SureTorque
by Mesa Labs

Instruction Manual
S3 Automatic Torque Tester

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1. Introduction

The SureTorque S3 Automated Torque Tester is a test instrument intended to be incorporated into a quality control program of bottle packaging companies. The S3 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. SureTorque recommends the user to obtain copies of the standards developed by the ASTM D10.31 subcommittee and ISBT (International Society of Beverage Technologists) for reference.

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 is an indicator of packaging quality. Low removal torque values may indicate a poor cap product design or bad capping process which may result n product contamination or leakage. Testing the thread break torque within a quality control program (combined with accelerated aging and leak testing) will ensure that your packaged products are consistently and reliably closed and product leakage/contamination is minimized or eliminated.

Package Development: Thread break/tamper evident band break/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, min. 4A
Torque range:	0 – ~88 lbfin (pound-force inch), 0 – 10 Nm
Speed range:	0rpm – 60rpm
Transducer accuracy:	0.5%FS static
Torque resolution:	min. 0.1 lbfin
Dimensions:	12"(W) x 20"(D) x 29"(H)
Weight:	Approx. 86lbs
Communication:	RS232 (optionally RS485 or Ethernet)
Data output:	Configurable for Printer (Result only) or PC (Result only or Real-time)

3. Description

The S3 is a precision test instrument utilizing 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. For general arrangement and change part descriptions please refer to the pictures below.

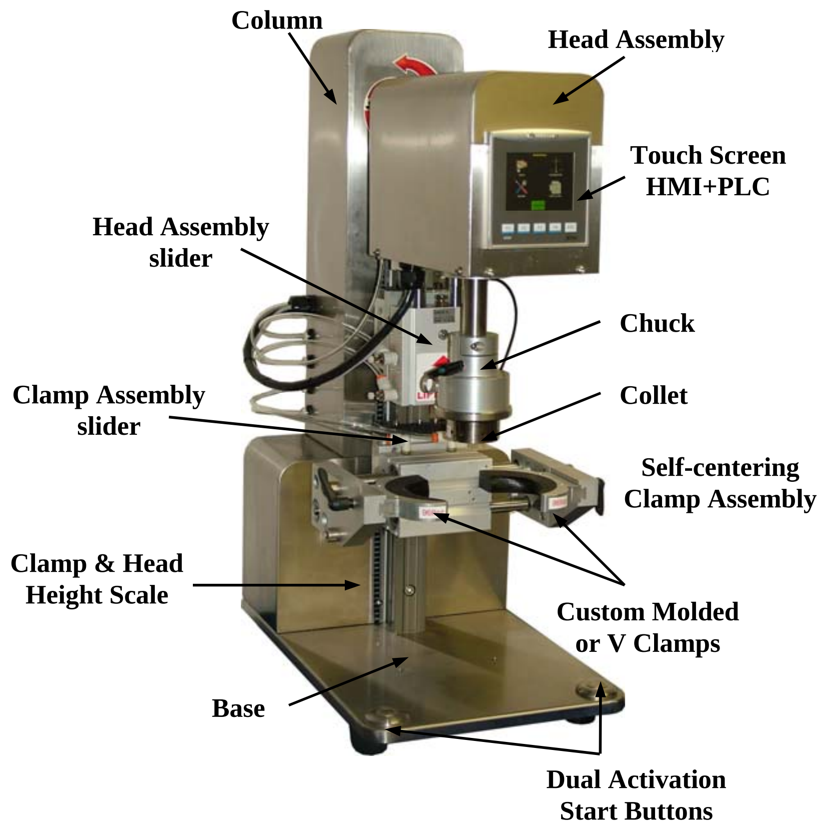


Figure 1: S3 General Arrangement

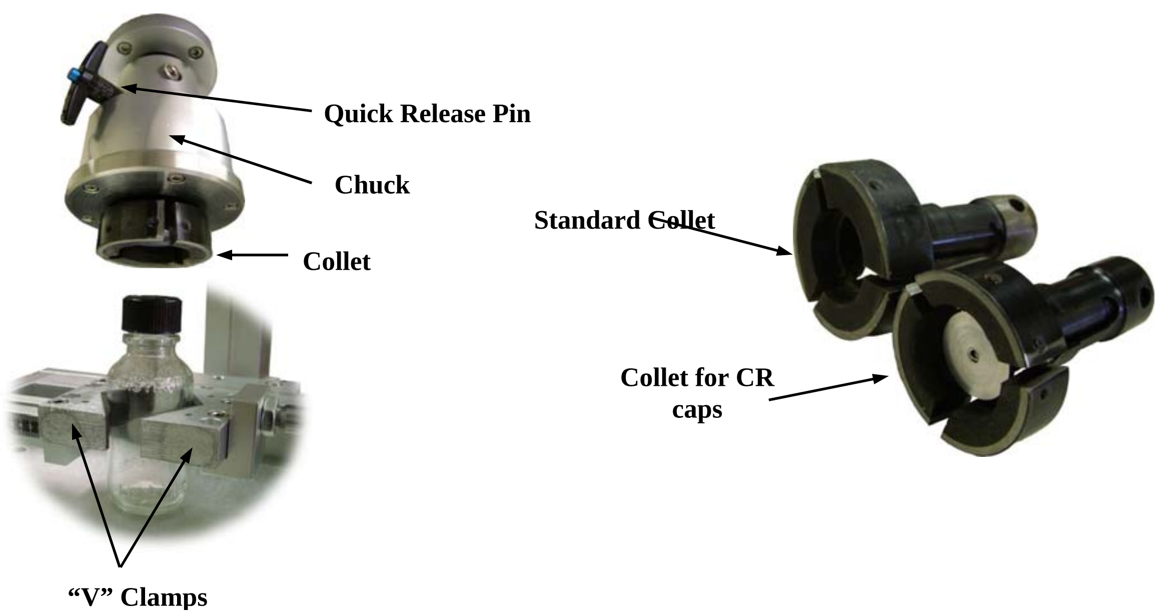


Figure 2: Product Specific Tooling

4. Installation

1. Locate unit on a table top.
2. Plug power supply into standard 115VAC outlet.
3. Hook-up a clean, dry, air supply of 80 psi at 4 cfm. Connect the airline to the 1/8" NPT fitting at air filter on the rear panel.
4. If applicable, connect data cable to communication port at the column.

5. Basic Operation

By pressing the dual activation safety start buttons the process starts. First, the clamps close to hold the container securely, then the head lowers followed by the chuck actuation. When the chuck is active and the cap is being securely held by the collet, the control starts increasing the torque, according to the torque ramp and speed/acceleration parameters pre-defined in the test recipe. During a test cycle the trend of the actual torque and angle may be displayed on screen or transferred to a PC. Depending on customer specification, an optional audio/visual alarm can be activated for every defective product.

6. Calibration, Setup, Operation

a. Power Up

Power up the unit by connecting the power cord to AC power and resetting any emergency switches. The status lights and PLC screen lit up, and the manufacturer and software version information (as shown in Figure 3.) is shown on the first "splash" screen during the boot-up procedure.

Figure 3: Support Display

Figure 4: Main Menu

b. Main Menu

The main menu (Figure 4.) allows the user to navigate to the main areas of the control system. This screen may be accessed from any of the displays by pressing the BACK key a couple of times.) Press the appropriate icon to test caps, calibrate the machine, explore historical measurement data or setup the machine.

SETUP:	Manual operation and general electronic setup
CALIBRATE:	Calibration, linearity check and recalibration.
TEST:	Torque Test
DATALOG:	Historical measurement data

c. Calibration

Select the Calibration Icon in the Main Menu. This mode may be used to troubleshoot measurement issues and calibrate the machine.

Figure 5: Calibration – Main Menu

Figure 6: Calibration – Linearity Check

1. Find the calibration kit, remove the clamps, attach the calibration frame on the clamp slide and insert the calibration pulley in the chuck. Make sure the screw in the pulley is facing the operator.

Figure 7: Calibration – Setup

Figure 8: Calibration – Close-up

2. Run a quick torque verification. When the chuck is unloaded and the scaled readout is not zero, press the zero offset key. Then lock the shaft by pressing the appropriate key, hang a known weight on either side of the pulley system and check the scaled torque readout on the display. Before hanging the weight on the pulley make sure:
   - A, the wire is running at least 90deg around the pulley (180deg is optimal)
   - B, the pulleys are aligned properly (the wire must run parallel to the base between the two pulleys),
   - C, the shaft is locked. If it's not locked the chuck is free to rotate and the weight will drive the chuck until a hard stop.

If the torque readout is out of tolerance, follow the steps below to recalibrate the display

3. Press the RECAL key, type the password if required (default password: 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, follow the instructions on the bottom of the screen.

4. First, unload the pulley and press the NEXT key. This registers the zero offset of the calibration.

5. In the next step, hang the weight on the right side of the pulley, let it settle, then press the NEXT key. This registers the gain of the calibration for CCW direction.

Figure 9: Calibration – Mechanical Setup for CCW calibration

Figure 10: Calibration – Mechanical Setup for CW calibration

6. Now hang the weight on the left side of the pulley, let it settle, then press the Next key. This registers the gain of the calibration for CW direction.

7. The display is now calibrated both CW and CCW directions, press the NEXT key again to return to the calibration check screen and test linearity by hanging different weights on the pulley, or just press the BACK key to return to the Main Menu.

d. Mechanical Setup

Select to the SETUP submenu from the MAIN MENU then enter the password if required (default password is 1111).
In the SETUP submenu, select the MANUAL mode to troubleshoot pneumatic and mechanical issues and setup the machine for product testing. Follow the steps below for machine setup.

Figure 11: Setup – Menu

Figure 12: Setup – Manual Mode

1. Locate the appropriate change parts (collet and a set of clamps) for the product. Mesa Labs SureTorque testers require the use of product specific tooling, it is important to use the correct change parts for the testing. Usually change parts are labeled for easy identification.

Figure 13: Setup – Finding the collet

Figure 14: Setup – Selecting the clamps

2. To allow safe pneumatic actuations, slide the clamp assembly to the bottom of the machine, raise the head assembly to the top of the column. Secure the head assembly slides with the handle.

Figure 15: Setup – Lowering clamps

Figure 16: Setup – Lifting Head

3. Now slide the clamps into the clamp bracket, then adjust the clamp assembly height until by lowering/raising the clamp slide until the change part profile matches the containers as shown on the picture below. Secure the clamp slide.

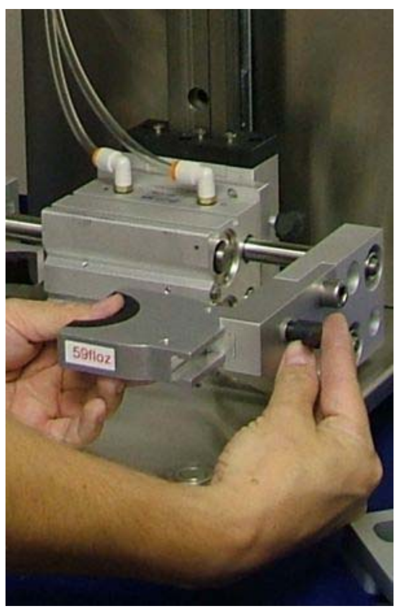


Figure 17: Setup – Attaching clamps

Figure 18: Setup – Clamp height adjustment

4. Insert the collet in the chuck, and secure it with the quick release pin. Activate the head cylinder by pressing the HEAD key on the HMI. Now release the head slide assembly and lower the head onto the cap. Make sure the collet does not interfere with any part of the container or the tamper evident band. Generally it's the best to insert approx. 4/5 of the cap (excluding the TEB) in the collet, then secure the head slide with the handle.

Figure 19: Setup – Securing the collet

Figure 20: Setup – Lowering the head

5. Press the CHUCK key 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 confirm that the collet is holding the cap securely. If the cap is slipping in the collet, make sure:
   A, the chuck cylinder or airline is not leaking (listen to the sound of leaking air, or remove the collet and look at the actuating plastic ring lowering and raising inside the chuck assembly).
   B, the correct collet is used and it is not excessively worn.
   C, the air pressure controlling the squeezing force/pressure of the collet is not too low. The chuck pressure can be adjusted by the "chuck" mini regulator on the rear panel).

6. Press the CLAMP key to activate the self-centering clamp cylinder. Inspect the setup for possible alignment issues. To make sure the clamps are holding the container securely, deactivate the head and chuck cylinders by pressing the appropriate keys on the screen, then manually apply torque on the closure/container while it's being clamped. If the container is slipping, make sure:
   A, the clamp cylinder or airline is not leaking (listen to the sound of leaking air).
   B, the correct clamps are used and they are not excessively worn.
   C, the air pressure controlling the clamping force/pressure is not too low. The clamp pressure can be adjusted with the "clamp" mini regulator on the rear panel).
7. In the final step, check the overall setup, deactivate the clamp the chuck and the head cylinders by pressing the corresponding keys, then activate them again one by one in the correct order. First the clamps, second the head, third the chuck. If clearances, positions, pressures look good, the setup is done, document the head and clamp assembly heights then press the BACK key to navigate to the Main Menu.

e. Electronic Setup, General Settings

There are test specific and general settings available for configuration. To change general configuration settings, navigate to the Setup from the Main Menu, (default password is 1111). This mode may be used to adjust the timers, system time, product recipes and a number of other variables.

Figure 21: Setup – Main Menu

Figure 22: Setup – Submenu

1. PRODUCT MANAGEMENT: In this submenu the operator can enter/modify product specific variables for 20 different products. These variables are for documentation purposes only; their use is optional and the settings/values stored in these fields do not have any effect on the operation of the machine.

Figure 23: Setup – Product Management 1

Figure 24: Setup – Product Management 2

Description of the product management data fields:

Name, Cap ID, Container ID: Customer specified product name, cap and container IDs.

Collet ID, Clamp ID: Identification entry for each product specific tooling.

Head height: The position of the top of the head.

Clamp height: The position of the top of the clamp slide.

Left clamp, right clamp: When applicable these fields can be used to document the right and left clamp positions.

Cap, Container type, shape, material, color: The type, shape, material and color of the cap/container system.

TEB, Liner: These fields may be used to document the presence of a liner or tamper evident band.

Cap, Container dimensions: Document product dimensions in these fields.

Figure 25: Setup – Passwords

Figure 26: Setup – Manual Mode

2. PASSWORDS: The passwords required to enter in Setup and Recalibration modes may be entered or modified here. Default passwords are 1111 to enter the setup menu and 1113 to recalibrate the display.

3. MANUAL MODE: Individual activation of the pneumatic cylinders are available in this submenu. Each cylinder can be activated/deactivated by pressing the appropriate button. To learn more about the mechanical setup, find section 6.d in the manual.

Figure 27: Setup – Other Settings

Figure 28: Setup – Timers

4. MISCELLANEOUS SETTINGS:

Screen Format: Select from "data only", "graph and data" or "pass/fail" display representations.

"Data only" displays only the numeric angle and torque values.
"Graph and data" provides not only numeric values on the screen but also the angle vs torque graph of the measurement.
"Pass/Fail" is the most basic of the result representations, it only displays whether the test passed or failed the specifications.

Serial Data: The data output of the machine may be set to the following:

Result only – PC: Data output is formatted for compatibility with the ST-DAQ software
Resut only – Printer: Data is formatted for printout on a 3" wide paper roll.
Realtime – Angle vs. Torque: The data output is a continuous stream containing the angle and corresponding torque values.
Realtime – Angle vs. Time: The data output is a continuous stream containing the time and the corresponding torque values.

No Output: When this option is selected, there is no automatic data output from the torque tester.

Test Settings: The editing of test variables may be enabled/disabled by changing this variable.

Date and Time: Change the sytem date and time.

5. TIMERS: Select this submenu to change the actuation delays.

Clamp On (mm:ss:hh): This timer is used to delay the clamp activation.
Chuck On (mm:ss:hh): This timer delays the chuck cylinder after starting a test.
Test Start (mm:ss:hh): Delays the rotation at the beginning of the test.
New cycle (mm:ss:hh): Delay after a test is finished.

f. Electronic Setup – Test Specific Settings

When the test settings are enabled in the OTHER SETTINGS general setup submenu, test specific setup variables can be changed directly from the test screens. This allows the operator to quickly adjust runtime variables such as the rotational velocity, torque ramp, applied setpoint, release fallback or other test specific settings when evaluating a new product. When all parameters are proven, the write access may be disabled to avoid accidental changes.

Variables:

Product Name: Select from the list of available products.
Test Mode: Select from Applied, Release, Release then Applied or Applied then Release test modes (other test modes are available upon customer specification).
Head Up/Down: Use this variable to enable/disable head actuation. In instances like quick calibration check with SureCheck or when testing a pump dispenser head, it is necessary to disable the head actuation.
Unit: Use this variable to change the unit system being used in the test.
Number of Cycles: For fatigue testing enter a number between 1 and 32000. This is the number of tests the machine will automatically conduct on the supplied container/cap.For example in an applied then release test the number of cycles may be set to 1000 in order to evaluate the torque degradation over a number of repetitive opening/closing cycles.
Applied Setpoint (lbfin): The torque applied in a cap tightening cycle.
Torque Limit (lbfin)**:** The maximum permissible torque in a removal cycle.
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. One may also consider this variable 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 allowed rotation during a test cycle.
Ramp time (s): This is a timer defining 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.
Method: The torque application method may be torque or rotation based. Torque based testing is recommended in Applied mode to immediately stop the test upon reaching the setpoint. On the other hand in a cap removal cycle, rotation based validation may be the best choice for some caps with Child Resistant feature or Tamper Evident Band.

Figure 29: Test – Settings 1

Figure 30: Test – Settings 2

Topload: It is possible to adjust the amount of force the head cylinder applies vertically while the product is being tested.

High pressure actuation is recommended for most CT (continuous thread) closures to determine the thread break torque or apply torque to a setpoint.

Low pressure actuation is recommended to measure the thread break torque on CR (child resistant) caps. By adjusting the head height and the pressure in the head actuator (with the mini regulator on the rear panel) it is possible to optimize the topload, making CR cap engagement repeatable and minimizing the topload introduced friction.

"Zero" actuation is recommended when both the thread break and the tamper evident band break torque has to be measured in one test cycle. This method allows a low adjustable pressure to compensate for the weight of the head assembly and "float" the head as the cap is being unthreaded. The "floating head" effect minimizes topload and allows the accurate measurement of both thread break and tamper evident bridge break in one test cycle.

Warning and Error Limits: Configure these variables to display warning and error messages on the screen. (low error < low warning < pass < high warning < high error).

For example: if the permissible removal torque range on a cap is 14-18lbfin, set the low error and warning to 14lbfin, the high error and warning to 18lbfin. When required allow a separate range for the warnings.

g. Testing

Navigate to the Test screen from the Main Menu by selecting the Test icon. Applied (clockwise) and Release (counterclockwise) testing may be initiated from here 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 other variables, various different torque tests may be performed. The sequence of operation and the operating principles are detailed below.

1. Place a container on the platform then press the dual activation safety start buttons. 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 trend real-time.

3. During the test cycle, observe the container/collet for indication of concentricity, excessive side load or downward pressure, and fine-tune the mechanical setup if required.

4. Anytime during the operation, you may press the BACK key 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.

5. Depending on the selected testing method, either when the maximum rotation is exceeded, or when the peak torque is measured, the chuck stops and the screen displays

the peak value. The actuators return to home position and the product is ready for removal.

Figure 31: Test – Start

Figure 32: Test – Display formats

h. Operation Modes

A number of different test modes may be created by selecting rotation-based or torque based measurements and/or changing the adjustable head pressure/topload.
In rotation based measurement the chuck moves until the angle exceeds the predefined limit, 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 the engagement torque of a child-resistant cap's outer shell) 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 drop in the torque the machine has to measure in order to qualify the peak torque as the thread break torque. 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 real thread break torque. Under these circumstances it may be preferable changing to the rotation based testing method. 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 in the Setup/Other Settings submenu. For more info on the selection see section 6.e.4.

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 data acquisition to analyze torque transients (analog data is sampled in approx. 10ms intervals at min. 16bit resolution).

- Or data may be saved in PLC memory without sending any data out on the com port.

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

7. Important Information

Pay special attention to pneumatic actuators operating at 80 PSI, as 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 MesaLabs torque 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, such as 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.

Mesa Labs
12100 W. 6th Ave.
Lakewood, CO, 80228

9. Variables in Torque Testing

1. Applied torque
2. Sensitivity of automatic thread break torque measurement
3. Cap squeezing pressure
4. Container squeezing pressure
5. Topload
6. Speed of torque ramp, update rate of torque digitization
7. Dwell time
8. Product variations (dimension, liner variations, etc)

1. Applied torque

Generally speaking, the higher the applied torque, the higher the thread break torque. This is true up to the strip torque where the threads break/deform irreversibly in a cap tightening cycle. Without the cap/container manufacturer's guidance, it is recommended to start with an application torque that equals to the cap outer diameter in mm divdided by two (in inch-pounds (in-lbs, lbf-in)).
The release torque / applied torque quotient depends on the specific cap design. It is usually in the 0.6-0.9 range and higher for glass and lower for plastic bottles. It is not uncommon to see values out of this range and dwell time usually decreases the quotient over time.

2. Sensitivity of automatic thread break measurement

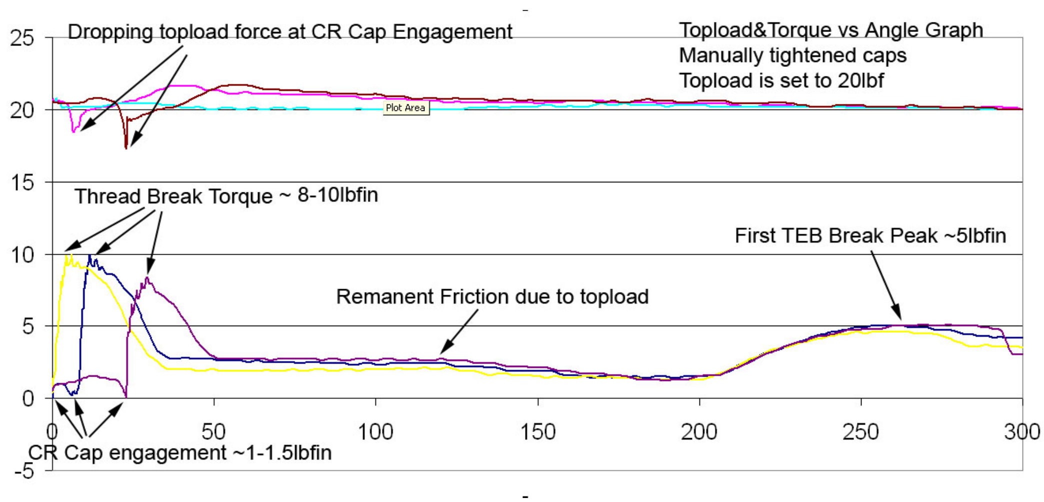
In the automatic detection of the thread break torque, two methods may be used to validate the result.

a. Fallback based peak torque validation: this is the fastest and most cost effective way to measure thread break torque on a cap. In CR cap applications, special attention must made when fine tuning the fallback value in order to avoid validating the shell engagement as the thread break torque.

b. Rotation based peak torque validation: to overcome the problem introduced by the torque drop during the CR engagement an additional encoder can be used to validate the thread break torque. The rotation limit must be set according the worst case scenario of the shell engagement.

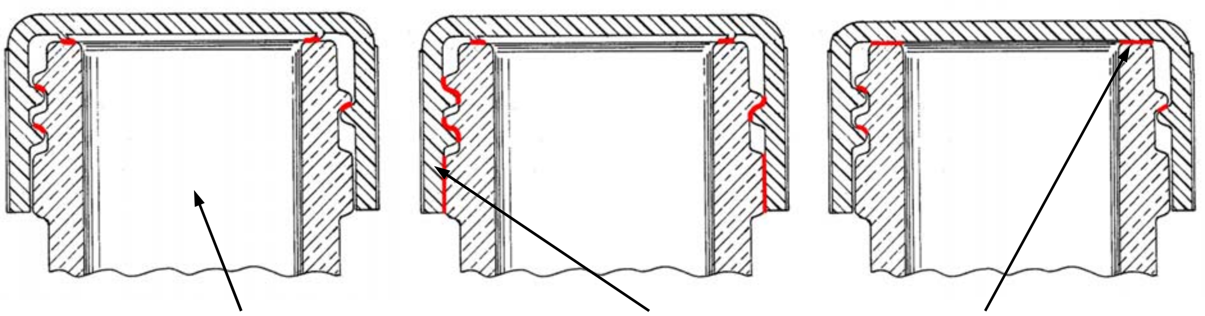
   If fallback based validation is used during a measurement and the fallback is set at <1.5lbfin, the tester will stop in <25 degrees and display the engagement torque. To avoid the false readout, either the fallback must be increased above 1.5lbfin (the recommended fallback for CR caps is 2.5lbfin), or rotation based validation must be used and the rotation limit set at ~40 degrees.

   See the topload vs. rotation and torque vs. rotation trends below to understand the variations during a CR cap removal cycle. The vertical axis represents both toque (lbfin) and topload (lbf), while the horizontal axis is the rotation in degrees.



3-5. Cap and container squeezing pressure, topload

The variation in cap/container squeezing pressure and the topload on the cap may also affect the torque reading. The pressure variation is caused by either force or contact area variation. The larger the contact area and/or the higher the force compressing the cap and the container threads, the higher the torque readout will be. Thus in some applications it is important to monitor the container and/or cap squeezing pressures and the topload force.



Optimal chuck pressure: the contact area is "minimal" and the torque readout is not affected.

High chuck pressure and/or excessive topload: the contact area is increased resulting in higher torque readouts.

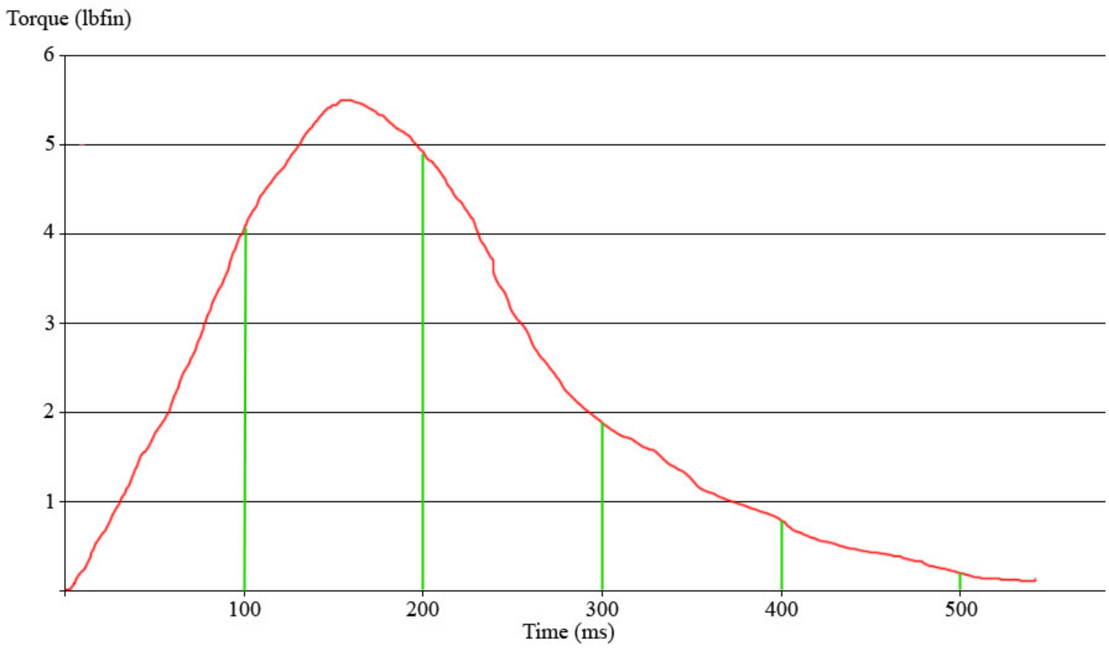
6. Speed of torque ramp, update rate of torque digitization

There are two phenomenons a package engineer must be aware of when setting a torque ramp setting:

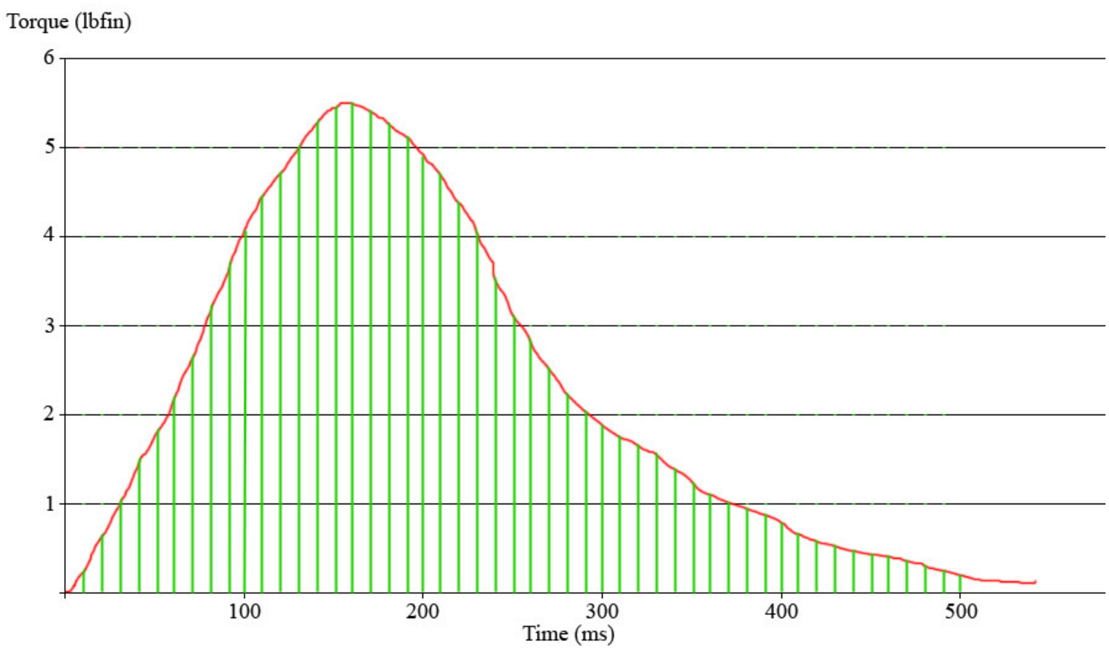
a. When the torque ramp up is fast compared to the conversion time of the digitizing device, the removal torque readout on the digital machine can be considerably lower than the real peak due to the slow analog to digital conversion speed. The error originating from the low sampling speed is not to confuse with the quantization error. To understand the error originating from inappropriate digitization, look at the graphs below and/or find more information on the internet about the Nyquist-Shannon sampling theorem and resolution /quantization noise.

b. When the torque ramp up time is slower, the removal torque tends to be lower because the gradually increasing fatigue lowers the peak force required to finally break the threads. If the torque ramp is faster the thread break torque is usually higher.

Even if a manual torque tester had fast digitizer circuit, the lack of torque ramp control may still cause considerable variation from one operator to another, and even for one operator depending on how fast he/she manually applied torque on a specific package.



Analog torque signal (red) sampled with a 12 bit, 100ms AD converter. The peak readout with this digitizer is ~4.9 lbfin at 200ms.



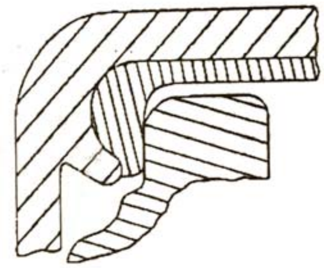
The same analog signal (red) sampled (green) with a 12 bit, 10ms AD converter. The peak readout with this system is ~5.5 lbfin at 160ms.

7. Dwell time

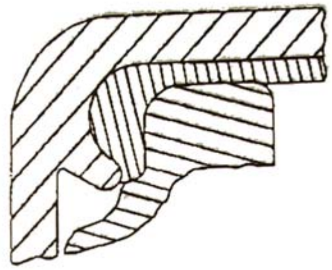
In various experiments it has been established that release torque levels are highest immediately after application and then gradually decrease to a stable level over a period of time (days/weeks). The rate of the release torque decay is greatest in the first couple of hours/days and then reduces at a decreasing rate before reaching its stable level. Production processes such as hot filling or using heat activated glue cap systems can produce a big difference in the release torque readout when compared with results measured in a laboratory environment.

8. Product variations

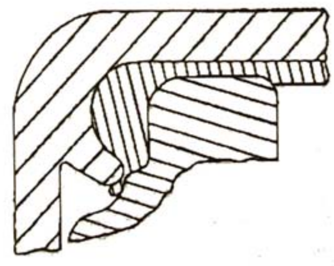
Minor changes in mold, material and liner can be also major contributing factors in torque variation's. See an example of different liner alignments and how it relates to the contact surface area and the release torque.



Under torqued cap
Result: smaller contact area, lower release torque



Properly torque cap
Result: normal contact area and release torque



Over torqued cap
Result: larger contact area, higher release torque

10. Torque 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

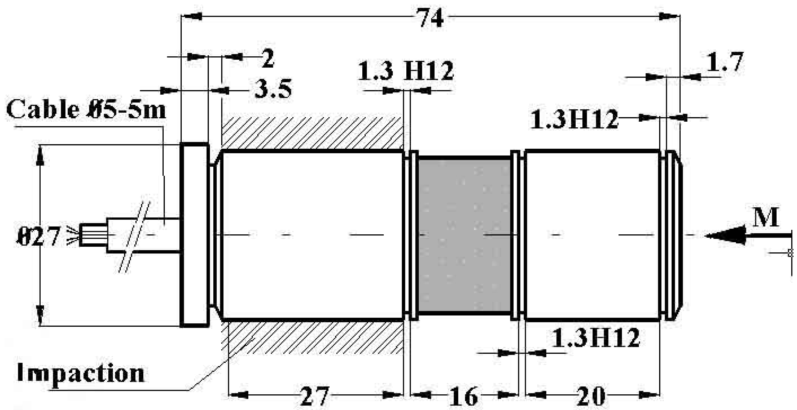
- DIN EN 12377:1998 Packaging - Flexible tubes - Test method for the tightness of closures
- DIN EN 14401:2004 Rigid plastics containers - Methods to test the effectiveness of closures
- SS-EN 12377 Packaging - Flexible tubes - Test method for the air tightness of closures

USPC Test Methods:

- CHAPTER 671: Containers - Permeation

11. Torque Transducer Specifications

This device utilizes an electronic strain gauge to measure very small amounts of changes as it is flexed or strained in either CW or CCW directions. The mechanical changes are measurable increases or decreases in electrical resistance. Our transducer has the ability to compensate over a wide range of temperatures and hold its accuracy for a cycle of over 1.000.000 measurements (under the specified operating conditions).



Reaction type torque transducer

Accuracy:	0.1% F.S.
Available Ranges:	5, 10, 20 Nm
Output:	2.0 mV/V ± 0.1%
Zero Balance:	±1% max.
Temperature Effect	
- Zero:	±0.05% / 10K max.
- Span:	±0.05% / 10K max.
Non-linearity:	±0.1% max.
Hysteresis:	±0.1% max.
Non-repeatability:	±0.03% max.
Creep over 30 minutes:	±0.04% max.
Input Resistance:	350 ohm ± 2
Output Resistance:	350 ohm ± 2
Excitation (recommended):	6-10 V
Excitation (max.):	12 V
Insulation Resistance:	5 Gohm min.
Temperature, Compensated:	-10°C...+40°C
Temperature, Operating:	-20°C...+65°C
Temperature, Storage:	-50°C...+85°C
Overload, Safe:	150%
Breaking Load:	300% min.
Protection:	IP 65
Corrosion protection:	Chem Nickel

Transducer Specifications