Remote S-Parameter Communication from NanoVNA v2

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Introduction

- Remote measurement of metabolites such as glucose and lactate is a field of growing interest. Often this is done by using wearable microwave devices that detect changes in blood dielectric characteristics [1].
- Laboratory VNAs used to detect these changes in dielectric properties are often too large to be used for these applications, as they limit the wearer's movement.
- A software package was developed to allow remote measurement using a small portable VNA (NanoVNA v2) attached to a person.

NanoVNA v2 Specifications	
Frequency Range	50 kHz-3GHz
Frequency Resolution	10 kHz
Noise Floor	-40 dB
Max Sweep Points	1024-65536 (firmware & PC dependent)
Interface	Micro-USB

NanoVNA v2 API

- The NanoVNA v2 connects to a single-board computer (e.g. Raspberry Pi) through a USB CDC virtual serial port [2].
- The computer-vna setup can be mounted to a person.
- Writing to registers (shown right) sets settings of the NanoVNA.
- Measurements can be read through a FIFO on the VNA.
  - Measurements are not calibrated; this must be done within software.
- VNA firmware limits some settings on the VNA to particular configuration, especially number of sweep points.

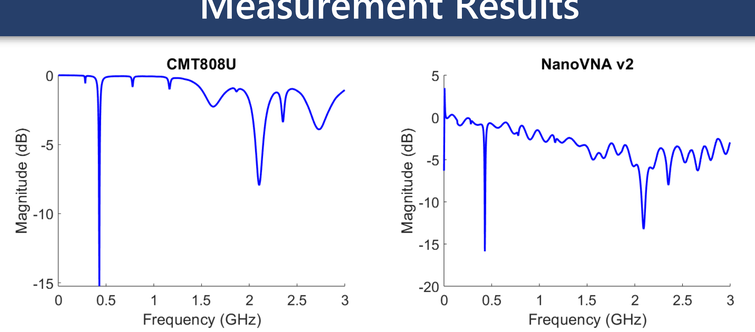
Address	Name	Description
00..07	sweepStartHz	Sets the sweep start frequency in Hz. **uint64**.
10..17	sweepStepHz	Sets the sweep step frequency in Hz. **uint64**.
20..21	sweepPoints	Sets the number of sweep frequency points. **uint16**.
22..23	valuesPerFrequency	Sets the number of data points to output for each frequency. **uint16**.
26	rawSamplesMode	Writing 1 switches USB data format to raw samples mode and leaves this protocol.
30	valuesFIFO	Returns VNA sweep data points. Each value is 32 bytes. Writing any value (using **WRITE** command) clears the FIFO. See FIFO data format section below.
f0	deviceVariant	The type of device this is. Always 0x02 for NanoVNA V2.
f1	protocolVersion	Version of this wire protocol. Always 0x01.
f2	hardwareRevision	Hardware revision.
f3	firmwareMajor	Firmware major version.
f4	firmwareMinor	Firmware minor version.

Hardware Setup

- Port 1 of both the CMT-808U VNA and NanoVNA was attached to a test antenna.
- Each VNA was connected to a computer.
- Using the developed Python script, the NanoVNA was polled for S_{11} data and the resulting data was stored to a Touchstone file [3]. The file was retrieved remotely and then analyzed.
- Measurements from the CMT-808U were taken through the S4VNA software.
- Measured resonance when using NanoVNA v2 is within 10 MHz of CMT808U measurement.

Setup of the NanoVNA connected to a test antenna

Measurement Results



Comparison of S_{11} versus frequency measurements using the CMT-808U Lab VNA (left) and the NanoVNA v2 (right).

Conclusion and Future Work

- Further develop software to include calibration capability that exists in other apps like VNA Viewer. This can be done using the scikit-rf Python library [4].
- Unify NanoVNA v2 Python library to be interoperable with the NanoVNA-H Python library.
- Experiment with Python interface to allow continuous streaming of measurement data for faster real-time analysis.

Acknowledgements

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References

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[2] "User Manual - NanoVNA V2," NanoVNA V2 Official Site. Accessed: Jan. 02, 2024. [Online]. Available: https://nanorfe.com/nanovna-v2-user-manual.html#specifications

[3] K. Hora, "NanoVNA v2 Interface." Nov. 26, 2023. Accessed: Jan. 04, 2024. [Online]. Available: https://github.com/ComputerAided3/NanoVNA_v2_Interface

[4] A. Arsenovic et al., "scikit-rf: An Open Source Python Package for Microwave Network Creation, Analysis, and Calibration [Speaker's Corner]," IEEE Microwave Magazine, vol. 23, no. 1, pp. 98–105, Jan. 2022, doi: 10.1109/MMM.2021.3117139.

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