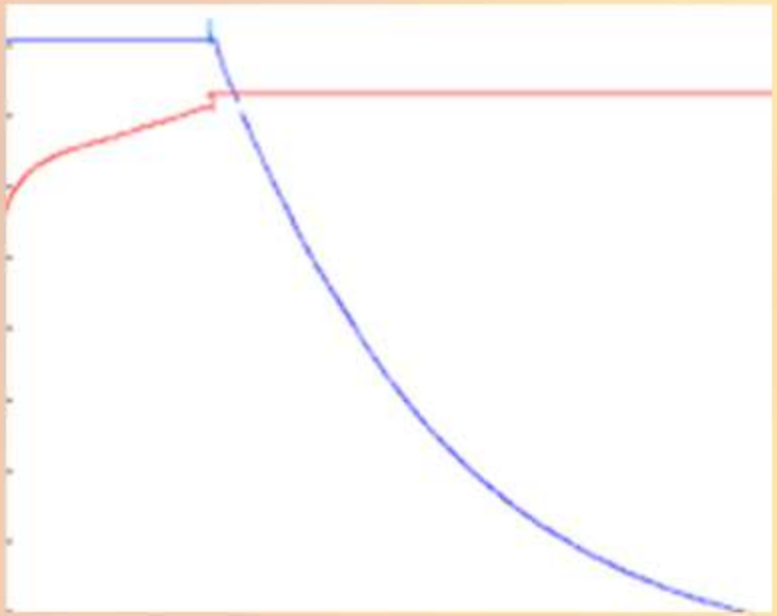
Voltage Spike

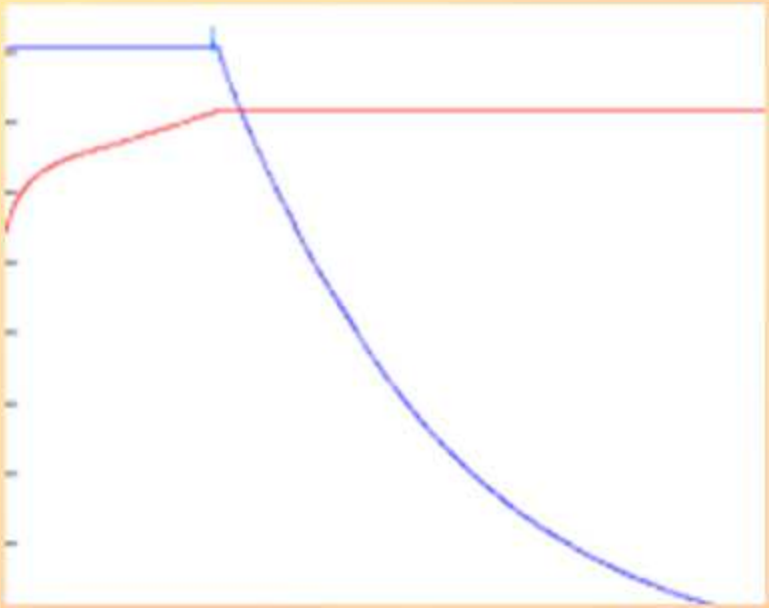
- For The Cases Where Sensing Rate and Transition(Mode Switching) Rate Is Slow.



Current Spike

- For The Case Where V Measurements And Control Values Are Different.
- For The Case Where Cut-off Values And Control Values Are Different.





What is Safety Condition?

- Stable Condition To Protect Instrument
- Safety Condition To Protect Cell
- For WBCS
  - Safety Limit For System and/or Cell
  - Watch Dog Function
  - Fail Function
  - Automatic Voltage Detection Before Run.
  - Independent Server Program
  - Poly switch instead of fuse
  - Software UPS function