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Josephson Impedance Bridge with pulse-driven Arrays

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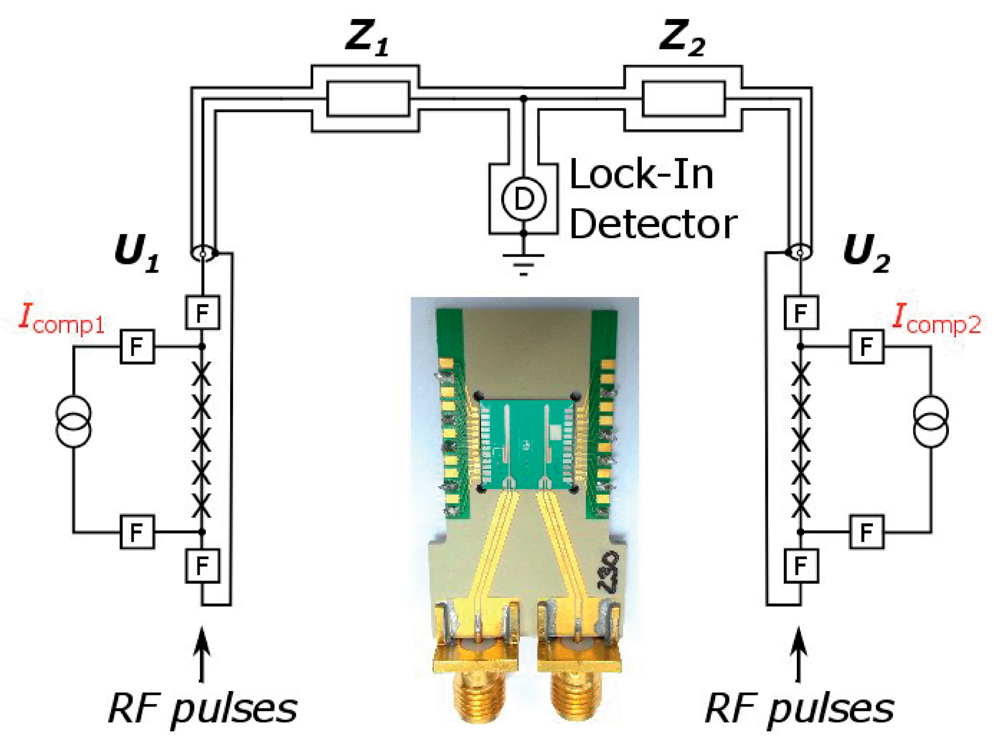
ABSTRACT — In order to determine arbitrary impedance ratios, an impedance bridge based on pulse-driven Josephson arrays was implemented at PTB. The sine-waves generated by this system possess high spectral purity and quantum precise amplitudes. This new impedance bridge allows to measure like impedance ratios (*R*:*R* or *C*:*C*) over a wide range and also to make quadrature measurements ($\omega RC = 1$).

Setup:



Two independent pulse-driven arrays arranged on one chip.

Pulse-driven arrays can be operated in a closed loop cryocooler.

The exact voltages and the phase angle between both voltages can be adjusted to balance the bridge.

$$\frac{Z_1}{Z_2} = \frac{U_1}{U_2}$$

Measurement results:

For the first measurements the bridge was equipped with a chip containing two arrays of 9000 triple-stacked junction.

Both arrays are driven by rf pulses only, resulting in maximum amplitudes of 20 mV per array.

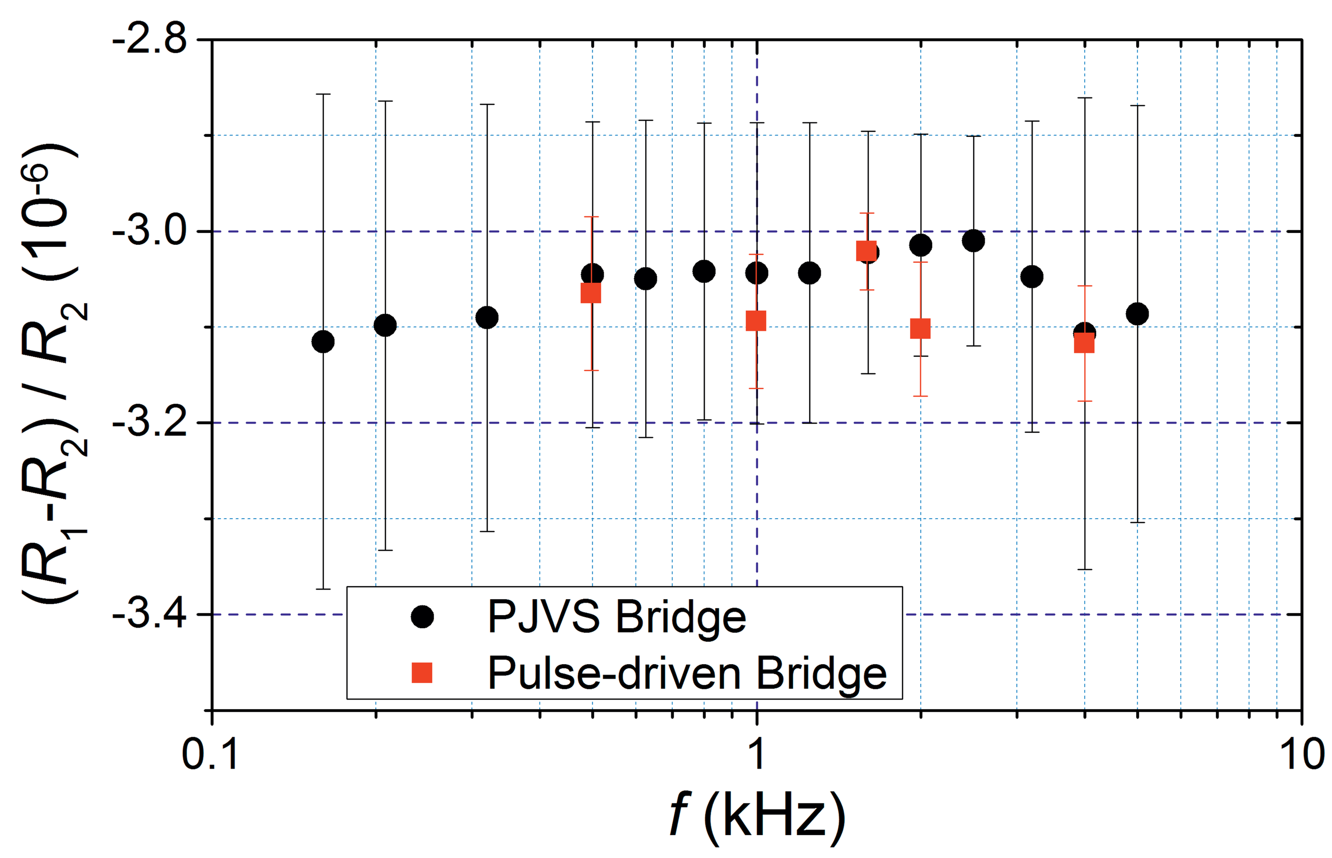
The bridge is balanced by changing the phase angle and the amplitude of U_2 to minimize the reading of the lock-in which is usually less than 1 nV.

The ratio of two 10 kΩ resistors was compared with the results of a programmable Josephson-bridge.

For the ratio of two 10 nF capacitors the results of the pulse-driven bridge agrees to 2 part in 10^8 compared to a commercial capacitance bridge.

Also the ratios of the capacitors and resistors obtained by direct and by quadrature measurements were compared.

in 10^{-6}	$(R_1-R_2)/R_2$	$(C_1-C_2)/C_2$
Direct measurement	-2,94 ± 0,05	+8,03 ± 0,01
Quadrature	-3,03 ± 0,30	+8,10 ± 0,10
Difference	**+0,09**	**-0,07**



Outlook:

The next major step is to trace back capacitors and resistors directly to the ac quantum Hall resistor at PTB and hence to enable absolute measurements.

Increasing the voltage

Measurement of various impedance ratios

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