

GalvanoTest 2000

Technical Reference and Operating Manual

Advancing with Technology

ElektroPhysik

© 12/2002 B-16-N

Technische Änderungen vorbehalten.

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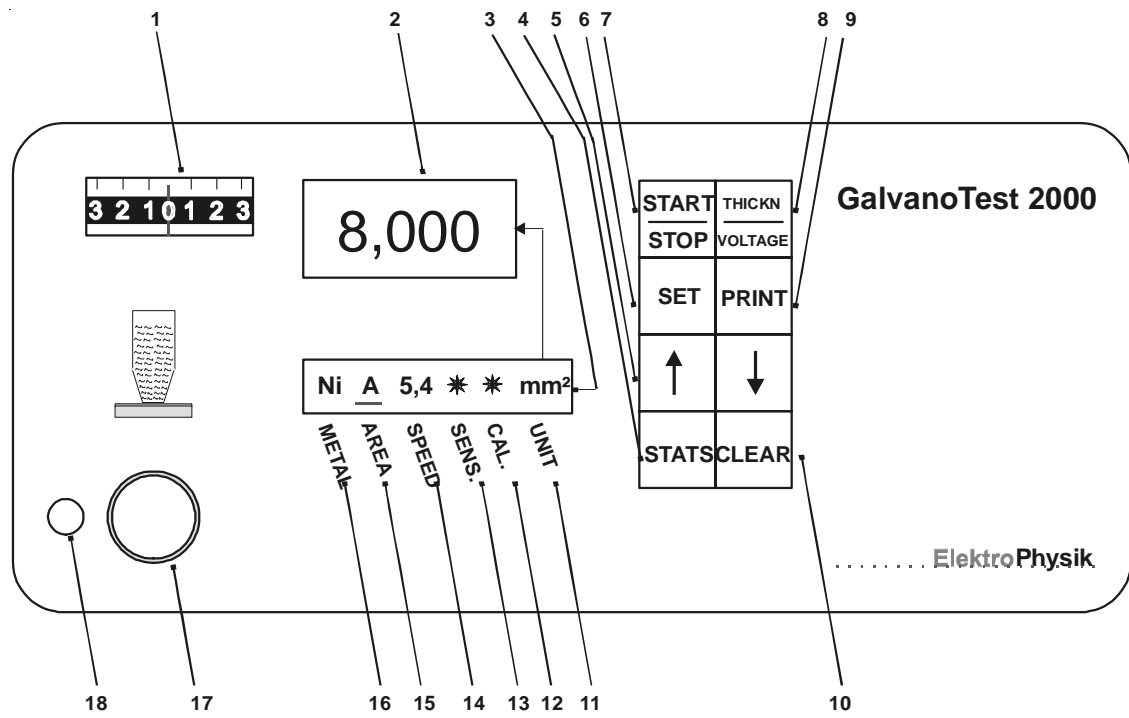
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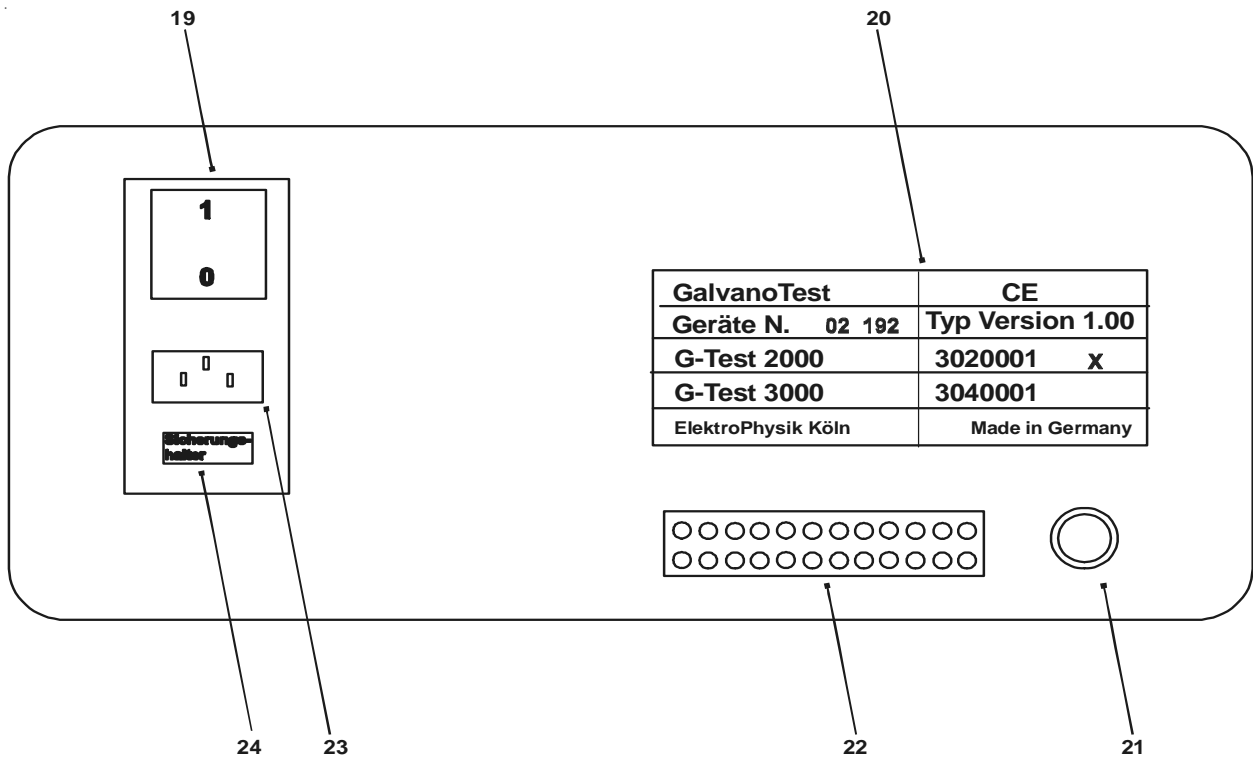
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1. Description

1.1 GalvanoTest 2000 - Front View



1.2 GalvanoTest 2000 - Back View



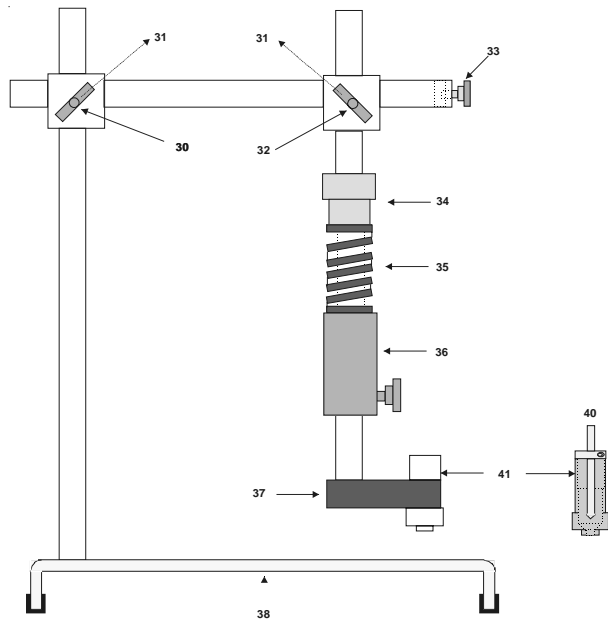
1	Analog meter for monitoring test voltage at measuring cell	6	SET-key for setting parameters selected by ARROW-keys
2	4-digit floating point display for showing readings	7	START/STOP-key for manual launching and stopping measuring process
3	16-digit alphanumerical display	8	THICKNESS/VOLTAGE-key for
4	STATS-key for activating statistics		- switching display to cell voltage view during the measuring process
5	ARROW-keys for setting		- printing-out voltage curve on MiniPrint data printer
	- substrate material	9	PRINT-key for printing out on MiniPrint 4100 data printer
	- measuring area		- date and time
	- de-plating speed		- readings
	- sensitivity		- statistical values
	- calibration	10	CLEAR-key for
	- thickness of coating thickness standard		- deleting the last reading
	- measuring unit		- setting default de-plating speed, default sensitivity and default calibration
	- date and time		
	- language		

	- interrupting printing process	17	socket for cable to connect gauge to measuring stand
	- for error reset	18	socket for pulsator hose
10 + 4	CLEAR + STATS-key for deleting current statistics memory	19	mains switch
11	UNIT: selected measuring unit	20	nameplate
12	CAL: selected calibration	21	socket for Y-T writer
13	SENS: selected sensitivity	22	socket for MiniPrint data printer or RS 232C
14	SPEED: selected de-plating speed	23	power socket
15	AREA: selected measuring area	24	fuse holder with supply voltage control 220V/50Hz or 110V/60Hz
16	METAL: selected coating material		

Switching from 220V to 110V:

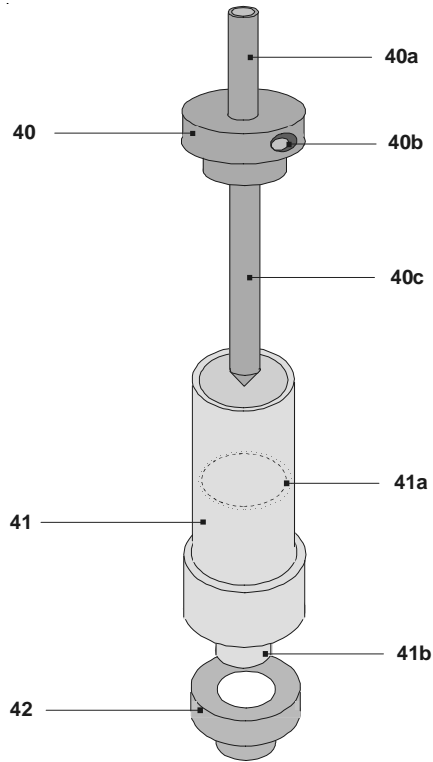
Remove fuse holder (24), turn 180 degrees and put in place again.

1.3 Measuring stand



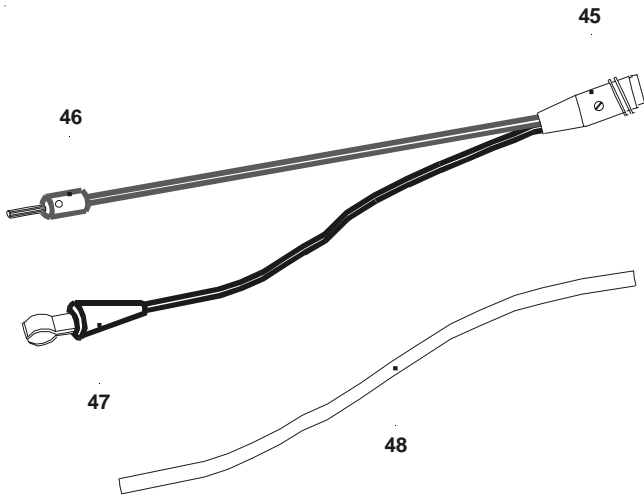
- 30 wing nut for vertical control
- 31 wing nut (back view) for horizontal control
- 32 wing nut for vertical positioning of the cell on the sample
- 33 clamping screw
- 34 stopper (to ensure constant pressure on the cell)
- 35 spring (to ensure constant pressure on the cell)
- 36 pressure device
- 37 cell holder
- 38 working surface for position the sample to be measured

1.4 Measuring cell



- 40 pulsator nozzle for stirring the electrolyte and for supplying the cathode
- 40a connecting piece to connect the pulsator hose
- 40b bore hole to connect the cathode plug
- 40c nozzle to ensure permanent agitation of the electrolyte during measuring
- 41 measuring cell to be filled with the electrolyte
- 41a rim - the measuring should be filled to this level
- 41b mounting for the circular rubber gasket
- 42 rubber gasket determines the measuring area and prevents leakage of the electrolyte

1. 5 Connecting pieces



- 45 plug for output (17) connection
- 46 cathode plug for connection to the socket (40b)
- 47 clamp for connecting to test sample
- 48 pulsator hose for connecting the pulsator output (18) to the connecting piece (40a) of pulsator nozzle (40)

2. Introduction

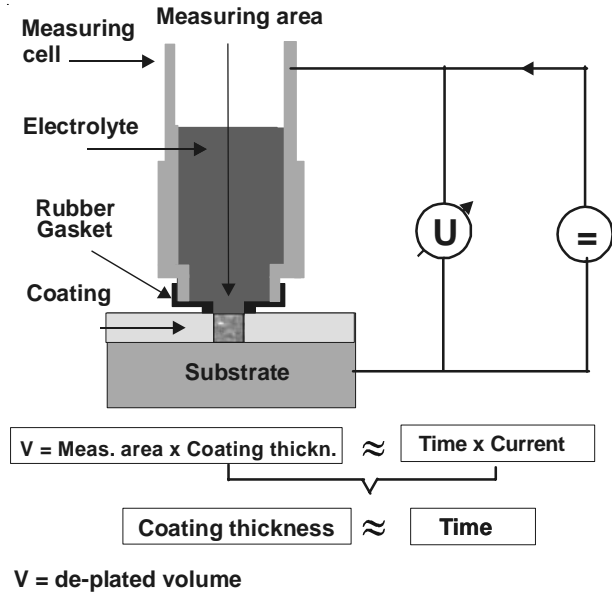
2.1 General Usage and Measuring principle

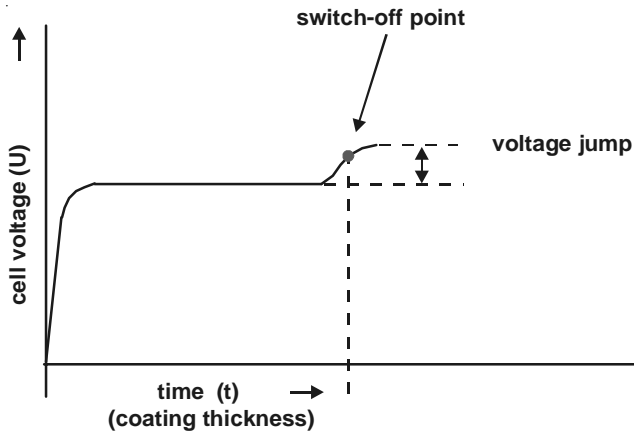
The coulometric or electrochemical de-plating technique according to DIN 50955 / ISO 2177 is suitable for the measurement of electroplated coatings on practically all substrate materials, i.e.: on steel, on non-ferrous metals and also on insulating materials, e.g. nickel on steel, zinc on steel, tin on copper, silver on copper and copper on epoxy. This method is also suitable for measuring the individual coatings of multi-layer systems such as chrome on nickel on copper on steel.

The measuring principle is based on Faraday's Law. The opposite of the electroplating method applies, the coating being electro-chemically removed from the sample.

On this purpose, a stainless steel measuring cell is placed on the sample to be measured. The cell is filled with an electrolyte solution which is selected according to the coating / base combination. A rubber gasket placed between the cell and the sample defines the area of measurement, e.g. 4 sq. mm. The measuring set-up is electrically connected to the electronic processing unit. When switched on, a constant current flows through the electrolyte to remove electro-chemically the metallic coating electro-chemically.

Throughout the entire de-plating process, a defined voltage can be observed between measuring cell and object to be measured. As soon as the metallic coating has been completely removed, a characteristic voltage jump occurs. This voltage jump is registered by the measuring gauge to interrupt the voltage supply and to stop the timer. Thickness is immediately displayed in mils or microns.





Rubber gasket	A	8,00 mm	(∅ 3,2 mm)
Rubber gasket	B	4,00 mm	(∅ 2,3 mm)
Mask	C	1,00 mm	(∅ 1,1 mm)
Electrolyte cup	K	for wires and small parts	

De-plating speed is adjustable from 0,3... 40microns/min.

The portable data printer MiniPrint 4100 provides data print-outs including all single readings and up to 6 statistical values including time and date of print-out.

Special feature: individual print-out of single measurements together with their characteristic voltage curves and switch-off points on the data printer MiniTest 4100.

The instruments allows storage of settings such as calibration or statistics which preset the unit when recalled.

Any operating error will be shown on the alpha-numerical display (English, German, French operator selectable).

Equipped with an RS 232 C interface, the instrument can be linked to an IBM PC or any compatible computer or printer.

2.2 Description

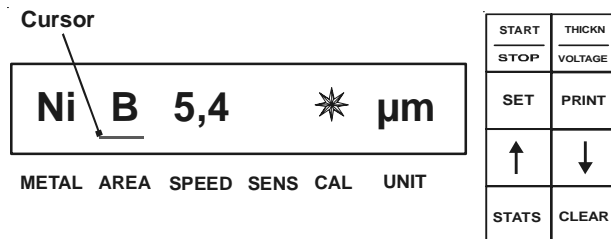
GalvanoTest 2000 includes 8 different metal selections which are preset. Cr, Ni, Cu, Messing, Zn, Ag, Sn, Pb, Cd. A further metal selection M1 is optional

The instrument can be used with three defined measuring areas of different sizes. In addition, the electrolyte cup allows to measure different measuring areas.

3. Taking Readings

3.1 Preparation and putting into operation

Before starting operation select supply voltage with the voltage control switch (24). After switching on, the analogue meter (1) lights up. The previous setting is shown on the alpha-numerica display (3), e.g. Z. B.:



The instrument can be adjusted by pressing SET (6) and ARROW-(5) keys. For setting into selection mode, press SET-key. The position of the red cursor on the alpha-numerical display indicates the parameter which is to be set (e.g. de-plating speed or metal selection).

Use the ARROW-keys for setting the required parameter. The parameters set by the ARROW-keys will be directly accepted.

For quick setting, press SET- and ARROW-keys continuously (Quick function).

3.1.1 Selection of the metal coating material (METAL)

Position the cursor to METAL by pressing SET-key. Use the ARROW-keys for setting your metal selection. The options are shown in the following order: Cr, Ni, Cu, Ms (brass), Zn, Ag, Sn, Pb, Cd, option.

3.1.2 Selection of the measuring area (AREA)

Position the cursor to AREA by pressing SET-key. Use the ARROW-keys for setting the required area (A, B, C, K). The size of your measuring area selection is shown on the reading display (2) while the corresponding unit is displayed on the alpha-numerical display (3) in sq. mm or thousands of sq. inch.

The measuring area K is only selectable in combination with the electrolyte cup (see section 7).

Note:

Another measuring area can only be selected if there are no data stored in the statistics memory. Otherwise, the following message will appear: "Memory overcharged"

3.1.3 Deplating speed control (SPEED)

Position the cursor to SPEED by pressing SET-key and use ARROW-keys for your de-plating speed selection. The de-plating speed is indicated in steps of 50% or 100%.

In general, the de-plating speed should be selected so that a measuring time between one and three minutes can always be ensured.

The de-plating speed ranges between 0.3 microns/min at minimum and 40 microns/min at maximum. When trying to set higher or lower, "MAXIMUM" or "MINIMUM" appear.

The de-plating speed indication on the reading display (2) is more accurate than on the alpha-numerical display (3). Microns or mils are displayed on the alpha-numerical display.

Set standad de-plating speed by pressing CLEAR-key. This standard value depends on the metal selection.

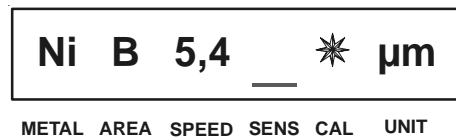
Note:

The de-plating speed also depends on the range of source of electricity powering the instruments. For special applications the de-plating speed is limited, so the de-plating speed for Chrome in combination with the measuring area A for instance, must not exceed 40 microns/min. The message "MAXIMUM" may occur.

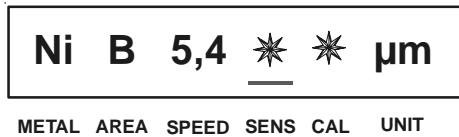
3.1.4 Sensitivity Control (SENS)

Position the cursor to SENS by pressing SET-key. The current sensitivity is shown on the reading display (2) and the voltage being displayed alphanumerically. Use the ARROW-keys for sensitivity control . Press CLEAR-key for standard sensitivity selection.

If the required sensitivity is equal to the standard sensitivity, there will be an empty space above the cursor.



If the required sensitivity is different from the standard sensitivity an asterix will be displayed above the cursor.



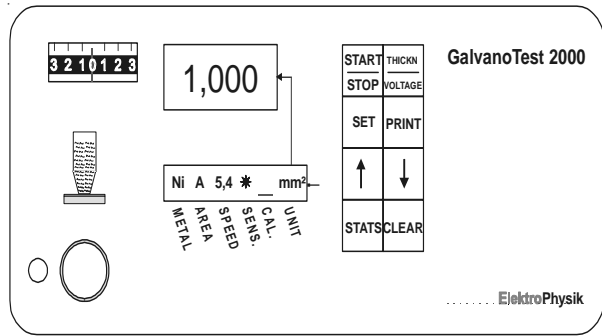
3.1.5 Calibration (CAL)

For sensitivity selection please refer to section 10.

Press SET-key for positioning the cursor to CAL. The current calibration (factor) is displayed on the reading display while on the alpha-numerical display a crossbar is shown on the position for "unit", i.e. the calibration factor is indicated without unit.

Use ARROW-keys for setting calibration or select standard calibration by pressing CLEAR-key.

If the required calibration factor is equal to standard calibration (factor 1,000), there will be an empty space above the cursor and 1,000 for standard value can be read.



3.1.6 Measuring Unit (UNIT)

Press SET-key for positioning the cursor to UNIT. Use ARROW-keys for selecting metric (microns) or American mode (mils).

If you press SET-key again, the cursor disappears. For resetting the cursor to the first position (METAL) and repeating the whole setting procedure, press SET once more.

3.1.7 Pulsator ON/OFF

- Switching the pulsator off:
Press ↓ -and START keys simultaneously.
A multiple signal will sound before the measurement.
- Switching the pulsator on:
Press ↓ -and START keys simultaneously.

3.2 Preparing Measurement

3.2.1 Cleaning the sample

The surface of the sample should be free of grease, lacquer, oxide or passivation films. Use ordinary solvent for cleaning. Oxide films can be removed by means of alcohol or by means of the rubber pencil supplied with the instrument.

Use ElektroPhysik PE 1 solution (accessories) or the rubber pencil for removing chromate coatings on zinc (see also paragraph 8.5).

3.2.2 Positioning the sample

The sample should be placed on the working surface (38) in a stable position. Make sure that the measuring cell can sit at right angles to the sample. If necessary, the small part holder can be used (section 6).

Place an appropriate rubber gasket for 8 mm², 4 mm² or 1 mm² onto the mounting (41b).

Note:

For measurements with C mask (1 mm²) use rubber gasket with dia. 1,5 mm. This gasket with the measuring area 1,8 mm² is always to be used in conjunction with the mask!

Loosen wing nut (32) and place the measuring cell onto the sample (do not force). Tighten wing nut (32). Loosen the knurled screw of the constant pressure device (36) and move it upwards to the stop.

Tighten the knurled screw. Loosen the wing nut. The spring (35) now exerts a constant pressure on the sample. It is thus guaranteed that the gasket always keeps the same shape and therefore the same measuring area.

3.2.3 Electrolyte solution selection table

Coating	Silver	Cadmium	Chrome	Copper	Brass	Nickel	electro-less Nickel	Lead	Lead/Tin	Tin	Tin/Zinc ⁴	Zinc
Substrate												
non-ferrous metal	E 4	E 5	E 11	E 4	E 4	E 14	E 17 ⁸	E 15 ⁸	E 4 ⁸	E 7	E 7 ⁸	E 6
Silver								E 15 ^{1:8}				
Aluminium	E 4 ⁸	E 5 ⁸	E 11 ⁸	E 4 ⁸	E 4 ⁸	E 14 ⁸	E 17 ⁸	E 15 ^{1:8}	E 4 ⁸	E 11 ⁸		E 6 ⁸
Bronze	E 8 ⁸									E 7 ⁸		
Cadmium										E 7 ⁸		
Copper	E 8 ST	E 5 ST	E 7 ST			E 14 ST		E 15 ^{1:8}	E 4 ⁸	E 9 ST	E 7 ⁸	E 6 ST
Steel	E 4 ST	E 5 ST	E 11 ST	E 4 ST	E 4	E 14 ST	E 17	E 15 ^{1:8}	E 4 ⁸	E 7 ST	E 7 ⁸	E 20 ST
Brass	E 8 ST	E 5 ST	E 7 ST	E 12 ⁸		E 14 ST		E 15 ^{1:8}	E 4 ⁸	E 9 ^{ST,3}	E 7 ⁸	E 6 ST
Nickel	E 4 ⁸	E 5 ⁸	E 11 ST	E 4 ⁸	E 4 ⁸			E 15 ^{1:8}		E 7 ⁸		E 6 ⁸
Silicon						E 14 ⁸						
Zinc				E 12 ^{ST,2,8}								
Kovar				E 4 ⁸				E 15 ^{1:8}				
Argentan	E 8 ⁸		E 7 ⁸								E 7 ⁸	
Zinc diecasting				E 12 ⁸								

¹⁾ For lead measurement please renew electrolyte solution when reaching 30 microns coating thickness

²⁾ s. section 8.9 (CU/Zn)

³⁾ s. section 8.10 (SN/MS)

⁴⁾ for Tin / Zinc 78%/22%

⁸⁾ Please take special care for measurement. If necessary, please contact ElektroPhysik or your local dealer.

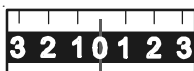
^{ST)} coating thickness standards available on stock

3.2.4 Taking readings

Fill in the appropriate electrolyte by means of the corresponding pipette. Lead the pipette through the opening of the gasket and place it onto the measuring area in order to avoid air bulbs on the de-plating area which might cause interruption of circuit and thus incomplete de-plating and erratic readings.

Fill the measuring cell up to the mark and put the pulsator nozzle onto the cell.

Press START-key. The launch of measuring procedure is indicated by analogue meter (1) deflection. After that, the needle returns to zero position. Deviations up to +/- 0.5 can be ignored.



The reading display (2) continuously shows the coating thickness being removed.

During measuring, it can be switched from thickness to voltage by pressing THICKNESS/VOLTAGE-key (8) with the corresponding unit (microns/mils or Volts, respectively) being shown on the alpha-numerical display (3).

Shortly before the measurement being finished, a slow analogue meter (1) deflection to the right can be observed indicating the start of the voltage jump. A few seconds later, the instrument cuts off the measuring current and emits an audible signal. At the same time, the continuous reading display (2) stops and displays the de-plated coating thickness in microns or mils.

If you have switched to Voltage display, the instrument switches automatically to coating thickness at the end of measurement.

The readings are automatically stored in the statistics memory and, if the printer is connected, printed-out along with their current identification number.

If the reading is not be stored in the statistics, press CLEAR-key for deletion. Deletion is confirmed by the printed message „*CANCEL*“.

After completion of measurement, press THICKNESS/VOLTAGE-key for recalling previous voltage setting at the measuring cell.

Measurement can be interrupted manually by pressing STOP. If measurement is interrupted later than 3 seconds after being started, the measurement is valid and the reading will be processed as usual (automatic stop).

3.2.5 After measurement

Remove the nozzle (40) from the measuring cell (41) and clean with a soft paper towel.

Remove the used solution with the pipette and fill it into the bottle for used solution.

Note:

Do not mix up used solutions with new ones!

Unscrew the pressure device (36) at the stand and lift. Before using another solution, rinse the measuring cell (41) with distilled water.

For evaluation of results, the measuring point should be examined after each measurement. This point must show a clean, round and complete de-plating of coating across the measuring area.

3.2.6 Y-T writer output

During measurement, the cell voltage can be taken at the y-t writer output (21) and displayed in the form of a voltage curve relating to measuring time. This provides supplementary information on the measuring process especially regarding diffusion coatings.

If the y-t writer is switched on, a current flow can be observed for a period of about 1/16 of the measuring time, providing the measuring process has been stopped automatically (not manually). Thus the voltage curve can be monitored even after completion of the de-plating process.

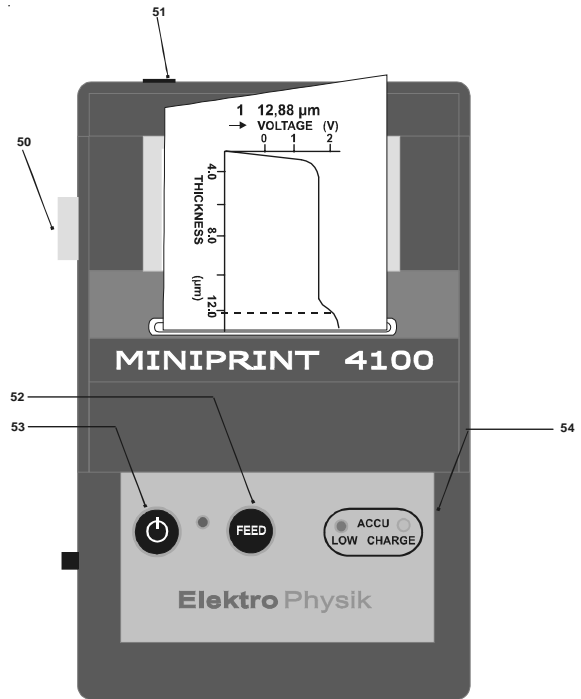
4. MiniPrint 4100 Data Printer

4.1 Print-out of voltage curve

The data printer MiniPrint 4100 allows immediate print-out of voltage curve after the measuring process.

Optimum scaling and print-out of both, readings and voltage values can be automatically obtained by pressing THICKNESS/VOLTAGE-(8) key. (Keep on pressing more than 1 second after measurement).

If you press THICKNESS/VOLTAGE-key during measurement, the measuring current will continue to flow for a period of about 1/16 of the measuring time, ensuring that the voltage curve can be monitored also after completion of the de-plating process.



- 50 interface for connecting the GalvanoTest instrument
- 51 bush for charging unit
- 52 paper FEED
- 53 ON/OFF-key
- 54 charging control lamp

4.2 Printing out readings and statistics

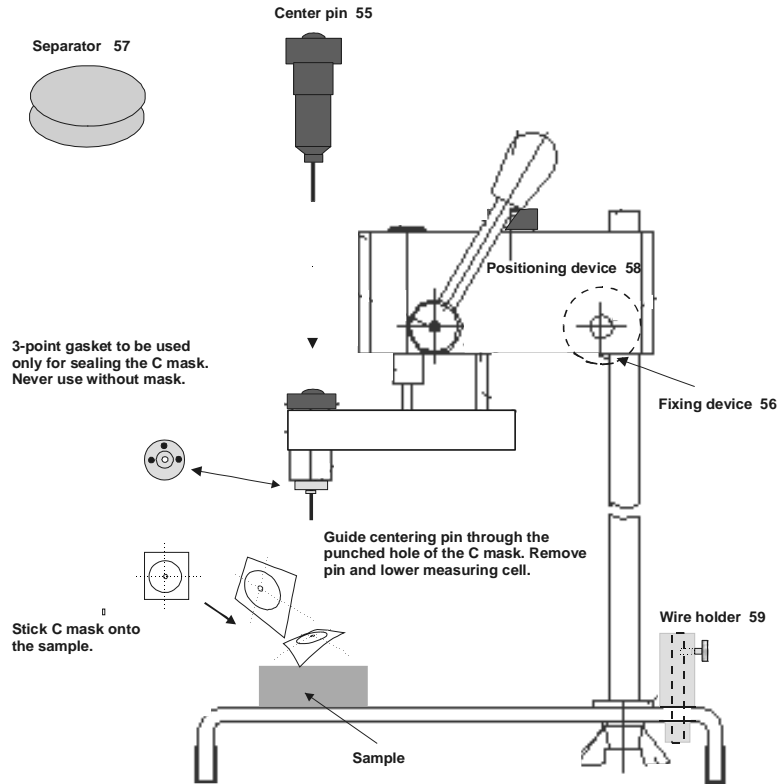
If the MiniPrint 4100 data printer is connected, the readings are printed out after each measurement. The statistical values are printed out individually after completion of the measuring series when pressing STATS-key (4).

If the printer is switched not before the measuring series has been stored, you can actuate the complete print-out by pressing PRINT-key (9).

0001	0,96µm	Single readings
0002	1,08µm	
0003	1,72µm	
0004	1,18µm	
0005	1,40µm	
MEAN	1,27µm	Statistics calculated from above single readings
S.D.	0,30µm	
Kvar	0,24	
N	5	
MAX	1,72µm	
MIN	0,96µm	

ElektroPhysik		
STATS. Program		
02-SEP-02	08:27	
Metal	Cr	Type of metal coating
Area	B	Measuring area
0001	0,96µm	Single readings
0002	1,08µm	
0003	1,72µm	
0004	1,18µm	
0005	1,40µm	
MEAN	1,27µm	Mean value
S.D.	0,30µm	Standard deviation
Kvar	0,24	Variation coefficient
N	5	Number of readings
MAX	1,72µm	Maximum reading
MIN	0,96µm	Minimum reading

5. High-Precision Stand incl. Centering Tool (Optional Accessories)



55	Centering device	for pin-point positioning of the cell for measurements using the C mask (1 mm ²)
56	Fixing device	for height control of the positioning device Positioniereinheit
57	Separator	for constant pressure during measurements with the rubber gaskets 4mm ² and 8 mm ²
58	Positioning device	for vertical positioning of the cell
59	Wire holder	for wire measurements, to be used instead of the cell

Place the measuring cell onto the sample by means of the lever arm of the positioning device.

After completion of the measurement, lift the measuring cell for inspecting the measuring area. After that, reset the measuring cell into the previous position and continue with the next smaller measuring area (section 8.4).

For measuring multi-layers, the measuring area should be examined especially

- if the nature of layers is unknown
- if, after de-plating of the upper layer, an oxide film has been produced which requires cleaning
- in case of irregular analogue meter (1) deflection

5.1 High-precision stand

Position the sample on the working surface in a stable position. Place the measuring cell rectangular to the area to be measured (if necessary use the holder for small parts).

Lift the lever arm to the stop. Place the separator (57) onto the sample. Loosen the fixing device (56) and move the positioning device down ensuring that the measuring cell is placed onto the separator without pressure. Now tighten the fixing device.

Remove separator and press the selected rubber gasket (42) onto the mounting (41b).

5.2 Centering tool

The centering tool (55) is used when, because of the shape of the sample, a C mask (1mm²) in combination with the 1.5 mm dia. gasket (for sealing the mask) is required.

Place the centering tool (55) into the measuring cell (41) as far as possible. Clean the sample and stick the mask on the area to be measured.

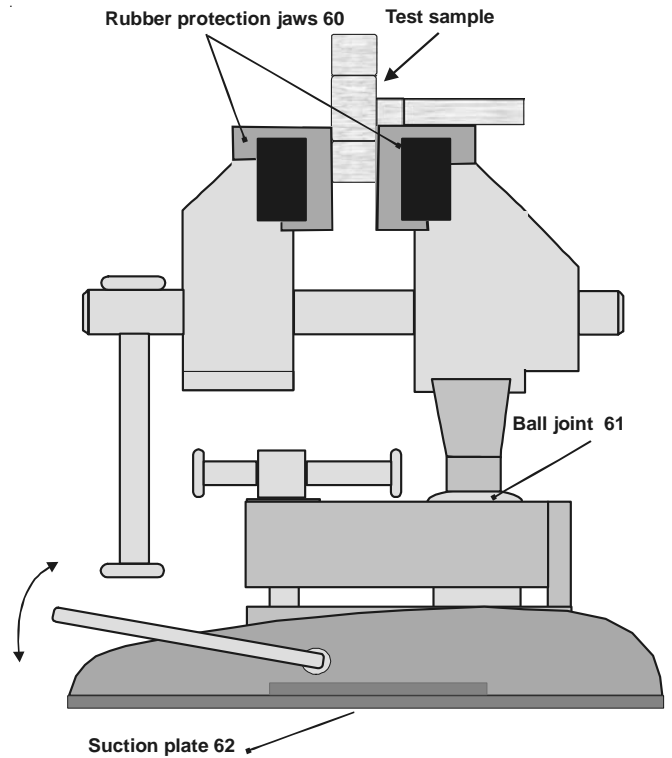
Adjust the precision stand ensuring that the center pin touches the sample through the punched hole of the mask with a very slight contact. Tighten the fixing device (56).

Position the measuring cell and remove the centering tool.

6. Small Parts Holder

For measuring small and irregularly shaped samples.

- 60 rubber protection jaws
- 61 ball joint for positioning the test sample
- 62 suction plate for ensuring stable position of the small parts holder during measuring



7. Electrolyte cup

7.1 Variable measuring area for small parts and wires $\geq \varnothing 0,3 \text{ mm}$

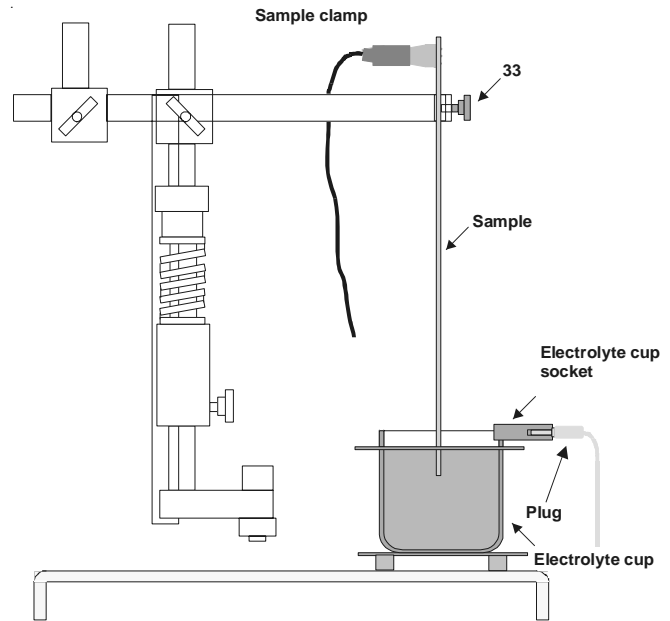
This method is also a time/voltage measurement. While the standard method always provides a defined de-plating area which is determined by the size of the gasket, the electrolyte-cup-procedure requires a calculation to be made in order to determine the de-plating area.

The electrolyte cup is suitable for measurement of wires and small parts with de-plating areas ranging from 0.25 to 16 mm².

Choose the appropriate solution according to the electrolyte selection table (section 3.2.3) and fill the cup to about up to 1 cm from the rim. Areas of samples which are not to be measured or the ends of wires have to be insulated e.g. by using lacquer.

Note:

Use the black and yellow connecting cable for measurements with the cup!



Adjust measuring area to „K“ and continue settings as described under section 3.

Dip the sample into the electrolyte cup ensuring that the area dipped into the cup approximately corresponds to your setting of measuring area.

Adjust the electrolyte cup holder so that the sample is in the middle of the cup. The sample must not touch the cup at any point, even on the bottom.

Fit the cathode plug into the socket on the cup and fix the sample clamp to the sample. The contact point must be clean so that a good electrical contact is made.

After pressing START/STOP key, the following message is shown on the alphanumerical display; „Measuring area?“. Use ARROW-keys for setting the approximate measuring area.

Press START/STOP-key or SET-key for starting measurement.

At the end of the measuring procedure, the alphanumerical display shows again „Measuring area?“.

Use the ARROW-keys for setting the precise de-plating area and confirm by pressing SET-key. The instrument now calculates, displays and stores the thickness value of the coating.

Measurement in the electrolyte cup is made without pulsator.

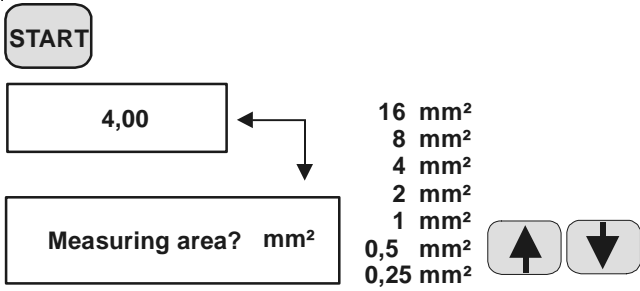
Note:

The solution can be used for several measurements (20 to 30 depending on the size of the samples), but it should not be left in the cup for a longer time, but removed and stored in a suitable bottle. Do not refill into the bottle with new solution!

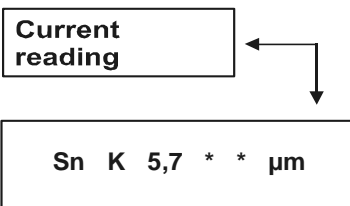
Depending on the type and thickness of coating, wires $\leq \varnothing 0,3$ mm may also be measured.

Example for measurement of wires using the electrolyte cup:

Press START-key and use ARROW-keys for setting the measuring area according to wire diameter and depth of immersion.

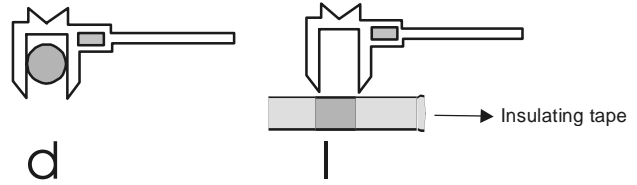


START Press START again.



After completion of measurement remove wire.

After this, use a caliper to measure diameter and length of the de-plated area.



Use the above parameters to determine the actual deplated wire area as follows:

$$F = d \times \pi \times l$$

$$F = \text{Area}$$

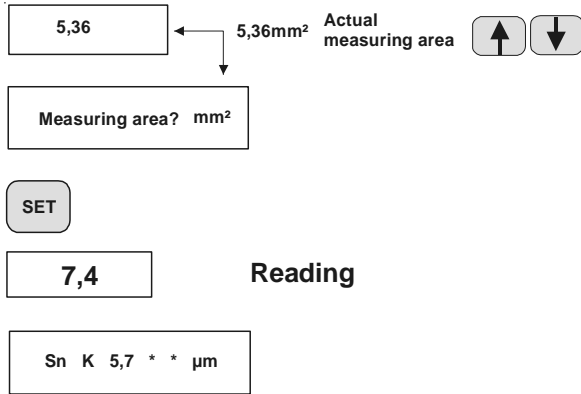
$$d = \text{Diameter of wire}$$

$$\pi = 3,14$$

$$l = \text{length of de-plated area}$$

Use ARROW-keys for setting the actual measuring area, e.g. 5,36 mm².

Press SET-key to show the reading as calculated by means of the actual measuring area, e.g. : 7,4



7.2 “C” mask for wires $\varnothing \geq 2$ mm

Use the „C“ mask for measuring wires with a dia. ≥ 2 mm.

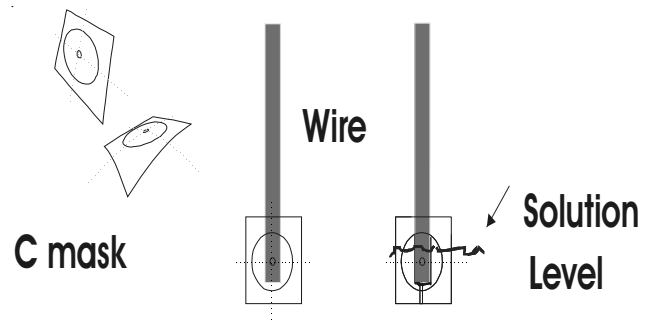
Stick the mask onto the wire ensuring to insulate the end of wire completely. If necessary, use lacquer. Dip the wire into the electrolyte cup ensuring that the punched hole of the C mask is completely immersed into the solution.

Continue as described under section 3.2.4 “Taking readings”. Please note that the red and black connecting cable is to be used and select measuring area “C”.

As soon as the instrument switches off automatically, the reading can be read from display. It is not necessary to calculate the measuring area.

If you are using the standard measuring stand, the wire is to be fixed by means of the clamping screw (33).

If you are using the high-precision stand, use the wire holder (59) to fix the wire. Loosen measuring cell to take it off. Insert wire holder and tighten.



8. Specific Measuring Problems

8.1 Convexe-shaped areas

- circular gasket $A \geq \varnothing 16 \text{ mm}$
- circular gasket $B \geq \varnothing 8 \text{ mm}$
- circular gasket $\varnothing 1,5 \text{ mm}$ with C mask $\geq \varnothing 6 \text{ mm}$
- circular gasket $\varnothing 1,5 \text{ mm}$ (adaptable to the sample dia.) and C mask $\geq \varnothing 4 \text{ mm}$

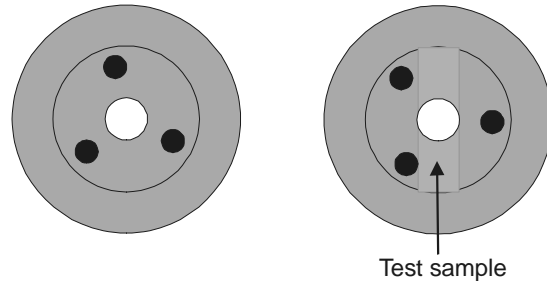
Use abrasive paper to adapt the circular gasket to the geometry of sample.

Samples with smaller diameters such as wires should be measured by means of the electrolyte cup.

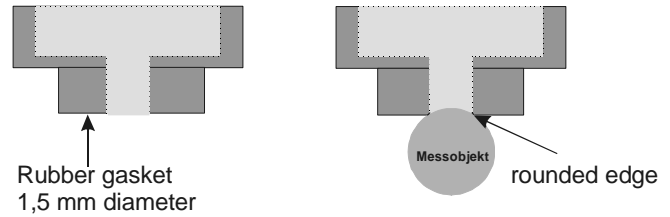
Wires $\geq \varnothing 2 \text{ mm}$ can be measured in the electrolyte cup using a mask.

Depending on type and thickness of coating, wires $\leq \varnothing 0,3 \text{ mm}$ may also be measured.

Rubber gasket - bottom side



Rubber gasket - longitudinal view



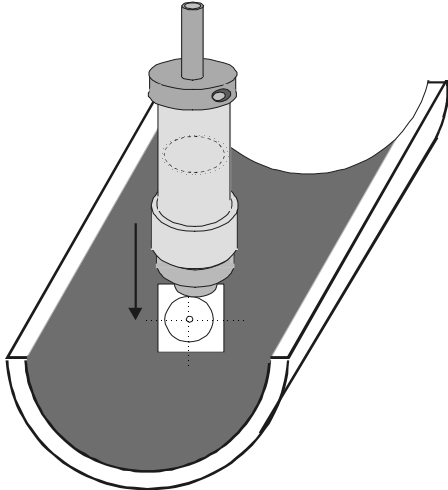
Circular gaskets A and B should not be adapted to the diameter as this would change their defined measuring area.

8.2 Concave-shaped areas

From minimum sample $\varnothing 100$ mm, the circular gasket $\varnothing 1,5$ mm can be used in combination with the C mask.

Note:

Only samples accessible from the upper side can be measured.



8.3 Coating thickness > 40µm

If coatings > 40µm are to be measured with the 8mm² gasket, the STOP-key must be pressed before reaching 40µm. Use a new solution to continue measurement.

The total range of up to 75µm can be covered in one measuring procedure by means of the 4mm² gasket or 1 mm² mask.

For exceptions, please refer to the electrolyte solution selection table.

8.4 Multilayer coatings

The GalvanoTest is suitable for measuring subsequently the individual coatings of multilayer systems (such as chrome, nickel, copper on steel) at one measuring point.

Measurement of the upper layer is carried out according to the general instructions of section 3. After-switch-off, lift out the pulsator nozzle (40) without moving the position of the gasket on the sample.

Remove the solution with the appropriate pipette and rinse out the measuring cell (41) twice with distilled water for the next measurement. After that, the electrolyte cup is filled with the solution for the second layer.

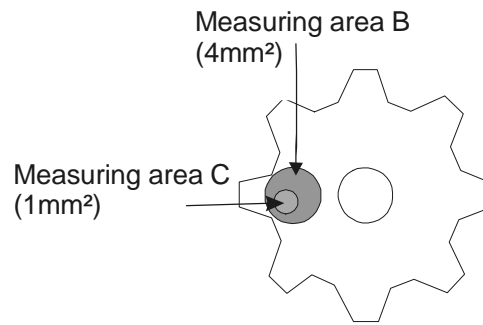
Note:

At this point, do not forget to set the new coating material (METAL) on the alphanumeric display (3).

In general it is not necessary to lift off the measuring cell between the individual measuring procedures.

In some cases, however, it may become necessary to lift off the measuring cell between the individual measurements in order to clean the sample from electrically insulating deposits which may built-up during the de-plating process.

After this, use the next smaller measuring area for the next measurement.



8.5 Chromed zinc coatings

Before placing the measuring, remove any passivation layers that may have built-up on the sample. This is done best with a rubber pencil or with ElektroPhysik solution PE1.

Put some solution in the measuring cell and leave for a few seconds. Then rinse out the measuring cell with distilled water and proceed as in 3.2.4.

8.6 Diffusion layers

Some metals tend to penetrate into the surface of the next layer. For that reason, the instruments may switch-off after de-plating the pure metal, e.g. Sn.

If you examine the measuring area, you cannot see the next metal layer but the metal which remains to be de-plated.

In this cases, we recommend to decrease sensitivity i.e. to set a higher voltage value.

On the other hand, when measuring extremely distinctive diffusion layers (e.g. Zn), the voltage jump may not be sufficiently strong for switching off measurement. In such cases, the voltage curve may return to normal until a new voltage jump occurs after a short while. This voltage jump however may be too slow to switch-off measurement. In such case we recommend to increase sensitivity i.e. to set a lower voltage value.

With optimum sensitivity, the instrument switches off not before the second voltage jump.

The print-out of voltage curve on MiniPrint 4100 shows both, thickness of the pure metal as well as the thickness of the diffusion coating. Please refer also to section 10 "Sensitivity Control".

8.7 Currentless Nickel (Chemical Nickel)

When measuring currentless nickel, the phosphor content will cause a slowing down of the de-plating process. The variation of de-plating speed with phosphor content can be described as follows:

Posphor content in %	4	5	6	7	8	9	10	11
Correction value	1,11	1,14	1,16	1,19	1,22	1,24	1,26	1,28

The correction values as specified in the above table only apply if calibration has been carried out by means of a nickel standard without phosphor content.

For accurate measurement, the calibration factor has to be determined according to section 9.1 and then divided by the appropriate correction value as specified in the table above.

8.8 Nickel on copper on steel

If the instrument does not switch off when using E14 solution for nickel coatings on copper ($\text{Cu} < 2 \mu\text{m}$), it is recommended to use E4 solution. Please note that in this case, the instrument must be calibrated accordingly and that E4 solution removes both layers in one measuring process.

8.9 Copper on zinc

Select „M“ for optional metal selection. It is recommended to adjust the instrument as follows:

De-plating speed: 3...4 $\mu\text{m}/\text{min}$.
Sensitivity: 1,0
Calibration factor: 2-2,1
Solution: E12

8.10 Tin on brass

Select „M“ for optional metal selection. It is recommended to adjust the instrument as follows:

De-plating speed: 5...6 $\mu\text{m}/\text{min}$
Sensitivity: 2,5
Calibration: 1,7-1,75
Solution: E9

The instrument settings under 8.9-10 are general specifications and may vary according to the individual gauges. For that reason, calibration must be carried out for each individual gauge.

8.11 Thick coatings

When measuring thick coatings, the instrument may switch off prematurely i.e. before the coating is removed completely. In such cases "0.00" is shown on display. Example: If you want to measure Cu 50 μm at a de-plating speed of 3,14 $\mu\text{m}/\text{min}$, the instrument switches off after removing a coating thickness of 31,4 μm as maximum de-plating time is 10 minutes:

$$10 \times 3,14\mu\text{m} = 31,4\mu\text{m}$$

In such cases, please proceed as follows:

- Switch off the instrument manually before automatic switch-off.
- The readings will be stored automatically.
- Restart measurement. As soon as the gauge switches off automatically, both values can be added to give you the total thickness.

9. Calibration

Accurate calibration is most important for successful measurement. Previous calibration values can be overwritten by new ones. Stored readings remain unchanged. New measurement series, however, cannot be stored until previous readings in the statistics have been deleted (see 12.5).

Note:

CLEAR-key pressing during instrument setting procedure sets standard calibration: „1.000“.

9.1 Calibration by means of coating thickness standards

Take measurement on the coating thickness standard.

Press SET-key for positioning the cursor to CAL. Now a value is shown on the reading display. The unit microns or mils is shown on the alphanumerical display.

Use the ARROW-keys for setting thickness of calibration standard. Continuous pressing of ARROW-keys supports quick function. Your setting will be valid without the need of being confirmed.

If MiniPrint 4100 is switched on, the message „*Cancel*“ will be printed after pressing the ARROW-key.

The following measurements will be carried out on the basis of your calibration selection without need to confirm.

For checking, take another measurement on your calibration standard.

9.2 Calibration by means of calibration factors

If coating thickness standards are not available, calibration can also be performed by means of factors, providing the instrument setting parameters are known. Calibration by means of a factor is only possible

- if the cursor is not be seen on the alphanumerical display. On that purpose, press SET-key.
- if there is no value indicated on the reading display. Press CLEAR-key (10).

Then perform setting as follows:

- Use SET-key to position the cursor to CAL (12). The previous factor selection, e.g. 1.300 is shown. On the alphanumerical display , UNIT (11) will be marked by a bar.
- Use ARROW-keys for selecting the required factor, e.g. 1.150. Your setting does not need to be confirmed. The following measurements will be automatically made on the basis of your factor selection.

9.3 Calibration factor control range

In both methods, calibration by means of coating thickness standards and calibration by means of calibration factors a special factor is set.

For the preset metal selections such as Cr – Cd, the calibration factor can be set from 0.5...2, for optional metal selection "M", it ranges from 0.2...5.

When trying to exceed these ranges, the alphanumerical display will show the following messages: "Maximum" or "Minimum".

9.4 Standard calibration (1.000) reset

If for special applications, the factor selection is different from 1.000, (1.300 for instance), an asterisk (*) will appear on CAL position.

- Use SET-key for positioning the cursor to CAL.
- Select 1.000 by pressing CLEAR-key. Now (*) will disappear.

Note:

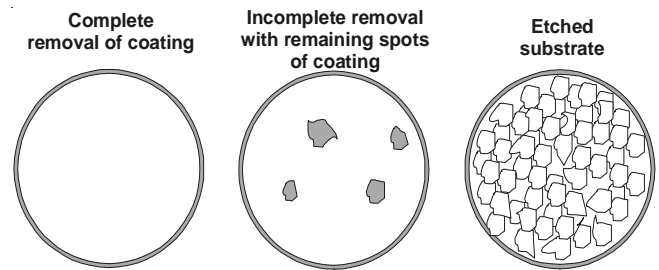
When pressing CLEAR-key, any reading changes according to the current factor selection, eg.

2.6 μm changes to 2.0 μm .

10. Sensitivity Control (SENS)

The coulometric technique uses a controlled “de-plating” current rate, the time required to remove the plating material and the diameter and length of the sample area to determine the plating thickness. For that reason, the end of de-plating time must be exactly determined (see time-voltage diagram on page D-9.).

Your sensitivity setting determines the switch-off point. If after switch-off the coating is not completely removed, GalvanoTest has switched off prematurely and some spots can be observed on the de-plating area. In this case, it is recommended to increase voltage setting. E.g. for nickel it is recommended to increase the default setting from 1.0 Volt to 1.2 Volt.



If the instrument does not switch off in time, the substrate is going to be etched. In this case, sensitivity should be decreased (for nickel, e.g., decrease from 1.0 to 0.8 Volt).

10.1 Standard sensitivity reset

The instrument is factory adjusted so that a certain sensitivity value (Volt) is preset for the different metal selections. When changing sensitivity preset, an asterisk (*) will appear at SENS. For resetting to standard sensitivity selection, please proceed as follows:

- Use SET-key to position the cursor to SENS.

-
- Press CLEAR-key. The sensitivity value U resets to factory setting (default value). The asterisk (*) above the cursor disappears. The sensitivity value U is shown in Volts on the reading display.

11. Measuring Uncertainty

Careful calibration ensures precise measurement within the range of the guaranteed measuring uncertainties (please refer to the technical data).

For optimum mean value evaluation we recommend to take several measurements at the same spots. For immediate deletion of measuring errors, press CLEAR-key.

11.1 Error sources

- The coating to be measured is thicker than the maximum thickness range of the instrument. If the appropriate measuring time is exceeded, a larger area than the defined measuring area will be de-plated and readings will be out of the guaranteed measuring tolerance. For that reason we recommend not to exceed the instrument's measuring range.
- The current efficiency varies depending on the de-plating speed. It is recommended to use the same de-plating speed for both, calibration and following measurements.
- Impurities or alloy components in the coating material may lead to erratic readings. If necessary, carry out comparison measurements according to the cross-cut method.
- The efficiency of the solution may decrease. It is recommended to use fresh electrolyte solution.

12. Statistics Mode

All readings of a measuring series will be recorded automatically for statistical evaluation. Ten different metal selection memories are available to store 2000 readings in total.

The statistics program is designed to calculate on the basis of at least two readings the following statistical values:

Mean value	(<i>MEAN</i>)
Standard deviation	(<i>S.D.</i>)
Variation coefficient	(<i>Kvar</i>)
Number of readings	(<i>N</i>)
Maximum single reading	(<i>Max</i>)
Minimum single reading	(<i>Min</i>)

12.1 Recording a measuring series and statistics calculation

On switch-on, the instrument is ready for operation. Before starting measurement, check if recalibration is necessary and/or if the statistics must be deleted. If necessary, overwrite the previous calibration.

Note:

A measuring series can be recalled and continued after off/on-switching.

All statistical readings will be deleted according to section 12.4.

12.2 Recalling statistical values (display and print-out)

Press STATS-key for display or print-out (printer ON) of the statistical values as above. The statistical values can be displayed or printed out at any time after measurement.

12.3 Print-out of readings and statistical values

Press Print-key for printing:

- date and time
- all readings
- all statistical values

While printing, the alphanumeric display shows „Printing...“. Press CLEAR-key for print stop.

If there is no printer connected, the data can be transferred via RS 232 C interface (see section 19).

12.4 Deleting a previous reading

Deletion is only possible directly after the last measurement, i.e. before taking the next one.

Press CLEAR-key.

An audible signal confirms deletion. If the printer is connected, the following message will be printed out: „*Cancel*“.

12.5 Deleting a measuring series and statistics

- Make your metal selection - e.g. Ni for Nickel
- The cursor should not be seen.
- Press CLEAR-key and keep pressed down, then press STATS-key at the same time.
- An audible tone sounds and the message „STAT. deleted“ appears for about 2 seconds.

12.6 Exceeding storage capacity

At the beginning of any measurement, there is automatic storage capacity checking. Maximum capacity is indicated by “Full Memory”. For further measurements delete any statistics memory (see section 12.5).

13. Date and Time

GalvanoTest is equipped with a crystal-controlled time which includes an integrated leap year control up to the year 2100. The data printer MiniPrint 4100 provides print-outs including current date and time.

Call and set time as follows:

Press SET-key for about 3 seconds until an audible signal sounds. A certain date and time are shown on the alphanumeric display. The cursor is positioned at the section for "year".

Use ARROW-keys for setting the current year. Use the SET-key for positioning the cursor to the section for "month". Use ARROW-keys for setting the month.

Likewise, day, hour and minutes can be set.

After completion of your required settings, press SET-key until the cursor disappears from display. Now current date and time are valid.

Press SET-key for returning to standard operation mode.

14. Language Selection

Three operator selectable languages are available: German, English and French.

Make your language selection as follows:

Switch off the instrument.

Press both ARROW-keys continuously while you switch the instrument on. The current language selection appears on display, "English" for example.

Keep both ARROW-keys pressed down and release keys as soon as your required language is shown. Your selection is valid without need to confirm.

15. Error messages

Error messages appear on the alphanumerical display. In some cases, the cursor is positioned under the relevant parameter which the error message refers to.

Maximum	Calibration (CAL), sensitivity (SENS), de-plating speed (SPEED) or measuring area (AREA) have reached maximum value
No cell	No measuring cell connected
No test current	No current flow in the solution. The cause may be: Clamp (47) is not connected to the test sample. Any air bubble on the surface. No solution available in the measuring cell (41). Another solution in the cell. Surface insulated by grease, paint, etc. Cell voltage exceeding 10V.

Time exceeded	If measurement exceeds 10x the selected de-plating speed, the measuring process will be interrupted automatically and the reading display will show „0,0 „.Measurement is invalid.
---------------	--

Mem. charged	In case of a new measuring area selection at full statistics memory. Note: It is not possible to select a new measuring area without deleting the current statistics memory (see 12.6).
--------------	---

Mem. overcharged	Measurement not possible. For further measurements, delete any statistics memory (see 12.6).
------------------	--

No statistics	Error message when trying to call in or print any statistics but no data are available in the statistics memory.
---------------	--

16. Further sources of error

1. The analogue meter and both displays do not light up on switch-on:
 - Check power suppl.
 - defective fuse
2. Solution leaks:
 - cell not correctly positioned
 - gasket worn
 - curvature radius of the sample too small
3. Premature switch-off, unsteady meter deflections:
 - poor contact
 - dirty cell or measuring area
 - air bubble on measuring area
 - insufficient solution
4. Instrument does not switch off, no deflection on meter:
 - gasket leaking
 - sensitivity too low
 - pulsator hose not connected
 - unsuitable solution
 - Coating has been removed within the first three seconds, i.e. de-plating speed is too high.
5. Instrument does not switch off, but clear meter deflection:
 - sensitivity too high
6. Coating is not properly removed:
 - sensitivity too low

-
7. Wrong measuring result:
- check steps 2., 3. and 6.
 - instrument misadjusted, no or wrong calibration
 - unsuitable solution

The cell and gasket must be rinsed with distilled water after use, in case a new solution will be used.

If the same solution is to be used, it is sufficient to dry the bottom of the gasket after each use.

The pulsator nozzle and the cell may build up residue or metal deposits after several measurements. This generally does not affect measurements. It is enough to rinse with distilled water.

8. On switch on the instrument does not show the previous setting, statistics, time and date are deleted:
- Lithium buffer battery discharge. Please refer to your dealer.

In case of very strong pollution or routinely once a month, the pulsator nozzle and the cell should be cleaned in a solution of 4 parts concentrated sulphuric acid (Caution: caustic) and one part concentrated nitric acid. They should be immersed in the solution for not longer than 10 to 15 seconds and then rinsed under running water. The procedure can be repeated if necessary until the components are clean and shiny after which they should be tried and polished.

If you are not able to solve the problems yourself by means of above hints, please contact ElektroPhysik or your local dealer. If necessary, return the gauge along with the sample to be tested.

17. Maintenance

Please keep the instrument clean. Avoid spilling solution on the instrument. Measuring cell, pulsator nozzle and power supply must be kept clean to ensure error free operation.

18. Data Printer MiniPrint 4100

During printing, the GalvanoTest operating mode is switched off. For further information please refer to MiniPrint 4100 operating instructions.

19. RS 232 C Interface

The GalvanoTest instrument is equipped with an RS 232 C interface. By means of an appropriate cable, a Personal Computer, MiniPrint 4100 or a printer equipped with a suitable interface can be connected.

For data transfer to a Personal Computer a data transfer program MSave is available.

For data transfer to a Personal Computer press PRINT-key for initiating the data transfer program. Before transferring data to MiniPrint 4100, press printer ON/OFF-key for switching the printer on.

20. After sales service

Please return defective or faulty instruments to your local dealer or to ElektroPhysik for checking or repair. Please enclose a short trouble report.

21. Hints for using electrolyte solutions

It is recommended to use solely original ElektroPhysik solutions. Please do also refer to the security data sheets 91/155/EWG (available on request).

22. Technical data

Measuring principle	coulometric de-plating method
Measurable coating/base combinations	more than 70, please refer to the electrolyte selection table
Measuring range	0.05 to approx. 75 microns
De-plating speed	0.3...40 microns / min (adjustable)
Measuring unit	μm (microns)/ inches (adjustable)
Display of readings	4-digits digital display with floating point
Alphanumerical display	16-digits display of instrument settings and operating steps
Analogue instrument	for monitoring the de-plating process
Data memory	max. 2,000 readings storable in a maximum of 10 application memories
Operation	via key pad
Data ports	RS 232 C für MiniPrint 4100, PC or other compatible printers analogue output for y-t writer
Power supply	switchable from 110V / 200V $\pm 10\%$ 50...60Hz / 10 Watts
Weight	instrument: approx. .2,5 kg precision holder: approx. 2,5 kg

22.1 Measuring uncertainty

The following data are based on calibration with ElektroPhysik thickness standards):

Gasket	∅	De-plating area	Measuring uncertainty (of reading)
A	3.19 mm	8 mm ²	5%
B	2.26 mm	4 mm ²	6%
C	1.13 mm	1 mm ²	9%
D	0.56 mm	0.25 mm ²	20%

Note:

If the instrument is only works calibrated, measuring uncertainty in connection with the A gasket is 10% of reading.

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