# HF2LI-RT / HF2IS-RT Real-time

Zurich Instruments

## Embedded Programming Environment

Product Specification
Release date: August 2014

## Key Features

- User programmable embedded processor
- 32-bit processing unit at 64 MHz, 32-bit floating-point unit, 64 MB of data RAM
- Real-time system reaction time better than 20 µs
- Extensive development kit in C
- File I/O support
- Access to HF2 Instruments data and settings
- Automatic synchronization with user interface


## Summary

The Zurich Instruments HF2LI-RT / HF2IS-RT real-time option enables the user to implement and run software directly on the embedded processor inside the HF2 Instrument. This option transforms the Instrument into a versatile programmable measurement device with the capability to rapidly react to changing inputs according to a user-defined algorithm. Since this software runs directly inside the measurement instrument, it ideal for achieving low reaction latencies or high data throughput.

## Description

Zurich Instruments HF2 Instruments allow implementation of custom algorithms at two places. Custom functionality with loose timing constraints is sensibly implemented on the host PC. The available LabOne APIs (LabVIEW, MATLAB, Python or C) are best suited for such applications.

In case of tight latency requirements, e.g. below 50 ms, the user benefits from the HF2LI-RT / HF2IS-RT option as it allows having custom code executed in the measurement instruments on the embedded processor with guaranteed timing and deterministic run-time behavior.

The attainable latency varies with the complexity of the algorithm, but for many applications the latency can be below 20 µs with a loop update rate around 50 kSa/s which is a performance that is hard to achieve even with expensive real-time computers.

Real-time programs can read all inputs and outputs of the HF2 Instrument as listed in the following table.

**Supported inputs and outputs**

| | |
|---|---|
| inputs | demodulator outputs (X, Y), or (R, Phi), frequency (F), time (T) for up to 8 channels, auxiliary analog inputs, digital I/O port |
| outputs | stdio via USB and ziServer, auxiliary analog outputs, high-frequency outputs, digital I/O port |

## Software

The delivered environment includes:

- C compiler and programming tools for generating an executable and downloading to the HF2 Instrument
- ANSI C standard stdlib library for general purpose functions like memory allocation, process control, conversions and others
- ANSI C standard math library for mathematical operations
- ANSI C standard stdio library for functions and types used for various input and output operations, in particular log files

- Support for direct communication between software running on the host computer and the real-time program
- Programmer and host computer tools
- Real-time program configuration at run-time via the user interface

**Software implementation comparison**

| | Algorithm on host computer | HF2LI-RT / HF2IS-RT option |
|---|---|---|
| programming language | LabVIEW, C, C++ | C |
| ease of implementation | + | - |
| complex algorithms | + | = |
| debugging | + | - |
| latency | - | ++ |
| user friendliness | = | + |

## Example Applications

One category of applications requires quick computation based on measured signals for the control of other parts of the setup. Another set of applications comprises closed-loop operation where real-time algorithms provide considerable speed increase. A third category focuses on offline data monitoring and local storage for longer periods of time.

- Event detection with real-time setup control
- Closed-loop scanning imaging
- Closed-loop setup parameter regulation
- Long term offline measurements

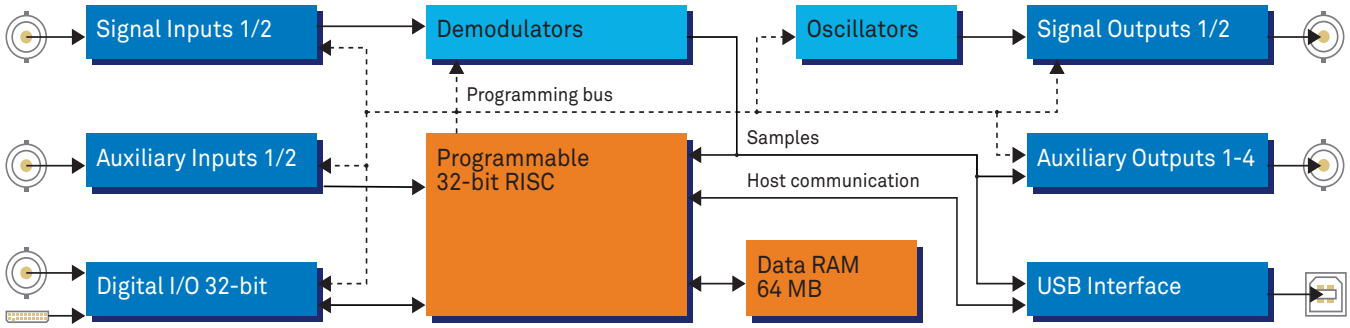
## Specifications

**Processor data**

| | |
|---|---|
| processor type | MicroBlaze, 32-bit RISC processor with Harvard architecture |
| floating point unit | 32 bit in hardware |
| processor frequency | 64 MHz |
| program memory | 64 kB |
| data memory | 64 MB |

**Timing and performance**

| | |
|---|---|
| typical latency (depends on complexity of algorithm) | 20 µs |
| get/set parameter rate | 200 kHz |
| PID loop rate (example) | 50 kSa/s |

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Zurich Instruments makes lock-in amplifiers, phase-locked loops, and impedance spectroscopes that have revolutionized instrumentation in the high-frequency (HF) and ultra-high-frequency (UHF) ranges by combining frequency-domain tools and time-domain tools within each product. This reduces the complexity of laboratory setups, removes sources of problems and provides new measurement approaches that support the progress of research.