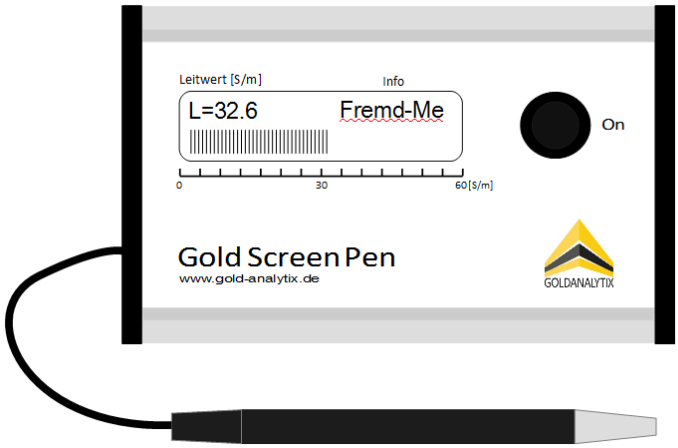
GOLDANALYTIX



GoldScreenPen

The universal conductance measurement device with the worldwide most compact probe tip

Instruction manual

July 2016, Rev 1, 06/16

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Introduction

The Goldanalytix GoldScreenPen is a non-destructive, easy and fast to use testing system for determination of electrical conductance of precious metal mouldings. Primarily developed to test the authenticity of precious metal coins and small ingots, it is with restrictions also suited for determination of jewellery and base metals. A quick and clear statement is possible within seconds, without having to interpret the results first. The measurement principle is based on a non-contact, inductive measurement method that allows the electric conductance of the sample not only on the surface, but also into the depth of 500 µm of it.
The measurement system is provided with the at the moment worldwide smallest probe spool that allows to make the determination of the sample's conductance possible even on small surface.

Scope of supply

The tester is delivered with the scope of supply listed in table 1. If the tester is damaged or if something's missing, please contact Goldanalytix immediately.

GoldScreenPen
Mini-USB cable
Manual (this instruction guide)
Small suitcase

Table 1 – Scope of supply

About Goldanalytix/ Contact

Goldanalytix was created in 2010 and is meanwhile the leading provider for precious metal testing methods in Germany. In our team, we are working for you on the development and sales of certain and reliable testing methods for every kind of precious metal. The GoldScreenPen is developed and fabricated completely in Regensburg, Germany. Thanks to the close synergy of analytic know-how and development of the device, we are always up to date and achieve highest standards in quality and function.

If you need our customer support for product data, service assistance, please visit our homepage on www. gold-analytix.de, or call:

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Description of the measurement principle

The GoldScreenPen uses the characteristic electric conductance of metals for its measurement principle. The metals that come to mind for falsifications because of their density like tungsten, lead or tantalum differ sometimes significantly in their conductance of pure gold or gold alloys, like e.g. the Krügerrand.

The patented, inductive testing method uses low-frequency electromagnetic alternating field whose penetration depth depends on the used measurement frequency and electrical conductance of the testing sample. For the GoldScreenPen, the measurement frequency is chosen in a way that it can completely pervade the metal layers of forgings usually applied chemically or by electroplating. A measurement independent from geometries is nonetheless possible. The penetration depth depends on the testing sample's conductance. Silver shows a value of about 150 µm, gold alloys one of up to 500 µm.

The whole sensory- and evaluation electronics are inside the compact casing of the battery operated and therefore mobile GoldScreenPen.

Setting up the measuring site and safety indications

Inside the GoldScreenPen, you will find highly sensitive sensory- and evaluation electronics for realizing the measurement. The latter needs you to observe the following in order to achieve a perfect measurement:

- **Please only use the included mini-USB adapter cable.**
  Low-quality products can cause measurement failures or destroy the GoldScreenPen.
- **Don't use the testing device near explosive gases, vapours or dust or in wet surroundings.**
- **Operate the device at room temperature and not in direct proximity to heat sources (e.g. the ventilation of your notebook, etc). The measured values which depend on temperature are linearized by balancing algorithms, but the measurement accuracy is at its highest at room temperature.**

Meaning of the operating and display elements of the GoldScreenPen

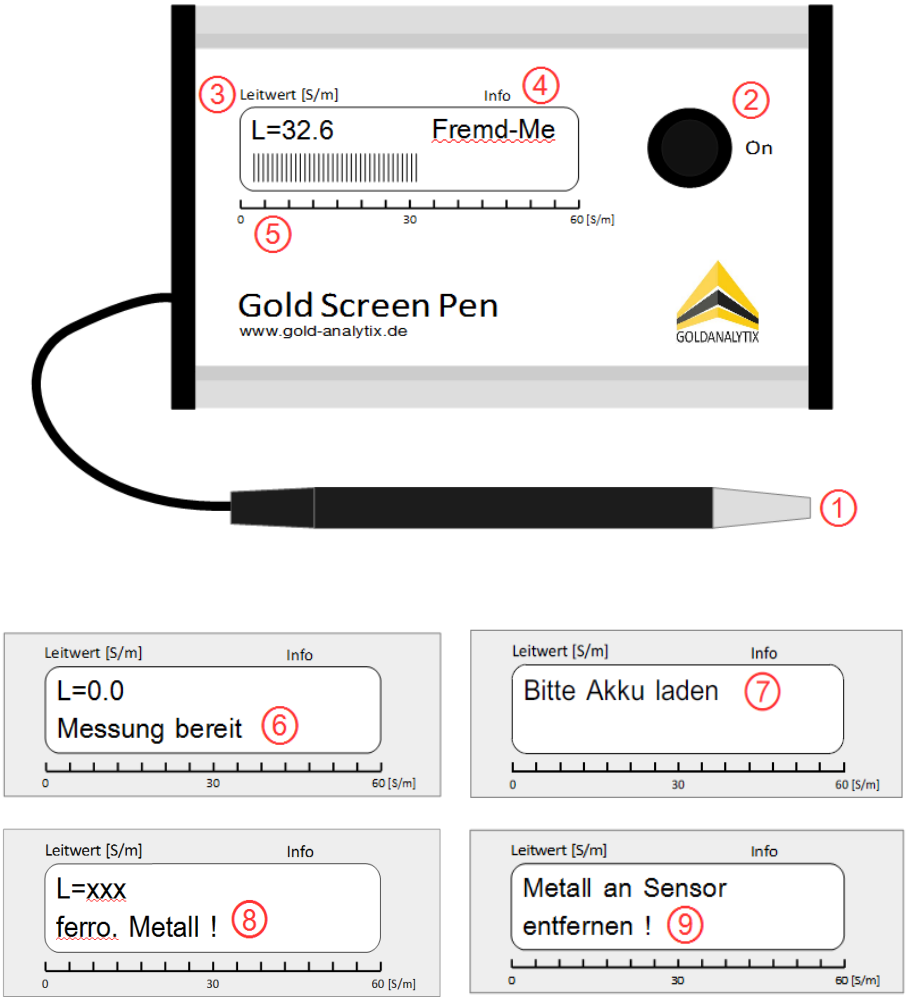

Image 1 – Overview of the operating elements and display modes

Nr.	Description
①	Miniature-sensory tip
②	ON-Button
③	Conductance display
④	Metal information
⑤	Conductance scale 0-62 [MS/m], represents the conductanct in a clear and graphical way. It does not represent a direct statement about the authenticity of the testing sample.
⑥	Display "Measurement ready to go"
⑦	Low battery indication
⑧	Indication of ferromagnetic metals / alloys
⑨	Indication of present metal when starting

Table 2 – Description of the operating elements and display modes

Performance of a measurement

Starting the device:

Push the button of the Goldscreenpen for more than 2 seconds.
Then, the device automatically performs an auto-calibration. During the latter, there must not be any metal object near the probe tip, as it influences the calibration accuracy (display ⑨). If there is a conductive object near the device, the display will give you the corresponding indication.
If the calibration has successfully been completed, the display will show "Messung bereit" (display⑥).
If the device runs for at least 2 minutes without being used, i.e. no new conductance value is detected, the device will automatically turn off to maximise the life of the accumulator.
The accumulator integrated into the GoldScreenPen charges automatically when connected to the computer or the USB-battery charger. When the battery is completely discharged, the device can't be started until about 2 minutes charging.

Boundary conditions for maximum measurement accuracy:

- The device is also able to determine the conductance through thin blisters and plastic films (maximum thickness of about 0.25 mm). But the measurement accuracy will hereby decrease, i.e. if possible, the Die probe tip should touch the testing sample directly.
- The contact surface of the sample should at least cover the diameter of the probe tip (mind. 3.5- 4mm^2) to guarantee an exact measurement
- The contact surface should be as plane as possible (it's recommended to measure on a spot without striking) and should not have strong bends
- Put the measurement tip vertically and not diagonally on the testing sample.
- The testing sample's thickness must be bigger than the penetration depth, i.e. at least 0.5 mm.

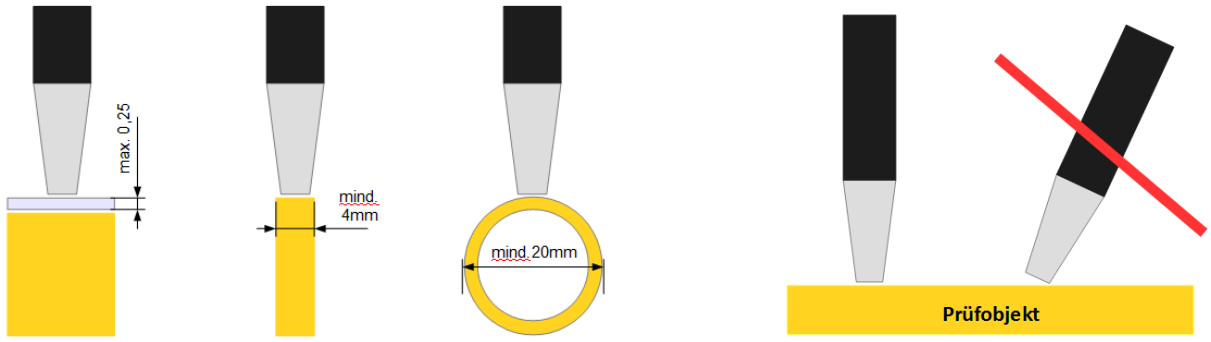

Image 2 – Advice about the probe tips position

Performing a measurement:

The device recognizes present metal bodies automatically from a certain distance to the testing sample and executes a measurement about twice a second. The electrical conductance as a measurement quantity is shown at the top of the left on the display (**see image 1**) with an accuracy of one decimal place.

The device auto-calibrates itself automatically in between times about every 2 seconds, if the tip isn't near a metal object. **For optimal measurements, wait some seconds between the measurement of two testing samples to give the device the possibility to calibrate.**

Evaluation:

Using the conductance table (see table 3) makes it possible to assign the value that appeared on the display with the indicated tolerance to the corresponding metal. Please keep in mind that there are conductance ranges in which foreign metals and valuable alloys overlap. Especially in these cases it is necessary to add at least one further testing method, like e.g. density determination.

Interpretation of the measurement result:

The GoldScreenPen as the most universal device available allows the identification of various objects made of (precious) metal. For instance, bullion ingots and coins can be tested for their authenticity as well as alloys of jewellery can be measured. Additionally, there are further application fields:

- Determination of dental gold (Presence of ferromagnetic additives)
- Identification of old metal in recycling centres
- General material testing in research and technology
- Purity testing of metals and alloys
- Metallurgy and electroplating
- Metal identification in old metal trade and jumble sales
- Differentiation of special steels
- and much more

That's why combined with the miniaturised probe tip, it offers a lot of application possibilities.

The conductance value established by the GoldScreenPen in MS/m are to be compared to the conductance table (**Tab.3**).
To give an example, we will talk about the differentiation between pure gold coins and –ingots and the at the moment commonly existing tungsten forgings: The GoldScreenPen shows a value of about 44 [MS/m] for pure gold, whereas for forgings, is will show 15-25[MS/m]. This makes the differentiation quickly possible.

Pure silver in general shows the highest electrical conductance of all metals (about 62 MS7m]. The metal with the second best conductance is copper with 58 MS/m. This shows, that silver-plated copper only differs minimally from pure silver.

The most dangerous forgings regarding silver are produced with metals that have the same or a similar density as silver, like lead/tin- [3-6MS/m] or molybdenum alloys [about 19 MS/m]. Compared to silver, these metals are very cheap and easily to process. The conductance however differs significantly, which makes the use of the GoldScreenPen very obvious.

The metals **platinum and palladium** in their pure form and a conductance of a bit over 9[MS/m] show a similar conductance like 917 gold alloys. Platinum alloys, as they are often found on jewellery, have a very low conductance of 1-3 [MS/m]. Not magnetisable stainless steels and platinum are therefore difficult to distinguish via their conductance.

When using in the **domain of jewellery**, please keep in mind that the values in the conductance table are based on common standard alloys. In the majority of cases, a quick classification is possible with that. Please keep in mind that the sometimes very different alloy compositions of different fabricants can differ from the indicated base values.

Please keep in mind for gold alloys that the values of **white/yellow/red gold** are generally different.

White gold means every jewellery alloy that is deprived of its golden colour by using chrome, platinum or palladium, in order to give it a silver colour.

The main components of yellow gold however consist only of silver, copper and gold.

The shading of red gold and rose gold is due to the presence of copper, which is the only metal to be alloyed with gold. The higher the copper content of the alloy, the more reddish is the shade. It can be seen that, due to the very different compositions of the jewellery, a clear assignment is limited. It has however to be kept in mind that most jewellery alloys can be classified in the range of <12MS/m.

The device shows “foreign metal” at the top of the right (siehe **Abb.1.** ④) in case of conductance values that are neither in the range of gold (alloys) nor of pure silver. We have gone without a display of corresponding gold alloys depending on the conductance because showing that could be misinterpreted due to the mentioned ambiguities.

The electric conductance of the testing sample does however not indicate the precious metal content. Especially in the case of gold alloys, but also of pure gold, there are various foreign metal alloys that show a very similar conductance value to the one of gold. The “nordic gold” alloy of the 10/20 euro cent coins show almost the same conductance value as the gold of Krügerrand (917 red gold). Cheap electric copper that, compared to pure copper and due to alloy additives, loses a significant amount of conductance can be in the same range as pure gold concerning the conductance value. It is essential for a successful test to perform an additional determination of the testing sample’s density through measuring geometry and weight or through the Archimedes’ principle, which is used, for example, by the Goldanalytix Density scales. The densities of these foreign metal (alloys) always differ significantly from the very high density of gold. Alternatively to the density scales, the gold content can be established with a destructive, with classic testing acids, or non-destructive ways with electronic testing acids (GoldAnalytix CaratScreenPen AGT3). The established carat values can be investigated consecutively with the corresponding conductivities (see table 3) with the GoldScreenPen. In case of jewellery, it normally can be said that yellow gold (maximal 750, 18 carats) has a conductivity inferior to 10 MS/m and over 3 MS/m. In case of white gold, the tendency is analogous and the conductivities are normally under 4 MS/m. Like that, the carat establishment (CaratScreenPen) on the surface is combined with a look under the surface (GoldScreenPen). The density scales can establish the gold content in a pervading way, but needs a homogeneous piece of jewellery. Tungsten-based forgings mostly show very similar densities compared to gold, but in this case, the conductance differs significantly from the precious metal.

One exception from that rule is the value range of the Austrian Ducats. The display will show “foreign metal”, as the conductance is in the range of the common tungsten-based forgings.

If the tested metal is ferromagnetic, i.e. iron, magnetisable steel, nickel or cobalt, the display will show “ferromagnetic metal” (siehe **Abb.1.** ⑧). The electric conductance value can’t be shown in this case.

Very thin nickel layers with a single-digit µm range are often used for forgings to apply gold layers on metal base bodies, but don’t automatically cause the display of ferromagnetism.

Non-magnetic stainless steels will be shown in a very low range of <2 MS/m regarding the conductance.

Conductance overview of common alloys on bullion precious metals

Description	Type	electric conductance [MS/m]	Tolerance Conductance [MS/m]	Fineness [%]	Density [g/cm^3]	Penetration depth [µm]
GOLD						
Fine gold	A	**44.7**	+/- 2.2	999.9	19.25	168
Ducat - gold	B	**25.5**	+/- 1.3	986	19.0	222
Krügerrand - gold	C	**9.7**	+/- 0.5	917	17.55	361
American Eagle - gold	D	**11.1**	+/- 0.6	917	17.8	337
Britannia - gold (1990 +)	E	**11.8**	+/- 0.6	900	17.8	328
Reichsmark/Vreneli -gold	F	**8.9**	+/- 0.4	900	17.2	380
Silver						
Fine silver	G	**62.0**	+/- 3.1	999.9	10.50	142
Britannia silver	H	**52.4**	+/- 2.6	958.4	10.41	156
Silver-lat. Mon. Union	J	**49.0**	+/- 2.5	835	10.17	161
Platinum						
Fine platinum	K	**9.1**	+/- 0.46	999.5	21.45	373

Type A	Bullion gold ingots, Vienna Philharmonic, American Buffalo, Kangaroo Nugget, Maple Leaf, China Panda, Mexico Libertad, Australian Lunar, Coins Germany
Type B	Ducats Coin Austria, Emperor Franz Joseph from 1915 on & coinings
Type C	South Africa Krügerrand, Great Britain Britannia (1987-89), Canadian 100 Dollar, Turkey 100 Piaster
Type D	USA American Eagle of the US Mint since 1986, Nominal value in US-Dollar
Type E	Great Britain Britannia from 1990 on
Type F	Germany Reichsmark, Austrian Krone Emperor Franz Joseph until 1915 & coinings, Austrian Gulden, Austrian Babenberger, Schwiss Vreneli, Dutch Wilhemina, French Marianne/Napoleon/Republic, Italian UmbertoI, Vittorio Emanuelle II, Danish Frederik VIII, Belgian Albert/Leopold II, Russian Rubel Alexander III/Nikolais II, Russian Tscherwonetz, USA Female bust/ Liberty/ Native American/ Statue, Chilean Pesos, Mexican Pesos, Mexican Libertad
Type G	Modern Bullion coins: Canadian Maple Leaf, Austrian Philharmonic, USA Eagle, Australian Koala/Kookaburra, Great Britain Britannia (from 2013 on), Armenian Noah's Ark, China Panda, Australian Lunar, Mexican Libertad(from 1996 on)
Typ H	Great Britain Britannia (1997-2003)
Typ I	Austrian Maria Theresia Taler
Typ J	Australian Koala, Canadian Maple, Isle of Man

Table 3 – common gold alloys for coins, medals and ingots

Conductance overview of common alloys of jewellery precious metals

A clear assignment of the conductance to corresponding alloy compositions is unfortunately not easily possible. As only the gold fineness is punched on, and the other contents consist of different metals, there are very different conductance values.

Hallmark	electr. conductance [MS/m]
Red gold (Copper-Gold-Alloys)	
999	**44.7**
995	**35.2**
986	**25.5**
916/22K	**9.7**
900	**8.8**
875	**8**
750/18K	**5-7**
585/14K	**4-6**
333/8K	**7-11**
White gold (Cu.Pt.-Leg)	
750	**2.2**
585	**4.5**
333	**5-6**
Silver	
999	**62**
925-Sterling	**51**
835	**49**
600	**47**
500	**46**

Table 3 –common jewellery gold alloys

Foreign metals	electr. conductance [MS/m]
Pure copper	**58**
Copper alloys	**41-57**
Brass	**13-33**
Pure aluminium	**36.5**
Aluminium alloys	**30-36**
Pure tungsten	**18.8**
Tungsten alloys	**20-28**
Sintered tungsten	**<2**
Molybdenum	**19**
Tantalum	**7.6**
Tin	**7.9**
Chromium	**7.8**
Lead	**4.8**
Titanium	**0.5-2.5**

Table 4 – Overview of foreign metals

Tolerances for the conductance values in these tables are of at least ± 1.5 MS/m. In case of jewellery alloys, the conductance depends on the fabricant.

Further metals	electr. conductance [MS/m]
Antimony	**2.4**
Lead	**4.8**
Chromium	**7.8**
Copper	**58**
Magnesium	**23**
Messing Ms95	**33.3**
Messing Ms90	**25**
Messing Ms60	**15**
Molybdenum	**19**
Nickel silver	**3.2-5.7**
Palladium	**9.5**
Platinum	**9.6**
Rhodium	**20.9**
Steel, stainless	**0-2**
Titanium	**0.5 – 2.5**
Bismuth	**0.9**
Zinc	**17**
Tin	**8**

Table 5 –Overview of further metals

Goldanalytix – a registered trademark of

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