LIQUID INSTRUMENTS

Moku:Delta 제품 소개

Moku:Delta 개요, 특징 및 장점,
애플리케이션 소개

Moku:Delta

Accelerate product design and validation with 2 GHz bandwidth, ultra-low noise performance, and mixed-signal test capabilities.

High-Speed Onboard Storage
1 TB

Noise Performance
< 10 nV/√Hz

FPGA Enabled
Xilinx RFSoC

Clock Stability
1 ppb

Analog inputs

8 input channels at 5 GSa/s, dual 14/20 bit ADCs

2 GHz analog bandwidth

Analog outputs

8 output channels at 10 GSa/s, 14-bit DACs

2 GHz analog bandwidth

Digital I/O

32 channels, 250 MSa/s

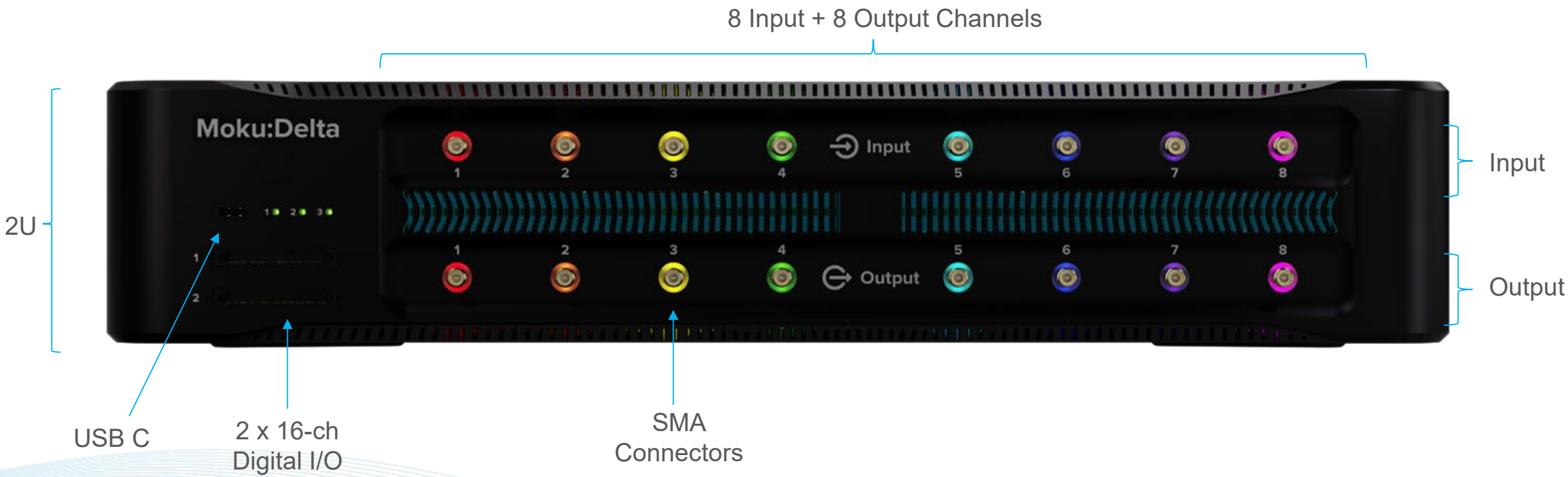
Hardware features

< 10 nV/√Hz analog input noise

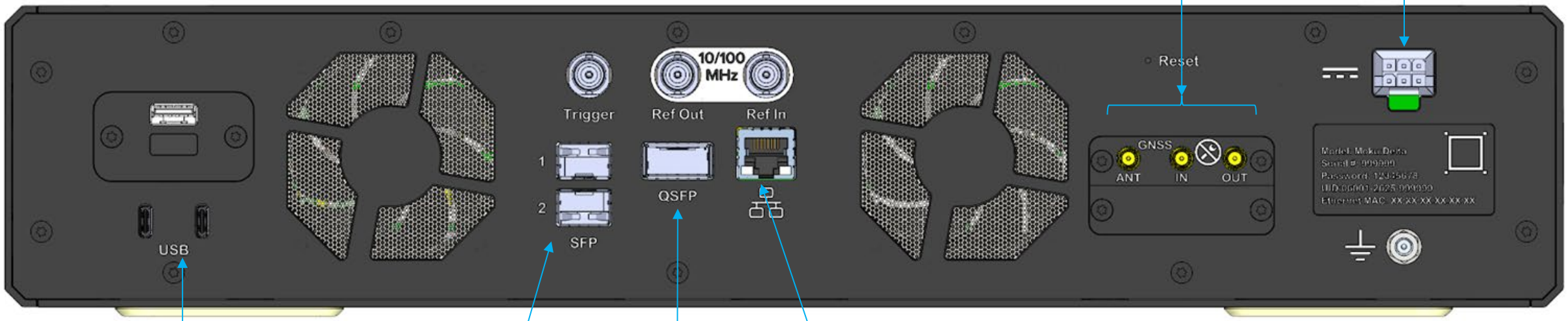
1 ppb OCXO clock stability

GPS-disciplined oscillator

Front panel


8 Input + 8 Output Channels
Moku:Delta
Input
Output
1
2
3
4
5
6
7
8
2U
Input
Output
USB C
2 x 16-ch
Digital I/O
SMA
Connectors

Rear panel


10 MHz Ref In/Out and Trigger
3 x BNC Interface
GNSS Module
3 x SMA Interface
Power supply connection
Trigger
10/100 MHz
Ref Out
Ref In
Reset
GNSS
ANT
IN
OUT
1
2
SFP
QSFP
USB
2 x USB 3.0
(1 USB-A and 1 USB-C)
2 x SFP
(25GbE)
QSFP
(100GbE)
Gigabit
Ethernet

The power of FPGAs

Replace multiple pieces of equipment. Switch easily between instruments. Build entire test systems.

Moku portfolio

Moku:Delta

- 8 inputs @ 2 GHz
- 8 outputs @ 2 GHz
- 32 channel digital I/O

Moku:Pro

- 4 inputs @ 600 MHz
- 4 outputs @ 500 MHz

Moku:Go

- 2 inputs @ 30 MHz
- 2 outputs @ 20 MHz
- 16 channel digital I/O

Moku:Lab

- 2 inputs @ 200 MHz
- 2 outputs @ 300 MHz

# of Channels

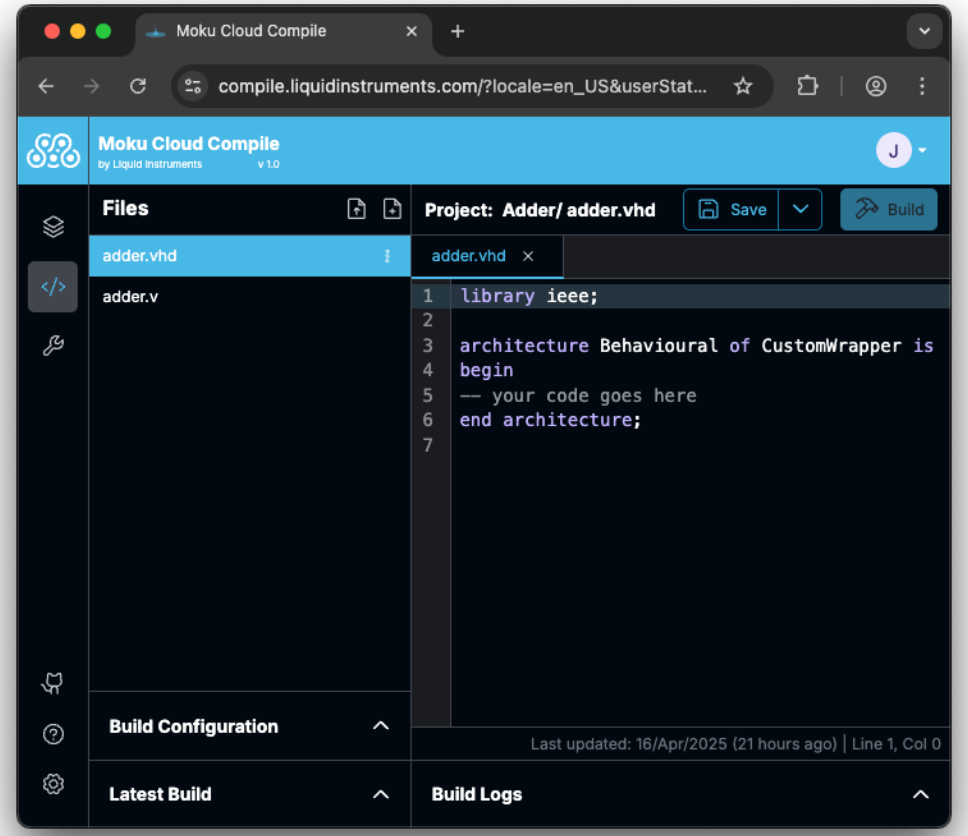
Bandwidth

Multi-instrument Mode for greater efficiency

- Run multiple instruments simultaneously
  - Moku:Delta: Up to 8 instruments
  - Moku:Pro: Up to 4 instruments
  - Moku:Lab & Moku:Go: 2 instruments
- Create a test system or multi-channel instrument on one device
- Instantly swap and combine software modules
- Lossless, reconfigurable, high-speed, interconnects between instruments
- Arbitrarily route instruments to input and output connectors

Moku Cloud Compile

Implement custom functionality alongside other instruments in Multi-instrument Mode.



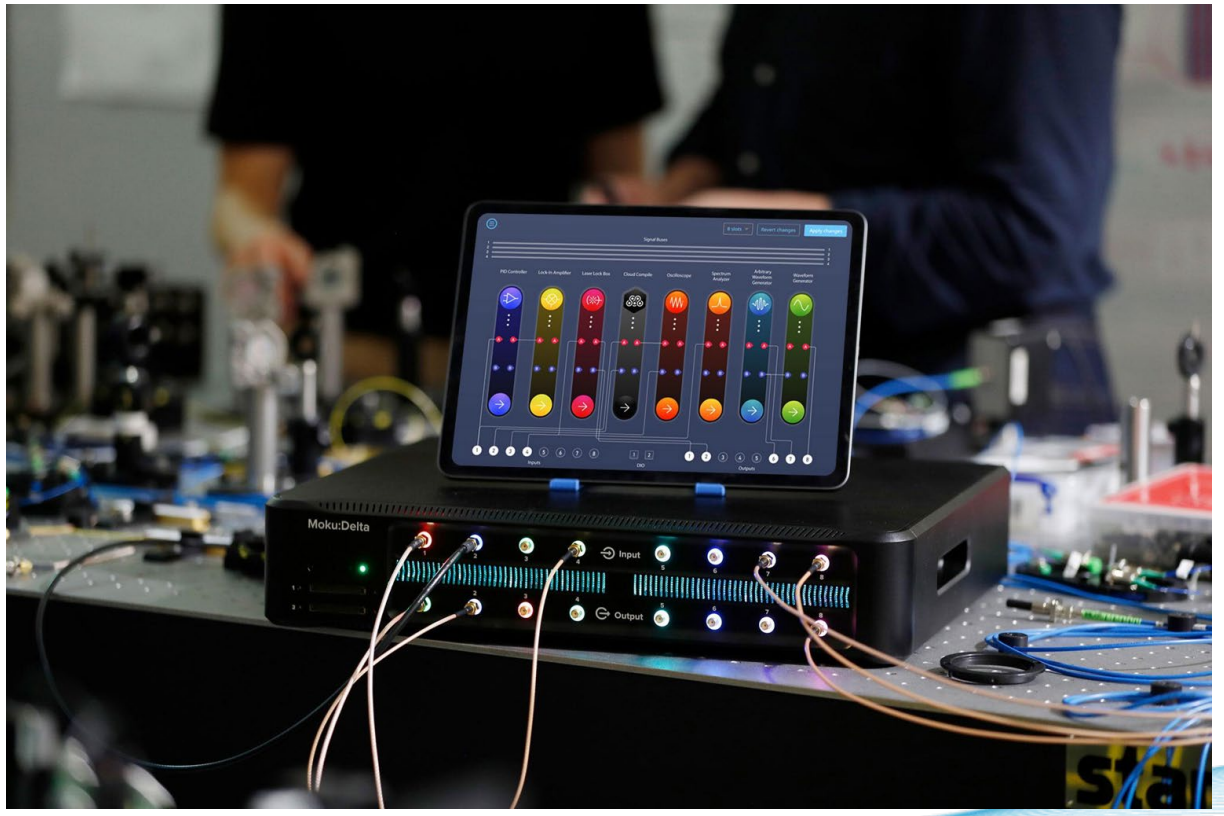
Develop and deploy custom functions in minutes, not months:

- Code, compile, and deploy code from a browser with no additional software download
- Implement custom signal processing in VHDL or Verilog
- Compatible with HDL generation tools from third parties like HDL Coder and ChatGPT
- Iterate on designs more rapidly than with a dev board

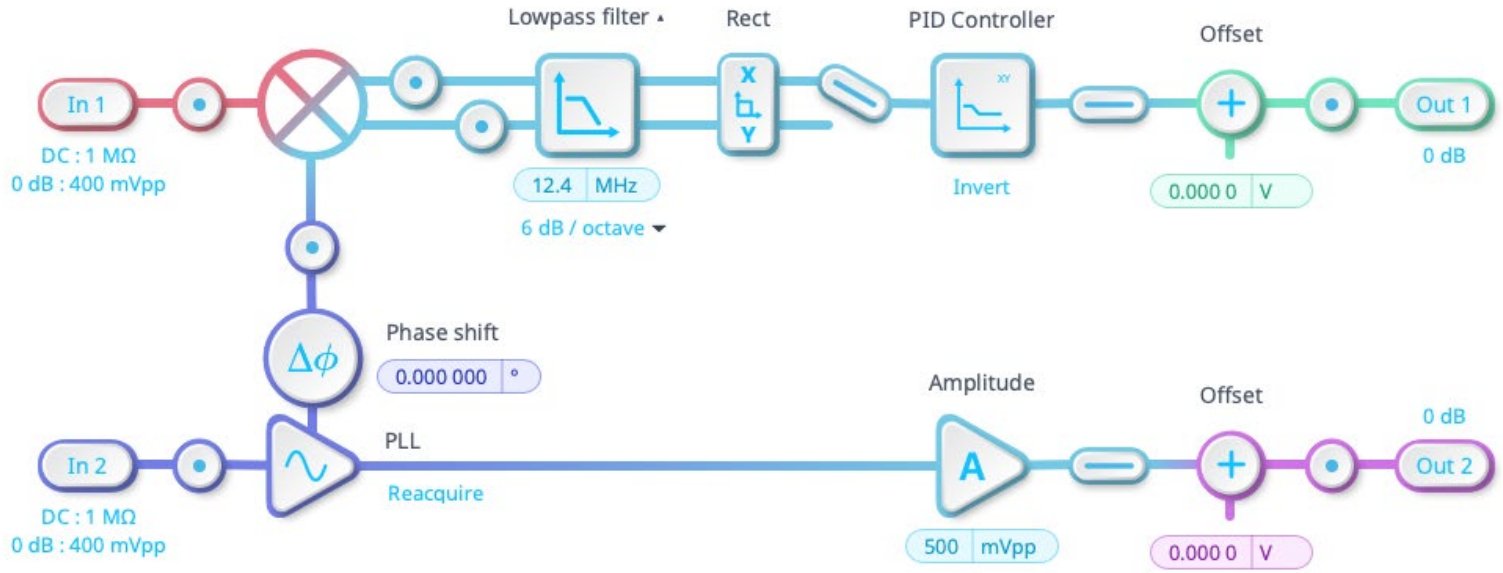
LIQUID INSTRUMENTS

Purpose-built for optics and photonics research

- **Lock-in Amplifier with dual-phase demodulation**
  Superior usability, up to 2 GHz
- **Sophisticated laser stabilization and metrology tools**
  Low noise across the spectrum, high dynamic reserve
- **Integrated capability to streamline your lab**
  Multiple instruments, upgradable, customizable



Advanced lock-in detection



- **Lock-in Amplifier with dual-phase demodulation**
  Superior usability, up to 2 GHz
- **Integrated PID Controller**
  Optional high-speed PID Controller for closed-loop control
- **Multi-frequency demodulation**
  Deploy up to four Lock-in Amplifiers at once with Multi-instrument Mode

APPLICATION

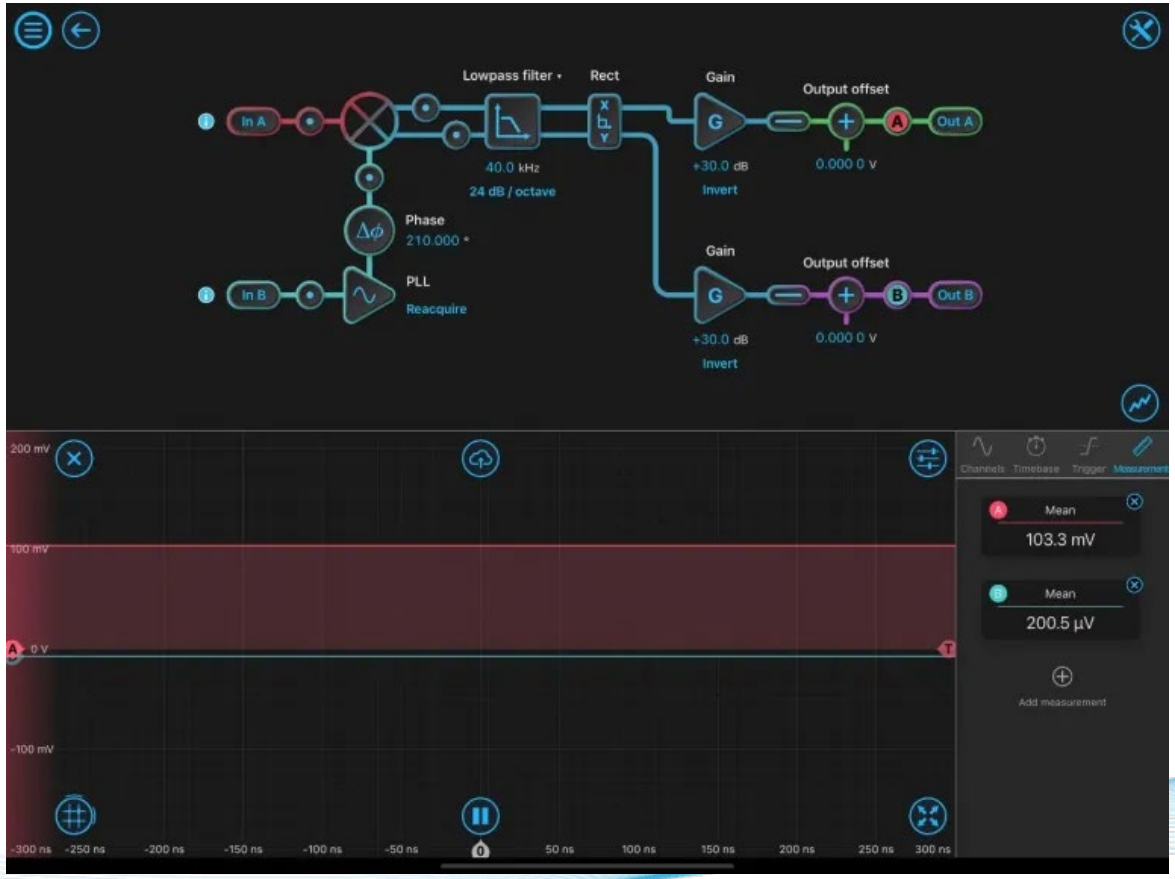
SRS microscopy

Self-heterodyne signal detection with the Moku Lock-in Amplifier

- **Modulation transfer detection**
  Extract weak signals from a noisy background using dual-phase demodulation

- **Multiple frequency analysis**
  Deploy multiple lock-in amplifiers for monitoring signals of different frequency or from separate detectors.

- **Integrated instruments**
  Monitor and log data using the embedded oscilloscope and data logger.



LIQUID INSTRUMENTS

Multi-frequency Lock-in Amplifier

- Measure harmonics of a single oscillator or multiple oscillators of arbitrary frequency
- Simplify lab setup, reduce cost, and configuration time

Example:
Using three slots to demodulate three different input signals with a shared reference

Independent input signals fed into three **Lock-in Amplifiers**

All three Lock-in Amplifiers share the same **external reference**

Demodulated signals routed to output connectors or logged to internal **SSD**

Closed-loop system control

- Perform high-bandwidth closed-loop design and characterization with on-fabric, low-latency DSP

Example:
PID Controller for real-time closed-loop control and Frequency Response Analyzer for in-situ system characterization

Frequency Response Analyzer to characterize the impulse/step response and transfer function of the system under test.

Adjust the **PID Controller** in real time to optimize system performance and see the effect in the monitoring devices.

View system response in the frequency domain via the **Spectrum Analyzer**.

Phase-locked loop (PLL)

- Implement and verify PLL design and performance
- Adapt to new applications and experiments with flexible configuration and intuitive UI

Example:
using Lock-in Amplifier to lock on to an external signal

Lock-in Amplifier detects the phase difference between its LO and the signal on Input A. This is routed via Output A to the VCO

Observe the PLL locking in both time and frequency domains.

The **Oscilloscope**'s data logging is used to record statistics, including the standard deviation of frequency of the PLL.

APPLICATION

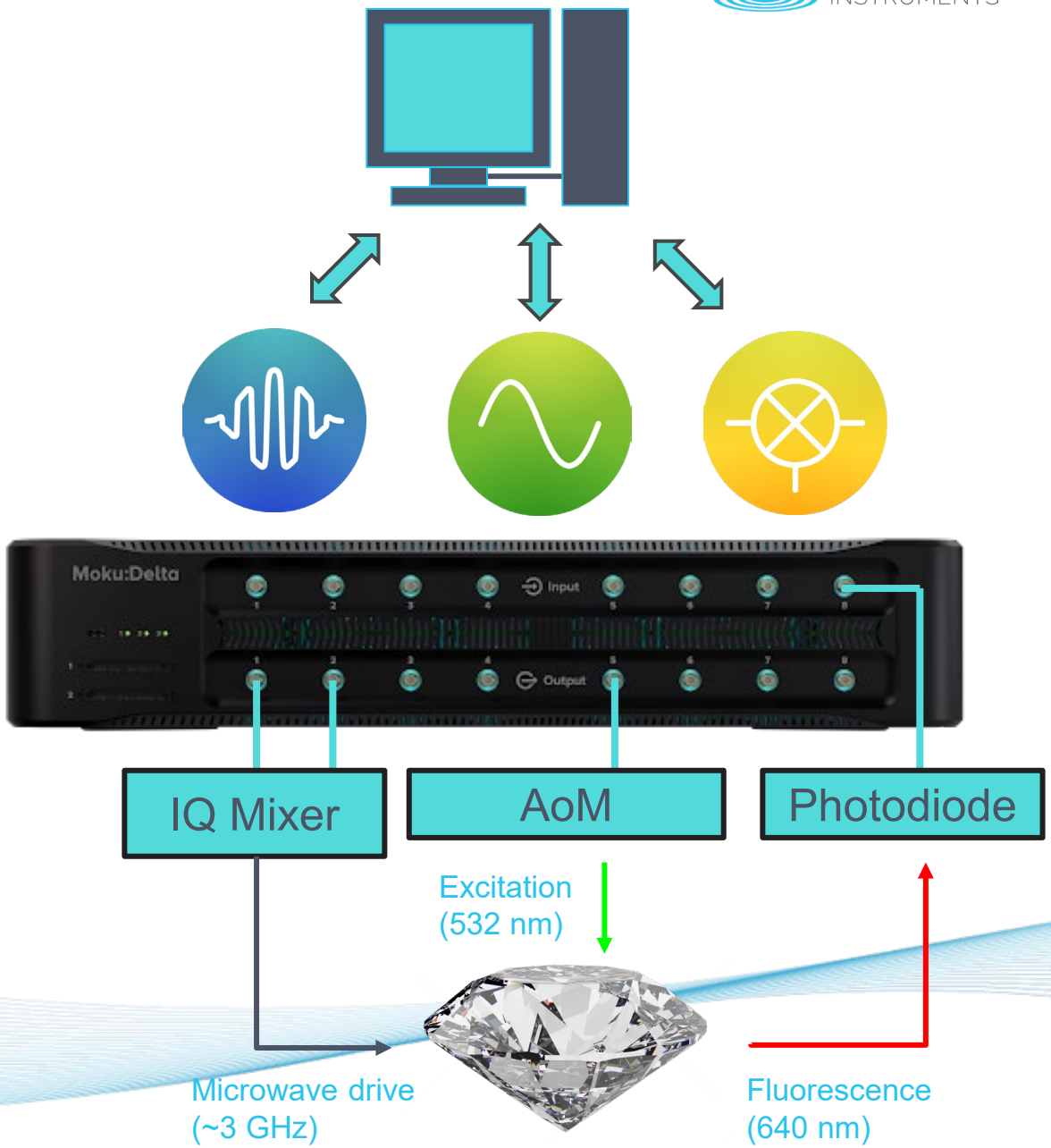
Quantum Sensing

Initialize, manipulate, and readout spin defects for precise EM field sensing

- **IQ modulation with Arbitrary Waveform Generator**
  Generate I and Q baseband signals and use an external IQ mixer for drive pulses

- **Drive synchronized laser pulses with Waveform Generator**
  Combine with an AoM to gate initialization and readout pulses

- **Efficient detection of fluorescence with Lock-in Amplifier**
  Observe periodic signals with low input noise and high dynamic reserve



LIQUID INSTRUMENTS

Moku:Delta Quantum Instruments

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Fluorescence and single-photon detection with **real-time analysis**

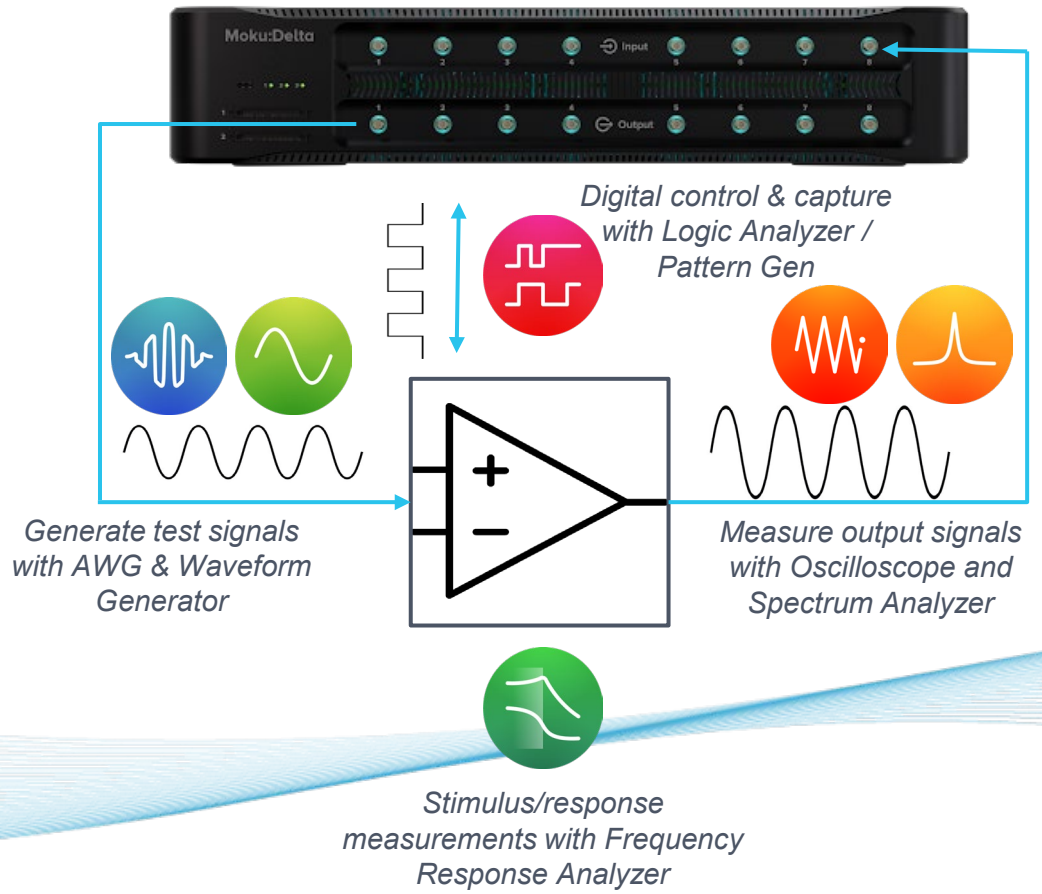
Coherent detection and demodulation with **ultra-low input noise**

Lock multiple lasers simultaneously for synchronized feedback

Save time in semiconductor design validation

Characterize dynamic performance with class-leading precision.

- Test multiple DUTs in parallel or run multiple tests at once
  - Frequency range: **0 Hz to 2 GHz**
  - Channels: **8 input**, **8 output**, and **32 DIO**
  - Outputs: 14-bit
  - Inputs: 14- and 20-bit blended for **<10 nV/√Hz** noise floor
- Reconfigure instruments and connections on the fly for different tests or DUTs as needed
- Reduce fixturing, switching and cabling with flexible, FPGA-based signal bus and connector routing
- Reduce test development time with intuitive, unified interface and standard APIs, including Python
- Save space with 2U rack-mountable form factor



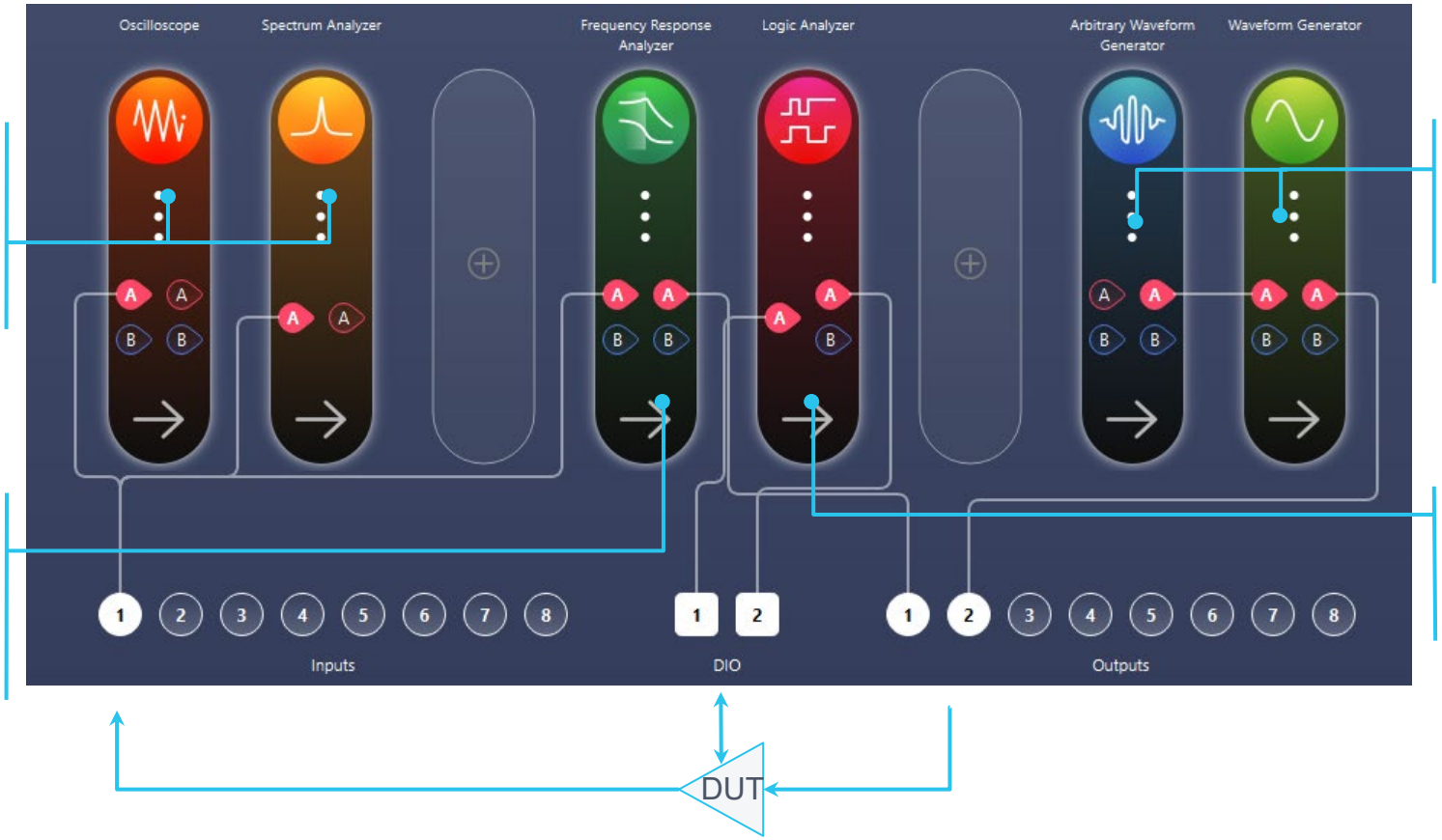
LIQUID INSTRUMENTS

Semiconductor IC characterization

- Characterize dynamic (AC) performance with up to 8 instruments in a single device.
- Reduce fixturing, switching and cabling with flexible, FPGA-based signal bus and connector routing

Oscilloscope and **Spectrum Analyzer** monitor or measure DUT output signals in the time and frequency domain simultaneously.

Frequency Response Analyzer performs stimulus/response measurements to analyze the transfer function of the DUT.



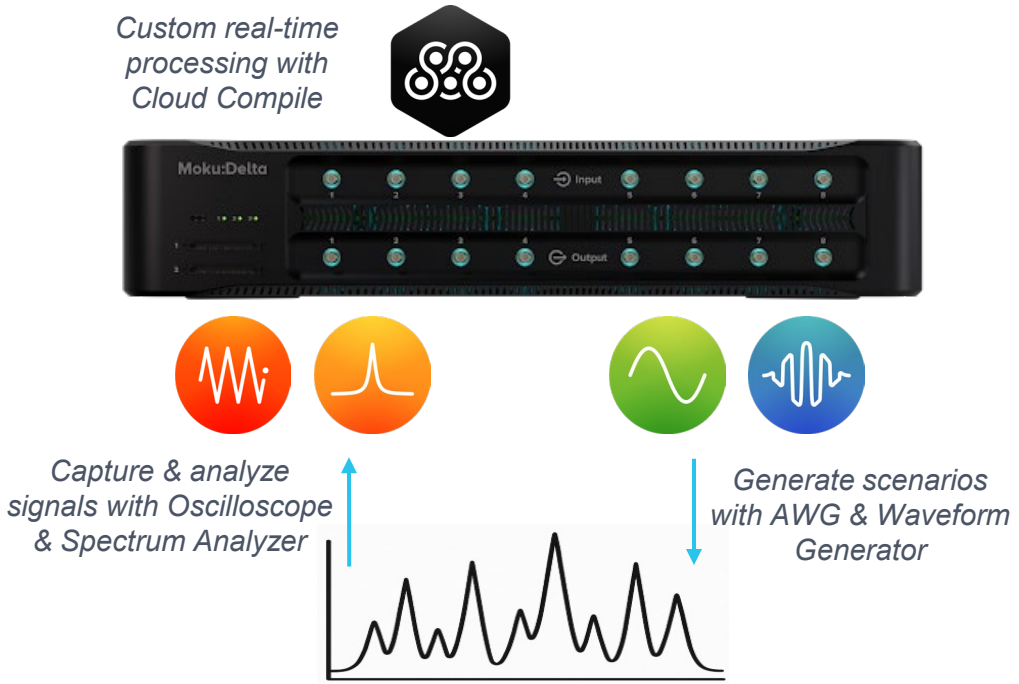
AWG and **Waveform Generator** generate test signals from simple sine waves to complex modulated waveforms.

Logic Analyzer / Pattern Generator provides digital signal decoding and control.

A dynamic testbed for electromagnetic spectrum assurance

High-performance, cost-effective, future-proof.

- Generate and analyze complex scenarios to test system performance and countermeasures
  - **2 GHz** instantaneous bandwidth
  - **8 input** and **8 output** channels
  - **2U** rack-mountable form factor
- Get the capability you need while reducing cost by an order of magnitude
  - Removable **GNSS module** to synchronize distributed units or timestamp data
  - User-programmable FPGA for real-time in-line processing
  - Intuitive interfaces that reduce training and maintenance burdens
  - Reconfigurable, upgradeable via software



Example applications:

- L-band threat emulation
- Verification & validation of RF environments
- Record/playback for direct inject testing