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(54) PRECISION BALANCE OR MASS COMPARATOR WITH MODULE FOR DETECTING A MEASUREMENT UNCERTAINTY

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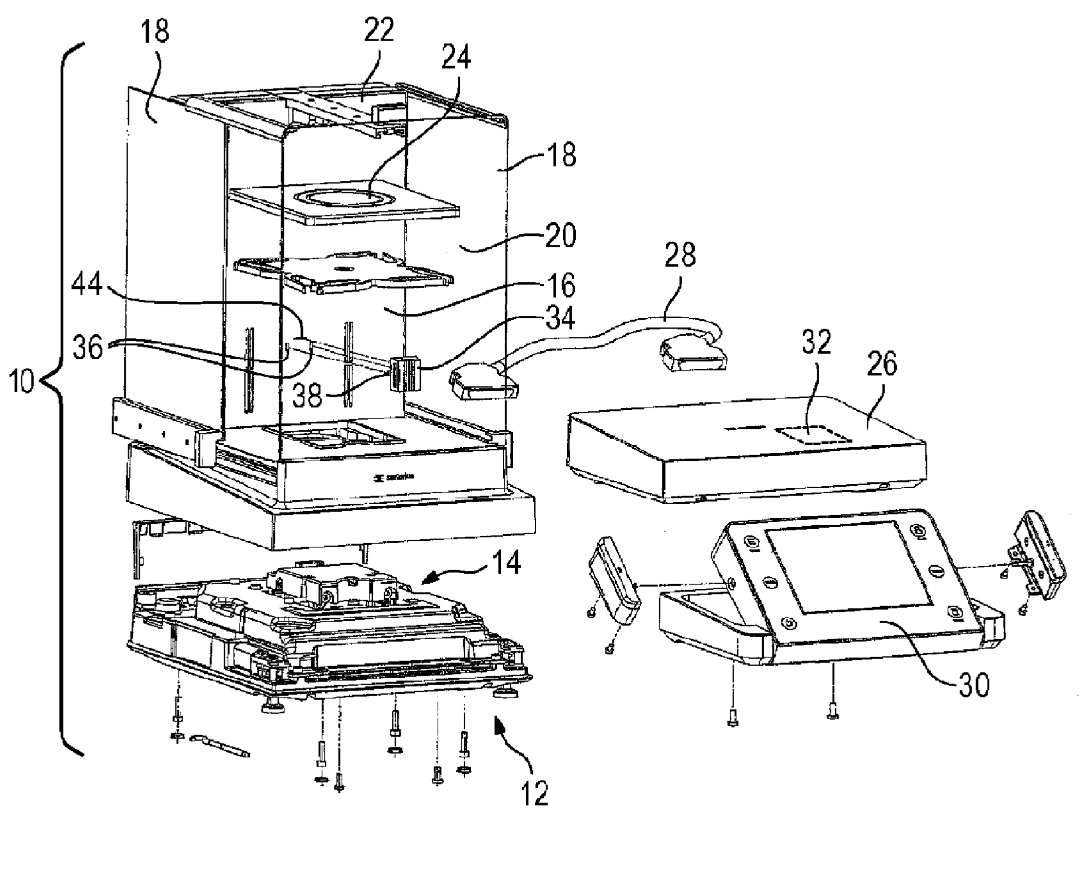
(57) **ABSTRACT**

A precision balance including a weighing chamber (**16**), a draft shield (**18**, **20**, **22**) which surrounds the weighing chamber, a climate module (**34**) which is detachably disposed in the weighing chamber, a processor (**32**), a data input unit, and a data transmission path over which data is exchanged between the climate module and the processor. The processor has a measurement uncertainty determining module (**33**) with which the measurement uncertainty of the balance is determined. Also disclosed are a method for determining a measurement uncertainty of a balance and a climate module **4** that forms a self-contained modular unit, and includes an air pressure sensor (**62**), an air humidity sensor (**54**) and an air temperature sensor (**52**). A data transmission path transmits data to a processor external to the climate module.



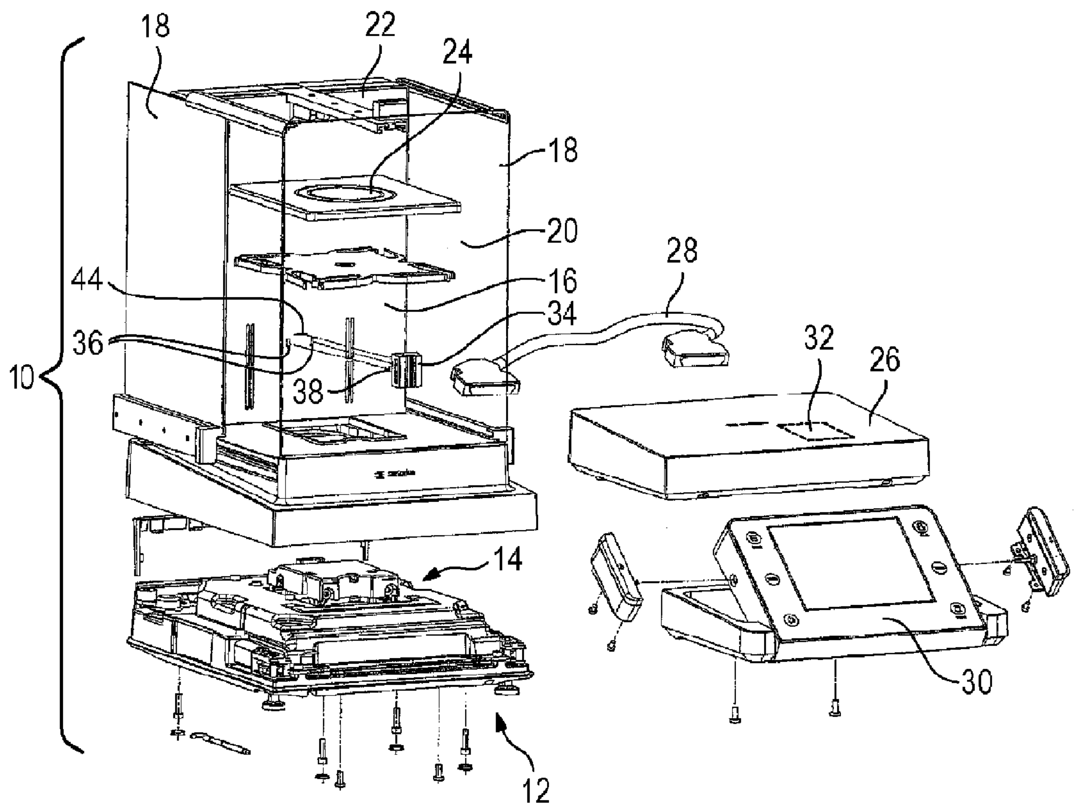


Fig. 1

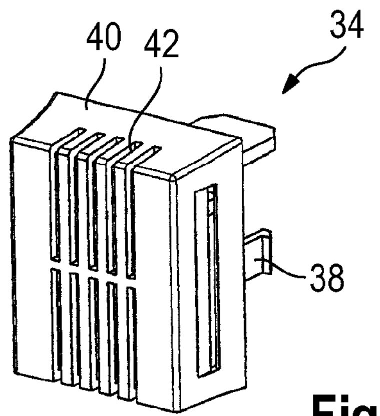


Fig. 2

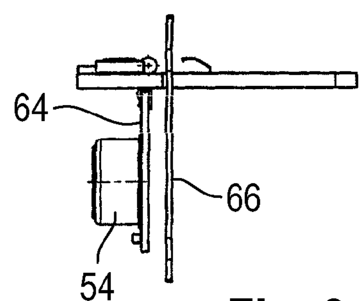


Fig. 3

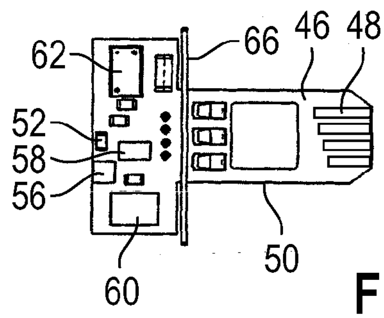


Fig. 4

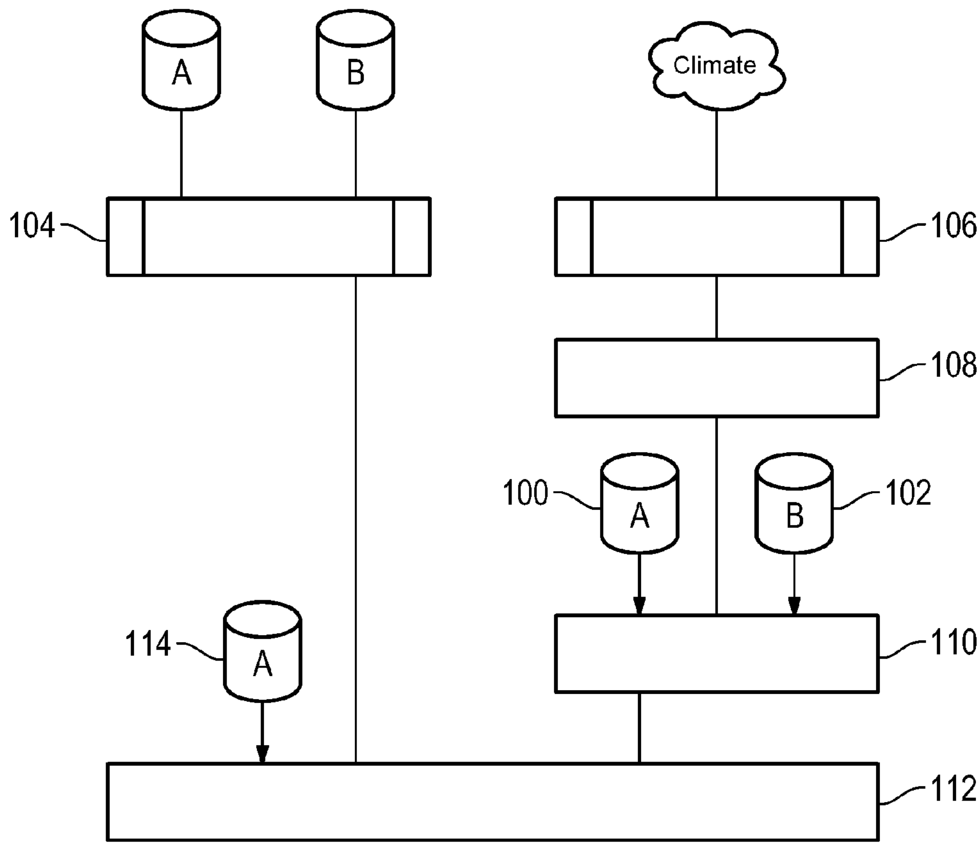
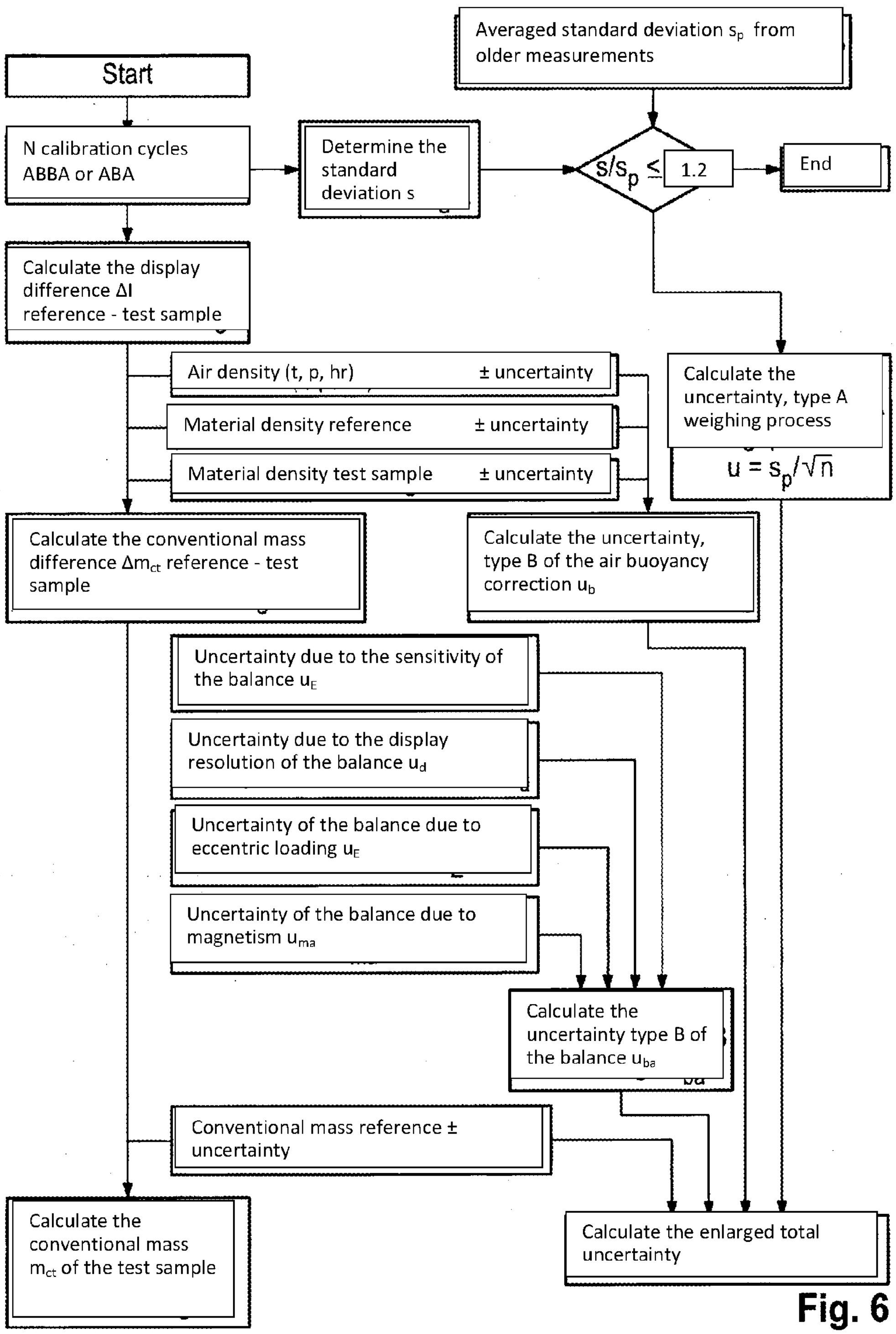


Fig. 5



Averaged standard deviation s_p from older measurements
Start
N calibration cycles ABBA or ABA
Determine the standard deviation s
$s/s_p \leq$ 1.2
End
Calculate the display difference ΔI reference - test sample
Air density (t, p, hr) ± uncertainty
Material density reference ± uncertainty
Material density test sample ± uncertainty
Calculate the uncertainty, type A weighing process
$u = s_p/\sqrt{n}$
Calculate the conventional mass difference Δm_{ct} reference - test sample
Calculate the uncertainty, type B of the air buoyancy correction u_b
Uncertainty due to the sensitivity of the balance u_E
Uncertainty due to the display resolution of the balance u_d
Uncertainty of the balance due to eccentric loading u_E
Uncertainty of the balance due to magnetism u_{ma}
Calculate the uncertainty type B of the balance u_{ba}
Conventional mass reference ± uncertainty
Calculate the conventional mass m_{ct} of the test sample
Calculate the enlarged total uncertainty

Fig. 6

PRECISION BALANCE OR MASS COMPARATOR WITH MODULE FOR DETECTING A MEASUREMENT UNCERTAINTY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a Continuation of International Application PCT/EP2014/002853, which has an international filing date of Oct. 22, 2014, and the disclosure of which is incorporated in its entirety into the present Continuation by reference. The following disclosure is also based on and claims the benefit of and priority under 35 U.S.C. §119(a) to German Patent Application Nos. DE 10 2013 018 767.2, filed Nov. 8, 2013, and to DE 10 2014 101 563.0, filed Feb. 7, 2014, which are also incorporated in their respective entireties into the present Continuation by reference.

FIELD OF THE INVENTION

[0002] The invention relates to a precision balance or a mass comparator.

[0003] BACKGROUND

[0004] In high-resolution electronic precision balances and mass comparators of this type, the problem presents itself that a plurality of external parameters influence the result of the weighing. If, during the mass determination of a test sample or during a weighing procedure, the measuring error is to be smaller than **10** ppm, the user can hardly avoid consideration of the measuring uncertainty.

[0005] The measuring uncertainty is influenced, inter alia, by the air density prevailing during the measurement, which affects the buoyancy on the test sample and is dependent on the ambient temperature, the air pressure and the air humidity. The user also exerts an influence on the measurement results and thus on the measuring uncertainty, since the manner in which the measurement is carried out influences how exactly a particular measurement result can be reproduced.

[0006] DE 37 14 540 C2 discloses a method for automatic calibration of a high-resolution balance in which the balance goes through a sequence of test steps in which the disturbance variables influencing the weighing result are compared with limit values and, if the limit values are exceeded, a calibration is carried out.

[0007] DE 299 12 867 U1 discloses a balance which has at least one measurement value sensor for climate parameters. The measurement values are output on a separate display unit.

[0008] EP 0 864 852 A2 discloses an electronic balance which is calibrated by weighing the same load several times and these data are statistically evaluated in order to increase the measuring accuracy.

[0009] If the measurement uncertainty of the weighing procedure is to be estimated, all these influencing factors are taken into account. For this purpose, guidelines are given in the international recommendations of OIML R111 as to how the estimation of uncertainty is to be made. PC programs and Excel-based solutions for uncertainty calculation are known from the background art for this purpose. In the formulae used there, details relating to the balance, the climate and the reference weights are to be input. In addition to the PC which carries out the calculation, external sensors with which the climate data are acquired are also needed. The software in the PC calculates a total uncertainty for the weighing process from the weighing results of the balance, the climate sensor values, the input parameters of the reference weights and the other uncertainty parameters.

[0010] The disadvantage of this solution lies therein that data from a plurality of systems (balance, climate sensors for air density determination, reference weights, etc.) must be transferred to a PC. Herein lies the fundamental risk of a faulty input. Also, a PC which carries out the calculation of the uncertainty and accesses a database with information (for example, information concerning the reference weights used) is always required for the evaluation. The computer has no influence on the overall weighing process; it can only read weighing results from the balance. Thus, simplifying, the balance can be regarded as a sensor which supplies the weighing results.

SUMMARY

[0011] It is an object of the present invention to provide a precision balance or a mass comparator and a method with which the determination of the measurement uncertainty is facilitated and the measurement uncertainty can be output directly together with the weighing result.

[0012] In order to achieve this object, according to one formulation of the invention, a precision balance is provided, having a weighing chamber, a draft shield which surrounds the weighing chamber, a climate module which contains an air pressure sensor, an air humidity sensor and an air temperature sensor and is removably arranged in the weighing chamber, a processor, a data input unit, and a data transmission path over which data can be exchanged between the climate module and the processor, wherein the processor contains a measurement uncertainty determining module with which the measurement uncertainty of the balance can be determined. According to further formulation, this object is achieved with a method for determining the measurement uncertainty of a precision balance of this type or of a mass comparator is provided, having a weighing chamber which is separated from the surroundings by a draft shield and in which an air pressure sensor, an air humidity sensor and an air temperature sensor are arranged, wherein the sensors are coupled to a data transmission path and wherein the sample to be weighed is weighed in the form of a test sample. During the weighing process, the air pressure, the air humidity and the air temperature in the weighing chamber are determined s with the sensors. Furthermore, the test sample is weighed. Then the following uncertainties are determined, for example, according to OIML R111-1: standard uncertainty of the weighing method, uncertainty due to the normal being used, uncertainty of the balance and the uncertainty of the air buoyancy correction. Finally, a total uncertainty of the mass determination is ascertained. The invention is based on the underlying concept of integrating all the components that are needed for determining the measurement uncertainty into the balance. The climate module supplies the data regarding the microclimate which prevails around the test sample, that is, within the draft shield. Any changes of the microclimate during the weighing process are also immediately incorporated into the determination of the measurement uncertainty. It is not necessary to input the acquired climate data and their uncertainties by hand; erroneous input is thus prevented. Since all the components necessary for determining the measurement uncertainty are integrated into the balance itself, it can be transported by the operator in the manner of a self-contained weighing laboratory to where the weighing procedure is to be performed.

[0013] Generally expressed, it can be provided that the user is reliably guided through the weighing process, for example, during the measurement calibration according to OIML R111-1 and that therein, alongside the conventional mass, the real mass and all the relevant uncertainties are also calculated. At the end of the mass calibration, the balance issues an evaluation of the test weights according to pre-defined accuracy classes and all the necessary data are made available for the production of a test certificate. The balance functions like a mass laboratory since all the required sensors and data for mass determination are integrated into the balance.

[0014] The balance preferably contains a user interface (display) in order to guide the user, for example, through a mass calibration according to a pre-defined sequence program. The load change from reference weights and test weights necessary for mass determination are recognized and in the event of an erroneous operation, the mass calibration is terminated. The balance makes plausibility tests and evaluations based on the standard deviation of the mass differences between the reference weight and the test sample and compares these with earlier standard deviations. The permitted uncertainties for an accuracy class of weights to be calibrated are checked and evaluated. The balance can also open the doors of the draft shield automatically in order to enable a load change. All the necessary sensors for mass determination are integrated into the balance and the uncertainties of all sensors are stored in the balance in order to calculate a total uncertainty for the mass determination.

[0015] The standard uncertainty of the weighing method uw (type A) is determined with an averaged standard deviation sp of the balance (on different days) or alternatively from the standard deviation from mass differences between the reference weight and the test sample. The uncertainties (type B) of the reference weights u(mcr) and the instabilities of the reference weights Uinst(mcr) are stored in the balance and are used for calculating the total uncertainty. The uncertainty (type B) of the air buoyancy correction ub is calculated from the uncertainties of the climate sensors for temperature, air pressure and relative humidity integrated into the balance as well as from the uncertainties of the densities of reference weights and test weights as well as the uncertainty portion of the formula for calculating the air buoyancy correction. The uncertainty portions of the balance uba are calculated from the uncertainty by the display resolution of the digital balance, the uncertainty due to the off-center loading, through magnetic influences of the sample (or the weights) and the uncertainty factor based on the sensitivity of the balance.

[0016] To solve the aforementioned problem, a climate module for releasable electrical coupling to a precision balance or mass comparator is also provided, wherein the climate module forms a self-contained modular unit and has an air pressure sensor, an air humidity sensor and an air temperature sensor, as well as a part of the data transmission path via which the data can be transmitted to a processor outside the climate module. Since the climate module is interchangeable (thus, releasable from the balance without destruction), if required, it can be sent to an external institution or service provider for calibration. In the interim, the precision balance or the mass comparator can continue to be operated in that a replacement climate module is used. Thus, one or (in the case of a plurality of precision balances) a plurality of the climate modules can be used, in a rolling manner, for calibration while measurements are made with the other climate modules. Overall, a compact weighing laboratory is made available to the user, which can even be configured transportable and in which all the components and functions, which are necessary for an air buoyancy correction of weighing results, are to be united in the precision balance or mass comparator. Therefore, no external computers, sensors, etc. are needed. With regard to the measurement uncertainty, a further advantage is that older balances can be retrofitted. Aside from the data transmission path, for this purpose, only the software of the processor must be amended.

[0017] With regard to accuracy, the precision balance according to the invention has the advantage that the climate data are measured behind the draft shield (and not only in the room in which the balance is situated). Therefore, the air density is determined in the immediate vicinity of the test sample. Furthermore, since the buoyancy values and their measurement uncertainties are automatically transferred to the processor, transmission errors which can occur during the transmission of values from the "calibration certificate" to a calibration software package can practically be precluded.

[0018] According to one embodiment, it is provided that the climate module is connected via an electric plug connection or over a wireless transmission to the processor. The plug connection can be integrated into a mechanical receptacle which serves for mounting the climate module on the precision balance. In this way, the data transmission path to the processor is created automatically when the climate module is arranged at its place within the draft shield. On use of a wireless transmission, the climate module can be arranged at an arbitrary site within the draft shield, for example at a side wall where it is least obtrusive, without the need to ensure that a plug connection can be arranged at this site. Furthermore, dispensing with a plug connection is advantageous in that the interior space of the weighing cabin can be configured smoother and therefore more easily cleaned.

[0019] It can also be provided that a sensor for determining the degree of ionization in the weighing chamber is present and is linked to the data transmission path. As a result, an additional parameter can be determined and taken into account during the correction of the weighing result. Depending on the degree of ionization, an output signal is generated by the processor, for example, in order actively to change the degree of ionization in that an ionization device is used which is activated after reaching a particular degree of ionization. Furthermore, a display can make the user aware that the degree of ionization within the weighing chamber is too high and should be discharged.

[0020] It can also be provided that a light sensor which is coupled to the data transmission path is provided in the weighing chamber. As such, an additional parameter can be determined and taken into account during the correction of the weighing result. The processor can emit an output signal above a pre-determined incident light level. The influence of the incident light level on the weighing process is therefore determinable in order to take measures, if needed, during the process. The output signal can also be a display.

[0021] According to one embodiment, it is provided that the processor is configured so that, on the basis of the density of the sample to be weighed, it determines the air buoyancy of at least the test sample or the buoyancy correction factor from the air pressure, the air humidity and the air temperature in the weighing chamber. In this way, metrologically traceable climate values with which the processor is able to correct the weighing result and to determine and display the mass or the conventional mass can be obtained and fed back by the climate module synchronously with the receipt of the weighing result.

[0022] According to one embodiment, an electronic memory is provided, in particular an EEPROM, which is readable by an external reader and in which calibration values and correction values for the climate module can be stored. For adjustment, the calibration values and correction values can be stored in an electronic memory on the climate module, in particular on an EEPROM. This can also take place without a balance. When the climate module is coupled again to the precision balance, these data are directly available to the processor of the balance. In addition, inter alia at least some of the following information can be placed in the memory for sensor calibration: the number of the calibration certificate, the current calibration values, the calibration date, the name of the calibrating laboratory and the technician, as well as the calibration history. "Uncertainty values" for each climate variable can also be placed in the memory of the climate module so that for example, in order to calculate the air density, the calculation of the uncertainty of the air density is also performed by the precision balance.

[0023] According to one embodiment, it is provided that the climate module is also usable outside a balance as an independent unit and is connectable via an PC bus to a USB port of a PC. This facilitates the external calibration. In addition, the climate module can be used in other implementations to record climate variables without being connected to a balance. For this purpose, with little effort, the circuit board of the climate module can have a plug-in extension so that it can be connected to a USB adapter.

[0024] In order to solve the aforementioned problem, a method for determining the measurement uncertainty of a precision balance is further provided, with a weighing chamber which is separated by a draft shield from the surroundings and in which an air pressure sensor, an air humidity sensor and an air temperature sensor are arranged, wherein the sensors are coupled to a processor and wherein a sample to be weighed in the form of a test sample are weighed. Herein, the air pressure, the air humidity and the air temperature in the weighing chamber are determined with the sensors and the test sample is weighed. Furthermore, the standard uncertainty of the weighing method and the uncertainty of the mass of the test sample are determined. From this, a total uncertainty of the weighing result is determined. With regard to the resulting advantages, reference is made to the description above.

[0025] Furthermore, it can be provided that during the determination of the total uncertainty, the result of earlier determinations of the total uncertainty is also taken into account. Using the total uncertainty determined in earlier measurements, firstly, a plausibility estimation of the currently determined total uncertainty can be undertaken. If the previously determined total uncertainty was notably lower than that currently determined, an indication can be issued to the user that the overall weighing procedure has not proceeded satisfactorily. Secondly, the currently determined total uncertainty can be corrected upward somewhat if currently a total uncertainty has been determined that is notably below the total uncertainty of earlier weighing procedures.

[0026] Further features and advantages of the invention are disclosed in the following description and the attached drawings, to which reference will be made. In the drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** is an exploded view of a precision balance according to the invention,

[0028] FIG. **2** is a perspective view of a climate module according to the invention which can be used with the precision balance according to the invention,

[0029] FIG. **3** is a side view of the climate module of FIG. **2** without the outer housing,

[0030] FIG. **4** is a plan view of the climate module of FIG. **2**, also without the outer housing,

[0031] FIG. **5** is a flow diagram which illustrates a method for operating the balance, and

[0032] FIG. **6** is a flow diagram which illustrates a method for determining the total uncertainty of a mass comparison in accordance with OIML R111-1 carried out with the balance.

DETAILED DESCRIPTION

[0033] FIG. **1** shows a high-resolution electronic precision balance which in this exemplary embodiment enables mass comparisons in all the accuracy classes under OIML R111-1 and also according to ASTM E617-13.

[0034] The precision balance comprises a load cell **14** with a base **12**. The load cell **14** also comprises a weighing chamber **16** which is provided by a draft shield with adjustable side walls **18**, a front wall **20** and a rear wall **22**. The weighing chamber **16** is separated from the surroundings by the draft shield. A balance dish **24** serves for placement of the sample to be weighed. These components together form a weighing module **10**

[0035] An electronic evaluation system **26** configured herein as a separate part is electronically linked via a cable **28** to the load cell **14**. A display unit **30** which is linked to the evaluation system **26** serves both as a display and also as a data input unit. While the electronic evaluation system **26** and the display **30** are embodied as components physically separated from the weighing module **10** in the illustrated embodiment, other embodiments can incorporate one or both of these components **26** and **30** into the weighing module **10**.

[0036] Among other things, a processor **32** which receives data from the load cell **14** is accommodated in the electronic evaluation system **26**.

[0037] Also provided in the electronic evaluation system **26** is a measurement uncertainty determination module **33** with which the measurement uncertainty of a current weighing process can be determined. Furthermore, a memory in which the total uncertainty of earlier weighing processes is stored is also integrated into the measurement uncertainty determining module **33**.

[0038] Provided in the weighing chamber **16** is a climate module **34** which is configured as a structurally separate unit which can mechanically couple via a releasable plug connection to the rear wall **22** (that is, it is mounted to be non-destructively releasable), preferably without the aid of a tool.

[0039] For this purpose, the rear wall **22** has two slots **36** spaced from one another in which flexible locking hooks **38** (see also FIG. **2**) lock onto the outer housing **40** of the climate module.

[0040] The climate module **34** is shown in detail in FIGS. **2** and **4**.

[0041] The outer housing **40** has numerous openings **42** via which the interior of the outer housing **40** transitions into the weighing chamber **16** and is part of the weighing chamber **16** so that the climate in the interior of the weighing chamber **16** corresponds to that in the interior of the outer housing **40**.

[0042] The climate module **34** is linked electronically via an electric plug connection to a corresponding plug receptacle **44** in the rear wall **22**. The plug receptacle **44** is electrically linked to the processor **32**. A plug **46** with contacts **48** on the climate module **34** is inserted into the plug receptacle **44**. Thus the plug **46** forms a module-side part of the electrical plug connection.

[0043] As an alternative to an electric plug connection, a wireless transmission, for example, WLAN or Bluetooth, can be used.

[0044] The electrical plug connection (or the alternatively used wireless transmission) forms a data transmission path with which data can be transferred from the climate module **34** to the processor **32** and possibly back again.

[0045] The plug **46** is preferably a portion of a circuit board **50** on which a plurality of sensors are arranged for detecting the climate in the weighing chamber **16**. Thus, an air temperature sensor **52**, an air humidity sensor **54**, a light sensor **56** arranged in the immediate vicinity of an opening **42** and a sensor **58** for detecting the degree of ionization in the weighing chamber **16** are provided on the circuit board **50**, as well as an electronic memory **60**. An air pressure sensor **62** is electrically and mechanically connected via a holder **64** to the circuit board **50**.

[0046] A plurality of the sensors can also be grouped together into combined sensors.

[0047] A wall **66** closes the shell-like outer housing **40** so that the narrow, tongue-like portion of the circuit board **50** positioned to the right of the wall **66** in FIG. **4** is pluggable into the rear wall **22** and into the plug receptacle **44**.

[0048] Each sensor is linked to the processor **32** through suitable contacts **48**. The memory **60** is also linked to the processor **32**.

[0049] When operated as a comparator balance, the balance functions according to the following method, described by reference to FIG. **5**:

[0050] The density of the sample to be weighed (test weight, also referred to as test sample B, and reference weight A) is input into the comparator balance in steps **100** and **102**, for example via the display unit **30** which simultaneously serves, with a touch screen, as a data input unit. Alternatively, the density of the sample to be weighed can be input in advance.

[0051] A sample to be weighed is placed on the balance dish **24** after pre-settable process steps, for example, firstly the reference weight A, subsequently the test sample B twice and finally the reference weight A again. This involves a comparison weighing (double substitution) from which in step **104**, the display difference of the balance is given. Other sequence steps are also possible, for example, ABA rather than ABBA.

[0052] The air pressure, the air humidity and the air temperature are determined in step **106** via the sensors **62**, **54** and **52** and the corresponding data are then passed on to the processor **32**.

[0053] The air density is determined in the processor **32** in step **108**. Using the input densities, in the processor the air buoyancy correction factor is determined in step **110** and/or the air buoyancy of the sample to be weighed is determined dependent on the air pressure, air humidity, air temperature and the density of the sample to be weighed and, in step **112**, the conventional weighing result of the test sample, i.e. the mass of the test sample B corrected by its air buoyancy is determined and reproduced as a protocol in the display unit **30**, wherein the conventional mass **114** of the reference weight is included in the determination of the conventional mass of the test sample.

[0054] Furthermore, calibration values and correction values that were stored in the climate module **34** during the calibration of the climate module **34** are stored in the memory **60**.

[0055] This calibration takes place outside the comparator balance. For this purpose, the climate module **34** is simply unplugged from the weighing chamber **16** without a wire connection needing to be released. The climate module **34** is then sent to a suitable calibration center which places the number of the calibration certificate, i.e. the new calibration values, the calibration date, the name of the calibrating laboratory and handling technician and the calibration history, into the memory **60**. These values are later read out by the application program when the climate module **34** is in the precision balance or comparator balance again and is used directly in the calculation.

[0056] The values of the light sensor **56** and of the sensor **58** for determining the degree of ionization in the weighing chamber **16** are also determined.

[0057] For example, if the incident light level is raised, a suitable signal is output to the display that, for example, the measurement is inaccurate due to increased exposure to light and therefore an altered temperature in the weighing chamber. Thus an output signal dependent on the incident light level is emitted by the processor.

[0058] As soon as the degree of ionization is too high, an ionization device which ionizes the air in the weighing chamber is activated and provides for discharging of the sample to be weighed, or a warning of excessive charging of the sample to be weighed is issued.

[0059] The memory **60** is preferably an EEPROM.

[0060] Furthermore, the connection between the climate module **34** and the rest of the precision balance or comparator balance is realized with an PC bus.

[0061] The climate module **34** can be connected via a USB adapter into which it is plugged, to a computer in order to calibrate the sensors **52** to **58** and **62** without the climate module **34** having to be connected to the weighing module **10**.

[0062] The total uncertainty of the mass determination is determined in the following way (see also FIG. **6**):

[0063] Firstly, the standard deviation s is determined from the results of the calibration cycles. This is compared with the averaged standard deviation sp as found from previous measurements. The standard deviation determined for these measurements is stored in a memory of the measurement uncertainty determining module **33**. If the difference between the current standard deviation and the averaged standard deviation of the earlier measurements is greater than a value defined as reasonable, the current weighing procedure is terminated. Otherwise, the uncertainty of the type A weighing process is determined from the standard deviation.

[0064] The type B uncertainty of the air buoyancy correction ub is calculated from the uncertainties of the air density, the material density of the reference and the material density of the test sample. The values for the uncertainty of the air density are stored in the climate module **34**, where they were stored during its calibration.

[0065] The type B uncertainty of the balance uba is calculated on the basis of the uncertainty due to the sensitivity of the balance uE, the uncertainty due to the display resolution of the balance ud, the uncertainty of the balance due to eccentric loading uE and the uncertainty of the balance due to magnetism uma.

[0066] From the values for the type B uncertainty of the air buoyancy correction and the type B uncertainty of the balance, from the type A uncertainty for the weighing process and additionally from the known uncertainty of the mass of the reference, the broader total uncertainty of the weighing process is calculated. The special advantage lies therein that this can be realized integrated within the balance by the measurement uncertainty determining module **33** to which merely information concerning the test sample and the reference used must be input. All the other data are either stored therein or are automatically requested, for example, by calling the uncertainty values stored in the climate module. This enables the relevant total uncertainty to be given automatically for a weighing process.

LIST OF REFERENCE NUMERALS AND CHARACTERS

[0067] **10** weighing module
[0068] **12** base
[0069] **14** load cell
[0070] **16** weighing chamber
[0071] **18** side wall
[0072] **20** front wall
[0073] **22** rear wall
[0074] **24** balance dish
[0075] **26** evaluation system
[0076] **28** cable
[0077] **30** display unit
[0078] **32** processor
[0079] **33** measurement uncertainty determining module
[0080] **34** climate module
[0081] **36** slots
[0082] **38** locking hook
[0083] **40** outer housing
[0084] **42** openings
[0085] **44** plug receptacle
[0086] **46** plug
[0087] **48** contacts
[0088] **50** circuit board
[0089] **52** air temperature sensor
[0090] **54** air humidity sensor
[0091] **56** light sensor
[0092] **58** sensor
[0093] **60** memory
[0094] **62** air pressure sensor
[0095] **64** holder
[0096] **66**wall
[0097] **100** step
[0098] **102** step
[0099] **104** step
[0100] **106** step
[0101] **108** step
[0102] **110** step
[0103] **112** step
[0104] **114** conventional mass of reference weight
[0105] A reference weight
[0106] B test sample

What is claimed is:

1. Precision balance, comprising:
a weighing chamber,
a draft shield which surrounds the weighing chamber,
a climate module which comprises an air pressure sensor, an air humidity sensor and an air temperature sensor, and which is detachably disposed in the weighing chamber and is configured to mount within an to detach from the weighing chamber,
a processor, a data input unit, and
a data transmission path over which data is exchanged between the climate module and the processor,
wherein the processor comprises a measurement uncertainty determining module with which a measurement uncertainty of the balance is determined.

2. The precision balance as claimed in claim **1**, wherein the data transmission path comprises an electrical plug-in connection or a wireless transmission path.

3. The precision balance as claimed in claim **1**, further comprising a sensor coupled to the data transmission path and configured to determine a degree of ionization in the weighing chamber.

4. The precision balance as claimed in claim **1**, wherein the weighing chamber comprises a light sensor, which is coupled to the data transmission path.

5. The precision balance as claimed in claim **1**, wherein the processor is programmed to determine, based on a density of a substance to be weighed, an air buoyancy of at least a test sample or a buoyancy correction factor from the air pressure, the air humidity and the air temperature in the weighing chamber.

6. The precision balance as claimed in claim **1**, wherein the measurement uncertainty determining module comprises a memory that stores results of earlier determinations of the measurement uncertainty.

7. Method for determining the measurement uncertainty of a precision balance that comprises a weighing chamber, which is separated from a surrounding area by a draft shield and in which an air pressure sensor, an air humidity sensor and an air temperature sensor are disposed, wherein the sensors are coupled to a processor and wherein a test sample is weighed, said method comprising:
determining the air pressure, the air humidity and the air temperature in the weighing chamber with the sensors;
weighing the test sample;
determining a standard uncertainty of the weighing of the test sample;
determining a standard uncertainty of the mass of the test sample; and
determining a total uncertainty of the mass determination.

8. The method as claimed in claim **7**, further comprising weighing a reference weight in addition to the test sample.

9. The method as claimed in claim **7**, wherein the determination of the total uncertainty comprises factoring in results of earlier determinations of the total uncertainty.

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