

An Integrated 16-Channel Potentiostat Platform Enables Parallel Electrochemical Measurements

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Electrochemical sensing | Custom hardware | Multiple channels | Programmable current ranges



Motivation & Objective

Electrochemical sensing offers high sensitivity, rapid response, and compatibility with miniaturized biosensing systems. However, commercial multi-channel potentiostats are often costly and difficult to adapt to custom multi-electrode arrays.

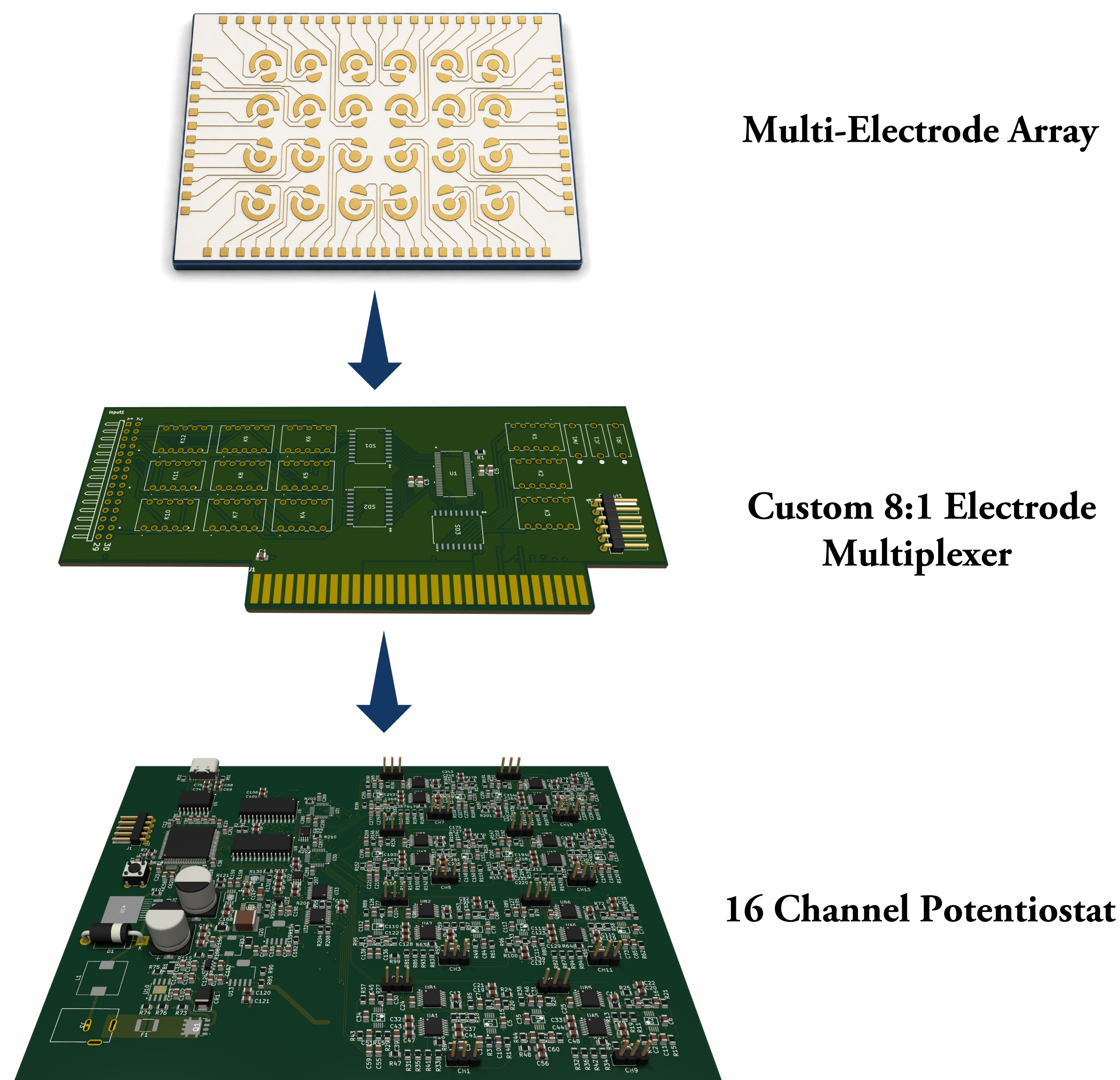
This work develops a modular multi-channel platform integrating a multi-electrode array (MEA), a physical-relay-based electrode multiplexer (MUX), programmable current measurement, and stable power delivery for flexible and scalable biosensing research.



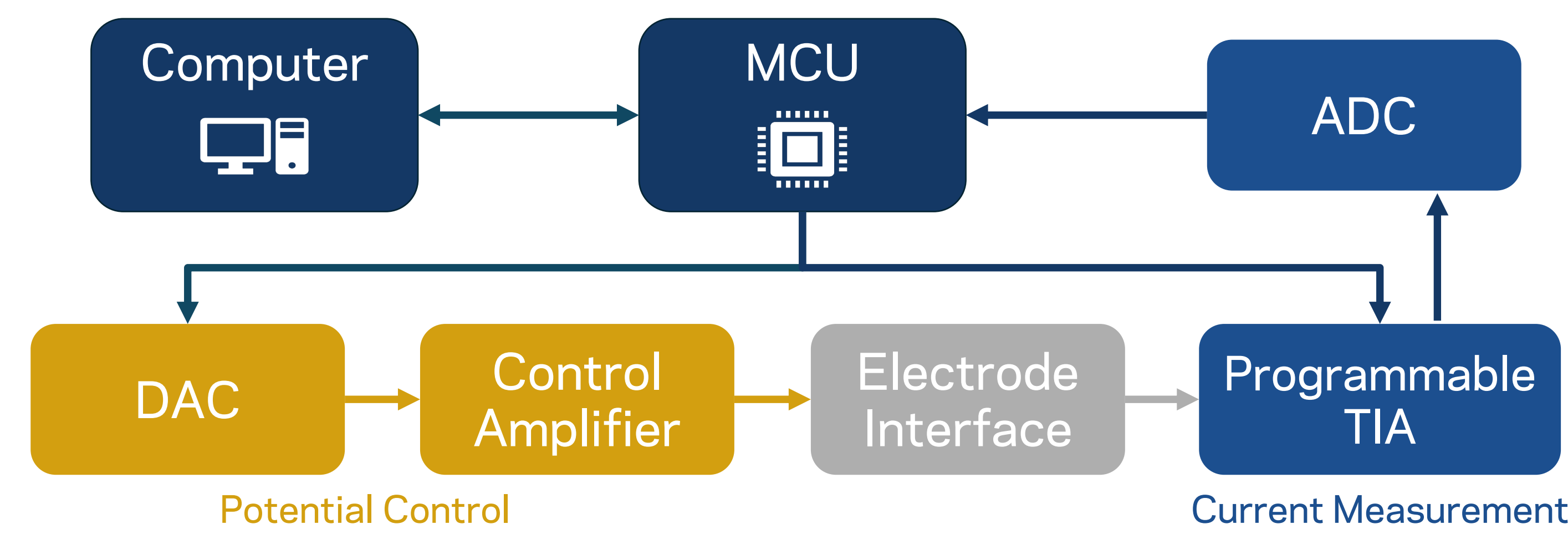
Platform Highlights

- Supports complete electrode arrays with 24–96 electrodes
- 8:1 physical-relay-based electrode multiplexer
- 16 parallel electrochemical sensing channels
- ± 100 nA to ± 100 μ A current range and ± 3 V potential range
- Programmable transimpedance amplifier (TIA) with feedback networks
- Integrated DAC, ADC, MCU, references, and analog front-end
- Isolated USB-C 2.0 Full-Speed communication
- Fuse, PMOS reverse protection, TVS, and eFuse protection

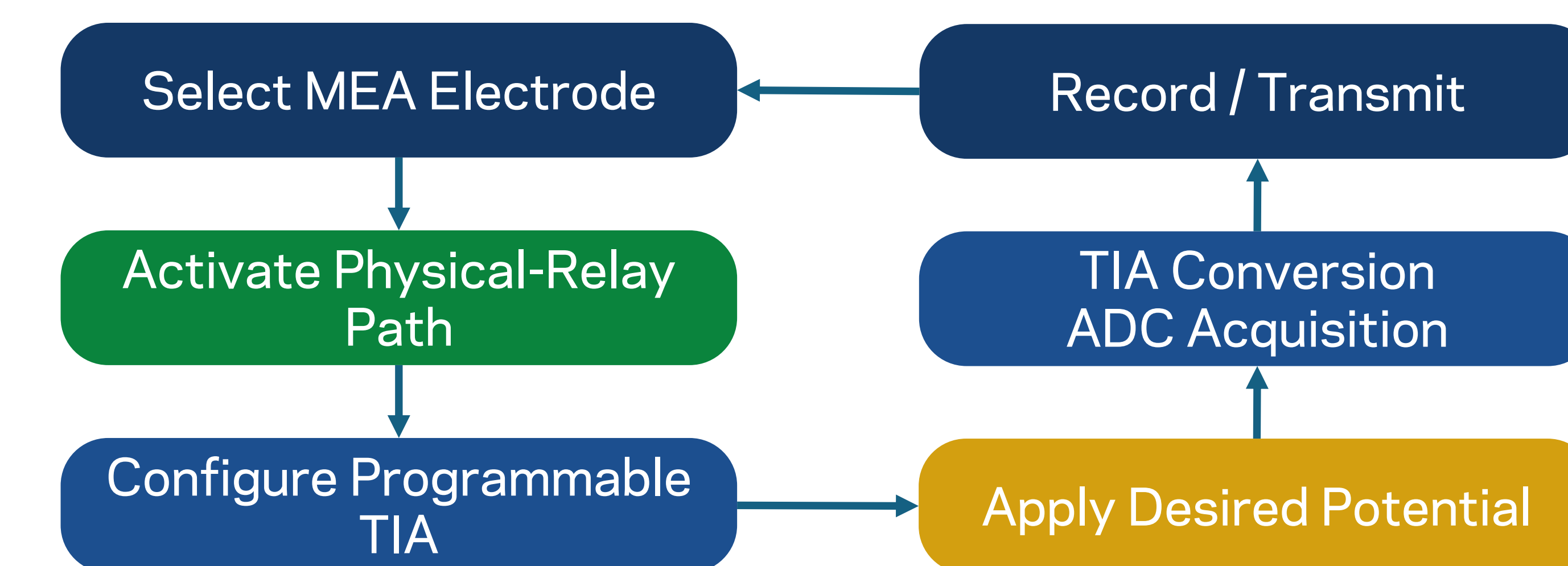
Integrated Platform Overview



Potentiostat Architecture



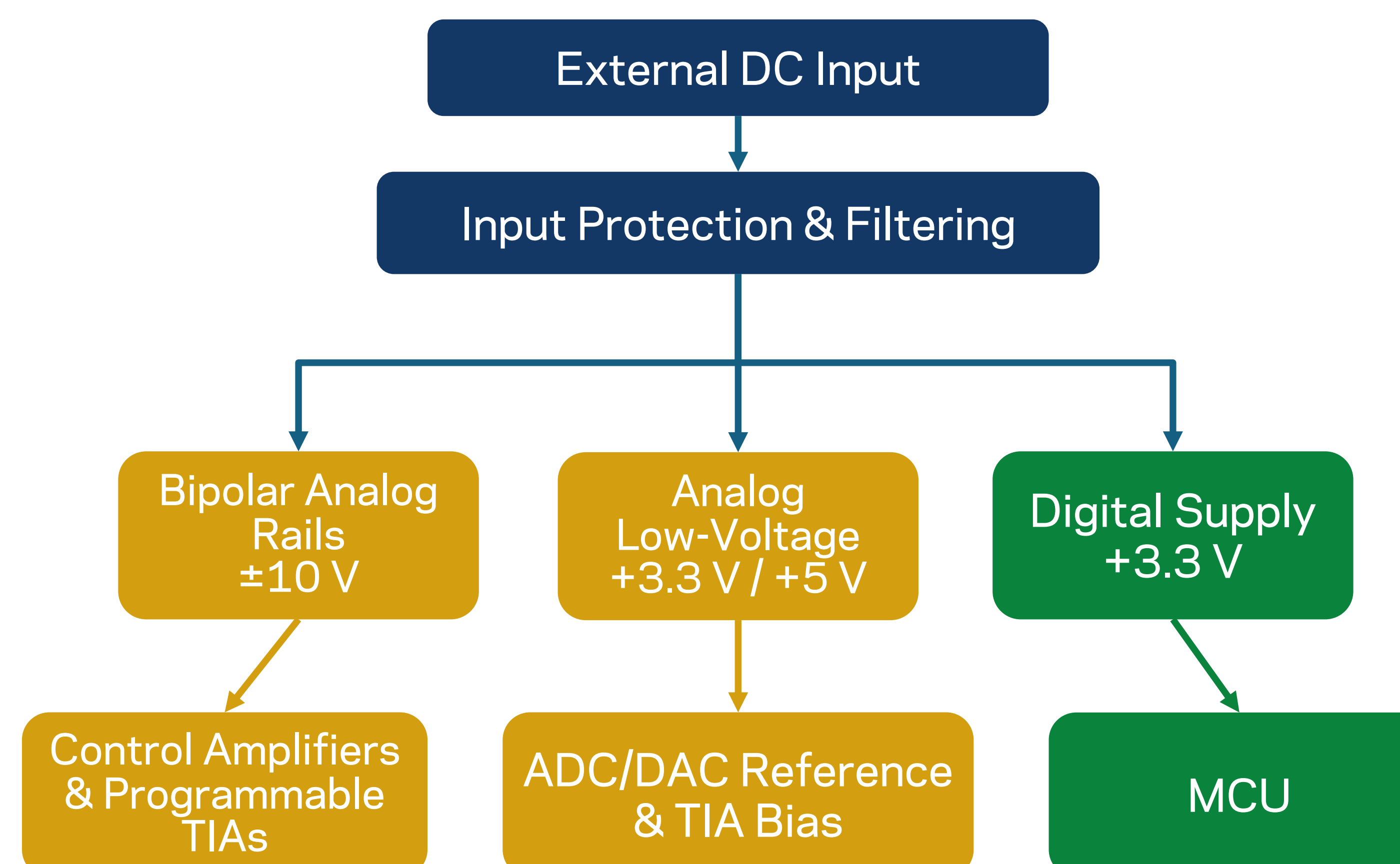
Electrochemical Measurement Workflow



Why Power Matters

Electrochemical signals are often small and are measured using high-gain analog front-ends. Consequently, power-supply noise, reference drift, and digital switching disturbances can directly appear as measurement error. Stable, low-noise power rails and precision voltage references are therefore essential for accurate potential control, sensitive current measurement, and consistent multi-channel operation.

Power Architecture



Why Multiplexing

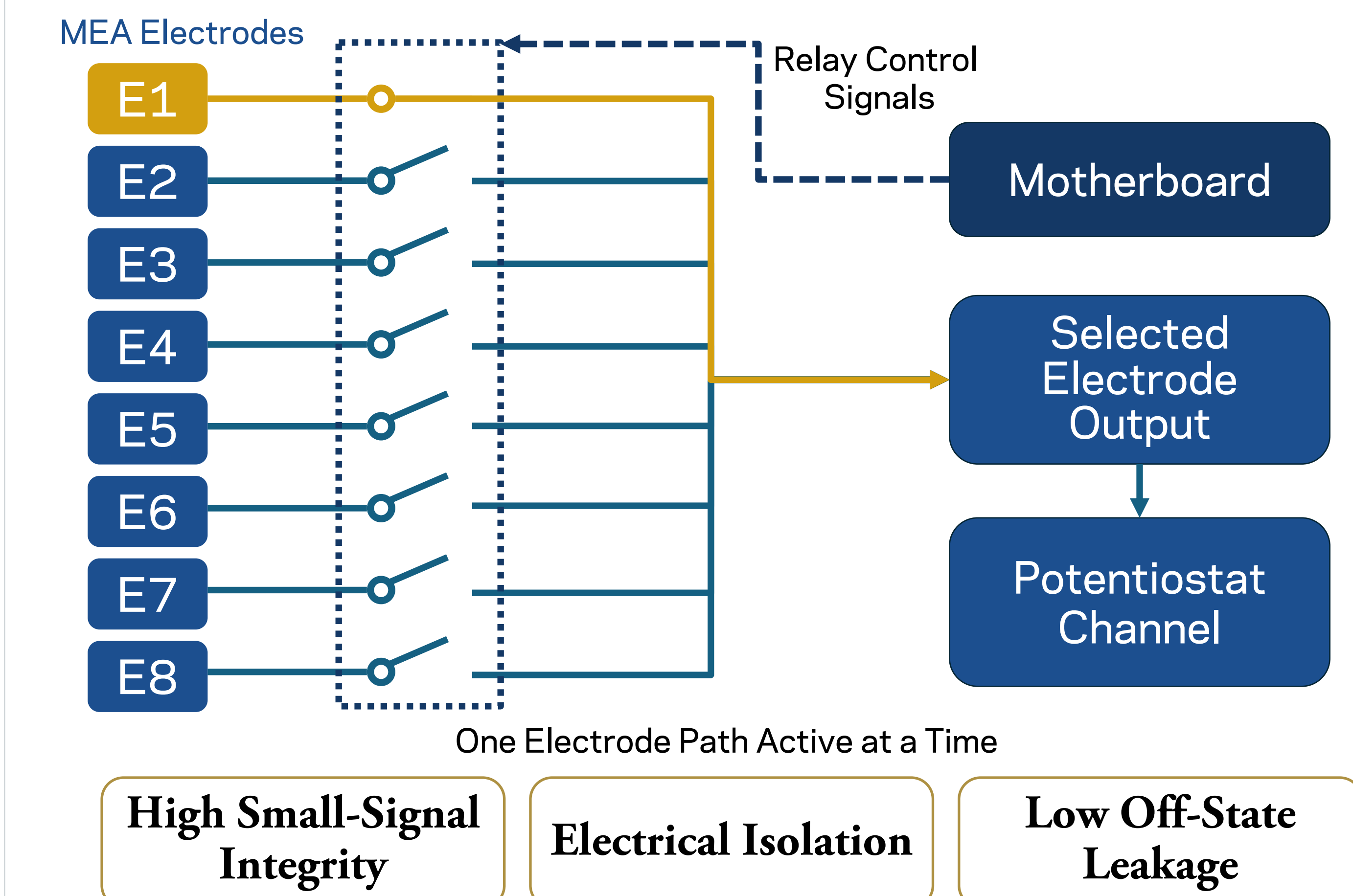
High-density MEAs can contain more sensing electrodes than can be directly connected to the available potentiostat channels. A physical-relay-based electrode multiplexer was designed to preserve the small-signal integrity required for biosensing while routing selected MEA electrodes to the 16-channel measurement platform. This enables configurable electrode access without redesigning the analog front end.

Configurable electrode access

Reduced interconnect complexity

Scalable MEA integration

Custom 8:1 Physical-Relay Electrode Multiplexer



Next Steps

- Finalize physical-relay MUX control firmware and safe electrode-switching sequences.
- Implement core electrochemical measurement methods, including open-circuit potential (OCP), cyclic voltammetry (CV), chronoamperometry (CA), and other measurement methods.
- Improve and calibrate the potentiostat hardware, power architecture, and programmable current ranges.
- Validate the complete MEA–MUX–potentiostat platform through electrochemical measurements.

Acknowledgments

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