SPM - ILCO System Presentation

May 2021

The task of the SPM-ILCO (Integration Line Control Objectification) * is to objectify and control the tightening of the CLIC clamps.
It comes out in two hardware versions depending on the type of connection between the Tool and the Control Unit.
With the Bluetooth version the operator is free to handle the tool.
Compared to the wireless system, the ‘cable’ system uses an additional unit to power the tool; then the tool is without battery.
The ‘cable’ solution is mostly used when the electromagnetic environment is hostile or when the tool has to be installed in an automated station.
However so far SOFCA has installed Bluetooth systems in various automotive plants in Italy and abroad without problems.
For both versions the system performances are the same.

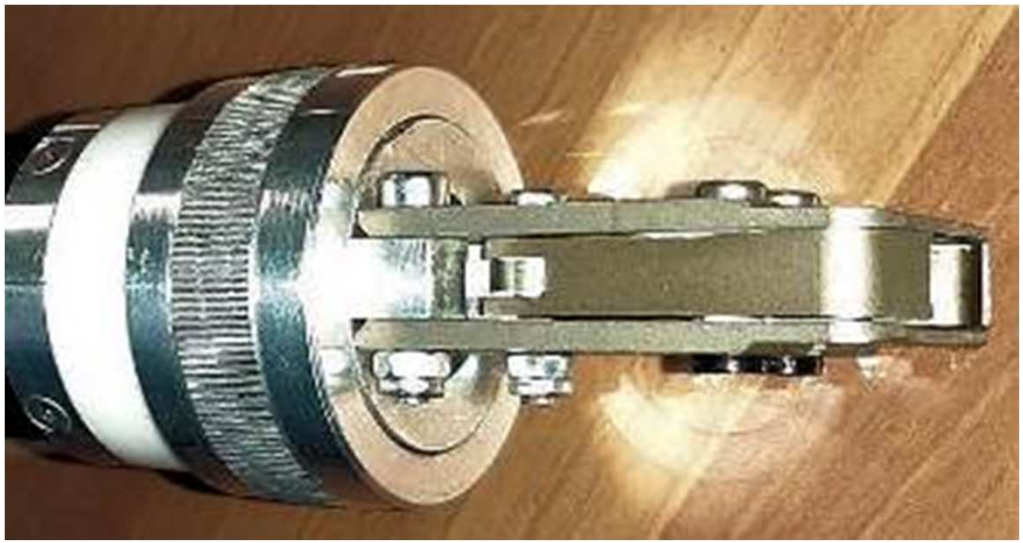
** Patent Pending*

Bluetooth:

or by cable:

ILCO Rotating head

The tool head can be manually rotated and fixed at any angle and without disassembly / reassembly operation in order to facilitate the introduction of the pliers in areas that are not easily accessible and allow the best positioning of the jaws on the clamp.



ILCO Control Unit (ICU) operating mode

Main tasks of the ICU:

- *In setting Phase*
  Associates a tightening “program” to each clamp; the “program” refers to parameters set manually by the operator or (recommended) derived automatically by the machine-learning procedure.
- *In tightening Phase*
  Processes data and decides the outcome of the tightening; detects anomalies.
- *In post tightening phase*
  Releases results in graphic form, switches on the lights on the tool, prints the results, releases data to external PLC / PC or remotely over Ethernet; reports anomalies; warns for maintenance.

ILCO Control Unit operating mode (cont'd)

The ICU can be controlled in several ways for the tightening

- Manual program selection by selecting the program to run on the ICU panel or by selecting the program on the external selector (GPBOX)
- Remote program selection by connecting directly the ICU to the PLC, PC, or company server through Ethernet
- Remote control from / to SNIFFER or PFCS systems
- Barcode input

COMMISSIONING

The procedure to put into service the ILCO system is based on the following main steps:

1. Check how the ICU operates, i.e. stand alone or connected to a PLC, PC, RS232, Profinet or remotely via Ethernet
2. Check the presence of peripheral devices , i.e. traffic light, Barcode, GP Box or other custom devices/interfaces
3. Check custom settings for Printer, Buzzer and Barcode options and other parameters, e.g. the “Max KO” parameter (max number of “failed” clamps that can be repeated for each tightening)
4. Use the machine-learning facility to set automatically the clamping programs; or, as an alternative, perform the manual setting of the clamping programs
5. Enable the Programs Linking Option to define a list of programs to be linked and run in sequence

Some of our customers carry out the start up by themselves, but we recommended that the first SPM-ILCO start-up is made by the SOFCA technical team.

Objectification concept

Objectification is a procedure that, once executed, makes a smart equipment capable of monitoring a production process.
The objectification consists of two phases: a programming phase and an execution phase, which may include the series production.
During programming an expert performs a sequence of assemblies that have to be performed properly; in this phase the equipment is set in acquisition mode with the purpose of learning what is being done.
In the next phase of execution the equipment will have to monitor the operations on the production line, verify them with respect to what it has learned previously and, in case, report any anomaly in the values of the measured parameters.

The ILCO implements the objectification with a machine-learning functionality to be carried out at the system start-up; with the built-in wizard, the operator will set programs for each tightening operation, optimizing the parameters.

Machine-learning procedure

The purpose is to set two acceptance windows, one for the tightening force and the other for the stroke of the clamp band so that the system will declare:

- pass if the two values of force and stroke are inside both windows
- fail if just one of them is outside

Too wide windows implies a lack of quality

Too narrow windows implies many items discarded.

Procedure execution

Initially the Force & Stroke windows are large.

Then clamps begin to be tightened under the supervision of an expert who declares, under his responsibility, that each subsequent clamp was correctly tightened.

After each iterative operation, the ILCO will adjust the force and stroke windows.

The more are the operations, the better is the windows definition.

In the end it is still possible to widen or narrow manually the windows, always under the responsibility of the expert.

The machine-learning procedure must be performed after:

- changing the type of clamp
- repairing a component
- pre-determined period of time or number of clamps made
- installing a new or different SPM ILCO

TIGHTENING OPERATION in production line

Before using the tool, it is necessary to set the correct parameters for each tightening operation to be performed.

The combination of these parameters can be set manually or automatically with the machine-learning facility.

First, if no external device is used, e.g.:

- remote control by PC,
- GPBox unit
- Barcode input

recall directly a program from those previously defined in the ICU and trigger the tightening with the push-button on the tool.

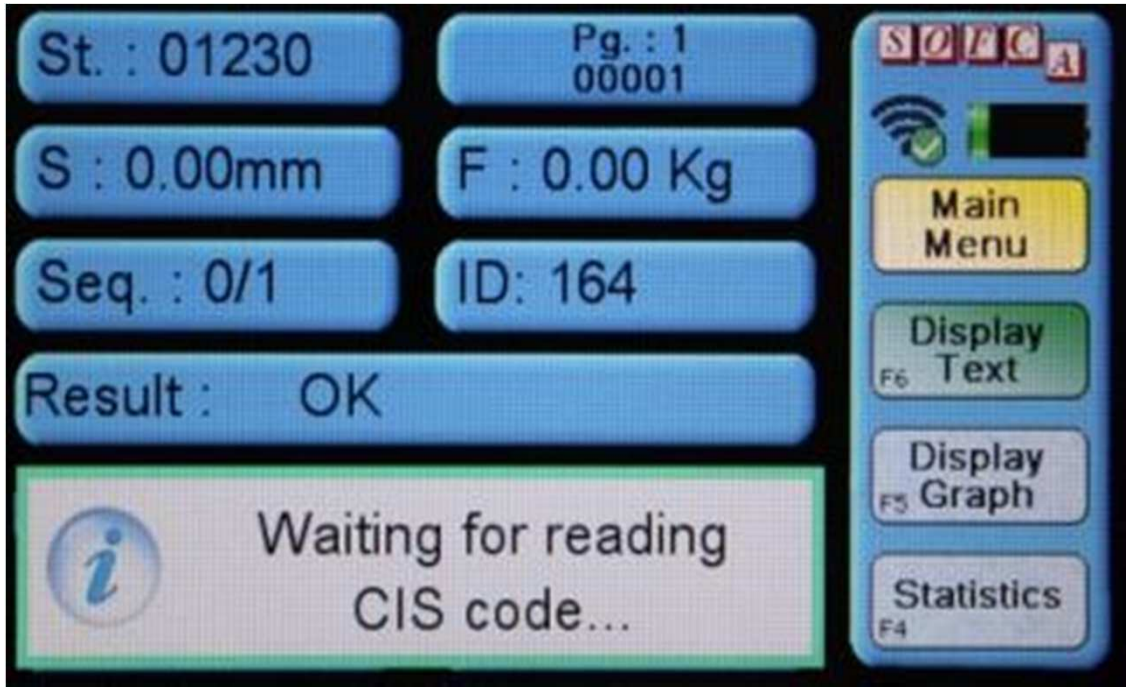
GP BOX

GP BOX option is an equipment which allows an easier selection of the programs to be performed.

It consists of an external selector for choosing the tightening program among those defined previously in the ICU. The unit has a hardware key to enable the operation.

If the GPBox is used, then, as long as no selection is made, the ICU displays the main screen with the following message:

In case the Barcode option is enabled for the automatic selection of the program, the ICU displays the following screen:



Auxiliaries

Operator bench

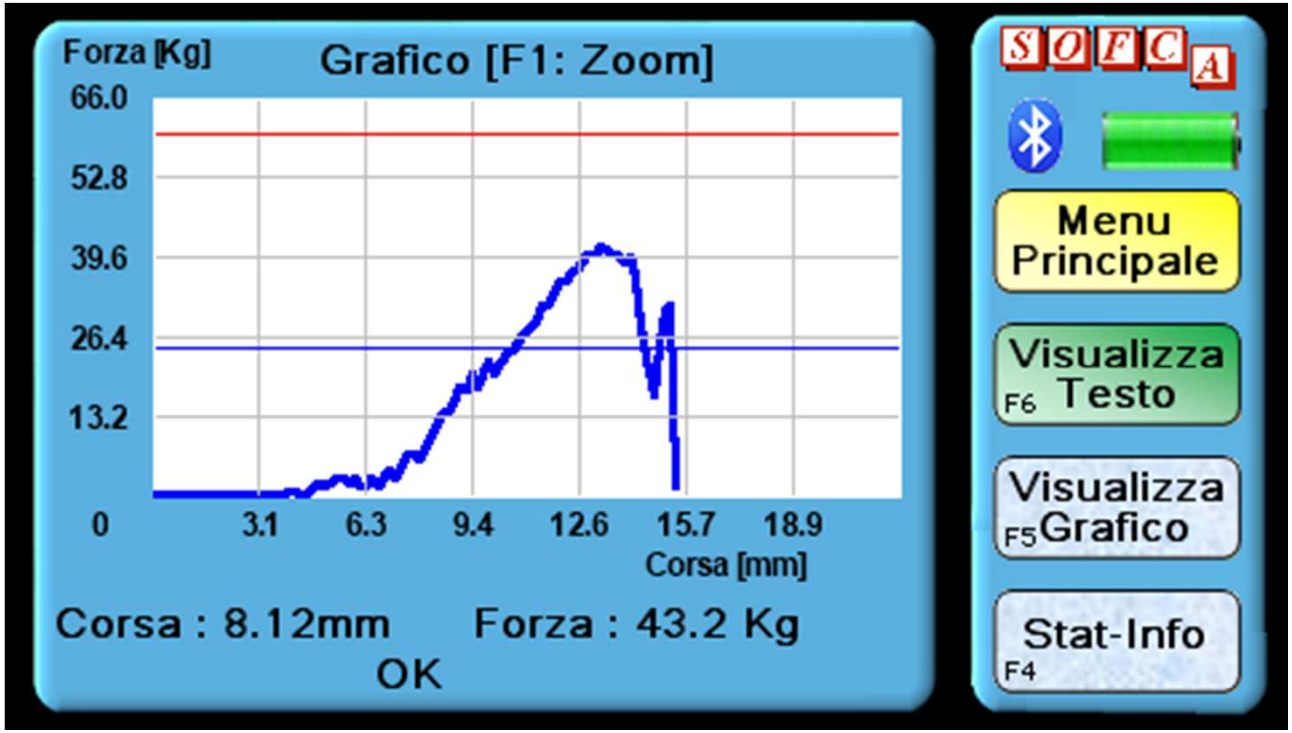
Traffic light

Support

Balancer

Tightening - Main screen

Tightening - Graph Display

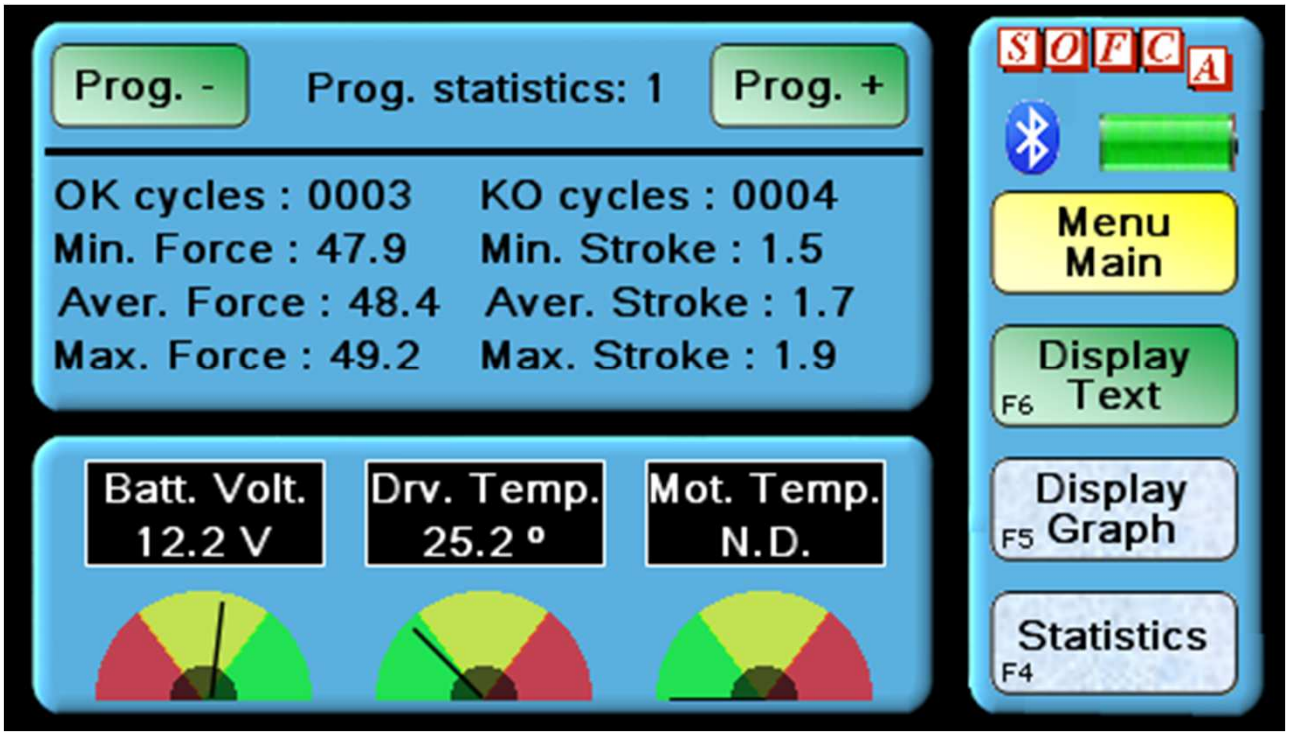


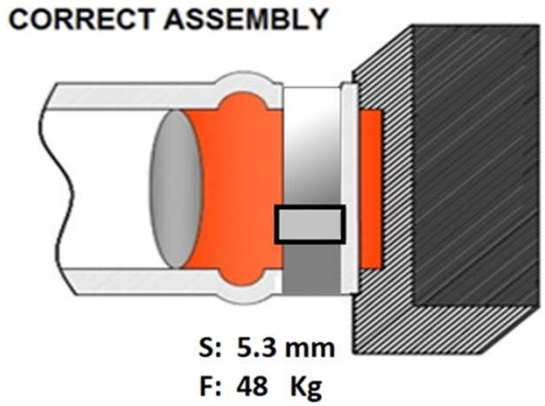
Tightening -Graph Display (cont'd)

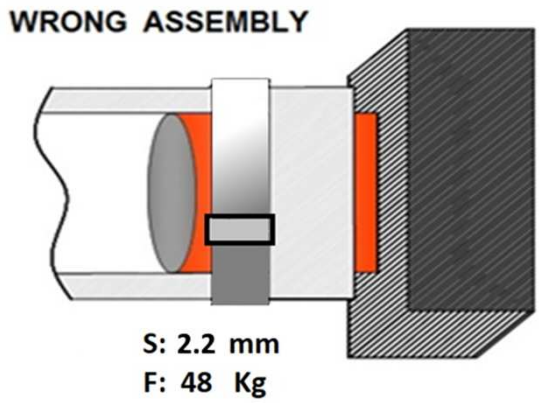
The lowest part of the screen may also be labeled with the following information:

- OK (outcome of the tightening)
- Cycle in progress
- KO for Smin, Smax, Fmin, Fmax
- Warnings: replace spring, jaws, axes
- Anomalies: Imax; resolver; motor voltage; low battery; motor high temperature; drive high temperature; etc.

Tightening - Statistics







Reporting anomalies

The SPM ILCO can give “Not Ok” for some types of incorrect tightening. Some anomaly occurrences may be due to the use of a wrong clamp or a wrong sleeve.

The picture aside shows an example of bad positioning of the clamp over the sleeve.

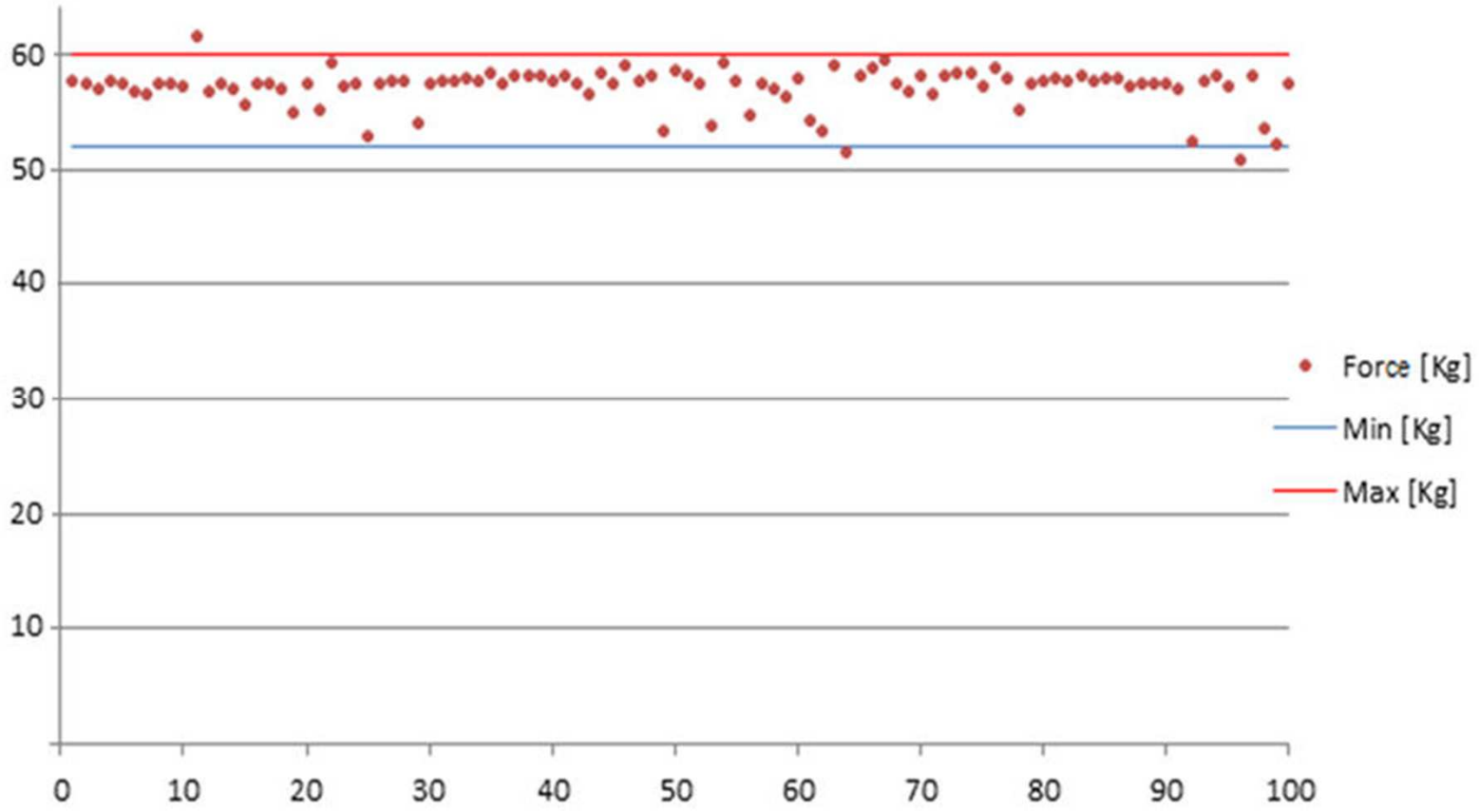
Acceptance windows

As an example, a series of tightenings were made during a certain production in line.

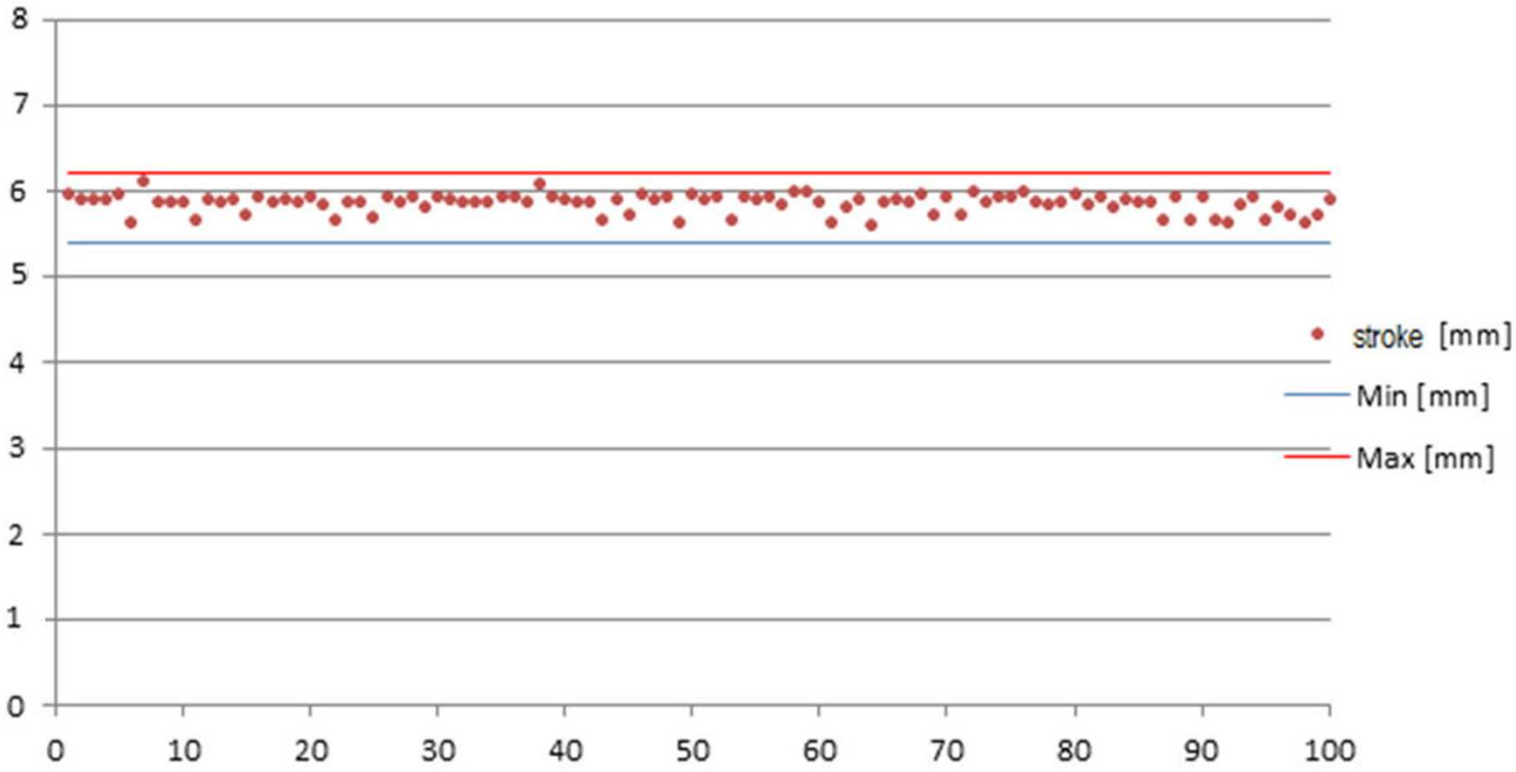
The recorded data relative to stroke and force parameters were collected and they are shown as:

- Graph of detected tightening forces versus number of operations
- Graph of detected tightening strokes versus number of operations
- Graph of a single tightening represented by force versus stroke

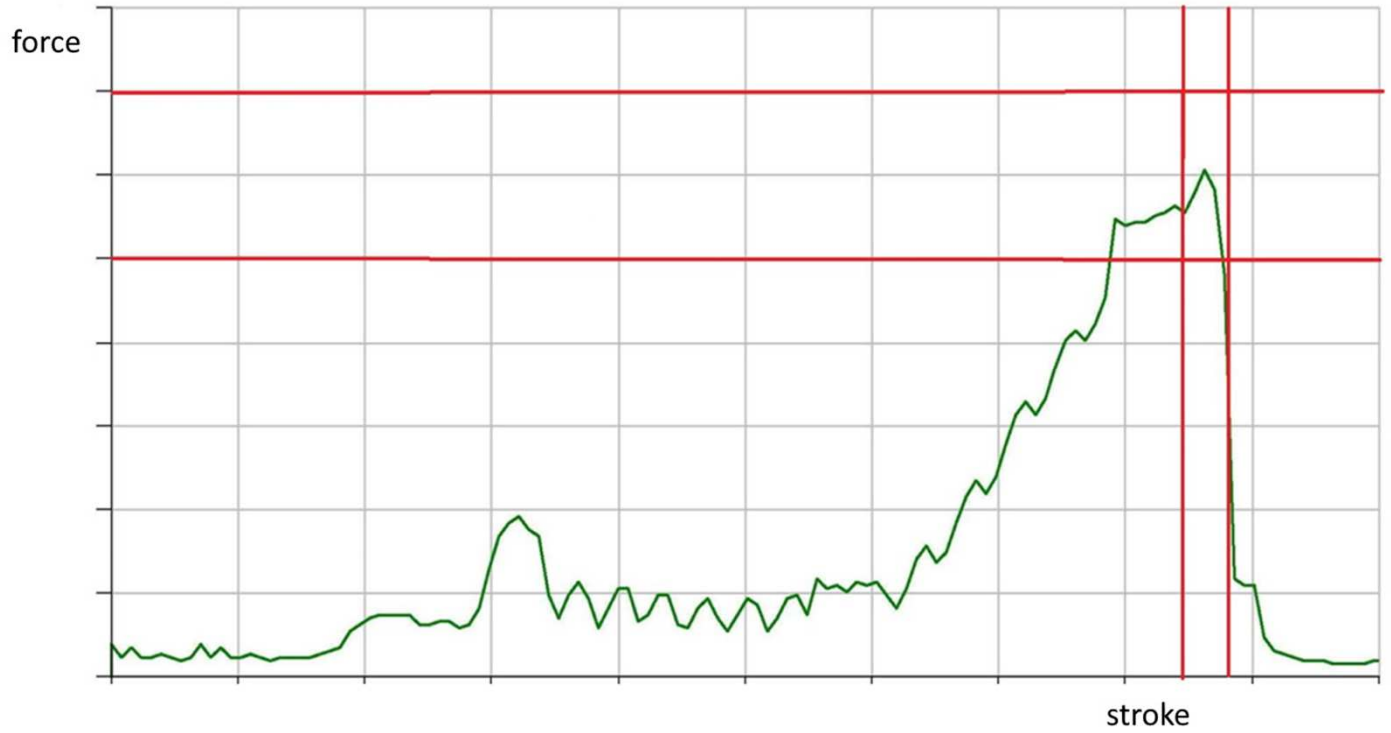
Acceptance window – Force



Acceptance window – Stroke



Acceptance window – Force vs. stroke



Quality Assurance Policy

When the ILCO system comes out of factory production, it is first functionally tested, then characterized and validated in our laboratory before being delivered to the customer.

Once assembled, the following tests are performed on each ILCO:

- Functional & characterization tests on ICU and tool
- Bluetooth tests with range and RF power measurements
- Tens of clamps tightenings
- Stress tests on ILCO mechanics for detecting early defects

Quality Assurance Policy - Validation

The characterization tests are then performed, manually and for each system, with an instrumented bench where the system performances of the ILCO are evaluated by detecting the relevant physical magnitudes operating in the tool.

Detected magnitudes

- Motor input current
- Torque at the output of the gearhead
- Force at the output of the nut screw (i.e. available force at the nose)
- Linear stroke

Test Outcomes

- Characterization of Current/Torque/Force/Stroke
- Nut/Screw efficiency as Force to Torque ratio
- Motor/Gearhead performances as Torque to Current ratio
- Stroke linearity and repeatability

After warranty support

After the installation, start up and machine-learning procedure, the SPM ILCO is ready to operate in the production line.
Since then, the aging of the mechanical components becomes important because the internal friction will lower the available output force with time.

Thus a regular periodic monitoring of the tool performance is recommended to maintain the initial quality level of the customer production line.

SOFCA can provide three-level support for extraordinary maintenance:

1. The customer returns the tool to Sofca for repairing; usually it consists in replacing the degraded component.
2. The Sofca, under a separate maintenance contract, performs the extraordinary maintenance at the customer plant
3. The customer is equipped by an instrumented bench and himself performs the extraordinary maintenance, under his responsibility, after a maintenance course.

Produced documentation

- User Manual
- Service Manual
- Quality Assurance Policy
- Test Bench Specifications
- Test Bench – Accuracy & Resolution
- Validation Test Results
- ACCREDIA Certificate: *Bench Load Cell*
- ACCREDIA Certificate*: Linear Transducer*
- CE Certification
- Company site www.sofcaproject.it