

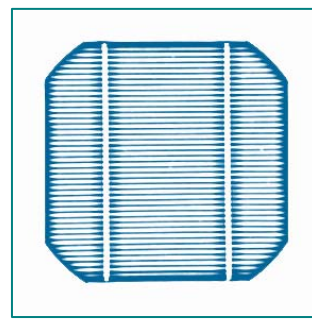
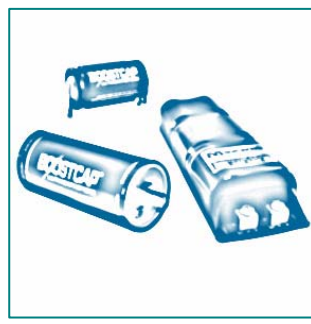
**We Adapt
So You Don't Have To!**



WEIS500 Electrochemical Workstation



Electrochemical Workstation
including internal FRAs
10Volt/5Amps
For
Batteries
Fuel Cells
Super Capacitors
Solar Cells



All in one system for electrochemical energy application

- Versatile High quality All in One system for Electrochemical application (potentiostat/galvanostat/ZRA/ impedance analyzer)
- Compact size with full functions with +/-10V & +/-5A control; 60Watt
- Wide current ranges(5A to 50pA) for various application
- Optional software packages:
 - Battery test software package(BATS),
 - EIS software package (EIS)
 - Electrochemical analysis software package(EAS)
 - Corrosion software packages(CORS)
- Pulse charge/discharge test(GSM,CDMA etc) & pulse plating available in BATS-option
- For accurate control/measurement, this system has 3 voltage reading ranges and 12 current ranges
- Signal Generator Function is available.
- USB communication



System Feature

- Touch screen type front color LCD panel
- Capable of multitude of applications: battery, fuel cell, super capacitor, solar cell, corrosion, general electrochemistry, sensor, etc
- -10V to 10V@5Amp control range
- High speed potentiostat circuit
- Impedance measurement capability (with EIS option) - no separate analyzer required
- Simultaneous voltage measurement between WE and CE, between RE and CE and between WE and RE
- Current range from 50pA to 5A
- Bipolar pulse capability (with BATS option)
- Max. sample rate : 10usec/point(burst mode)
- Temperature measurement as standard
- Waveform generator function
- Auxiliary two Analog output & two Analog Input
- Digital output & Digital Input
- Expandable up to 8 channels per PC
- EIS data analysis software(ZMAN™)-option
- Free software upgrade
- Two years warranty

System

WEIS500, the outstanding potentiostat/ galvanostat, is the best choice for the complete DC and impedance characterization of various energy sources and storage such as fuel cells, batteries, solar cells, and super capacitors. And also, its versatile functions make it suited to other application including corrosion, coatings, sensors and other fundamental electrochemical analysis.

This system is designed under FPGA and DSP control for high speed capability with

DAC control: Two set of high speed 16bit DAC(50MHz) for offset & scanning & two set of 16bit DAC(172kHz) for auxiliary analog output control

ADC control: Two set of 16 bit 500kHz ADC for reading voltage / current and 4 channel 16bit 250kHz ADCs for Auxiliary data input such as temperature, auxiliary voltage etc. It can provide high frequency EIS, fast pulse techniques with options and high speed sampling time.

The control sweep voltage's full range will be set as maximum control voltage value. This specific function makes accurate voltage control using 16bit resolution of sweep or sine wave' maximum value.

WEIS500 is equipped with a frequency response analyzer(FRA) as standard and it can provides high performance impedance measurements over the frequency range 10uHz to 1MHz with EIS software package option. Due to having I2C port for other device control, other instruments including oven(FaradHT model) and other I2C communication devices can be added to the system and it makes **WEIS500** can test cells at different temperature or other environment by the device control

Versatility

The system has additional two analog inputs (Auxiliary voltage input) and 2 analog output, whereas 8 digital output and 8 digital inputs and one temperature input with K type thermocouple. It will help user expand the usage of instrument.

For example,

1. User can measure the voltage between working electrode and counter electrode and between counter electrode and reference electrode adding to measurement between working electrode and reference electrode using 2 additional analog input(Auxiliary voltage inputs).
2. Using Analog output, it can control rotating speed of rotator, MFC flow rate etc by +/-10V full scale.
3. User can control on/off of Max five devices by DO etc.

Safety

1. This system has "fail" function to protect the system and cell, the system will stop automatically when measured

value is far different from control value caused by battery/fuel cell failure or bad cell connections etc.

2. When communication failure between PC and WEIS occurs, Watchdog function will continue the experiment within data memory size inside WEIS.

3. User can define safety condition setting by inputting his/her own safety levels for voltage, current, temperature etc. If the measurement value exceeds this setting value, The system will automatically stop to protect the system and cell.

The system is controlled from a PC via USB or Ethernet connection(Future function). Using the Ethernet connection, multiple users can access the instrument remotely through the local area network.

Front Panel color LCD display

Touch screen type color LCD display shows information including graphics as followings. You can select display mode by screen touch.



- ✓ Mode display: Potentiostat mode, Galvanostat mode, ZRA mode, FRA mode etc.
- ✓ Current range display
- ✓ Run status display
- ✓ Time display

Mode Selection

- DC mode
 - Graphic selection; I vs. V, V&I vs. time, V vs. logI etc
 - Data value display Time, Voltage, Current, Aux voltage, Aux voltage2, temperature

- EIS mode
 - Graphic selection; Nyquist, Bode etc
 - Data value display Time, Real part(Z'), Imaginary part(Z''), Magnitude, Phase
- BAT mode
 - Graphic selection; V,I vs.time etc
 - Data value display Time, Voltage, Current, Capacity, Power, Temperature

Application

WEIS500 Electrochemical Workstation is ideal for power device research such as battery materials, fuel cells and super capacitors but it can support fundamental research in electrochemistry, development and quality assurance of new sensors, corrosion/coatings evaluation.

- Batteries



The system is very well adapted for researches on cycling behavior of battery. It provides many techniques for battery cycling in both current and potential control modes.

Fast pulse capability for GSM, CDMA test is included in BAT option

- Fuel Cells



WEIS500 is ideal for characterizing the fuel cells and anodic/cathode process mechanism at a development and research grade.

This system can be directly used for PEMFC, DMFC, DEFC etc. With our FaradHT faradaic caged

temperature oven, cell can be tested within RT to 200C by WEIS500 control.

- Super Capacitors



WEIS500 has fast potentiostat circuit with high speed data acquisition. This function is well applicable to super capacitors testing. Charging/Discharging capability is used for this application.

- Solar cells



Solar cell development and production requires extensive material and device testing to improve efficiency and match individual cells for panel

construction. **WEIS500** is the best solution for photovoltaic cell characterization. With each channel's AI, AO, DI, DO, this system can monitor other device's signal and controllable those device too.

- Sensors

WEIS500 can be used for sensor research using with DNA chips or screen printed electrodes. System's minimum current range is 50pA with EIS capability

- Corrosion

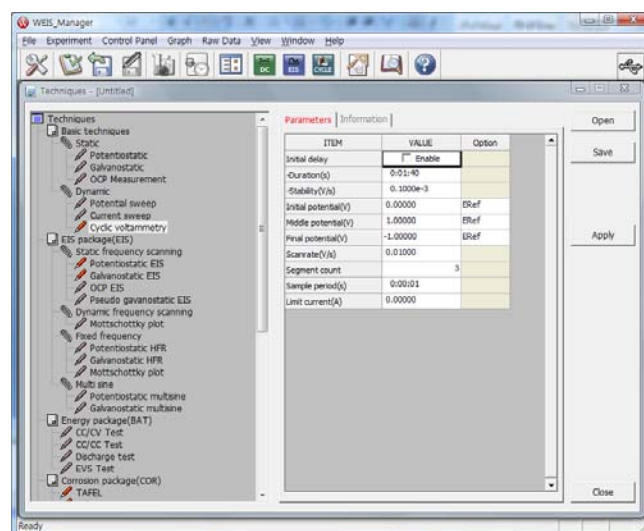
The system is suitable for various electrochemical corrosion measurement application including corrosion rate measurement, coating evaluation using EIS etc. (Corrosion software package and/or EIS software package is needed)

It can do temperature experiment for corrosion research using FaradHT faradaic caged temperature oven.

- Electrochemistry

WEIS500 is also suitable for the development of bio-research, electron transfer kinetic studies or electrochemical analysis of compounds at low trace levels with WEIS' various analog/digital input & output. These will make specific experiment available

Software

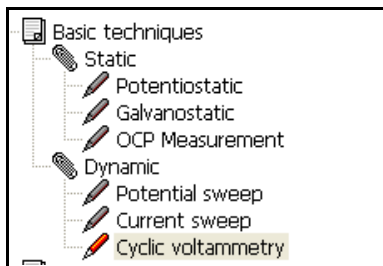


Techniques list by license

Standard software for WEIS500 includes;

- **Basic techniques with standard functions**
 1. Potentiostatic
 2. Galvanostatic
 3. Voltage sweep
 4. Current sweep
 5. Cyclic voltammetry

The above functions can be used sequentially by step control function



Condition-1		
Item	OP	DeltaV
None		
None		
StepTime		
Current		
Current/cm2		
Voltage		
Capacity		
-dV		
dV/dt		
dI/dt		
dT/dt		
Temperature		
Aux1		
Aux2		
Aux3		

● **Sequence manager;**

User can design his/her experiment procedure using TASK sequential routine editor.

➤ **Control Task Parameters:**

- Constant potential, Current
- Scanning potential, Current
- Step potential, Current
- OCP control
- Rest (voltage monitoring only)
- Loop(Cycle) control

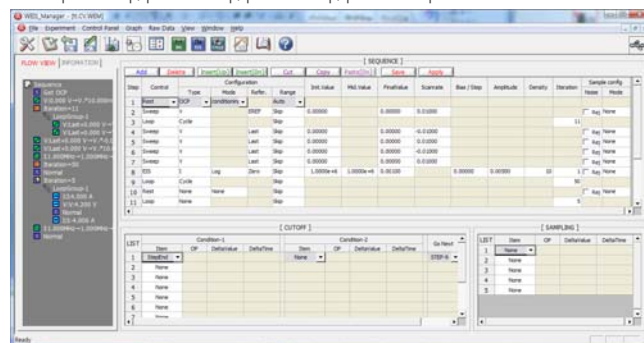
Add Delete Insert[Up] Insert[Dn]				
Step	Control	Configuration		
		Type	Mode	Refer.
1	Rest	OCP	conditioning	
2	Constant Step	V		EREF
3	Sweep	Cycle		
4	EIS	V		Last
5	Loop	V		Last

Add Delete Insert		
Step	Control	Type
		1
2	Sweep	I
3	Loop	C-Rate
4	Sweep	V
5	Sweep	P
		L
		OCP

➤ **Cut-off(Vertex) condition**

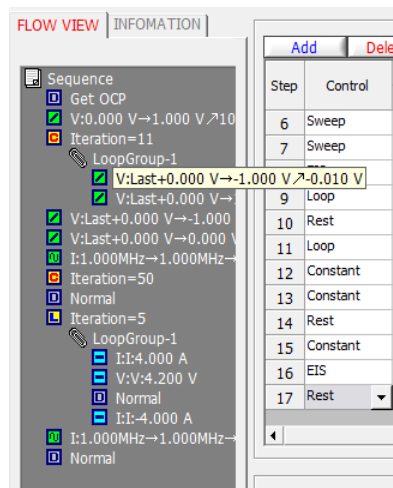
- Time(Step,Loop,cycle)
- Current
- Voltage
- Capacity
- dV/dt or absolute value
- dI/dt or absolute value
- dT/dt or absolute value
- Temperature
- Aux1,2,3
- Eoc etc

➤ Sampling condition: time, |dI/dt|, |dV/dt|, |dT/dt|, |dA1/dt|, |dA2/dt|, |dA3/dt| etc.



Sequence editor

➤ **Flow view**



➤ **Batch function;**

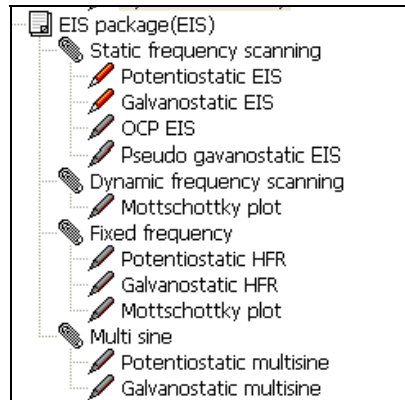
User can design batch file including multiple technique files and/or sequence files. With this batch file, user can do experiments as several techniques/sequence in series automatically.

Other application software package can be added by option.

WEIS500 option software package

For a wide range of application, specific experimental techniques software packages are provided as option

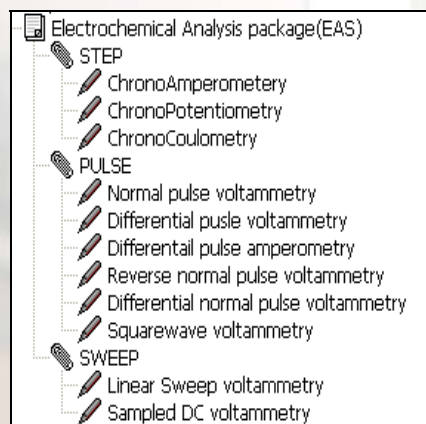
1. EIS software package(EIS)-Option



- 1) Potentiostatic EIS
- 2) Galvanostatic EIS
- 3) Pseudo Galvanostatic EIS
- 4) OCP^(*) EIS
- 5) Dynamic Mottschotky Plot
- 6) Static Mottschotky Plot
- 7) Galvanostatic HFR Monitor
- 8) Potentiostatic HFR Monitor
- 9) Multisine Potentiostatic EIS
- 10) Multisine Galvanostatic EIS

*1. The system measures open circuit potential before for each frequency change and apply AC sine wave on this potential.

2. Electrochemical Analysis software package(EAS)



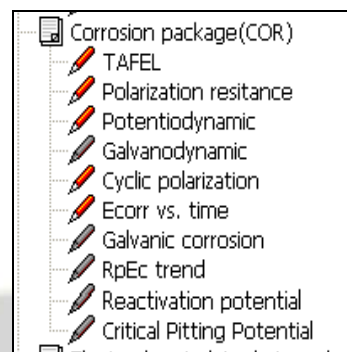
- Voltammetry techniques
 - CA(Chronoamperometry)
 - CC(Chronocoulometry)

- CP(Chronopotentiometry)
- LSV(Linear Sweep Voltammetry)
- SDV(Sampled DC Voltammetry)

- Pulsed techniques

- DPV(Differential Pulse Voltammetry)
- SWV(Square Wave Voltammetry)
- DPA(Diff. Pulse Amperometry)
- NPV(Normal Pulsed Voltammetry)
- RNPV(Reverse normal pulse voltammetry)
- DNPV(Differential normal pulse voltammetry)

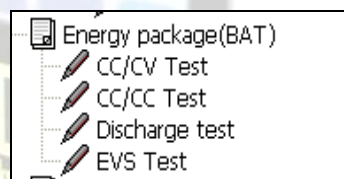
3. Corrosion software package(CORS)-Option



- Tafel(Tafel Experiment)
- Rp(Polarization Resistance)
- CPT(Critical Pitting Temperature) *2
- PDYN(PotentialDynamic)
- CYPOL(Cyclic Polarization resistance)
- GDYN(GalvanoDynamic)
- Reactivation
- RpEc trend
- CPP(Critical Pitting Potential)
- Galvanic Corrosion

*2. This requires Farad-HT faradaic caged oven required.

4. Battery software package(BATS)



4-1) Battery Test techniques

- CC/CV test for Lithium battery charging/discharging cycle life test
- CC/CC test for NiCd or NiMH etc battery

charging/discharging cycle life test

- Discharging test
- EVS(Electrochemical voltage spectroscopy)
- Pulse mode is available for GSM & CDMA profile

4-2) Control mode

- 1) Charge: CC,CC-CV,Pulse
- 2) Discharge: CC,CP,CR,pulse

4-3) Cutoff condition;

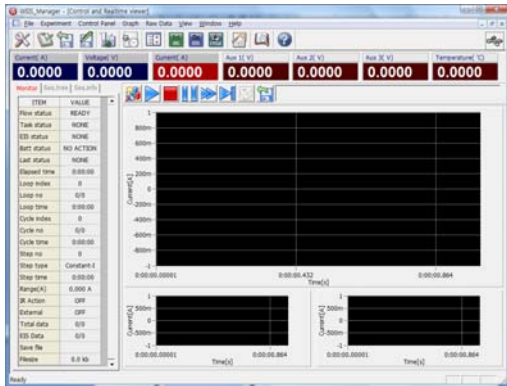
Time,voltage,current,power,temperature,AuxV etc

Various battery charge/discharge test is available including pulse discharge for GSM, CDMA application
 Each software package's upgrade will be provided at free of charge.

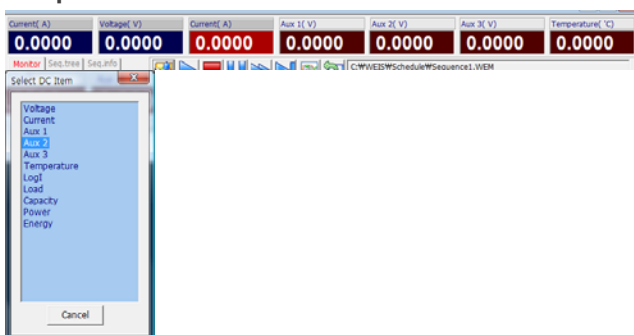
Real time graphic

There are 3 real time graphs for DC test & AC test. User can define each graph's X & Y axis.

Group	Graph	Plot time	X Item	Y Item	Point	Grid	Command
1	1	0:00:01	Voltage	Ampere	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply
	2	0:00:01	Time	Voltage	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply
	3	0:00:01	Time	Ampere	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply
2	1	0:00:01	Time	Ampere	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply
	2	0:00:01	Time	Ampere	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply
	3	0:00:01	Time	Ampere	<input checked="" type="checkbox"/> View	<input type="checkbox"/> View	Apply

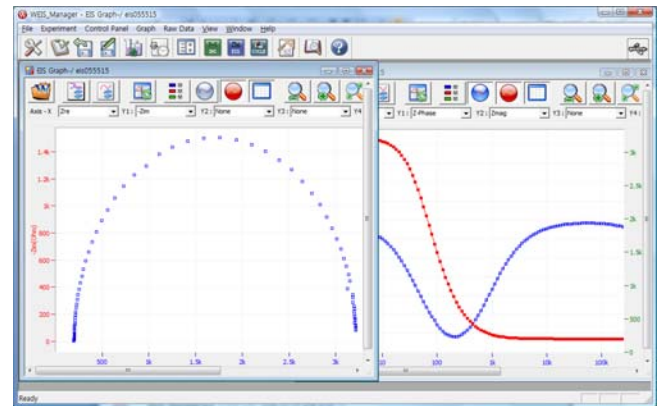


Simple Monitor



- ✓ Major Value display on screen during experiment.
- ✓ 6 parameters can be selected by user

Graph view



- ✓ Free selecting X,Y1,Y2,Y3,Y4 parameters without reloading the files
- ✓ Max. 4 Y axis display
- ✓ Overlay: Max. 5 files
- ✓ Cursor value display

Predefined graph format by graph tool bar

DC graph

- ✓ Current vs. voltage
- ✓ Voltage vs. LogI

Cycle graph

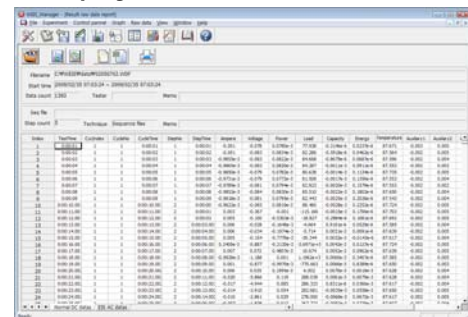
- ✓ Capacity(charging & discharging) vs. cycle number
- ✓ Average voltage(charging/discharging) vs. cycle number

EIS graph

- ✓ Bode
- ✓ Nyquist

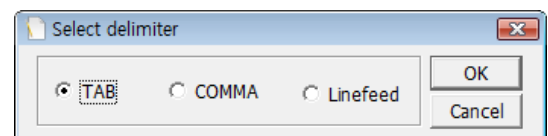
Data Operation

1) Display Data



2) Data file conversion

a. Ascii file conversion



b. Excel file conversion

WEIS500 Specification

Main system	
PC communication	USB2.0 or Ethernet(not ready)
Line voltage	100-240VAC
Front panel	Color Graphic touch screen LCD
Size	130x265x370mm(WxHxD)
output power	Max. 60Watt

Common	
Cell cable	1meter shielded type
Control	FPGA with DSP
Calibration	Automatic
Data Acquisition ADC	2x16bit ADCs (500kHz)for voltage, current 4x 16bit ADCs(250kHz) for auxiliary reading
DAC	2x16bit DAC(50MHz) for offset & scan 2x16bit DAC(172kHz) for analog output

Power amplifier(CE)	
Power	60Watt (12V@5A)
Compliance voltage	+12V to -12V ^{*3}
Maximum current	±5A
Bandwidth selection	Dual
bandwidth	1MHz
Slew rate	8V/usec

Potentiostat Mode(voltage control)	
- voltage control	
Control voltage range	+10V to -10V
Voltage resolution	16 bit per setting Max value as full scale
Voltage accuracy	0.1% f.s
Max. scan range	+10V to -10V vs. ref. E
- current measurement	
Current ranges	12 Ranges(auto/manual setting) 50pA ~ 5A
Current resolution	16 bit; 150uA,15uA,1.5uA,150nA,15nA,1.5nA, 150pA,15pA,1.5p,150fA,15fA,1.5fA
Current accuracy	0.1% f.s(5A-5uA), 1%f.s(500nA-50pA)

Galvanostat Mode(current control)	
- Current control	
Control current range	Max. ±5A ± full scale depending on selected range
Current resolution	16 bit; 150uA,15uA,1.5uA,150nA,15nA,1.5nA, 150pA,15pA, 1.5p,150fA,15fA,1.5fA
Current accuracy	0.1% f.s(5A-5uA), 1%f.s(500nA-50pA)
- Voltage measurement ^{*5}	
Voltage ranges	10V, 1V, 100mV
Voltage resolution	16 bit; 0.3mV,30uV,3uV
Voltage accuracy	0.1% f.s

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Specifications subject to change

Electrometer	
Max input voltage	±10V
Input impedance	10 ¹⁰ Ω 100pF for high current ranges
Bandwidth	>2MHz
CMRR	>60dB (@100kHz)

EIS(Internal FRA)	
Frequency	10uHz ~ 1MHz
Amplitude	0 ~ 10Vpp 0.1 ~ 50%(GST)
Mode	Potentiostatic, Galvanostatic, Pseudo-Galvanostatic, OCP EIS, Potentiostatic & Galvanostatic HFR, Multisine EIS(PST & GST)

Interfaces	
DI/DO port	
● Digital Output	8 TTL outputs
● Digital Input	8 TTL inputs
Aux port	
● Auxiliary voltage Inputs	2 Analog Inputs: ±10V For measurement of WE vs. CE CE vs. RE or other signal
● Analog Output	2 Analog output: ±10V For stirrer,MFC,RDE etc
● Sig Generator output	1 Analog output as waveform generation output
Peripheral communication	I2C to control external devices ; Farad-HT etc
Temperature measurement	1 K-type thermocouple input
Temperature control	Via I2C

Software	
Max steps per experiment	256
Shutdown safety limits	Voltage, current, temperature etc
Max. sampling rate	100kHz(10usec)-burst mode
Min. sampling rate	Unlimited
Sampling condition	Time, dv/dt, dI/dt, temp.

PC requirement	
Operating System	WindowsXP/2000
PC specification(minimum)	Pentium4, RAM 512MB
Display	1024x768 high color

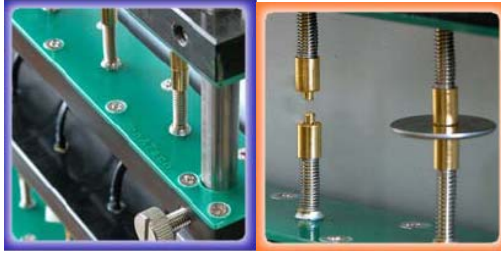
General	
Dummy cell	One external dummy cell included
Thermocouple	1.5meter K-type (option)
Auxiliary cable	Option
DI/DO cable	Option

Optional accessories

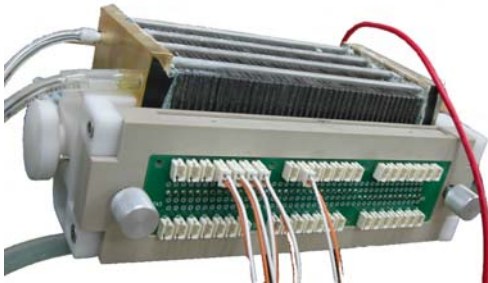
1. Faradaic caged temperature oven (Farad-HT)



2. Battery Jigs



3. Fuel cell stack jig



4. Thermocouples
5. AI/AO cables
6. Aux cables
7. I2C cables



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