GOLDANALYTIX

BAR TESTING KIT

GAX1000

Instruction manual

October 2020, Rev. 2, 05/21

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1. About Goldanalytix / Contact

Goldanalytix, founded in the year 2010, is the leading supplier of precious metal testing methods in Germany. Our team works for you to develop safe and reliable testing methods for all kinds of precious metals. The product development and production is carried out completely in Regensburg, Germany. The synergy of analytical know-how and product development allows us to always be up-to-date. Thanks to our steady improvements, we can guarantee highest quality standards.

Do you need data about our products, support on how to use the device or technical support? No problem. You can reach us on many ways:

In the Internet: www.gold-analytix.com

Via e-mail: gold-analytix@marawe.eu

Via telephone: +49 941 29020439

We are looking forward to hearing from you!

2. Introduction

Congratulations on your purchase of the Goldanalytix Bar Testing Kit GAX1000, the tried and tested solution for authenticity measurements of bars.

Please read this instruction manual thoroughly before first using the bar testing kit. Please be aware that no testing method is able to identify each kind of falsifications. You can find the most up-to-date version of these instructions at gold-analytix.com/bar-testing-kit-gax1000 by clicking on “information”, which helps you to always be up-to-date after the purchase.

The combination of ultrasonic and density testing allows you to identify the most common falsifications of gold and silver bars by high chance. Mostly, the density scale detects all kinds of materials and alloys featuring a different density. However, there are also metals and alloys whose densities resemble those of gold or silver significantly. Gold has a density of 19.30 g/cm³, which is very close to tungsten’s density with its 19.32 g/cm³. Silver has a density of 10.49 g/cm³. An alloy of the two metals tin and lead in correct proportions has one of about 10.50 g/cm³. Please keep in mind that these miniscule differences cannot be detected by a density scale, which is why one has to turn to an additional test for e.g. a fake gold bar with tungsten.

In that case the ultrasound testing is utilized. Because there is no material available which exhibits identical ultrasound velocity *and* density according to our best knowledge.

3. Scope of supply

Your Goldanalytix Bar Testing Kit GAX1000 set contains the following components:

Precision scales

Density measurement assembly, consisting of:

- **Water container (Plexiglas)**
- **Base object (Plexiglas)**
- **Measurement tray holder (Plexiglas)**
- **Measurement tray (stainless steel)**
- **Lid (Plexiglas)**

Bag of small components, consisting of:

- **4 fixing rods**
- **4 oval-head screws**
- **1 aluminum cone**
- **1 fixing bolt**

Pair of tweezers

Ultrasonic device

Ultrasonic measurement head

Contact gel (100 mL)

Power supply

Instruction manual

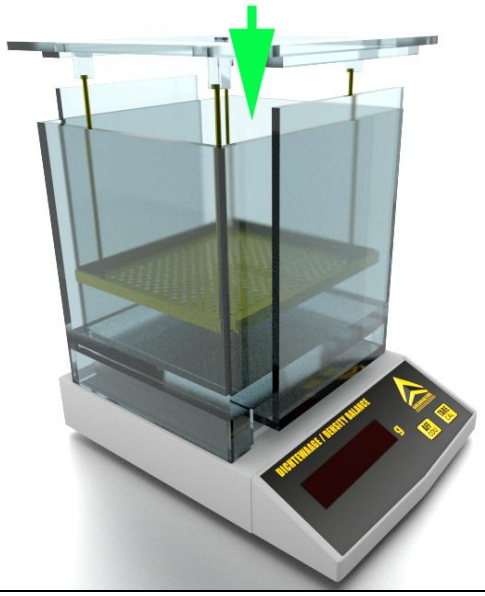
Digital caliper

Aluminum suitcase

Should this device or its components be damaged or should some parts be missing, please contact us immediately (contact information, see p. 2).

4. Assembly of the DensityScreenScale

Step	Description	
1	Put the scales on a firm and stable surface.	
2	Put the aluminum cone with light pressure on the scales' cone with the screw thread.	
3	Fix the base object made of Plexiglas with the included bolt (in the bag) on the aluminium cone as shown in the picture. Please guarantee that the vertical surfaces are arranged in the way shown in the picture. Pull out the bolt cautiously with a screwdriver. Please be very cautious here and use as little pressure as possible to prevent the scales from being damaged.	

4	Put the empty water container on the scales as shown in the picture. Please guarantee that the container is positioned to fit in the ducts on the scales.	
5	After that, put the already assembled measurement tray holder on the base object. Please guarantee that the ducts in the tray holder are positioned precisely into the lateral walls to guarantee a firm grip of the tray holder. The scales are now ready for use!	

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5. Preparing the measurement

We recommend you to respect these instructions in order to avoid inaccuracies while establishing the density.

Operating time of the scales

Turn on the scales 5 to 10 minutes before the measurement to guarantee highest precision. Like this, the scales give you the best results because a temperature adjustment of the fine mechanics is needed. Also guarantee a firm place without risk of shaking for the scales. The results of every precision scales are disturbed significantly by shaking, air drafts and fluctuations in temperature.

Ambient air temperature

The density scales have been proven reliable in most surroundings, where a room temperature of 20 to 25 °C is ideal. While the device has been shown to work at temperatures above 35 °C and below 15 °C, one normally avoids such temperatures. The important thing is that the temperature during the operating time stays constant.

Temperature of the bath

It is ideal to use water with a temperature of about 25 °C for the water bath. Do not fill in water that is either very cold or very warm, as this influences the precision of the density measurement. In case of water at room temperature, you can simply use the simplified formula for calculating the density.

Sample

The sample has to be dry and clean and should not have a layer soluble in water. Layers of grease and oil have to be removed before the test.

Insertion depth

Please guarantee that the liquid level between the corresponding establishments of the air value (L) and the water value (W) does not change significantly. The rise of the water level caused by the sample is only important for objects with a big volume and has to be kept in mind accordingly.

Bubbles

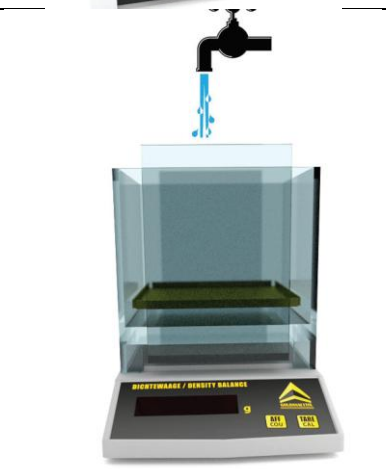
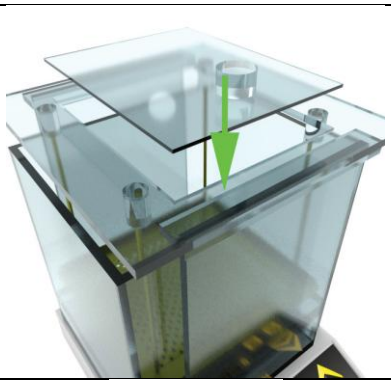
In case of liquids that cover feebly (e.g. normal water) it may happen that air bubbles settle down on the support or the sample. A bubble of a diameter of 2 mm, there can already be an inaccuracy of 4 mg. In order to avoid air bubbles, please follow the following steps:

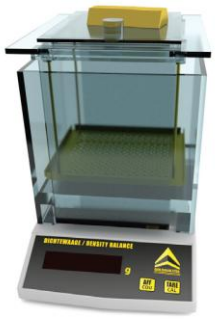
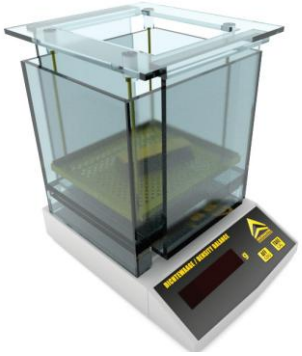
- Degrease the sample and the measurement tray
- To remove the air bubbles, shake the whole assembly with caution after the first immersion
- Remove more stubborn bubbles with a small brush
- Clean the measurement tray regularly

Porosity of solid matters

When dipping solid matters into a liquid, not the entire air is normally replaced in the (micro-) pores. This leads to inaccuracies and therefore to differing densities in case of porous solid matters.

6. Carrying out the measurement

Step	Description	
1	Before the measurement: Turn on the scales and take out the measurement tray (if in the device).	
2	Fill the container with pure, clean water. The tank's complete filling volume is 1.5 litres, so please fill in about 1.2 to 1.3 litres. In case of voluminous objects with very high displacement, please fill in bit less.	
3	Dip the tray holder slowly into the water and put it on the tray plate. In case of bigger air bubbles, please remove them carefully with a brush. Please absolutely guarantee that no water drops stick to a part pushing on the measurement cell! All these components have to stay dry.	
4	Put on the lid.	
5	Tare the scales.	

6	Lay the sample, e.g. a gold bar, on the lid to establish the air value (**L**). Write this value down. In our example, it is 1000.13 g.	
7	Take the sample and the lid off the scales.	
8	Tare the scales.	
9	Lay the object on the tray using the included tweezers and establish the water value (**W**). It is important that the whole object is under water. Please wait until the values are stabilized. In our example, this was 948.31 g. This means that the *difference* between **L** and **W** is 51.82 g. The air value **L** divided by *this value* equals the density, for example, that means 19.32 g/cm³.	
10	Calculate the density value according to the simple, opposite formula with a calculator.	p=L / (L-W) Unser Beispiel: p= 1000,13 / (1000,13-948,31) = 19,32 --> exakt die Dichte von Reingold
11	For every other measurement, please restart at step 4.	

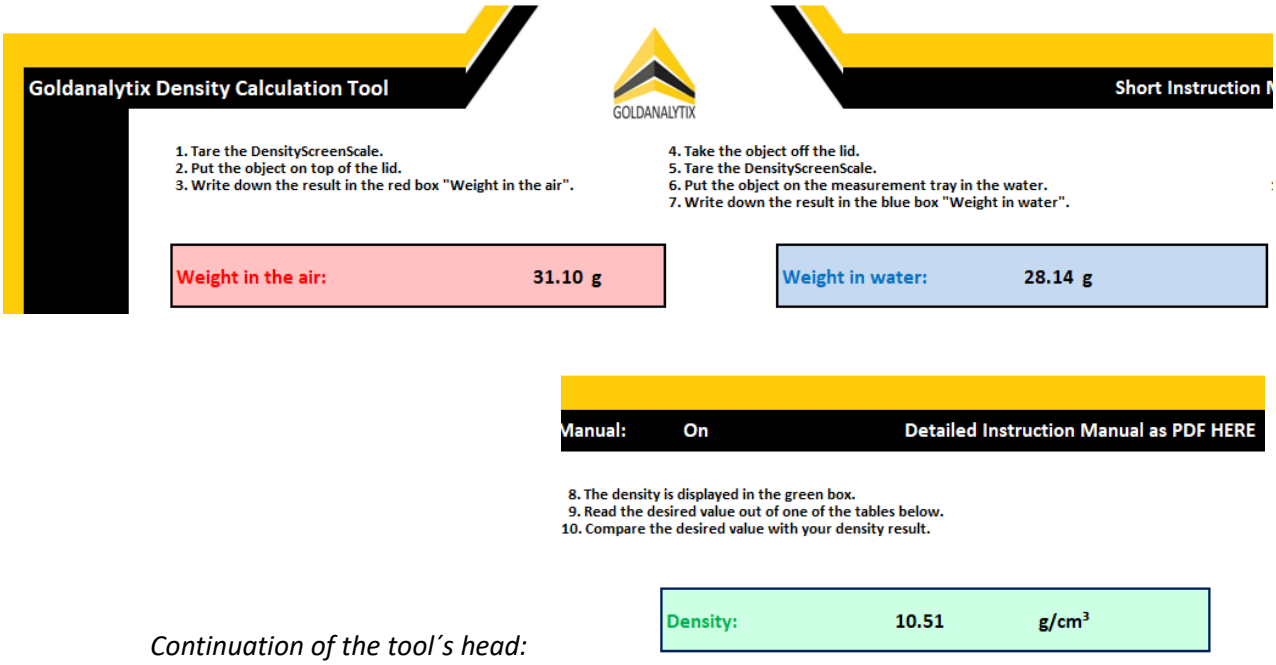
Alternatively to your own calculation (step 10), you can use the calculation tool “Goldanalytix density calculation” saved on the included flash drive. This tool is designed especially for the DensityScreenScale and allows you a quick calculation of the density value including short instructions for the density measurement.

All of the density tables are also included in the software. Additionally, you can easily save the values with one click in document.

7. Goldanalytix Density Calculation Tool

The provided flash drive includes a calculation tool (Microsoft Excel). With the help of the Goldanalytix Density Calculation Tool you can easily determine the density of your testing objects. The head of the calculation tool contains a short instruction manual which gives you the most important steps for determining the density of solid materials.

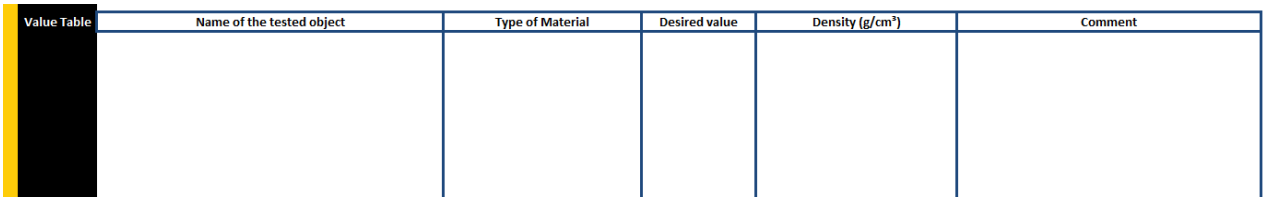
The second part provides the calculation tool. Please fill in the entry fields "**Weight in the air**" (exemplarily 31.10 g) and "**Weight in water**" (exemplarily 28.14 g) according to steps 3 and 7 of the short instruction manual. The calculated density will be given in the result field "**Density**" (exemplarily 10.51 g/cm^3). In case you need some more information you will find this instruction manual (latest version) as pdf by clicking on the hyperlink "**Detailed Instruction Manual**" (internet connection required).



Continuation of the tool´s head:

Below the head of the calculation tool you will find extensive tables giving density values of several alloys (gold, silver, platinum, and palladium) as well as some pure metals. You can assign the calculated density value of your testing object to the values of the tables and compare it to the presumed alloy of your testing object.

Finally, the bottom of the calculation tool contains a table (see below) in which you can enter all of your tested objects, the determined density, and some other information.



8. Interpretation and evaluation of the results

The density is defined as the quotient of the mass and the volume of a material.

$$\rho = \frac{m}{V}$$

The density, according to the international system of units, has the SI-unit kg/m³ or g/cm³ (SI: International System of Units, French: *Système international d'unités*) and the symbol ρ (Rho).

Theory of the density establishment of solid matters

By using a liquid of know density ρ_o (mostly water), one can establish the density of the sold matter dipped into it. The solid matter is first weighed at air (**L**) and then in the water (**W**). The density can be established in the following (simplified) formula.

$$\boldsymbol{\rho = \frac{L}{L - W}}$$

This formula allows you to calculate the density by yourself.

Example: For a gold coin (1 ounce) made of 999.9 pure gold, an air value **L** of 31.13 g has been established. Afterwards, the water value **W** has been established at 29.52 g. Now, you distract 29.52 g (i.e. the water value **W**) from the 31.13 g (air value **L**). This iquals 1.61. This value is divided by the air value **L**, i.e. 31.13 divided by 1.61, which gives you the density value of 19.32 g/cm³. This corresponds to the density of pure gold.

Compare the received values with the values you can find in the comparison tables on the next two pages.

Please keep in mind that the value given out by the DensityScreenScale can show deviations from the real density value depending on the mass of the sample. This is fundamentally determined by the principle the measurement is based on. The smaller and denser the sample, the bigger the deviations will be and more water will be deplaced by the object. One ounce of silver is therefore easier to examine with a smaller deviation range than e.g. one ounce of pure gold (see picture 1).

This means for example that a differentiation of e.g. sterling silver (10.40 g/cm³) and pure silver (10.49 g/cm³) is not possible until a certain weight because the theoretical deviations will be small enough. Please keep these limitations of the density measuring principle in mind when evaluating the results.

Please still keep in mind that the densities – especially of 750 to 900 gold alloys – can be achieved by different alloys of metals like tantalum, tungsten, molybdenum and lead and these gold alloys are often imitated by forgers.

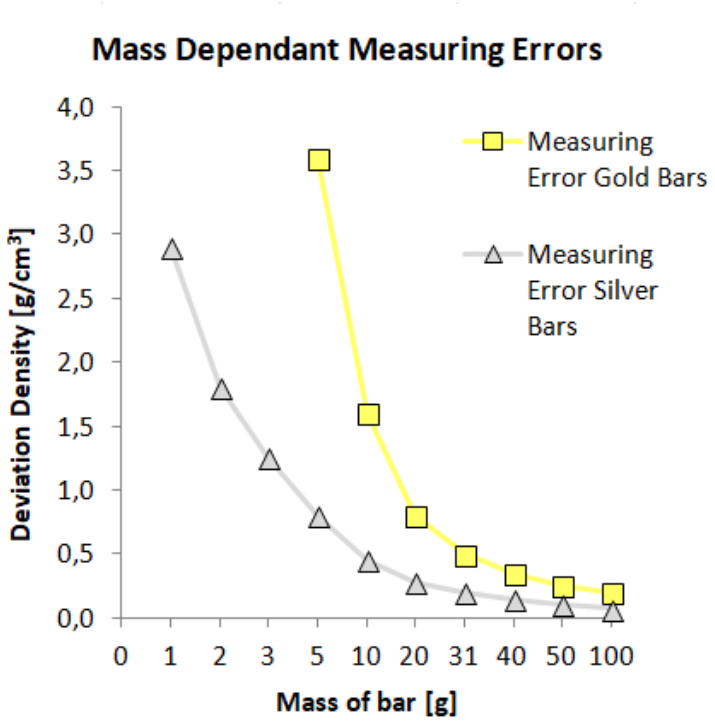


Figure 1. Density scales inaccuracies of gold- and silver bars depending on the mass.

9. Density tables of metals and alloys

Alloy	Density [g/cm^3]	Metal	Density [g/cm^3]
Yellow gold alloys (standard alloys)		Iridium	**22.6**
		Osmium	**22.6**
999	**19.3**	Platinum	**21.5**
986	**19.0**	Gold	**19.3**
916	**17.8**	Tungsten	**19.3**
850	**16.8**	Uranium	**19.1**
800	**16.2**	Mercury	**14.3**
750	**15.4**	Palladium	**12.0**
416	**11.5**	Lead	**11.3**
375	**11.2**	Silver	**10.5**
333	**10.9**	Molybdenum	**10.2**
Silver alloys (standard alloys)		Bismuth	**9.8**
		Cobalt	**8.9**
999	**10.5**	Copper	**8.9**
925	**10.4**	Nickel	**8.9**
900	**10.3**	Cadmium	**8.7**
835	**10.2**	Iron	**7.9**
800	**10.1**	Manganese	**7.5**
720	**10.0**	Indium	**7.3**
Bullion coins		Chromium	**7.2**
Maple Leaf	**19.3**	Zinc	**7.1**
Philharmonic	**19.3**	Antimony	**6.7**
Yuan Panda	**19.3**	Zirconium	**6.5**
American Eagle	**17.5**	Vanadium	**6.1**
Krugerrand	**17.5**	Tin	**5.8**
		Titanium	**4.5**
		Aluminum	**2.7**
		Beryllium	**1.8**
		Magnesium	**1.7**

Table 1 – Overview of the density values [g/cm^3] of pure metals and alloys.

Gold 333 alloys					
Alloy					Density [g/cm^3]
Ag in ‰	Cu in ‰	Zn in ‰	Sn in ‰	Ni in ‰	
534	133	0	0	0	**11.0**
445	222	0	0	0	**10.9**
333	334	0	0	0	**10.9**
200	467	0	0	0	**10.8**
95	572	0	0	0	**10.7**
114	431	114	0	8	**10.8**
255	350	47	15	0	**11.2**
Gold 585 alloys					
Alloy					Density [g/cm^3]
Ag in ‰	Cu in ‰	Zn in ‰	Cd in ‰	Ni in ‰	
382,5	32,5	0	0	0	**13.7**
310	35	0	70	0	**13.7**
280	135	0	0	0	**16.6**
188	227	0	0	0	**15.5**
110	184	71	0	50	**13.5**
90	325	0	0	0	**13.4**
0	415	0	0	0	**13.2**
Gold 750 alloys					
Alloy					Density [g/cm^3]
Ag in ‰	Cu in ‰	Cd in ‰			
250	0	0			**15.9**
214	36	0			**15.8**
167	83	0			**15.6**
125	125	0			**15.4**
83	167	0			**15.2**
0	250	0			**14.8**
167	0	83			**15.5**

Table 2 – Overview of density values [g/cm^3] of (non-standard-) gold alloys.

10. Features of the high precision scales

Turning on/off (I/O):

On the scales' backside, you can find the main switch for turning the device on or off. The auto-test begins with the display test. When working properly, "8.8.8.8.8.8" will light up first before the nominal weight ("2000.00 g").

Warnings

Overload (------)
In case of overload, the display will show "------" (overload). Reduce the load immediately to avoid damages.

Error 1 and Error 2
Error 1 hints to a swinging load, Error 2 hints to an unstable load without swinging. Please guarantee that the load sits stable on the scales.

Reset (TARE / CAL)
With TARE, you can set the scales back to 0. This step is essential for e.g. dipping the sample into water and for cases in which the lid is put on the object. Additionally, you can reset the empty weight of a recipient put on top with the CAL-function.

Calibration (CAL)
By pressing the TARE/CAL-button, you will get to the calibration menu. You will first see --CAL--, as soon as a value lights up, a weight has to be put on the scales. After a short amount of time, the display will be stabilized and you can take off the calibration weights, which concludes the calibration. Please calibrate the scales always after assembling the density scales. You can also use the scales with the included scale tray for normal weight examination.

Counting mode (ZAE)
In the counting mode, you can find out how often your weight to be measured can be divided in relation to a sample mass. Please put the sample mass on the scales. Change to the corresponding counting mode with the [ZAE]-button in the weighing zone. You will see --COU-- and then the number 10 blinking. With the [TARE/CAL]-button, you can do the corresponding classification (from 10 to 500 in 10, 20, 50, 100, 250, 500 steps). Put the reference weight / number of pieces on the weighing zone. Confirm the configuration with the [ZAE]-button to be able to weigh in the counting mode.

IMPORTANT: Please keep in mind that due to the devices own weight, the maximum measurable load for density measurements is reduced accordingly. This is whay the density of a 2 kg bar cannot be established.

11. Specifications of the high precision scales

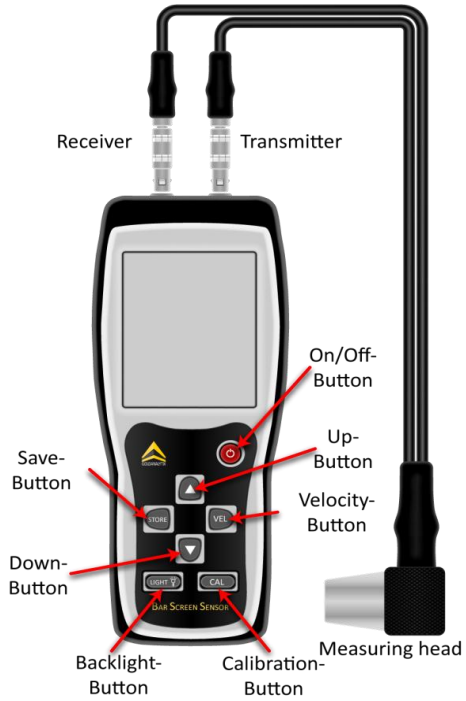
Specifications	Description
Net weight (without top part)	about 1.7 kg
Measurement range	2000 g/0.01 g
Additional functions	Auto-calibration Tare-function Counting Error display
Ambient conditions	+5 °C to + 35 °C when functioning +10 °C to + 50 °C when stored

12. Ultrasound scanning

Functions of the ultrasound analysis device

The ultrasound measuring device is controlled by a microprocessor and allows quick and precise measurement of the thickness and sound speed of materials. This device consists of a transmission circuit, a receive circuit, a high-frequency oscillator, a CPU, a screen and an operating surface. For the connections between sample and measuring head, the set contains 100 ml of coupling gel.

Specification	Description
Measuring frequency	5 MHz
Measuring head (Radius)	5 mm
Ultrasound speed range	1000-9999 m/s
Display	4-digit visualization
Minimum unit	0.1 mm
Measuring range	1.2-225.0 mm (steel)
Precision	+/- (1% D +0.1) mm, D describes the measured thickness, for thicknesses inferior to 20 mm, the precision is of +/- 5%
Working temperature	0 to 40 °C
Power supply	3x 1.5 V AA-batteries
Exterior dimensions	70 x 145.5 x 28 mm



In order to get the device ready to use please connect the measurement head and the ultrasound measuring device. Therefore it does not matter what plug is in which connector. Now the device is ready to use.

Attention: When you would like to remove the plugs please be careful and use the mechanism (pushing back the silver button). If you remove the plug with force this can damage the cable and the connector!

13. Scanning bars

In this chapter, we briefly explain the scanning of bars with the ultrasound measuring device. The bar has been divided by the middle and provided with drill holes then filled with lead. This method is used frequently to fake silver bars using lead-tin alloys.

Preparation of measurement: Calibrating the BarScreenSensor

The first step consists of the calibration of the measurement unit by using the included stainless steel measurement plate. The calibration should be done at least after every replacement of the measurement head and/or the batteries. Apply enough coupling gel on the measurement head and/or the stainless steel plate and press the measurement head on the test block on the device. Press **CAL** to reach the calibration mode. Wait until the display shows 4.0 mm, which indicates that the calibration has finished. After that, the device will turn back to the selected speed and the measurement can begin.

Measurement 1: Testing with already known sound speed

1.) Establishing the speed value

We have summarized some values of the most important (precious) metals for you in an overview that you can find in “6. Tips and tricks“. If you know the material you want to test, you can read the values in this overview.

After starting the device, please adapt the sound speed in the menu by pressing the VEL-button. You can now use the arrow keys up and down to switch between the saved sound speeds. If the sound speed is close to your desired value, push the VEL-button again. This allows fine adjustment of the sound speed. In this example, we have selected 4329 m/s for the brass bar.

The next step is **measuring the bar's thickness at the spot you want to test by using calipers**. Over its complete length, our bar has a thickness of 20 mm. In case of bars of unusual forms, you might have to measure the thickness of various spots.

Now you can carry out the actual ultrasound measurement. **Apply enough ultrasound gel on the spot you want to measure and lay the measurement head onto it.** Now the device will give you the object's thickness. In our example, the value matches exactly with the previously established thickness. This means that the selected sound speed of 4329 m/s for this object at this spot is correct.

After this, you should **„scan“** the bar. **To do so, you lay the measurement head on different spots to exclude inclusions of foreign material.** In case of a fake, the value of the thickness can differ significantly.

Measurement 2: Examination of <u>UNKNOWN</u> sound speeds

There are several situations where the sound speed is not exactly known. Some bars are made of alloys, others of uncommon materials. The sound speeds for those are not listed in our overviews and the online data sources sometimes differ significantly from each other. In this case, you have to choose the procedure that is explained as follows.

If you know that the material (for example on the exterior edge) is not pervaded by the normally centrally situated foreign metal bars, you can establish the speed of sound here. The measurement head is laid on spot in question with the ultrasound gel. In this case, it is irrelevant, which speed of sound is selected.

The device now gives you a value for the object‘s thickness.

Of course, this value is incorrect because the previously selected sound speed is wrong. This is why you now take off the measurement head from the bar and measure the objects thickness with calipers. Use the arrow keys to adjust the thickness for the BarScreenSensor in a way that it matches with the actual thickness.

As a last step, you press the VEL-button once again. The device then calculates the correct speed of sound. Having done this, you can scan the rest of the bar like you did in measurement 1.

Saving the data

The established value can now be saved on the device's memory. In order to do so, push STORE for 2 seconds to get to the save mode. Push the up / down buttons to select the save file. In order to look at the saved data, push STORE for 2 seconds when in normal mode and you will obtain the saved data. Push STORE to exit the save mode.

14. Tips & Tricks

Surface quality

Surfaces which are too rough will cause measurement errors. Please only use smooth and plane surfaces for the investigation. In case of bars, please do not adapt the measuring head on the hallmark but on the smooth area of the bar.

Non-parallel surface

The contact area should be parallel to the opposite side in order to avoid wrong measured values.

Temperature

Please be aware of a constant environmental temperature as well as the temperature of the testing object.

Calibration

Calibrate the device regularly with the integrated circular blank (4 mm thickness).

Thin testing objects

In case of the testing object features a thickness <20 mm measurement errors can occur.

Rough surfaces

On rough, embossed or otherwise uneven surfaces on the opposite side of the measured area inaccurate measured values can arise.

Wear of the measuring head

Since the measuring head is made from plastics wear marks can appear after long-term use of the device. Sometimes, polishing with sandpaper might help. In some cases it is inevitable that the measuring head has to be replaced.

Metal	Longitudinal Sound Velocity [m/s]
Aluminum	6250-6350
Antimony	3420
Beryllium	12900
Lead	2160
Cadmium	2770
Chromium	6200
Iron	5170
Gold	3240
Copper	4700
Magnesium	5800

Continuation of page 23	
Metal	**Longitudinal Sound Velocity [m/s]**
Manganese	4660
Molybdenum	6250
Nickel	4900
Palladium	3250
Platinum	3960
Mercury	1450
Silver	3607
Titanium	6100
Uranium	3380
Bismuth	2000
Tungsten	5180
Zinc	4170
Tin	3300

Table 1 – Ultrasound velocity in pure metals

15. Environmental- and waste disposal information

Used electronic devices are not allowed to be deposited in the household waste according to European regulations [1], but have to be disposed separately. The symbol on the dustbin indicates on the necessity of the separation from the household waste. Please help to protect the environment. Please asure that in case of not using the device anymore to give it to the corresponding garbage pick-up.

Please inform yourself about the local waste calendar and your city or municipal administration, respectively, about the opportunities of returning old equipment.

If you need more information please contact us at **gold-analytix@marawe.eu.** WEEE- number: DE70793505

[1] Regulation 2002/95/EG of the European Parliament and Council for electronic old equipment

16. More non-destructive testing devices by Goldanalytix

GoldScreenPen

The GoldScreenPen is one of the most versatile electronic precious metal testers. The world´s smallest probe tip enables the user to measure of coins, ingots and jewellery (even through films and blisters). The measured conductivity value, which is detected up to a depth of 0.5 mm, is displayed on the digital screen.

www.gold-analytix.com/goldscreenpen-electronic-gold-tester

GoldScreenCard

The GoldScreenCard tests coins and ingots by utilising the eddy current method. The penetration depth is up to 4 mm depending on the metal species. The database, included in the purchased software, features values of most common coins and can be extended by the user with own values – the perfect solution for numismatists.

www.gold-analytix.com/goldscreencard-gsc

GoldScreenBox

The GoldScreenBox measures the conductivity of coins and ingots by using the eddy current method with penetration depths up to 650 µm. You can characterize the authenticity of those precious metal objects even through capsules, films and blisters up to a thickness of 3 mm.

www.gold-analytix.com/goldscreenbox

MagneticScreenScale

You can easily identify many counterfeits with the Magnetic Balance, especially the ones made from tungsten. The strong magnetic field of the Magnetic Balance penetrates the ingot or coin without damaging it. Tungsten is detected up to 3 mm beneath the gold plated surface!

www.gold-analytix.com/magnetic-scale

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MARAWE GmbH & Co. KG

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93055 Regensburg

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