Assembly instructions for a frequency modulated continuous wave (FMCW) radar

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Abstract

We describe the assembly of a frequency modulated continuous wave radar, implemented by a commercial radar module, controlled by a Raspberry Pi computer extended with an AD/DA card. The intent is to make a very simple and cheap radar system for educational purposes.

1 Material

The parts for the assembly can be seen in Figure 1.

- Radar unit IVS-162, from Innosent GmbH.
- Raspberry Pi.
- ADCDAC Pi Zero from AB Electronics UK.
- LM358 operational amplifier.
- 10 kΩ potentiometer.
- 9 V battery, battery holder.
- Protoyping board.
- Prototyping connector cables, male-female, 6 pieces.
- Wooden board, about 11.5 cm × 20 cm.
- Wood screws, 2.5 mm thickness, 16 mm or more in length.
- Plastic beads as distances.

2 Assembly

1. Mechanical assembly:
   (a) Choose a side of the wooden board resulting in minimum wobbling when on a flat surface.

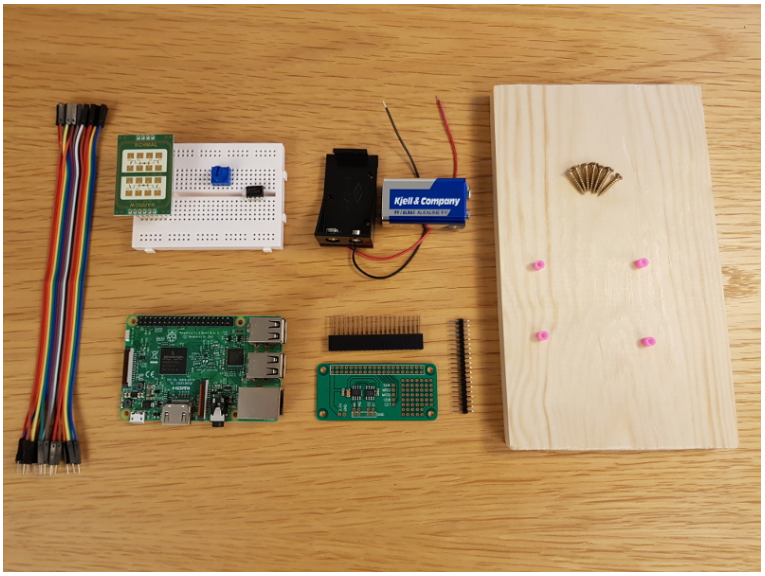

Figure 1: Material for the assembly.

(b) Mount the prototype board on top of the board. In the present case, it was supplied with an adhesive which was simply pressed to the board.

(c) Fasten the battery holder beneath the prototype board using wood screws.

(d) Fasten the Raspberry Pi beneath the battery holder using wood screws and plastic bead distances to keep it elevated above the board. See Figure 2.

See Figure 3 for the result.

2. Assembly of ADCDAC:

(a) The ADCDAC is delivered unassembled. The parts are shown in Figure 4.

(b) Use the assembly jig (can be downloaded from AB Electronics web site) to stabilize the setup during soldering, see Figure 5.

(c) Soldering extra pins to the output and input of the ADCDAC can be a bit tricky. Try to find a prototype circuit board where you can use the holes to stabilize the position of the extra pins during soldering, see Figure 6.

See Figure 7 for the result.

3. Wiring the prototype board:

(a) The schematic of the wiring is shown in Figure 8. Note that the actual capsule used for the LM358 contains two OP:s, but we are only using one. See separate datasheet for the LM358 and the radar module.

(b) Do the wiring for the non-inverting amplifier part according to Figure 9, that is, do not mount the radar module or connect the Raspberry Pi yet.

(c) Set up a signal generator to generate a sinusoidal signal with $V_{\text{min}} = 0\,\text{V}$, $V_{\text{max}} = 2\,\text{V}$, frequency around 100 Hz. Verify the signal with an oscilloscope. Connect the signal generator as input to the non-inverting amplifier, and verify

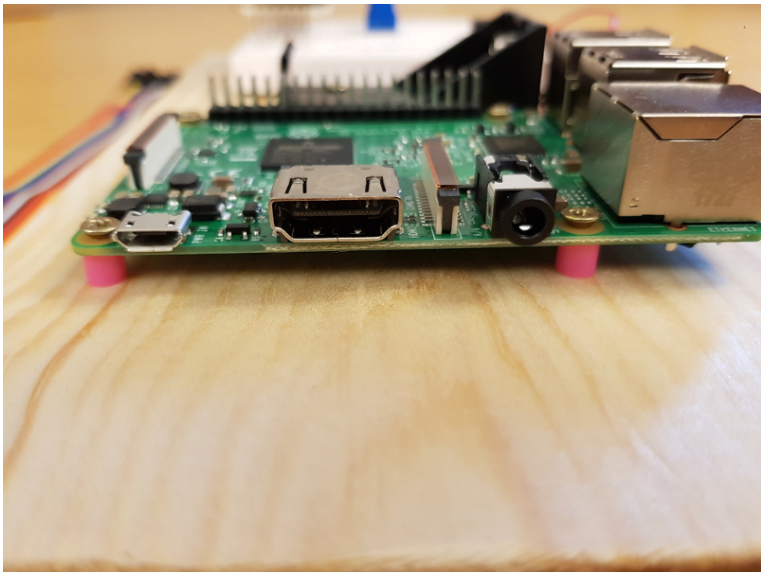

Figure 2: Using plastic beads as distances.

the functionality with the oscilloscope. Adjust the potentiometer until the output signal is a sinusoidal with $V_{\text{min}} =$ V and $V_{\text{max}} \approx 7\,\text{V}$. See Figure 10.

(d) After verification that the amplifier part is working, mount the radar module (part with six pins at the top, four pins at the bottom), see Figure 11. Also connect the Raspberry Pi unit using prototyping connector cables. The pins of the Raspberry can be sensitive if connected to wrong voltage (the whole unit can become useless), be careful and doublecheck everything before connecting!

4. Software:

   (a) Start with a standard Raspberry installation like NOOB.

   (b) Download and install the extra libraries for controlling the ADCDAC from AB Electronics.

   (c) Some software controlling the radar based on Python3 or C is available next to this assembly instruction.

Done!

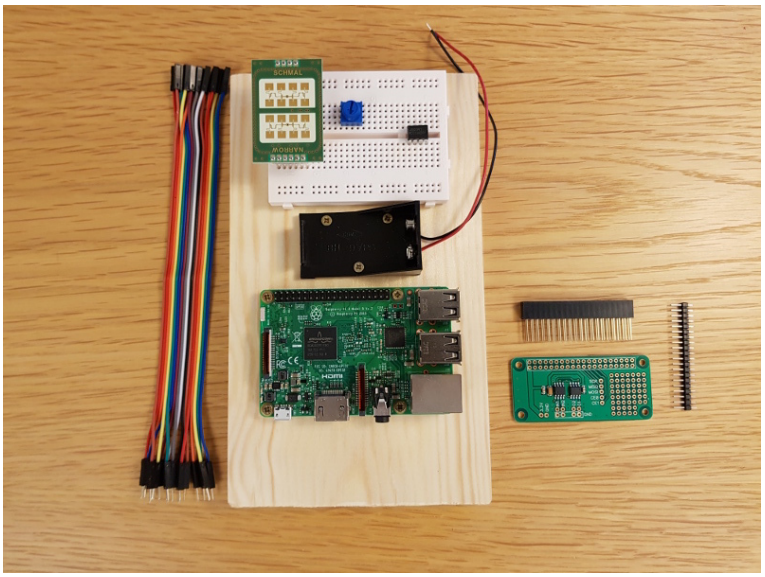

Figure 3: Result of mechanical assembly.

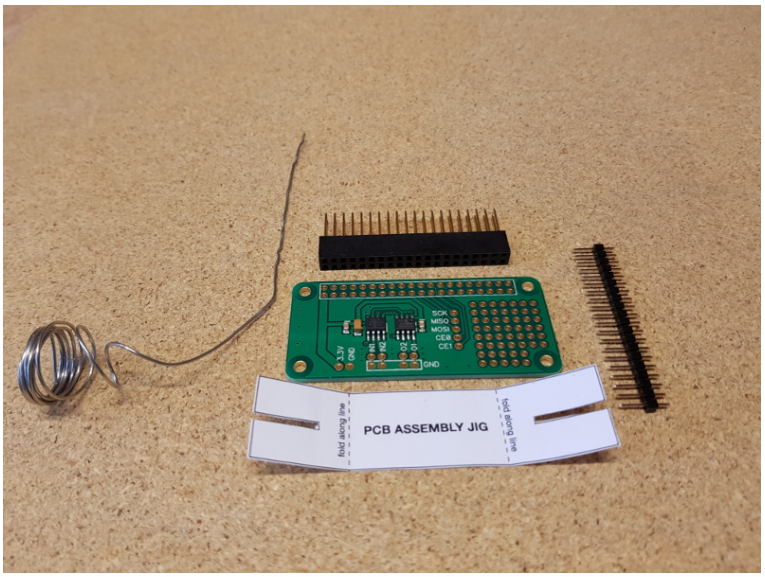

Figure 4: Parts for assembling the ADCDAC.

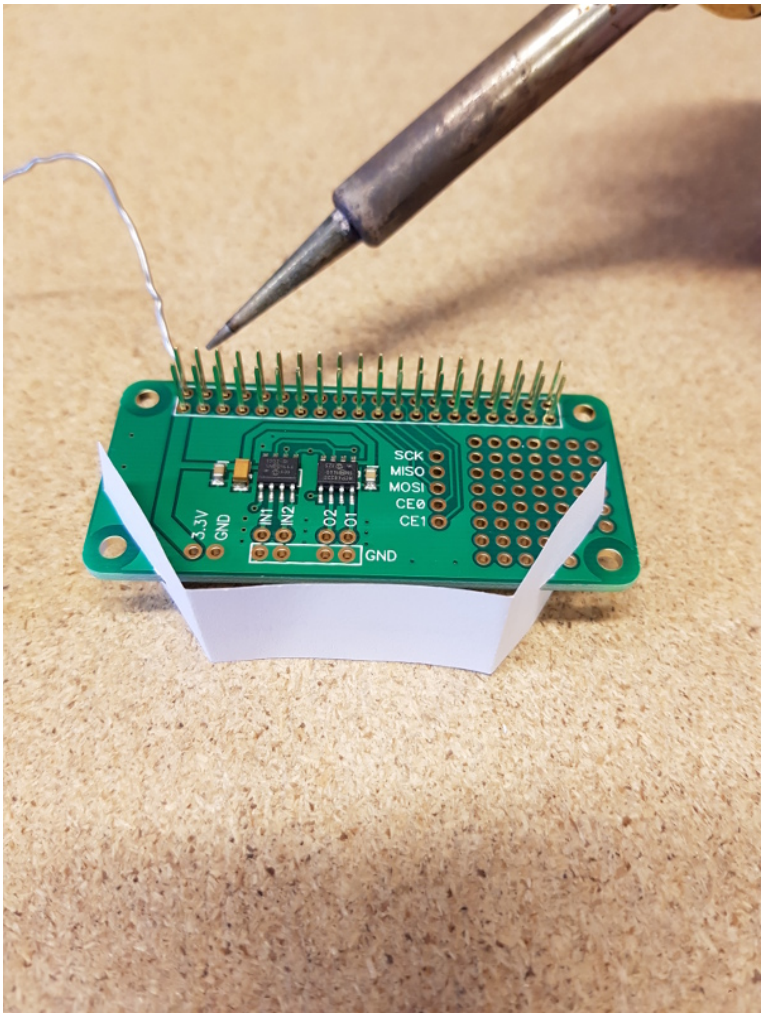

Figure 5: Soldering the ADCDAC.

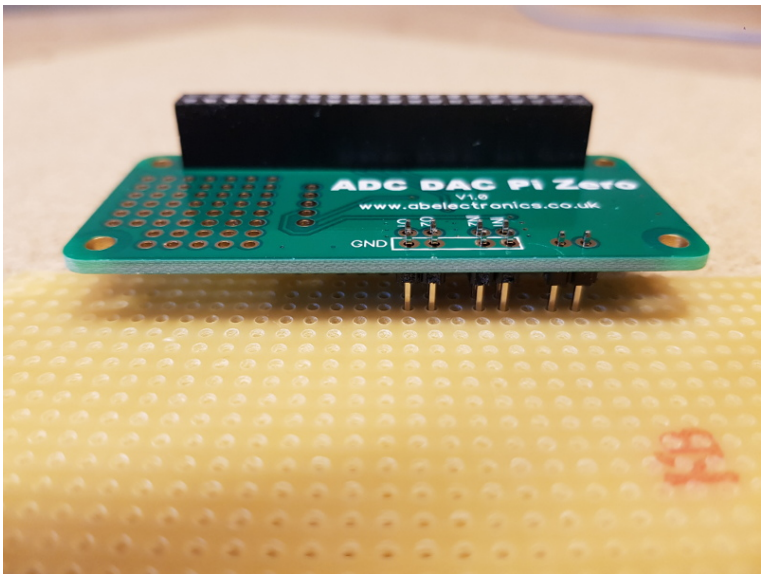

Figure 6: Mounting the extra pins on the ADCDAC. The prototype circuit board below is used only to stabilize the pins while soldering.

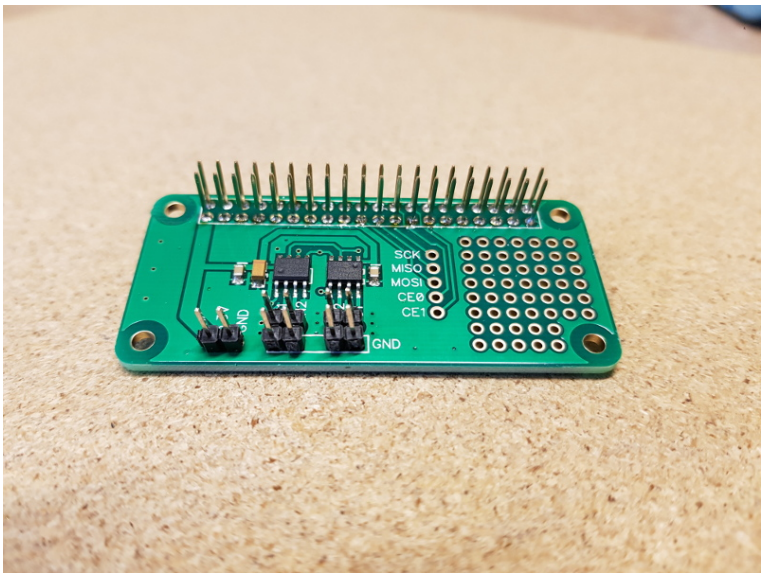

Figure 7: Assembled ADCDAC.

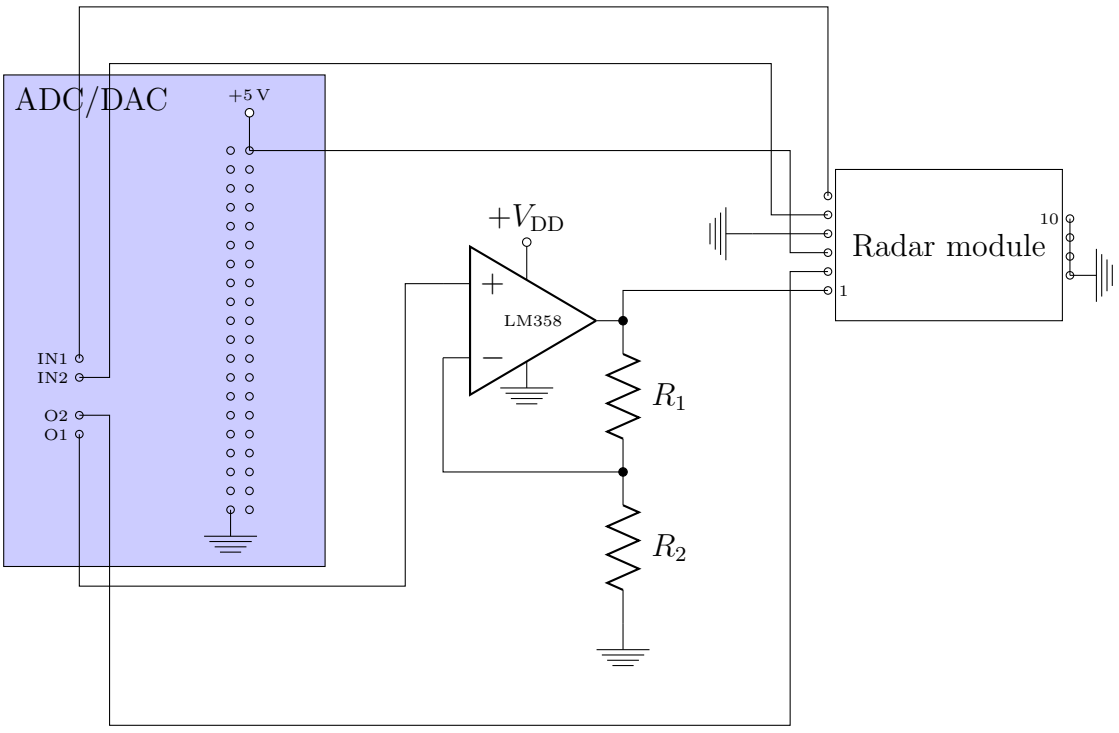

Figure 8: Schematic of the radar system.

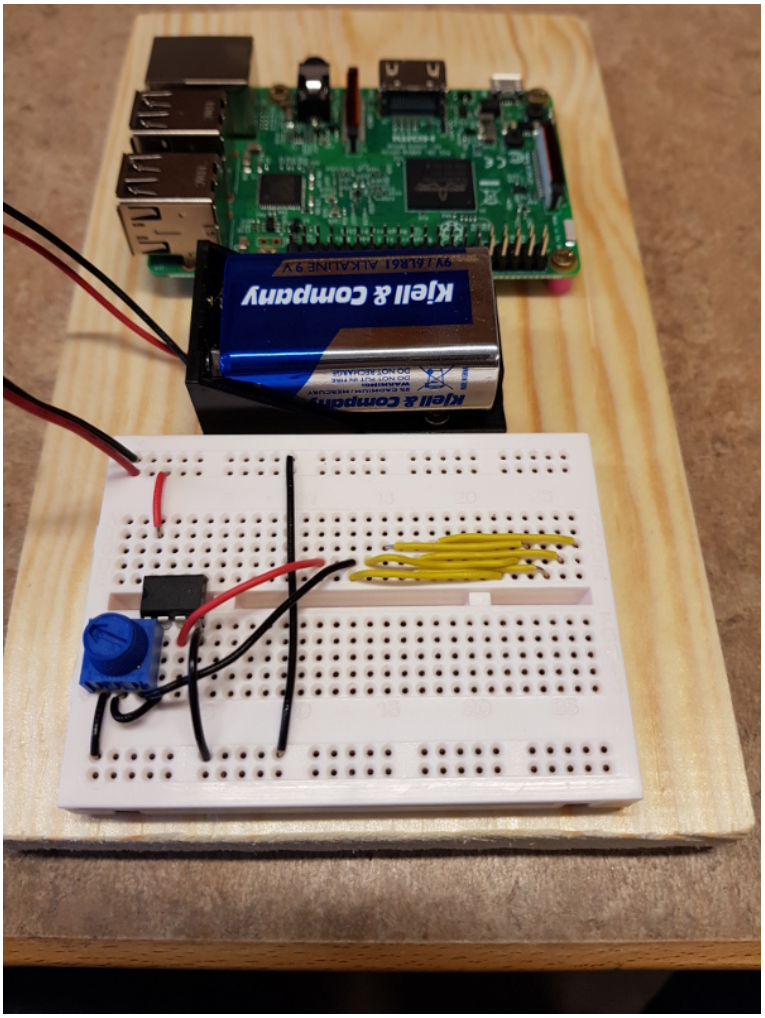

Figure 9: Wiring before mounting the radar module. The top rail is ground, the one below that is $V_{CC} = 9\,\mathrm{V}$. The ground is also connected to the second rail from the bottom. Note the yellow wires on the right, which are translating the 6 connections to the radar module to the left. This is required since the module is slightly oversized, and covers all available connections on the board.

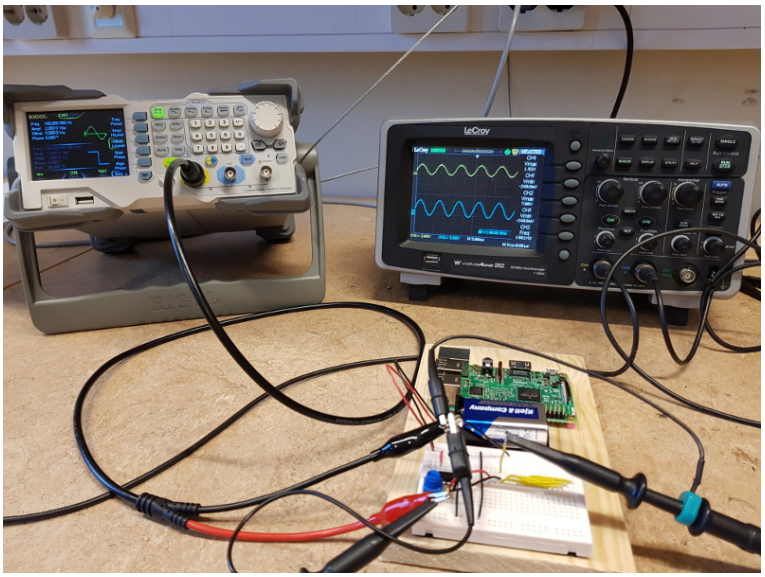

Figure 10: Measurement verification before mounting the radar.

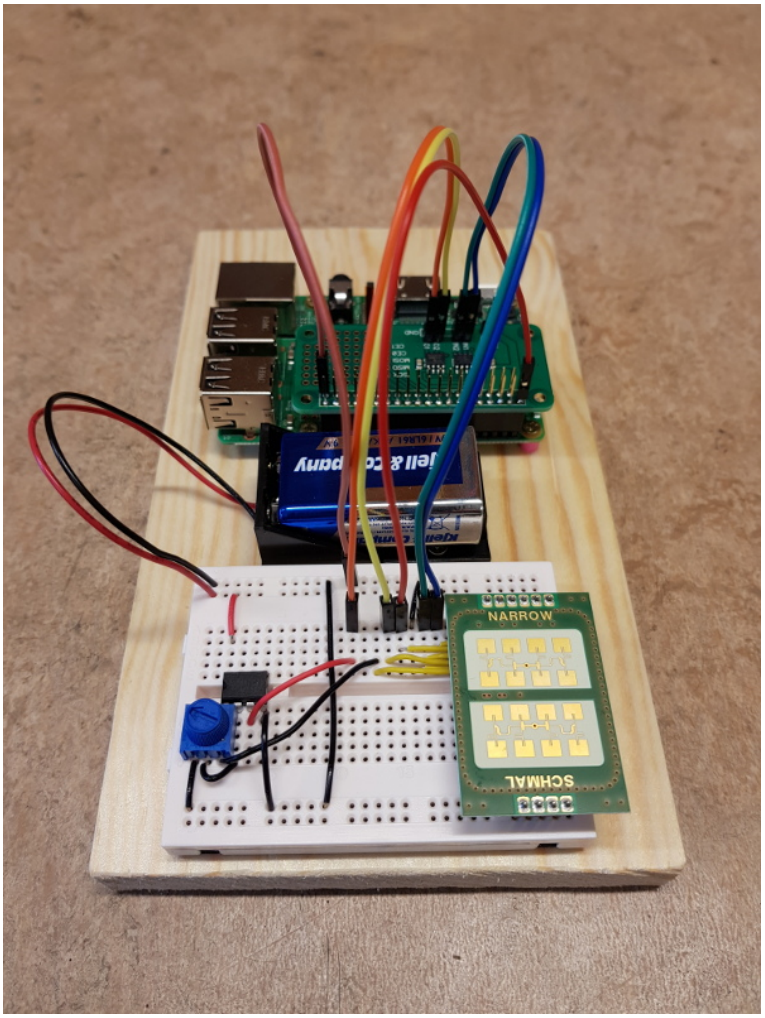

Figure 11: Finished assembly.