AN OPEN-SOURCE MAX14866 DEVELOPMENT BOARD

A POLYGLOT DOCUMENTATION FILE

Luc Jonveaux*
Tinkerer, Milly le Meugon, France
contact@un0rick.cc

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ABSTRACT

Non destructive testing and imaging ultrasound have been around since the '50s. Many ultrasound open-source projects are emerging, mostly focusing on image processing - while hardware has been left behind. Several teams have produced successful designs to be used on commercial US scanners, but they are not cheap, and are difficult to access.

I couldn't find designs to play with, that would be affordable or open, so I decided to update the previous one, the un0rick, for a more cost-efficient board designed for makers, researchers and hackers.

Having a single-channel device was not enough to play with small linear or annular arrays, so we developped a small high voltage switch control to allow pulse-echo, separating transmit and receive paths, on a 8-element array, or to access up to 16 elements with the same TX/RX path.

This PDF is also a ZIP that contains the sources to the hardware and some data too, don't hesitate to have a look. Just rename the file from .PDF to .ZIP and you're ready to go .

Keywords open-source · ultrasound · hardware · ice40 · fpga

1 Overview

This wonderful board has been designed to provide a curious tinkerer with the basis to play with, and understand, imaging with multi-element ultrasound sensors.

As stated by its datasheet, "the MAX14866 is a 16-channel, high-voltage (HV), analog SPST switch primarily intended for HV multiplexing in ultrasound applications. The MAX14866 operates from one only low-voltage supply (+5V) and does not require dedicated HV supplies, resulting in cost-saving and system simplification. ". The MAX14866 can transmit undistorted analog signals up to 210VP-P. There are also bleed resistors.

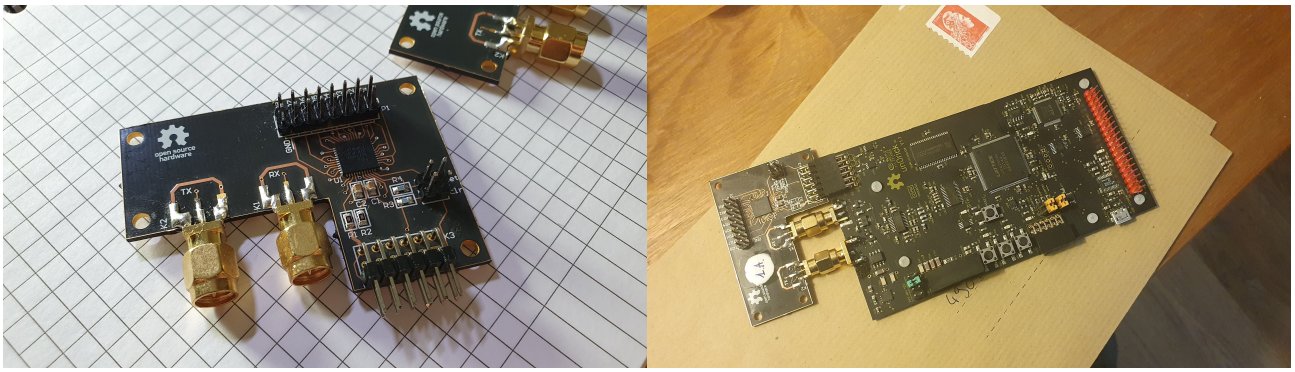

Figure 1: Top side of the max14866 board and its connexion to the un0rick.

This allows for a relatively simple design.

*More on the website http://un0rick.cc. This paper has its on Zenodo DOI 10.5281/zenodo.5792252

2 Where to find the latest sources

The latest sources of the hardware as well as software are available at https://github.com/kelu124/max14866/. However, this PDF also doubles as an archive (you can rename the .pdf as a .zip, and you'll see), and contains, in short: a set of gerbers and BOM, and some documentation. There may be some other stuff there, but I forgot what I put there.

3 Operation

We have run tests as showed in figure 2. The FPGA had all the right logic in place to provide you with a full control over the pulse-echo process.

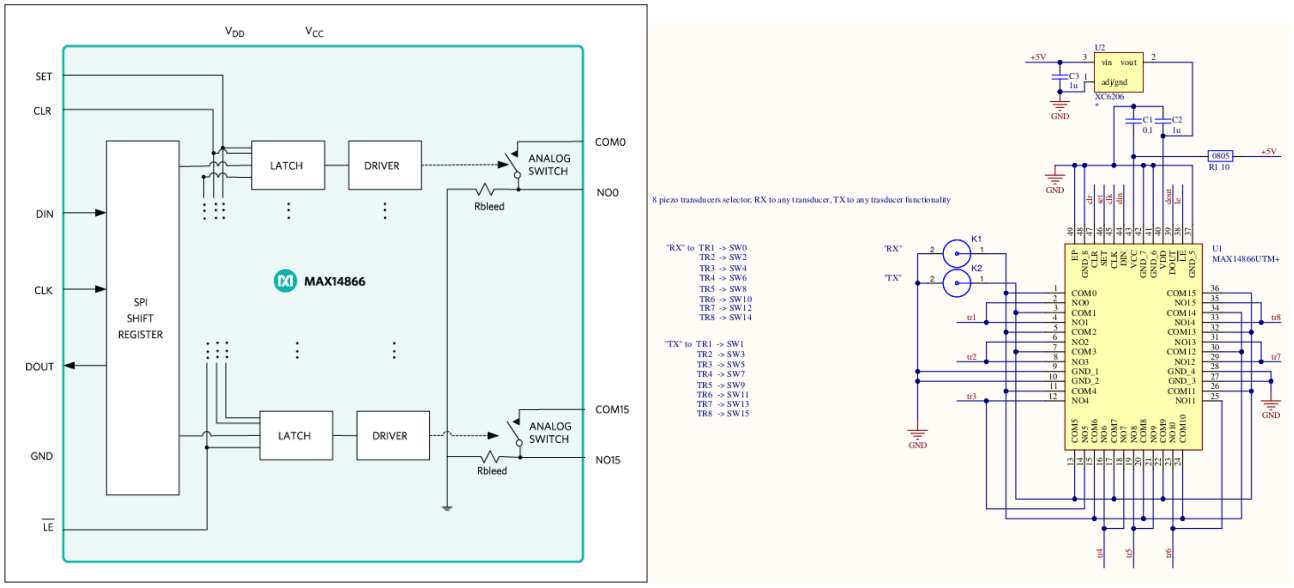

Figure 2: Principles of the board

The second figure 3 shows all acquisitions for all pairs of tx/rx combination : we ran the tests on a 5-element arrays, with a pin missed during soldering. That being said, it demonstrates the feasibility to get echoes using the max14866 board.

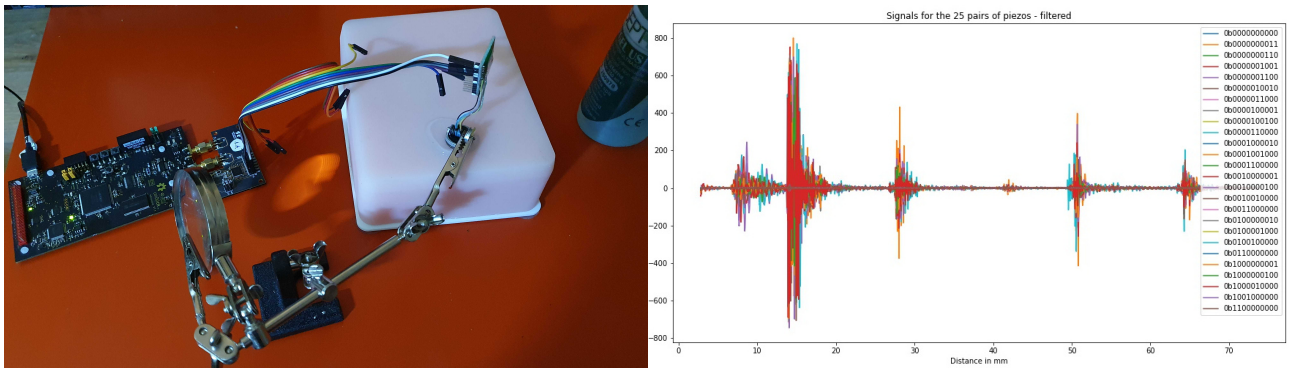

Figure 3: Top side of the max14866 board and its connexion to the un0rick.

4 Last details

Certification The development board is open-hardware certified, under ID FR000014.

License This work is based on previous projects, the un0rick and the echOmods projects. The lit3rick project and its boards are open hardware and software, developed with open-source elements.

5 Links to go further

- Come and chat : join the Slack channel
- The full GitHub repository for the un0rick "motherboard".
- The board's Tindie shop to get it
- The project Hackaday page with more logs
- Check out my previous work on the topic of ultrasound modules [1] and its dataset on Zenodo. More to come!

6 Next steps

Plenty to do on the next steps! Let me know if you'd like to contribute. The current shopping list (non-exhaustive) may include:

- Improving the documentation, and updated the work of its predecessor, the un0rick [2].
- Shift to a "real", PMOD-compliant connector.
- Have a better connector

References

[1] Luc Jonveaux 2017. Arduino-like development kit for single-element ultrasound imaging. In *Journal of Open Hardware, 1(1), p.3*. DOI: 10.5334/joh.2

[2] Luc Jonveaux 2019. un0rick : open-source fpga board for single element ultrasound imaging On *Zenodo*. DOI: 10.5281/zenodo.3364559

[3] Luc Jonveaux 2021. lit3rick: an up5k ultrasound pulse-echo device On *Zenodo*. DOI: 10.5281/zenodo.5792245