

Micro-Weighing Guide



Maximize Efficiency
in Micro-Weighing

Improve Quality
of Results
Ensure Safer
Operations

10 Steps to Successful Micro-Weighing

METTLER TOLEDO

Table of Contents

| | |
|--|----|
| 1. Which Microbalance Is Right for Me? | 3 |
| 2. Where Should I Place the Microbalance? | 5 |
| 3. Why Is Calibration of the Microbalance Important? | 6 |
| 4. How Can I Ensure Accurate Results Every Day? | 7 |
| 5. How Can I Deal With Drifting Weight Results? | 9 |
| 6. How Can I Optimize Working with Small Samples? | 10 |
| 7. How Should I Clean My Microbalance? | 11 |
| 8. How Can I Make the Weighing Process More Efficient? | 13 |
| 9. What Data Capture/Data Transfer Options Do I Have? | 14 |
| 10. Other Helpful Tips to Optimize Micro-Weighing | 16 |

1. Which Microbalance Is Right for Me?

There are essential criteria to consider when choosing the right balance for your needs.

Every measurement on ANY balance is subject to uncertainty. Understanding this uncertainty is the key to ensuring accurate weighing results and avoiding errors in downstream processing. For a microbalance, the uncertainty is almost entirely due to repeatability (precision) when weighing small samples (i.e. at the low end of the weighing range of a specific balance).

It is not the readability that determines the accuracy of a weighing instrument, but rather its repeatability, or depending on it, its minimum weight capability.

To find the appropriate microbalance for your needs you should define the smallest amount you want to weigh and how accurately you need to weigh it (i.e. at what tolerance). From this basic information, the accuracy of the required microbalance can be determined. Your weighing consultant can calculate this for you and verify that it meets your daily needs:

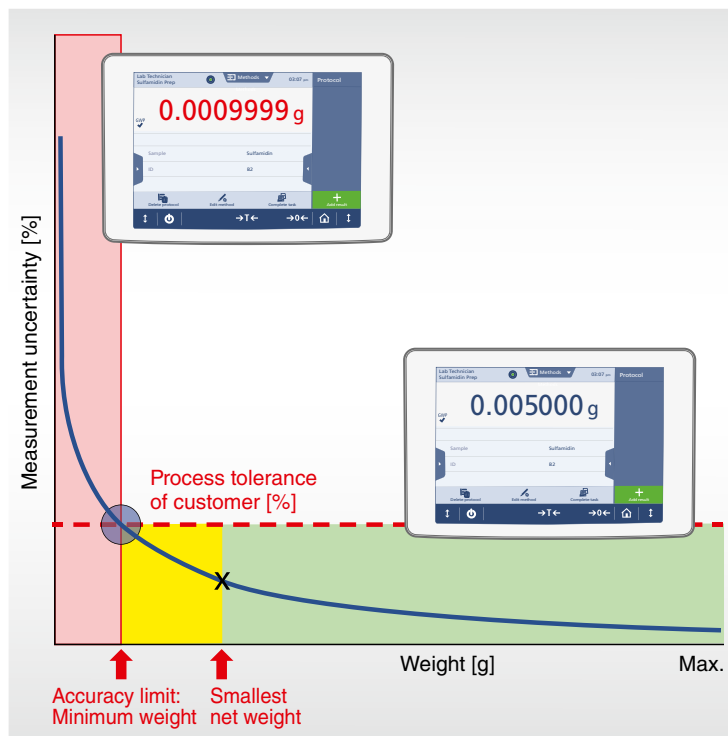


Figure 1: Typical measurement uncertainty curve of a typical ultra-microbalance. At the accuracy limit the relative measurement uncertainty increases with decreasing sample weights above the user defined tolerances. The yellow area represents a safety margin between user formulated smallest net weight and accuracy limit.

Example

- Smallest sample typically weighed in (defined by user).
(smallest net weight = 2 mg)
- Tolerance required = 2 mg \pm 10 μ g [= 0.5%]

Formula Applied to Fulfill User Requirement

Smallest net weight \geq minimum weight * safety factor

Minimum weight = Repeatability of the balance * k / Required tolerance [%]

For a safety factor of 2, select a balance with a repeatability \leq 2.5 μ g

Explanation of Terms

Safety factor: A safety margin to protect against variations in the weighing process, environmental conditions or user influence. A safety factor of 2 is recommended for typical processes. For higher risk processes, a higher safety factor is recommended.

Expansion factor (k): Typically an expansion factor $k = 2$ is used.

(For a Gaussian distribution, 95% of the results statistically fall within the $k = 2$ range; 99.7% of the results fall within $k = 3$).

Recommendation

A microbalance is advised for use in this application. An analytical balance has a repeatability of 7 μ g and is not accurate enough for this task, and an ultra-microbalance with a repeatability of 0.15 μ g would allow weighing much smaller amounts of sample as required and might not be needed. The XPR3 microbalance with a repeatability of 0.5 μ g fulfills the requirements perfectly.

**Special Tip**

- Ask your METTLER TOLEDO consultant about GWP® Recommendation which helps you select the right weighing instrument based on your weighing requirements: ► www.mt.com/gwp-recommendation.

2. Where Should I Place the Microbalance?

Several factors should be considered when choosing a suitable location for accurate weighing.

When choosing a location for your microbalance, take into consideration the three main external influences that have an impact on the accuracy of microweighing: vibrations, air drafts and temperature variations. The impact of these external influences can be prevented or minimized by taking simple precautions:

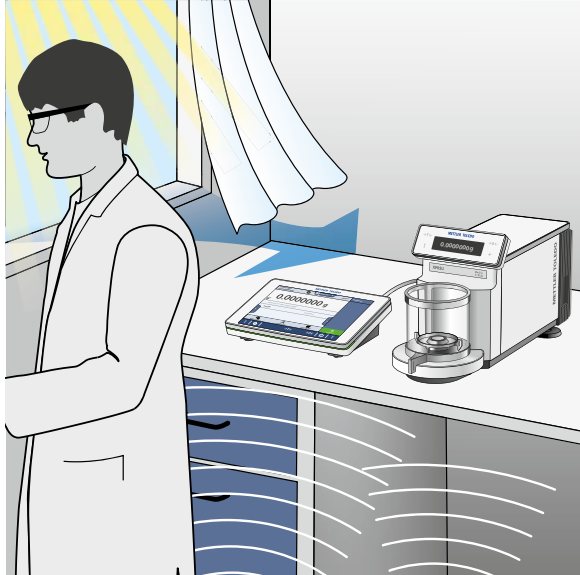


Figure 2: Microbalances are sensitive against environmental influences and the installation place should be selected carefully.

Vibrations

Use a solid, stable weighing table to reduce vibrations. Damper plates can be helpful in some cases. Avoid positioning the balance near mechanical equipment, such as pumps, etc.

Air Drafts

Avoid locating the balance near an opening door or in a position where many people walk past. Avoid positioning near or under an air conditioning unit. Always close the draft shield during weighing (and tare weighing) operations.

Temperature Variations

Avoid locating the balance near any direct heat sources, such as radiators, or near to windows.



Special Tips

- Avoid vibrations and use an appropriate weighing table.
- Strong air drafts can be avoided by using an external draft shield.
- Find more useful accessories for controlling external influences at: ► www.mt.com/accessories.

3. Why Is Calibration of the Microbalance Important?

Ensure the accuracy of your microbalance in your laboratory.

The accuracy of the weighing device is determined by calibration. The calibration certificate is the basis to prove that your microbalance is working correctly in accordance to your weighing requirements. Manufacturer's specifications (or tolerances) are measured under standardized and stable conditions. As microbalances can be influenced by several external factors, it is important to understand how a specific balance performs in its actual working environment.

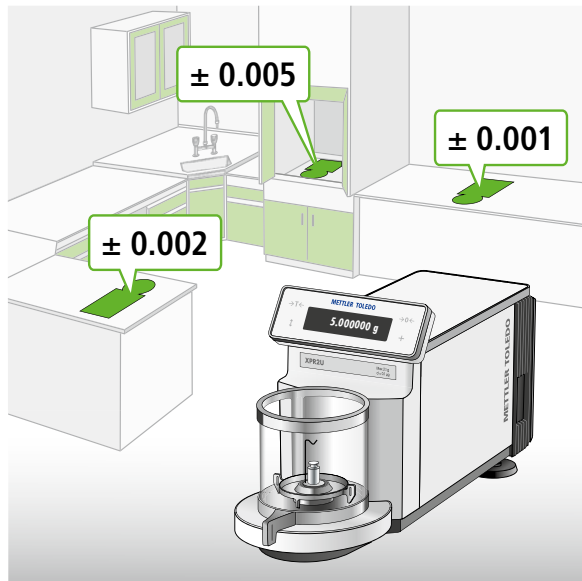


Figure 3: At different locations the balance measurement uncertainty may be different as well. With a calibration certificate you make sure your microbalance is working correctly in accordance to your weighing requirements.

Balance calibration by a qualified service provider determines the measurement uncertainty over the whole weighing range at the actual weighing location.

The calibration certificate includes the reported measurement uncertainty:

$$U = U_0 + C * I$$

(U_0 is the measurement uncertainty at zero load, C is the parameter that describes the increase of the measurement uncertainty with the load and I is the net load indication).

Since the external conditions and the balance performance can change over time, the calibration should be carried out periodically.



Special Tips

- The XPR microbalance stores the parameters of the measurement uncertainty for full traceability: [▶ www.mt.com/xpr-micro](http://www.mt.com/xpr-micro).
- GWP® Verification gives you clear advice how often you should calibrate your equipment. This advice is based on your specific risk and process requirements: [▶ www.mt.com/gwp-verification](http://www.mt.com/gwp-verification).
- A qualified calibration certificate is provided by METTLER TOLEDO (e.g. Accuracy Calibration Certificate). For more information go to [▶ www.mt.com/service](http://www.mt.com/service) or contact your local METTLER TOLEDO service office.

4. How Can I Ensure Accurate Results Every Day?

It is important to perform routine testing on your balance even though it has been calibrated.

In addition to regular calibration, weighing instruments also require periodic routine testing between calibrations and should be tested regularly with an external weight for two reasons:

- Within the calibration period, changes of the balance performance may occur. A routine test is a quick and traceable check that the balance still performs according to the required user defined process tolerance.
- By following a routine test procedure you might elongate the time between calibration cycles (based on the risk of the weighing application), i.e. annually rather than every 6 months.

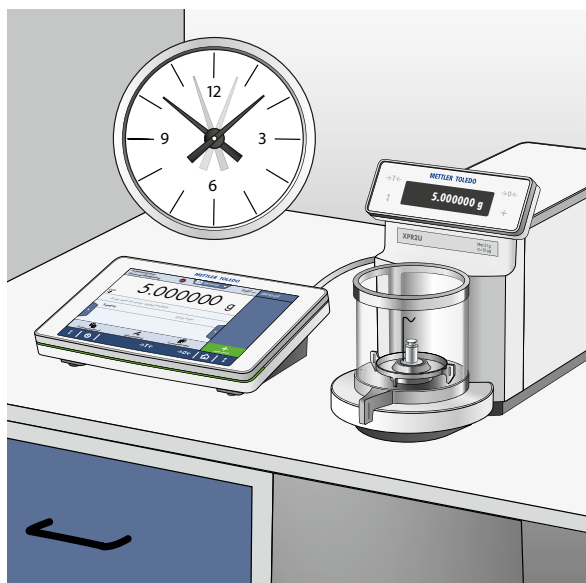


Figure 4: Conditions can change within the long calibration intervals. A routine test detects changes in the conditions which would have an impact on your results.

The overall measurement uncertainty (short: MU) consists of four main contributing factors – repeatability, sensitivity, eccentricity, and non-linearity. All of these factors are measured during calibration, but typically repeatability and sensitivity should be checked routinely by the user, as defined by Good Weighing Practice™, the science-based global weighing standard.

Repeatability Testing (RP)

With test weights up to 5% of the balance capacity, repeatability (also called “precision”) is the dominant contributor to measurement uncertainty and is constant. Repeatability is measured by performing 10 replicate weighings under the same conditions using a test weight at 5% of the balance capacity.

Sensitivity Testing (SE)

With test weights close 100% of the balance capacity, sensitivity (also called “error of indication”) is the dominant contributor to measurement uncertainty. Sensitivity is measured by placing a test weight close to the capacity on the balance and comparing it with the mass value of the weight.

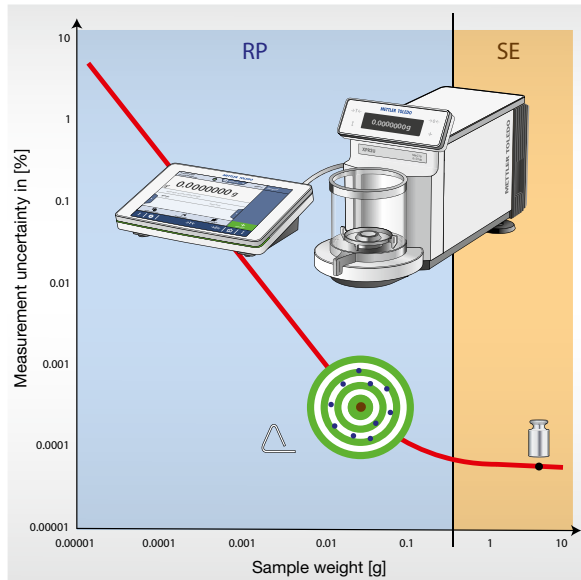


Figure 5: A typical measurement uncertainty curve of a typical microbalances. With sample weights below 5% of the capacity the repeatability is the biggest error where as around maximum capacity the sensitivity is dominant.



Special Tips

- METTLER TOLEDO’s GWP® Verification is a risk-based assessment. It provides you with a personalized recommendation on how to test your balance and how often to perform each routine test: [▶ www.mt.com/gwp-verification](http://www.mt.com/gwp-verification).
- CarePacs® include the two correct test weights needed for the user to perform routine repeatability and sensitivity balance tests for any balance model: [▶ www.mt.com/carepacs](http://www.mt.com/carepacs).

5. How Can I Deal With Drifting Weight Results?

What to do if the balance settings are correct, all tests are passed, but your weighing results are still drifting.

The influence of the sample or weighing vessel on the measurement result is often overlooked, and can frequently be a cause of drifting results. Most of these external influences can be prevented or reduced by the following simple measures:

| Observed Problem | Possible Reason | Recommended Actions |
|--|---|--|
| Weight reading shows steady (linear) increase | Sample is hygroscopic and absorbing moisture, causing steady increase in mass | <ul style="list-style-type: none"> Close the vessel Keep air humidity constant and store sample under these conditions before weighing |
| Weight reading shows steady (linear) decrease | Sample is evaporating and losing moisture, causing steady decrease in mass | <ul style="list-style-type: none"> Close the vessel Keep air humidity constant and store sample under these conditions before weighing |
| Weight reading shows small, sometimes stepwise, increase or decrease | Temperature differences between sample and environment cause heating or cooling effects in the weighing chamber, and therefore change in mass | <ul style="list-style-type: none"> Use tweezers to handle the weighing vessel Allow sufficient acclimatization time of the samples and vessels in the weighing environment (at least 30 minutes) |
| Weight reading shows unpredictable drift (jumping up and down) | Electrostatic effects typically produce chaotic drift patterns | <ul style="list-style-type: none"> Avoid the use of plastic or PTFE weighing vessels wherever possible Use a good ionizer to dissipate static charges in the sample and vessel. Discharge the samples for several seconds |

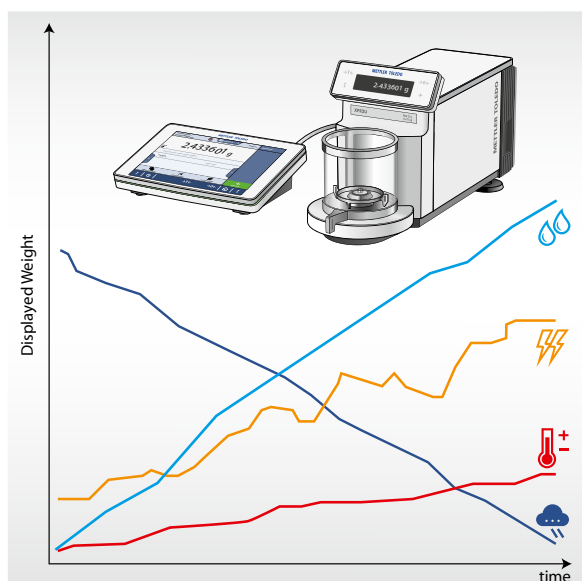


Figure 6: Typical weight changes over the time due to different influences by the sample itself.



Special Tips

- The XPR6UD5 or XPR10 and XPR10U balances have sufficient capacity to allow a flask to be weighed with a cap or lid on.
- Use an ionizer to remove charges from samples and weighing vessels. METTLER TOLEDO offers various ionizer options: ► www.mt.com/accessories.

6. How Can I Optimize Working with Small Samples?

Weighing very small samples can be tricky, but there are tools available to make this task easier.

Weighing out small amounts on a microbalance can be challenging, especially when wearing gloves. Handling small objects, such as crucibles can also be difficult. Accessories that are specifically designed for the application can make these tricky tasks easier:



Figure 7: Sample sizes, flasks or crucibles are tiny. Using the appropriate tools will have a positive influence on your weighing in terms of speed, accuracy and convenience.

- A micro spatula with a thick handle supports precise sample transfer.
- Specially shaped tweezers can be a big help in transferring the sample into the balance smoothly.
- Flat-bottomed weighing dishes can be positioned safely on the weighing pan.
- Using a foot switch for opening and closing the balance door frees up your hands and aids concentration.
- A tubular weighing pan kit makes the weighing of tubular samples, such as stents, springs and wires, much easier (available for the XPR microbalance).



Special Tip

- Specialized tweezers, weighing pans and all the latest accessories for micro-weighing can be found at:
▶ www.mt.com/accessories.

7. How Should I Clean My Microbalance?

Use recommended procedures for cleaning toxic or sticky substances.

- Switch off the balance.
- Coarse cleaning can be done with brush and tissues (only for non-toxic samples). Fine cleaning should be done with detergents or suitable solvents.
- The inner parts of the draft shield can be brushed out. To clean more thoroughly, dismantle the drip tray and the weighing pan. These parts may also be cleaned in sonic water baths if required.
- Usually use common cleaning agents such as 70% alcohol or isopropanol, or common detergents. The inner draft shield parts are made from stainless steel and are chemically resistant and robust.
Note: stainless steel is not compatible with strong acids.
- Acetone should NOT be used, even for highly sticky substances. This solvent can dissolve plastics and attack the glued surfaces of the draft shield. Keep acetone away from the plastic handles and balance terminal screen.
- Balance manufacturers will usually provide a chemical compatibility list.
- Always check the instructions given in the operating manual.



Figure 8: Keeping your microbalance clean helps to protect your balance for many years to come.

| | | Tools | | | Cleaning agents | | | | | | |
|----------------------|----------------------------------|--------------|-------|------------|-----------------|---------|---------------|-------------------|---------------------------|------------------------------|-----------------------|
| | | Paper tissue | Brush | Dishwasher | Water | Acetone | Ethanol (70%) | Isopropanol (70%) | Hydrochloric acid (3–10%) | Sodium hydroxide (0.2–1.0 M) | Peracetic acid (2–3%) |
| Around the balance | Balance housing | ✓ | R | — | R | — | R | ✓ | R | R | R |
| | Feet | ✓ | R | — | R | — | R | ✓ | R | R | R |
| Balance terminal | Terminal | ✓ | R | — | ✓ | PR | R | R | R | R | R |
| | Display | ✓ | — | — | ✓ | PR | R | R | R | R | R |
| | Terminal cover | ✓ | R | — | ✓ | — | R | R | R | PR | PR |
| Balance draft shield | Glass panels | ✓ | R | R | R | PR | ✓ | ✓ | R | R | R |
| | Non-removable handles and frames | ✓ | R | — | R | PR | ✓ | ✓ | R | R | R |
| Weighing area | Weighing pan | R | R | ✓ | R | R | ✓ | ✓ | R | R | R |
| | Drip tray | R | R | ✓ | R | R | ✓ | ✓ | — | — | R |

Legend

- ✓ Best recommendation by METTLER TOLEDO; can be used without limitation.
- R Recommended by METTLER TOLEDO; can be used without limitation.
- PR Partially recommended by METTLER TOLEDO: individual resistance to acid and alkali must be evaluated, including dependence to the time exposure.
- Not recommend. High risk for damage.



Special Tip

- Find more details in our e-learning: “Lab Balances: External influences and Cleaning”, which can be found at: www.mt.com/lab-elearning-influences.

8. How Can I Make the Weighing Process More Efficient?

Some simple balance functions can make life easier.

Most microbalances contain built-in software which provides useful features to accelerate and simplify weighing, but sometimes configuring them may be difficult or time-consuming. Check out the user manual of your specific balance for more information.

The weighing time can be decreased by optimizing the Weighing Mode, Environment, Value Release settings. As these changes will also have an influence on the measurement uncertainty, a calibration should be made to ensure weighings are within the required tolerances.

Separate User Profiles

For XP microbalances, individual user accounts can be used to preconfigure certain parameters. Use the right account for your weighing tasks. For XPR microbalances, tolerance profiles can be programmed. These profiles are linked to all necessary quality and weighing settings including the correct preventive maintenance procedures.

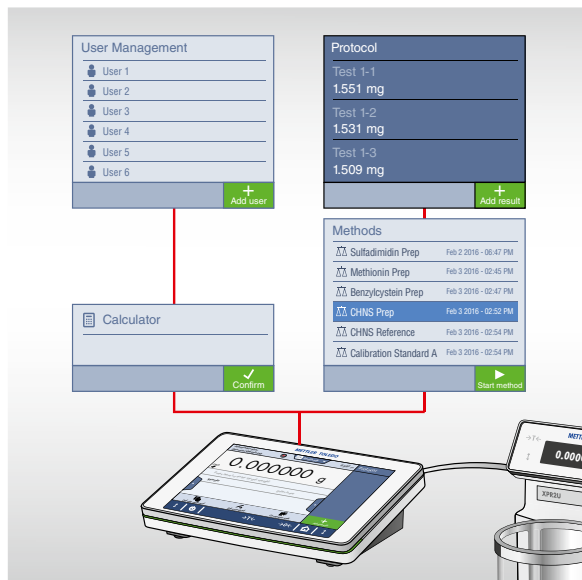


Figure 9: Modern microbalances provide many helpful features and functions to support the efficiency of your daily weighing tasks.

Method Storage

The XPR user interface (short UI) offers the possibility to store general sample parameters in “methods” which can be selected by a single click. Click directly on important parameter fields and directly type in required values and start directly your weighing tasks. This is especially helpful for repetitive weighing tasks.

Select Parameters with One Click

On the XPR, you can click directly on important parameter fields (e.g. target weights, sample ID's, \pm tolerances) and type the required values. Efficient data input is supported by state-of-the-art touch screen user interfaces which simplify typing and method enable swiping.



Special Tips

- With the XPR microbalances you can do simple calculations such as concentration to sample weight conversions.
- Many functions can be accessed directly from the touchscreen. Take a closer look at all the options on the display and explore the possibilities.

9. What Data Capture/Data Transfer Options Do I Have?

Time consuming and error prone manual data capture and transfer processes can be improved.

Usually the weight data are recorded and used in subsequent calculations or steps downstream in the process. The weight is often noted down by hand, or typed into a spreadsheet or other instrument software. Manual data transcription is time-consuming and a major source of errors. Especially transcription errors can quickly lead to extended rework.

Most balances offer useful functions to simplify and automate data transfer from the balance to another system:

How to Identify the Sample?

Sample IDs can be scanned with a barcode reader (1D or 2D) to avoid manually recording the sample.

How to Transfer the Data to Microsoft Excel (or other MS Program)?

Simple software (e.g. LabX direct) allows transfer of results easily into MS programs, such as MS Excel (for XP/XS microbalances). For latest XPR balances, the data can be transferred easily without need for special software or drivers.

How to Transfer the Data to an External Software Package?

XP balances can export data such as weights fast and error free to an external software (e.g. analytical instrument) over the so-called transfer key using a standardized output protocol. A helpful function especially when weighing numerous samples.

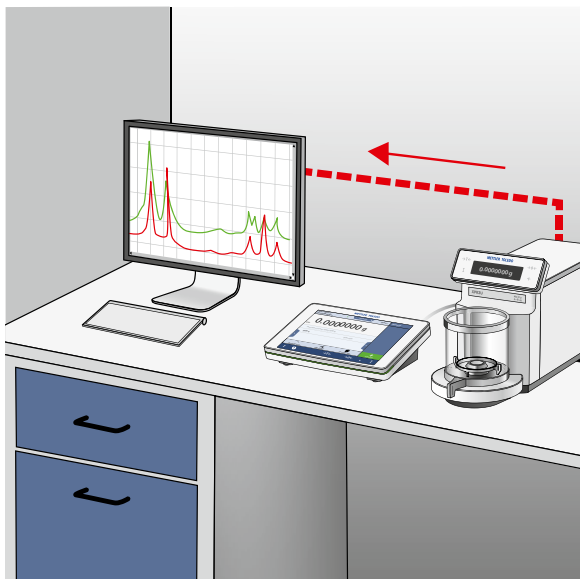


Figure 10: Data transfer is cumbersome and prone to errors. Use the data transfer opportunities provided by your microbalance to remove this time consuming task.

For Remote Control of the Balance?

For complex integration into customer's data systems (e.g. LIMS) the user can use the METTLER TOLEDO Standard Interface Command Set (MT-SICS). The balance can be completely controlled remotely. Please download the MT-SICS command set or contact your local weighing consultant for more information.

What is the Most Secure Data Transfer Option?

For data centralization and to ensure 21 CFR part 11 compliance LabX software is recommended. LabX can be used not only to record all results but also to control the weighing process, balance data and record the audit trail for all balances in the laboratory. LabX ensures that raw data cannot be manipulated. LabX is currently available for XP/XS microbalances.

**Special Tips**

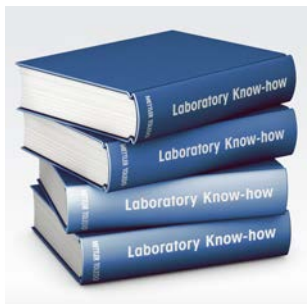
- For maximum data transfer security, use LabX software: ► www.mt.com/labx.
- For complex integration to LIMS ask the MT-SICS.

10. Other Helpful Tips to Optimize Micro-Weighing

- ✓ Only unplug a balance if absolutely necessary. For best weighing results a microbalance needs 24 hours to warm up and stabilize after being plugged in.
- ✓ Ensure the balance is leveled. XPR LevelControl should always be active.
- ✓ Work faster and more conveniently with touch-free weighing. IR sensor allows automatic opening/closing of the door by waving hand in front of sensor alternatively use a footswitch to leave hands completely free.
- ✓ Use an appropriate weighing pan for your sample e.g. use a filter weighing pan or a filter weighing kit for determining particulate matter, and a dedicated weighing pan for tubular samples such as wires, stents, springs etc.
- ✓ Always close the balance door whilst weighing to avoid drafts causing instability in the weighing result.

Benefit from Our Weighing Expertise

With decades of experience in laboratory weighing, METTLER TOLEDO can offer you a wide range of online learning resources. Take advantage of our expertise to enhance your weighing know-how and make the most of your balance. Check out the documentation on our internet page for a range of relevant materials.



Laboratory Expertise

Valuable know-how is at your fingertips on our competence pages. Learn about:

- USP Revisions
- Electrostatic Influences
- Calibrating Your Weighing Device

► www.mt.com/lab-expertise

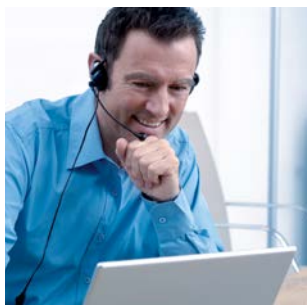


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- USP Compliance
- Lab Balances – External Influences and Cleaning

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The global weighing guideline GWP® reduces risks associated with your weighing processes and helps to

- choose the appropriate balance
- reduce costs by optimizing testing procedures
- comply with the most common regulatory requirements

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