Many physical quantities or parameters have to be measured indirectly, i.e. they need to be measured by means of other measurable components. The first chart of multi-parametric measurements is shown in Fig. 1.

**Physical measurement** of physical properties, such as length or mass, is often measured for relative uncertainties is:

\[ \delta = \sigma / \mu \]

where \( \sigma \) is the standard deviation and \( \mu \) is the mean value of the measurement.

**The measurements of three times by Wheatstone bridge** made from the balancing resistor \( R_b \) and 3 tested resistors connected in different order \( (R_a, R_b, R_c, R_d) \) in the circuit loop. Three values of \( R_b, R_c, R_d \) of the balance resistance are \( R_b = R_c = R_d = R \).

From these relations the following values of tested resistances can be calculated

\[ R_a = R_b + R_c + R_d \]

The sensitivity matrix for relative uncertainties is:

\[ S = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \]

For not-correlated input variables the matrix of output std. relative uncertainties is

\[ \sigma_y = S \sigma_x \]

So the standard relative output quantitys are defined:

\[ \delta_y = \frac{\sigma_y}{\mu_y} \]

and correlations:

\[ \rho_{xy} = \frac{\sigma_{xy}}{\sigma_x \sigma_y} \]

**Wien's bridge for measurement of two terminal RC in parallel structure**

The balance condition of four armed AC bridge (supplied by the sinusoidal current source), as a result of which the bridge is in equilibrium form.

\[ 2R_c + 2R_b \]

The process of balancing bridges rely on setting of resistance \( R_b \) and \( R_c \) alternately in this way, so every time to get minimum of zero detection.

\[ R_b = \frac{R_c}{2} \]

**Covariance matrix and cover region for three dimensional case**

The cover region of three dimensional uncertainty for Gaussians-Student distribution is created by ellipsoid (Fig. 4). For correlation coefficients satisfy the condition

\[ -1 < r_{ij} < 1 \]

Then characteristic equations for three dimensional inverse of covariance matrix \( \rho_p \)

\[ \det(p) = \rho \cdot p \]

Above equation of third order has three positive real roots. The half axes of the ellipsoid are described by Cardano formulas, as follows:

\[ a = \frac{1}{\sqrt{A}} \]

\[ b = \frac{1}{\sqrt{B}} \]

\[ c = \frac{1}{\sqrt{C}} \]

where \( k_{ij} \) - expanded coefficient of uncertainty; coefficient \( y \) and angle \( x \) are defined as:

\[ k_{ij} = \sigma_{ij} / \mu_{ij} \]

As we see from non-diagonal elements of \( \Sigma \), pairs of relative uncertainties \( \sigma_{12}, \sigma_{22}, \sigma_{32} \) of output quantities are correlated with negative coefficients. In particular case, when \( \sigma_{12} = \sigma_{21} = \sigma_{23} = \sigma_{32} = 0 \), then

\[ \sigma_{12} = \sigma_{23} = \sqrt{\sigma_{11} \sigma_{22}} \]

The parameter \( n+1 \) and \( n+2 \) points are defined as:

\[ w_{n+1} = \frac{1}{\sqrt{n+1}} \]

\[ w_{n+2} = \frac{1}{\sqrt{n+2}} \]

and the uncertainty coverage region of Gauss distribution has the 3D ellipsoidal form.