Lab::Measurement – measurement control with Perl

S. Reinhardt¹, C. E. Lane², C. Butschkow¹, A. Iankilevitch, A. Dirnaichner and A. K. Hüttel
¹Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany
²Department of Physics, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104, USA

Flexible measurement needed?!

• Tired of dealing with many files in square meters of LabVIEW’s interface?
• Tired of clumsy string handling and low-level driver functions in your loong C program?
• Use a text processing language to manage your measurement! Use Perl!

Currently supported hardware

Hardware driver backends:

• NI-VISA (MS Windows) and all hardware supported by it
• LinuxGPIB and all hardware supported by it
• TCP connection, generic network socket (both Linux and MS Windows)
• USB-TMC lightweight driver (Linux, libusb)
• VXI-11 lightweight driver (Linux, libtrpc)
• Zurich Instruments LabOne API (both Linux and MS Windows)

Growing number of high-level drivers (more are very easy to add):

• Multimeters: HP / Agilent / Keysight
• DC sources: Yokogawa / Keithley / Keysight
• Lock-in amplifiers: Stanford Research / Signal Recovery / Zurich Instruments
• Temperature controllers: Lakeshore / Oxford Instruments
• RF / microwave sources, spectrum analyzers, VNAs: Rohde & Schwarz, HP / Agilent, Rigol
• and many more...

Real world measurement

• Ferromagnetic resonance measurement with vector network analyzer (VNA)
• Outer loop: continuous sweep of magnetic field with OI Mercury IPS magnet controller
• Inner loop: VNA transmission measurement at multiple discrete microwave frequencies

Hardware driver backends:

• Contributors and cooperations welcome!
• Releases on CPAN, development on Github
• USB-TMC lightweight driver (Linux, libusb)
• NI-VISA (MS Windows) and all hardware supported by it

Recent improvements

• Extensive tutorial
• New drivers
  – Oxford Instruments Mercury magnet controller and level meter
  – Oxford Instruments Triton system control
  – Lakeshore 340 temperature controller
  – Zurich Instruments MFLI lock-in amplifier and MFIA impedance analyzer
  – Rigol DSA815, HP 8596E Spectrum Analyzer
  – Keithley 2400, Keysight B2901A “sourcemeter”
  – HP 34420A nanovoltmeter
• More configurable live plots
• Compatibility with newer versions of Zurich Instruments LabOne API

Key facts

• Open source / free software
• https://www.labmeasurement.de/
• License: same as Perl (GPL-1+ or Artistic)
• Releases on CPAN, development on Github
• Contributors and cooperations welcome!

Layer structure

• Modular structure. Easy to extend with new instrument drivers and connection types
• Abstract IO layer, makes instrument drivers independent of hardware backends

High-level sweep framework

• Modern Perl implementation; use state of the art object-oriented programming
• Separate classes for sweeps, datafiles, datafolders, and plots
• Most operational details of the sweeps are implemented in subclasses of the Lab::Moose::Sweep base class
• High modularity: very easy to extend with new functionality

Advanced sweep features

• Multidimensional sweeps, e.g. 3D sweep: creating one 2D datafile for each step of the outermost sweep
• Log arrays and matrices of data (PDLs). Useful for spectrum analyzers, VNAs, oscilloscopes
• Extensive support for live plots via gnuplot: line plots (2D data) and color maps (3D data)
• Customizing live plots: access to all gnuplot plot and curve options via PDL::Graphics::Gnuplot

Output files

Recent improvements

• Extensive tutorial
• New drivers
  – Oxford Instruments Mercury magnet controller and level meter
  – Oxford Instruments Triton system control
  – Lakeshore 340 temperature controller
  – Zurich Instruments MFLI lock-in amplifier and MFIA impedance analyzer
  – Rigol DSA815, HP 8596E Spectrum Analyzer
  – Keithley 2400, Keysight B2901A “sourcemeter”
  – HP 34420A nanovoltmeter
• More configurable live plots
• Compatibility with newer versions of Zurich Instruments LabOne API

Reference / Cite as

"Lab::Measurement — a portable and extensible framework for controlling lab equipment and conducting measurements”, S. Reinhardt et al., Comp. Phys. Comm. 234, 216 (2019)