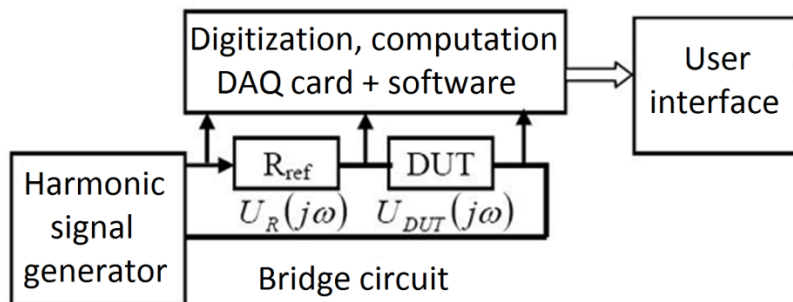


II MEASUREMENT OF DC RESISTANCE AND COMPLEX IMMITTANCE

THEORY: Circuit models of the resistor, capacitor and coil, virtual parameters, real (physical) parameters. Definition of real and virtual parameters and quality of coil. Definition of real and virtual parameters and loss factor of the capacitor. Vector RLCG meter – autobalancing bridge. Kelvin's probes. Principle of RLC measurement. Measurement of DC resistance by multimeters. Two- and four- wire measurement of resistors.

Exercises:

1. Measure DC resistance of available resistors using multimeter with two-wire connection. Note the results, take into account the precision of both the instrument and resistor. Try holding resistor leads with your fingers during measurement.
2. Measure DC resistance of the coil windings by the multimeter.
3. Measure the capacitance of available capacitors. Compare measured values with nominal ones and explain the differences.



4. Get acquainted with virtual RLCG meter which consists of measuring Data Acquisition (DAQ) card, reference resistor, external harmonic signal generator and the supplied software (see figure). This virtual RLCG meter will be used in following exercises. Generate the harmonic excitation signal by Agilent 33220A. Set the amplitude to 1,1 V and change the frequency in a range of cca. 100Hz to 20kHz. Use an appropriate frequency step (e. g. logarithmic, 100 – 200 – 500 – 1k – 2k – 5k – 10k Hz). Note that DUT is measured via four-wire (Kelvin) connection. The software displays parameters of both parallel and series model at the same, determined by an internal calculation. Think about what is actually acquired by DAQ card – what do we need in order to calculate displayed values?

a.) Measure capacitors from exercise 3 and an additional coil using RLCG meter. Select an appropriate circuit model and note values Y and Z with immittance phasor angle. Compare results with those from previous measurements and explain differences. How do you select an appropriate virtual model?

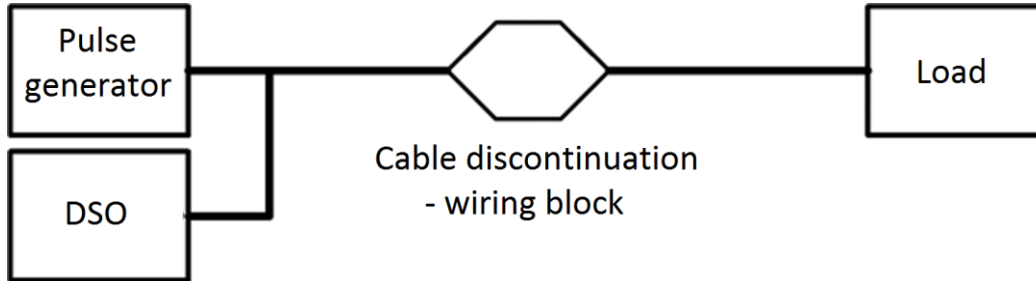
b.) Measure the quality factor, dissipation factor and loss angle for parallel and series circuit model of these components using calculated Z and Y values and imittance angle φ . How is the immittance vector changing with increasing frequency of the excitation signal (module and angle for the capacitor, module and angle for the coil)?

5. Measure DC resistance of loudspeaker using multimeter and impedance by the virtual RLCG meter (serial circuit model, resistance R_s). Compare measured values. What do measured results represent? What does the value $Z=4\Omega$ or $Z=8\Omega$ imprinted on the loudspeaker represent? Do nominal values match with the measured ones?

6. Repeat exercise 5 with a rheostat.

7. Get acquainted with time domain reflectometry measurement.

a) Measure the electric length of a cable setup with a valid connection (between two pieces of cable) and an open end. You will need an information about delay per meter of cable length, which will be supplied at the workstation.



b) Find out how the reflection looks like with a short and open circuit at the cable end.

c) Simulate a cold joint using a series resistor connected at the wiring block. Simulate a leakage by a parallel resistor. Determine how far on the cable is the simulated fault and what kind of fault is it by reflectometric method.

d) Determine characteristic impedance of the cable by adjusting the potentiometer (load) at its end. Vary the potentiometer setting until you find a resistance, that returns no reflection. Now measure the potentiometer resistance using a multimeter and note its value. Such resistance is equal to the characteristic impedance of the cable.

e) Change the potentiometer setting, so the load impedance is not matched. Calculate load resistance from the reflection coefficient. Measure actual load value by a multimeter and compare the results.

Instrument manuals:

[Generator Agilent 33220A](#)