Reference Manual

Volume Measurement System

VMS2 & VMS20

METTLER TOLEDO

Table of Contents

1 Introduction

Thank you for choosing a METTLER TOLEDO instrument. The instrument combines high performance with ease of use.

In purchasing this semi-automated volume and density determination system, you have chosen a highly professional measuring equipment. The combination of METTLER TOLEDO's world-class weighing sensor technology with the density application-oriented VMS2 and VMS20 systems gives a new dimension to volume and density determination. Manual handling enables highest efficiency at accuracy levels that meet metrological regulations requirements. With the supplied software, handling and complex calculations are performed at the touch of a button.

Software version

This document is based on the software version **VMS Control 2.0**.

EULA

The software in this product is licensed under the METTLER TOLEDO End User License Agreement (EULA) for Software. ▶ www.mt.com/EULA

When using this product you agree to the terms of the EULA.

Disclaimer for comparators

In this document, the term "balance" is used to describe both balances and comparators.

1.1 Further documents and information

Mass comparators website

▶ www.mt.com/comparators

XPR Precision Balances website

▶ www.mt.com/xpr-precision

XPR Precision Balances and Comparators Reference Manual (RM)

▶ www.mt.com/XPR-precision-RM

Search for documents ▶ www.mt.com/library

For further questions, please contact your authorized METTLER TOLEDO dealer or service representative.

▶ www.mt.com/contact

1.2 Explanation of conventions and symbols used

Conventions and symbols

Key and/or button designations and display texts are shown in graphic or bold text, e.g., ✎, **Edit**.

Note For useful information about the product.

Refers to an external document.

Elements of instructions

In this manual, step-by-step instructions are presented as follows. The action steps are numbered and can contain prerequisites, intermediate results and results, as shown in the example. Sequences with less than two steps are not numbered.

- Prerequisites that must be fulfilled before the individual steps can be executed.

1 Step 1

⇨ Intermediate result

2 Step 2

⇨ Result

1.3 Acronyms and abbreviations

ASTM	American Society for Testing and Materials
INI	Installation Instructions
OIML	Organisation Internationale de Métrologie Légale (International Organization of Legal Metrology)
RM	Reference Manual
VMS	Volume Measurement System

2 Safety Information

- This Reference Manual contains a full description of the instrument and its use.
- Keep the Reference Manual for future reference.
- Include the Reference Manual if you transfer the instrument to other parties.

Only use the instrument according to the Reference Manual. If you do not use the instrument according to the Reference Manual or if it is modified, the safety of the instrument may be impaired and Mettler-Toledo GmbH assumes no liability.

2.1 Definitions of signal words and warning symbols

Safety notes contain important information on safety issues. Ignoring the safety notes may lead to personal injury, damage to the instrument, malfunctions and false results. Safety notes are marked with the following signal words and warning symbols:

Signal words

DANGER	A hazardous situation with high risk, resulting in death or severe injury if not avoided.
WARNING	A hazardous situation with medium risk, possibly resulting in death or severe injury if not avoided.
CAUTION	A hazardous situation with low risk, resulting in minor or moderate injury if not avoided.
NOTICE	A hazardous situation with low risk, resulting in damage to the instrument, other material damage, malfunctions and erroneous results, or loss of data.

Warning symbols


Electrical shock


Heavy object

2.2 Product-specific safety notes

Intended use

This instrument is intended to be used by trained staff. The instrument is intended for determining the density and the mass of artifacts up to 2 kg or 20 kg, respectively.

Any other type of use and operation beyond the limits of use stated by Mettler-Toledo GmbH without consent from Mettler-Toledo GmbH is considered as not intended.

Responsibilities of the instrument owner

The instrument owner is the person holding the legal title to the instrument and who uses the instrument or authorizes any person to use it, or the person who is deemed by law to be the operator of the instrument. The instrument owner is responsible for the safety of all users of the instrument and third parties.

Mettler-Toledo GmbH assumes that the instrument owner trains users to safely use the instrument in their workplace and deal with potential hazards. Mettler-Toledo GmbH assumes that the instrument owner provides the necessary protective gear.

Safety notes

⚠ WARNING

Death or serious injury due to electric shock

Contact with parts that carry a live current can lead to death or injury.

1 Only use the METTLER TOLEDO power cable and AC/DC adapter designed for your instrument.
2 Connect the power cable to a grounded power outlet.
3 Keep all electrical cables and connections away from liquids and moisture.
4 Check the cables and the power plug for damage and replace them if damaged.

⚠ WARNING

Heavy object

– Single person lift could cause injury.
– Do not move or lift this equipment without assistance.

NOTICE

Damage to the instrument or malfunction due to the use of unsuitable parts

– Only use parts from METTLER TOLEDO that are intended to be used with your instrument.

3 Design and Function

By knowing the density of artefacts, the physical influence of air buoyancy effects, mass, pressure and force metrology can be reduced.

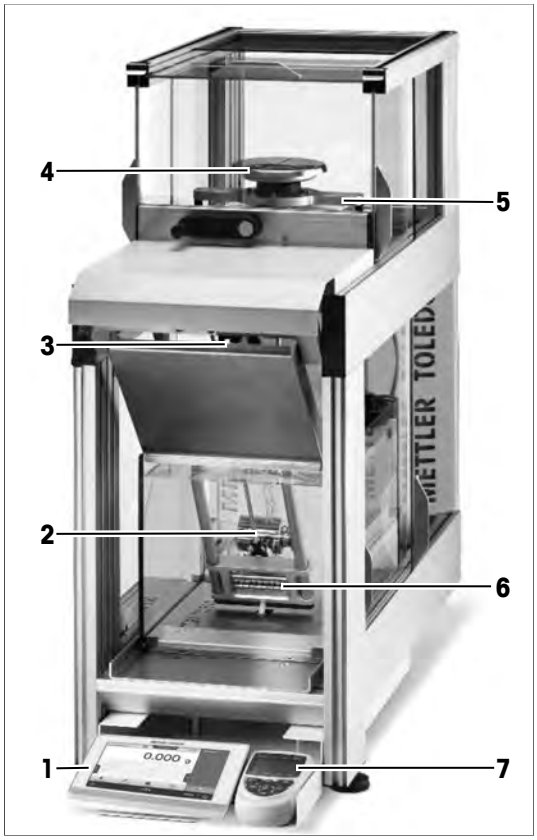
OIML R111-1:2004, chapter 10.2.2 requires density measurement for mass of E1 class weights if used above 330 m, and other classes when used 800 m above sea level. The VMS systems have a built-in balance which can be used both for mass determination and density determination.

The VMS Control software guides the user through the measurement process and creates a detailed measurement report, including uncertainties.

The measurement methods cover OIML R111-1:2004, methods A1 and A3.

3.1 Scope of Delivery – VMS2

- METTLER TOLEDO XPR2004SC comparator (balance, touch screen terminal, AC adapter)
- High-accuracy temperature measuring unit Almemo 2490-1, including temperature sensor
- Complete mechanics of the in-liquid loading device
- Tool to remove air bubbles from the weight and the weighing pan in liquid
- Microsoft® Windows® Excel®-based VMS Control software



VMS2

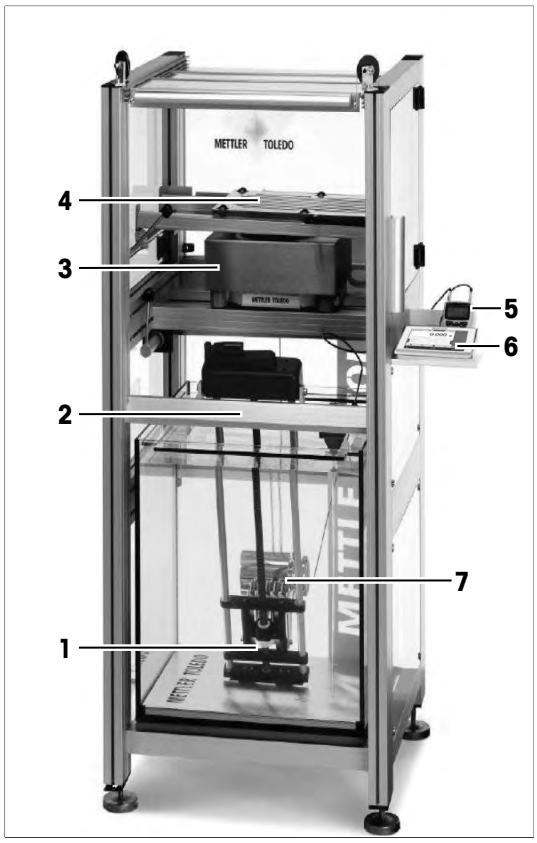
1	XPR2004SC terminal	2	Weighing position in liquid
3	Loading device lever	4	XPR2004SC comparator
5	Weighing position in air	6	Weighing pan in liquid lifter
7	Temperature measuring unit		

XPR2004SC

1	Terminal with touch screen display	2	LevelMatic weighing pan

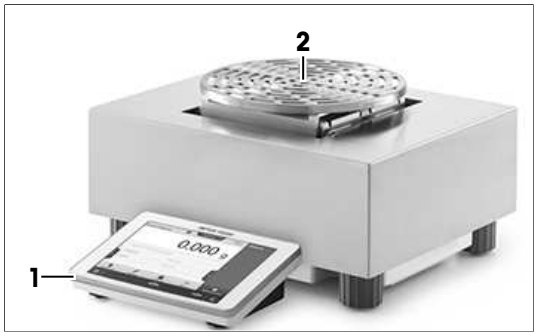
3.2 Scope of Delivery – VMS20

- METTLER TOLEDO XPR26003LC comparator (balance, touch screen terminal, AC adapter)
- High-accuracy temperature measuring unit Almemo 2490-1, including temperature sensor
- Complete mechanics of the in-liquid loading device
- Tool to remove air bubbles from the weight and the weighing pan in liquid
- Microsoft® Windows® Excel®-based VMS Control software



VMS20

1	Weighing pan in liquid lifter	2	Loading device lever
3	XPR26003LC comparator	4	Weighing position in air
5	Temperature measuring unit	6	XPR26003LC terminal
7	Weighing position in liquid		



XPR26003LC

1	Terminal with touch screen display	2	LevelMatic weighing pan

4 OIML R111 Measurement Methods

4.1 Water penetrating the adjustment cavity (OIML R111-1:2004, B.7.2.4)

NOTICE

Weights with adjustment cavity

Water penetrating the adjustment cavity affects both density and mass determination results. Water in the adjustment cavity could destabilize the mass.

1 Do not immerse weights with adjustment cavity in water.

2 For weights with an adjustment cavity, geometric volume determination is the method of choice.

3 If, however, all water can be removed afterwards, perform hydrostatic weighing with an open cavity, from which trapped air has been carefully removed.

4.2 Air bubbles removal (OIML R111-1:2004, B.7.2.5)

NOTICE

Air bubbles on weight or weighing pan

Air bubbles adhering to the weight or the weighing pan affect the measurement results in liquid.

1 Remove air bubbles with the supplied air bubbles removal tool.

2 Additionally, the water and the weight in liquid can be deaerated by applying a sub-atmospheric pressure to the container for about 10-15 minutes.

4.3 Drying the weight (OIML R111-1:2004, B.7.2.8)

After removing the weight from the water bath, most of the water runs off the weight's surface.

1 Wipe off remaining droplets with a fine cloth.

2 For stabilization, place the weight under a suitable cover. For example, cover the weight with an upside down beaker on spacers to allow for ventilation.

4.4 OIML R111 Density determination method A1

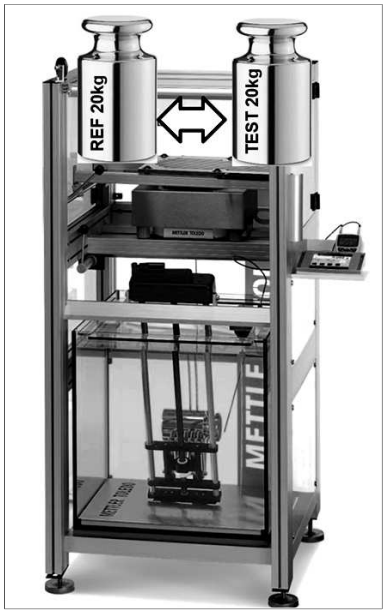
Measurement steps 1 – 2

1. The test weight is measured in air.
2. The test weight is compared against a reference weight in air to obtain the conventional mass value of the test weight.

Measurement process (example: 20 kg weight)

1 Load **test weight** in air (20 kg).
⇨ The measured value is captured.
2 Unload test weight in air.

3 Load **reference weight** in air (20 kg).
⇨ The measured value is captured.
4 Unload reference weight in air.



Example: Measurement steps 1 – 2 (VMS20)

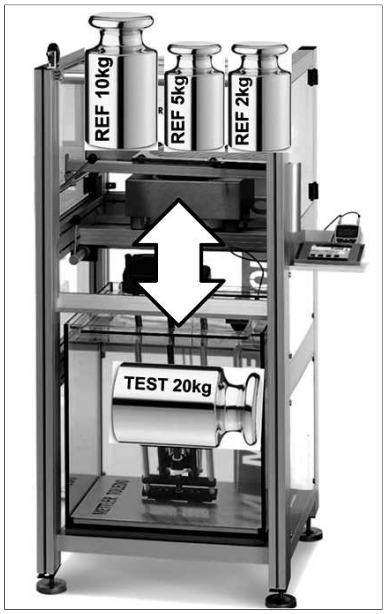
Measurement steps 3 – 4

1. The test weight is measured in liquid.
2. The test weight is compared against a reference weight in air.

Measurement process (example: 20 kg measurement)

1 Immerse **test weight** (20 kg) fully in the liquid.
2 Center the weight by lowering and lifting it on and off the weighing pan a few times until it has found its equilibrium position.
3 Load **test weight** (20 kg) on weighing pan in liquid.
⇨ The measured value is captured.
4 Unload test weight in liquid.

5 Load **reference weights** in air equal to the mass of the test in liquid (17 kg).
⇨ The measured value is captured.
6 Unload reference weights in air.



Example: Measurement steps 3 – 4 (VMS20)

For details on method A1, see OIML R111-1:2004, B.7.4.2.

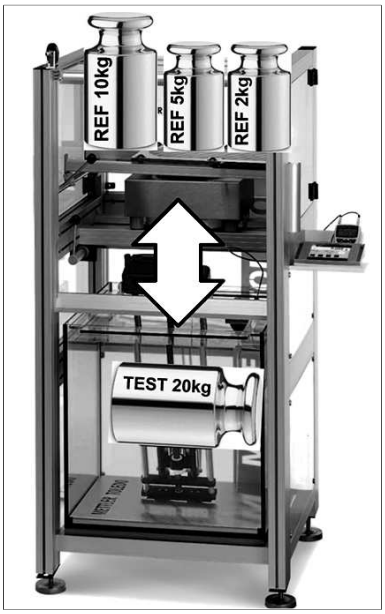
4.5 OIML R111 Density determination method A1 (with known mass)

Measurement steps

The test weight in liquid is compared against a reference weight in air.

Measurement process (example: 20 kg measurement)

1 Immerse **test weight** (20 kg) fully in the liquid using the loading device.
2 Center the weight by lowering and lifting the weight on and off the weighing pan a few times until it has found its equilibrium position.
3 Load **test weight** (20 kg) on weighing pan in liquid using the loading device.
⇨ The measured value is captured.
4 Unload test weight in liquid.
5 Load **reference weights** in air equal to the mass of the test in liquid (17 kg).
⇨ The measured value is captured.
6 Unload reference weights in air.



Example: Measurement steps (VMS20)

This method is based on OIML R111-1:2004 (B.7.4.2) method A1, with the assumption that the mass of the test weight has already been obtained.

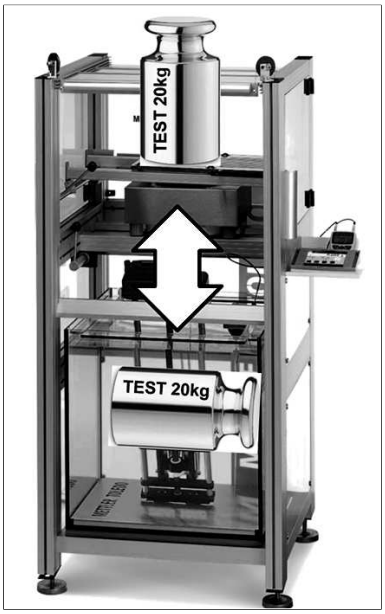
4.6 OIML R111 Density determination method A3

Measurement steps 1 – 2

1. The test weight is measured in air.
2. The test weight is measured in liquid.

Measurement process (example: 20 kg weight)

1 Load test weight (20 kg weight) on weighing pan in air.
⇨ The measured value is captured.
2 Unload test weight in air.
3 Immerse test weight fully in the liquid using the loading device.
4 Center the test weight by lowering and lifting it on and off the weighing pan a few times until it has found its equilibrium position.
5 Load test weight (20 kg) on weighing pan in liquid using the loading device.
⇨ The measured value is captured.
6 Unload test weight in liquid.



Example: Measurement steps 1 – 2 (VMS20)

For details on method A3, see OIML R111-1:2004, B.7.4.4.

5 Putting into Operation

5.1 Starting the system

1 Switch on the balance by tapping ⏻ (ON/OFF) on the balance terminal.
2 Switch on the temperature measuring unit.
3 Let warm up the balance for at least three hours.

NOTICE

Weighing cell will cool down if balance is switched off or set to standby mode

A cooled weighing cell affects the performance of the balance.

– Do not switch off the balance nor set the balance to standby mode.

5.2 Adjusting the balance

Prior to performing the density measurements, the balance has to be adjusted with the internal weight or with an external reference weight.

For details, see the Reference Manual for XPR Precision Balances and Comparators.

Note

The adjustment is especially important for the Method A3, as the balance is used as an absolute weighing instrument. For method A1, only differences are measured, which reduces the influence of linearity and sensitivity of the weighing instrument.

5.2.1 Adjusting the balance for volume determination with VMS2

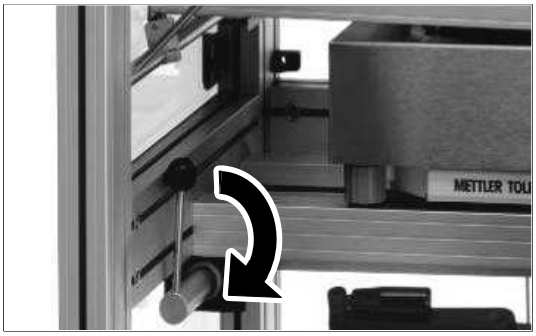
The balance has to be adjusted with the hanging weighing pan (weighing pan in liquid) connected to the weighing cell.

– To load the weighing pan in liquid, turn the lever to the left.

5.2.2 Adjusting the balance for volume determination with VMS20

The balance has to be adjusted with the hanging weighing pan (weighing pan in liquid) connected to the weighing cell.

– To load the weighing pan in liquid, turn the lever to the right.



VMS20 – balance calibration position for volume determination

5.3 Preparing the measurement system

5.3.1 Preparing distilled water

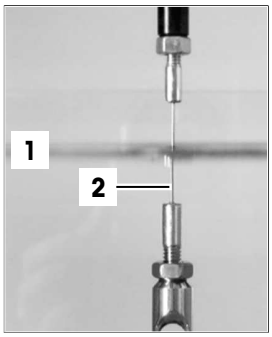
- Use distilled and reverse osmosis water only.
- The water must not be degassed, as the water in standard environment would be gaining the gas content again within short time.
- The calculation of the water density is based on gas-saturated water.
- The water quality shall be according to 'ISO 3696 Water for analytical laboratory use – Specification and test methods (Edition 1987) Grade 3'.

5.3.2 Preparing the water bath

1 Use a tube to fill the water bath.

2 Lower the tube to the bottom of the bath to reduce spilling and aeration of the water.

3 Fill the water bath. Filling level (**1**): middle of the media bridge (**2**).

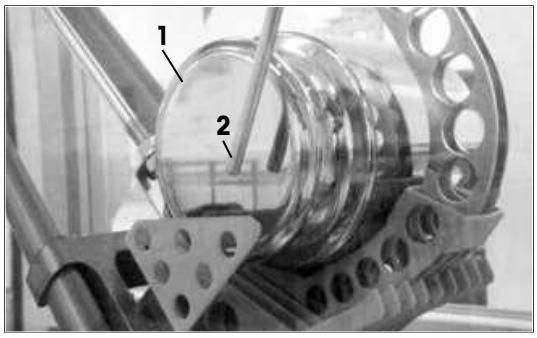


5.3.3 Positioning the water temperature sensor

The water temperature is used to determine the water density.

Water density is determined according to Tanaka M., et al., 2001, 'Recommended table for the density of water between 0 °C and 40 °C', Metrologia 38 301-309.

– Position the tip of the temperature sensor (**2**) at the approximate horizontal center of the artifact (**1**).



5.4 Loading test artifacts on VMS2

Prerequisite

1 To eliminate the risk of pollution of the liquid, clean the artifacts with appropriate cleaning methods.

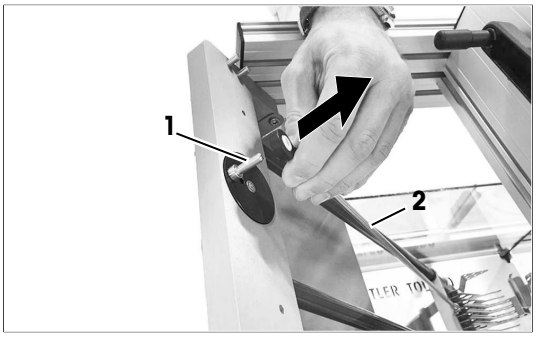
2 When using cleaning agents or liquids, ensure that the weights are stored prior to the measurement to stabilize again according to OIML R111-1:2004, B.4.2.

3 Thermally stabilize the artifacts. To reduce influences of convection in the liquid, the artifacts must have the same temperature as the liquid bath.

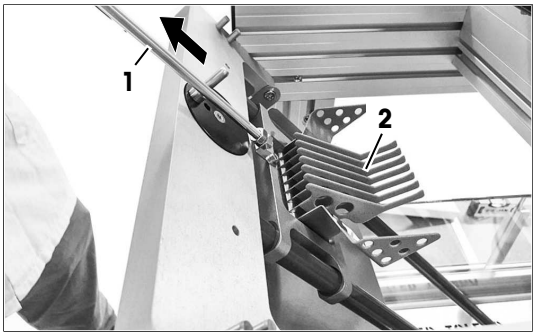
5.4.1 Loading the weight on the weighing pan in liquid

1 Turn the loading device lever to the right.

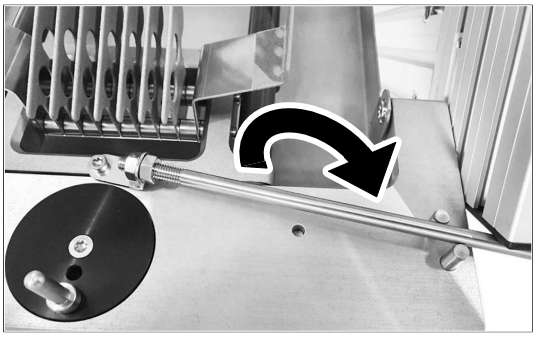
2 Lift the loading rod (**2**) from the holding pin (**1**).



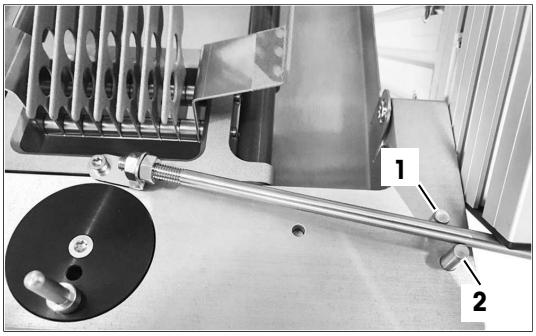
3 To move the loading device (**2**) upwards, pull the loading rod (**1**) towards yourself until the loading device has reached the upper position.



4 Fold the loading rod either to the left or right side.



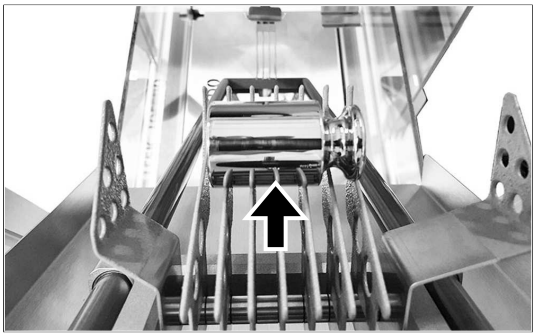
5 To secure the position of the loading device, clamp the loading rod between the two holding pins (**1**, **2**) on the left or on the right side.



6 Put on gloves.

7 Place the weight in horizontal position onto the fork section of the loading device, with the knob facing to the right.

8 Place the weight on the approximate center of gravity of the loading device.



9 Lift the loading rod out of the two holding pins.

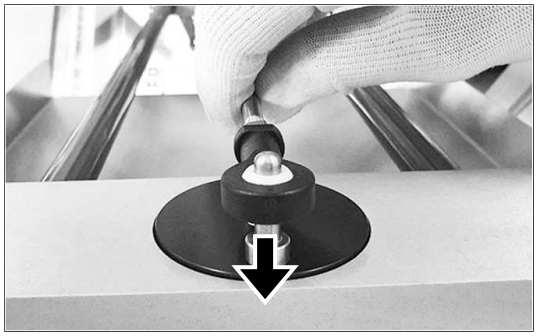
10 Lower the loading device slowly into the liquid.
NOTICE: To reduce the risk of air bubbles adhering to the weight, immerse the weight carefully into the liquid.

11 Lower the weight into the upper weighing position.
NOTICE: Do not yet lower the weight onto the weighing pan.

12 To secure the loading rod, push the rod's holding eyelet onto the holding pin.

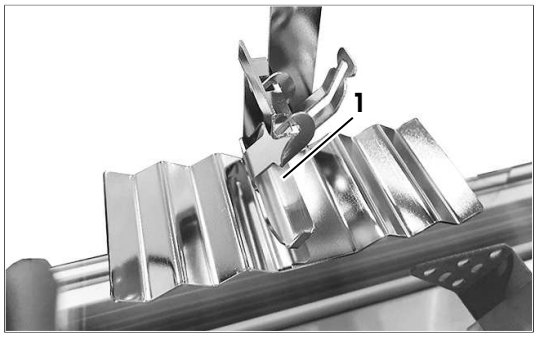
13 Make sure that the lowered weighing pan does not touch the loading device.

14 Check visually for air bubbles on the weight, the loading device and the weighing pan. See [Removing air bubbles ▸ Page 18].

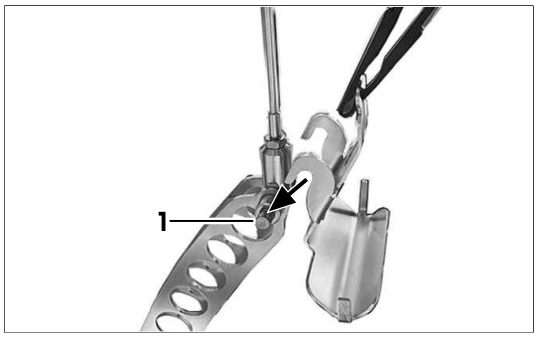


5.4.2 Loading the test weight on the add-on weighing pan in liquid

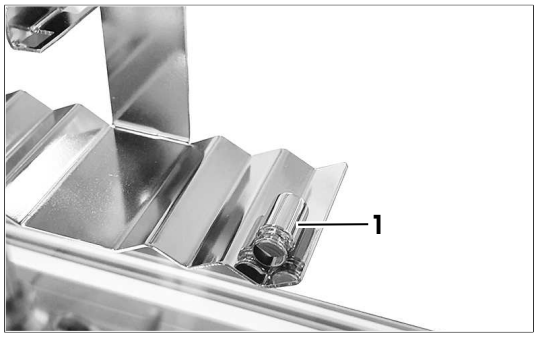
1 Use tweezers to lift the add-on weighing pan from its standby position (**1**). **NOTICE: Do not lift the weighing pan out of the liquid. Air bubbles could form when reentering the liquid.**



2 Mount the add-on weighing pan on the axle with the spacers (**1**) above the weighing pan in liquid.



3 Use tweezers to grab the weight and lift it from its standby position (**1**).



4 Place the weight in horizontal position on the add-on weighing pan.

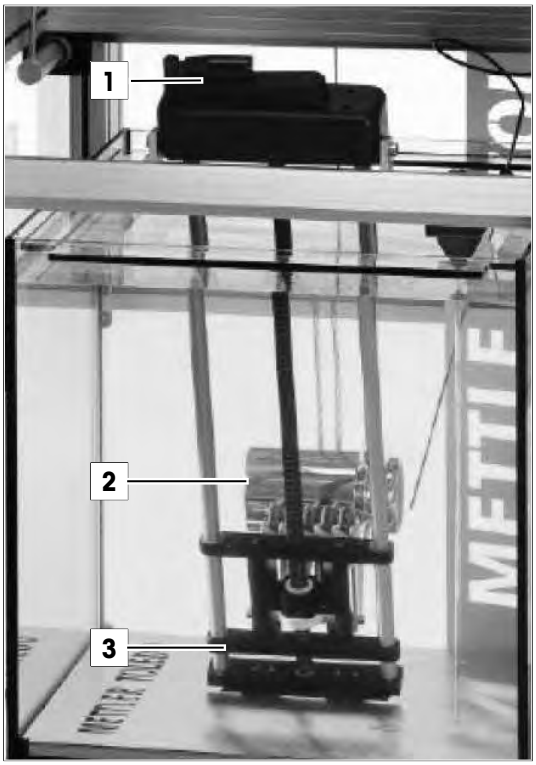
5.5 Loading test artifacts on VMS20

Prerequisite

1 To eliminate the risk of pollution of the liquid, clean the artifacts with appropriate cleaning methods.
2 When using cleaning agents or liquids, ensure that the weights are stored prior to the measurement to stabilize again according to OIML R111-1:2004, B.4.2.
3 Thermally stabilize the artifacts. To reduce influences of convection in the liquid, the artifacts must have the same temperature as the liquid bath.

5.5.1 Loading the weight for liquid measurement on the weighing pan in liquid

1 Turn the loading device crank (**1**) clockwise to lift the loading device (**3**) to the upper position.
2 Turn the crank rod (**1**) to the horizontal position.
3 Put on gloves.
4 Lift the weight onto the loading device (**3**).
5 Place the weight on the approximate center of gravity of the loading device.
6 Turn the crank (**1**) clockwise to lower the weight to the weighing position (**2**). Stop about 2 cm above the weighing pan in liquid.
7 Make sure that the lowered weighing pan does not touch the loading device.
8 Check visually for air bubbles on the weight, the loading support and the weighing pan in liquid. See [Removing air bubbles ▸ Page 18].



5.6 Removing air bubbles

Air bubbles on the weighing pan or on the test artifact influence the density determination result. The effect of air bubbles is not necessarily apparent in the final measurement result.

NOTICE

Air bubbles on the test artifact or on the weighing pan

Air bubbles on the test artifact or on the weighing pan influence the measurement result.

1 To reduce the risk of air bubbles, store the smaller weights in standby position between the measurements.

2 To remove air bubbles, use the supplied air bubble removal tool.

3 To fill the bellow, insert the bellow into fresh water and press it gently several times, until the outflowing water does not contain any air bubbles.

4 Press the bellow gently to generate a water jet. Direct the water jet towards the air bubbles on any part of the weighing pan in liquid, as well as the test weight, and wash them away.

6 Measuring with VMS Control Software

6.1 Installing the software

Prerequisite

Microsoft® Excel®. The software is based on a macro-enabled Excel spreadsheet. The Excel spreadsheet can be opened with Excel version 2016 or later.

Software components

Excel file **VMS_SW_vX.X.xlsm**

Software installation

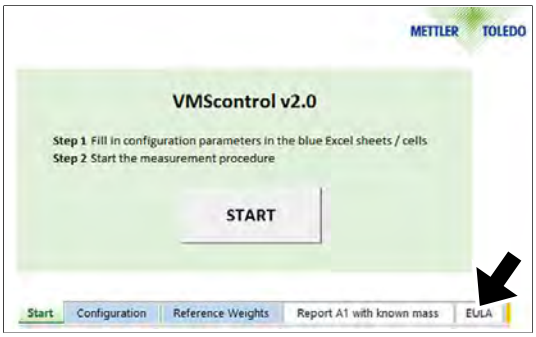
1 Copy file **VMS_SW_vX.X.xlsm** from source.

2 Paste file **VMS_SW_vX.X.xlsm** into a folder on your computer.

6.2 Accepting the End User License Agreement

- Excel file **VMS_SW_vX.X.xlsm** is open.

1 Open the **EULA** tab.

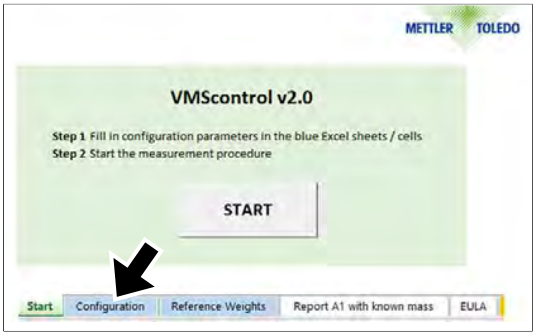


2 Activate the checkbox to accept the End User License Agreement.

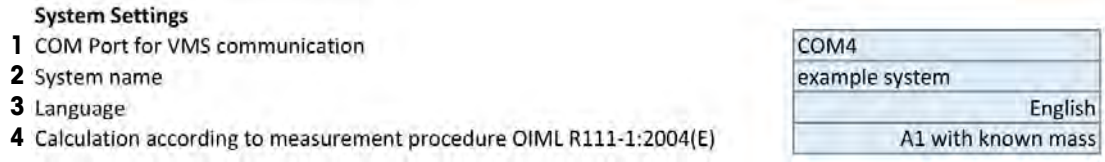
6.3 Configuration

– Open the **Configuration** tab.

Note On the **Configuration** sheet, enter values only in cells which are highlighted blue.



6.3.1 System settings



	Parameter	Description	Value
1	COM Port for VMS communication	Select serial communication port of connected balance	COM1–16
2	System name	Define system name – for example, VMS2 or VMS20	
3	Language	Select desired language	English Chinese
4	Calculation according to measurement procedure OIML R111-1:2004(E)	Select method	A1 A3 A1 with known mass

6.3.2 Test weight parameters

	Parameter	Description	Value
1	Customer address	Enter customer address	
2	Calibration number	Enter a calibration number	
3	Remarks	Enter any information	
4	User name	Enter name of person executing the density calibration	
5	Test weight ID	Enter identification of the calibrated test weight	
6	Test weight nominal	Enter nominal weight of test weight (in grams)	g
7	Thermal volume expansion factor	For stainless steel weights the value 48 ppm/K is required	ppm/K
8	Thermal vol. exp. factor uncertainty (k=1)	Thermal volume expansion factor uncertainty	ppm/K

6.3.3 Parameters for OIML method A1 with known mass

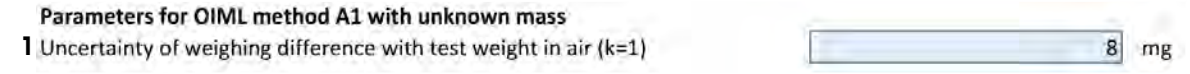
Note Only values for the selected method have to be filled in. Leave input fields for unused methods blank.

	Parameter	Description	Value
1	Test weight conv mass error	Test weight conventional mass error. When using method "A1 with known mass", the mass has to be predetermined on a high-accuracy mass comparator. Enter the value from the measurement report or a calibration certificate.	mg

	Parameter	Description	Value
2	Test weight conv mass	Test weight conventional mass. No data input required. The software calculates this value automatically.	kg
3	Test weight mass uncertainty (k=2)	Enter uncertainty of conventional mass.	mg

6.3.4 Parameters for OIML method A1 with unknown mass

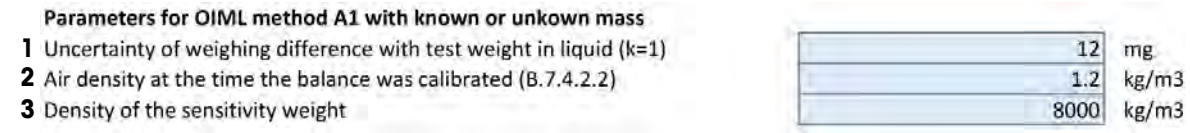
Note Only values for the selected method have to be filled in. Leave input fields for unused methods blank.



	Parameter	Description	Value
1	Uncertainty of weighing difference with test weight in air (k=1)	Enter the uncertainty of the weighing difference, which is carried out in air. Hereby, the reference weight is compared against the test weight. To obtain the uncertainty, a good estimate is the standard deviation of repetitive weighings. **Note** In general, the repeatability is the largest contributor of this uncertainty when conventional mass value is determined. Linearity and sensitivity can be neglected, as a comparative weighing with two weights with similar masses is carried out. Eccentricity can be neglected, as VMS2 / VMS20 are equipped with a LevelMatic weighing pan. **Note** In OIML R111-1:2004: $u(\Delta m_{wa})$.	mg

6.3.5 Parameters for OIML method A1 with known or unknown mass

Note Only values for the selected method have to be filled in. Leave input fields for unused methods blank.



	Parameter	Description	Value
1	Uncertainty of weighing difference with test weight in liquid (k=1)	Enter the uncertainty of the weighing difference, which is carried out with the reference weight in air vs. test weight in liquid. To obtain the uncertainty, a calibration of the balance is recommended, where the parameters repeatability, linearity and sensitivity are considered. **Note** In general, repeatability is the largest contributor to this uncertainty. However, linearity and sensitivity have to be considered, as the weight in air compared to the weight in liquid may not have similar weight. Eccentricity can be neglected, as VMS2 / VMS20 are equipped with a LevelMatic weighing pan.	mg
2	Air density at the time the balance was calibrated (B.7.4.2.2)	Recommendation: Adjust the balance prior to the density calibration of the test weight. Observe temperature, humidity, and pressure when adjusting the balance. Calculate the air density from these three values.	kg/m^3
3	Density of the sensitivity weight	Enter the density of the weight which has been used for adjusting / calibrating the balance. The density of the internal weight of the balance is 8,000kg/m^3.	kg/m^3

6.3.6 Parameters for OIML method A3

Note Only values for the selected method have to be filled in. Leave input fields for unused methods blank.

	Parameter	Description	Value
1	Indication in air uncertainty (k=1)	This parameter is the uncertainty of the weighing in air against the zero point, which corresponds to a usual weighing uncertainty of the balance. However, eccentricity can be neglected as VMS2 / VMS20 are equipped with a LevelMatic weighing pan, and the fact that the empty hanging weighing pan is attached and is submersed into the water has to be accounted for. **Note** In OIML R111-1:2004: $u(I_{to})$	mg
2	Indication in liquid uncertainty (k=1)	This parameter is the uncertainty of the weighing in liquid against the zero point. In comparison to a usual weighing uncertainty of the balance, this component must be enlarged in order to account for the effects of weighing in the liquid. However, eccentricity can be neglected as VMS2 / VMS20 are equipped with a LevelMatic weighing pan. **Note** In OIML R111-1:2004: $u(I_{ti})$	mg

6.3.7 Environment

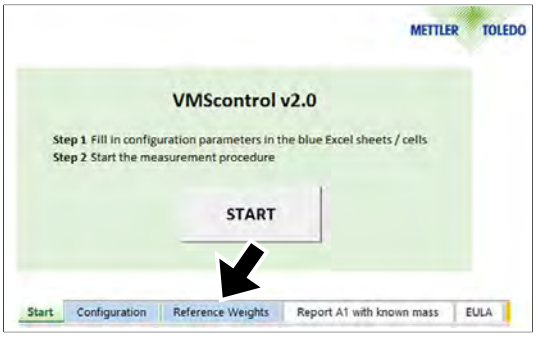
	Parameter	Description	Value
1	Water temperature	Use the temperature sensor to measure the water temperature at the approximate center of the weight. See Adjusting the water temperature sensor.	°C
2	Air temperature	Enter the environmental parameter.	°C
3	Air pressure	Enter the environmental parameter.	hPa
4	Air relative humidity	Enter the environmental parameter.	%RH

6.3.8 Uncertainties

	Parameter	Description	Value
1	Water temperature uncertainty (k=1)	Enter the uncertainty (k=1) of the water temperature measurement.	K
2	Air pressure uncertainty (k=1)	Enter the uncertainty (k=1) of the air pressure measurement.	hPa
3	Air temperature uncertainty (k=1)	Enter the uncertainty (k=1) of the air temperature measurement.	K
4	Air relative humidity uncertainty (k=1)	Enter the uncertainty (k=1) of the humidity measurement.	%RH

6.4 Reference weights

– Open the **Reference Weights** tab.



Parameters and values

Reference Weights

1	2	3	4	5	6	7	8	9	10	11	12
Weight Set ID	Weight ID	Accuracy Class	Nominal, in g	Conventional mass error, in mg	Conventional mass, in kg	Mass uncertainty Umc (k=2), in mg	Density, in kg/m3	Density uncertainty U (k=2), in kg/m3	Comment	Use for comparing reference against test weight in air ("x"=selected)	Use for comparing reference against test weight in liquid ("x"=selected)
Ref 1	20 kg 1	E1	20000	0.1022	20.0000001	2.1	8050	100		x	-
Ref 1	10 kg 1	E1	10000	-0.4781	9.999999522	1.5	8000	50		-	x
Ref 1	5 kg 1	E1	5000	0.2	5.0000002	1.2	8000	30		-	x
Ref 1	2 kg 1	E1	2000	-0.119	1.999999881	0.1	8000	30		-	x
Ref 1	1kg 1	E1	1000	1.5	1.0000015	0.15	7960	30		-	-
N/A										-	-
	Reference for measurement in air				20.0000001	2.1	8050	100			
	Reference for measurement in liquid				16.9999996	2.8	8000	41.76470559			

	Parameter	Description	Value
1	Weight Set ID	Enter the identification of the weight set.	
2	Weight ID	Enter the identification of the single weight.	
3	Accuracy Class	Enter the weight class of the weight. **Note** This value is not used for the calculations.	
4	Nominal, in g	Enter the nominal weight	g
5	Conventional mass error	Enter the conventional mass value of the reference weight. This value can be found on the calibration certificate of the weight.	mg
6	Conventional mass in kg	No data input required. The software calculates this value automatically (as the sum of conventional mass and conventional mass error).	kg
7	Mass uncertainty Umc (k=2), in mg	Enter the uncertainty of the conventional mass value. This value can be found on the calibration certificate of the weight.	mg
8	Density, in kg/m^3	Enter the density of the reference weight.	kg/m^3
9	Density uncertainty U (k=2), in kg/m^3	Enter the density uncertainty of the reference weight.	kg/m^3
10	Comment	Enter any comment can be entered – for example, the date when the values have been entered.	
11	Use for comparing reference against test weight in air ("x"=selected)	Select 'x' from the drop-down list if a reference weight is used for the calibration of the test weight in air. **Note** This parameter applies only to method A1 with unknown mass.	
12	Use for comparing reference against test weight in liquid ("x"=selected)	Select 'x' from the drop-down list if a reference weight is used for the comparison of the test weight in liquid. Only select the weights which are used for the actual density measurement. **Note** This parameter applies only to methods A1 and A1 with known mass.	

6.5 Starting the measurement process

– Press **Start** to start the density calibration process.

⇨ The software guides through the density calibration process.

⇨ The weighing values will be captured automatically, as the balance is connected to the computer.

NOTICE

Incorrect result due to unstable weighing value

Stabilization can last up to one minute for measurement in liquid. Only press **OK** when the weighing value is stable.

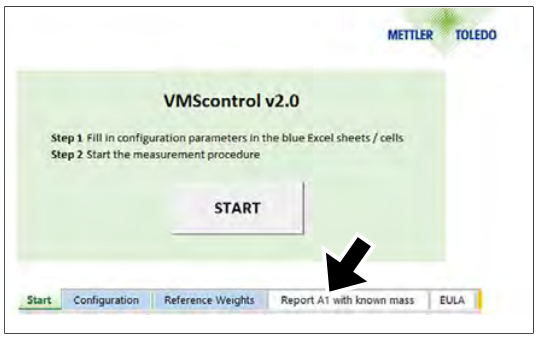
6.6 Measurement report

- As soon as the measurement has been completed, the software shows the corresponding report for A1, A1 with known mass, or A3 as a tab.

– Open the corresponding tab to display the measurement report.

⇨ The measurement report is displayed.

⇨ The most relevant data, such as test weight density, density uncertainty, volume, volume uncertainty are formatted in **bold letters**.



Density measurement report VMS

Customer address	Daytona
Calibration number	234
Date	February 12, 2020
Remarks	Test
Calculation according to measurement procedure OIML R111-1:2004(E)	A3
System name	example system
Balance model	XP26003L
VMS Control Software Version	VMS Control v1.9
Signature	Wartex

Test Weight Parameters

Test weight ID		99999
Test weight nominal		20000 g
Test weight conv mass error		1.66 mg
Test weight mass uncertainty (k=2)	$U(m_t)$	5.2 mg
Thermal volume expansion factor	γ	48 ppm/K
Thermal vol. exp. factor uncertainty (k=1)	$u(\gamma)$	5 ppm/K

Results

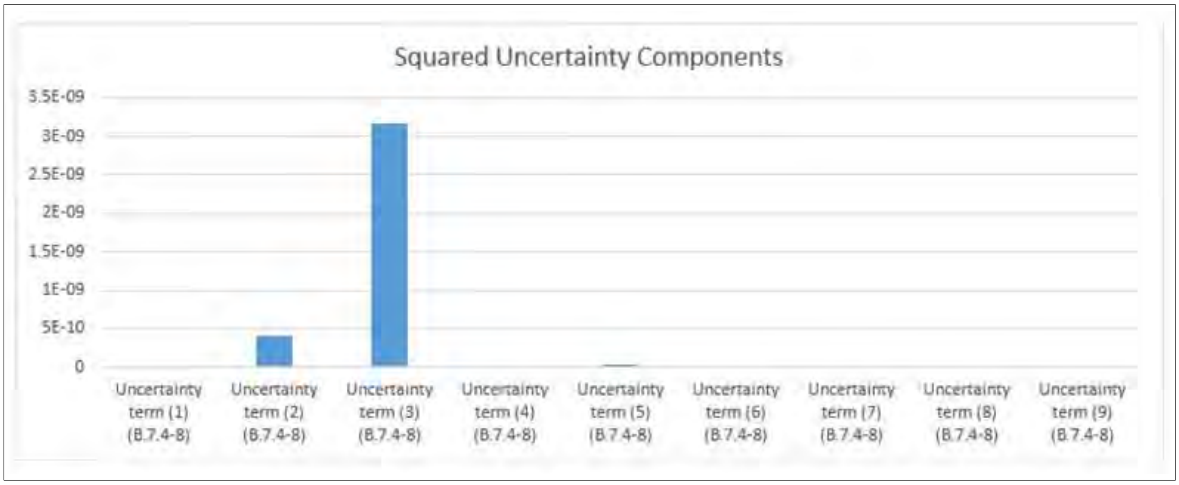
Test weight density at 20 °C	$\rho_{t,20°C}$	**8014.416239 kg/m3**
Test weight volume at 20°C	$V_{t,20°C}$	**2495.509517 cm3**
Expanded uncertainty test weight density (k=2) at 20 °C	$U(\rho_{t,20°C})$	**0.999227442 kg/m3**
Expanded uncertainty test weight volume (k=2) at 20 °C	$U(V_{t,20°C})$	**0.311137021 cm3**

Example measurement report

The symbols and definitions of OIML are used. For details, see OIML R111-1:2004, page 8.

Squared uncertainty components

The graph in the report indicates the contribution of the terms of the relative uncertainty calculation.



Graphical representation of uncertainy terms

For details on the formula, see OIML R111-1:2004, B.7.4.2.2.

7 Calculation Formulas

The test artifact density is calculated according to OIML R111-1:2004, density determination methods A1 and A3.

OIML does not describe the method A1 with known mass. However, in most cases, the conventional mass value is known, as the calibration is carried out on a high-accuracy mass comparator prior to the density measurement.

For details on method A1 formulas, see OIML R111-1:2004, B.7.4.2.2.

For details on method A3 formulas, see OIML R111-1:2004, B.7.4.4.2.

7.1 Determining conventional mass

To determine the conventional mass value according to OIML, use METTLER TOLEDO mass calibration software **MC Link** (order no. 30208278).

For details on MC Link, see the METTLER TOLEDO website.

▶ www.mt.com/comparators

8 Maintenance

Please contact your METTLER TOLEDO representative for details about the available service options. Regular servicing by an authorized service technician ensures constant accuracy for years to come and prolongs the service life of your instrument.

For further information on maintenance, cleaning and software updates, consult the Reference Manual (RM) of the balance.

9 Troubleshooting

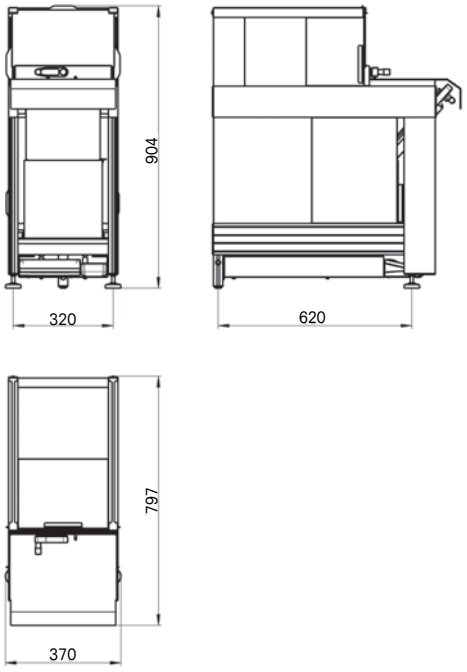
Error messages

Error message	Possible cause	Diagnostic	Remedy
Could not open COM Port	Communication between VMS Control software and balance failed.	–	Verify on balance terminal that port settings are correct. See Reference Manual of balance model on how to configure port settings.
			If using a USB cable (not the RS232 adapter), make sure that an XPR driver is installed. Drivers can be downloaded from the METTLER TOLEDO website. ▶ www.mt.com/labweighing-software-download

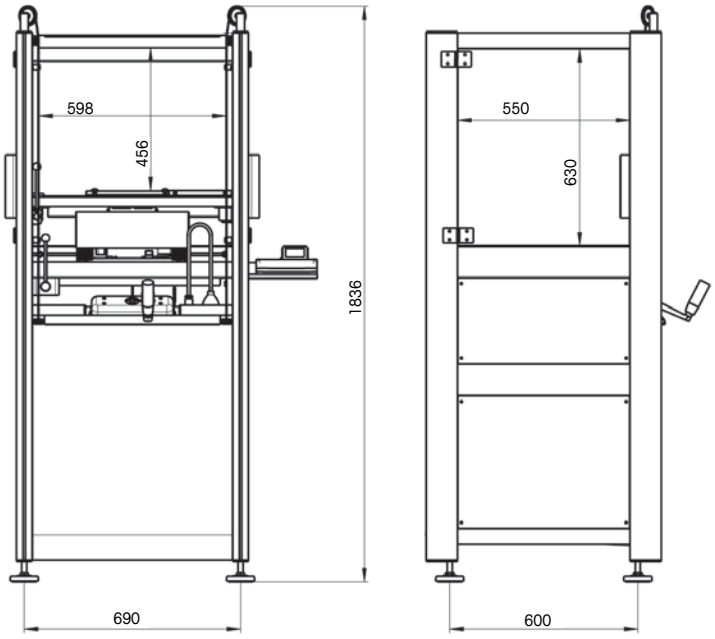
Please contact a METTLER TOLEDO service representative if you need support updating the software.

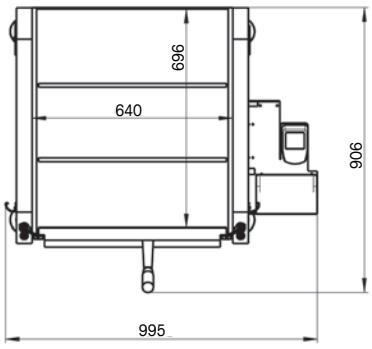
10 Technical Data

10.1 Dimensions



VMS2 dimensions in mm





VMS20 dimensions in mm

11 Disposal

In conformance with the European Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE) this device may not be disposed of in domestic waste. This also applies to countries outside the EU, per their specific requirements.

Please dispose of this product in accordance with local regulations at the collecting point specified for electrical and electronic equipment. If you have any questions, please contact the responsible authority or the distributor from which you purchased this device. Should this device be passed on to other parties, the content of this regulation must also be related.

GWP®

Good Weighing Practice™

GWP® is the global weighing standard, ensuring consistent accuracy of weighing processes, applicable to all equipment from any manufacturer It helps to:

- Choose the appropriate balance or scale
- Calibrate and operate your weighing equipment with security
- Comply with quality and compliance standards in laboratory and manufacturing

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