Instruction Manual
Automated Torque Tester

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1. Introduction

The SureTorque Automated Torque Tester is a test instrument intended to be incorporated into a quality control program of bottle packaging companies. The ST-Lab is a motorized testing equipment with a strain gage based torque transducer used to measure the removal/applied torque of threaded closures. The equipment was developed in accordance with various ASTM D10.31 and ISBT voluntary bottle testing standards.

As a quick reference, please find the various standards including the ones developed by ASTM and ISBT listed below:

ASTM (developed by D10.31):

- D2063-91(2002) Standard Test Methods for Measurement of Torque Retention for Packages with Continuous Thread Closures
- D3198-97(2002) Standard Test Method for Application and Removal Torque of Threaded or Lug-Style Closures
- D3469-97(2002) Standard Test Methods for Measurement of Vertical Downward Forces to Disengage Type IIA Lug-Style Child-Resistant Closures
- D3470-97(2002) Standard Test Method for Measurement of Removal Lug Strippage of Type IIA Child-Resistant Closures
- D3472-97(2002) Standard Test Method for Reverse-Ratchet Torque of Type IA Child-Resistant Closures
- D3474-90(2002) Standard Practice for The Calibration and Use of Torque Meters Used in Packaging Applications
- D3475-07 Standard Classification of Child-Resistant Packages
- D3481-06 Standard Test Method for Manual Shelling Two-Piece Child-Resistant Closures That Are Activated by Two Simultaneous Dissimilar Motions
- D3810-97(2002) Standard Test Method for Minimum Application Torque of Type IA Child-Resistant Closures
- D3968-97(2002) Standard Test Method for Monitoring of Rotational Torque of Type IIIA Child-Resistant Closures
- D7257-06 Standard Test Method for Automated Shelling Two-Piece Child-Resistant Closures That Are Activated by Two Simultaneous Dissimilar Motions

ASTM (other):

- D5094-90 Standard Test Methods for Gross Leakage of Liquids from Containers with Threaded or Lug-Style Closures
- D5419-95 Standard Test Method for Environmental Stress Crack Resistance (ESCR) of Threaded Plastic Closures

ISBT Voluntary Standard Test Methods for Plastic Flat Top Closures

- Top Closures
- Back-off
- Ball Impact
- Drop Impact
- Elevated Temperature Cycle
- Opening Performace
- Pressure Retention: Zahm Nagel
- Pull Up
- Removal Torque
- Secure Seal Test
- Security
- Strip Torque
- Top Load Vent

- Vacuum Retention

Foreign Test Standards

- DIN EN 12377:1998 Packaging - Flexible tubes - Test method for the tightness of closures
- DIN EN 14401:2004 Rigid plastics containers - Methods to test the effectiveness of closures
- SS-EN 12377 Packaging - Flexible tubes - Test method for the airtightness of closures

The automated test system can be used for the following purposes;

Cap tightening: The unit may be used as a portable precision cap tightener in low volume production facilities.

Closure integrity testing: The torque required to remove the cap from the container threads can indicate the quality of the package. Low removal torque values may indicate a poor capping process which may result n product contamination or leakage. Using this method within a quality control program (aging, leak testing) will ensure that your packaged products are consistently and reliably closed and product leakage is minimized or eliminated.

Package Development: Thread break/closure removal/strip and applied torque testing can be utilized for package development and marketing. New materials and designs can be evaluated by comparing the value and repeatability of test results.

Validation: The test results from the SureTorque tester can be used to validate and set the limits of the packaging process.

Packaging Machinery Troubleshooting: The torque testing results can aid in troubleshooting a packaging machine configuration or operation.

2. Specifications

Power supply:	24V, 5 Amps
Torque Range:	0 – 80 lbfin (pound-force inch)
Speed Range:	0rpm – 60rpm
Rotation limit:	32000 degrees
Torque accuracy:	0.1%FS static
Torque Resolution:	0.01 lbfin
Dimensions:	18” x 18” x 24”
Weight:	Approx. 60lbs

3. Installation

1. Locate unit on a table top.
2. Plug power supply into standard 115VAC outlet.
3. Hook-up a clean, dry, filtered air supply of 80 psi at 4 cfm. Connect the airline to the 1/8” NPT fitting at rear panel of main enclosure.

4. Description

The SureTorque Tester is an instrument that utilizes a unique torque and speed controlled servo motor, a patented pressure controlled closure gripping mechanism and a strain gage based torque transducer to measure the opening/closing torque of threaded closure systems. Test methods were developed based on various ASTM, ISBT standards and current testing practices at the world's largest bottle packaging companies. SureTorque recommends that you obtain copies of the standards developed by the ASTM D10.31 subcommittee and ISBT (International Society of Beverage Technologists) for your reference.

The torque tester is controlled by a PLC with an Operator Interface.

5. Basic Operation

The operator places a container on the base and presses the dual activation (green) pushbuttons until the right clamp closes. Once the clamps are closed and the container is held securely, the head lowers and the chuck activates. The chuck starts the rotation at the predefined torque ramp, speed/acceleration and when the preset rotation/torque is reached, the peak value is displayed on the screen. During a test cycle the trend of the actual torque and angle may be displayed on screen or transferred to a PC.

6. Calibration, Mechanical Setup and Test Modes

a. Power Up

Power up the unit by turning on the switch located on the rear panel. The PLC screen shortly lits up, and the manufacturer and software version information (as shown in Figure 1.) is shown on the first "splash" screen during the boot-up procedure. Then the PLC automatically goes in the default Automatic Test mode.

Figure 1: Support Display

Figure 2: Main Menu

b. Main Menu

The main menu (Figure 2.) allows the user to navigate to the main areas of the control system. Use the left and right arrow keys to scroll through the main menu. (This menu may be accessed from any of the displays by pressing the ESC key a couple of times.) When the desired function is highlighted, press Enter.

SETUP: Navigate to the SETUP submenus.
MANUAL: Navigate to the MANUAL MODE screen.
CALIBRATE: Navigate to the CALIBRATION function screen.
TEST: Navigate to the TEST screens.

c. Calibration

Navigate to the Calibration Mode from the Main Menu. This mode may be used to troubleshoot measurement issues and calibrate the machine.

1. Find the calibration kit, move the clamp slides to the side, attach the calibration frame on the clamp slide and insert the calibration pulley in the chuck. Your setup should look similar to Figure 3.

Figure 3: Calibration – Default

2. Run a quick torque verification, press the ARROW button to zero the offset then the TEST (#1) to lock the shaft. Hang a known weight on either side of the pulley system and check the scaled torque readout on the display. (Figure 8.)
   If the torque readout is out of tolerance, follow the steps below and recalibrate the unit.
3. Press the ENTER key, type the password (if required, the default password is 1113), then accept or change the calibration variables (unit system (0-ozfin, 1-lbfin, 3-kgfcm, 6dNm), pulley radius and weight). Use the numeric keypad to enter a variable then press the ENTER key to accept the change. When all variables are entered and the cursor is not flashing anymore, follow the instructions on the bottom of the screen.
4. Unload the pulley and press the CAL/#0 key. This registers the zero offset of the calibration.
5. Manually rotate the pulley in the position shown on Figure 4., lock the chuck by pressing the TEST/#1 key, then hang the weight on the right side of the pulley, let it settle, then press the CAL/#0 key. This registers the gain of the calibration for CCW direction.

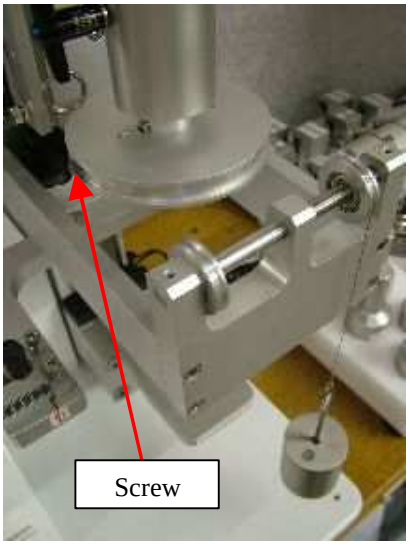

Figure 4: Calibration – CCW 1

Figure 5: Calibration – CCW 2

6. Manually rotate the pulley in the position shown on Figure 6., lock the chuck by pressing the TEST/#1 key, then hang the weight on the right side of the pulley, let it settle, then press the CAL/#0 key. This registers the gain of the calibration for CW direction.

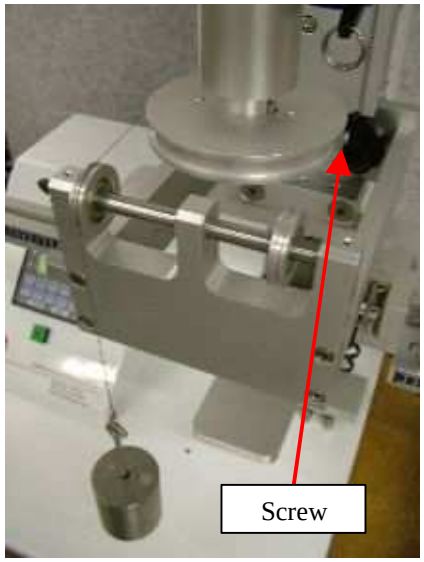

Figure 6: Calibration – CW 1

Figure 7: Calibration – CW 2

7. At this point the display is calibrated both CW and CCW, press the CAL/#0 key again to return to the calibration check screen and test linearity if required (Figure 8.) or press the ESC key to navigate to the Main Menu.

Figure 8: Calibration – Display

d. Mechanical Setup

Navigate to the Manual Mode from the Main Menu, enter the password (if required, the default password is 1114). This mode may be used to troubleshoot pneumatic and mechanical issues and setup the machine for product testing.

1. Pick a container and the related change parts (collet and a set of clamps) attach the clamp to the slides and insert the collet in the chuck housing.
2. Slide the head assembly up, the clamp assembly down and the clamps to the sides. This will allow safe pneumatic actuations and maximum space to start the setup procedure.
3. Activate the head cylinder by pressing the Head key on the HMI. This will lower the head. The head cylinder can be activated by a high pressure and an adjustable pressure. The mini regulator controlling the adjustable pressure source is located and labeled on the back panel. The head and clamp slide reference points (the top of the slide blocks) and the back panel are shown below.

Figure 9: Manual – Reference

Figure 10: Manual – Back panel

4. Release the head slide screw and carefully lower the head. Let the collet slide onto the cap deep enough to provide a good grip but not too much to avoid gripping the container body/neck.
5. Press the CHUCK key (#8) to squeeze the cap. This naturally centers the container under the test head. The squeezing pressure may be adjusted with the mini regulator on the back panel. Try to manually rotate the container body to see if the collet is slipping or holding the cap securely. If the cap is slipping in the collet, then check the collet, rubber insert, chuck pressure and contact surfaces.
6. Move in the left clamp slide until it firmly fits the container and tighten the left clamp slide. We recommend clamping as high to the container neck as possible (better centering). If the molded clamp is profiled to the container, set the clamping height to allow the container to fit perfectly in the clamp's profile.
7. Press the CLAMP (#7) key to activate the clamp cylinder. For operator safety, try to minimize the clamp pressure with the mini regulator on the back of the machine.
8. Slide the right clamp to firmly grip the container, then tighten the right clamp temporarily. Deactivate the clamp cylinder then move the right side 1 count closer to the container. (1 count is the smallest unit on the scale)
9. Check the setup, deactivate the clamp the chuck and the head cylinders by pressing the corresponding keys. Activate the clamp cylinder then test the tightness of the clamping by manually torquing the cap. If the container is held securely your clamp setup is good, if it slips you need to readjust the sliders or the clamping pressure. Activate the head and check collet/cap/container neck clearance.
10. If clearances, positions, pressures look good, the setup is done. When the torque tester is mechanically configured, press the ESC key to navigate to the Main Menu.

e. Electronic Setup 1

Navigate to the Setup from the Main Menu, (if required, the default password is 1111). This mode may be used to adjust the timers, rotational velocity, torque ramp, system time, and a number of other variables. Please find more details below.

Figure 11: Setup – Timer

Figure 12: Setup – Speed

Clamp On (mm:ss:hh): This timer is used to delay the clamp activation.
Head HP-LP On (mm:ss:hh): This timer is used to delay the head lowering cycle in order to allow proper container clamping before the collet slides onto the cap.

Head HP Off (mm:ss:hh): This timer delays the switch to low pressure mode. Low pressure allows minimal toplod force to be applied on a cap for TEB or other topload sensitive applications.
Chuck On (mm:ss:hh): This timer delays the chuck cylinder after starting a test.
Chuck Off (mm:ss:hh): This timer delays the chuck cylinder de-activation at the end.
Dwell Delay (mm:ss:hh): This timer defines the delay between following tests in cyclic modes.
Cycle Start (mm:ss:hh): Delays the rotation at the beginning of the test.
Cycle End (mm:ss:hh): Delay after a test is finished.
Clamp Burst (mm:ss:hh): Timer controlling an air burst to break the sticktion between container body and clamps when retracting the clamp cylinder.

Torque ramp time (s): This timer defines the speed of the torque ramp up. 60s means the maximum torque is reached in 60s. When the timer is set to 0, the torque applied during a cycle is constant and defined by the starting torque value.
Starting torque (%): The torque applied at the beginning of the test. Default value is 2.5%-5%, which is approx. 0 lbfin.
Speed (rpm): The speed of the rotation during a test cycle.

Figure 13: Setup – Miscellaneous 1

Figure 14: Setup – Miscellaneous 2

Time (mm/dd/yy hh:mm:ss): Set the system time with this variable.
Default mode: Set 0 to default Applied and 13 to default Release test. (Other mode codes: 1-A>R, 14-R>A, 17-Strip)
LCD contrast: Adjust LCD screen contrast between 0 and 100.
Release Testing Method: Enter 0 to select rotation based or 1 for torque based test validation. (When 0 is selected the machine compares the actual angle with the maximum rotation, and when the actual angle exceeds the maximum rotation the test stops and the peak torque is displayed as the result).
Applied Testing Method: Enter 0 to select rotation based or 1 for torque based test validation.
Maximum rotation (degrees): The rotation is a test cycle when rotation based operation is selected.
Keyboard lock: Locks the keyboard. Press the ESC key to enable/disable keyboard lock during normal operation.
Safety start button: 1 enables, 0 disables safety start function. (When the safety start buttons are enabled both pushbuttons must be pressed until the chuck closes to successfully initiate a cycle).
Offset autozero: Set 0 to disable and 1 to enable the autozero feature. This feature is similar to the tar function on weight scales. By enabling this feature any parasitic torque

can be cancelled at the beginning of a cycle. Parasitic torque may be introduced by sideload, topload or other variables and are usually the result of improper mechanical setup.

Figure 15: Setup – Data

Figure 16: Setup – Unlock

Clear historical data: Set 0 to keep and 1 to erase historical data.
Historical data table size: Set number of records to keep in PLC memory (0-4000).
Serial data format: This is the code to select the required communication method.
(0-data is formatted for printing on 3" width paper, 1-data is formatted for compatibility with previous data acquisition software, 2-continuous data stream is sent to PC which may be captured and saved as an excel compatible data file, 3-data is only saved to PLC memory but not transferred to PC.

Unlock Codes: Enter correct/incorrect unlock code from Settings sheet to enable/disable features.

Alarm Settings: Not applicable for units without the alarm option.

f. Electronic Setup 2

Enter in the Setup from the Applied/Release/Etc. test screens, (if required, the default password is 1112). This mode may be used to quickly adjust runtime variables: rotational velocity, torque ramp, dwell time, etc. Please find more details below.

Figure 17: Setup – Runtime 1

Figure 18: Setup – Runtime 2

Applied Setpoint (lbfin): The torque to be applied in a cap tightening test.

Applied Fallback (lbfin): Only applicable in Strip Test mode when the torque based validation method is selected. This variable defines the amount of drop in the torque that validates a peak as a strip torque. You can also consider this variabe as the sensitivity of the strip test.
Release fallback (lbfin): When sensitivity based testing is enabled this variable allows the automatic determination of thread break torque (or other characteristic drops in torque). In other words, the release fallback defines how sensitive the control is to the torque variations/transients during a cycle.
Please note that the fallback values have no effect on the operation when rotation based test methods are active.
Maximum rotation (degrees): The maximum rotation during a test cycle. Only active when the rotation based testing methods are enabled.
Ramp time (s): This timer defines the speed of the torque ramp up. 60s means the maximum torque is reached in 60s. When the timer is set to 0, the torque applied during a cycle is constant and defined by the starting torque value.
Starting torque (%): The torque applied at the beginning of the test. Default value is 2.5%-5%, approx. 0 lbfin. 100% is approx 80 lbfin.
Speed (rpm): The angular speed of the rotation during a test cycle.
Dwell Delay (mm:ss:hh): This timer defines the delay between following tests in cyclic modes.
Number of Cycles: This variable defines the number of cycles in R>A and A>R modes.
Default mode: Set 0 to default Applied and 13 to default Release test. (Other mode codes: 1-A>R, 14-R>A, 17-Strip)

g. Testing

Navigate to the Test screen from the Main Menu by selecting the Test icon and pressing the ENTER key. Applied (clockwise) and Release (counterclockwise) testing may be performed to determine the torque required to rotate a cap both in CW and CCW directions. By adjusting the rotational speed, torque ramp, maximum rotation and dwell time variables, a number of different torque tests may be performed in both directions. The sequence of operation and the operating principles are detailed below.

1. Place a container on the platform then press both start. During this process, and anytime when pneumatic cylinders activate, keep yourself and others clear of the moving parts.
2. Once the clamps are closed and the chuck is activated, pinch points are eliminated and the product is firmly supported from all sides. You may release the start buttons now. The chuck starts rotating at the pre-defined velocity, torque ramp and acceleration. Check the display during the cycle to analyze the torque/ angle trends real-time.
3. During the test cycle, the operator should observe the container/collet for indication of concentricity, excessive side load or downward pressure, and fine-tune the mechanical setup if required.
4. The operator may press the ESC key anytime during the operation to stop the automatic test if the unit is not able to measure the torque/angle properly, mechanical or electrical adjustments are required, or there is an emergency situation. During the escape/reset process a status message is displayed (Figure 21).

Figure 19: Test – Application

Figure 20: Test – Graph

5. Depending on the selected testing method, at the maximum rotation, or at the peak torque the chuck stops and the display shows the peak value. The actuators return to home position and the product is ready for removal.

6. Repeat from 1.

Figure 21: Test – Status

h. Operation Modes

Various test modes may be created by selecting rotation-based and torque based measurements and/or changing the adjustable head pressure/topload.
In rotation based measurements the chuck rotates the predefined angles then shows the peak torque on the screen, as opposed to the torque based measurement, where the break torque is automatically determined based on the fact, that the torque drop after the thread break or other distinctive break point (for example child resistant cap engagement torque) is reached.
When the torque based testing method is enabled the unit can automatically determine the break torque with the help of the Release fallback parameter. The Fallback is the amount of torque drop that has to be measured after a torque peak to qualify that peak as the break point. The fallback may be also considered as the sensitivity of the automatic torque test.
When testing products with multiple “break” points, increasing the Fallback value will eliminate the possibility of measuring a local force drop as the absolute thread peak torque. On the other hand, when the fallback is increased too much, the tester may loose its ability to consistently recognize the break point. Under these circumstances it may be

preferable to change the testing method to rotation based. This will allow the tester to rotate the chuck to the angle defined by the maximum rotation variable and then display the peak.
To achieve repeatable and accurate results, we recommend the customers to analyze every cap/container system and configure the runtime variables accordingly.

i. Data management, Communication

A number of communication options may be selected by entering the appropriate number in the serial data format variable, see Setup section for more details.

The serial communication is set to RS232, configured for 9600/8/n/1. Available output options:

- The data output may be formatted to ASCII characters to be printed on 3" roll paper.
- It may be formatted to ASCII strings, including peak torque value, date and time stamps, etc. - compatible with the previous SureTorque data acquisition software.
- Data may be configured for real-time (analog data is sampled in approx. 10ms intervals at min. 16bit resolution) data acquisition to analyze torque transients.
- Or data may be saved in PLC memory only without sending any string to other devices.

Data acquisition softwares are available to download from www.suretorque.com.
For more information on communication, contact the manufacturer.

7. IMPORTANT INFORMATION

Pay special attention when operating the machine. Pneumatic actuators operating at 80 PSI pressure may cause serious damage to operator, equipment and product.

Overloading the transducer (both transient and continuous) may damage it and move the unit out of calibration. Please find the specifications of the loadcell in the Appendix.

Do not attempt to recalibrate the unit without having the calibration kit and certified weights.

The SureTorque tester is a precision torque measurement device. The torque is transformed to an electrical signal with a strain gage based force transducer. Like in case of any other strain gage based measurement device, it is recommended to check the calibration and/or re-calibrate the device as often as possible. Usually the recalibration timeframe is not more than 6 months, but proper determination depends on many factors, like the duty cycle and the average load on the transducer, also the possibility of overloading the strain gage. Calibration kit and certified weights are optionally available from SureTorque.

8. Contact Information

For technical support please use the following contact information.

SureTorque

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