

PosiTest[®] AT

Pull-Off Adhesion Tester

Full Guide v. 5.0



Introduction

The **PosiTest AT Pull-Off Adhesion Tester** measures the force required to pull a specified test diameter of coating away from its substrate using hydraulic pressure. The pressure is displayed on a digital LCD and represents the coating's strength of adhesion to the substrate.

In accordance with ASTM D4541, D7234, ISO 4624 and others, the **PosiTest AT** evaluates the adhesion (pull-off strength) of a coating by determining the greatest tensile pull-off force that it can bear before detaching. Breaking points, demonstrated by fractured surfaces, occur along the weakest plane within the system consisting of the dolly (*loading fixture, stub*), glue, coating layers and substrate.

The **PosiTest AT** is available in *Manual* (pg.5) and *Automatic* (pg.7) models.

Basic Steps to Perform a Pull-Off Test

1. Dolly & Coating Preparation

The dolly and the coating are cleaned and abraded (see pg.2).

2. Glue & Dolly Application

The glue is prepared and applied to the dolly. The dolly is then adhered to the coated surface and the glue is allowed to cure (see pg. 2).

3. Test Area Separation - *optional*

The test area of the coating is isolated from the area surrounding the dolly by cutting or drilling (see pg. 3).

4. Pull-Off Test

- a) PosiTest AT-M (manual) (see pg. 5)
- b) PosiTest AT-A (automatic) (see pg. 7)

5. Analysis of Test Results

The dolly and the coating are examined and evaluated to determine the nature of the coating failure (see pg. 4).

Dolly & Coating Preparation

Dolly Preparation

1. To remove oxidation and contaminants, place the included abrasive pad on a flat surface and rub the base of the dolly across the pad 4-5 times.
2. As required, remove residue left from the abrading process using a dry cloth or paper towel.

Coating Preparation

1. Lightly roughen the coating using the included abrasive pad.

NOTE: As coating abrasion may introduce flaws, it should only be used when necessary to remove surface contaminants, or when the bond strength between the glue and the coating is insufficient for pull testing.

2. To promote the bond between the dolly and the coating, degrease the area of the coating to be tested using alcohol or acetone to remove any oil, moisture or dust.

NOTE: Ensure that any alternative abrasion techniques, degreasers or adhesives do not alter the properties of the coating. Test by applying a small amount of degreaser or glue to a sample area and observing effects.

Glue & Dolly Application

Glue Selection

The glue included in the PosiTest Adhesion Tester kit has been selected due to its versatility. This glue has minimal impact on a variety of coatings and has a tensile strength exceeding the maximum performance capabilities of the pressure system under ideal conditions. Other glues may be preferred based on requirements such as cure time, coating type, working temperature and pull-off strength. Quick curing one-part cyanoacrylates (super glues) may be sufficient for painted surfaces, but two-part epoxies are preferred for porous or rough coatings.

Dolly Application

1. Mix the glue per manufacturer's instructions and apply a uniform film of glue on the base of the dolly
2. Attach the dolly to the prepared coating test area.

NOTE: If the coated surface to be tested is overhead or vertical, a means to hold the dolly in place during the cure time may be required, i.e. removable tape.

3. Gently push down on the dolly to squeeze out excess adhesive. Do not twist or slide the dolly back and forth on the coating as air bubbles may be generated.
4. Carefully remove excess adhesive from around the edges of the dolly with included cotton swabs.
5. Allow to cure per the adhesive manufacturer's instructions.

Test Area Separation

The decision of when to cut around a dolly is dependent on the standard, specification or contractual agreement to which the test is to comply. The primary purpose for cutting through the coating is to isolate a specific diameter test area. When the decision to cut into the coating has been made, it is recommended to cut all the way through to the substrate. As a minimum, it is suggested to carefully cut away excess glue from the dolly application process. This typically prevents a larger area of coating from being pulled away from the substrate, resulting in a higher pull-off pressure.

Cutting Instructions

1. Cut through the coating around the edges of the dolly with the included cutting tool, removing any excess glue.
2. Clear away any debris from the cutting process.

NOTE: - Cutting may induce coating surface flaws such as microcracking that may alter test results.
- For coatings with strong lateral bonding, it is recommended to cut completely through the coating down to the substrate.

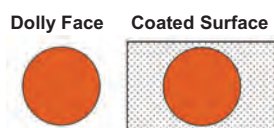
Drilling Template

When testing very thick coatings, an optional drilling template may be preferred.

Analysis of Test Results

Upon completion of the pull-off test, the dolly and coated surface should be examined. In addition to pull-off force, many National and International standards such as ASTM D4541 and ISO 4624 require the nature of the fracture to be recorded.

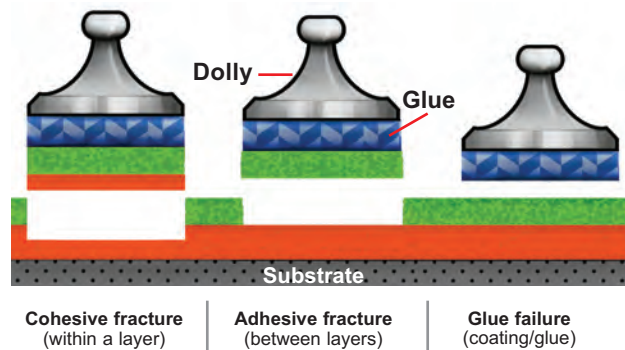
- **Cohesive fracture:** fracture occurs within a coating layer (same coating on dolly face and coated surface).



- **Adhesive fracture:** fracture occurs at the interface between layers (coating on dolly face differs from surface).

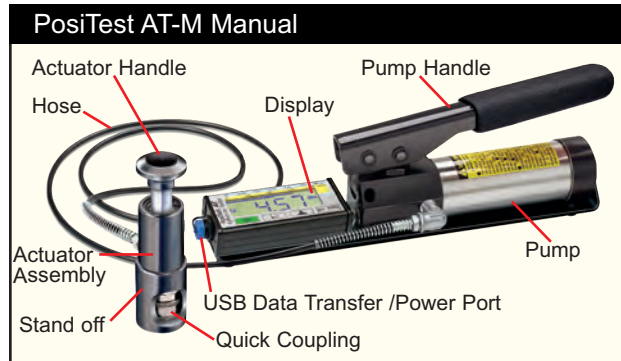


- **Glue failure:** visible separation of the glue from itself, the coating or dolly (no coating visible on the dolly face).



Glue failures typically occur when the glue is improperly mixed or the coated surface has not been adequately prepared (see pg.2).

The PosiTest AT-A model provides an interface to document the nature of the fracture for each pull-off test (see pg. 11). Fracture results are included in test reports.

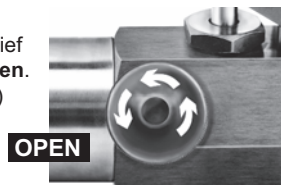


The *PosiTest AT-M* powers-up and displays dashes when the  button is pressed. To preserve battery life, the instrument powers-down after 5 minutes of no activity.

Quick Guide

- (1) **Open** pressure relief valve completely (*turn counter clockwise*)
- (2) **Connect** the actuator to the dolly
- (3) **Close** the pressure relief valve completely (*turn clockwise*)
- (4) **Zero** - Press the  button
- (5) **Pump** pressure into the system until the dolly pulls

1. Ensure the pressure relief valve is **completely open**.
(turn counter clockwise)



2. Push the actuator handle completely down into the actuator assembly. Place the actuator over the dolly head and attach the quick coupling to the dolly by reaching through the holes in the actuator and lifting the coupling. Release the quick coupling when the dolly head is completely engaged.

3. Close the pressure relief valve on the pump **completely** (turn clockwise).



As required, verify and adjust the dolly size by pressing the  button. Select the pressure units by pressing the  button. The instrument will maintain these settings even after the  button is pressed.

4. Zero the instrument **BEFORE** pumping by pressing the button. This prepares the instrument for the test by clearing the display, and zeroing the instrument.

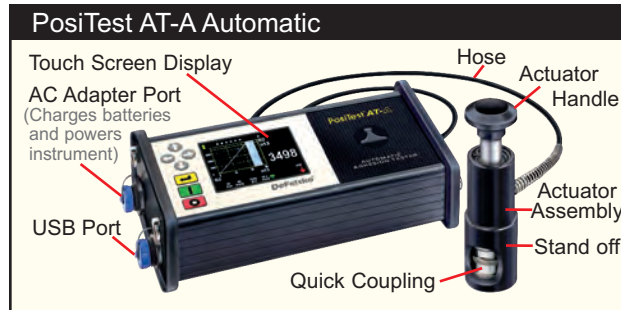
5. Prime the pump slowly until the displayed reading approaches the priming pressure. The priming pressure is the point that the instrument begins calculating and displaying the pull rate. It is also the pressure at which the ability to store readings is enabled. Priming pressures for the various dolly diameters are:

10 mm	400 psi	2.8 MPa
14 mm	200 psi	1.4 MPa
20 mm	100 psi	0.7 MPa (default setting)
50 mm	50 psi	0.4 MPa

For optimum results, prior to exceeding the priming pressure, return the pump handle to its full upright position and then complete a **single continuous stroke** at the desired pull rate until the actuator separates the dolly from the coating.

6. Open the pressure relief valve and remove the dolly from the actuator assembly.

7. Readings may be stored into memory by pressing the  button (memory storage for up to 200 pulls). Press again to review stored readings. Stored measurements can be accessed using our PosiSoft 3.0 desktop software (pg. 18).



The *PosiTest AT-A* powers-up when the  button is pressed. To preserve battery life, the instrument powers-down after 5 minutes of no activity. Alternatively, press and hold the  button for 5 seconds or select *Power Off* from the menu.

Instrument functions are menu controlled. To access the Menu, press the  button. Navigate using the *multifunction keypad* or *touch screen display*.

Multifunction Keypad



Directional buttons are used to navigate through menu options and adjust parameters.

Note: Some menus display on more than a single view. Use the  or  buttons or swipe the touch display to switch between views.

Access Menu / Select

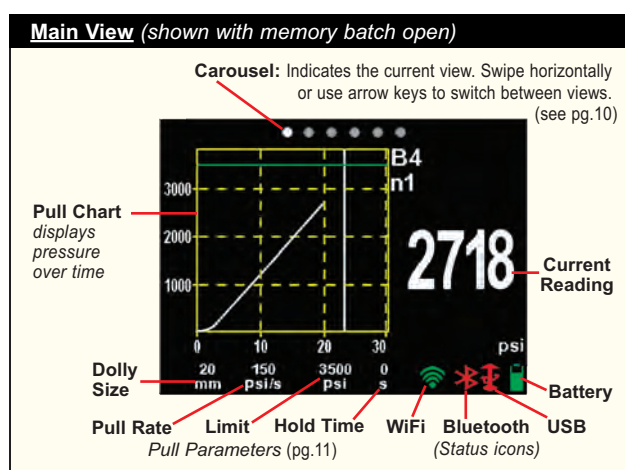
Power On / Start Test / Return to Main View

Stop Test / Power-down (hold for 5 seconds)

Screen Capture: Press both   buttons at any time to copy and save an image copy of the the current display. The last 10 screen captures are stored in memory and can be accessed when connected to a computer (see *PosiSoft USB Drive* pg. 15).

Touch Screen Display

Use the touch screen to interact with menu options. Swipe *horizontally* to navigate between views or *vertically* to move between batch readings. Alternatively, the directional buttons can be used for navigation.



How to Measure

Prepare the Instrument

1. Push the actuator handle completely down into the actuator assembly. Place the actuator over the dolly head and attach the quick coupling to the dolly by reaching through the holes in the actuator and lifting the coupling. Release the quick coupling when the dolly head is completely engaged.
2. Press the **I** button to power-up the instrument if necessary.
3. Verify **Pull Parameters** (pg. 13) are set to the preferred *dolly size*, *pull rate*, *pull limit* and *hold time*. Change if necessary.

NOTE: If recording of test results is desired, a memory batch must be opened prior to the test. Select *New Batch* from the *Memory* menu (pg. 13).

Perform the Test

4. Press the  button to initiate the test.

■ The instrument begins building pressure (priming stage) and a green animated arrow (up) appears on the display. When the priming pressure is achieved the LCD starts displaying pressure over time on the pull chart. Refer to step 5 (pg. 6) for *Priming Pressures*.

■ Pressure build-up stops when the dolly is pulled from the surface, the *pull limit* has been reached or when the  button is pressed. The maximum pressure value will blink on the display and a red animated arrow (down) will display while the pump retracts the actuator.



CAUTION: *To avoid injury, keep fingers away from the quick coupling and actuator assembly until the pull test has completed and the actuator has been fully retracted. Press the stop button to abort the pull test at any time.*

NOTE: Setting a *Pull Limit* or stopping the test before a fracture occurs is useful when the coating strength exceeds specified requirements.

5. Remove the dolly from the actuator assembly.

6. Examine the dolly and surface to analyze the result (pg. 4).

Recording the Result

If a memory batch is open, the maximum pressure result is automatically stored into memory (pg.13). Pass/fail, pull parameters, date and time are also recorded.

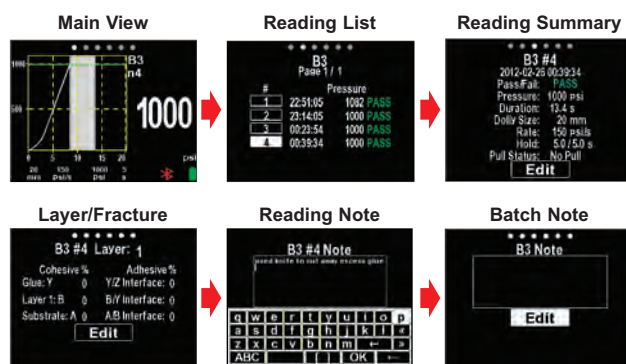
The nature of the fracture (cohesive, adhesive, glue), batch and reading notes can also be recorded. Swipe the touch screen horizontally or use the left/right buttons to navigate to the appropriate view and select *Edit*. See *Memory Views* (pg. 10).

All stored measurement data can be accessed using *PosiSoft* solutions or the *PosiTector App* (pg. 18).

Memory Views (carousel)

When a memory batch (pg. 13) is open, a carousel appears at the top of the display. Views are represented by dots, the solid dot indicates the current view.

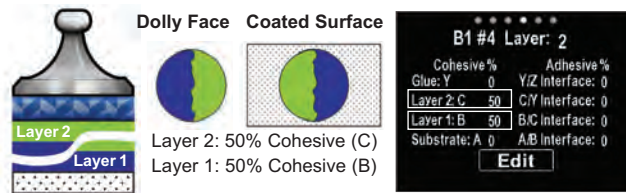
Swipe *horizontally* to navigate between views or *vertically* to move between batch readings. Alternatively, the directional buttons can be used for navigation. Six views are available:



Recording the Nature of the Fracture

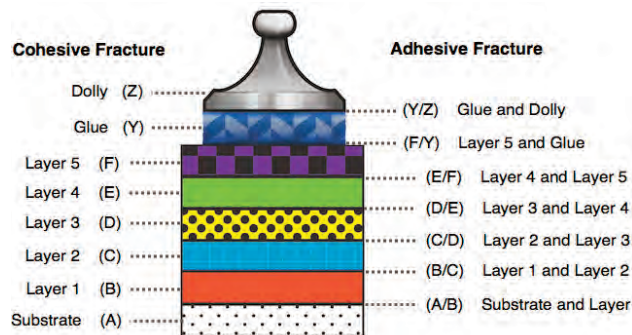
The cohesive and adhesive fracture visual analysis can be recorded using the PosiTest AT-A's keypad or touch screen display. Alternatively, the information can be reported using the PosiTector App (pg. 18).

Fractures are visually estimated and recorded as a percent of each. The two layer example below illustrates a cohesive fracture within coating layer 1 and layer 2 (visually estimated at 50% each). Recorded results are included in reports.



The PosiTest AT-A can record fracture information for up to five layers.

Cohesive and adhesive fractures are identified as follows:



Select **Edit** to set the number of layers and cohesive/adhesive fracture details. Use the   buttons to adjust.

B3 #4 Layer: 2

Cohesive %		Adhesive %	
Glue: Y	0	Y/Z Interface:	0
Layer 2: C	0	C/Y Interface:	0
Layer 1: B	0	B/C Interface:	0
Substrate: A	0	A/B Interface:	0

Edit

Examples:



B5 #2 Layer: 5

Cohesive %		Adhesive %	
Glue: Y	0	Y/Z Interface:	0
Layer 5: F	0	F/Y Interface:	0
Layer 4: E	0	E/F Interface:	0
Layer 3: D	0	D/E Interface:	100
Layer 2: C	0	C/D Interface:	0
Layer 1: B	0	B/C Interface:	0
Substrate: A	0	A/B Interface:	0

Done

100% cohesive fracture at D/E coating interface (layer 3/layer 4)



B5 #1 Layer: 5

Cohesive %		Adhesive %	
Glue: Y	0	Y/Z Interface:	0
Layer 5: F	0	F/Y Interface:	0
Layer 4: E	0	E/F Interface:	0
Layer 3: D	0	D/E Interface:	0
Layer 2: C	30	C/D Interface:	0
Layer 1: B	70	B/C Interface:	0
Substrate: A	0	A/B Interface:	0

Edit

70% cohesive failure within layer 1; 30% cohesive within layer 2

Memory Menu

The PosiTest AT-A stores 100,000 readings in up to 1,000 batches. *Stored measurements can be reviewed on-screen or accessed via computers, tablets and smart phones.*

New Batch

Closes any currently opened batch and creates a new memory batch, named using the lowest available number (example: B2). New batches are date stamped when they are created.

Open

Selects a previously created batch to open and make current.

Close

Stops the recording process, closes the current batch, and removes batch information from the display.

Delete

Removes a batch and associated measurements from memory.

NOTE:

i

Setup Menu

Pull Parameters

Select desired parameter using the   buttons or touch screen. Use the  and  buttons to adjust.

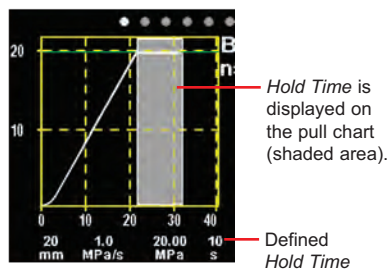
Dolly Size: Select the dolly size being utilized for the test (10, 14, 20 or 50 mm)

Rate: User selectable pull rate (unit/sec). Specified rate is maintained for the duration of the test.

Limit: Pressure will build-up until the set *Limit* is reached or the dolly is pulled from the surface, whichever occurs first. By default, the instrument will pull to maximum for selected dolly size (see *Technical Specifications* pg. 16).

Hold Time:

(up to 60 seconds)
pressure is maintained
(held) at defined *Limit*.
Default: 0 seconds.

**Orientation**

Rotates display between landscape (*default*) or portrait views.
Ideal for use in horizontal or vertical positions.

Units

Converts the display from psi, MPa, N/mm² or Newtons (unit of force). Existing measurements in memory are not converted. Switching units closes *Memory*.

Gage Info

Displays the model number & serial number, *PosiSoft.net* registration key, the amount of remaining memory for storage of readings, date and time, and software packages.

For security purposes, the registration key is required to add the Gage to your *PosiSoft.net* account (pg. 14).

Reset

Restores factory settings and returns the instrument to a known condition. The following occurs:

- All batches, stored readings, notes, batch names and screen captures are erased.
- Menu settings are returned to the following:

Memory = OFF	Bluetooth = ON	Units = psi
Pull Parameters = <i>default</i>	WiFi = OFF	Backlight = Sun
Orientation = Landscape	USB Drive = ON	Language = English

NOTE: *Date, Time and WiFi are not affected by a **Reset**.*

Connect Menu

PosiSoft.net

Select **Sync Now** to immediately synchronize stored measurement data via USB or WiFi to *PosiSoft.net* (pg.14). *PosiSoft Desktop Manager* and an internet connection are required when using USB.

The instrument automatically attempts synchronization with PosiSoft.net when initially connected via USB to a PC running *PosiSoft Desktop Manager*.

NOTE: Additional measurements added to memory while connected are synchronized only when the USB cable is disconnected, then reconnected or when the *Sync Now* option is selected.

USB Drive



The instrument uses a USB mass storage device which provides a simple interface to retrieve data in a manner similar to USB flash drives, cameras or digital audio players.

When checked, any computer can view readings stored in memory by navigating a virtual drive labeled "PosiTest" using the included USB cable.

A formatted HTML report is viewed by selecting the "index.html" or "START_HERE.html" file found in the root directory. Optionally, text ".txt" files located in each batch folder provide access to measurement values. Stored readings and graphs can be viewed or copied using universal PC/Mac web browsers or file explorers.

The last 10 screen captures (pg. 7) stored in memory can be accessed by navigating to the "screen_capture" directory.

When your **PosiTest AT-A** is first connected to your Windows PC via a USB cable, an enumeration process is started that installs device drivers without re-booting your computer. You may see several pop-up windows in the taskbar at the bottom right of your screen. Wait for the entire process to be completed before proceeding.

Bluetooth Smart

Allows communication with a smart device running the *PosiTector App* (pg.18) via  **Bluetooth**® wireless technology. No pairing required. When connected, measurement data is automatically transferred. Select **Send Batch** to manually transfer batches (useful when switching between smart devices).

WiFi

WiFi technology wirelessly communicates with PosiSoft.net, downloads software updates, and provides access the PosiTest AT-A's stored measurement data using standard web browsers.

On/Off  : Turns WiFi functionality **On**. Press it again to deactivate WiFi.

Networks: Available networks detected by the instrument are listed on the screen along with any networks that have previously been connected to that are not currently within connection range.

If the network is secure, the password must be entered (if unknown, contact the Network Administrator). Use the QWERTY keyboard to enter the password, then press *OK*. Select *Connect* to establish the WiFi connection. When connected the  icon will appear on the display.

Information: Displays information about the local WiFi network connection including...

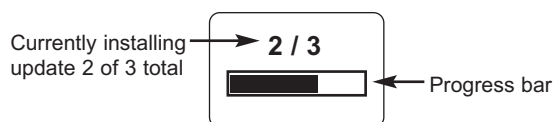
- SSID*: the network's name
- State*: displays if the Gage is connected to the network or not
- IP Address*: the IP Address provided by the network
- IP Settings*: allows manual entry of network information

Any WiFi enabled device connected to the same network can view the PosiTest AT-A's built-in mass storage drive. Using your device's web browser, enter the IP address of your PosiTest AT-A to access the drive. For complete details see:

Updates

Determines if a software update is available for your instrument. If an update is available, a prompt will appear allowing the user to choose to perform the update at this time or not.

WARNING: Ensure that stored readings are backed up to a computer or PosiSoft.net. The instrument will **Reset** (pg. 14) after the update and ALL readings in memory will be erased.



 **DO NOT** unplug the Gage during the update operation.

Accessing Stored Measurement Data

PosiSoft solutions for viewing, analyzing and reporting data:

PosiTest AT (all models)

- **PosiSoft 3.0** - Desktop software for downloading, viewing, printing and storing measurement data.

Customizable reporting tools allow you to add pictures and screen captures, notes and annotations, add or remove sections (drag and drop), change headings and more. Save your custom layouts as templates for future use.

PosiTest AT-A

In addition to *PosiSoft 3.0*, the PosiTest AT-A is also compatible with the following solutions...

- **PosiSoft USB Drive** - connect to a PC/Mac using the supplied USB cable to access and print stored readings, graphs, notes and screen captures. No software or internet connection required. *USB Drive* must be selected. (see pg.15)
- **PosiSoft.net** - a free web-based application offering secure centralized storage of instrument readings. Access your data from any web connected device. Go to: www.PosiSoft.net
- **PosiTector App** - Wirelessly transfer measurement data to your *Apple iOS* or *Android* smart device. Create, customize and share professional PDF reports quickly and easily. Add notes, images, nature of the fracture and more. The PosiTector App is available on the *iTunes App Store* and *Google Play*.

Power Supply / Charging

PosiTest AT-M (manual)

Power Source: Built-in rechargeable NiMH battery**
~60 hours continuous with full charge

The built-in rechargeable NiMH batteries are charged using the included USB AC power supply/charger. Ensure batteries are charged prior to use. The battery icon will blink while the instrument is charging and disappear when fully charged. The charging process will take up to 14 hours depending on remaining battery power.

Alternatively, the AC power supply or any computer USB port can be used to power and charge the instrument.

****Do not attempt to remove or replace the PosiTest AT-M internal NiMH battery pack. In the unlikely event power issues are experienced, please contact our technical support for assistance.**

PosiTest AT-A (automatic)

Power Source: Built-in rechargeable NiMH battery
>200 pulls with full charge

The built-in rechargeable NiMH batteries are charged using the included AC power supply/charger. Ensure batteries are charged prior to use. The USB port will not charge or power the PosiTest AT-A.

The charging process will take 2-3 hours depending on remaining battery power. Alternatively, the AC power supply can be used to power the instrument.

The  icon will display while the instrument is charging.
When fully charged the  icon will appear.

NOTE: The PosiTest AT-A internal NiMH battery pack is user replaceable. In the unlikely event power issues are experienced, please contact our technical support or your local dealer for OEM battery pricing, availability and detailed replacement instructions.

Calibration and Verification

Calibration

The PosiTest AT is shipped with a Certificate of Calibration showing traceability to a national standard. For organizations with re-certification requirements, the PosiTest AT may be returned at regular intervals for calibration. DeFelsko recommends that our customers establish their instrument calibration intervals based upon their own experience and work environment. Based on our product knowledge, data and customer feedback, a one year calibration interval from either the date of calibration, date of purchase, or date of receipt is a typical starting point.

Verification

The PosiTest AT Verifier is available for verifying the accuracy and operation of *PosiTest Adhesion Testers* and is an important component in fulfilling both ISO and in-house quality control requirements. Fully portable with hardshell carry case for use in the field or laboratory. Learn more at: www.defelsko.com/at/verifier

Technical Data

Conforms to: ASTM D4541, ASTM D7234, ISO 4624 and others.

Specifications:

Resolution: 1 psi (0.01 MPa) **Accuracy:** ±1% Full Scale

Dolly Size (mm)	Max Pull-Off Pressure (AT-M)	Max Pull-Off Pressure (AT-A)
10 mm	10,000 psi (70 MPa)	14,000 psi (96 MPa)
14 mm	6,000 psi (40 MPa)	7,000 psi (50 MPa)
20 mm	3,000 psi (20 MPa)	3,500 psi (24 MPa)
50 mm*	500 psi (3.5 MPa)	560 psi (3.8 MPa)

*requires the use of a 50 mm stand off

The instrument also measures in N/mm² and Newtons (unit of force). See **Units** (pg. 14).