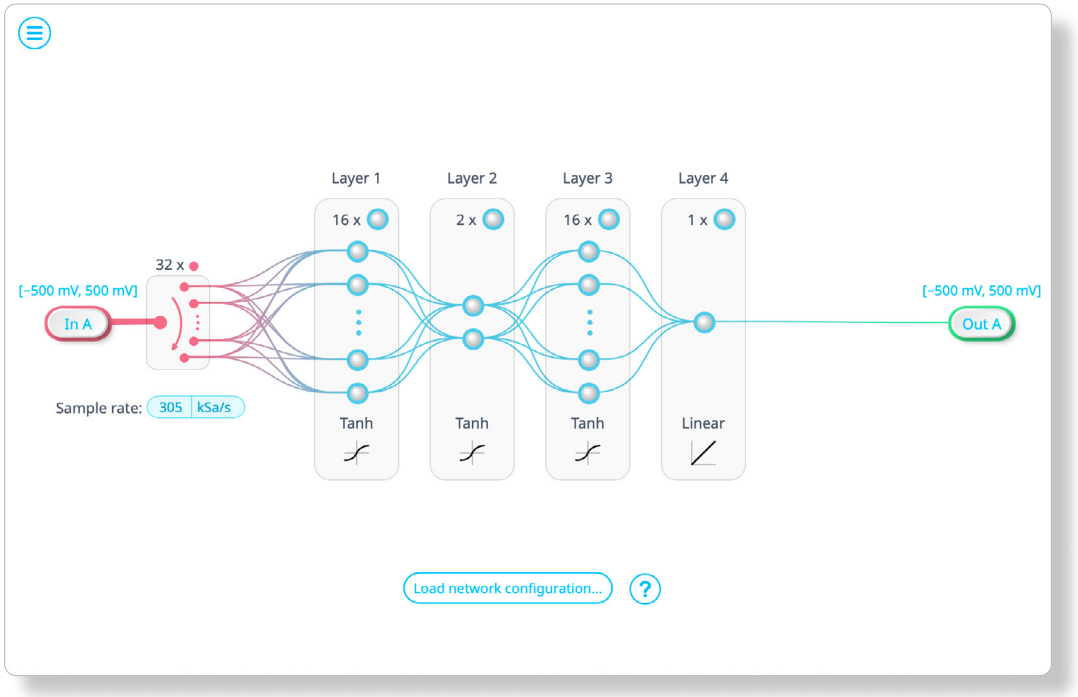
Moku:Delta Instrument Datasheet

Neural Network

The Moku:Delta Neural Network enables real-time deployment of user-defined models within Multi-instrument Mode. Networks are designed and trained offline in Python, then compiled into Liquid Instruments Neural Network (.linn) files containing weights, biases, and activation functions for accurate hardware reconstruction. Running on the FPGA, the Neural Network delivers low-latency inference, deterministic feedback, and supports up to five hidden layers with 100 nodes per layer and five activation functions. Integrated operation with other instruments allows users to capture, analyse, and respond to signals in real time, making it ideal for applications such as adaptive control and quantum experiments.



Max number of layers	Max neurons per layer	Maximum throughput	Number inputs	Number of outputs	Precision
5	**100**	**Up to 305 kHz sample rate in all modes and network sizes**	**1 to 4 in parallel, 1 to 100 in serial**	**1 to 4 in parallel, 1 to 100 in serial**	**18-bit fixed-point representation**

Features

- Training
  - Collect training data on any Moku device or simulate a desired complex process
  - Train the Neural Network offline
  - Upload the network configuration to a Moku:Delta device for real-time performance
- Datalog network outputs with the Moku Data Logger, Oscilloscope, or other instruments
- Examples available, including a user guide

Specifications

- Activation functions:
  - Nonlinear: ReLU, Softsign, Tanh, Sigmoid
  - Linear and (future) arbitrary
- Microsecond latency

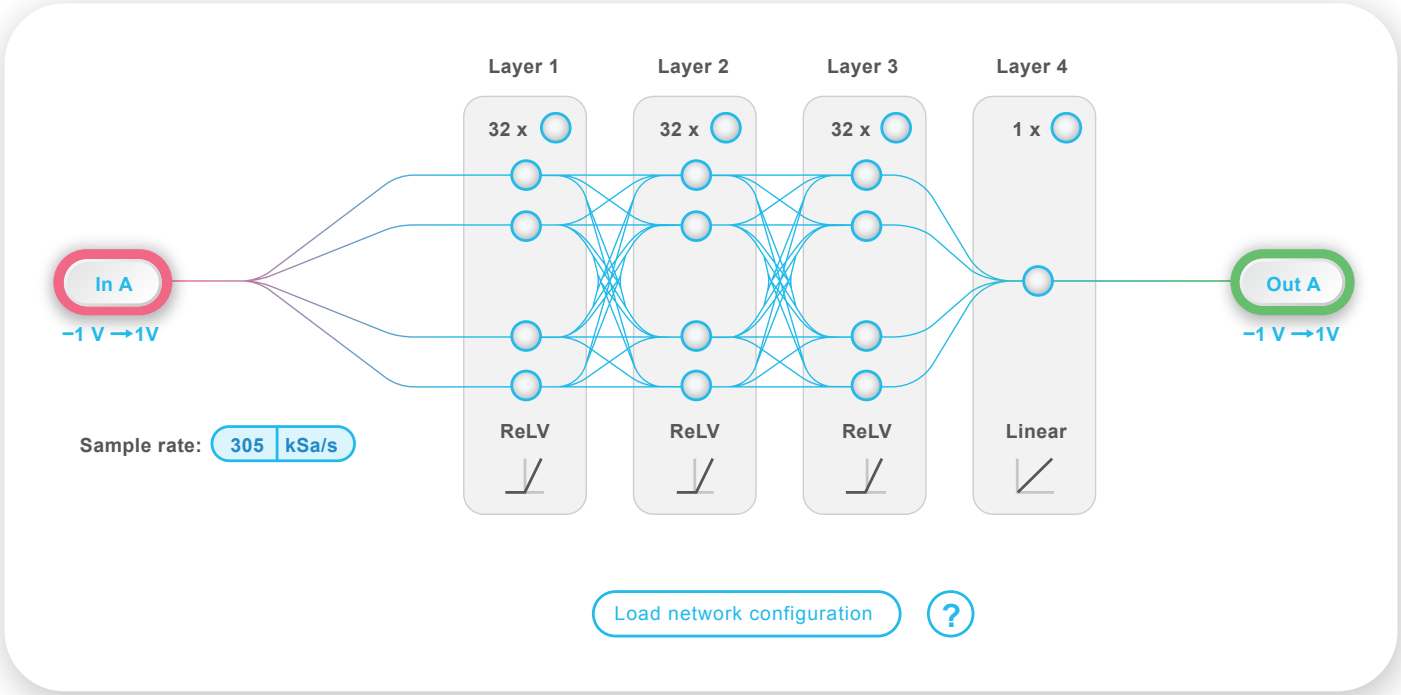
Applications

- Control systems
- Sensor conditioning
- Signal classification
- Signal denoising

Moku:Pro Instrument Datasheet

Neural Network

The Moku:Pro Neural Network enables fast, agile implementation and evaluation of user-defined neural networks utilizing Multi-instrument Mode for Moku:Pro. Design and train your network configuration offline. Then, upload it to the Moku app for real-time Neural Network operation.



Max number of layers	Max neurons per layer	Maximum throughput	Number inputs	Number of outputs	Precision
5	**100**	**Up to 305 kHz sample rate in all modes and network sizes**	**1 to 4 in parallel, 1 to 100 in serial**	**1 to 4 in parallel, 1 to 100 in serial**	**18-bit fixed-point representation**

Features

- Training
  - Collect training data on any Moku device or simulate a desired complex process
  - Train the Neural Network offline
  - Upload the network configuration to a Moku:Pro device for real-time performance
- Datalog network outputs with the Moku Data Logger, Oscilloscope, or other instruments
- Examples available, including a user guide

Specifications

- Activation functions:
  - Nonlinear: ReLU, Softsign, Tanh, Sigmoid
  - Linear and (future) arbitrary
- Microsecond latency

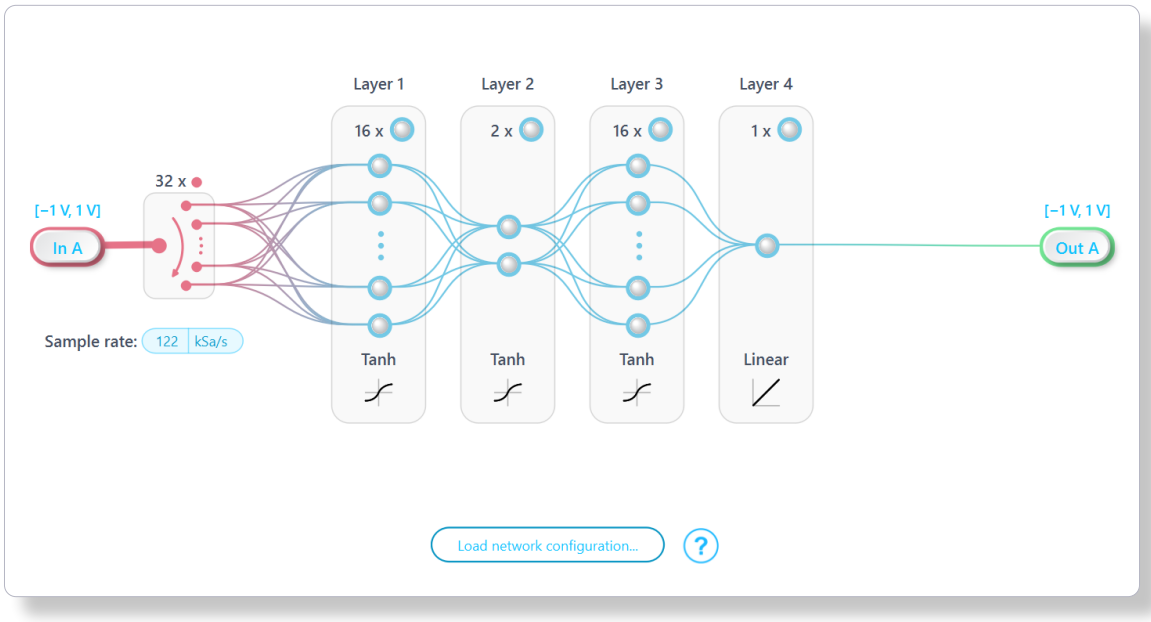
Applications

- Control systems
- Sensor conditioning
- Signal classification
- Signal denoising

Moku:Lab Instrument Datasheet

Neural Network

The Moku:Lab Neural Network delivers deterministic performance for real-time applications by running inference directly on the FPGA with sub-100 microsecond latency and 18-bit fixed-point precision. You can implement fast control loops, perform on-device sensor conditioning, or run classification and denoising models. The FPGA executes each layer in parallel using your selected activation functions, allowing you to evaluate compact networks of up to five layers and eighty neurons per layer with consistent timing. This capability enables practical deployment of embedded inference workloads, from adaptive filtering to predictive or state-estimation tasks, as part of an integrated Moku test setup.



Max number of layers	Max neurons per layer	Maximum throughput	Number of inputs	Number of outputs	Precision
5	**80**	**Up to 122 kHz sample rate in all modes and network sizes**	**1 or 2 in parallel, 1 to 80 in serial**	**1 or 2 in parallel, 1 to 80 in serial**	**18-bit fixed-point representation**

Features

- Collect training data on any Moku device or simulate a desired complex process
- Train the Neural Network offline
- Upload the network configuration to a Moku:Lab device for real-time performance
- Datalog network outputs with the Moku Data Logger, Oscilloscope, or other instruments

Specifications

- Activation functions:
  - Nonlinear: ReLU, Softsign, Tanh, Sigmoid
  - Linear and (future) arbitrary
- Max neurons per layer
  - 2-slot mode: 80 neurons
  - 3-slot mode: 50 neurons
- Input sampling rate: up to 122 kSa/s
- Sub-100 microsecond latency

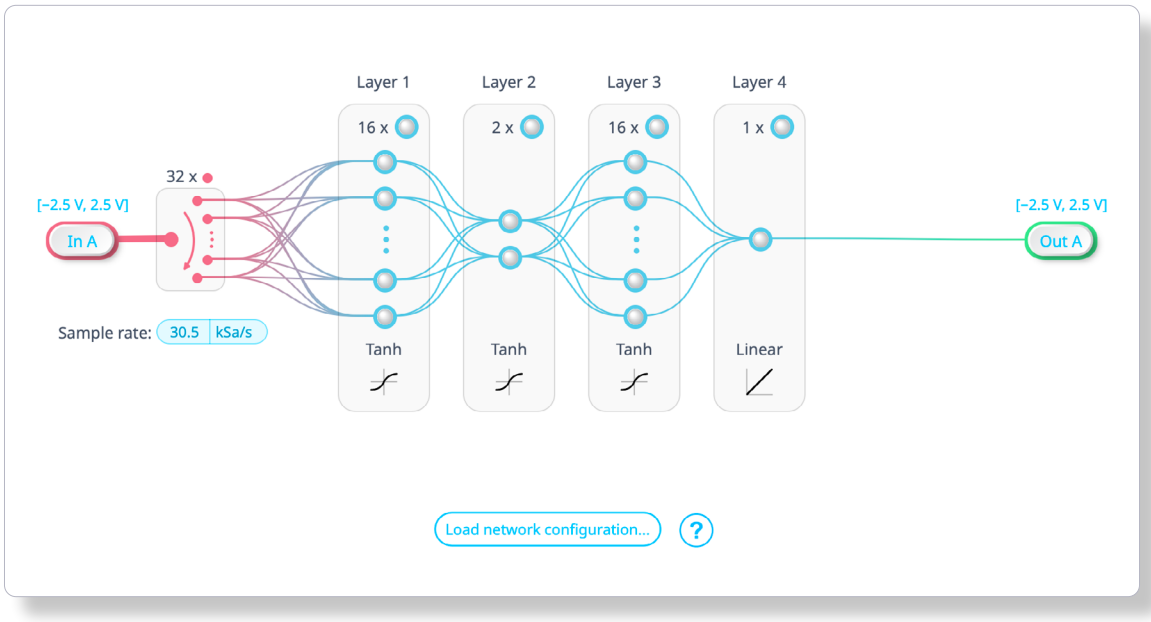
Applications

- Adaptive filtering
- Anomaly detection
- Real-time control systems
- Sensor conditioning
- Signal classification
- Signal denoising

Moku:Go Instrument Datasheet

Neural Network

The Moku:Go Neural Network delivers deterministic performance for real-time applications by running inference directly on the FPGA with sub-millisecond latency and 18-bit fixed-point precision. You can implement control loops, perform on-device sensor conditioning, or run classification and denoising models. The FPGA executes each layer in parallel using your selected activation functions, allowing you to evaluate compact networks of up to five layers and eighty neurons per layer with consistent timing. This capability enables practical deployment of embedded inference workloads, from adaptive filtering to predictive or state-estimation tasks, as part of an integrated Moku test setup.



Max number of layers	Max neurons per layer	Maximum throughput	Number of inputs	Number of outputs	Precision
5	**80**	**Up to 30.5 kHz sample rate in all modes and network sizes**	**1 or 2 in parallel, 1 to 80 in serial**	**1 or 2 in parallel, 1 to 80 in serial**	**18-bit fixed-point representation**

Features

- Collect training data on any Moku device or simulate a desired complex process
- Train the Neural Network offline
- Upload the network configuration to a Moku:Go device for real-time performance
- Datalog network outputs with the Moku Data Logger, Oscilloscope, or other instruments

Specifications

- Activation functions:
  - Nonlinear: ReLU, Softsign, Tanh, Sigmoid
  - Linear and (future) arbitrary
- Max neurons per layer
  - 2-slot mode: 80 neurons
  - 3-slot mode: 50 neurons
- Input sampling rate: up to 30.5 kSa/s
- Sub-millisecond latency

Applications

- Adaptive filtering
- Anomaly detection
- Real-time control systems
- Sensor conditioning
- Signal classification
- Signal denoising