Completion and testing of the AltiCube 35 GHz radar test board

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The development of a 35 GHz altimeter radar test board was started under the initial project funding of NSO for the *Dutch knowledge network on small spaceborne radar instruments and applications* (acronym NL-RIA). At the end of that project the test board was almost ready to test. TU Delft, Swartvast, ISIS and Robin Radar acquired a new project "AltiCube – A Dutch CubeSat radar altimetry instrument", financed by NSO and kicked off in December 2023 to develop a compact RF frontend without antenna feed that, in combination with a backend, can go into space as a CubeSat Altimeter in 3 to 4 years. As part of this project the test board could be finalized and tested, both in the laboratory and in a field test.

The radar test board front-end has the following features:

parameter	values
Central frequency	35.6 GHz
Bandwidth	320 MHz
Pulse width	48 µs
PRF	4 kHz
Output Power	30 dBm
Receive Power	-127 dBm
Noise figure	5 dB
IF bandwidth after dechirping	5 MHz

The aim is to achieve a design with the smallest possible volume, weight and energy consumption. This summary gives an impression of the results.

Below is the block diagram and the realized Printed Circuit Board (PCB) with the dimensions of 10 x 10 cm with all COTS components placed on one side. On this PCB, an 8.85 GHz linear sweep of 80MHz is generated and then multiplied by four and amplified to 1 Watt (30 dBm). The received signal is amplified by an LNA and converted to an offset frequency of 500MHz.

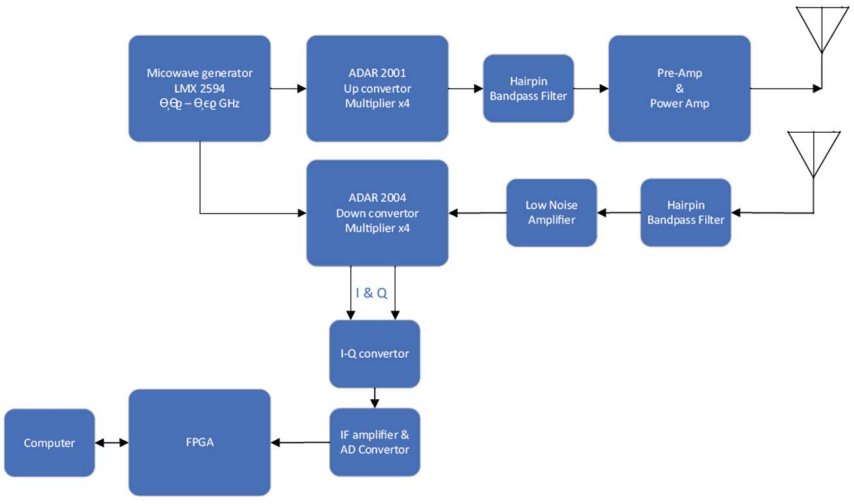

Figure 1 Block diagram of the Front-end

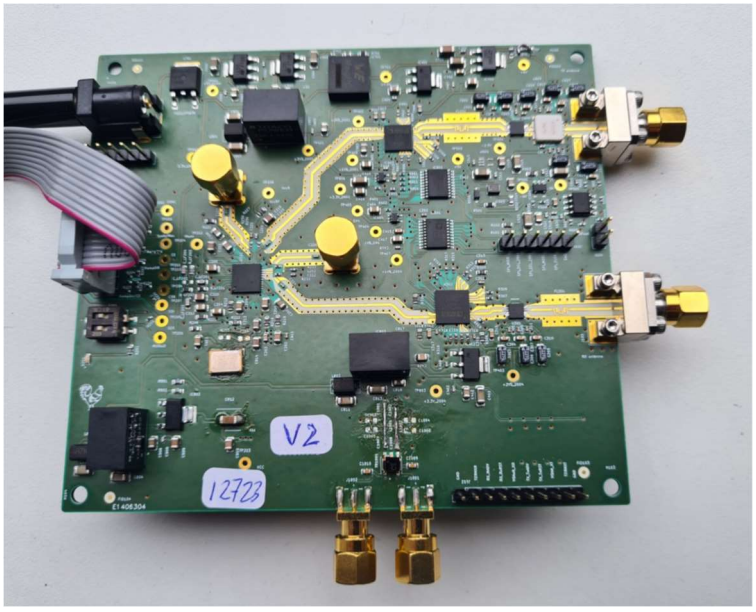

Figure 2 PCB with the entire Front-end placed on one side without ADC, FPGA and computer.

Some results of the measurements:

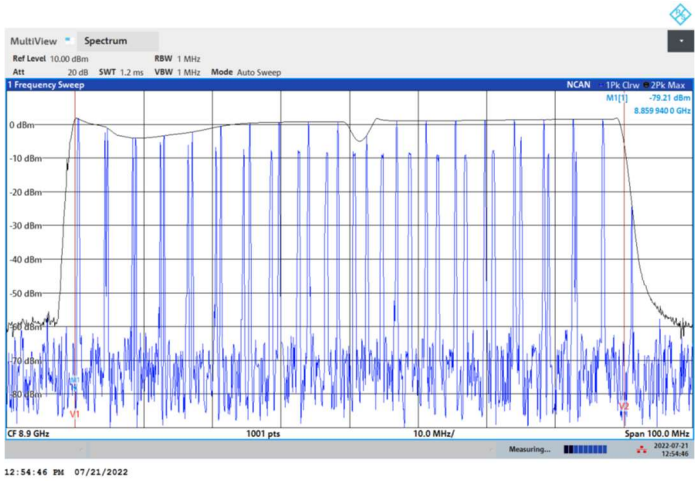

Figure 3 RF signal at 8900MHz with bandwidth 80MHz

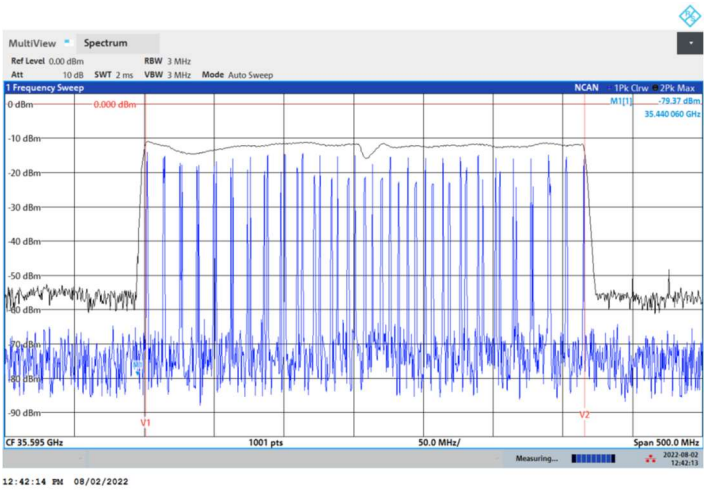

Figure 4 Output signal at 35.6GHz with bandwidth 320MHz

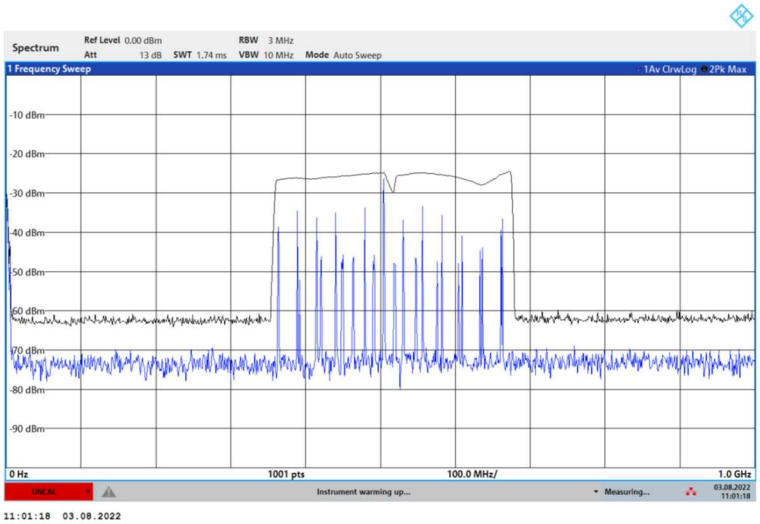

Figure 5 Offset IF signal at 500MHz and with bandwidth 320MHz

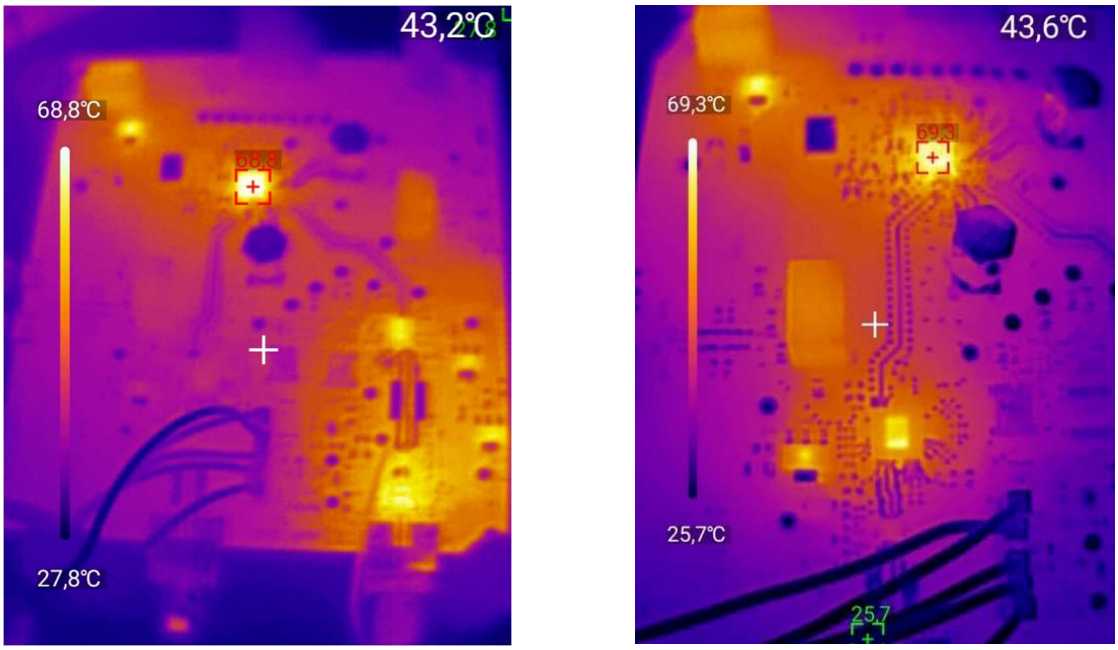

Figure 6 Thermal picture of the TX chain (right) and the RX chain (left)

It has been possible to design a well-functioning compact front-end for the radar altimeter and to implement it in electronics that meet the basic requirements.

The assembled electronics were tested from the Swartvast church tower, the Cornelius Basilica in Welberg, with a free field of view of 3.5 km to corner reflectors. The measurements give a good indication of the performance.

Figure 7 Our test site is the Cornelius Basilica in Welberg

Figure 8 The Ka-band horn transmitting antenna

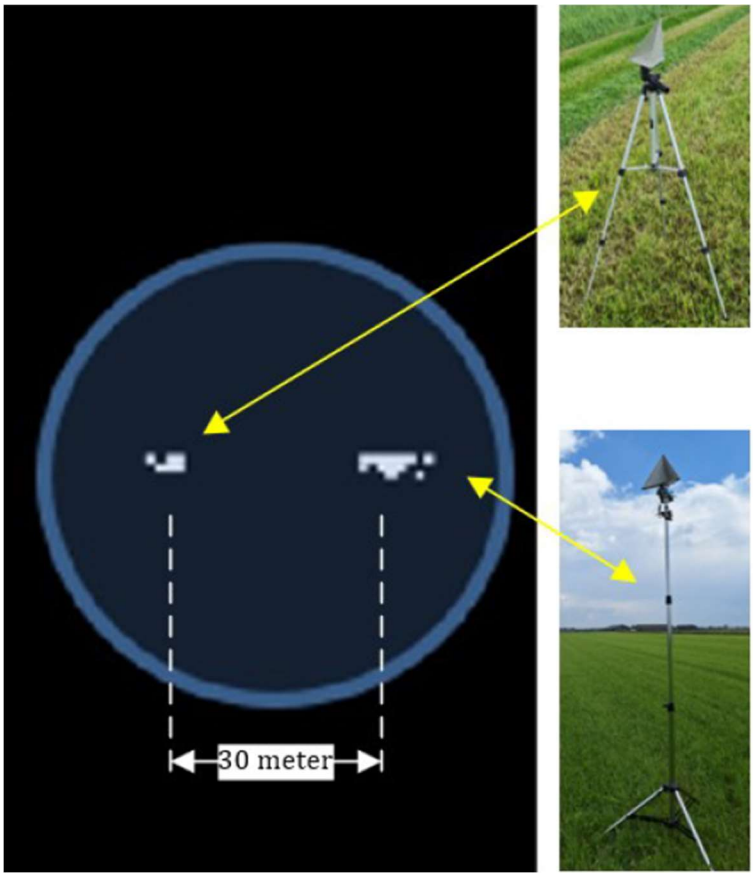

Figure 9 two corner reflectors, 30 m apart at 3.5 km from the radar were successfully imaged.

With this, this project has been successful, and the next step can be taken towards a final product.