

Elcometer 121/4

Paint Inspection Gauge

Operating Instructions

elcometer

English



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Thank you for your purchase of this Elcometer 121/4 Paint Inspection Gauge (P.I.G.). Welcome to Elcometer.

Elcometer are world leaders in the design, manufacture and supply of inspection equipment for coatings and concrete. Our products cover all aspects of coating inspection, from development through application to post application inspection.

The Elcometer 121/4 P.I.G. is a world beating product. With the purchase of this gauge you now have access to the worldwide service and support network of Elcometer. For more information visit our website at www.elcometer.com

1 ABOUT YOUR GAUGE

The Elcometer 121/4 P.I.G. is a hand-held gauge that offers a quick, versatile method of coating examination and measurement in a portable, easy-to-use format.

The gauge is available in two versions, Standard and Top:

- Standard gauges can be used for microscopic coating examination and destructive measurement of coating thickness.
- Top gauges have the same functionality as standard gauges and can also be used for cross hatch adhesion testing using optional tools.

This manual describes the operation of both versions of the gauge; any differences between the function of the two versions are highlighted in the text as [TOP] or [STANDARD].



Top gauge

Your gauge can be used on single or multiple coats on virtually all substrates, including wood, plastics, metals etc.

To maximise the benefits of your new gauge, please take some time to read these Operating Instructions. Do not hesitate to contact Elcometer or your Elcometer supplier if you have any questions.

1.1 FEATURES

- Lightweight and durable - anodised aluminium construction.
- [STANDARD] The gauge holds a single cutting tool with built-in storage for 3 cutting tools.
- [TOP] Cutting tools are mounted on a rotary tool holder within the body of the gauge, allowing rapid change from one test to the next.
- [TOP] The tool holder accommodates three cutting tools plus an optional cross hatch cutting tool.
- Built-in 50x microscope with rotatable graticule scale.
- Bright white LED light - ensures clear vision through the microscope.
- Small size - facilitates use of the gauge in confined areas.

1.2 STANDARDS

Depending upon model, the Elcometer 121/4 P.I.G. can be used in accordance with the following National and International Standards (optional accessories will be required to test in accordance with some of the standards listed):

Standard	Standard	Top
AS 1580.108.2	✓	✓
ASTM D4138-A	✓	✓
DIN 50986	✓	✓
ISO 2808-6B supersedes ISO 2808-5B and BS 3900-C5-5B	✓	✓
ASTM D 3359-B	x	✓
EN 13523-6 supersedes ECCA T6	x	✓
NF T30-123	✓	✓
AS 1580.408.4	x	✓
AS 3894.9	x	✓
ISO 16276-2	x	✓
ISO 2409 supersedes BS 3900-E6, NF T30-038	x	✓

1.3 WHAT THE BOX CONTAINS

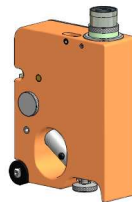
- Elcometer 121/4 P.I.G., Top or Standard model
- Cutting tools, 3x, supplied loose:
 - Cutter #1
 - Cutter #4
 - Cutter #6
- Hexagonal wrench, 2.5 mm
- Black marker pen
- Wrist strap
- Carrying case
- Operating instructions
- Calibration certificate for each cutter (if specified at time of ordering)

The gauge is packed in a cardboard package. Please ensure that this packaging is disposed of in an environmentally sensitive manner. Consult your local Environmental Authority for further guidance.

STANDARD model



TOP model



2 MEASURING FILM THICKNESS

1. Mark the surface to be tested with a stroke of the black marker pen provided with your gauge. Note that there should always be a distinct contrast between the colour of the pen ink and the coating; different pen ink colours may therefore be required for dark coatings.

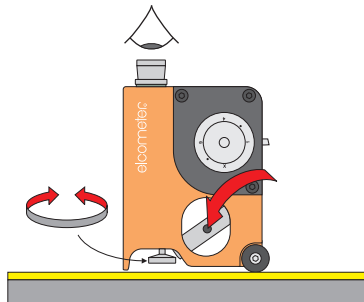
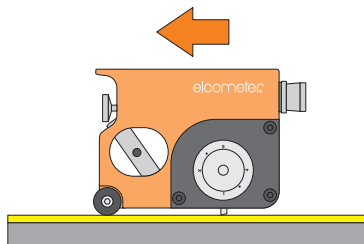
2. Fit/select the appropriate cutting tool - see page 19.

3. Cut the coating at right-angles to the pen mark as follows:

Place the gauge on the specimen with both guidance wheels in contact with the surface of the specimen (this ensures that the knife blade produces an exact vertical cut with no tilting to one side).

Pull the gauge towards you and apply a little pressure. Slight pressure is normally sufficient to penetrate through to the substrate. Heavier pressure may be required for very thick coatings and very hard surfaces.

4. Position the gauge vertically so that the microscope lens is over the cut.
5. Press and hold the light switch to illuminate the cut.
6. Look through the microscope lens and rotate the focus adjuster until the cut is visible clearly.



7. Rotate the graticule scale until it is at right-angles to the cut and the scale divisions are parallel to the cut. Note that one side of the cut will have a straight edge and the other side is likely to be ragged.
8. Measure the width of the cut coating (or coatings) by counting the number of graticule divisions.
To convert the width of the cut coating into coating thickness, either:
Multiply the number of graticule divisions by the graticule scale factor shown in Table 1.

Table 1: Graticule Scale Factor

Cutting tool #	Practical maximum thickness ^a		Cutting angle	Graticule scale factor	
	(μm)	(mils)		mm scale (μm)	inch scale (mils)
1	1600	64	45°	20	0.8
4	800	32	26.6°	10	0.4
6	160	6.4	5.7°	2	0.08

a. Based on using 80% of cutter width

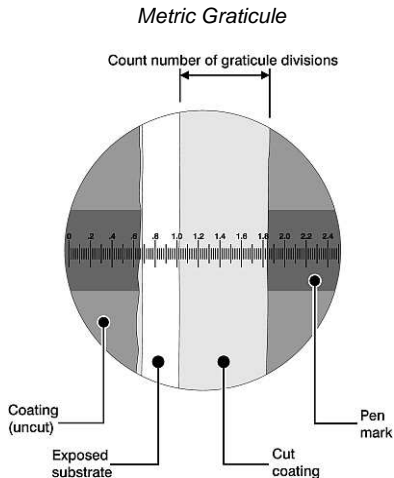
elcometer

In the example shown, the coating thickness using cutting tool #4 is:

41 divisions x 10 μ m per division = 410 μ m or;

41 divisions x 0.4mils per division = 16.4mils.

Or alternatively, calculate the coating thickness using the Table 2, "Additions Table," on page 9.



In the example shown, the coating thickness using cutting tool #4 is:

41 divisions = 40 divisions; 400 μ m (16mils) plus 1 division 10 μ m (0.4mils)

= 410 μ m (16.4mils)

Table 2: Additions Table

Graticule Divisions	Cutting tool #1		Cutting tool #4		Cutting tool #6	
	µm	mils	µm	mils	µm	mils
1	20	0.8	10	0.4	2	0.08
2	40	1.6	20	0.8	4	0.16
3	60	2.4	30	1.2	6	0.24
4	80	3.2	40	1.6	8	0.32
5	100	4.0	50	2.0	10	0.40
6	120	4.8	60	2.4	12	0.48
7	140	5.6	70	2.8	14	0.56
8	160	6.4	80	3.2	16	0.64
9	180	7.2	90	3.6	18	0.72
10	200	8	100	4	20	0.80
20	400	16	200	8	40	1.6
30	600	24	300	12	60	2.4
40	800	32	400	16	80	3.2
50	1000	40	500	20	100	4.0
60	1200	48	600	24	120	4.8
70	1400	56	700	28	140	5.6
80	1600	64	800	32	160	6.4

2.1 MEASURING MULTI-LAYER COATINGS

The thickness of individual layers can be calculated by measuring each layer (see illustration opposite).

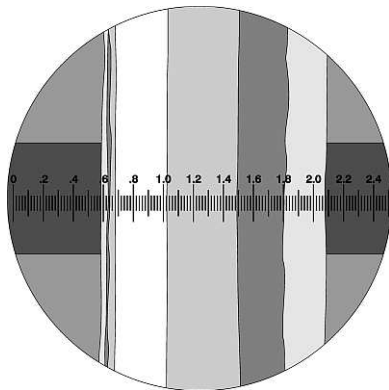
2.2 IRREGULARITIES

Irregularities can occur if very hard, brittle films, or films with insufficient adhesion to the substrate are tested. The following can arise and can be avoided as follows.

IRREGULAR, SHELL-LIKE CUT

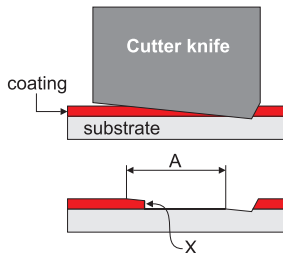
Measure to an imaginary straight line through the best estimate of the centre of the irregular cut edge using the graticule scale. This will give a mean value for thickness.

Typical Multi-layer Coating



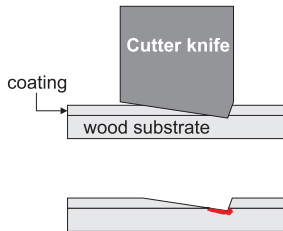
POOR ADHESION (GIVES THE ILLUSION OF TOO LITTLE FILM THICKNESS)

Despite the fact that the coating may have fractured at point 'X', always measure distance 'A' to obtain the thickness of the coating (single layer of coating in this example).



NO SEPARATION

When measuring the thickness of clear varnish on wood, there may be no visible demarcation between the coating and the substrate. If this is the case, soak the exposed wood grain with a dye solution (fountain pen ink). The coating will not absorb any dye, but the wood cells do. This enables the cut width to be measured.



3 [TOP] MEASURING CROSS-CUT ADHESION

The optional cross hatch cutting tool which can be fitted to the Top model scores through the coating right down to the next coating layer or down to the substrate. Two cuts are made at right angles to each other resulting in a grid of small squares. Adhesion is then assessed visually by comparing the grid of squares against ISO, ASTM or Corporate Standards.

3.1 SELECTING CUTTING TOOLS

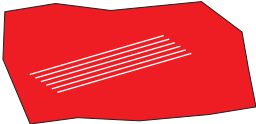
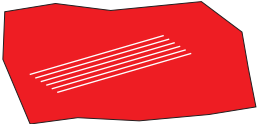
A range of cross hatch cutting tools is available for different thicknesses and types of coating (see “Cross hatch cutting tools” on page 23). Use the table below to select the correct blade.



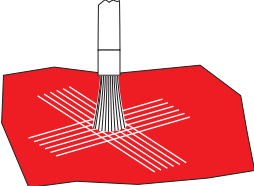
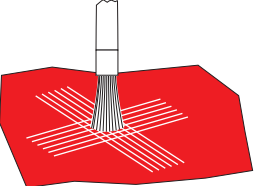
Coating Thickness		Cutter blade - Number of cuts		
(μm)	(mils)	ASTM - Metal substrates	ISO - Hard substrates (metal)	ISO - Soft substrates (wood, plaster)
0 to 50	0 to 2	1 mm - 11 cuts		
50 to 125	2 to 5	2 mm - 6 cuts		
> 125	> 5	x		
0 to 60			1 mm - 6 cuts	2 mm - 6 cuts
61 to 120			2 mm - 6 cuts	2 mm - 6 cuts
121 to 250			3 mm - 6 cuts	3 mm - 6 cuts

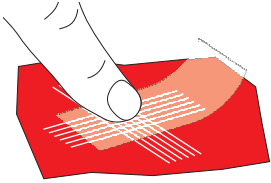
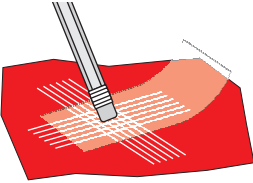
3.2 FITTING THE CUTTING TOOL

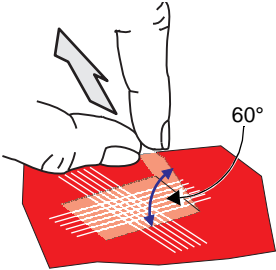
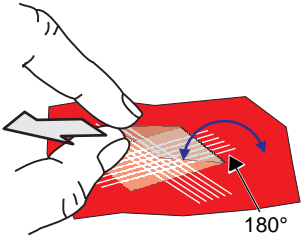
See “Fitting a cross hatch cutting tool” on page 21.

3.3 TEST PROCEDURE

Step	ISO	ASTM
1	<p>Place the cutting tool on the sample, press down gently and pull the tool towards you in one steady movement to make a series of parallel cuts approximately 20 mm long. Apply sufficient pressure to ensure that you cut right through the coating to the surface of the substrate.</p> <p>Note: <i>If the substrate is wood or similar, make cuts at 45° to the direction of the grain.</i></p>	<p>Place the cutting tool on the sample, press down gently and pull the tool towards you in one steady movement to make a series of parallel cuts approximately 20 mm long. Apply sufficient pressure to ensure that you cut through the coating to the substrate.</p>
		










Step	ISO	ASTM
2	Place the cutting tool on the sample at 90° to the first cut and repeat step (1) to create a lattice pattern on the coating.	Place the cutting tool on the sample at 90° to the first cut and repeat step (1) to create a lattice pattern on the coating.
		
3	Using a suitable brush, brush lightly several times forwards and several times backwards along the diagonals of the lattice to remove debris.	Using a suitable brush, brush lightly to remove detached flakes or ribbons of coating.
		
4	Inspect to ensure the cuts have penetrated all the way through the coating.	

Step	ISO	ASTM
5	If the substrate is soft, jump to step (10). If the substrate is hard or wood, proceed to the next step (6)	-
6	Using suitable adhesive tape (see “Adhesive tape” on page 23), remove and discard two complete turns of adhesive tape. Remove an additional length of tape at a steady rate and cut a piece approximately 75 mm from this length.	Using suitable adhesive tape (see “Adhesive tape” on page 23), remove and discard two complete turns of adhesive tape. Remove an additional length of tape at a steady rate and cut a piece approximately 75 mm from this length.
7	Centre the cut piece of tape over the lattice and smooth into place using a finger. Rub the tape firmly using a finger nail or finger tip to ensure good adhesion between the tape and the coating.	Centre the cut piece of tape over the lattice and smooth into place using a finger. Rub the tape firmly using the eraser on the end of a pencil to ensure good adhesion between the tape and the coating.
		

Step	ISO	ASTM
8	Within 5 minutes of applying the tape, remove the tape by pulling in a single smooth action taking approximately 0.5 to 1 seconds at an angle of 60° to the coating surface.	Within 90 seconds (± 30 seconds) of applying the tape, remove the tape by pulling in a single smooth action at an angle of 180° to the coating surface.
		
9	To maintain a permanent record of the test, retain the tape by applying it to a transparent film	-

Step	ISO	ASTM
10	<p>Assess the coating adhesion by viewing the lattice of cuts in good light. If agreed, use an eye glass to aid viewing.</p> <p>Compare the lattice of cuts with the ISO and ASTM standards shown in “ISO and ASTM standards” on page 18.</p>	<p>Assess the coating adhesion by viewing the lattice of cuts using an illuminated magnifier.</p> <p>Compare the lattice of cuts with the ISO and ASTM standards shown in “ISO and ASTM standards” on page 18.</p>
11	Repeat the test at two other positions	
Note: For full details of the test method, consult the standard.		

Table 3: ISO and ASTM standards

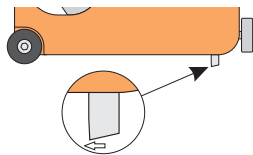
Surface		Description	ISO	ASTM
		The edges of the cuts are completely smooth; none of the squares of the lattice is detached.	0	5B
		Detachment of flakes of the coating at the intersections of the cuts. A cross cut area not significantly greater than 5% is affected.	1	4B
		The coating has flaked along the edges and/or at the intersections of the cuts. A cross cut area significantly greater than 5%, but not significantly greater than 15% is affected.	2	3B
		The coating has flaked along the edges of the cuts partly or wholly in large ribbons, and/or it has flaked partly or wholly on different parts of the squares. A cross cut area significantly greater than 15%, but not significantly greater than 35%, is affected.	3	2B
		The coating has flaked along the edges of the cuts in large ribbons and/or some squares have detached partly or wholly. A cross cut area significantly greater than 35%, but not significantly greater than 65%, is affected.	4	1B
		Any degree of flaking that cannot be classified even by classification 4 (1B).	5	0B

4 FITTING CUTTING TOOLS



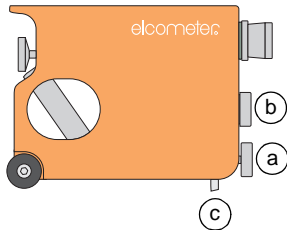
Always take care when handling cutting tools and when handling the gauge with cutting tools fitted. Cutting tools are very sharp and can cause injury if not handled with care.

When fitting any cutting tool, ensure that the tool is inserted such that the highest point of the tool is closest to the wheels of the gauge as shown in the illustration.



4.1 [STANDARD] MODELS

1. To remove a cutting tool, place the gauge on its side, loosen the retaining screw (a) and then pull out the cutting tool.
2. Spare cutting tools are stored in the body of the instrument. To gain access to this built-in storage, unscrew the end cap (b) and invert the gauge, taking care not to drop the cutters as they slide out (cutting tips can be damaged by impact). Replace the spare cutting tools and re-fit the end cap.
3. Fit the cutting tool (c), pushing it all the way into the recess. When inserted correctly the cutting tool should protrude from the base of the gauge the same extent as the wheels.
4. Tighten the retaining screw to secure the cutting tool.



4.2 [TOP] MODELS

Your gauge is supplied with a set of three cutting tools. Before using the gauge for the first time you must fit the cutting tools onto the cutter holder. If you are using the gauge for cross hatch adhesion testing, also fit the optional cross hatch cutting tool.

The cutting tool selection wheel is marked 1, 4, 6 and X to indicate the position of the tools in the tool holder (X indicates the position of the optional cross hatch cutting tool - page 23).

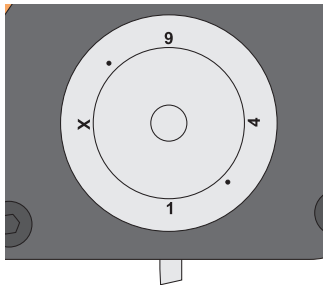
When you are fitting a tool into the tool holder, ensure that it is fitted in the appropriate position (tool # 1 in position 1, etc.).

The tool selection wheel is also marked with two dots:

- The dot between 1 and 4 indicates the safe position for the tool holder. When the tool selection wheel is in this position all the cutting tools are withdrawn into the body of the gauge.

Note: *In order to reduce the risk of cuts from an exposed cutting tool, always place the tool selection wheel in this position when the gauge is not in use.*

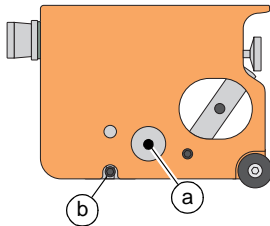
- The dot between 6 and X indicates the correct position of the tool holder when fitting the optional cross hatch cutting tool.



Cutting tool selection wheel

FITTING CUTTING TOOLS 1, 4 AND 6

1. Unscrew the tool holder locking screw (a).
2. Rotate the cutting tool selection wheel until a cutting tool mounting screw becomes visible (b).
3. Tighten the tool holder locking screw.
4. Place the gauge on a flat surface with the cutting tool selection wheel facing downwards.
5. Using the hexagonal wrench supplied, unscrew the cutting tool mounting screw.
6. Place the cutting tool in the tool holder with the reference number of the cutting tool facing towards the selection wheel. Slide the cutter into the tool holder as far as it will go. When inserted correctly the cutting tool should protrude from the base of the gauge the same extent as the wheels.
7. Tighten the cutting tool mounting screw.
8. Repeat the above steps for the remaining cutting tools. Do not forget that a cutting tool is already loaded; take care!



FITTING A CROSS HATCH CUTTING TOOL

The cross hatch cutting tool is fitted into the cutter holder in the location engraved with an X.

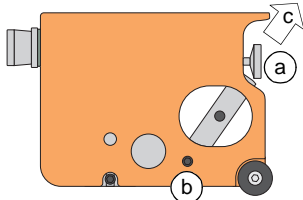
To fit a cross hatch cutting tool, follow the instructions given previously for fitting cutting tools but rotate the tool selection wheel to the dot between 6 and X and lock into this position before mounting the tool.

5 REPLACING BATTERIES IN THE TORCH

The Elcometer 121/4 P.I.G. uses dry cell batteries only.

The torch is fitted with 4x AG3 batteries which will give many hours of illumination. To fit or replace the batteries:

1. Unscrew and remove the focusing thumbscrew (a).
2. Using the hexagonal wrench supplied, loosen the single mounting screw (b).
3. Remove the torch from the gauge in the direction of the arrow (c).
4. Rotate the end cap (the end opposite to the LED) of the torch and remove.
5. Remove the old batteries.
6. Fit new batteries into torch (positive end first) and then refit the end cap of the torch
7. Secure the torch in the gauge body in reverse order.
8. Replace the focusing thumbscrew.



(illustration shows [TOP] model)

Note: Remove the batteries from the gauge if it is to remain unused for a long period of time. This will prevent damage to the gauge in the event of malfunction of the batteries.

Batteries must be disposed of carefully to avoid environmental contamination. Please consult your local Environmental Authority for information on disposal in your region.

Do not dispose of any batteries in fire.

6 SPARE PARTS AND ACCESSORIES

The following spare parts and optional items are available from Elcometer, or your local supplier:

6.1 CUTTING TOOLS

Cutting tool #1	T99915761-1
Cutting tool #4	T99915761-4
Cutting tool #6	T99915761-6

6.2 CROSS HATCH CUTTING TOOLS

Cutting tool, 6 x 1 mm:	T99913700-1
Cutting tool 11 x 1 mm:	T99913700-2
Cutting tool 11x 1.5 mm:	T99913700-3
Cutting tool, 6 x 2 mm:	T99913700-4
Cutting tool, 6 x 3 mm:	T99913700-5

6.3 MISCELLANEOUS

Black marker pen:	T1214434-
Carrying case:	T12121191
Hexagonal wrench, 2.5 mm:	T9996287-

6.4 ADHESIVE TAPE

Adhesive tape, ASTM D3359 1 Roll:	K0001539M001
Adhesive tape, ASTM D3359 2 Rolls:	T9998894-
Adhesive tape, ISO2409 1 Roll:	K0001539M012
Adhesive tape, ISO2409 2 Rolls:	T9999358-

7 MAINTENANCE

The Elcometer 121/4 P.I.G. is designed to give many years reliable service under normal operating and storage conditions.

If the cuts become ragged, replace the cutter tool. If the light does not work, replace the battery.

The gauge does not contain any other user-serviceable components. In the unlikely event of a fault, the gauge should be returned to your local Elcometer supplier or directly to Elcometer. The warranty will be invalidated if the instrument has been opened. Contact details can be found on the outside cover of these instructions and at www.elcometer.com

8 TECHNICAL DATA

Gauge range:	Depends upon cutting tool; see tables on pages 7 & 11
Microscope magnification:	50x
Accuracy:	Depends upon cutting tool cut angle and user's reading
Gauge body material:	Anodised aluminium
Power supply (torch):	4x AG3 batteries
Gauge weight:	[STANDARD] 369 g (13 oz), [TOP] 383 g (13.5oz)
Gauge dimensions:	[STANDARD] 110 mm x 75 mm x 30 mm (4.3" x 3" x 1.2") [TOP] 110 mm x 75 mm x 40 mm (4.3" x 3" x 1.6")

9 RELATED EQUIPMENT

In addition to the Elcometer 121/4 P.I.G., Elcometer produces a wide range of other equipment for testing and measuring the characteristics of coatings. Users of the Elcometer 121/4 P.I.G. may also benefit from the following Elcometer products:

- Elcometer 157 Coating Thickness Gauge
- Elcometer 195 Säberg Drill
- Elcometer 456 Coating Thickness Gauge
- Elcometer Coating Adhesion Testers

For further information contact Elcometer, your local supplier or visit our website at www.elcometer.com