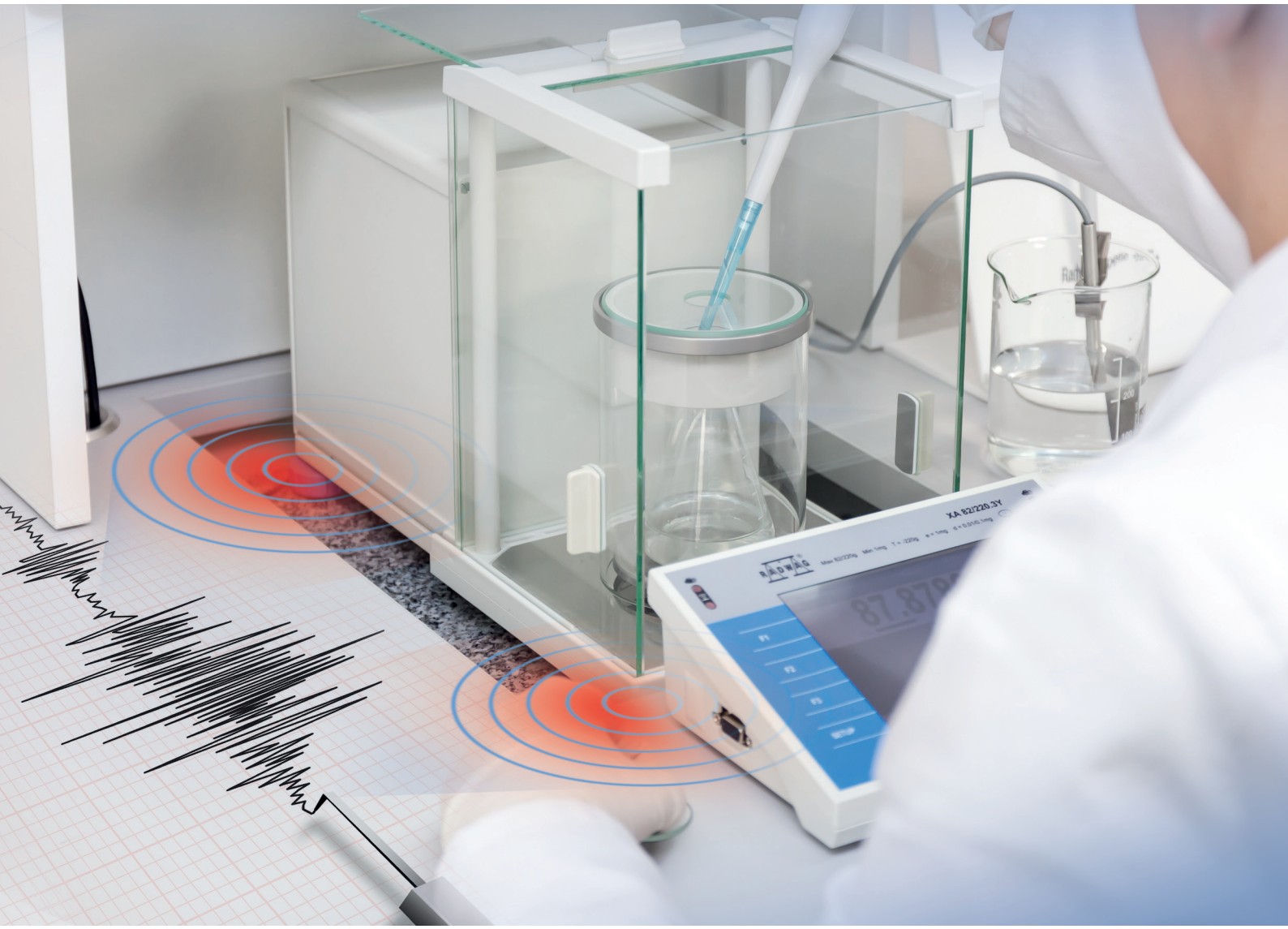
RADWAG BALANCES AND SCALES
ADVANCED WEIGHING TECHNOLOGIES



DETECTION OF VIBRATIONS AT THE ELECTRONIC BALANCES WORKSTATION

1. INTRODUCTION

Mechanical vibrations are defined as movement of particles of elastic medium in relation to equilibrium point. The particles can spread in both liquid and solid mediums. In industry, it is known that the mechanical vibrations are a co-existing element of a technological process. However the vibrations can also be a phenomenon of random nature, i.e. they can be an effect of exploitation of various machines and devices (e.g. press, saw, means of transport etc.). Vibrations negatively influence human beings and measuring equipment such as balances, scales and mass comparators. Permissible values of vibrations in the operating environment, regarding operators, are defined by respective standards, e.g. PN-EN ISO 5349-2:2004/ A1:2015-11: „Mechanical Vibration. Measurement and Evaluation of Human Exposure to Hand-Transmitted Vibration. Part 2: Practical Guidance for Measurements at the Workplace". For measuring instruments such as electronic balances and mass comparators there are no standards that would define tolerance threshold of vibrations. Nevertheless it happens that the users are provided with vibration-related guidelines developed by the manufacturers themselves on the basis of self-conducted research (RADWAG is an example of a company that has adopted this kind of practice).

For metrology experts it is obvious that weighing process accuracy is affected by many factors. In order to obtain the expected measurement accuracy, it is necessary to analyse not only measuring signal curve, but also dynamics of temperature, humidity and vibrations change. Values of the said factors can be observed using ambient conditions module of 4Y series balances manufactured by RADWAG.

Photo1 *XA.4Y laboratory balance. Ambient conditions module equipped with vibrations sensor.*

Measurement of temperature and humidity is not a complex issue, this is due to the fact that such measurement concerns one value only. Both the current value and the dynamics of its change over a particular time interval are assessed. Values that can be accepted are displayed in green, those that are out of tolerance are red. Analysis of vibrations is a much more complicated process. Measurement in this case concerns three axes X, Y, Z, all of which may be characterised with changeable amplitude and frequency. Additionally the observed value must be subjected to proper mathematical analysis.

2. VIBRATIONS IN THE WEIGHING PROCESS

The main principle of operation of balances and mass comparators (with electromagnetic compensation) is to maintain state of equilibrium. Equilibrium is obtained through generating an electric signal that compensates for weight value of load resting on the load receptor. Figure 1 visualizes the above in a form of a diagram.

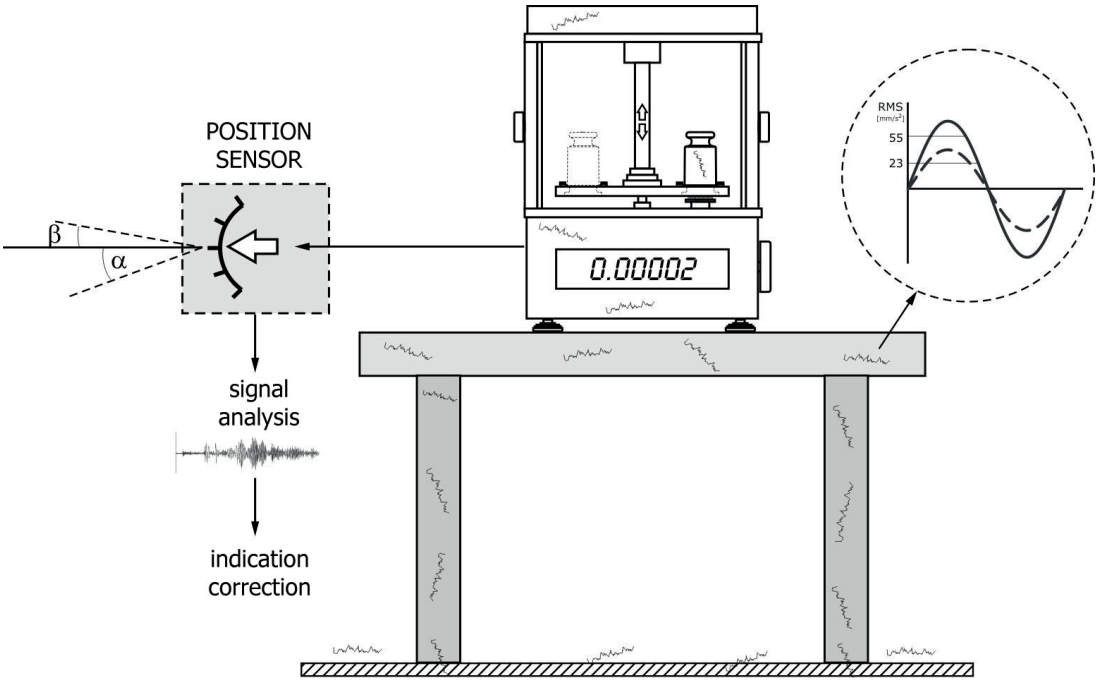


Fig. 1 *Principle of operation of balances and mass comparators.*

In case of model working conditions such system can operate even with resolution of 100 000 000 million scale intervals. Occurrence of ground vibrations results with deflection of weighing system equilibrium. The weighing system recognizes such deflection as either increase or loss of weight of measured load. In practice this means deterioration of measurement precision. Realising the above, it becomes obvious that vibration-related information is of great importance, and that measurement of vibrations amplitude at the workplace is a must. All the above was taken into account while designing RADWAG mass comparators and laboratory balances of 4Y series. Ambient conditions module of both mass comparators and 4Y balances has been equipped with sensor measuring vibrations on X, Y, Z axes. As a result of self-conducted laboratory measurements, permissible vibration value has been determined, the determined value is set as 100%. If in the course of operation the vibrations are lower than the declared value, then green vibrations pictogram is displayed. Otherwise (vibrations value higher than the default 100 %) the displayed pictogram turns to red (figure 2). Usually, more intense vibrations result with worse repeatability of indications. In some cases the weighing process can take more time.

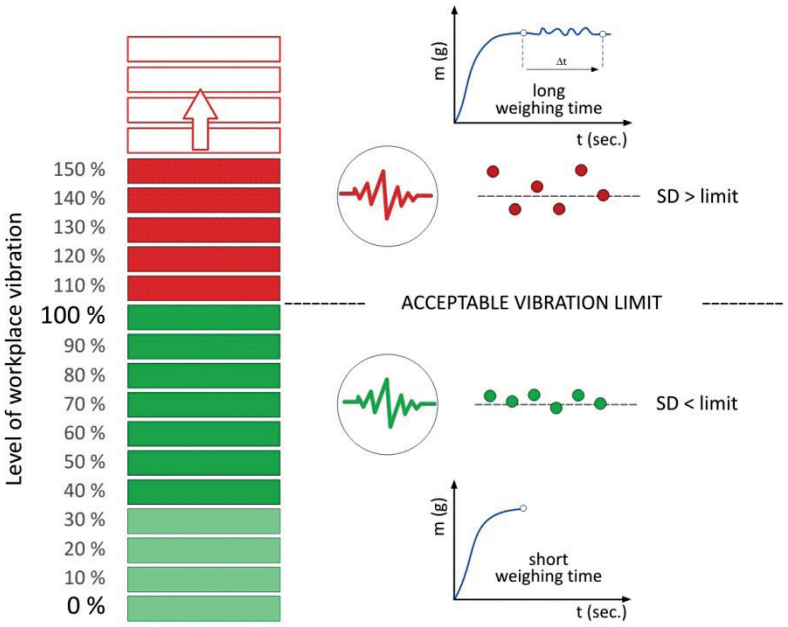


Fig. 2 *Vibrations at mas comparators and balances' workplace.*

Apart from graphic visualization the ambient conditions module of 4Y series balances displays numeric value of currently measured vibrations. The value is presented in the information box along with temperature and humidity values.

Photo 2 *MYA 4.Y microbalance – ambient conditions module, numeric values.*

Due to the following 3 factors: specified values of free vibrations, resolution, and permissible weighing instrument errors, the analysis of vibrations must be carried out with regard to the right effective value (rms value) and bandwidth. Unfortunately it is not possible to reliably compare indications of various instruments measuring vibrations if their metrological parameters cannot be configured in the same way. This refers mainly to analysed signal frequency range, used filters type, and mathematical analysis method. Instruments measuring vibrations that are offered on the marked are intended to analyse workplaces. Their parameters, more specifically their filters, analyse vibrations to which people are exposed. In case of the module that is in-built into mass comparators (balances) manufactured by RADWAG, the filters analyse those frequencies to which the weighing devices are sensitive.