

BLM LABwrench GYRO

Atlas Copco BLM



REVISION TABLE

Revision	Date	Author	Description
2006-01	08 Jun 2006	FD	First Edition
2006-02	13 July 2006	OS	New product denomination

ELECTRONIC TORQUE WRENCH

BLM LABwrench GYRO

USER'S GUIDE

Safety Instructions

IMPORTANT

All locally legislated rules with regard to installation, operation and maintenance shall be respected at all times.

WARNING

When using electric products, basic precautions should always be taken, including the following:

- Read all instructions before using the product.
- Do not expose the system to excessive moisture (dripping or splashing), and do not use it near water (near a washbowl, or in a wet basement) or other liquids.
- The product should not be subjected to continuous or excessive shock or vibration.
- For minimum electrical interference, use the product far away from possible sources of electrical noise (arc welding equipment etc).
- There are no user serviceable parts inside the product. Hence, under no circumstances should you open or resume to repair the product. Doing so will invalidate all warranties. Refer all service needs to your local Atlas Copco service personnel.
- Always plug/unplug connection cables with power off.

CAUTION

Danger of explosion if the battery is incorrectly replaced. Replace only with same or equivalent type recommended by the equipment manufacturer. Discard used batteries according to the manufacturer's instructions.

EC Declaration of conformity

- **Individual machinery and safety components:**

We Atlas Copco BLM – Paderno Dugnano - ITALY declare under our sole responsibility that the product to which this declaration relates, is in conformity with the requirements of the Council Directive of 22 June 1998 on the approximation of the laws of the Member States relating to machinery (98/37/EEC).

- **Information on Waste of Electrical and Electronic Equipment:**

This product and its information meets the requirements of the WEEE Directive (2002/96/EC) and successive modifications.

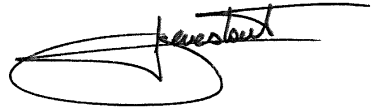

See Manual "ATLAS COPCO BLM Torque Wrenches WEEE parts identification" for WEEE parts identification.

The products and their components and/or batteries that must be treated as WEEE when at end of life are marked with a crossed trashcan according to WEEE (2002/96/EC). See figure below:



In the European Union, this symbol indicates that products must not be disposed of as unsorted municipal waste but must be dealt with separately, in accordance with the WEEE Directive (2002/96/EC).

At the end of its life, this product should be returned to your local Atlas Copco supplier. Visit Internet page: <http://www.atlascopco.com> to identify your local supplier.

<i>Name of issuer</i>	<i>Position</i>	<i>Signature</i>
Frédéric Genestout	General Manager	
Ovidio Scarpulla	Product Quality Manager	

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MAIN CHARACTERISTICS



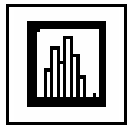
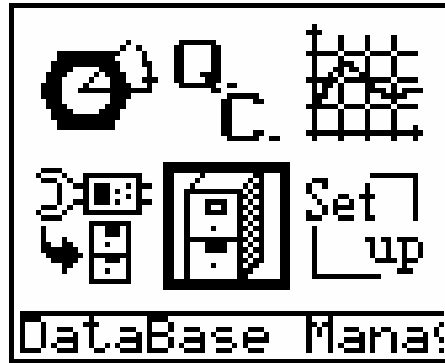
BLM LABwrench-GYRO is Compact and lightweight, with a graphic display for immediate visualisation of the torque/angle progress during tightening. Ideal for

- tightening up to the yield point during production,
- quality control and torque/angle tightening analysis,
- quality control to detect breakaway torque values.

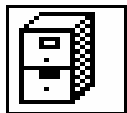
BLM LABwrench-GYRO uses the innovative torque/time software that does away with the need to have a fixed reference in order to measure the angle. Large memory for saving data and curves with processing of statistics. The wrench is not affected by the position of the operator's hand, making measurements more accurate and repeatable.

Main functions

- Software for objective measurement of breakaway torque via torque/time analysis: fixed reference NOT required to read angle!
- Display, saving and direct transfer to printer or PC of the torque values, calculating the max, min, average values, standard deviation, Cp and Cpk indices.
- Peak memory, or continuous measurement.
- Torque tightening, torque + angle, with a signal telling you when the set limit is reached. Possibility to save the relevant torque and angle values in a file.
- Tightening to yield point with display of the torque/angle curve (during tightening) with a signal telling you when the yield point is reached.
- Possibility to tighten beyond the yield point (up to actual breakage) for complete analysis of the behaviour of the joint being tested in order to optimise the tightening parameters during production.
- Processing of statistics using readings.
- Automatic acquisition of torque readings.
- Special Windows software available for transfer of curves to PC and their management, including overlaying of curves and print-outs.



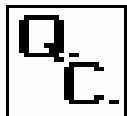
Statistical functions: a series of statistics can be displayed for each torque level or series of controls, together with Cp and Cpk factors for process control. These values are saved, displayed or transferred to PC for further investigation.



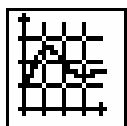
Creation of "files": to save the acquired torque values using quality control methods or during tightening. Values and statistics can be viewed (Cp, CpK, Min, Max, Media, sigma) and sent to PC via the RS232 port. Specific files can be created for each joint.



Acquisition of tightening values: torque, torque with definition of the tolerance limits and torque + angle. Tightening with continuous torque reading or with detection of the max peak or yield point plus acoustic warning when the relevant torque value is reached.



Quality control: tightening control using **breakaway (peak+angle, torque/time)** and **unscrew+screw** methods for improved control objectivity.



Graphs: graphic representation of the torque/time function (with automatic recognition of the breakaway torque) and torque/angle function for easy use when using the tool in "file" mode. Chance to send acquired curves to a PC for further processing ("Curves for Windows" software available, specifically written for such analysis).

LABwrench-GYRO characteristics:

- Processor with wide graphic display (80x64 pixels)
- Simple, intuitive software with icons
- Flat panel with number keys and five function keys
- Alarm function with possibility to pre-set three different thresholds, with three leds (yellow, green and red) and buzzer
- RS232 serial output for printer or PC connection
- Universal fitting for use of reversible ratchet or fixed open end to work where bushes are impractical.
- Rechargeable Ni-MH batteries
- Readings in Nm, lb.ft., lb.in., oz.in., kgf-m, cNm, kNm
- Precision: $\pm 0.5\%$ reading (from 20% to 100% max value)
 $\pm 1\%$ reading (from 10% to 20% max value)

Model	Capacity	Fitting	Supplied ratchet
LAB-GYRO 30-10	30 Nm	9 x 12	3/8"
LAB-GYRO 50-10	50 Nm	9 x 12	3/8"
LAB-GYRO 100-13	100 Nm	9 x 12	1/2"
LAB-GYRO 150-13	150 Nm	14 x 18	1/2"
LAB-GYRO 250-13	250 Nm	14 x 18	1/2"
LAB-GYRO 400-20	400 Nm	14 x 18	3/4"
LAB-GYRO 600-20	600Nm	21 x 26	3/4"

1. WORK MODES

The LABwrench-GYRO is a measure tool which has been designed to perform a set of test types: for each test type it has to be defined a set of parameters and usually each test has to be performed “N” times resulting in a set of “N” values.

Tightening analysis tests (see 5.3) don't follow this general rule: a single test returns a curve i.e. an ordered set of values.

For the repeatable test types we can identify three “work modes” depending on how and when the parameters are defined, and on the way the tests results are handled.

Free Test Mode:

In this mode the wrench works as a stand-alone tool. If the user has to perform quickly a test, it's possible to define it on-the-fly: by selecting the desired test type from the icon-menu and by entering the requested parameters the wrench is ready to work (see 5.1, 5.2 and 5.3). The user performs the proofs using the inserted test definitions.

At the end of the test sequence, it's possible to examine the obtained results and to compute the statistical values.

But it's not possible to permanently save the tests on the wrench i.e. after the user exited the test, the results are discarded.

Local File Mode:

In this mode the wrench must be “prepared” to perform a specific test: to maintain the informations, data are stored in “files”. During this phase the user has to create a file (see 5.5.1) by choosing the test type and by entering the parameters. In this way the test definition can be performed once and the parameters remain stored in the wrench memory.

To perform a test the user has to select the desired file (see 5.4.1) and then the wrench is ready to work.

The user performs the proofs using the test definition of the file and the results are saved in the file itself.

Later it's possible to recall this file (see 5.5.3): the results can be examined, printed and transmitted via RS232 to a remote PC.

When the maximum number of tests for a file has been acquired the oldest tests are automatically discarded when new test are performed. When no more needed, tests results can be deleted. If desired it's possible to delete the test definition too (see 5.5.4).

Remote File Mode:

In this mode the preparation of the test definition isn't performed on the wrench, but on a remote PC by using a management software like Torque Supervisor (see APPENDIX C). The test definition is then uploaded into the wrench by the management software (see 5.6.6).

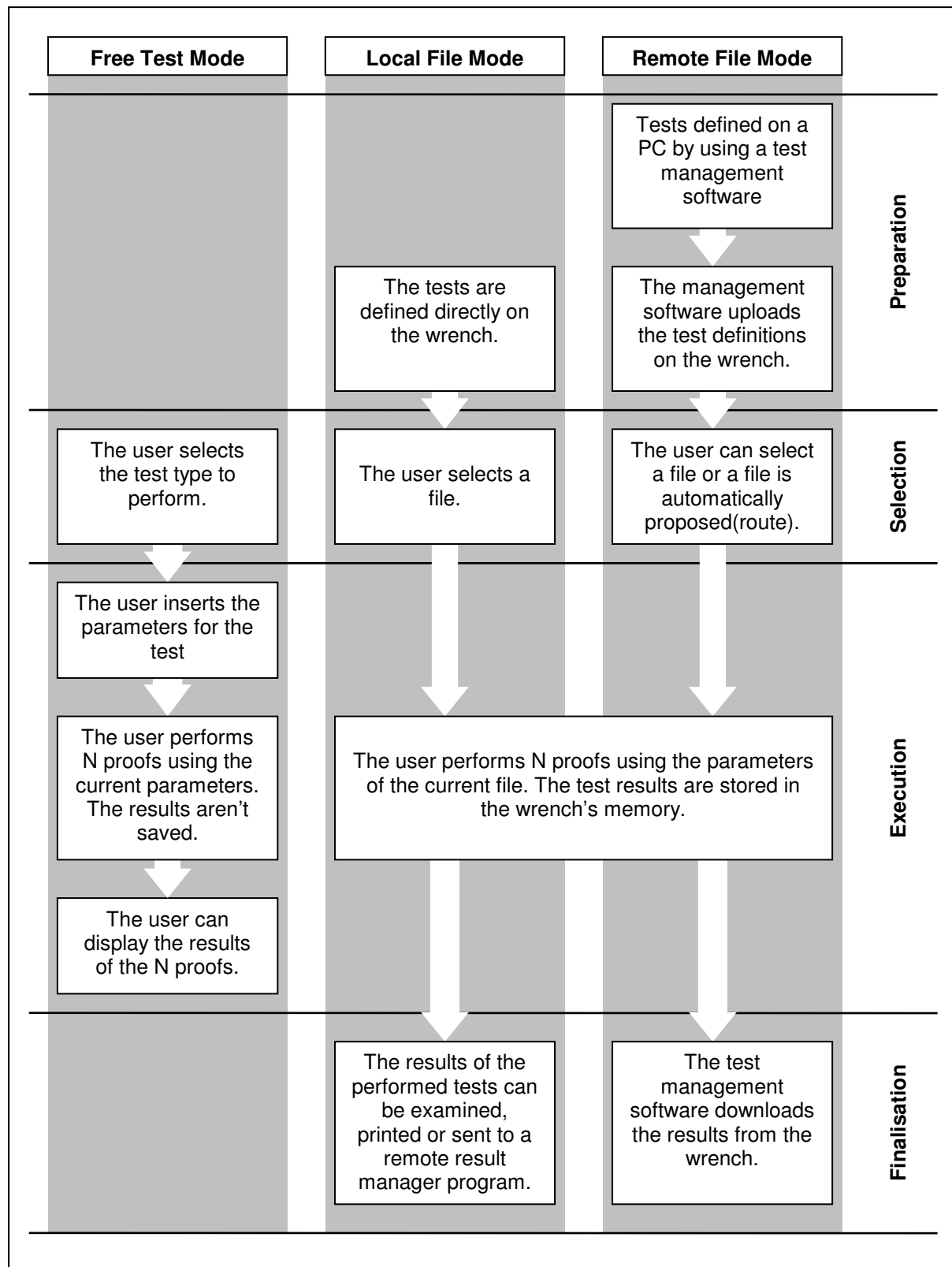
In addition the management software can define a sequence of execution, called “Auto-Route”: in this way the test selection isn't up to the user, but the wrench chooses the tests sequence automatically.

The user performs the test and the results are stored in the files.

After performing the tests, the wrench has to be connected to the PC: the management software downloads the tests results, stores them in its database and restores the wrench memory.

The Free Test Mode is always available.

When Remote configuration is active (see 5.4.2) by default no local files can be defined directly on the wrench, anyway, on demand, it is possible to reserve a set of files for local definition even when remote configuration is selected by editing the wrench setup.



LABwrench-GYRO work modes flow-chart

2. KEYBOARD

NUMERICAL KEYS:

In addition to the natural function of entering numbers, these keys also let you choose options in a menu(when displayed) by recalling it with a number rather than using the arrow keys.

ON KEY:

Hold down for 2 seconds to switch the tool on.

OFF KEY:

Used to switch the tool off. It must be pressed for 2 seconds to avoid accidental switching-off.



ESC KEY:

This key let you quit a menu on completion of the necessary steps.

ARROW KEYS:

If a menu is displayed, these keys let you go from one option to another. If a graph is displayed, they let you move a cursor around the graph to get accurate torque/time analysis.

NO/DELETE KEY:

During tightening and quality control, the NO/DELETE key lets you delete the value just acquired and instruct the tool to take a second reading. When entering numbers, it also lets you delete the last figure entered.

OK/ENTER KEY:

During tightening and quality control, the ENTER key lets you acquire a value and prepare the tool for the next reading. When entering numbers or choosing menu options, it lets you confirm the number of choice of option.

3. SIGNAL DEVICES

There are 3 leds that are activated depending on the programs being used. Usually during the test the meaning of the leds is the following:

- **GREEN LED (associated with symbol <)**
In *tightening* mode, it indicates that the min set torque or angle has been reached
- **YELLOW LED (associated with symbol =)**
In *tightening* mode, it indicates that the nominal set torque or angle has been reached;
In *quality control* mode, it indicates the end of a given reading.
- **RED LED (associated with symbol >)**
In *tightening* mode, it indicates that the max set torque or angle has been reached;

At the end of the test the meaning is:

- **GREEN LED**
It indicates that the result of the test falls inside the set limits.
- **RED LED**
It indicates that the result of the test falls outside the set limits.

BUZZER

This sounds every time a key is pressed or when a set alarm threshold is reached (depending on the current function). Different tones and sounds signals also if the test result is OK or Not OK.

4. SWITCHING-ON

Hold the **ON** key down until the buzzer sounds and the display comes on.

The tool first tests the signal leds, then the basic tool data and firmware release details appear on the display.

The torque transducer is then cleared (indicated by **SETTING ZERO**).

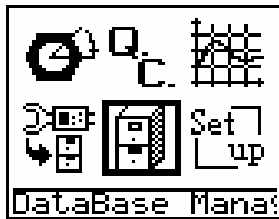
The wrench must not, therefore, have any loads attached when you switch it on.

An indicator (+, -, =) appears for a few seconds telling you the transducer is being cleared; this pause also lets the sophisticated onboard electronic circuits reach their correct working temperature (warm-up).

5. MAIN MENU

After automatic clearing, the **Main Menu** appears on the display:

The available options are:

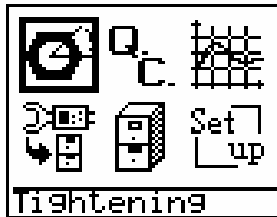


1. Tightening
2. Quality Control
3. Tightening analysis
4. Data Collection
5. Database Manager
6. Setup Menu

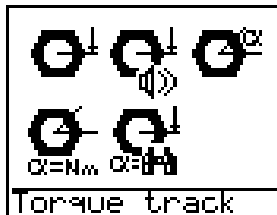
You can either use the **arrows** or the **number keys** to select an icon (number **1** for the icon in the top left corner; the numbering continuing from left to right).

Having selected an icon, some text appears at the bottom of the display indicating the menu or function. Press **ENTER** to activate the selected function.

5.1 TIGHTENING MENU



On selecting the **Tightening Menu** in the **Main Menu**, you have the following options:



1. **Torque Track** (see 5.1.2)
2. **Peak + Alarm** (see 5.1.3)
3. **Torque + Angle** (see 5.1.4)
4. **Torque at Angle** (see 5.1.5)
5. **Torque drive (Angle surveillance)** (see 5.1.6)

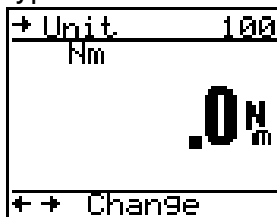
The options in this menu are all for "*direct*" tests (Free Test Mode) without saving of any parameters or data: if you're linked to a printer, you can get a print-out of all the values shown by pressing **OK/ENTER**.

After tightening, press **ESC** to get the relevant statistics (see 5.1.7).

5.1.1 Change of test's measure unit

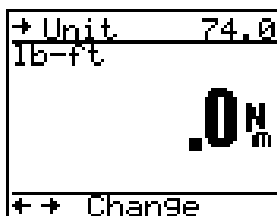
It's possible to perform a test using a measure unit different than the basic calibration measure unit of the wrench.

The way to specify the test measure unit can be different, depending on the test type.

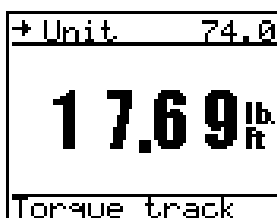


For the test without parameters i.e. the Torque-Track test it's possible to change the measure unit directly during the execution of the test.

During the Torque-Track test press the right arrow to enter in "change measure unit mode". During this phase the reading of data will be stopped.

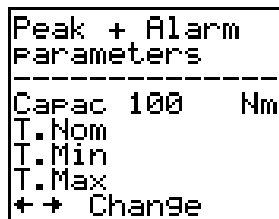


By pressing the arrows is possible to select a measure unit: on the top right will be updated the wrench capacity expressed using the new measure unit.

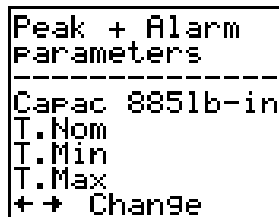


To return to the acquisition press **OK**.

For the tests which require a set of parameters the selection of the measure unit is comparable to the definition of a parameter.



During the insertion of parameters for a test (e.g. Peak + Alarm test), when the cursor is on the capacity field, in the last row is displayed the writing “change” and by pressing the arrows keys it’s possible to change the measure unit.

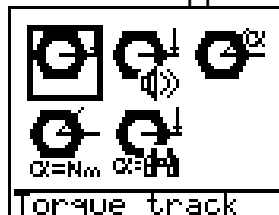


By changing the measure unit, the capacity of the wrench expressed in the new measure unit will be computed automatically.

Accept the chosen measure unit by pressing the OK button.

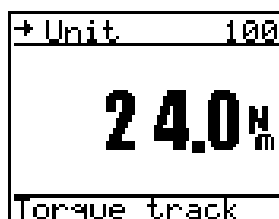
5.1.2 Torque Track

In Torque Track mode, the instantaneous reading of the torque applied to the transducer appears on the display (continuously updated).



The program is used to tighten joints, with the direct continuous reading of the applied torque appearing on the display. This program is also used for wrench calibration and control purposes using a fixed torque cell.

This lets you clear the torque reading by pressing key **0** (zero).

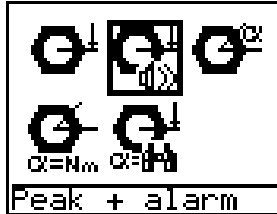


The tool is enabled for reading of the torque values in both directions of rotation: the value is preceded by a minus sign (-) if anti-clockwise.

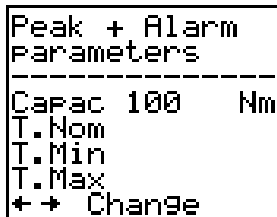
Torque track	If the “RS232 Send-Readings” function is enabled a string containing Torque reading is sent periodically (5 Hz) through the serial port for communication with remote calibration software.
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5.1.3 Peak+Alarm

The program is used for tightening with direct measurement of the applied torque in "peak mode". A buzzer (alarm) also sounds when the set nominal torque is reached.



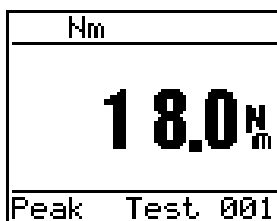
Select the **Peak+Alarm** icon in the **Tightening Menu**: the display will show the test's parameter page.



Select the test's measure unit.

Then fill the other fields in the list (i.e. Nominal Torque, Minimum and Maximum Torque that will be used in the statistical analysis of data. See 5.1.7)

Once the required parameters have been set, the tool gets ready to measure the torque applied to the joint.



The torque values shown on the display can be acquired by pressing **ENTER**: if connected to a serial printer, and the automatic printout function is enabled (see 5.6.3), the values will also be printed.

The test counter automatically updates the number of saved tightening cycles to the next number (up to 100). On reaching 100, any further tightening cycles will not be saved.

The torque value read directly on the display is also indicated by the various led as appropriate:

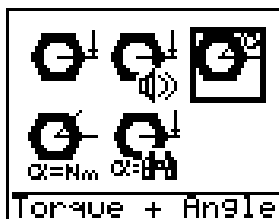
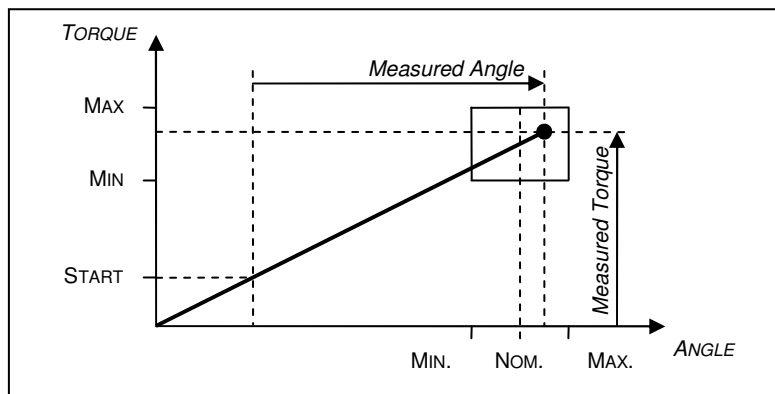
- **Green led**: the min set torque value has been reached.
- **Yellow led**: the nominal set torque value has been reached.
- **Red led**: the max set torque value has been exceeded.

A buzzer also sounds when the yellow led comes on, of use to operators when tightening joints in positions where the display or relevant leds can't be seen.

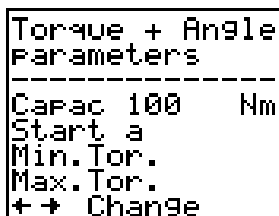
At the end of the tests session the statistics and results menu is displayed (see 5.1.7).

5.1.4 Torque + Angle

This program is used to perform a tightening using the Angle as drive measure. The count of the angle starts when a Torque threshold (Start) has been passed, then the user is driven to reach a final angle. The results of the test are the final measured Torque and the final measured Angle, but the success criteria of the test use only the angle result.



Select the **Torque + Angle** option in the **Tightening Menu**: the display will show the torque parameters page.



Select the test's measure unit.

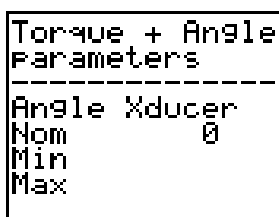
Then fill the other fields in the list:

Start at: torque value to start counting the angle from.

Min.Tor: Min torque envisaged to end of tightening.

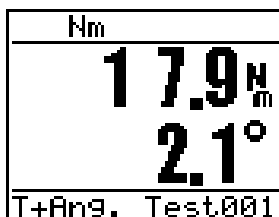
Max.Tor: Max torque envisaged to end of tightening.

These two values are needed as thresholds for the Cp-Cpk calculation. They can be left as zero if you're not interested in this calculation.



Confirm by pressing OK the entered values and pass to the angle parameters page and insert the Nominal, the Minimum and the Maximum angle value.

After setting and confirming these parameters, you can start using the tool. The display looks like this:



During the test, the display will show the progressive torque value, but the angle count will only start once the torque value has reached the value set in the **"Start at"** parameter.

The torque and angle values read directly on the display are also indicated by the various led as appropriate:

- **Green led:** the min angle value has been reached.
- **Yellow led:** the nominal angle value has been reached.
- **Red led:** the max angle value has been exceeded.

A buzzer also sounds when the yellow led comes on, of use to operators when tightening joints in positions where the display or relevant leds can't be seen.

The torque and angle values shown on the display can be acquired by pressing **ENTER**: if connected to a printer, the values will also be printed

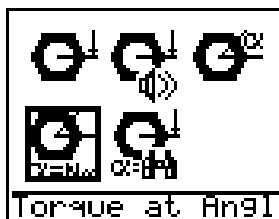
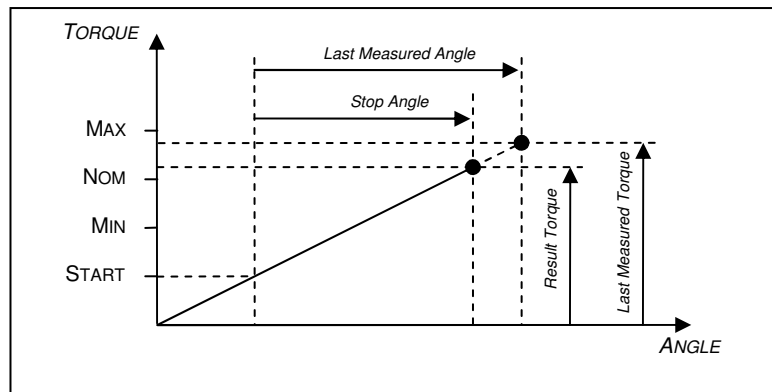
The test counter automatically updates the count of tests to the next number (up to 100). On reaching 100, any further tightening cycles will not be saved.

At the end of the tests session the statistics and results menu is displayed (see 5.1.7). Both torque and angle statistics will be available for this kind of test.

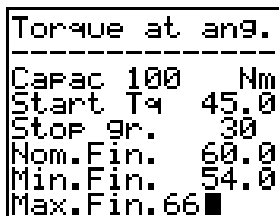
5.1.5 Torque at Angle

This method allows to analyse a joint by retrieving the value of the Torque after a rotation of a given Angle. The count of the angle starts when the measure of the Torque passes a given threshold (Start). The test ends when the Angle reaches the given Stop angle.

The user can continue the tightening (as in graph) but the result value will be the torque measured at the Stop Angle.



Select the **Torque at Angle** option in the **Tightening Menu**.
the display will show the test's parameter page.



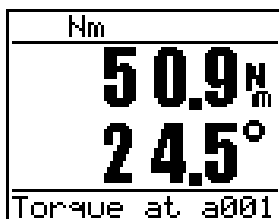
Select the test's measure unit.

Then fill the other fields in the list:

Start Tq: torque value to start counting the angle from.

Stop gr.: angle value to evaluate the corresponding torque value.

Nominal, Minimum and Maximum Final Torque will be used in the statistical analysis of data. See 5.1.7)



By accepting the parameters, the test will start.

During the test, the display will show the progressive torque value, but the angle count will only start once the torque value has reached the value set in the **"Start Tq"** parameter.

The result of the test will be indicated by the leds:

- **Green led:** the result torque is in the tolerance interval (greater than the minimum torque and lesser than the maximum torque).
- **Red led:** the result torque is outside the tolerance interval.

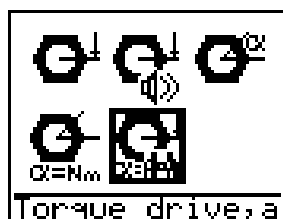
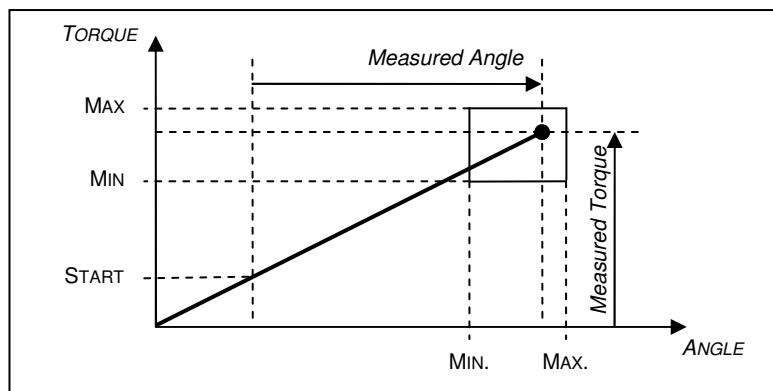
At the end of the tests session the statistics and results menu is displayed (see 5.1.7). Only torque statistics will be available for this kind of test.

5.1.6 Torque drive (Angle surveillance)

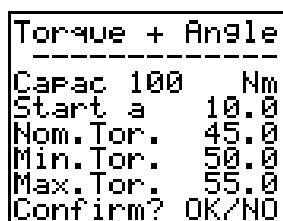
This function can be used to perform a tightening using the Torque as drive measure. Moreover during the tightening will be measured the Angle value.

The count of the angle starts when the Torque reading passes a threshold (Start) and ends when the user accepts the result by pressing the OK button.

The results of the test are the final measured Torque and the final measured Angle, and the success criteria of the test use both results.



Select the **Torque drive, angle surveillance** option in the **Tightening Menu**: the display will show the torque parameters page.

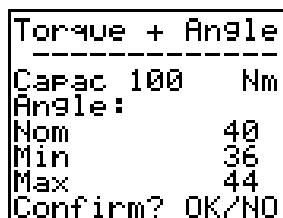


Select the test's measure unit.

Then fill the other fields in the list:

Start at is the Torque value to start counting the angle from.

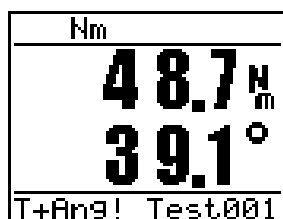
Nominal, Minimum and Maximum Final Torque will be used in the statistical analysis of data (see 5.1.7).



Confirm to pass to the angle parameters page and insert the values for Nominal, Minimum and Maximum Final Angle.

Confirm by pressing OK button and start the test.

The display will show the Torque peak value and the corresponding Angle value.



During the tightening the leds will indicate to the user the position of the Torque with respect of the Torque tolerance interval.

- **Green led:** the min Torque value has been reached.
- **Yellow led:** the nominal Torque value has been reached.
- **Red led:** the max Torque value has been exceeded.

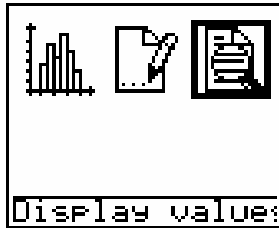
By ending the test the display will show the final value and the result of the test. Only if both Torque and Angle are in range, the test result will be OK. The leds show the final result for the Torque as following:

- **Green led:** the result Torque value is in the tolerance interval.
- **Red led:** the result Torque value is outside the tolerance interval.
-

At the end of the tests session the statistics and results menu is displayed (see 5.1.7). Both torque and angle statistics will be available for this kind of test.

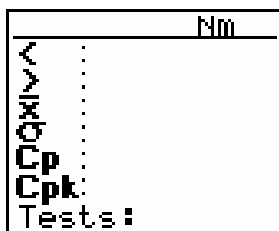
5.1.7 Statistics

There are three options:



1. Show Statistics
2. Modify Parameters
3. Display Values

5.1.7.1 Show Statistics



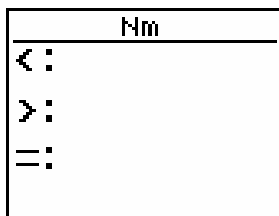
The processed statistics are automatically shown, including the **Cp** and **Cpk** calculations to suit the min and max torque limits set earlier.

With the Torque+Angle function (Par. 4.1.3), if you press **ENTER** once the display has shown the statistic for the max torque value reached, a new table appears on the display

showing the same statistics for the angles:

Note: see **Appendix A** for a brief intro to **Process Functioning** and the meaning of the indices **Cp** - **Cpk**.

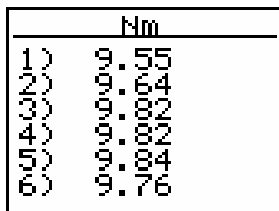
5.1.7.2 Modify Parameters



Here you can vary the torque and angle parameters (min, max or nominal) set before measuring.

If you then want to use the **View Statistics** option again, the statistics will be re-processed to suit the new parameters.

5.1.7.3 Display Values

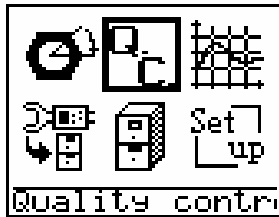


The test values (max 100) are shown on the display.

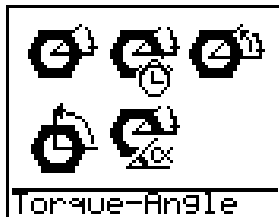
Use the arrow keys to move up and down the list.

These data can be accessed until you return to the **Tightening Menu**.

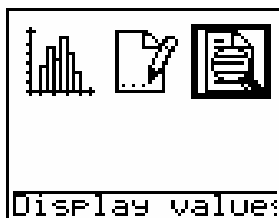
5.2 QUALITY CONTROL MENU



Select the **Quality Control** icon from the **Main Menu** to select one of the following options:



1. **Breakaway** (see 5.2.1)
2. **Torque/Time** (see 5.2.2)
3. **Loose + tighten** (see 5.2.3)
4. **Loose peak** (see 5.2.4)
5. **Torque-Angle** (see 5.2.5)



Press **ESC** after tightening to view the relevant statistics (see 5.1.7).

All the 5 quality control test methods have basically the same purpose to identify the residual torque of an already tightened joint. They differ in the algorithm to better match joint conditions and customers' procedures.

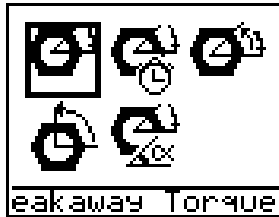
5.2.1 Breakaway

This test method lets you measure the torque with which a nut has been tightened by measuring the amount of torque needed to get further minimal rotation of the nut ("**breakaway**" torque).

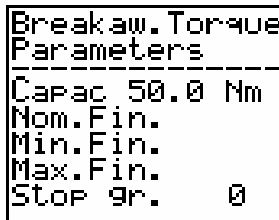
The tool requires that the operator stops as soon as the nut is moved.

There are two possible methods:

- Automatic method: set a rotation angle greater than zero and the tool will automatically detect the torque value as soon as it measures rotation equal to the set value (in this case, the measurement is correct even if the operator "pulls" the nut even further).
- Manual method: set a rotation angle equal to zero and the tool will ask the operator to stop as soon as the nut is moved.



Select the **Breakaway** icon from the **Quality Control** menu: the display will show the parameters page.
Select the test's measure unit.

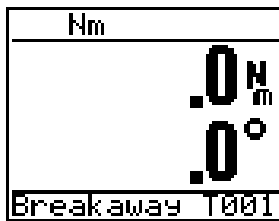


Set the reference value for the control as the nominal torque value; values **Fin. Min.** and **Fin. Max.** are used by the tool for statistical analysis (calculation of **Cp** and **Cpk**). Fin.Min = Lower torque limit, Fin.Max. = Upper torque limit.

The **Stop Gr.** parameter (default angle setting = 3 degrees) corresponds to the degrees needed to get min rotation of the nut, taking into consideration any play in the bushes or adapters, plus elastic torsion in any extensions. The max torque value measured during this rotation will be taken as the breakaway value and saved (manually or automatically).

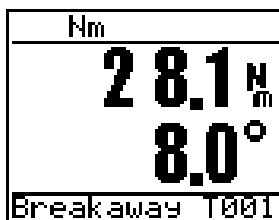
The test counter is updated automatically to the next test number (max 100). Any tests after 100 will not be saved.

Having set all the parameters and pressed **ENTER**, you can start measuring.



The display will look like this:

On reaching the set angle of rotation, the green led or red led comes on (depending on whether the test value falls within or outside the set limits). The buzzer also sounds at this point: one beep for the green led (tightening within tolerance) or a double beep for the red led (tightening outside tolerance).



Automatic acquisition (with angle measurement)

You can set the angle within which to measure the torque at will (normally between 2 and 10 degrees). This angle must take any play or elastic deformation into account: if you use extensions or adapters, you can get rotation of 4-7 degrees due to the rotation of the system before actually moving the nut. This effect is especially evident with high torque values and/or the use of long, thin extensions.

If in doubt, we recommend carrying out a torque/angle test, checking the value of rotation measured with min movement of the nut.



Manual acquisition (without angle measurement)

Set a degree value of 0 and the tool works in manual mode, without the use of the gyroscope. The operator is responsible for increasing the torque until the nut just starts moving. The tool will accept the detected peak value as the breakaway

value. Of course, the sensitivity of the user here will influence the results.

Each detected torque datum remains on the display until you press ENTER or a set time-out is exceeded.

A further sub-menu appears at the end of testing, letting you get statistics for these measurements (see 5.1.7).

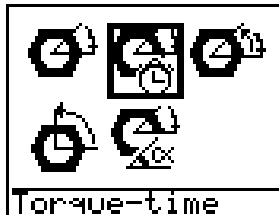
5.2.2 Torque/Time

This test method lets you carry out tests to measure the torque needed to turn an already-tightened nut even further.

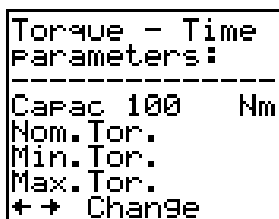
Unlike the breakaway method described above, this program involves analysis of any sudden changes in the torque increasing slope during the nut breakaway (due to the passage from static to dynamic attrition).

The "sharper" the tightening, the more reliable the method: lubricants (especially if low-friction) make it much harder to detect any differences in friction during breakaway.

Test must be performed in "one shot" pulling avoiding operator's hesitations which could be detected as the breakaway point from the analysis algorithm.



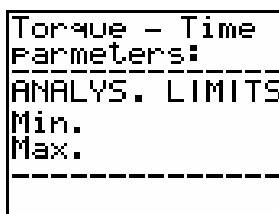
Select the **Torque/Time** icon in the **Quality Control** menu: the display will show the Torque parameters page.



Select the test's measure unit.

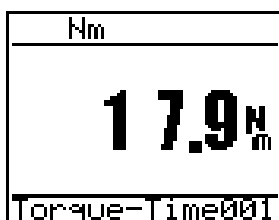
Insert the Nominal, Minimum and Maximum Torque (used for statistical purposes).

Confirm the entered values by pressing the OK button: the display will show the analysis parameters page.



The analysis limits are used to tell the tool the range within which it should seek the breakaway value. The min and max values that can be measured by the tool are normally set as the default settings.

You can then start measuring after confirming these data.



The display looks like this:

During tightening the torque applied to the nut is displayed. After testing, the tool shows the detected breakaway torque and lights up the green or red led depending on whether the value falls within or outside the set limits.

The test counter automatically updates the consecutive number of the test (max 100 tests). Any tests after 100 are not saved.

If the test isn't carried out correctly, the word NULL appears on the display; if, on the other hand, the test is carried out correctly, but the tool can't establish the breakaway torque, the word ERROR appears. In either case, no value is saved.

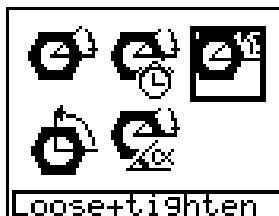
A further sub-menu appears at the end of testing, letting you get statistics for these measurements (see 5.1.7).

5.2.2.1 Pick-A-Point

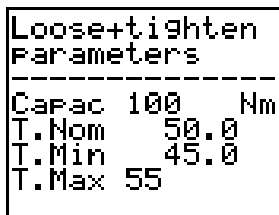
This function allows to check the result of a Breakaway Torque-Time test: by pressing the right arrow after a valid test result (not an "Error" or a "Null" result) it displays the torque/time curve: a vertical bar indicates the torque estimated as the residual torque of the joint. With the arrows is possible to move the vertical bar and to select another couple (torque, time). By pressing the OK button the user will be prompt to save the selected torque value as the torque result for the test.

5.2.3 Loose + Tighten

This method consists in slightly loosening the nut to be tested and then tightening it again, saving the torque value needed to return the nut to its original angle position (**re-tightening torque**).



Select the **Loose + Tighten** option in the **Quality Control** menu: the display will show the parameters page.

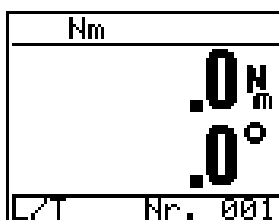


Select the test's measure unit .

Then insert the Nominal, Minimum and Maximum Torque Values (used for the calculation of statistics).

Once you finish setting the data, the tool gets ready as follows:

It starts by loosening the nut. After rotation of **10** degrees (shown on the display), the green led lights up, telling you to stop loosening the nut and start re-tightening it.



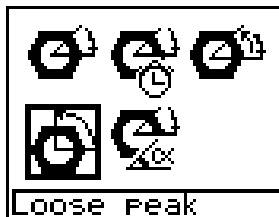
During retightening, the angle count on the display decreases until it reaches zero. The green led goes off at this value, the buzzer sounds and the current torque value is acquired (manually using **ENTER** or automatically if so set in the **Setup Menu**— see 5.6.5).

The test counter is updated automatically to the next test number (max 100). Any tests after 100 will not be saved.

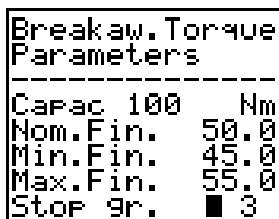
A further sub-menu appears at the end of testing, letting you get statistics for these measurements (see 5.1.7).

5.2.4 Loose peak

This test lets measure the residual torque by loosing an already tightened screw. The result of the test will be the peak of the torque acquired during the unscrewing.



Select the **Loose peak** icon in the **Quality Control** menu:
The display will show the parameters page.

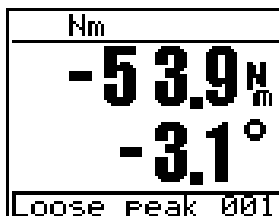


When the cursor is over the capacity field select the test's measure unit by pressing the arrow keys.

The fields Nominal, Minimum and Maximum Final Torque are used in the statistical analysis of the results.

The **Stop Gr.** parameter is the angle value at which the test should stop.

By setting a 0 value for the Stop Gr. Parameter, the test will be performed without the angle reading.



During the loosing of the screw, it will be displayed a negative value of the torque and a negative value of the angle. The greatest absolute value will be chosen as the test result.

When the Stop Angle has been passed the **Yellow led** turns on.

The test ends when, after passing the Stop Angle, the applied torque returns to 0.



In a Loose Peak Test without angle reading, the test stops when a timeout interval expires.

After the test ended the meaning of the led will be the following:

- **Green led:** the result Torque value is in the tolerance interval.
- **Red led:** the result Torque value is outside the tolerance interval.

A further sub-menu appears at the end of testing, letting you get statistics for these measurements (see 5.1.7).

5.2.5 Torque-Angle (QC)

This method estimates the residual torque needed to turn an already tightened screw. Similarly to the breakaway Torque-Time it uses the sudden changes of Torque reading when the friction passes from static to dynamic.

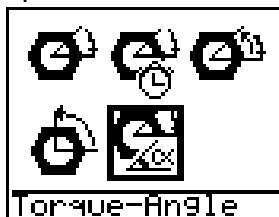
The user has to perform a over-screwing of the bolt, stopping as soon as the bolt starts to move.

The method uses a “peak acquisition” for the angle i.e. the wrench shows and saves the current value of the Torque and the peak value of the Angle.

The algorithm plots a curve using the acquired (Torque, Angle) couples.

- It defines as “slope” of the curve in a point as the direction of the tangent line in the point.
- For each point of the curve the algorithm detects 2 close auxiliary points, and for both it computes the slope of the tangent line.
- For each point by using the directions associated to each tangent line, it estimates the slope's variation (as an angle);
- It chooses the point in the curve with the greatest slope's variation. This is the estimated breakaway point.

The Torque-Angle curve is time-independent, i.e. the curve doesn't depend on the speed execution of the test.



Select the **Torque-Angle** option in the **Quality Control** menu: the display shows the torque parameters page.

```
Torque - Angle
Parameters:
-----
Capac 100    Nm
Nom.Tor.    40.0
Min.Tor.    36.0
Max.Tor.    44.0
Confirm? OK/NO
```

When the cursor is over the capacity field select the test's measure unit by pressing the arrow keys.

The fields Nominal, Minimum and Maximum Final Torque are used in the statistical analysis of the results.

```
Torque - Angle
Parameters:
-----
ANALYS. LIMITS
Min.        5.0
Max.       100.0
Confirm? OK/NO
```

After setting all the parameters, press OK button to open another page where you need to enter the analysis limits.

These limits are used to tell the tool the range within which it should seek the breakaway value: the minimum limit must not be lesser than the minimum load of the wrench and the maximum limit must not be greater than the capacity of the wrench.

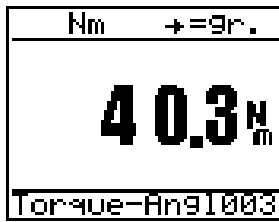
You can then start measuring after confirming these data.

```

Nm    +-gr.
 27.6 Nm
  6.2°
Torque-Angle1002
```

The display looks like this:

During the tightening the green led indicates when the lower analysis limit has been passed.



The user informs the wrench that the tightening is ended by pressing the OK button: the estimated breakaway Torque is displayed.

If the algorithm can't find a breakaway point using the acquired data, the display will show a NULL message and the wrench don't save the result.

The test counter automatically updates the consecutive number of the test (max 100 tests). Any tests after 100 are not saved.

After the test ended the meaning of the led will be the following:

- **Green led:** the result Torque value is within the tolerance interval.
- **Red led:** the result Torque value is outside the tolerance interval.
- **Green and Red leds simultaneously on:** the result of the test is NULL.

A further sub-menu appears at the end of testing, letting you get statistics for these measurements (see 5.1.7).

5.2.5.1 Pick-A-Point

This function allows to check the result of a Breakaway Torque-Angle test: by pressing the right arrow it displays the torque/angle curve: a vertical bar indicates the Torque estimated as the residual torque of the joint and the corresponding angle.

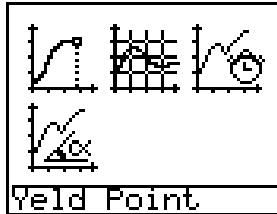
It's possible to move the segment along the curve by using the keys:

- ←, → keys select respectively the previous or the next point in the curve;
- "7", "9" keys select the point respectively back or forward of 5 positions;
- "4", "6" keys select the point respectively back or forward of 10 positions;
- "1", "3" keys select respectively the first or the last point of the curve.

By pressing the OK button the user will be prompt to save the selected Torque value as the Torque result for the test.

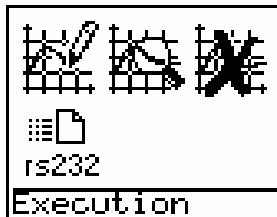
5.3 TIGHTENING ANALYSIS

Select the **Tightening Analysis** icon in the **Main Menu** to access the following options:



1. **Yield Point** (see 5.3.1)
2. **Tightening Analysis** (see 5.3.2)
3. **Breakaway** (see 5.3.3)
4. **Breakaway Torque-Angle** (see 5.3.4)

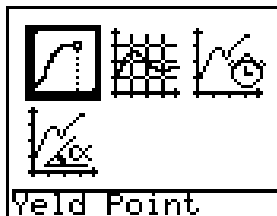
Select one of these options to access the **Curve Management** menu.



The options here are:

1. **Execution**
2. **Show Curve**
3. **Delete Curve**
4. **Send Curve**

5.3.1 Yield Point



This lets you tighten joints until they reach their yield point.

You can decide on the control program you want to use to suit the joint:

- **H = Hard:**
This program should be used when the joint is made from stiff steel elements, with high-strength or relatively short nuts and bolts, without washers.
- **M = Medium:**
For joints with washers, relatively soft material and medium-strength nuts and bolts.
- **S = Soft:**
For joints made from deformable elements (sheet steel, plastic or rubber components) that are easily deformed compared to the characteristics of the nuts and bolts. Ideal for joints with small nuts and bolts compared to their length (high diameter/length ratio).

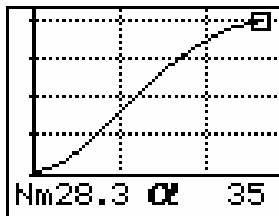
5.3.1.1 Execution - Yield

The program asks for the **number** of the curve (if already stored in the memory, the program asks if you want to overwrite it) and then the **joint type** (1=H, 2=M, 3=S) (hard - medium - soft) plus the threshold at which to start counting the angle¹.

The default setting is the last value set during the previous tests (the initial default setting is 1/3 the capacity of the transducer).

The required threshold is also important to allow the system to ignore any relaxation of the materials (e.g. washers) during the initial tightening and which could be interpreted as a yield point due to variation in the slope of the torque/angle curve (thus generating errors).

In fact, variations in the slope of the curve processed by the system using a sophisticated algorithm lets you identify the exact yield point in a joint.



After setting all the required values, you can start the test. The display will then show the graph:

Below are some elements shown on the display during tightening:

A) Correct tightening speed bars: these bars appear on the left of the display (max 5 sectors). Tightening must be at such a speed that all 5 sectors never appear: if 5 sectors appear, the system could have problems in acquiring all the torque and angle values needed to construct the graph properly and to highlight the yield point. If tightening is too fast, there's also the risk that the operator can't stop quick enough as soon as the tool detects the yield point is reached, thus causing non-conforming tightening.

B) Instant indication of torque and angle values: a vertical bar appears on the display that can be shifted at will using the arrow keys. The last line of the display shows the torque+angle or torque/time values corresponding to the intersection of this bar with the curve shown. This function lets you analyse the saved values more accurately.

¹ Warning: since the angle count only starts once a fixed torque value is reached (decided by the operator), if you set various thresholds, you'll get different angle readings that can't be directly compared with other sample measurements. To get a direct comparison of measurements using different tools, you must therefore use the same threshold value. We therefore recommend using the standard threshold value of 50% the yield point for the nuts and bolts in question.

C) Indication of yield point: This is a small square on the curve at the precise point where yield occurs.

D) Final indication of the torque+angle value at the yield point: the instant values as per **point B)** freeze at the yield point (also shown by a small square on the curve), but generation of the curve continues if the operator fails to stop tightening.

E) Lighting up of the yellow and red leds: the yellow and red leds come on together when the yield point is reached and the relevant torque+angle values are shown on the display, together with the positioning of the small square on the curve. If you want, you can always continue the test until the joint actually breaks.

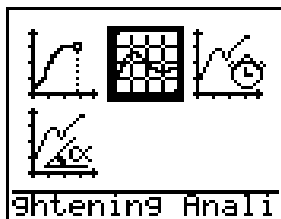
On completing the test, press **OK/ENTER** to save the curve. The curve is redrawn using an automatic scale for better visualisation and, at the same time, saved under the assigned consecutive number.

If, on the other hand, you press **NO/DEL**, you reject the curve and this is repeated with the same parameters. Alternatively, press **ESC** to reject the curve and return to the **Curve Management** menu).

Press **OK/ENTER** again to acquire a new curve using the same parameters as before, with a consecutive number.

If you want to vary the test parameters, keep pressing **ESC** until you return to the **Main Menu**.

5.3.2 Tightening Analysis



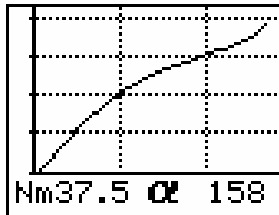
This option lets you study the characteristics of a tightening cycle by drawing a torque+angle curve for the values detected during a test (that can be continued until actual breakage of the nuts and bolts).

This function is particularly useful when it comes to viewing and recording the development of any phenomenon requiring a torque+angle graph (e.g., as well as tightening analysis, also the closing/opening of a valve, attrition checks during almost static rotation, etc.).

There is no indication when the yield point is reached.

When you select this option, the program simply asks you whether the analysis involves a fast tool that will reach the set torque in just a few milliseconds (e.g., a power tool) or a slow tool (e.g., a manual torque wrench).

5.3.2.1 Execution - Tightening Analysis

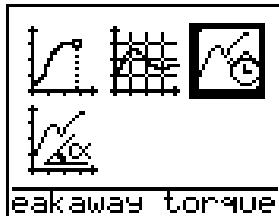


The program asks for the **number** of the curve to be saved (if it already exists, the program asks if you want to overwrite this).

You can now start the test: the display shows the curve:

The tightening curve and the relevant torque+angle values are saved by pressing **ENTER**.

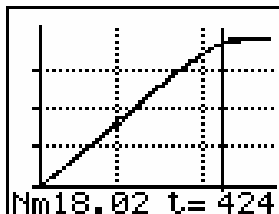
5.3.3 Breakaway



This mode lets you analyse the behaviour of a joint during the breakaway, using a torque/time graph: the characteristics of this graph let you see whether the joint allows for quality control based on the breakaway method depending on the tightening time or, alternatively, using different methods.

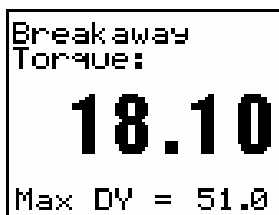
5.3.3.1 Execution - Breakaway

The program asks for the **number** of the curve to be saved (if it already exists, the program asks if you want to overwrite this).



You can now start the test: the display shows the curve:

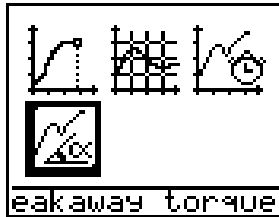
The x axis (horizontal axis) shows the time in milliseconds.



The breakaway torque is then shown on the display:

The greater the difference in curvature during the breakaway, the greater the **Max DY** parameter. We advise against using this method for joints with a DY value of less than 40.

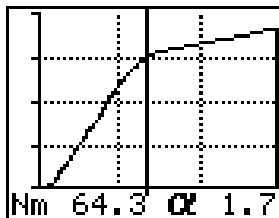
5.3.4 Breakaway Torque-Angle



This mode lets you analyse the behaviour of a joint during the breakaway, using a torque/angle graph: the characteristics of this graph let you see whether the joint allows for quality control based on the breakaway Torque-Angle method (see 5.2.5).

The acquisition of the Torque and Angle values, and the estimation of the breakaway Torque follow the rules for the Torque-Angle breakaway test.

5.3.4.1 Execution – Breakaway Torque-Angle



Select the Execution icon: the program asks for the **number** of the curve to be saved (if it already exists, the program asks if you want to overwrite this).

Then fills the fields with the analysis parameters.

The acquisition starts: the display shows the current value of the Torque and the peak value of the Angle.

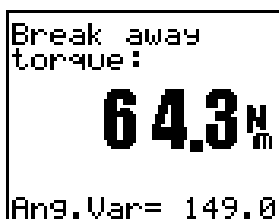
Perform the test and press the OK button to end the acquisition phase and to start the search for the breakaway point.

The display shows the Torque-Angle curve and shows a vertical segment: the intersection of curve and segment indicates the estimated breakaway point.

It's possible to move the segment along the curve by using the keys:

- ←, → keys select respectively the previous and the next point in the curve;
- “7”, “9” keys select the point respectively back or forward of 5 positions;
- “4”, “6” keys select the point respectively back or forward of 10 positions;
- “1”, “3” keys select respectively the first and the last point of the curve.

The values for Torque and Angle of the currently selected point are displayed in the last row.

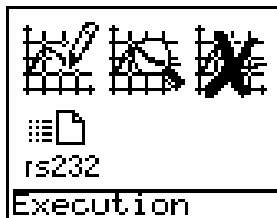


Press OK to accept the result: the display will show the estimated residual Torque.

Angle Variation (Ang.Var.) is an estimation of the “variation of direction” of the curve computed in the estimated breakaway point.

5.3.5 Curve Management

Selection any of the icons in the **Tightening Analysis** menu to access the **Curve Management** menu:



1. Execution
2. View Curve
3. Delete Curve
4. Send Curve

5.3.5.1 Execution

This command lets you start acquisition of the curve in the chosen analysis mode. See the specific paragraph describing these modes for greater details:

- Yield Point (see 5.3.1.1)
- Tightening Analysis (see 5.3.2.1)
- Breakaway Torque-Time (see 5.3.3.1)
- Breakaway Torque-Angle (see 5.3.4.1)

5.3.5.2 View Curve

This option lets you see a graph containing a previously saved curve, after entering the number of the curve (if no curve is found for the number entered, the following message appears: "No data exist for this curve!").

A vertical bar appears on the display. You can move this at will using the arrow keys. The last line of the display shows the torque/time values corresponding to the intersection of the bar with the curve shown. This function lets you analyse the stored data more accurately.

The last line of the display shows the torque/time or torque+angle values corresponding to the intersection of the bar with the curve shown.

5.3.5.3 Delete Curve

Select this option to delete any curves you no longer want to keep: simply enter their code numbers when requested (**Delete - From number: ... To number: ...**)

5.3.5.4 Send Curve

Select this option to send the curves you want to a PC via RS232 port: simply enter their code numbers when requested (**Send Curves - From number: ... To number: ...**).

The wrench sends the curves using an ASCII (text) protocol: it's possible to check the communication between the PC and the wrench by using a terminal program like

Windows HyperTerminal. To correctly configure the RS232 communication, use the same parameters both on the PC and on the wrench (to change the wrench RS232 parameters see 5.6.2).

The wrench sends via RS232 every (X, Y) couple of the curve: where X can be the Time or the Angle, while Y is the Torque.

To receive, view and store the curves on a PC it's possible to use the BLM "Curves" software. See Appendix C.

5.4 DATA COLLECTION

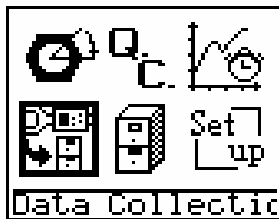
The LABwrench-GYRO can save in its memory a set of definitions of test. For each definition of test it's possible to perform and to save a set of results. We use the "Files" to organize the data in memory.

It's possible to choose from 2 memory modes:

1. **More Results mode:** in the wrench can be defined up to 60 files and in every file can be saved a maximum of 100 test's results.
2. **More Files mode:** in the wrench can be defined up to 200 files and in every file can be saved a maximum of 15 test's results.

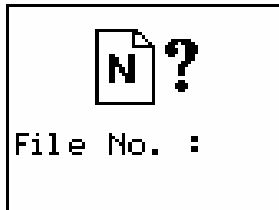
5.4.1 Stand-alone configuration

This configuration can be set in the wrench's setup: the tests can be defined by using the Database Management function (see 5.5). The choice of the test to perform is up to the user.



Select the **Data Collection** from the Main Menu, to use files previously created in the **Data Management** menu.

The parameters needed for the defined tests are stored in the files: by performing the tests, the results will be saved in the files too.



It's possible to select a test only by selecting directly its number(max 60 or 200 depending on the memory mode): then the wrench is ready to start a set of tests.



The results are appended after any data saved in previous work sessions (max 100 or 15 depending on the memory mode). On reaching this limit (e.g. 100), the new value will be saved in the last position (e.g.100) and the previous values all drop a position (e.g., number 99 becomes number 98, 98 becomes 97..., 2 becomes 1); the value previously saved as number 1 will be deleted.

This makes sure that the last values are always saved in the right chronological order.

5.4.2 Remote configuration

This configuration can be set in the wrench setup: a test can be defined using a remote program (Torque Supervisor or QSTorque see Appendix C) and then downloaded into the wrench (see 5.6.6).

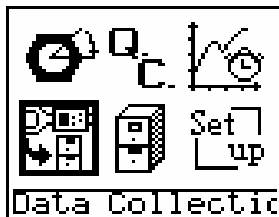
The word “group” is used to denote a set of tests with the same test definition.

In addition, it's possible to define sequences of execution of the tests (“Routes”). A sequence can't be defined locally but must be downloaded from a remote program.

In this way during the execution of the tests, the LABwrench-GYRO can propose directly which test perform, without asking the user to select the test.

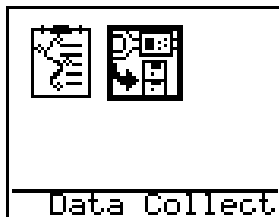
After the execution of the tests it's possible to send back the tests results to the same remote program that previously defined the tests to perform (see 5.6.6).

When this configuration is active, the user cannot modify the parameters of the downloaded tests. However it's possible to reserve a number of tests for “local definition”, but is not possible to define a sequence of execution for those files.



Select the **Data Collection** from the Main Menu, to use files and routes previously downloaded from a remote program (Torque Supervisor or QSTorque).

5.4.2.1 Data Collection in single file



If the downloaded route contains tests not associated to a sequence, it's possible to select directly a file.

Select the “Data Collection in single file” to select manually a file definition specifying the test number or the test location.

A test location is defined in Torque Supervisor as a short code to identify the screw to test.



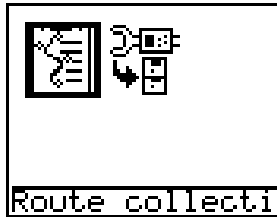
To move the cursor from the test location box to the test number box use the arrows.

Confirm the selection by pressing OK. Note that if the selected test has been downloaded alongside with a sequence the display shows the error message “Only in Route”, and the test cannot be executed.

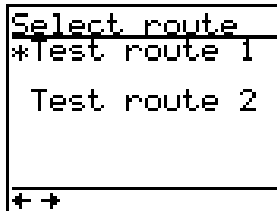


After recalling the desired test it's possible to execute it using the selected definition.

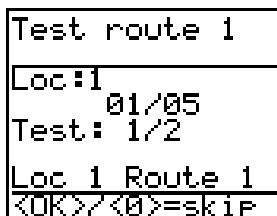
5.4.2.2 Data Collection (from a Route)



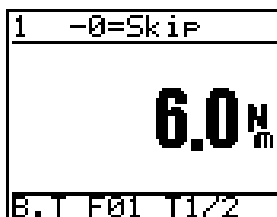
Select the Route Collection icon to enter in the route selection menu. After the selection, the wrench is ready to work, and proposes automatically the test to execute.



The display shows the list of the routes that have been downloaded in the wrench. Select the desired route from the list.



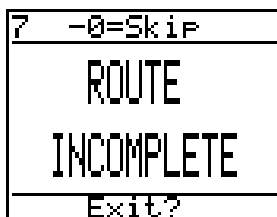
The display will show informations about the first test to perform: the route name, the location code of the test, the group number in the current route, the number of tests to perform in the current group, a description of the current group of tests.



Execute the tests in the group.

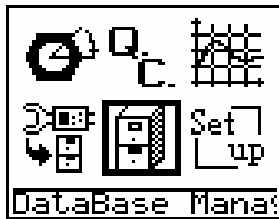


When the group has been completed the wrench informs the user, and it continues with the next group.



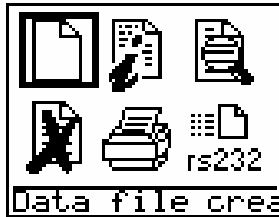
It's possible to abort the sequence of tests. The user will be prompt to exiting the route. If later the user selects the incomplete route, the execution starts from the previously aborted test.

5.5 DATABASE MANAGEMENT



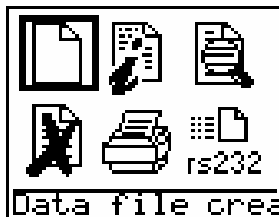
Select **Database Management** in the **Main Menu** and the following sub-menu appears:

This menu lets you create and manage data files. The menu options are:



1. Data file creation
2. File index
3. Data file display
4. Delete
5. Print
6. Files transmission

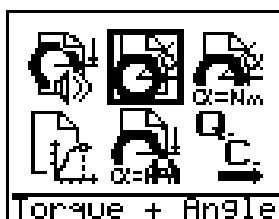
5.5.1 Create File



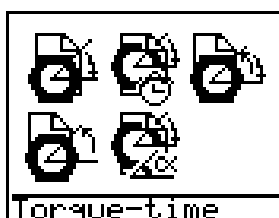
If you select **Create File** in the **Data Management** menu, the system asks you to indicate the **number** you want to give to the new **data file** (a message appears if the name already exists: "File already exists", asking you to enter a different name).

After entering the number, a series of icons appears on the display, for the various different types of file that can be created.

The options are:



1. **Peak+Alarm** (see 5.5.1.2)
2. **Torque+Angle** (see 5.5.1.3)
3. **Torque at Angle** (see 5.5.1.4)
4. **Yeld point** (see 5.5.1.5)
5. **Torque drive (angle surveillance)** (see 5.5.1.6)
6. **QC methods** will display the following sub-menu



1. **Breakaway** (see 5.5.1.7)
2. **Torque Time** (see 5.5.1.8)
3. **Loose+Tighten** (see 5.5.1.9)
4. **Loose peak** (see 5.5.1.10)
5. **Breakaway Torque-Angle** (see 5.5.1.11)

5.5.1.1 Test's measure unit

It's possible to select the measure unit to use during the test. During the Creation of File when the cursor is on the Capacity field it's possible to select the available measure units by pressing the arrow keys. The value of the wrench's capacity expressed using the new measure unit is computed automatically.

5.5.1.2 Peak + Alarm

This program is used to effect tightening or control torque wrenches. The display immediately shows the direct measurement of the applied torque in "peak mode". The buzzer (alarm) also sounds when the set nominal torque is reached (see 5.1.3).

```
File 2   Peak
-----
Cap.  100 Nm
Nom.Tor.
Min.Tor.
Max.Tor.
-----
+ + Change
```

Select the **Peak+Alarm** option in the **Create File** menu: the display show the torque parameters page.

When the cursor is on the capacity field, insert the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque value.

After you enter and confirm this data, the program returns to the **Database Management** menu.

5.5.1.3 Torque+Angle

This program is used to perform a tightening using the Angle as drive measure. The count of the angle starts when a Torque threshold (Start) has been passed, then the user is driven to reach a final Angle. The results of the test are the final measured Torque and the final measured Angle, but the success of the test depends only on the Angle (see 5.1.4).

```
File 20  T+ang
-----
Cap.  100 Nm
Start a  15.0
Nom.Tor. 25.0
Min.Tor. 22.5
Max.Tor. 27.5
Confirm? OK/NO
```

Select the **Torque + Angle** option in the **Create File** menu: the display shows the torque parameters page.

Select the test's measure unit.

Insert the torque threshold to start counting the angle from(Start at).

Insert the Nominal, the Minimum and the Maximum Torque.

```
File 20  T+ang
-----
Angle Xducer
Nom      15
Min      12
Max      18
-----
Confirm? OK/NO
```

After the confirmation of the entered values the display shows the angle parameters page.

Insert the Nominal, Minimum and Maximum Angle.

To end confirm the parameters by pressing the OK button and return to the **Database Management** menu.

5.5.1.4 Torque at Angle

This method is used to analyse a joint by retrieving the value of the Torque after a rotation of given Angle. The Angle's count starts when the Torque passes a given threshold (Start). The test ends when the Angle reaches the given Stop angle (see 5.1.5).

```
File 3   T/ang
-----
Capac 100   Nm
Start at   0.0
Stop deg.
Nom.Tor.
Min.Tor.
Max.Tor.
```

Select the **Torque at Angle** option in the **Create File** menu:

Insert the test's measure unit.

Insert the torque threshold to start counting the angle from (Start at).

Insert the stop angle(Stop deg.).

Then enter the Nominal, Minimum and Maximum Torque.

To end confirm the entered values by pressing OK button and return to the **Database Management** menu.

5.5.1.5 Yield

This lets you tighten joints until they reach their yield point.

```
File 1   Snerv
-----
Windowed? Y
1=H,2=M,3=S:
Lower analysis
lim.      Nm:
-----
<Esc> = Abort
```

When you select the **Yield** icon in the **Create File** menu, a page appears that lets you enter the nominal test torque value and its limits (needed to provide a test result and statistics).

The system lets you define a "window" within which a yield point should be found, identified by min and max envisaged torque and angle values.

Yield values detected outside this window will be considered as invalid and thus not saved.

Press **ENTER** and the system asks for the parameters for the window; press **NO/DELETE** and the window is ignored.

Then chose the type of joint (Hard, Medium, Soft).

```
Window   Limits
-----
T.Min    5.0
T.Max
Min Angle
Max Angle
-----
<Esc> = Abort
```

The following page appears if a window is required:

Enter the envisaged min and max torque and angle values defining the "window".

During data acquisition, the system draws the torque+angle curve for each tightening cycle and identifies the yield point by means of the Yellow and Red Leds (a small box will appear on the curve at this point).

5.5.1.6 Torque drive (angle surveillance)

This method allows to perform a tightening using the Torque as drive measure and at the same time measuring the Angle value. The count of the angle starts when the Torque reading passes a threshold (Start) and ends when the user accepts the result by pressing the OK button.

The results of the test are the final measured Torque and the final measured Angle. The test is successful when both Torque and Angle are in range (see 5.1.6).

```
File 21  T+A!
-----
Cap. 100 Nm
Start a 10.0
Nom.Tor. 20.0
Min.Tor. 18.0
Max.Tor. 22.0
Confirm? OK/NO
```

Select the **Torque drive, angle surveillance** option in the **Create File** menu: the display shows the torque parameters page.

Insert the test's measure unit.

Insert the torque threshold to start counting the angle from.

Then insert the Nominal, Minimum and Maximum Torque.

```
File 21  T+A!
-----
Angle Xducer
Nom 10
Min 8
Max 12
Confirm? OK/NO
```

Confirm the inserted parameters by pressing OK and enter the angle parameters page.

Insert the Nominal, Minimum and Maximum Angle

To end confirm the entered parameters by pressing the OK button and return to the **Database Management** menu.

5.5.1.7 Breakaway

This test method lets you measure the torque used to tighten a nut by measuring the amount of torque required to get minimum rotation of the nut ("**breakaway**" torque). The display then shows the breakaway torque.

The operator then needs to increase the torque until the nut starts moving slightly. The tool will accept the detected peak value as the breakaway value. Of course, the sensitivity of the user here will influence the results (see 5.2.1).

```
File 4  B.T.
-----
Capac 100 Nm
Nom.Tor. 50.0
Min.Tor. 45.0
Max.Tor. 55.0
Stop deg. 12
Confirm? OK/NO
```

Select the **Breakaway** option in the **Create File** menu: the display shows the parameters page.

Insert the value of the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque.

Insert the value of the Stop angle (Stop deg.).

After you enter and confirm this data, the program returns to the **Database Management** menu.

5.5.1.8 Torque/Time

Unlike the breakaway method described above, this program involves analysis of any sudden changes in the torque during the nut breakaway (due to the passage from static to dynamic attrition).

The "sharper" the tightening, the more reliable the method: lubricants (especially if low-friction) make it much harder to detect any differences in friction during breakaway (see 5.2.2).

```

Fil.4  T/time
-----
Cap.  100 Nm
Nom.Tor.
Min.Tor.
Max.Tor.
-----
+ + Change
  
```

Select the **Torque/Time** icon in the **Quality Control** menu: on the display appears a set of parameters.

Select the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque.

```

Fil.4  T/time
-----
Cap.  100 Nm
TEST LIMITS:
Anal.Min  5.0
Anal.Max.
-----
<Esc> Abort
  
```

Confirm the parameters by pressing OK button and enter the analysis limits page.

These limits are used to tell the tool the range within which it should seek the breakaway value.

Insert the Analysis Torque limits(Minimum and Maximum).

After you enter and confirm this data, the program returns to the **Database Management** menu.

5.5.1.9 Loose + Tighten

This method consists in slightly loosening the nut to be tested and then tightening it again, saving the torque value needed to return the nut to its original angle position (**re-tightening torque**) (see 5.2.3).

```

File 12  L/T
-----
Cap.  100 Nm
Nom.Tor.  50.0
Min.Tor.  45.0
Max.Tor.  55.0
-----
Confirm? OK/NO
  
```

Select the **Loose + Tighten** option in the **Create File** menu: the display shows the parameters page:

Select the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque.

To end confirm the entered values by pressing OK button and return to the **Database Management** menu.

5.5.1.10 Loose peak

This test lets measure the residual torque by loosing an already tightened screw. The result of the test will be the peak of the torque acquired during the unscrewing (see 5.2.4).

```
File 13   Loos
-----
Capac 100 Nm
Nom.Tor. 60.0
Min.Tor. 54.0
Max.Tor. 66.0
Stop deg. 3
Confirm? OK/NO
```

Select the **Loose + Tighten** option in the **Create File** menu: the display shows the parameters page:

Select the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque.

The **Stop deg.** parameter is the angle value at which the test should end. If this parameter is 0 the test is performed without

reading the angle.

To end confirm the entered values by pressing OK button and return to the **Database Management** menu.

5.5.1.11 Breakaway Torque-Angle

This method estimates the residual torque needed to turn an already tightened screw. Similarly to the breakaway Torque-Time it uses the sudden changes of Torque reading when the friction passes from static to dynamic (see 5.2.5).

```
File.21  T/ang.
-----
Cap. 100 Nm
Nom.Tor. 50.0
Min.Tor. 45.0
Max.Tor. 55.0
Confirm? OK/NO
```

Select the **Loose + Tighten** option in the **Create File** menu: the display shows the parameters page:

Select the test's measure unit.

Insert the Nominal, Minimum and Maximum Torque.

```
File.21  T/ang.
-----
Cap. 100 Nm
TEST LIMITS:
Anal.Min 5.0
Anal.Max 100.0
Confirm? OK/NO
```

Confirm the parameters by pressing OK button and enter the analysis limits page.

These limits are used to tell the tool the range within which it should seek the breakaway value.

Insert the Analysis Torque limits(Minimum and Maximum).

After you enter and confirm this data, the program returns to the **Database Management** menu.

5.5.2 File index



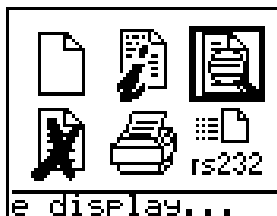
Select **File index** in the **Database Management** menu to view the files saved on the tool.

These are in compact form (file number, relevant test type and nominal torque). Use the arrow keys to move up and down the list.

A missing file or empty file is indicated with a series of asterisks (*).

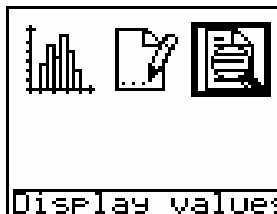
Press **ESC** to return to the **Database Management** menu.

5.5.3 View Files



Select **View Files** in the **Database Management** icon to use existing files.

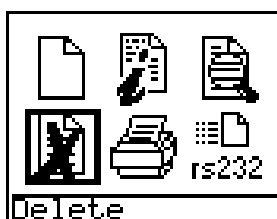
The system asks you to enter the number of the file (an error message appears if the file doesn't exist).



A page appears looking exactly like the one for direct testing, and with the same functions:

See 5.1.7.

5.5.4 Delete files

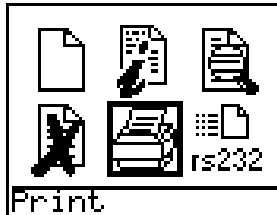


Select **Delete** in the **Database Management** menu to delete the files you no longer want.

The **Delete** menu offers 4 options:

1. **Delete Files:** this lets you delete one or more files in order. The system asks you to specify the range of the files you want to delete (from number... to number ...).
2. **All Files:** this lets you delete all the files. The systems asks for confirmation: if you give the OK, all files will be deleted.
3. **Data Files:** this option lets you delete the data stored in the selected files, leaving the set parameters in these unaltered.
4. **All data:** as for the previous option, only the saved test data are deleted, leaving the set parameters unaltered.

5.5.5 Print

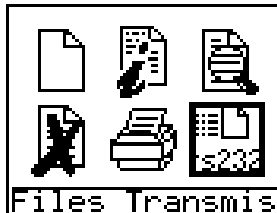


Select the **Print** option in the **Database Management** menu to send the data saved in the files to a printer.

The options here are:

1. **File Names:** This lets you print the names of the files and their set parameters.
2. **File Data:** This lets you print the data saved in each file (select using the file number).

5.5.6 Send Files



Select the **Send Files** option in the **Database Management** menu to send the data saved in a file via the serial port.

Connect the PC to the tool via the RS232 serial port. The system then asks you to enter the number(s) of the file(s) you want to send (from number ... to number ...).

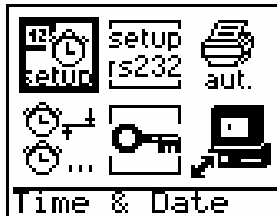
Press **ENTER** and the data are then sent via the RS232 serial port.

To receive the results from a PC is possible to use the BLM “Curves” software. See APPENDIX C.

5.6 SETUP MENU

Select the **Setup Menu** option in the **Main Menu** to access the following sub-menu:

The options here are:



1. **Date and Time**
2. **RS232 Setup**
3. **Automatic Printout (ON/OFF)**
4. **Automatic Capture Times**
5. **Other Functions**
6. **Remote Control**

5.6.1 Date and Time

This option lets you adjust the date and the time (format: dd/mm/yy and hh:mm:ss).

Use the number keys to change the date and time figures in sequence.

Press **ESC** on completion to return to the **Setup Menu**.

5.6.2 RS232 Setup

This option lets you vary the parameters for the RS232 serial port to suit the computer parameters (connected for transmission of curves or data) or those of the printer for direct printouts.

This menu contains the following parameters:

1. **Baud:** to choose the **baud** rate: **300 - 600 - 1200 - 2400 - 4800 - 9600 - 19200**.
2. **Parity:** lets you choose the **parity: None - Even - Odd**.
3. **Data Bits:** lets you chose the **data bits**. The system contains an automatic control for the choice of these acceptable rates:
 - **8** data bits only with "**Even**" parity.
 - **7** or **8** data bits with "**Odd - None**" parity.
4. **L/F:** is used to enable or disable the automatic linefeed during print data transmission.
5. **Pause:** lets you chose the pause during transmission of successive lines of text (usually needed to synchronise the system with slow devices like printers).

5.6.3 Automatic Printout (ON/OFF)

You can set the tool to get automatic data printouts (data acquired by pressing **ENTER** or automatically).

Press **ENTER** to enable/disable this function (if disabled, a large cross appears above the drawing of the printer).

5.6.4 Automatic Capture Times

This option lets you chose between manual and automatic data acquisition during quality control (not during actual tightening).

To acquire the value shown manually, press **ENTER** and then set the two **Capture Time** and **Holding Time** values as zero.

The value will remain on the display until you press **ENTER** again.

To acquire the value automatically, set the time in seconds after which the value shown on the display will be acquired (**Capture Time**).

The **Holding Time** specifies how long the value will remain on the display before being cleared.

You can, however, acquire a value before the Holding Time time-out by pressing **ENTER**.

5.6.5 Other Functions

This key lets you access certain password-protected menus that let you set a large number of tool management parameters.

PASSWORD 0956

This password lets you access the tool setting menu, if you need to adjust the tool calibration.

Warning: we recommend making a note of the original value used to calibrate the tool. Keep this in a safe place. If successive calibration of the tool leads to inaccurate measurements, it's best to reset the original value.

```

SETUP STRM. 1+
On.Mis. Nm
F.Sc. 100
mU/U 0.40240
Pn9:GYR
St: 5%
12 1 0.0
  
```

Press "OK" button to access the first option. Alter the setting and then confirm with "OK" button or press this key again without making any changes to go to the next option.

There are 5 possible options for this type of wrench:

- **Measure Unit**

Used to change the unit of measurement (by pressing the arrow keys) to suit the transducer type and its capacity (options: Nm, lb.ft., lb.in., oz.in., kgf-m, cNm, kNm).

- **Capacity**

This option lets you set the max transducer capacity.

- **mV/V sensitivity**

This parameter, together with the max value, determines the tool's gain factor. This value is needed to alter the calibration of the tool should there be a difference between the read torque value and the value actually measured. For example, if the max value is 99.3 Nm instead of 100, having checked that the reading of the 0 value (zero) is correct, the sensitivity value needs to be reduced by 0.7% (e.g. supposing the original parameter was 1,8357, we would get 1,8228 if we reduce this by 0.7 %). Likewise, if the reading is higher rather than lower, the sensitivity value needs to be increased by the relevant amount.

- **Ang.**

This parameter means "Angle Use" and must be "GYR" (Gyroscope).

- **St: %(Percentage threshold)**

This determines the threshold value in the static peak mode, expressed as a percentage of the transducer capacity: generally **5%**. The tool uses this parameter to avoid capturing unwanted peaks (often errors or measurements taken while still moving the tool on the nut or cell).



From the first setup page, by pressing the right arrow it's possible to access the Angle setup:

Press "OK" button to access the first option in the list.

There are 3 possible options:

- **C.A. (Coefficient of Angle)**

Used to transform the reading of the angular speed into the measurement of the angle.

- **C.C.A. (Correction Coefficient for Angle)**

The rotation of the screw and the rotation measured by the wrench can be different due to the elastic deformation of the wrench when applying torque. CCA is used to compensate this difference.

- **zero**

Points associated to the zero of the angular speed.

PASSWORD 0855

This password lets you access the **Auto-Shutdown Setup** and the **Program Setup** menus.

- **Auto-Shutdown Setup**

This lets you decide how many minutes should pass before the tool automatically shuts down.

5.6.6 Remote Control

This function enables the communication of the LABwrench-GYRO with a remote program.

After the selection of the option, the wrench is ready to receive commands from the remote program via the RS232: the wrench works like a server, the client (i.e. the remote program) can send commands to the wrench and can receive the results of the sent command from the wrench.

If the remote program is a file-management program e.g. Torque Supervisor, it can:

- upload on the wrench the informations regarding the tests to perform, the routes, etc.
- download from the wrench the results of the performed tests.

If the remote program is a calibration software tool, it can:

- start a calibration sequence;
- interrogate the wrench requesting the calibration values;
- command the wrench to send periodically (5 Hz) the torque readings;
- command the wrench to change the calibration parameters.

APPENDIX A: PROCESSES AND STATISTICS

BRIEF NOTES ON HOW THE PROCESS WORKS

The functioning of a process is a measure of its reliability. A certain amount of variability can be found in each process due to:

- natural causes
- determinable causes

While the first type of variability is quite normal in a process, being attributable to ordinary causes, the second type is linked to specific or special causes: if suitably adjusted or controlled, the variability associated with them can be eliminated.

Since the variability in the process can be described by a single distribution, usually *normal*, the functioning or capacity can be assessed using the properties of this distribution.

Evaluation of the functioning of the process lets you make predictions as to the quality and so adopt the appropriate measures to avoid possible defects.

Normal distribution

The manner in which each value occurs around the most frequently found value (the mean value) is called *distribution*. Normal (or Gaussian) distribution is the frequency distribution that a magnitude usually tends towards when it undergoes a large number of accidental causes of variation, each of which acts independently of the others and with a very small effect when compared to the sum of all the effects.

Normal distribution is represented by a bell-shaped curve with several interesting features.

Without going into the details of the mathematical and statistical concepts involved, we still need to explain the meaning of the *mean value* (the sum of the values divided by their number),

$$\overline{X} = \frac{X_1 + X_2 + X_3 + \dots + X_N}{N}$$

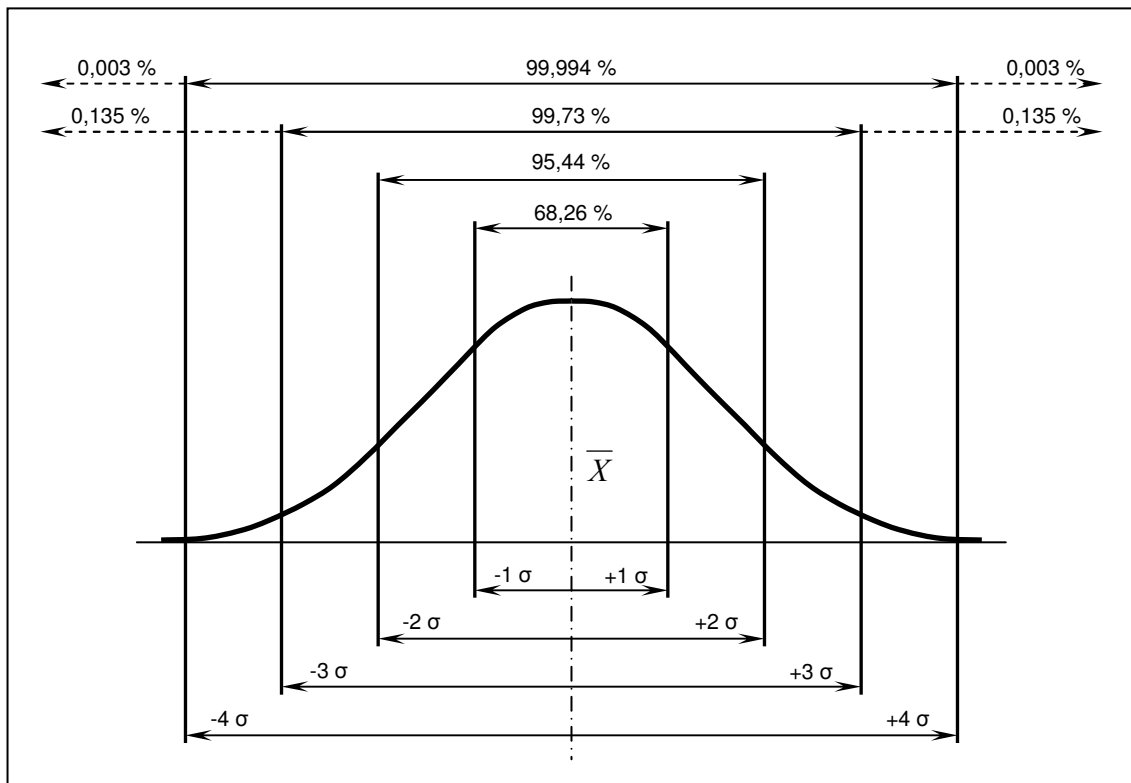
and the calculation of the *standard deviation*, indicated by σ (sigma) and expressed as the square root of the mean of the deviation squares:

$$\sigma = \frac{X_1^2 + X_2^2 + X_3^2 + \dots + X_N^2}{N}$$

Statistical studies show that, if the process is distributed in a normal fashion, the dispersion of the values around the mean value will be as follows:

- 68.26% of the values fall within ± 1 standard deviation ($\pm 1 \sigma$)
- 95.44% of the values fall within ± 2 standard deviation ($\pm 2 \sigma$)
- 99.73% of the values fall within ± 3 standard deviation ($\pm 3 \sigma$)
- 99.994% of the values fall within ± 4 standard deviation ($\pm 4 \sigma$)

as can be seen in the diagram below:



Characteristics of normal distribution

Cp index

The most commonly used functioning indices are **Cp** and **Cpk**: **Cp** (process efficiency) is the index of tolerance at 6 sigma.

The formula for its calculation is:

$$Cp = \frac{L_{\max} - L_{\min}}{6 \cdot \sigma}$$

The 6σ in the **Cp** formula derives from the fact that, in normal distribution, 99.73% of the values will have dispersion of 6σ ($\pm 3 \sigma$).

We can see with this formula that the **Cp** values can deviate by very little (almost zero) or a lot (very high positive numbers).

When the **Cp** value is less than 1, the tolerance is less than the 6 σ amplitude; when the **Cp** value is greater than 1, the tolerance is greater than the 6 σ of the distribution.

The higher the value, the less the dispersion of the values and the better the **Cp** index.

But the **Cp** value is only a measure of dispersion; in other words, the amplitude of distribution of the values around the mean value, not their **centring**.

In the specific case of a power tool, the **Cp** index could be of acceptable size (greater than 1) meaning that there is limited dispersion around the mean value, but this mean value could differ considerably from the expected value.

This would mean that the power tool is of good quality as the torque values are all around the same absolute tolerance value, but that it has not been calibrated correctly and so needs to be re-calibrated.

Cpk index

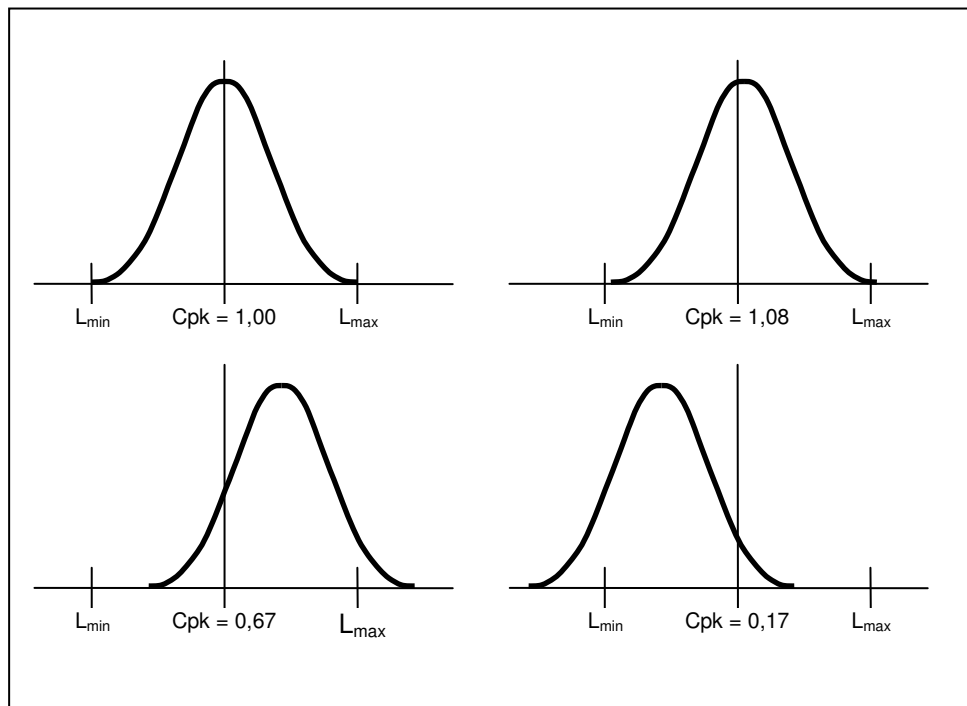
While the **Cp** is simply a measure of dispersion, the **Cpk** index is a measure of both the dispersion and the *centring*: i.e., its calculation formula takes into account both the amplitude of the distribution and its location compared to the mean point. The formula is:

$$Cpk = \min \left\{ \frac{L_{\max} - \bar{X}}{3 \cdot \sigma}, \frac{\bar{X} - L_{\min}}{3 \cdot \sigma} \right\}$$

On selecting the lesser of these two values, we discover just how reliable our process is with regard to the worst part of the distribution (that closest to the specifications limits).

- The highest **Cpk** value is the best: a **Cpk** value greater than 1 means that the 6 σ ($\pm 3 \sigma$) amplitude of the values measured falls completely within the limits of the specifications.
- A **Cpk** value of 1 means that one edge of the 6 σ amplitude falls on the specifications limit.
- A **Cpk** value between 0 and 1 means that part of the 6 σ amplitude falls outside the fixed limits.
- A negative **Cpk** value indicates that the mean of the values is not within the specifications limits.

The following diagrams show the distribution patterns for the four different types of **Cpk** value.



A small **Cpk** value means that the process is not centred on the mean point of the specifications, deviates from the specifications or both cases.

The **Cpk** index does not tell us if the process is above or below the set mean point; to find out, we just need to look at the mean of the values and compare this to the set mean value.

Many users require a **Cpk** index of 1.33 for their power tools.

An index of 1.33 means that the difference between the mean value and the specifications limit is 4σ (given that $1.33 = 4/3$). With a **Cpk** index of 1.33, 99.994% of the values measured will fall within the specification limits.

Obviously, it is important to determine the acceptable **Cpk** in order to qualify the power tools appropriately and to determine their effective level of reliability. However, the cost of this should not outweigh the benefits.

NOTE

From the formulae given above, we can see that the **Cmk** index cannot be higher than the **Cm** value: if the mean is exactly centred on the mean point in the specifications, **Cpk** = **Cp**.

The **Cp** value, therefore, indicates how much better the **Cpk** value will be if the mean of the values measured is closer to the required mean value.

It also tells us whether the required limits can be satisfied as entities of the tolerance.

The **Cpk** value tells us if this is actually the case.

APPENDIX B: BATTERY RECHARGER

USING THE FEEDER-BATTERY RECHARGER

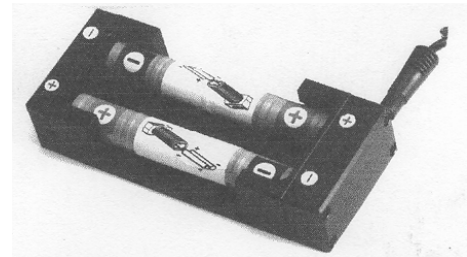
The battery recharger is specifically designed for accumulator batteries. All Nickel-Cadmium and Nickel-Metal- Hydride batteries can be recharged. The number of cells needed ranges from 4 to 10 elements, while capacity range is 500 - 3000 mAh. The "memory effect" can be eliminated using the battery-discharge function (using the "Press" button).

Fast battery changeover system: simply turn the closing screw by half a turn: from the red dot (closed) to the green one (open).



There's even a special safety device that prevents the operator from inserting the batteries the wrong way round (respecting their polarity).

It's possible to get a second set of batteries with relevant seat for recharging and so work with the tool, while recharging a second battery set at the same time.



DISCHARGING/RECHARGING CYCLE

- Connection to AC mains
 - red LED flashes once
- Connection to battery
 - red LED briefly flashes (battery and connections test)
 - or
 - red LED flashes continuously
 - wrong battery polarity; invert polarity and reconnect to the battery;
 - red LED flashes briefly
 - wrong number of elements (4 - 10)

- Press button
 - red LED flashes (discharging)
 - red LED stays on without flashing (recharging)
 - red LED goes off; green LED comes on (final recharging or standby)

RECHARGING CYCLE WITHOUT DISCHARGING

- As above without pressing the button

SIGNALS

red LED flashes - battery recognition (Test)
- wrong element number
- wrong battery polarity
- after activation using button, indicates battery being discharged

red LED steady - recharging in progress

green LED steady - standby

Warning

Only NiCd or NiMH batteries can be used.
NEVER USE NON-RECHARGEABLE BATTERIES (alkaline batteries, carbon-zinc batteries, etc.)
RISK OF EXPLOSION!

APPENDIX C: REMOTE PROGRAMS

The BLM LABwrench-GYRO can exchange data via RS232 with other programs that run on a remote PC.

Curves

BLM "Curves" for Windows allows to manage the saved curves, sent to PC.

The features of this software are:

- management of an unlimited number of curves
- search options (by code or archive date)
- direct viewing on monitor
- the chance to view graphs and overlay these with automatic adjustment of the scales
- the chance to get print-outs on any printer supported by Windows
- saving of data in an Excel compatible format

Torque Supervisor

BLM "Torque Supervisor" for Windows is a complete quality control tests management software.

- The software transmits the test parameters to the wrench and receives the results back.
- Quality control tests are split in routes dedicated to each area or operator.
- Tree structure facilitates immediate retrieval of required information.
- Torque Supervisor processes statistics, creates and prints graphs showing trends for Process Capability, X-bar, R charts and Cp-Cpk.

It is easy to compare results of residual torque controls (Cpk) with the nutrunner (Cmk) for improved error analysis. Quality control, production and maintenance managers can keep all their tightening operations as well as the tools in use under control.