Bedienungsanleitung MiniTest 600 Version 2.4 Englisch

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MiniTest 600

Technical Reference and

Operating Manual

Advancing with Technology

ElektroPhysik

Table of Contents

1. General Information

1.1 Applications

This compact, handy pocket gauge is designed for non-destructive, fast and precise coating thickness measurement. The principal applications lie in the field of corrosion protection. It is ideal for manufacturers and their customers, for offices and specialist advisers, for paint shops and electroplaters, for the chemical, automobile, shipbuilding and aircraft industries and for light and heavy engineering.

The range of applications is indicated by the probes available.

- F probes work on the magnetic induction principle and should be used for non-magnetic coatings such as aluminium, chrome, copper, zinc, paint and varnish, enamel, rubber etc., on an iron or steel substrate; they are also suitable for alloyed and hardened magnetic steel.

- N probes work on the eddy-current principle and should be used for insulating coatings on all non-ferrous metals and on austenitic stainless steels, e.g. paint, anodising coatings, ceramics, etc. applied on aluminium, copper, zinc die-casting, brass, etc.

- FN probes work on a combination of the magnetic induction and the eddy-current principle. One probe only is required for coating measurement both on ferrous and non-ferrous metal substrates. When switched to automatic mode (see 1.2) both principles are used for coating measurement (the gauge version MiniTest 600 B is not equipped with an automatic mode to switch automatically between the two measuring principles).

1.2 Description of the gauge

Measured values and user information are shown on a large, easy-to-read LC display. A display back light (optional) ensures easy reading of screen data in poorly-lit conditions. The gauges' user-friendly measuring system permits automatic storage of up to 9 999 readings in one memory matrix for later statistical evaluation (statistical evaluation is not possible with MiniTest 600 B).

Note:

- MiniTest 600 FN is equipped with a manual as well as with an automatic mode.
- The manual mode serves to activate either the magnetic induction principle (F) or the eddy-current principle (N) by means of the arrow keys.
- Owing to a special evaluation algorithm the correct coating thickness is always shown after corresponding calibration when the

gauge is switched to automatic mode working on ferrous steel as well as on non-ferrous metal (the gauge version MiniTest 600 B is not equipped with an automatic mode).

- The statistical values measured on steel or on nonferrous metal (n, x, s, max, min) are stored in separate memories.

- All MiniTest 600 gauges are suitable for particular fields of application, e.g. for measurement on special geometries. After storage of the corresponding parameters the gauge automatically takes them into consideration.

The portable data printer MiniPrint 4100 allows immediate printing of measured values and subsequent printing of the 5 statistical values. The data printer is connected to the MiniTest by means of a cable and is instantly ready for use (printing and statistical evaluation are not possible with MiniTest 600 B).

1.3 Equipment

Standard gauge including probe(s), 2 alkaline batteries, zero standards, calibration foils and operating instructions.

1.4 Probe construction

All probe systems are spring-mounted in the probe sleeve. This ensures safe and stable positioning of the probe and even contact pressure. A V-groove in the sleeve of the probes facilitates reliable readings on small cylindrical parts.

The probe should be held by the spring-mounted sleeve.The hemispherical tip is made of hard and durable material.

2. Preparing the MiniTest 600 gauges

2.1 Checking the power supply

1. 2 x 1.5 volt alkaline-battery or
   2 x 1.2 volt rechargeable battery

2. Check battery condition by pressing ON .

- no LC display:

  battery missing or batteries charge too low to illuminate display

- no BAT display:

  batteries is sufficiently charged

- flashing BAT display, gauge switches itself off after about 1 sec:

  replace batteries immediately

If the BAT display flashes during measurement, the batteries are running low and should be replaced before the gauge is switched on again. If not, the LC display will show the permanent BAT warning and the gauge will switch itself off after about a second.

Note:

Note that the gauge will not make faulty measurements even if the voltage is very low.

2.2 Replacing the batteries

1. Place the gauge upside down on a suitable surface.
2. Push the lid of the battery compartment in direction of the arrow and raise the lid of the compartment.
3. Remove batteries.
4. Insert new batteries.
5. Replace the battery compartment lid.

Caution:

Make sure that the positive and negative poles are correctly positioned. If not, all data saved to memory will be lost.

An interval of more than 10 seconds between removing the old batteries and inserting the new one will also result in the loss of data (readings, calibration values, time and date).

2.3 Start-up functions

The MiniTest 600 gauges include a number of functions that can only be called up or activated through start-up of the gauge.

Function	Key combination
Total reset	ZERO + CLEAR + ON
LCD-Test	⇑–key + ON
Set gauge options	ZERO + ON

2.3.1 Total reset

A total reset erases all statistical and calibration data and the gauge will resume the basic MODI-setting (ZERO - : / 0, see section 2.4).

1. Switch off gauge.
2. Press CLEAR-, ZERO- and ON simultaneously.

Total reset is confirmed by a long bleep.

2.3.2 LCD segment test

The LCD segment test enables all sections of the LC display to be inspected and checked.

1. Switch off the gauge.
2. Hold down the ⇧-key, press ON and keep both keys depressed. As long as the arrow key is depressed, all sections of the LC display will be shown.

2.4 Basic gauge settings

1. Switch off the gauge, hold down the ZERO key and press ON.

2. Keep both keys pressed until you hear the signal. The gauge will now display a pair of numbers: 1:0 or 1:1.

Note:

If you are using a MiniTest 600 FN, use the arrow keys to activate the F section (⇧) or the N section (⇩) or wait 3 seconds until switching between sections is performed automatically.

3. Press ZERO to move through each of the table's function from 1 to 4. Use the arrow keys to set the option 0 or 1.

4. Press ZERO again to return to measuring mode.

Table of basic settings

Zero-key	Arrow-keys ↑↓	Modi-setting	
1	0	wwitch-off mode	short-term mode
	1		long-term mode
2	0	key lock mode for ZERO Cal	off
	1		keylock
3	0	display light (option)	inactive
	1		active
4	0	measuring mode	metric/mm
	1		imperial/inch

2.4.1 Switching between short-term and long-term modes

The gauge is programd to switch itself off after about 90 seconds of inactivity. This can hinder operations in certain circumstances. In this case please switch sto the alternative long-term mode.

To switch the gauge to long-term mode, please refer to the table of gauge settings in section 2.4.

Adjust to the new mode with the ZERO- and arrow keys as described.

2.4.2 KEYLOCK Function for ZERO- and CAL-keys (locks calibration keys)

An accidental recalibration or unintentional offset input can be prevented by using the KEYLOCK function.

To activate the KEYLOCK function please refer to the table of gauge settings in section 2.4. Select option with the ZERO and arrow keys as described.

2.4.3 Activating/deactivating the LC display light (optional)

A switch-on LC display lamp can be supplied as an optional extra. When activated, it lights the display for about 2 sec after a reading has been taken. Please remember that using the lamp requires extra power.

To activate the display light please refer to the table of gauge settings in section 2.4. Select option with the ZERO and arrow keys as described.

2.4.4 Select a measuring unit 'metric' - 'inch' (imperial)

Readings can be taken and displayed in metric and imperial units. To switch from metric units (µm, mm, cm) to imperials (mils, inch) or vice versa, please refer to the table of gauge settings in section 2.4. Select option with the ZERO and arrow keys as described.

3. Calibration and measurement

3.1 General remarks on calibration

3.1.1 Methods of calibration

Three different calibration methods are available for the MiniTest 600 gauges:

- Standard calibration

  recommended for even surfaces and for approximate measurements, i.e. those that do not require the degree of accuracy of one-point calibration.

- One-point calibration:
  set zero without foil

  recommended when measuring errors up to 4 % are permitted. The given error range of the probe of ± 2 µm should also be taken into account.

- Two-point calibration:
  set zero and calibrate with one foil

  recommended when measuring errors of between 2 % of the measured value are permitted. The given error range of the probe of ± 2 µm should also be taken into account.

3.1.2 Saving calibration values

If the gauge is calibrated for a particular purpose, the calibration values will be logged in memory until changed.(See also section 3.1.8, ‘Stabilisation of calibration values’).

If a calibration is to be altered using the same probe, simply carry out a new calibration. This automatically deletes the previous calibration values and saves the new ones for immediate use.

Note:

If during the calibration procedure:

- an incorrect reading is taken

- an incorrect command is entered
- the gauge is for any reason switched off

calibration cannot be continued. Restart the procedure from the beginning.

3.1.3 Example of calibration

Calibration is the most important requirement for accurate measurement. The more closely the calibration sample matches the product sample, the more accurate the calibration, and therefore the reading, will be.

Example:

If a product is to be measured on a steel cylinder, quality ST37 (mild steel) with a diameter of 6 mm (0.24"), the calibration of an uncoated sample must take place on a steel cylinder of similar quality with the same diameter.

The calibration sample must correspond to the product sample in the following ways:

- in the radius of curvature of the surface
- in the characteristics of the substrate
- in the thickness of the substrate
- in the size of the area to be measured

For more detailed information please refer to the technical details in chapter 12.

The point at which the calibration is made on the calibration sample must always be identical with the point of measurement on the product itself, especially in the case of corners and edges of small components. The precision stand proves invaluable here.

3.1.4 The effects of substrate thickness

In the case of steel substrates, the thickness is of no consequence as long as it is greater than the general measuring range of the probe in use.

In the case of non-ferrous metals, it is sufficient when the substrate is 50 µm (2 mils) thick and strong

enough not to give way under the pressure of the probe tip. A thin layer of aluminium foil can be suitable, if stuck on a hard base.

The enclosed steel and aluminium zero plates are for test purposes only and are generally not recommended for calibration.

Exceptions:

The zero plates may be used for calibration if the product sample has a smooth, even surface (not shot-blasted) and

- if steel parts are thicker than 1 mm (40 mils). In this case, the zero plate may be used for calibration by laying it on the coated sample.
- if aluminium parts are thicker than 50 µm (2 mils). In this case the enclosed aluminium plate may be used for calibration. (Thin layers of aluminium foil should be stuck to a hard base.)

3.1.5 High-accuracy calibration

To achieve high-accuracy readings, it is advisable to log calibration values (both zero values and calibration foil values) several times in succession. In this way the gauge will automatically establish a mean calibration value. For more details see sections 3.2.2 - 3.2.4 on calibration.

This method is an obvious advantage when calibrating on uneven, e.g. shot-blasted surfaces.

3.1.6 Cleaning the measuring point

Before calibration, the measuring point and the probe tip must be free from grease, oil, scraps of metal, etc. .The slightest impurity will affect measurement and distort readings.

3.1.7 Acoustic signal

Whether the probe is being used for calibration or for measurement, it must be held in place and not lifted until the bleep sounds.

3.1.8 Stabilisation of calibration values.

No recalibration is necessary in changeable external conditions, e.g. variations in ambient temperature, as the gauge automatically takes these into account.

3.2 Points to remember when calibrating

When calibrating according to sections 3.2.2 to 3.2.3, the basic procedure is always as follows:

1. Start calibration by pressing the appropriate calibration key (ZERO or CAL).

2. Apply the probe to calibration foil several times.

3. If necessary, adjust the value shown on the LC display to the calibration foil value by means of the arrow keys.

4. End calibration by pressing the calibration key again (ZERO or CAL).

3.2.1 Activate standard calibration

The probe must be at a distance of at least 50 mm (2") from metal components.

1. Press ZERO.
2. Press CLEAR.
3. Take readings.

The standard calibration stored in the gauge should only be used for measurements on even surfaces, i.e.

a) on steel components made of conventional construction steel (mild steel)

b) on aluminium components and other non-ferrous metals e.g. copper, zinc, brass etc.

Note:

It is important to record a sufficient number of exact zero readings on an uncoated sample. If not, one-point or two-point calibration should be used.

3.2.2 One-point calibration without foil (zero only)

1. Press ZERO to initialise ZERO calibration. The display will show ZERO (flashing) and MEAN (steady). MEAN indicates that the mean value of the readings will be shown on the display.

2. Place the probe on the uncoated sample (zero coating thickness) and raise it after the bleep.

   Place the probe on the uncoated sample several times. The display always shows the mean value of the previous readings.

   To discontinue ZERO calibration, press CLEAR.

3. Press ZERO to end zero calibration. The word ZERO will appear on the display (steady).

4. Now take readings by placing the probe on the unknown coating and raise it after the bleep.

   Read off the thickness value.

5. It may be necessary to delete the ZERO calibration if, for example, an incorrect zero value is entered. In this case:

a) press ZERO and then CLEAR to delete the zero calibration and any existing CAL calibration.

Note:

- This will reactivate the default standard calibration for use on even surfaces.
- ZERO calibration deletes an already existing CAL calibration.

3.2.3 Two-point calibration (ZERO with one calibration foil)

This method is recommended for high precision measurement and for measurement on small components and hardened and low-alloy steels.

1. Press ZERO to initialise ZERO calibration

   The display will show ZERO (flashing) and MEAN (steady). MEAN indicates that the mean value of the readings will be shown on the display.

2. Place the probe on an uncoated sample (zero coating thickness) and raise it after the bleep.

   Place the probe on the uncoated sample several times. The display always shows the mean value of the previous readings.

   To discontinue ZERO calibration, press CLEAR.

3. Press ZERO to end ZERO calibration. The word ZERO (steady) will appear on the LC display.

4. Press CAL to initialise foil calibration.

   The display will show CAL (flashing) and MEAN (steady). MEAN indicates that the mean value of the readings will be shown on the display.

5. Lay the calibration foil on an uncoated sample, place the probe on the foil and raise it after the bleep.

   The thickness of the foil should be roughly equivalent to the estimated coating thickness.

   Place the probe several times on the test sample. sThe display always shows the mean value of the previous readings.

Note:

If, for instance, an incorrect calibration value is measured by mistake, calibration can be discontinued by pressing CLEAR. The gauge returns to the measuring mode using the previous calibration.

6. Adjust to the thickness of the foil with the arrow keys.

7. Press CAL to end CAL calibration. CAL will appear on the display (steady).

8. Now take readings by placing the probe on the unknown coating and by raising it after the bleep.

9. It may be necessary to delete the CAL calibration if, for example, an incorrect calibration is entered. In this case:

a) Press CAL then CLEAR to delete the CAL calibration and any existing ZERO calibration.

Note:

- This will reactivate the default standard calibration for use on even surfaces.

- Even while a series of measurements is being taken, foil calibration can be carried out as often as necessary. The old calibration will be overwritten; the ZERO calibration remains in memory.

3.2.4 Calibration and measurement with MiniTest 600 FN

The universal probe of MiniTest 600 FN uses both the magnetic induction (measuring range: 0 ... 3mm (0 ... 0.12") and the eddy-current principle (measuring range: 0 ... 2 mm (0 ... 0.08")).

To select the measuring method, press ON. The word FERROUS will flash on screen. Press the ⇧-key to select FERROUS, i.e. the magnetic induction method.

Press the ⇩-key to select NON-FERROUS, i.e. the eddy-current method. If none of the keys is pressed, the gauge will automatically switch to automatic mode after about 3 sec.

This mode can be used if the substrate type (steel or non-ferrous metal) is not known.

Calibration for the automatic mode requires a previous measurement on the uncoated substrate. The display will then show FERR or NON-FERR.

For calibration and measurement, proceed as normal according to either 3.2.2 or 3.2.3 or 3.2.5.

For alternating measurements on steel and non-ferrous substrates, calibration must be performed on uncoated samples of both substrates. Measurements can then be carried out immediately.

3.2.5 Calibration and measurement on shot blasted surfaces

The physical nature of shot-blasted surfaces results in coating thickness readings which are too high.

The mean thickness over the peaks can be determined as follows (note that the statistics program is of great benefit in this procedure):

Method A

This method should be used for surfaces with a roughness grade of min. 20 µm (0.8 mils).

1. The gauge should be calibrated according to the method described in 3.2.2 or 3.2.3. Use a smooth surface with the same curvature radius and the same substrate.

2. Now take approx. 10 readings on the uncoated, shot-blasted surface to obtain the mean $\overline{x}_o$.

3. Subsequently, take approx. 10 further readings on the coated and similarly shot blasted test sample to produce the mean value $\overline{x}_m$.

4. The difference $(\overline{X}m - \overline{X}o) \pm s$ is the mean coating thickness over the peaks; s is the greater standard deviation of the two values $\overline{X}m$ and $\overline{X}o$.

Method B

This method should be used for surfaces with a roughness grade of max. < 20 µm (0.8 mils).

1. Carry out a zero calibration of 10 readings on a shot-blasted, uncoated substrate. Then calibrate with a foil on the uncoated substrate. The foil set should consist of a number of individual foils of max. 50 µm (2 mils) thickness each and should roughly correspond to the estimated coating thickness.

   The coating thickness can be read directly and should be averaged from 5 ... 10 single measurements. The statistics function is useful here.

3.2.6 Adjusting the basic calibration

In certain cases it can be of assistance or even imperative to reset the standard probe calibration e.g.

- if the probe tips are worn
- for special applications.

On request, adjustment of the basic calibration can be performed by the manufacturer, if necessary with samples from the customer.

3.3 General remarks on measurement

After careful calibration has been made all subsequent measurements will lie within the guaranteed measuring tolerance (see technical data).

Strong magnetic fields near generators or live rails with strong currents can affect the reading.

When using the statistic program (not available when using MiniTest 600 B) for obtaining a mean value it is advisable to place the probe several times in the

relevant areas. Any false or freak readings can be cleared immediately by pressing CLEAR.

The final reading derives from:

1. the statistical calculations and
2. the guaranteed tolerance levels of the gauge.

4. Measurement using statistics

The MiniTest 600 can calculate statistics from a series of stored measurements (max. 9 999 readings). The statistical values can be printed out without a list of corresponding single values (see 4.5). Single values can only be printed out directly during measurement.

This program automatically stores and evaluates the readings of a series. The analysis of any one series appears on the display and on the print-out as follows:

n-values: number of single values

mean ($\overline{x}$): mean of single values

st.d. (s): standard deviation

max: highest single value

min: lowest single value

At least 2 single values are required to obtain a statistical analysis which consists of the 5 values listed above.

4.1 Definition of statistical values

- Mean $\overline{x}$

  The mean is the sum of the single values divided by the number of readings

  MEAN = $\overline{x} = \frac{\Sigma x}{n}$

- Standard deviation s (STD. DEV)

  The standard deviation measures the scattering of readings. The greater the

scattering, the greater the standard deviation.

S is calculated from the positive square root of the scattering s^2.

Scattering is defined as the sum of the deviations from the arithmetical mean squared, then divided by the number of measured values minus 1.

scattering $$s^2 = \frac{\Sigma(x - \bar{x})^2}{n-1}$$

standard deviation $$s = \sqrt{s^2}$$

4.2 Entering a series of measurements for statistical analysis

1. The gauge can be used for measurements immediately after it is switched on. All readings will be automatically logged to the statistics program.

2. Remember to check whether calibration is required and/or if any redundant statistical values need to be erased.

3. To recalibrate, simply overwrite the old calibration.

4. Any remaining statistical values can be erased by pressing STATS and CLEAR.

4.3 Storage capacity overflow

If the storage capacity (more than 9 999 values) is exceeded the 5 statistical values will not be updated, although measurement can continue.

Subsequent readings will be marked with the error message E11.

4.4 Display and print-out of the 5 statistical values for a series of measurements (no single value)

Each time STATS is pressed the statistical values will appear in the order N (values), MEAN, ST.D., MAX, MIN.

If a MiniPrint printer is connected the statistical values can be printed out or transferred via a serial interface to a PC.

The statistical values can be viewed at any time, even while a series of measurements is being taken.

5. 'Delete' functions

5.1 Deleting the last reading taken

Press the CLEAR pad once immediately after a reading has been taken. A short bleep confirms that the reading has been deleted.

5.2 Deleting statistics

Press STATS and CLEAR. A short bleep confirms that the reading has been deleted.

For MiniTest 600 FN the statistics of the F-part and the N-part are deleted separately.

- The desired measuring procedure in automatic mode (F-probe or N-probe) is

activated through a measurement on the corresponding substrate (steel for F-probe, e.g. alumumium for N-probe). Press STATS and CLEAR. A short bleep confirms that the statistics of the last measurements have been deleted.

- Alternatively switch off the MiniTest 600 FN and activate the F-probe or N-probe by means of the arrow keys when switching the gauge on again. Press STATS and CLEAR. A short bleep confirms that the statistics for the selected measuring principle have been deleted.

7. Interface description

The gauge MiniTest 600 can be connected to a PC with a uni-directional RS232C interface. An RS232 interface connection cable is necessary which can be ordered from us.

Interface parameters:

Baud rate:	1200
Data bits:	8
Stop bits:	1
Parity:	No

8. Accessories

- In-service carrying case
- Clear-view cover for protection against mechanical damage.
- MiniPrint 4100, portable data printer
- Connecting cable MiniTest/PC
- Cable to connect MiniTest 600 to MiniPrint 4100, portable printer
- Precision stand for high-precision readings and measurements on small components

- Accumulator and battery charger 230V AC or 110V AC

9. Maintenance

The MiniTest needs an occasional battery change but is otherwise maintenance-free. Used batteries must be removed from the gauge without delay.

10. Customer service

Please send a damaged or defective gauge to us directly or forward it via your dealer.

We should be grateful if you could enclose a brief description of the fault.

11. Troubleshooting

The following list of error messages explains how to identify and eliminate faults. ”E“ (E = error).

Faults which cause the gauge to switch off:

E 3: Probe defective. This message only appears immediately after the gauge is switched on.

E 4: Probe is giving unreliable readings (e.g. as a result of strong fluctuations in the magnetic field or readings taken on soft coatings).

E 5: Probe was held too close to metal when switched on.

E 6: Battery voltage too low.

Error messages displayed for about 1.5 sec:

E 11: Memory full.

If faults occur without an error message appearing, e.g.:

- the gauge does not switch itself off automatically
- readings are no longer registered

- the keyboard does not function properly
- readings illogical

Note:

The quickest remedy is a total reset!

12. Example of how to operate the MiniTest 600

Gauges available:

- MiniTest 600 F;
- MiniTest 600 N;
- MiniTest 600 FN.

also required: steel or aluminium zero plate

1. Press ON.

- According to probe type, the display will show FERROUS or NON-FERROUS and µm or mils.

1a. Exception: MiniTest 600 FN:

a. FERROUS flashes on the display.

b. Press the arrow keys within the next 3 sec. to choose between measurements on iron and non-ferrous materials:

Press (⇧) for measurements on steel (“Ferr”).

Press (⇩) for measurements on non-ferrous metals (“Non-Ferr”).

(If necessary switch off the gauge and start again).

After 3 sec. the gauge automatically switches to automatic mode, i.e. after corresponding calibration, the gauge measures the right coating thickness on steel as well as on non-ferrous metals.

2. Press ZERO.

- ZERO flashes on the display

3. Place the probe several times on the zero plate.

   - F probes on the enclosed steel standard.
   - N probes on the enclosed aluminium standard.
   - FN probes either on the steel or aluminium standard.

4. Press ZERO.

   - The display will show ZERO.

5. Now start measurement.

E.g. take a calibration foil, lay it on the zero plate and place the probe on it several times.

The gauge will now display the calibration foil thickness, taking into account gauge tolerances.

For increased accuracy calibrate again with one of the calibration foils.

6. Press CAL

- CAL flashes on the display.

7. Place one of the enclosed calibration foils on the zero plate and apply the probe several times.

8. Adjust to the thickness of the foil with the arrow keys.

9. Press CAL.

- The display will show ZERO and CAL and µm or mils.

For further details, please look up the point you wish to clarify by referring to the Contents (at the front) or the Index (at the back) of the operating instructions.

13. Technical Data

13.1 Technical data (metric system)

Gauge type	600 F for steel substrates	600 FN for steel and NE-metal substrates	600 N for NE-metal substrates
Principle	magnet-inductive		
		eddy-current	
Measuring range	0 ... 3 mm	0 ... 3 mm (F) 0 ... 2 mm (N)	0 ... 2 mm
Low range resolution	0.2 mm		
Guaranteed tolerance level	± (2 µm + 2 % of the reading)		
Min. radius of curvature	5 mm convex		
	25 mm concave		

Min. measuring area	20 mm diameter	20 mm diameter	20 mm diameter
Min. substrate thickness	0.5 mm	F: 0.5 mm N: 50 µm	50 µm
Probe dimensions	150 mm diameter x 62 mm		
Power supply	2 x 1.5 V alkaline mignon batteries, NiMh accumulator batteries (LR6/AA)		
Industrial standards	DIN 50981, 50984; ISO 2178, 2360; BS 5411; ASTM B499, B244		
Ambient temperature gauge	0 ... 50° C		
Ambient temperature probe	-10 ... 70° C		
Dimensions	115 mm x 64 mm x 25 mm		
Weight	270 g		

13.2 Technical Data (imperial system)

Gauge type	600 F for steel substrates	600 FN for steel and NE-metal substrates	600 N for NE-metal substrates
Principle	magnet-inductive		
		eddy-current	
Measuring range	0 ... 120 mils	0 ... 120 mils (F) 0 ... 80 mils (N)	0 ... 80 mils
Low range resolution	0.02 mils		
Guaranteed tolerance level	± (0.08 mils + 2 % of the reading		
Min. radius of curvature	0.2 inch convex		
	1.2 inch concave		

Min. measuring area	0.8 inch diameter	0.8 inch diameter	0.8 inch diameter
Min. substrate thickness	20 mils	F: 20 mils N: 2 mils	2 mils
Probe dimensions	150 mm diameter x 62 mm		
Power supply	2 x 1.5 V alkaline mignon batteries, NiMh accumulator batteries (LR6/AA)		
Industrial standards	DIN 50981, 50984; ISO 2178, 2360; BS 5411; ASTM B499, B244		
Ambient temperature gauge	32 ... 122° F		
Ambient temperature probe	14 ... 158° F		
Dimensions	4.53 inch x 2.5 inch x 0.98 inch		
Weight	9.5 ozs		

Index

A

B

C

D

E

G

I

K

L

M

O

P

R

S

T

V

Z