Presto is a measurement platform for high frequency signal generation and analysis aimed at emerging applications in quantum technology. It has 16 RF input ports, 16 RF output ports, 4 digital input and 4 digital output ports, all synchronized to one very stable clock. Two branches of firmware provide a highly configurable platform for complex experiments with rigid timing constraints on multiple phase-coherent signals. *Continuous wave mode* is a microwave big-brother to our 3rd generation Multifrequency Lockin Amplifier (MLA-3). *Pulse sequencing mode* is our new approach to timed pulse generation and analysis for control and readout of quantum systems.

Modes of operation

Continuous wave mode

- Up to 192 generators with programmable frequency, amplitude and phase distributable between 16 output ports
- Up to 192 demodulators with programmable frequency and phase distributable between 16 input ports
- All modulators locked to single internal or external reference clock
- Direct mode operation: DC* up to 1000 MHz
- Mixed mode operation: Up to +- 500 MHz band around 0 to 9 GHz carrier (digital up- and down-conversion)

* note: Front-end sets lower analog limit. Custom solutions are possible.

Pulse sequencing mode

- *Output, at each port (x16)*
  - 16 templates (direct output) or envelopes (multiplied by carrier)
  - Maximum single-template length 1 us (concatenation and continuous looping possible)
  - Template sampling resolution 500 ps
  - 2 carrier-tone generators with user-defined frequency and phase
  - 2 user-defined scaling factors
- *Input, resources distributable between 16 input ports*
  - Continuous sampling window, maximum 524 us
  - Averaging of multiple windows in FPGA, maximum 65k windows at full-scale input
  - Template matching (state discrimination) in FPGA, 128 templates (max length 1 us)
- *Experiment design: sequencer*
  - Stepper with 512 values (40 bit resolution) of frequency and phase per carrier-tone generator
  - Stepper with 512 values (17 bit resolution) of scale per output scaler
  - Event coordinator for timing of input and output sequences, 10736 events
  - Event time resolution 2 ns
  - Fast feedback from template matching, total latency typical 200 ns

Specifications

RF inputs

# ports	16
Impedance	50 ohm
Coupling	various options
Maximum frequency*	9 GHz
Sampling	14 bit ADC up to 2.5 GSample/s (selectable at runtime)
Range**	1 dBm (min range)
Variable input attenuation (analog)	0 to 27 dB

* see input noise figure below
** see input range figure below

RF outputs

# ports	16
Impedance	50 ohm
Coupling	Various options. For example: 1x 6-7 GHz band pass, 7x 3.5-4.5 GHz band pass + bias tees, 8x DC to 800 MHz. Contact us for custom solutions
Maximum frequency*	9 GHz
Sampling	14 bit DAC up to 10 GSample/s (selectable at runtime)
Range*	6.5 dBm (at max range) < 200 MHz
Variable output power (analog)	-18.5 dBm to 6.5 dBm
Bias	Built-in bias tee for DC offset,16 bit DAC, ±1.25 V
Phase noise	-120 dBc/Hz at 10 kHz offset, 1 GHz carrier

* see output power versus frequency figure below

Noise and distortion

Input voltage noise*	10 nV/sqrtHz, -147 dBm/Hz @ 100 MHz
Output-input total harmonic distortion**	-73 dBc at 240 MHz
Output-input intermodulation distortion***	-73 dBc at 240 MHz
RF signals cross talk	-58 dBc at 6 GHz

* see noise figure below
** THD from 2nd and 3rd harmonic at 50% of DA
*** IMD from 3rd and 5th order at 50% of DA

Digital markers / triggers

| # input ports	4
Input impedance	10 kohm
# output ports	4
Output impedance	50 ohm
Output voltage	3.3 V
Output rise time, 10-90%	670 ps
Output rise time, 20-80%	440 ps
Output fall time, 90-10%	570 ps
Output fall time, 80-20%	360 ps

Clock reference

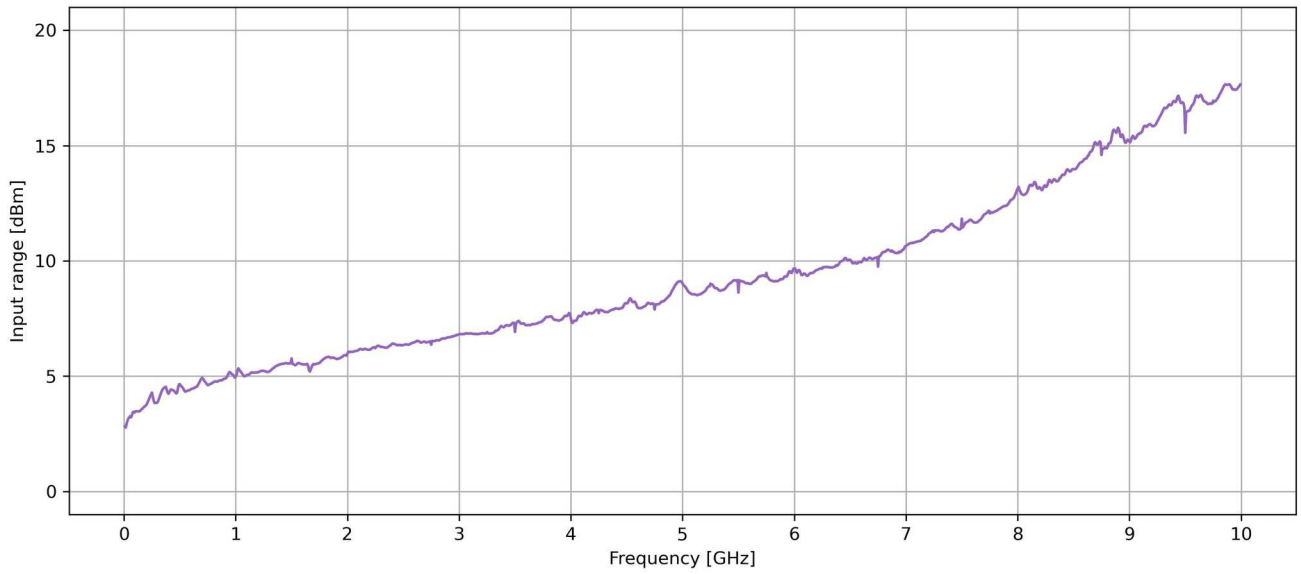| Internal	temperature-compensated crystal oscillator, ±50ppb frequency stability
External	Programmable reference input and output, 10 MHz (default), 100 MHz, other.

General

Connectors	SMA, signal ground isolated from enclosure / PE
Communication	Gigabit Ethernet. The device is fully computer controlled (Windows, Mac and Linux compatible).
Power supply	100-250 V, 50-60 Hz

Intermodulation products

Phase noise at select frequencies (preliminary)
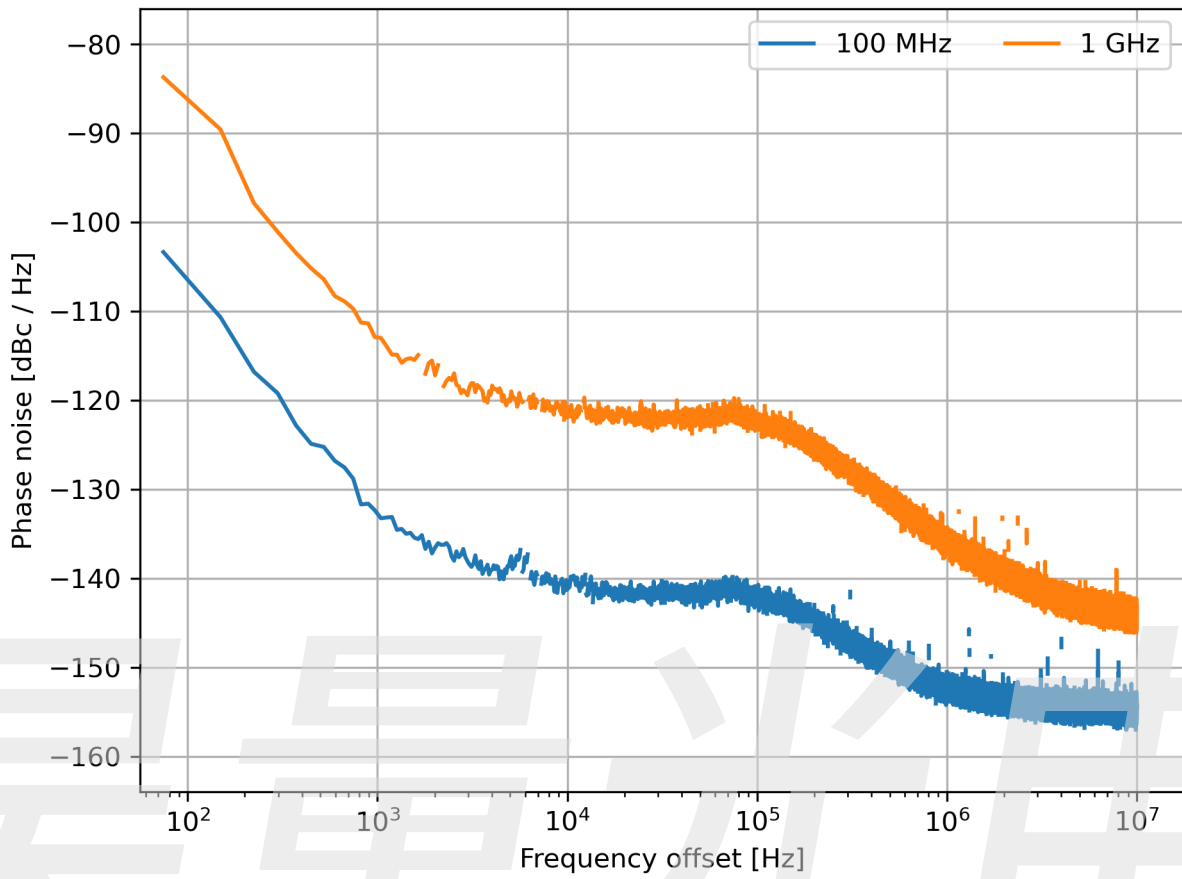
Input range versus frequency

Input noise versus frequency