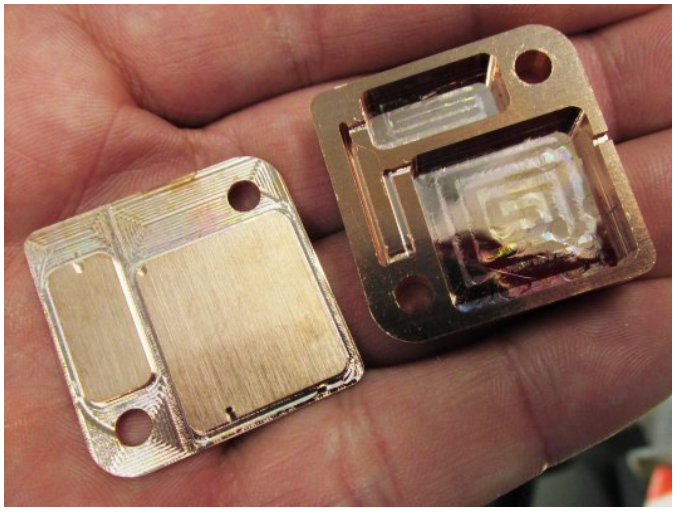
Thermometers for dilution fridges (V.Zavjalov, 11.2018)

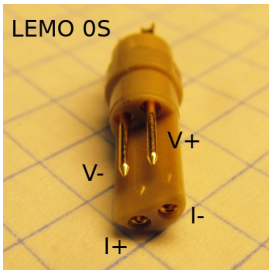
The goal is to make standard thermometers for use in dilution fridges. I use carbon OHMITE resistors (OD/OF series) [1], which are claimed to be good thermometers at millikelvin temperatures [2]. The series OD and OF have different sizes (diameter 2.5 mm and 3.8 mm and length 7 mm and 10 mm respectively). I grind resistors down to approximately 0.7 mm thickness and glue it in a slit in a copper box using Stycast 2850. This provides a good thermal contact with the box, mechanical stability, and protection against moisture.

Copper boxes are ordered in Schaeffer-AG company [3]. The box has $30 \times 30 \times 5$ mm size. It contains a $20 \times 18 \times 3$ mm compartment for RC lowpass filters, a $1 \times 16 \times 4$ mm slit for the resistor and a $16 \times 7 \times 3$ mm additional compartment which can be used for sample chips. Holes are compatable with standard 20×20 M4 hole grid on BlueFors refrigerator plates. Drawings in FPD format are available [4], price was 315€ for 10 boxes and 10 lids.



PCBs for filters are ordered in Multi-CB company [5]. Price is 75€ for 10 boards with two different filters and two small sample plates each. Kicad project [6] and Gerber files [7] are available.

To connect thermometers to BlueFors 4-pin sockets we use inserts of LEMO `FFA.0S.304.CLAC44` connectors (Farnell number: 2442870).



List of devices

N	Resistor	R_0	R_1	R_2
2018-11-02 N1	OD270JE	27	56	56.0
2018-11-02 N2	OD270JE	27	59	64.4
2018-11-02 N3	OF121JE	120	231	277

Here R_0, R_1, and R_2 are nominal resistance, resistance after grinding, and resistance after soldering and glueing. Change during glueing probably means that contacts with carbon in the resistor after grinding are not stable.

References

[1] Ohmite OD/OF series datasheet, https://www.ohmite.com/assets/docs/res_od_of_oa.pdf

[2] N. Samkharadze, A. Kumar, G. A. Csáthy, A New Type of Carbon Resistance Thermometer with.Excellent Thermal Contact at Millikelvin Temperatures, *JLTP*, **160**, 246–253 (2010), https://doi.org/10.1007/s10909-010-0192-5

[3] Schaeffer-AG company, https://www.schaeffer-ag.de/en/

[4] Box drawing in FrontPanel Disigner format, https://github.com/slazav/he3notes/raw/master/20181105-mk_therm/suppl/box_v1.zip

[5] Multi-CB company, https://portal.multi-circuit-boards.eu

[6] Filter PCB, KiCAD project, https://github.com/slazav/he3notes/tree/master/20181105-mk_therm/suppl

[7] Filter PCB, Gerber files for ordering, https://github.com/slazav/he3notes/raw/master/20181105-mk_therm/suppl/filter_pcb_v1.zip