

COATING THICKNESS TESTERS

MODEL E10/2 Version 3.5

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IMPORTANT

The **SERFILCO E10/2** uses the electronic properties of the base material as the basis for measurement. Large masses of ferrous materials and strong electromagnetic fields adversely affect these measurements. Therefore, do not attempt measurements on steel benchtops or near electric motors, transformers or high current conductors. If it is necessary to make measurements on steel benchtops, install a one-half inch thick insulator (wood, rubber, plastic, etc.) between the benchtop and the materials under test.

It is recommended that the instrument be allowed to come into thermal equilibrium with its environment before use. This ensures that the electronics are stable, thus minimizing deviation (temperature drift) after calibration.

The supplied calibration standards and base material must be treated with care. The accuracy of this instrument depends upon these and improper treatment or misuse will result in erroneous measurement readings. It is recommended that these materials be stored in the provided "Ziploc" bag at all times except when used for calibration. Oil films or oxidation on standards or materials to be tested have adverse effects. Large stray magnetic fields may result in permanent magnetization of the steel base material.

SECTION 1

APPLICATION

The **SERFILCO E10/2** is a non-destructive coating thickness measuring instrument based upon the induced eddy current principle. It is capable of measuring:

1. Non-conductive coatings on non-ferrous substrates.
2. Non-conductive coatings on para-magnetic substrates.

The **SERFILCO E10/2** meets ISO2360, ASTM B244, BS5411(3) and DIN50984.

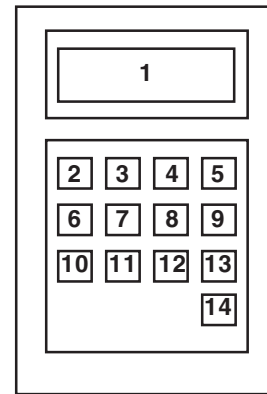
For other applications contact the factory.

SECTION 2

DESCRIPTION

This section discusses the measurement probe, the alphanumeric display and the function of each key. Refer to the following figure.

- 1) The Display. The E10/2 features a two row by sixteen col-



umn display. English alphanumeric text is displayed as well as special characters commonly used in statistical analysis. This display enables the user to operate the instrument with a minimum of guesswork and a minimum of key strokes to access statistical results. It will prompt the user for numeric entries, display statistics and display error messages should any problems develop.

The display (normal mode) is divided into four fields. Each field will always be present at the same location. Refer to the following figure:

MODE The mode field displays the active state of the in-



strument. The possible modes are CALIBRATE, RESULT, MEASURE, REVIEW, RESOLUTION, UNITS and BATCH.

UNITS The units field displays the measurement units. This field contains two characters. These characters are displayed as ml, IN, AD, um and mm.

DATA The data fields display any of the selected measurements and statistical results.

- 2) **CAL** The calibrate mode is accessed by pressing this key.

Refer to Section three for a complete description.

3) **RESULT** The results mode is accessed by pressing this key. This allows the statistical results to be displayed. The following will be displayed while in the results mode: batch number, application number, units, number of samples, arithmetic mean, standard deviation (sigma), six-sigma limit and range (maximum value and minimum value).

4) **DELETE** The displayed reading is deleted from the group of statistics. This key is active in the measure mode and the review mode.

5) **GO** This key (color coded in green) allows the user to respond to any displayed prompts. Pressing GO as a response enables the present operation to be accepted and subsequent operations to occur.

6) **UNITS** The measurement units are changed by pressing this key. The units available are mils (ml), inches (In), millimeters (mm) and micrometers (um). A fifth unit displayed is AD. This is an internal unit which is relative to the analog to digital conversion of a measurement.

7) **BATCH** This key is multi-functional. It accesses two selection functions. The first function changes the batch. Up to five batches may be selected in each application. This is a convenient means of grouping statistical results for each set of calibrations. The second function selects the application memory. Up to six applications may be selected. Each may contain up to four standard calibration points plus the base and "infinity" calibration data. The lower data field of the display will show which of the functions are active.

8) **CLEAR** The clear mode may be accessed with this key. Pressing once will clear the statistical buffer. All of the readings will be deleted. The statistics will be stored in the selected batch/application for later recall.

9) **NOGO** This key (color coded in red) allows the user to respond to any displayed prompts. Pressing NOGO cancels the displayed prompt and alternate prompts will be displayed. NOGO may be pressed a number of times until a desired operation is displayed. The GO key may then be pressed.

10) **RESL** The user may select the resolution of the measurements. That is, the arithmetic precision may be selected. Depending upon the measurement units selected, up to four digits of precision may be selected as follows:

ml (mils)	.0X thru XX.XX
In (inches)	.000X thru .0XXX
um (micrometers)	X.X thru XXX.X
mm (millimeters)	.00XX thru .XXXX

11) **PRINT** All of the stored data in the selected application is printed one batch at a time. PRINT is active only when in the MEASURE mode.

12) **REVIEW** All of the data in the measurement buffer may be reviewed. Pressing once will display the data beginning with

the first measurement. Continued pressing of REVIEW will step the measurement buffer forward so that subsequent measurements may be displayed. Pressing NOGO will step the measurement buffer backward so that previous measurements may be displayed.

13) **OFF** This key enables the power-down sequence. When pressed, the display prompts the user that the power-down sequence has been activated. This message will flash for approximately ten seconds. Once power is removed, any measurements not stored will be lost. It is recommended that the CLEAR key be pressed before OFF if statistics are to be saved.

To cancel the power-down sequence, any key may be pressed, except ON or OFF.

The power-down mode is automatically initiated if a measurement is not made or any key has not been pressed

after a three minute period. This feature extends the battery life significantly.

14) **ON** The power-up sequence begins by pressing this key. Upon power-up, a logon message is displayed giving the revision number of the software. It is displayed for approximately three seconds; the MEASURE mode is then accessed.

It should be noted that the function keys except GO, NOGO and ON also serve as numeric entry keys. The numeric values are located in the upper right hand side (in red color) of each key. When the user is prompted to enter a numeric value (in the CAL mode), the keys do not respond to function requests; i.e. pressing OFF will enter the number zero, not initiate the power-down sequence.

SECTION 3

CALIBRATION

The E10/2 is an induced eddy current type coating thickness gage. As with all gages, any individual measurement cannot be more accurate than the calibration standards and procedures used. Therefore, the time used to determine the proper calibration procedure for your product is the best guarantee of accuracy and precision available. The E10/2 permits the operator to use a 4, 3, 2 or 1 point calibration. The 4 point calibration is recommended for greatest accuracy throughout the entire range.

Calibration foils are the most convenient standards available. These foils permit calibrations to be made directly on the uncoated part. The calibration foil is placed directly on the area to be measured. The probe is then placed on the foil and the measurement made. This procedure permits the instrument to compensate for the physical properties of the base metal.

During the calibration procedure, the calibration is stored in the appropriate application memory. The calibration should be checked when it is recalled from memory and periodically during use. This is easily accomplished by measuring the base used for the calibration. If the base value (usually zero) has not changed significantly, the unit has retained its calibration and the testing procedure may continue. After some experience is gained with this instrument, one may elect to calibrate on a weekly or monthly basis.

A single point calibration is adequate for measurements that lie between zero (base metal) and the calibration point. In general, the accuracy will be +/- 5%. The exception is that in the range 0-0.6 mil (15um) the error is constant and approximately ± 0.06 mil (1.5u).

A two point calibration is adequate for measurements made between the two calibration points. Choose the smallest calibration range that includes all of the thickness measurements expected.

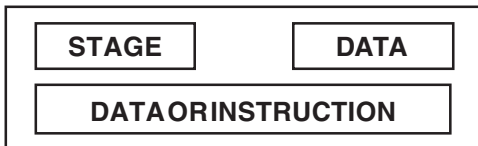
The best combination of foils for a three point calibration is by the following method. Estimate the range for the measurements expected. Choose a foil at the estimated mid-range. Choose a second foil slightly thinner than the estimated minimum reading. Then choose a foil slightly thicker than the estimated maximum reading.

A four point calibration can also be used to increase the accuracy in a narrow range. For instance the 5.0 +/-2 mil range of thickness can be improved by calibrating with a 3,4,5 and 7.5 mil foil.

The calibration program is entered by pressing the CAL button. Instructions for calibrating the E-10/2 are provided with text and prompts that are displayed as described in section 2. The display during the calibration mode has the following general format:

STAGES OF CALIBRATION

Calibration is performed by measuring selected standards. The stage of calibration is indicated in the upper left-hand corner of the display. The calibration sequence is listed as follows:



ner of the display. The calibration sequence is listed as follows:

- BASE
- STD 1 (optional)
- STD 2 (optional)
- STD 3 (optional)
- STD 4 (optional)

INSTRUCTION

CAUTION: Select the measurement units before starting the calibration procedure. The units cannot be changed while in the calibration mode. Units are displayed as per the figure on page 1. To change units press the UNITS key, press NOGO until the desired measurement unit appears. Then press GO.

The procedure for calibration is provided by commands indicated on the second line of the display. Each command requires action by the operator. The command and proper procedure are listed below.

- 1) Press Cal button to enter program.
- 2) [ENTER APP# !] Select an application number from 1 thru 6 and enter it on the keypad. If the proper number appears

on the display press GO. If an error is made, press the correct number and then press GO.

- 3) [MEASURE BASE ?] Press GO.
- 4) [MEASURE BASE !] Measure bare base metal 3 or more times; press GO.
- 5) [MEASURE STD 1 ?] Press GO to calibrate with first standard. Press NOGO to measure with internal calibration.
- 6) [MEASURE STD 1 !] Place foil standard on base and measure 3 or more times; then press GO.
- 7) [STD VAL = !] Enter the standard value by pressing the numbered keys.

FOR EXAMPLE The procedure for entering the standard value 23.1 mils is outlined below.

keypad entry	thickness display
	000.00 ml
2	000.02 ml
3	000.23 ml
1	002.31 ml
0	023.10 ml

Add trailing zeros in order to accurately position the decimal point. If the entry is correct press GO. If the entry is in error press NOGO to clear that entry; enter the correct number and press GO.

- 8) [MEASURE STD 2 !] If a 2, 3 or 4 point calibration is required, press GO and repeat steps 6 thru 9 for the remaining standards. If a one point calibration is adequate press NOGO. The calibration will then terminate and the MEASURE mode prompt will appear.

SECTION 4

MEASUREMENT

Please read the precautions on page one of this manual before measuring.

NOTE: Unit automatically powers down after 10 minutes of inactivity.

An individual measurement is made by placing the probe firmly on the area to be measured. The outer sleeve of the probe assembly must be flush with the sample surface. This ensures that the probe will be perpendicular to the sample surface and that a uniform pressure on that surface is maintained. After approximately one second a measurement will be displayed. The probe should then be lifted from the sample.

The **SERFILCO E10/2** stores the results of measurements for future reference. The statistical results are stored in one of five batches in each of the six calibration applications. This permits the inspection of up to thirty batches before it is necessary to retrieve data. Field measurements may be made and then the operator may return to the inspection department to print the results of such measurements.

Measurements may be made while in the MEASURE mode. The following prompt is displayed:
MEASURE tttt uu
N=nnn x=aaaa Az

Where tttt is the displayed thickness,
uu are the units of measure,
nnn are the number of measurements in current batch (1-256),
aaaa is the arithmetic average (mean value) of nnn measurements,
z is the current application (1-6)

PREPARATIONS FOR TESTING

Before measuring samples it is important to organize the statistical data into logical partitions. It is necessary to select an application (calibration memory) to be used and a batch number to be assigned. This is accomplished as follows:

STEP	KEY TO BE PRESSED	DISPLAY
1) start	press batch	BATCH Bb Az uu CHANGE APP/BAT ?
2) batch access	press GO, or	BATCH Bb Az uu ENTER BATCH # z
b & z OK?	press NOGO (exit to MEASURE)	MEASURE tttt uu N=nnn x=aaaa Az
3) select app. #	press 1-6 and then press GO	BATCH Bb Az uu ENTER BATCH # b
4) select batch #	press 1-5 and then press GO	BATCH Bb Az uu CHANGE APP/BAT ?
5) b & z OK?	press NOGO (exit to MEASURE)	MEASURE tttt uu N=nnn x=aaaa Az

Where tttt is the displayed thickness,
uu are the units of measure,
nnn are the number of measurements in current batch (1-256),
aaaa is the arithmetic average (mean value),
b is the current batch (1-5),
z is the current application (1-6).

You are now in the measurement mode. Measurements may now be made, and the results stored in application a, batch b.

Individual measurements and statistical data from previous lots can be removed from memory by pressing the "CLEAR" key twice.

REVIEW INDIVIDUAL MEASUREMENTS

After n measurements are made, the individual measurements may be checked by pressing the REVIEW key. The display will appear as follows:

REVIEW tttt uu
N=1 x=aaaa Az

Measurements 1 thru n may be reviewed in forward order by pressing the NOGO key. The measurements may also be reviewed in reverse order by pressing the REVIEW key. There are now three possible options:

- a) press DELETE to remove displayed value.
- b) press NOGO to continue reviewing.
- c) press GO to exit the REVIEW mode and return to MEASURE mode.

- Upon exiting the REVIEW mode there are four options.
- a) continue measurements.
 - b) press RESULT to obtain statistical results. (See next section)
 - c) press CLEAR once to store statistics and clear screen.
 - d) press CLEAR twice to clear statistical data

Upon CLEARing the display (and storing the data) it is recommended that the operator change to another batch so that the previously stored data can be recalled when necessary. Recalling this data is described in the next section.

RECALL STATISTICAL RESULTS (current batch)

Statistics for the current batch are accessed when in the MEASURE mode by pressing the RESULT key. This is accomplished as follows:

STEP	KEY TO BE PRESSED	DISPLAY
1) access results	press RESULT	RESULTS Bb Az uu N=nnn x=aaaa
2) need s?	press RESULT	RESULTS Bb Az uu s=sssss 6s=sssss
3) need range?	press RESULT	RESULTS Bb Az uu H=hhhhh L=lllll
4) review again?	press NOGO (return to step 2) press go (exit to MEASURE)	MEASURE tttt uu N=nnn x=aaaa

Where b is current batch number.
s is the standard deviation for the batch.
6s is the "six sigma limit" (6 x s).
hhhhh is the maximum measured value.
lllll is the minimum measured value.

BATCH REVIEW (review all batch statistics)

Use the following procedure to recall the statistical results that have been stored in the batch memory in the current application. If the statistical results of a different application need to be reviewed, follow the procedure outlined in PREPARATIONS FOR TESTING to select the desired application, and then proceed with the following.

STEP	KEY TO BE PRESSED	DISPLAY
1) access	BREVIEW press BATCH	BATCH Bb Az uu CHANGE APP/BAT ?
	press REVIEW	BREVIEW Bb Az uu N=nnn x= aaaaa
2) need s?	press RESULT	BREVIEW Bb Az uu s=sssss 6s=sssss
3) need range?	press RESULT	BREVIEW Bb Az uu H=hhhhh L=lllll
4) different batch?	press NOGO	BREVIEW Bb Az uu N=nnn x= aaaaa
	repeat steps 2-4 as required	
5) exit	BREVIEW press GO	MEASURE tttt uu N=nnn x= aaaaa

Battery: one (1) 9 Volt Lithium cell (Kodak UV9L) recommended, or one (1) 9 Volt Alkaline cell (NEDA 1604) supplied. Battery life: twenty two (22) hours continuous duty, auto power-down. AC option: 117 VAC, 60Hz, 8W input; 9VDC, 300mA output.

DISPLAY:
2 row x 16 column alphanumeric dot matrix LCD;
0.22"H x 0.12"W (0.56mm x 0.29mm) characters

PRINTER:
Optional forty (40) column, thermal, 2400 baud.

COMPUTER INTERFACE:
RS-232C serial port to PC, optional software for data acquisition.

PROBE:
Single pole probe and constant pressure sleeve guide with V-notch cut-out for measurements on cylindrical shaped parts.

COATING/SUBSTRATE REQUIREMENTS:
Measuring Range: 0-40 mils (0-1016um)
Minimum area: 1.2" x 1.2" (30mm x 30mm)
Minimum curvature: 0.6" (15mm) radius
Minimum substrate: 32 mils (0.8mm)

DATA STORAGE:
6 non-volatile application/calibration memories
5 batches per application/calibration memory
Maximum sample size of 256 measurements per batch

STATISTICS:
Mean, standard deviation (1 sigma), minimum, maximum, sample size and six-sigma limit

MEASUREMENT UNITS:
Mils, inches, millimeters, micrometers

ACCURACY:
greater than $\pm 5\%$ with multipoint calibration

DISPLAY RESOLUTION:
0.01 mil, 0.0001 mm, 0.0001 inch, 0.1 micrometer

SECTION 5

ACCESSORIES

The **SERFILCO E10/2** has several accessories available to enhance its operational capabilities. They are described below.

PRINTER The E10/2 contains an RS232-C port. It is located at the top of the unit. A standard printer may be purchased from **SERFILCO**, however, the owner of the E10/2 may provide their own. The requirements are:

- 1) RS232C serial interface.
- 2) 40 column, minimum field width.
- 3) 2400 baud, even parity, 8 data bits, 1 stop bit.

DATA ANALYSIS SOFTWARE SERFILCO shall soon be releasing a data analysis software package which reads the data from the stored batch/application memories. This will enable the user to keep a daily log of incoming/outgoing inspection, histograms and x-bar charts.

SECTION 6

TECHNICAL SPECIFICATIONS

DIMENSIONAL DATA:

Size: 7.08"L x 3.93"W x 1.73"H (180mm x 100mm x 44mm)
Weight: 1.02 lbs (0.46kg)

ELECTRICAL REQUIREMENTS: