# CS310X Multi-channel Potentiostat/Galvanostat

CS310X multi-channel Potentiostat/Galvanostat is a precise and cost-effective electrochemical instrument offering 4~8 channels. Each channel can work independently in a complete electrical isolation mode. All working electrodes are designed in switchable earthing/floating mode. CS310X can significantly boost experiment efficiency. It would be an ideal potentiostat for batch battery testing, corrosion, electrocatalysis, etc.

Customers can order the number of channels according to their budget. There are 4 basic options for CS310X.

**Option A:** 4-channel with EIS in one channel

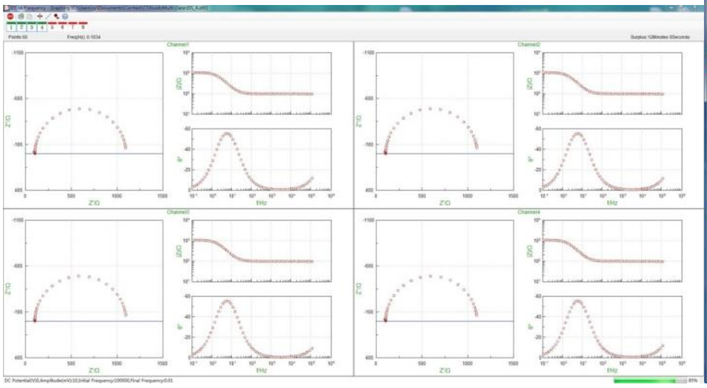
**Option B:** 4-channel, with EIS in all four channels

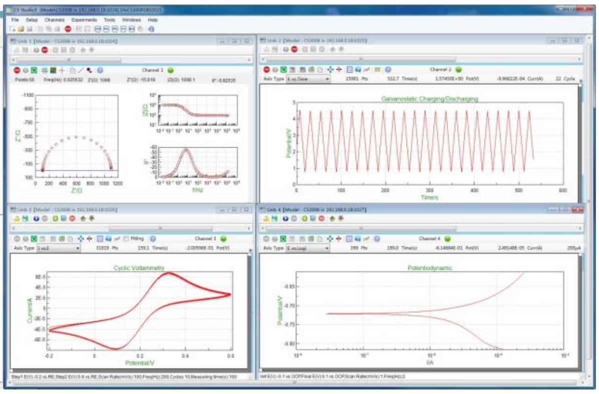
**Option C:** 8-channel, with EIS in one channel

**Option D:** 8-channel, with EIS in all 8 channels

The lower option can be upgraded into a higher one after the purchase.

CS310X can run the same experiment on all channels or different experiments on each channel simultaneously. It is beneficial for batch electrochemical tests.





Thanks to the expandable slot design, Customers can open the chassis and install the potentiostat board to increase the number of channels.

CS310X provides the maximum applied potential of ±10V, the maximum current of ±1A and the maximum compliance voltage of ±21V for each channel of potentiostats. Floating module and electrical isolation design guarantee complete independence of each channel.

| Specifications | |
|---|---|
| Number of channels with boards: 4/8 | Channel insulation resistance: >100MΩ |
| Communication: Ethernet | Lower-pass filter: covering 8-decade |
| Maximum Potential control : ±10V (each channel) | Maximum output current: ±1A (each channel) |
| Potential accuracy: 0.1%×full range±1mV | Current accuracy: 0.1%×full range |
| Potential resolution:10μV(>100Hz), 3μV(<10Hz) | Current resolution: 1pA |
| Potential rise time: <1μs(<10mA), <10μs(<2A) | Current range: 2nA ~2A, 10 ranges |
| Reference electrode input impedance: $10^{12}$Ω\|\|20pF | Maximum current output: 1A |
| Compliance voltage: ±21V | Current increment during scan: 1mA @1A/ms |
| CV and LSV scan rate: 0.001mV~10000V/s | Potential increment during scan: 0.076mV@1V/ms |
| CA and CC pulse width: 0.0001~65000s | DPV and NPV pulse width: 0.0001~1000s |
| SWV frequency:0.001~100KHz | CV minimum potential increment: 0.075mV |
| AD data acquisition:16bit@1MHz,20bit @1kHz | IMP frequency:10μHz~1MHz |
| DA resolution:16bit, setup time:1μs | Current and potential range: automatic |
| Operating system requirements: Windows 10 /11 | Net weight: 12.5 Kg Dimensions: 40*40*14cm |
| **Electrochemical Impedance Spectroscopy (EIS)** | |
| **Signal generator** | |
| Frequency range: 10μHz~1MHz | AC signal amplitude: 1mV~2500mV |
| Frequency accuracy: 0.005% | Signal resolution: 0.1mV RMS |
| DDS output impedance: 50Ω | DC Bias: -10V~+10V |
| Wave distortion: <1% | Waveform: sine wave, triangular wave, square wave |
| Scan mode: Logarithmic/linear, increase/decrease | |
| **Signal Integrator** | |
| Maximum integral time:$10^6$ cycles or $10^5$s | Measurement delay:0～$10^5$S |
| Minimum integral time:10ms or the longest time of a cycle | |
| **DC offset compensation** | |
| Potential compensation range: -10V~+10V | Current compensation range: -1A~+1A |
| Bandwidth adjustment: automatic and manual, 8-decade frequency range | |

# Techniques

**Stable polarization**

- Open Circuit Potential (OCP)
- Potentiostatic (I-T curve)
- Galvanostatic
- Potentiodynamic (Tafel plot)
- Galvanodynamic (DGP)

**Transient Polarization**

- Multi Potential Steps

- Multi Current Steps
- Potential Stair-Step (VSTEP)
- Galvanic Stair-Step (ISTEP)

**Chrono Method**

- Chronopotentiometry (CP)
- Chronoamperametry (CA)
- Chronocaulometry (CC)

**Voltammetry**

- Linear Sweep Voltammetry (LSV)
- Cylic Voltammetry (CV)
- Staircase Voltammetry (SCV) #
- Square Wave Voltammetry (SWV) #
- Differential Pulse Voltammetry (DPV) #
- Normal Pulse Voltammetry (NPV)#
- Differential Normal Pulse Voltammetry (DNPV) #
- AC Voltammetry (ACV) #
- $2^{nd}$ harmonic AC Voltammetry (SHACV)
- Fourier Transform AC Voltammetry (FTACV)

**Battery test**

- Battery Charge and Discharge
- Galvanostatic Charge and Discharge (GCD)
- Potentiostatic Charging and Discharging(PCD)
- Potentiostatic Intermittent Titration Technique (PITT)
- Galvanostatic Intermittent Titration Technique (GITT)

**Electrochemical Impedance Spectroscopy (EIS)**

- Potentiostatic EIS (Nyquist, Bode)
- Galvanostatic EIS
- Potentiostatic EIS (Optional freq.)
- Galvanostatic EIS(Optional freq.)
- Mott-Schottky
- Potentiostatic EIS vs. Time (Single freq.)
- Galvanostatic EIS vs. Time (Single freq.)

**Corrosion Measurements**

- Cyclic polarization curve (CPP)
- Linear polarization curve (LPR)
- Electrochemical Potentiokinetic Reactivation (EPR)
- Electrochemical Noise (EN)
- Zero resistance Ammeter (ZRA)

**Amperometric**

- Differential Pulse Amperometry (DPA)
- Double Differential Pulse Amperometry (DDPA)
- Triple Pulse Amperometry (TPA)
- Integrated Pulse Amperometric Detection (IPAD)

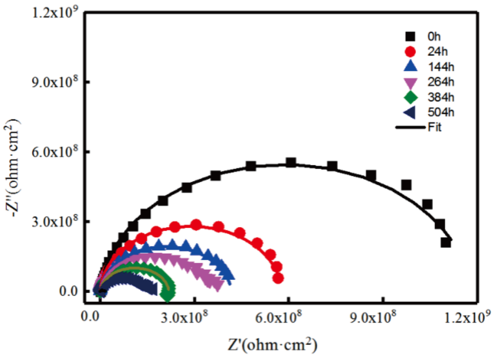
# There is corresponding stripping technique

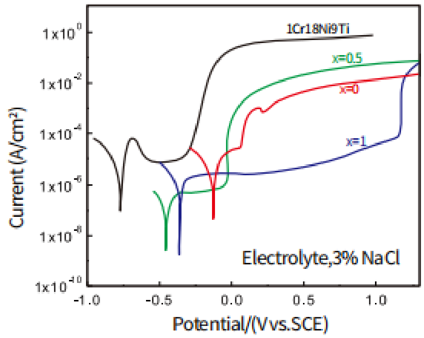
# Applications

## Corrosion Electrochemistry

CS potentiostats/galvanostats support a variety of electrochemical techniques for corrosion, such as OCP recorder, potentiodynamic, EIS, cyclic polarization (CPP), LPR, hydrogen diffusion test, zero resistance ammeter (ZRA), electrochemical noise (ECN), etc.

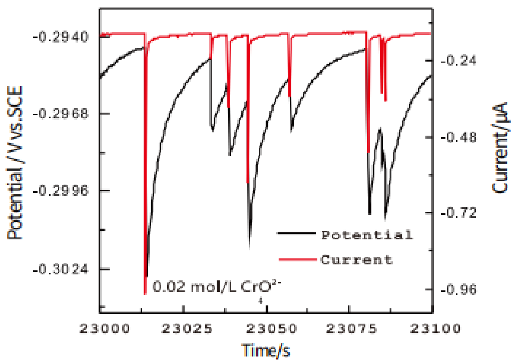
Due to their high input impedance($10^{13}\Omega$), they are especially suitable for EIS measurement of high-impedance systems like coating, concrete, and pure water.




High-impedance coating ageing test in salt spray tests

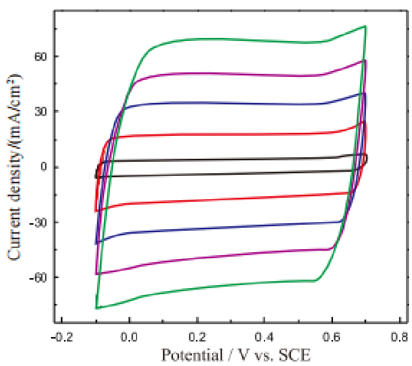
Polarization curves of Ti-alloy& stainless steel in 3%NaCl solution




ECN of low-carbon steel in 0.05mol/L Cl+0.1mol/L $NaHCO_3$

## Energy & Battery Testing

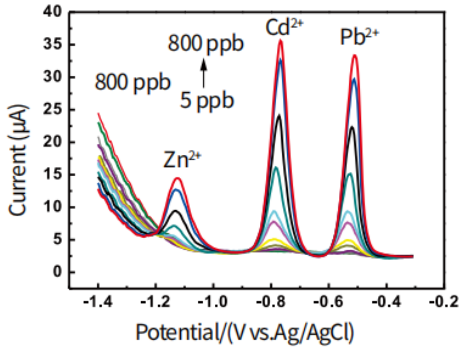
With versatile functions like linear sweep voltammetry (LSV), cyclic voltammetry (CV), galvanostatic charge/discharge (GCD), EIS(including potentiostatic and galvanostatic modes) with precise IR compensation, CS potentiostats are widely used in supercapacitor, Li-ion batteries, Li-S batteries, fuel cell, solar cell, solid-state batteries, flow batteries, and metal-air batteries, *etc*.




CV of PPy supercapacitor in 0.5 mol/L $H_2SO_4$ solution

## Analytical Electrochemistry

CS potentiostats include comprehensive voltammetric methods such as NPV, DPV, DNPV, SWV, and ACV, which make them ideal for quantitative analysis of trace elements via the intrinsic Voltammetry stripping techniques.

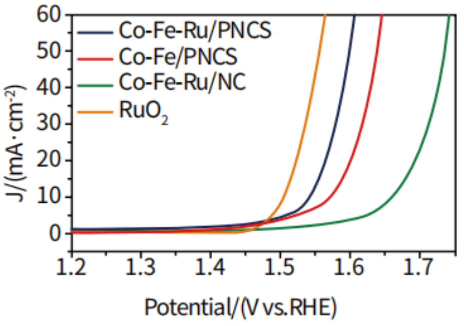



Stripping voltammetric curves in the solution dissolved with $Pb^{2+}$, $Cd^{2+}$, and $Zn^{2+}$ ions

## Electrocatalysis

Based on CV and LSV techniques, CS potentiostats can carry out long-term tests for ORR, OER, HER, and $CO_2$ reduction, which is crucial for evaluating catalyst stability. In addition, the CS2350M bi-potentiostat and multichannel potentiostat specialize in Faradaic efficiency synchronous measurement.

CS potentiostats can measure the half-wave potential (ORR) and overpotential (HER, OER) of catalysts and calculate the power density and energy density of Redox peaks.




LSV curves of various catalysts in alkaline solution

## Electrochemical Sensor

Thanks to the high current sensitivity(100fA) and voltage resolution(1 μV), the CS potentiostat can be used for the R&D of biosensors and electrochemical sensors.

# Technical Advantages

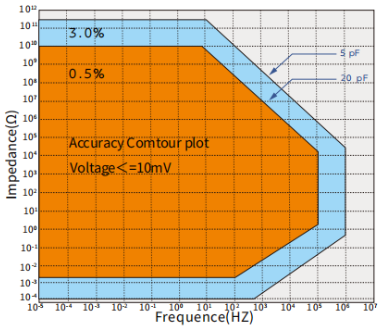
## Switchable floating and earthing mode

All CS potentiostats/galvanostats can switch between the floating and earthing modes, and this strategy is beneficial for studying electrochemical systems in which the working electrodes are intrinsically ground, such as autoclaves, in-site concrete structures and multi-working electrodes requiring isolation, etc.

## High-bandwidth EIS

with the help of built-in digital FRA and arbitrary signal generator, as well as the high input impedance ($10^{13}\,\Omega$), the CS potentiostat is particularly suitable for EIS measurements of high-impedance systems (such as coating, membrane, concrete, etc.)

Based on the DC bias compensation technique, CS potentiostats can conduct EIS tests under different charge/discharge states of batteries, making them suitable for ultra-low resistance systems, such as power batteries, fuel cells, water-splitting equipment, etc.




### Multiple electrode configurations

CS potentiostats support 2-, 3-, or 4-electrode configurations and can measure the galvanic current via built-in zero resistance ammeter circuits.

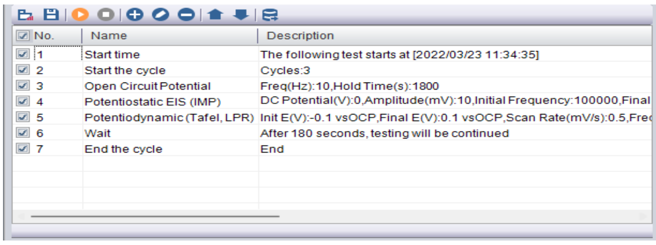
### Independent multiple channels

For CS 310X multi-channel potentiostat, each channel is completely independent. It can be used for the electrochemistry measurements of multiple cells or multiple working electrodes in a cell.

CS2350M Bipotentiostat/multi-channel potentiostat can be used for the RRDE test, dual-cell hydrogen diffusion test.

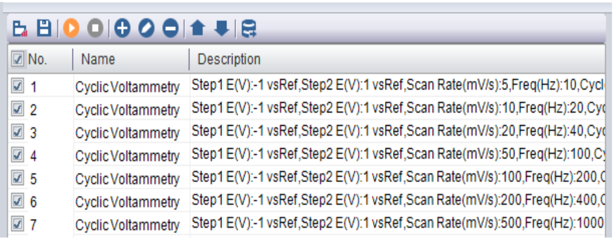
## User-defined sequence test

CS Studio 6.0 for Windows software supports user-defined sequence tests ("combination test"), which can facilitate automatic testing according to user-defined experiment sequences.



| No. | Name | Description |
|---|---|---|
| 1 | Start time | The following test starts at [2022/03/23 11:34:35] |
| 2 | Start the cycle | Cycles:3 |
| 3 | Open Circuit Potential | Freq(Hz):10,Hold Time(s):1800 |
| 4 | Potentiostatic EIS (IMP) | DC Potential(V):0,Amplitude(mV):10,Initial Frequency:100000,Final |
| 5 | Potentiodynamic (Tafel, LPR) | Init E(V):-0.1 vsOCP,Final E(V):0.1 vsOCP,Scan Rate(mV/s):0.5,Fre |
| 6 | Wait | After 180 seconds, testing will be continued |
| 7 | End the cycle | End |

Sequence Test: corrosion tests



| No. | Name | Description |
|---|---|---|
| 1 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):5,Freq(Hz):10,Cycl |
| 2 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):10,Freq(Hz):20,Cyc |
| 3 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):20,Freq(Hz):40,Cyc |
| 4 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):50,Freq(Hz):100,Cy |
| 5 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):100,Freq(Hz):200,C |
| 6 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):200,Freq(Hz):400,C |
| 7 | Cyclic Voltammetry | Step1 E(V):-1 vsRef,Step2 E(V):1 vsRef,Scan Rate(mV/s):500,Freq(Hz):1000 |

Sequence Test: Pseudocapacitor tests

### Power booster

Through CS2020B/CS2040B/CS2100B booster, the CS potentiostats can extend their output current up to ±20A/40A/100A, meeting the growing requirements in fuel cells, power batteries, electroplating and

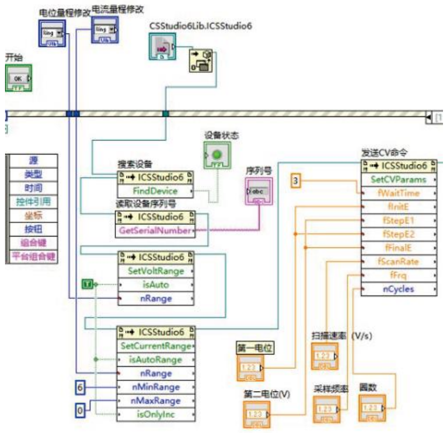
The compliance voltage of single-channel potentiostat can be customized(±30V),suitable for carbon/nitrogen electrochemical reduction.

With a multiplexer, the CS single-channel potentiostats can be extended to 16~32 channels for high throughput testing.

CS potentiostats can work with a CST520 arrayed electrode mapper to study the non-uniform corrosion of metal samples under deposits, coatings and anti-rust oils.

### Software development kit (SDK)

All CS potentiostats run under the control of CS Studio 6.0 for Windows (CSS 6.0). The CSS6.0 supports third-party languages, such as LabVIEW, C, C++, C#, VC, Python and others. Some API general interfaces and development examples can be supplied with the CS potentiostats. Through the SDK, customers can implement user-defined test methods.



## Real-time data saving

CSS 6.0 saves experimental data timely, even if the experiment is accidentally interrupted by a power failure or computer shutdown. CSS 6.0 supports several data formats compatible with Originpro and Microsoft Excel.

## Versatile data analysis functions

CSS 6.0 provides robust functions, including various electrochemical measurements and data analysis. It can complete Tafel plot fitting, CV derivation, integration and peak height analysis, EIS equivalent circuit fitting, etc.

3, 4 parameter polarisation curve fitting.

EIS fitting

Electrochemical noise spectrum analysis

Pseudo-capacitance calculation

GCD-specific capacitance, efficiency calculation

Mott-Schottky analysis

CV curve analysis

Activation/re-passivation curve analysis