# *6000* SERIES
# Coating Thickness Gage

## Instruction Manual

version 3.0

The **6000** hand-held, electronic Gage non-destructively measures the thickness of coatings on metals, quickly and accurately.

While all **6000** Gages look the same and behave in a similar fashion, each model has specific abilities or features as denoted by the model number (e.g. ***6000 FNS3***). The model number is engraved on the back and is displayed when the Gage is turned on.

## *Styles*

***Built-In Probe*** Gages have a permanent, built-in probe for easy, one-hand operation.

***Separate Probe*** Gages have the probe mounted at the end of a cable and have an "***S***" suffix in the model number. They allow greater accessibility onto small parts or into hard-to-reach areas. These separate probes retain their own unique calibration information and are completely interchangeable. On power-up the **6000** automatically determines what type of probe is attached, then self-calibrates.

## *Principles of Operation*

***F*** models use the *magnetic principle* to measure the thickness of non-magnetic coatings on ferrous metals.

***N*** models use the *eddy current principle* to measure the thickness of non-conductive coatings on non-ferrous metals.

***FN*** models combine the full abilities of *both* the ***"F"*** and ***"N"*** models.

## *Models*

***1*** **BASIC**- mils/microns, *FLIPLCD* and *RESET* features.

***2*** **STANDARD**- all BASIC features **plus** average, standard deviation and user adjustable HiLo limits.

***3*** **MEMORY**- all STANDARD features **plus** storage & printer/computer downloading for 5000 measurements

## Power-up / Power-down

The **6000** powers-up when any button is depressed and displays the last measurement. Gages with a ***Built-In*** probe turn on automatically when the probe touches the surface. To preserve battery life, the Gage powers-down after 60 seconds of no activity. There is no OFF button. All settings are retained during power-down including the last measurement. Always allow the Gage to power down automatically before changing the batteries.

## How To Take A Measurement

1. On ***Built-In*** probe models, slide the probe cover open FULLY. It acts as a second "foot" to steady the Gage when required.
2. Press any button to turn the Gage on. ***Built-In*** probe models turn on automatically when the probe is placed on a surface.
3. Place the probe FLAT on the surface to be measured and HOLD STEADY. When a valid coating thickness measurement is calculated, the Gage BEEPS and BLINKS twice and displays the measurement.

Lift probe AT LEAST 2 INCHES (50 mm) from surface between measurements - OR - leave probe in the same location for continuous measurements every 5 seconds.

When finished, slide the ***Built-In*** probe cover FULLY shut to prevent Gage from accidentally turning on and draining the battery. Keep ***Separate*** probes away from metal so they can power down automatically.

## Golden Rule

Measure your *uncoated* part first! This quick *zero-check* determines if any adjustment is needed for your particular substrate. *Zeroing* compensates for deviations in shape, diameter, composition, roughness, etc.

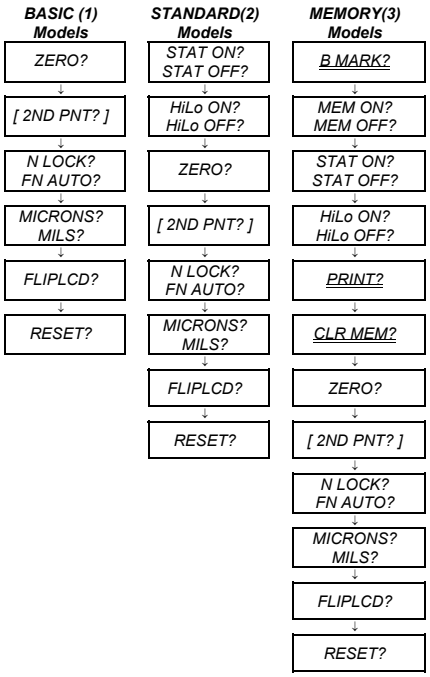
## Menu Operation

Gage functions are *menu controlled*. To access this menu, turn the Gage on and press ∅⊕ simultaneously to display the first menu choice.

To answer "YES" press ⊕ and the current choice will be selected.

To answer "NO" press ∅ and the next option will be displayed.

After the last MENU option, the Gage re-displays the last measurement.




◊ *N LOCK/FN AUTO* for ***FN*** models.

◊ [Bracketed options] appear only on ***FA*** & ***FHS*** Gages and ***microprobes***.

◊ *ZERO?* and *2ND PNT?* do not appear in MEMORY, STATS or HiLo modes.

◊ Underlined options appear only if readings are stored in memory

## Calibration

Calibration is ***instant and automatic***. The ***6000*** uses stored N.I.S.T. (*National Institute of Standards and Technology*) calibration data and no further calibration is required. Just ZERO on your uncoated substrate then measure.

***Verify*** calibration by measuring N.I.S.T.-traceable coating thickness standards or by placing the included precision plastic shim standards on your uncoated metal. Measurements should be within the combined tolerances of the Standards and the Gage. (*Contact your dealer to order Standards*).

Measuring a plastic shim with a micrometer or other Gage might not produce identical readings. This is due to differences in both the contact pressure and shape of each contact surface.

## Adjustment To Zero (Zeroing)

Although the **6000** requires no adjustment before measuring most applications, significant substrate variations can influence Gage readings.

Always check the Gage reads zero "0" on the uncoated substrate *or* reads a known thickness accurately, especially if the substrate changes in shape, diameter, composition, surface roughness or when measuring in a different location on the part. If necessary, make adjustments as described below.

**NOTE**: "***FN***" models retain separate "***F***" and "***N***" zero settings. Adjustments are made to the currently displayed substrate only.

### *Simple Zero Adjustment*

***(F, FS, FT, N, NS, NA, NAS, FN, FNS Gages)***

Measure your uncoated part. If the Gage does not read "0"or close to zero, lift the probe from the surface and adjust the display down ∅ or up ⊕ until the display reads "0". Measure and adjust until the average of a series of readings on the uncoated surface is "0".

### *Average Zero Adjustment*

On rough or curved surfaces the above method must be repeated several times to get "0". A preferred method is to take several readings on the uncoated part and average the result.

1. Select the *ZERO?* menu option.
2. Press ⊕ to select the number of readings to be used to obtain an average; typically 3 to 9 readings. The greater the variation between readings, the more readings should be taken to obtain an average. The display will show the number of readings remaining; i.e. *ZERO 5X?*
3. Repeatedly measure the uncoated part in the same area. After the last measurement the Gage will calculate and display "0" as indicated by a "triple BEEP". This "0" represents the average of all the ZERO readings taken.

### *Adjustment To A Known Thickness*

***(F, FS, FT, N, NS, NA, NAS, FN, FNS Gages)***

If an uncoated part is not available adjust the Gage to read a known thickness such as another coated object, Standards or plastic shims.

Measure the object. If the expected reading (within tolerance) is not obtained, lift the probe from the surface and adjust the display down ∅ or up ⊕ to the expected thickness.

## Two Point Calibration

***(FA, FHS Gages and Separate Microprobes only)***

The ***FA*** and ***FHS Gages*** and all ***Separate Microprobes*** should be checked to ensure that they are calibrated correctly. *One or two point calibration* can be performed.

*One point calibration* can be performed either on the uncoated part (*ZERO)* or at a known thickness (*2ND PNT)*.

*Two point calibration* is the preferred method. This requires taking a reading on both the uncoated part (*ZERO?*) and on a known thickness (*2ND PNT?*) as follows:

1. *"ZERO?"* the Gage as described in the previous "Average Zero Adjustment" section.
2. Select the *2ND PNT?* menu option.
3. Press ⊕ to set the number of readings used to obtain an average, typically 3 to 9. The greater the variation between readings, the more readings should be taken to obtain an average. The display will show the number of readings remaining to be taken; i.e. "*2NDPNT4X"*
4. Repeatedly measure the known thickness (coated part, a plastic shim or a Coating Thickness Standard) until the display shows *2PT=value*. Lift the probe from the surface and adjust the display down ∅ or up ⊕ until the display reads the known thickness value. Press ∅ ⊕ simultaneously to accept this value.

## RESET Feature

Selecting RESET restores factory calibration settings and returns the Gage to an out-of-the-box condition.

- all MODES are turned off (memory, statistics, HiLo).
- all readings in memory are erased.
- a zero reading and a ↑ symbol appears on the display. The ↑ symbol disappears if the Gage is zeroed or calibrated.

RESET is handy when:

- an uncoated object is not available to zero the probe on.
- an object of known thickness is not available to adjust Gage readings to.
- you are uncertain what previous adjustments have been made and wish to return the Gage to a known condition.

**NOTE**: Keep the probe away from metal while performing a RESET.

## FN Combination Probes

**FN** probes combine the capabilities of both "***F***" and "***N***" probes.

The probe first attempts a measurement using the *magnetic principle*. If the coating is non-magnetic, within the probe's thickness range and the substrate is ferrous, a reading is displayed with the letter ***"F"***.

If no valid reading is obtained with the *magnetic principle* the probe automatically attempts a measurement using the *eddy current principle*. If the coating is non-conductive, within the probe's thickness range and the substrate is a non-ferrous metal, a reading is displayed with the letter ***"N".***

If a reading is still not obtained, dashes ( -- -- -- -- -- ) appear on the display.

## ***Non-Ferrous Lock (N LOCK?)***

Select the *N LOCK?* menu option (non-ferrous lock) when operating regularly on non-ferrous substrates. This disables the automatic substrate determination ability and forces the probe to only use the *eddy current principle* when measuring, regardless of the substrate. This shortens measurement time and extends battery life.

**TIP**: *N LOCK* is also useful in instances such as measuring paint on galvanized (zinc coated) steel. In *AUTO*matic (normal) mode the probe measures both the paint and zinc over the steel using the magnetic principle. *N LOCK* makes the Gage measure the paint over the zinc only.

**TIP**: Select *N LOCK* to measure over slightly magnetic substrates; i.e. clear-coat on gold over nickel plated brass. Although the probe's magnet is used for the *magnetic principle*, it is also used in *N LOCK* to magnetically saturate a slightly magnetic substrate and allow the *eddy current principle* to operate unhindered.

**WARNING**. With *N LOCK* engaged it is possible to obtain a reading when measuring non-conducive coatings on steel. Eddy current is not the preferred measuring principle on steel.

Select the *FN AUTO?* menu option to return the probe to its auto selecting capability.

## Inch/Metric Conversion

Selecting the *MILS?* or *MICRONS?* menu option converts the display and all stored readings from inch to metric or vice versa.

## Flip LCD

The *FLIPLCD?* menu option causes the display to read upside down. On ***Separate Probe Gages*** this feature allows the Gage to be laid on a work table with the LCD conveniently pointed toward the operator, thus freeing the operator's hands to hold the probe and part to be measured. On ***Built-In Probe Gages*** this feature is useful when the Gage is used upside down to measure on a ceiling.

## Statistics Mode

***Standard(2) and Memory(3) models only***

When *STAT ON?* is selected, a $\bar{x}$ symbol and a counter (*n 0*) appear on the display. As each measurement is taken, the reading is displayed *and* the counter is increased. An incorrect reading can be removed by pressing ∅ before another reading is taken. After a desired number of readings, lift the probe from the surface and press ⊕ to display statistics. Example:

| | mils | microns |
|---|---|---|
| average: | x = 1.8 | x = 46 |
| Standard deviation: | σ = 0.5 | σ = 13 |
| number of readings: | n = 3 | n = 3 |

These statistics will be displayed until:

- the Gage powers-down.
- another reading is taken, in which case the sequence starts over.
- any button is pressed, in which case the last reading is displayed.

*HiLo* MODE must be off to activate STATISTICS MODE. Calibration adjustments cannot be made while in STATISTICS MODE. To turn STATISTICS MODE off, select *STATOFF?*

## High/Low Mode

***Standard(2) and Memory(3) models only***

When *HiLo ON?* is selected, the current *Lo* setting is displayed. Adjust down ∅ or up ⊕. Alternatively, measure a coating with a thickness close to the required value and make final adjustments with the ∅ ⊕ buttons. Press ∅ ⊕ simultaneously to accept this value.

The last *Hi* setting is now displayed. Follow the same procedure to adjust the *Hi* setting. The ↧↧ symbol will indicate *HiLo* MODE is now ON.

Measurements will now be compared to your defined limits. The Gage BEEPS TWICE (normal) if results are within those limits and ONCE if outside. The single BEEP is a LOW tone with a ↘ if it is below the *Lo* limit, and a HIGH tone with a ↗ if it is above the *Hi* limit.

**NOTE:** the LED will only BLINK if readings are within limits.

STATISTICS MODE must be off. Calibration adjustments cannot be made while in *HiLo* MODE. To turn *HiLo* MODE off select "*HiLoOFF?*".

## Memory Mode

***Memory(3) models only***

When *MEM ON?* is selected the  symbol and a counter ( *0*) appear. 5000 readings in up to 100 batches (groups) can be recorded.

In MEMORY MODE readings are simultaneously displayed and stored. The current BATCH number (*B 1*) is displayed. Remove the last reading from memory by pressing ∅. Erase ALL stored readings by selecting "*CLR MEM?".* Calibration adjustments cannot be made while in MEMORY MODE. To turn MEMORY MODE off select "*MEM OFF?".*

**NOTE:** press ⊕ at any time to view the average, standard deviation and number of readings in the current batch.

## ***Batch Markers***

Readings taken for different jobs or parts can be grouped together or "separated" by placing Batch Markers between sets of measurements. Select "*B MARK?".* A Batch Marker is set automatically if you turn *HiLo* or STATISTICS MODES on or off. Statistical summaries are calculated for each batch during downloading.

## ***Memory AND Statistics Modes Together***

When both these MODES are ON, individual measurements ARE NOT STORED. Instead, when ⊕ is pressed, the average, standard deviation and number of readings are simultaneously displayed and stored in memory. Again, statistical summaries are calculated for each batch during printing. This delivers the average of a

set of average readings as required by SSPC PA-2 guidelines.

**NOTE:** SSPC is a U.S.-based Society for Protective Coatings. PA-2 is a Paint Application specification.

## Downloading

***Memory(3) models only***

Data can be sent to a serial printer, data collector or IBM compatible computer using the supplied RS232 serial cable -- or directly to the optional wireless ***HP IR*** printer using the Gage's built-in IR port.

### ***Printer Output***

1. Select *PRINT?*
2. Choose an output option:
   *ALL* - individual readings + Statistical Summary
   *HISTO* - Statistical Summary + Histogram
3. Select *IR PRT* for the ***HP IR*** Printer -- or –
   Select a *TYPE* as below if printing to a serial printer or computer. If uncertain which *TYPE* to use, try each one, one at a time.

| TYPE | BAUD | Handshake |
|---|---|---|
| TYPE 1 | 9600 | Xon/Xoff |
| TYPE 2 | 9600 | DTR |
| TYPE 3 | 1200 | Xon/Xoff |
| TYPE 4 | 1200 | DTR |

Each batch (group of measurements) is printed separately. The mean, max/min measurement, standard deviation and number of readings is printed for each. Depending upon what MODE was active when the measurements were taken, three output types are possible:

- REGULAR MODE - all readings are output
- STATISTICS MODES - only averages and standard deviations are output
- *HILO* MODE - all readings are output, each followed by an indication of which limit they exceeded.

**NOTE:** The portable, battery operated, wireless ***HP IR*** printer is available from your dealer. It provides quick, convenient, low-cost output in the field or on the shop floor.

**NOTE:** The *histogram* shows a visual interpretation of the distribution of readings. The total spread of thickness is divided into a number of equal bands. The print-out consists of a bar chart, the length of each bar corresponding to the number of readings in that band.

### ***Sample Printer Output (ALL)***

```
 15 Readings                        ←Summary
  2 Batches
 ------------------------------
 STATISTICS BATCH # 1 FE      ←STATISTICS and
                                    MEMORY MODES on
   #    AVG    STDDEV    n
   1  15.20 mil   0.05     5
   2  15.20 mil   0.05     3      ←Only average
   3  15.10 mil   0.00     3      readings were stored
 ------------------------------
 MAX      15.20 mil
 MIN      15.10 mil
 N        3
 MEAN     15.17 mil           ←The Average
 STD DEV 0.06 mil             of averages!
 ------------------------------
 HI/LO BATCH # 2 FE           ←HiLo and MEMORY
   #   READING                  MODES on
   1  1.85 mil   OK
   2  0.00 mil   LO            ←2 readings are
   3  5.30 mil   HI                 ← outside limits
   4  1.85 mil   OK
 ------------------------------
 MAX      5.30 mil
 MIN      0.00 mil
 N        4
 MEAN     2.25 mil
 STD DEV 2.21 mil

  1 READINGS BELOW   1.75 mil
  1 READINGS ABOVE   2.10 mil
  2 READINGS WITHIN HIGH/LOW
```

### ***Downloading Measurements As They Are Taken***

If a serial printer, data collector or computer is connected to the Gage using the supplied RS232 serial cable, readings are immediately sent to the device as they are taken. Output is in the following form (example):

{STX} 15.0mil NONFE{CR}{LF}
*where:*
STX = ASCII code 02 = ^B
CR = ASCII code 13 = ^M
LF = ASCII code 10 = ^J

### ***Downloading Measurements Stored In Memory***

Measurements stored in the Gage's memory can be downloaded to a printer or computer using RS232 serial communication. Measurements are not erased from memory after being downloaded.

## PosiSoft® Software

**POSISOFT®** is supplied with the **6000** for downloading measurements to a computer. It runs on IBM compatible personal computers using Microsoft Windows® 3.1 or higher version and having an RS232 serial port. It allows entry of notes and annotations, prints histograms and basic Statistical Process Control Charts and is ideal for monitoring and analyzing coating thickness applications. Additional information is available in a README file on the diskette.

### ***Other Communications Software***

Existing communication software can be used, providing it can capture data from a COM port. Select *"PRINT?".*

### ***Serial Communications Configuration***

8 bit words, no parity, 1 stop bit
9600 baud
XON-XOFF handshaking

The supplied serial cable is a 3.5 mm STEREO PLUG to a DB9 F.

| Pinout | Description |
|---|---|
| 2 | TXD Transmit data (from Gage) |
| 3 | RXD Receive data (from PC / Printer) |
| 5 | GROUND |

## Temperature

Operating range: +32° to +120°F
(0 to +50°C).

The ***6000*** compensates automatically for temperature. Allow a few minutes for the Gage to reach ambient temperature before measuring.

Discard the first measurement taken in a notably different temperature condition. When measuring surfaces much hotter or colder than ambient, allow 1 second off the surface between measurements.

**TIP**: Ferrous substrates with extreme temperatures between -150°F and +450°F (-100°C and +230°C) can be measured with the **PosiPen®**. It is ideally suited for measuring on small, hot or hard-to-reach surfaces. Contact your dealer

### ***Instability Indication***

A high, fast, beeping sound emitted during measuring indicates the Gage requires more time than usual to determine a coating thickness measurement.

This occurs if the probe is touching a very hot or cold surface, or if the probe is not being held steady.

When temperature compensation has been made or the probe has stabilized, the beeping will stop and a measurement will be displayed.

## Maintenance

The **6000** requires no regular maintenance other than battery replacement. Paint, dirt and other marks may be removed with a solvent.

### ***Certification***

All Gages are shipped with a *Certificate of Accuracy*. Some companies have a compliance requirement to re-certify their Gages periodically. This can be done by measuring N.I.S.T. or DeFelsko Standards (*available from your dealer*) or by returning the Gage to an authorized dealer or to DeFelsko Corp. to be checked and re-certified.

### ***Quick Release Adapter***

The ***0° Microprobe*** has a quick release adapter to convert it to a constant pressure probe for alignment on small, flat or curved parts. It is held in place by a spring located on the microprobe cable. If the sleeve is not required, simply pull it off the probe. To re-attach it, slide it over the microprobe and screw it into the spring.

## Changing The Battery

As the batteries become weak the xxxx symbol will appear during measuring. The Gage can still be used in this condition but the batteries should be changed at the earliest opportunity.

**USE ONLY AA ALKALINE BATTERIES**

Nickel-cadmium and nickel-metal hydride rechargeable batteries will work but the low battery symbol may stay on

To retain all user settings and stored memory readings, disconnect the battery only after the Gage has automatically powered-down.

Battery Life: 30 hours continuous
15,000 readings

## Trouble Shooting

If *"SERVICE"* appears on the display, the Gage must be returned to the manufacturer or an authorized representative for repair.

A *"MEM LOST"* condition may appear if the batteries are disconnected while the Gage is on. It may also indicate a low battery condition. Simply depress the probe to continue. Substrate adjustments will have to be re-done. If *"MEM LOST"* persists, change the batteries and perform a *RESET*

As with any electronic device, harsh temperature and electromagnetic environments or rough handling may alter the performance of some Gage components causing the Gage to exhibit unusual behavior. A *RESET* will enable the Gage to recover from many of these disturbances without the necessity of returning the Gage for service.

### ***Service***

Before returning the Gage for service…

1. Install new Alkaline batteries
2. examine the probe tip to ensure no dirt or damage tip. Constant-pressure probes should move up and down freely.
3. perform a Gage *RESET*
4. place a plastic shim onto bare metal (steel or non-steel, depending upon whether you have an ***"F"*** or ***"N"*** probe) and attempt a measurement.

If you have to return the Gage for service describe the problem fully and include measurement results, if any. Be sure to include the probe, your company name and fax number.

## Technical Data

Conforms to: BS5411 Part 2 or 3 & 11, BS3900(C5), ISO 2178/2360/2808, DIN 50981/50984, ASTM B499/ D1186/D1400, SSPC-PA2

### ***Range***

| | |
|---|---|
| NA | 0-2 mils & 0-50 microns |
| FA | 0-10 mils & 0-250 microns |
| Microprobes | 0-25 mils & 0-625 microns |
| FT | 0-250 mils & 0-6 mm |
| FHS | 0-750 mils & 0-12 mm |
| All others | 0-60 mils & 0-1500 microns: |

### ***Increments***

| | |
|---|---|
| NA | 0.02 mil (0.5 µm) |
| FA | 0.1 mil to 4, 0.05 to 10 |
| | 0.5 µm to100, 1 to 250 |
| Micro | 0.01 mil to 4, 0.05 to 10, 0.1 to 25 |
| probes | 0.05 µm to 100,1 to 250, 2 to 625 |
| FT | 2 mil to 150, 5 to 750 |
| | 0.05 mm to 3.5, 0.1 to 6 |
| FHS | 1 mil to 400 mils, 5 to 750 |
| | 0.01mm to 10, 0.1 to 20 |
| All others | 0.05 mils to 2, 0.1 to 60 |
| | 1 µm to 50, 2 to 1500 |

### ***Fixed Tolerance***

| | |
|---|---|
| NA | ±0.02 mil (±0.5 µm) |
| FA | ±0.1 mil to 4, ±0.05 to 10 |
| | ±0.5 µm to100, ±1 to 250 |
| Micro | ±0.01 mil to 4, ±0.05 to 10, ±0.1 to 25 |
| probes | ±0.05 µm to 100, ±1 to 250, ±2 to 625 |
| FT | ±2 mil to 150, ±5 to 750 |
| | ±0.05 mm to 3.5, ±0.1 to 6 |
| FHS | ±1 mil to 400 mils, ±5 to 750 |

| | |
|---|---|
| | ±0.01mm to 10, ±0.1 to 20 |
| All others | ±0.05 mils to 2, ±0.1 to 60 |
| | ±1 µm to 50, ±2 to 1500 |

## ***Variable Tolerance***

| | |
|---|---|
| Microprobes | ±1% to 4mils (100µm), then ±3% |
| FHS | ±1%, ±3%, ±5% |
| All others | ±1% |

Specifications for the "**FN**" Gages are the same as for the "**F**" model when operating on ferrous substrates, and the "**N**" model when operating on non-ferrous substrates.

Gage dimensions:
5.8" x 2.4" x 1.0"
147 x 61 x 25 mm
Gage Weight (without batteries):
6 ounces (170 grams)
Constant Pressure Probe Pressure:
3½ ounces (100 grams)
Maximum Pressure for Microprobes:
2 ounces (55 grams)
Operating Temperature:
+ 32° to + 120°F (0° to + 50°C)
Measuring Speed:
> 35 readings per minute

## Warranty

The manufacturer fully warrants its products against defects in workmanship or materials for a period of one year from date of purchase. In the event that a Gage is found to be defective, return the product with proof of purchase to your dealer, and the defective product will be repaired or replaced at the manufacturer's option.

No responsibility is assumed for incidental or consequential damages.

The warranty is voided if the Gage has been opened.

Data subject to change without notice.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