

SPT-B22

## AUTOMATIC DIGITAL ADHESION TESTER OPERATION MANUAL

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MN-SPT-B22-E

V0

## INTRODUCTION

At present, there are three main methods to test the adhesion between a coating and a substrate, namely: the circle-drawing method, the grid-cutting method, and the pull-off method. Both the circle-drawing method and the grid-cutting method can only rate the adhesion and cannot quantify the results; while the pull-off method can quantitatively describe the specific size of the adhesion. It is clear and straightforward for evaluating the adhesion of different coatings, and is very suitable for researchers to use when developing formulations.

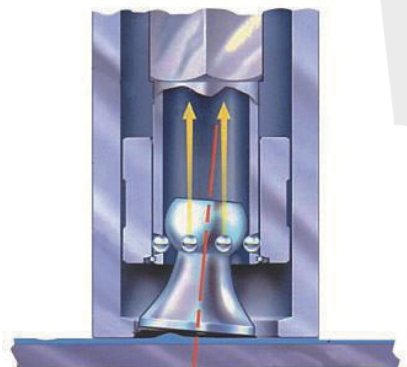
SPT-B22 automatic digital adhesion tester performs a pull-off test on coatings of a specific area through hydraulic pressure. The entire pull-off process is automatically completed by the instrument, with a stable and controllable pull-off speed, avoiding errors caused by unstable speed due to manual pressure application. The pull-off force can be accurately displayed through a digital display, with two different units (MPa and psi) available for selection. The instrument can set a pressure boost upper limit, enabling precise pressure application to the sample. After reaching the set pressure, the dwell time can be set to evaluate the durability of the sample under a certain pressure.

According to GB/T 5210, ASTM D4541/D7234, and ISO 4624/16276-1, and is widely used for testing the adhesion of coatings on concrete substrates, anti-corrosion coatings, or between different coatings in multi-coating systems.

## PRINCIPLE

The test sample or system is applied with a uniform thickness onto a flat plate with a consistent surface structure. After the coating system is dried/cured, a special pull-off test adhesive is used to directly bond the test stud to the surface of the coating. Once the special pull-off adhesive is cured, the instrument pulls the coating at an appropriate speed to test the force required to break the adhesion between the coating and the substrate.

It is worth noting that the test results are expressed by the tensile force causing interfacial failure (adhesion failure) or self-failure (cohesive failure), and adhesion/cohesive failure may occur simultaneously.



## SPECIFICATION

|                     |                                       |
|---------------------|---------------------------------------|
| Range               | 0~24MPa (0~3480psi)                   |
| Dolly dimension     | Ø20mm                                 |
| Resolution          | 0.01Mpa (1psi)                        |
| Accuracy            | ±1% full scale                        |
| Pull-off force      | 0.7~24MPa (102~3480psi)               |
| Pressurisation rate | 0.1~1.5MPa/s (15~215psi/s)            |
| Power               | built-in rechargeable lithium battery |
| Dimension (L×W×H)   | 240×138×81mm                          |
| Weight              | 4kg                                   |



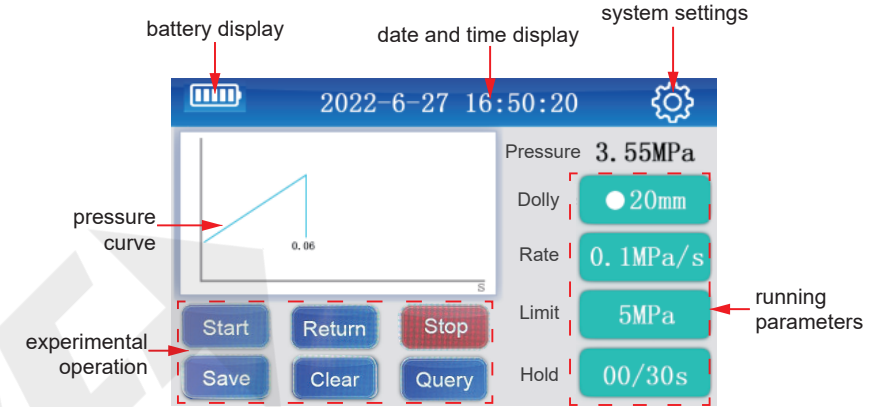
## Features:

1. Portable design with a built-in rechargeable lithium battery, no external power supply required, suitable for on-site and laboratories.
2. Adopting USB flash drive-style storage and equipped with a standard USB interface, it allows direct copying of stored experimental data after being connected to a computer, do not need to install additional driver software, making it simple and convenient to use.
3. Equipped with a built-in real-time clock, and all saved data are accompanied by corresponding experiment dates, times, etc.; this facilitates users in summarizing and managing experimental data.
4. For products with different bonding strengths, the sizes of pull-off studs provided include circular one (10mm, 14mm, 20mm, 50mm) and a square one (50mm), which expands the functionality of the instrument.
5. Internal storage of pull-off data, including maximum pull-off force, pulling rate, test time, and the size of the pull-off stud.
6. Simply press the buttons to select the size of the pull-off unit, change the measurement unit, or store the reading.
7. No conversion table is needed; the instrument automatically calculates the pull-off force according to the size of the pull-off unit.
8. The pull-off units are aluminum studs compliant with international standards; the aluminum self-centering pull-off units ensure that the pull-off force acts uniformly on the test surface when testing on either smooth or uneven surfaces, thus preventing one-sided pull-off.
9. LCD display with two units: MPa or psi.
10. It is equipped with a pull force curve display function, allowing for a clear observation of the changes in pull force throughout the entire pulling process.
11. Electric pull-off studs save effort while ensuring a stable and adjustable pulling rate, improving data repeatability.
12. It is equipped with a pressure holding function, which can determine whether the test passes by measuring the holding time of the coating under the set pulling force.

## OPERATION MENU

## 1. Main

Press the power switch on the operation panel to turn on the instrument, and the screen will display as follows:



**Battery Level Display:** Current battery level of the instrument is shown here. When the battery icon turns red, the instrument has a low battery. Please charge it in a timely manner.

**Time Display:** This shows the current system time, which can be modified in the "System Settings" interface. When using the instrument for the first time, you need to adjust the instrument's built-in date and time.

**System Settings:** Click to enter the "System Settings" interface. Here, you can select the display unit, or modify the system language and time. For details, refer to Section 2. System Settings Interface.

**Pressure Curve:** During the test, the pressure change curve will be displayed in this area. The number at the end of the curve indicates the current pressure value of the test, while the peak value (maximum pressure value) of the curve is shown in the "Peak Value" column on the right.

**Experimental operation:**

**Run:** Click the "Run" button, and the instrument will start operating to conduct the test.

**Return:** After the test is completed, click the "Return" button, and the working cylinder will start depressurizing until the pressure inside the cylinder reaches 0.

**Stop:** During the operation of the instrument, click the "Stop" button, and the instrument will stop pressurizing; the pressure in the working cylinder may drop slowly.

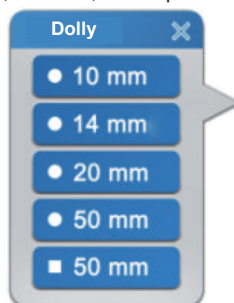
**Save:** In the standby state (after pressing the "Stop" button or upon the completion of a test), click the "Save" button to save the current test data. The saved content includes: test time, spindle diameter, selected unit, pressure increase rate, maximum pressure, pressure holding duration, and the pressure peak during the test.

**Zero:** Click the "Zero" button, and the "Pressure Curve" area and the "Maximum Pressure" value will be reset.

**Query:** Click the "Query" button to enter the "Data Query Interface"; see Section 3. Query Interface for details.

**Running parameters:**

**Dolly:** Click the input box to select the dolly diameter used in the test. There are five sizes available: Ø10mm, Ø14mm, Ø20mm, Ø50mm, and Square 50mm, as shown in the figure below:



**Rate:** Set the increasing speed of the drawing force during the test. Click the input box to modify the value; the setting range varies depending on the spindle diameter. For details, refer to "Drawing Rate" in "3.0 Main Technical Parameters".

**Limit:** Set the upper limit of the maximum pressure applied by the instrument to the bottom surface of the spindle in this test. Click the input box to modify the value; the setting range varies depending on the spindle diameter. For details, refer to "Pull-off Strength" in "3.0 Main Technical Parameters".

**Hold:** During a test, if the spindle still cannot be pulled off after the "Maximum Pressure" is reached, the instrument will maintain the current pressure and start timing the pressure holding duration. Click this input box to modify the pressure holding duration (range: 0-999 seconds).

**2. System Settings Interface**

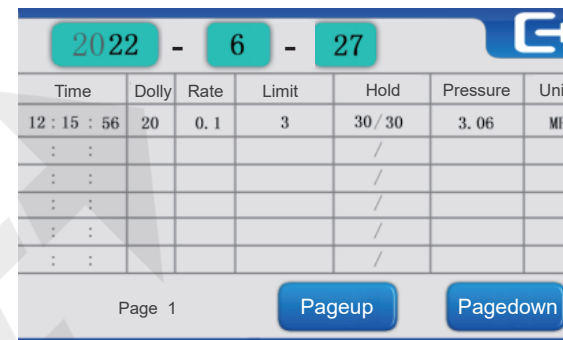
Press the "System Settings" button on the main interface to enter the System Settings Interface (as shown in the figure below):



In the Parameter Setting Interface, you can select the display unit (MPa or PSI), modify the system date and time, or choose the operating language (Chinese/English). Click the back icon in the upper right corner to return to the main interface.

**3. Query Interface**

Click the "Query" button on the main interface to enter the query interface (as shown in the figure below). The test records are listed from left to right as follows: Time, Dolly, Rate, Limit, Hold, Pressure and Selected Unit.



Click the date input box and enter the date you need to query; click "Pageup" and "Pagedown" to browse through the data, and click the back icon in the upper right corner to return to the main interface. When you need to delete stored records, please connect the instrument to a computer and then delete them using the computer (see Data Storage and Export for details).

**OPERATION****1. Pre-Experiment Preparation**

**1.1 Spindle Preparation:** Select a spindle of appropriate size based on the adhesion strength of the sample to be tested and Table 1. Carefully inspect the working surface of the spindle to ensure there are no defects such as gaps, scratches, burrs, or unevenness. Clean the spindle surface with a scouring pad (or sand the surface with fine sandpaper until it is flat and smooth, then clean it). To ensure the accuracy of the experimental results, prepare at least 6 spindles.

Table 1: Dolly Dimensions, Measured Adhesion Ranges, and Pressure Boost Rates

| shape               | size    | min. pull-off pressure | max. pull-off pressure | pressure boost rate |
|---------------------|---------|------------------------|------------------------|---------------------|
| circle<br>10pcs/bag | Ø10mm   | 4MPa                   | 96MPa                  | 0.4~6.0MPa/s        |
|                     |         | 580psi                 | 13920psi               | 58~870psi/s         |
|                     | Ø14mm   | 2MPa                   | 50MPa                  | 0.2~3.0MPa/s        |
|                     |         | 290psi                 | 7250psi                | 29~435psi/s         |
|                     | Ø20mm   | 0.7MPa                 | 24MPa                  | 0.1~1.5MPa/s        |
|                     |         | 102psi                 | 3480psi                | 15~215psi/s         |
| square<br>10pcs/bag | 50x50mm | 0.1MPa                 | 3.8MPa                 | 0.02~0.24MPa/s      |
|                     |         | 15psi                  | 550psi                 | 3~34psi/s           |
|                     |         | 0.1MPa                 | 3.0MPa                 | 0.01~0.19MPa        |
|                     |         | 15psi                  | 435psi                 | 2~27psi/s           |

**Note:** When the adhesion of the coating to be tested is too low, it is not recommended to use a smaller spindle (which generates greater tension) for the experiment to ensure measurement accuracy.

**1.2 Pretreatment of Test Samples:** Gently wipe the coating surface with a scouring pad (note: using a scouring pad may cause minor scratches on the coating surface; if not necessary, only use a soft cloth or paper towel for wiping). Meanwhile, to ensure the adhesive firmly bonds the coating to the spindle, clean oil stains, water marks, and dust from the coating surface using alcohol or acetone.

**Note:** When choosing a scouring pad or other materials to wipe the coating surface, selecting a cleaning agent to remove oil stains, or using other special adhesives for the pull-off test, ensure they do not alter the performance of the coating to be tested. Therefore, before using these materials, conduct a preliminary test to verify whether they affect the surface of the coating to be tested.

**1.3 Preparation of Special Adhesive for Pull-Off Test:** Prepare an appropriate amount of special adhesive for the pull-off test based on the selected spindle size.

**1.4 Preparation of Test Specimens:** Evenly apply the prepared special adhesive for the pull-off test to the bottom surface of the spindle, then gently press the spindle vertically onto the surface of the coating to be tested to squeeze out excess adhesive. Ensure uniform force application, observe the bonding condition between the spindle and the coating, and do not rotate or slide the spindle during the bonding process to avoid air bubble formation. Wipe off any adhesive that overflows around the spindle with a cotton cloth. At room temperature, the special adhesive for the pull-off test will fully cure after 24 hours; alternatively, refer to the adhesive's instructions—curing can be accelerated by placing the specimen in a 60°C environment for 2 hours.

**1.5 Isolation of the Test Area:** Use the cutter provided with the instrument to cut through the coating along the edge of the spindle until reaching the substrate. This creates a circular test area. Clean up any debris generated during cutting.

**Note:** Different sizes of spindles require different cutters for isolation; some sizes may require the user to perform isolation with a sharp tool independently.

## 2. Test

2.1 Take out the instrument and press the power switch to turn it on.

2.2 If the spindle quick connector is not at the bottom position, press the piston cap down with the palm of your hand until it reaches the bottom; then clamp the spindle quick connector onto the small end of the spindle.

2.3 Click the input box next to "Spindle Diameter" on the right side to select the spindle diameter. Then, enter the "Pressure Boost Rate" and "Maximum Pressure" based on the spindle size and the actual condition of the sample, and input the "Pressure Holding Time" as needed (refer to Table 1 in Section 1.1 for reference).

2.4 After entering the operating parameters, click the "Run" button. The instrument will start pressurizing, and the working cylinder will automatically pull the spindle upward. A pressure curve will be plotted on the left side of the screen. During the operation of the instrument, clicking the "Stop" button can pause the test, and at this point, clicking the "Save" button can record the current test data.

a) During the test, if the set "Maximum Pressure" is reached, the instrument will enter the pressure-holding phase, and the "Pressure Holding Time" will start counting. At this time, the "Peak Value" is equal to the "Maximum Pressure". After the set time is reached, the instrument will automatically relieve pressure. Once pressure relief is completed, click the "Save" button to save the test data of this run.

b) During the test, if the spindle is pulled off before the set "Maximum Pressure" is reached, the instrument will stop automatically, and the peak value in the pressure curve will be displayed in the first column on the right. At this point, click the "Save" button to save the test data of this run.

**Note:** During the operation of the instrument (including the pressure-holding phase and pressure-relief phase), data cannot be saved. Please perform the save operation only after the instrument stops. After clicking the "Zero" button or clicking the "Run" button again, the previous test data will no longer be savable, so please save the data in a timely manner.

2.5 After one test is completed, if the instrument does not automatically relieve pressure, first click the "Return" button. Wait until the instrument completes pressure relief, then release the spindle quick connector, take out the spindle, and click the "Zero" button to clear the data. If another test is required, repeat Steps 7.22–7.25 to continue measuring other specimens.

## 3. Recording of Test Results

Determine the failure property by visually inspecting the damaged surface, and evaluate the failure type in the following manner (as shown in the figure below):

A — Cohesive failure within the substrate;

A/B — Adhesive failure between the first coating layer and the substrate;

B — Cohesive failure within the first coating layer;

B/C — Adhesive failure between the first coating layer and the second coating layer;

N — Cohesive failure within the nth coating layer of the composite coating;

N/M — Adhesive failure between the nth coating layer and the mth coating layer of the composite coating;

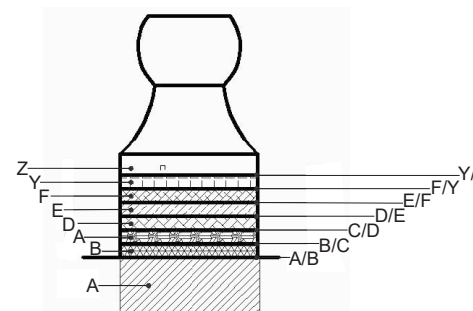
—/Y — Adhesive failure between the last coating layer and the adhesive;

Y — Cohesive failure within the adhesive;

Y/Z — Bond failure between the adhesive and the spindle.

For each failure type, estimate the percentage of the damaged area, accurate to 10%.

Example: If the coating fails under an average tensile force of 3 MPa, inspection shows that the cohesive failure area within the first coating layer is approximately 20%, and the adhesive failure area between the first coating layer and the second coating layer is approximately 80%. In this case, the test result of the pull-off test is: 3 MPa, 20%B, 80%B/C.



## STORAGE AND EXPORT

Data is stored as Excel spreadsheets via a simulated USB flash drive. When users view or export data using a computer, no additional drivers need to be installed—the measured data can be directly accessed with great convenience.

When the instrument is connected to a computer's USB port, Figure 1 will appear on the instrument's display, indicating a successful connection. The instrument has an internal storage capacity of 16 MB, which can hold up to tens of thousands of data entries—fully meeting users' daily testing requirements. Open the removable disk (shown as the instrument's drive) on the computer, and the format of the stored data will be visible, as illustrated in Figure 2.

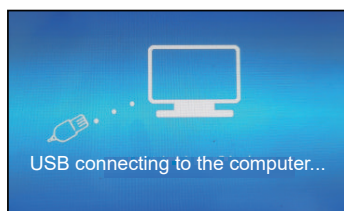


Figure 1

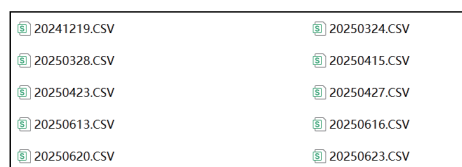


Figure 2

Data is stored in date-based categories: each day corresponds to one file, and all data measured on that day is saved to the file named after the respective date. Open the file corresponding to the date you want to view, as shown in the figure below:

| Time     | Dolly | Unit | Rate | Limit | Hold    | Pressure |
|----------|-------|------|------|-------|---------|----------|
| 11:12:20 | 20    | MPa  | 1    | 10    | 60/60   | 10.04    |
| 11:26:01 | 20    | MPa  | 1    | 10    | 5/5     | 9.99     |
| 11:42:05 | 20    | MPa  | 1    | 10    | 5/5     | 10.01    |
| 11:50:06 | 20    | MPa  | 1    | 5     | 24/999  | 15.06    |
| 11:53:06 | 20    | MPa  | 1    | 5     | 91/999  | 5.04     |
| 11:56:06 | 20    | MPa  | 1    | 5     | 144/999 | 5.09     |
| 11:57:06 | 20    | MPa  | 1    | 5     | 199/999 | 5.09     |
| 11:57:06 | 20    | MPa  | 1    | 5     | 201/999 | 5.09     |
| 11:58:06 | 20    | MPa  | 1    | 5     | 217/999 | 5.09     |
| 13:32:26 | 20    | MPa  | 1    | 5     | 8/999   | 5.03     |
| 13:33:23 | 20    | MPa  | 1    | 5     | 60/999  | 5.03     |
| 13:49:40 | 20    | MPa  | 0.1  | 20    | 63/999  | 20.1     |
| 13:52:40 | 50    | MPa  | 0.02 | 3.2   | 0/999   | 1.46     |
| 13:52:40 | 50    | MPa  | 0.02 | 3.2   | 0/999   | 1.43     |

When users need to delete stored records, they can either directly delete the record file for a specific date, or open the file, delete the corresponding record information, and then save the file.

## PRECAUTIONS

1. This instrument contains many precision measuring components. When moving it, handle it gently and place it carefully.
2. This is a specialized instrument. Non-professionals are not allowed to open the instrument casing or calibrate the instrument by themselves, as this may affect the instrument's measurement accuracy.
3. To ensure the authenticity of data, the instrument should be inspected by the company regularly once a year, or sent to the relevant metrological supervision department for verification and calibration once a year.
4. When the instrument displays low battery, charge it in a timely manner to avoid damaging the battery.
5. If the instrument is not used for a long time, its date may reset to the initial value. If the date does not match the actual date, you can enter the settings interface to reset the date.

## COMMON FAULTS

| common Issues                                                                          | check                                                              |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| unable to pressurize to the holding pressure                                           | check if the instrument is leaking oil                             |
| the instrument fails to reset to zero after the "Zero" button on the screen is pressed | check whether the "Return" button was pressed after the test ended |

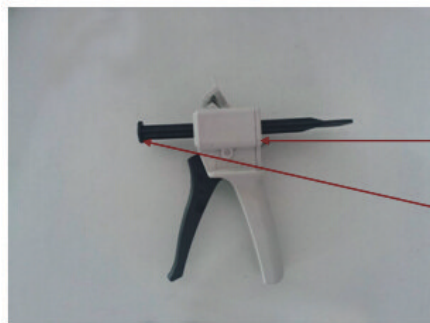
- \* When selecting the optional Ø50mm circular spindle, the corresponding cutter and sleeve must also be selected together. When selecting the optional 50mm square spindle, the corresponding sleeve and connector must also be selected together.

## Appendix I: How to use glue gun

SPT-B22 Automatic Digital Pull-Off Adhesion Tester comes with glue gun and 3M high strong adhesive:



- ① — Push board
- ② — Trigger
- ③ — Button for installing push board
- ④ — Fixed button for adhesive
- ⑤ — 3M Adhesive



1. Press down the button for installing push board
2. Insert push board from left to side with toothed side is down

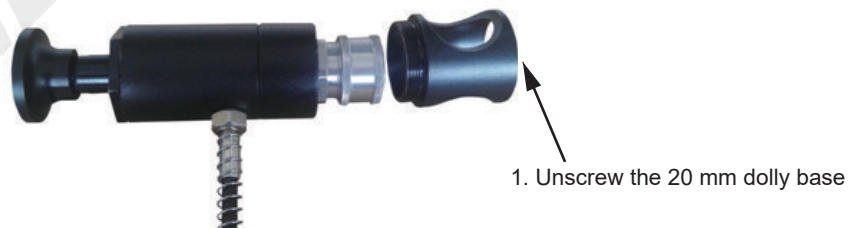


3. Put into adhesive from up to down
4. Tighten the fixed button for adhesive
5. Open the adhesive cover

Operator also can use the special one-time plastic mixing pipe (optional) and put it on the outlet of adhesive. The glue which pass through mixing pipe has been mixed completely and can be used directly. If don't use mixing pipe, operator can squeeze adhesive to a clean vessel, then mix it manually. (Check the operation of adhesive form ore detailed information)

## Appendix II: How to use 50mm dolly

If operator should use 50 mm dolly, please change dolly base as below pictures and steps:



1. Unscrew the 20 mm dolly base



2. Install the 50 mm dolly base on the Actuator handle.

### Appendix III: How to use glue gun

1. Loosen the two screws on the side battery cover, pull out the battery cover, and you will see the battery compartment:



2. Insert three 18650 batteries into the battery compartment, paying attention to the battery polarity—do not reverse them. During the battery installation process, be careful not to push the circuit board toward the positive electrode to avoid pushing the circuit board out. (If necessary, press the circuit board inward with your hand before installing or removing the batteries.) After installation, fasten the battery cover securely.



3. Note: The voltage of the three batteries must be consistent. If the battery voltages are inconsistent, first fully charge them using an external charger before installation. After installing the batteries for the first time or replacing them, you need to connect the charger first, then press the power button to activate the device before it can be used.