# M400

## Multi-functional display unit for measuring devices (Probes, instruments, scales, air gages…)


User's manual for firmware V1.4
Hardware V3

February 2018 edition

# 1. TABLE OF CONTENTS

## 2. FOREWORDS

**WARNING**

The information contained in this document can be changed without notice.

The manufacturer makes no warranty whatsoever with respect to the warranties of commercial quality of this product or its suitability to a particular use.

The manufacturer is not responsible for mistakes that could be found in this handbook and also for direct or indirect damage resulting from the equipment, its performances and the use of this product.

Do not use the M400 before reading the whole user's manual

Do not expose the M400 to an excessive temperature (over 35°C)

For cleaning, do not use the following products: acetone, benzene, toluene and halogens hydrocarbons.

Do not expose the M400 screen to the direct sun light. The screen life duration could be reduced.

Do not connect or disconnect an instrument or probe when the M400 is powered on.

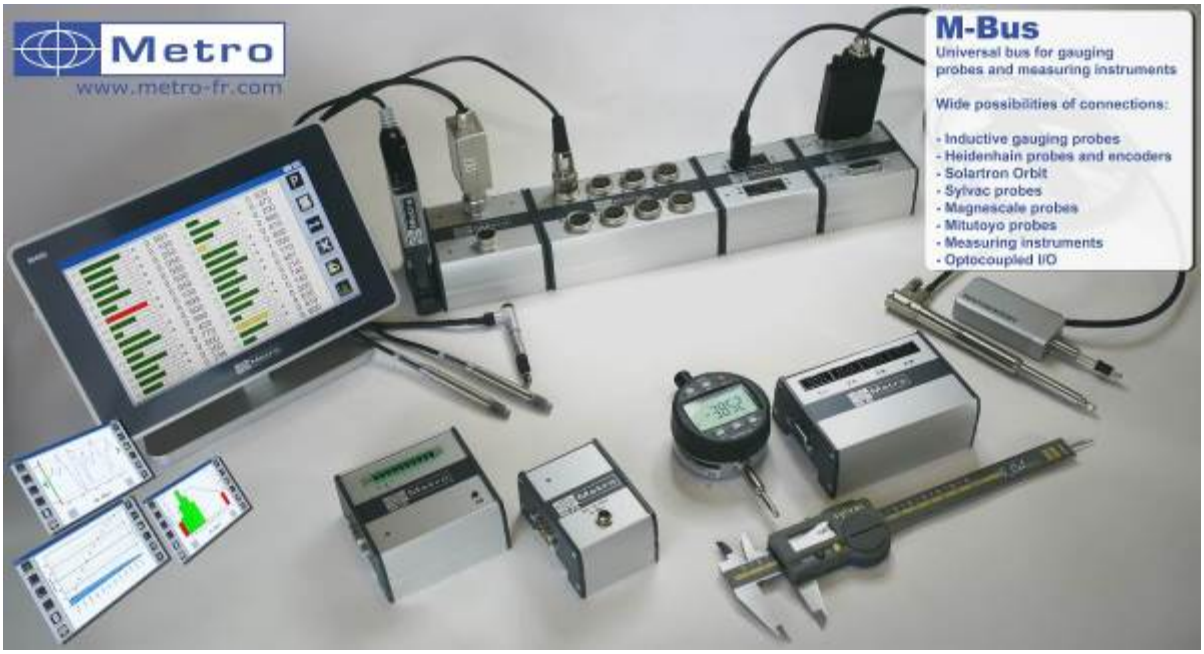
Always check the calibration and the measurement performances of the system before measuring your parts.

# 3. INTRODUCTION

## 3.1. PROBES CONNECTION

Probes and/or instruments are connected on a bus system to the M400 : **M-Bus**.
On the M400 it is possible to connect up to 99 probes or instruments.
Probes and instruments can be from different manufacturers and technologies and mixed:

- Inductive HBT (Metro, Tesa, Peter Hirt, Mahr etc…)
- Solartron Orbit 3
- Incremental probes  Heidenhain, Mitutoyo, Magnescale (ex Sony)
- Capacitive probes from Sylvac
- Incremental rotary encoders TTL Heidenhain, Baumer etc…
- Measuring instrument from any brand through digimatic interface (caliper, micrometer, digital indicator, weight scale etc.)
- Air gages
- Measuring instruments from Sylvac or Bowers with a Bluetooth connection.
- Force (piezo from Kistler) / distance (resistive)




***Connection example of the M-Bus***

Installation procedure of the M-Bus modules: please refer to the chapter 4.
« Installation of M-Bus modules »

## 3.2. CHARACTERISTICS

### 3.2.1. Mains technical characteristics

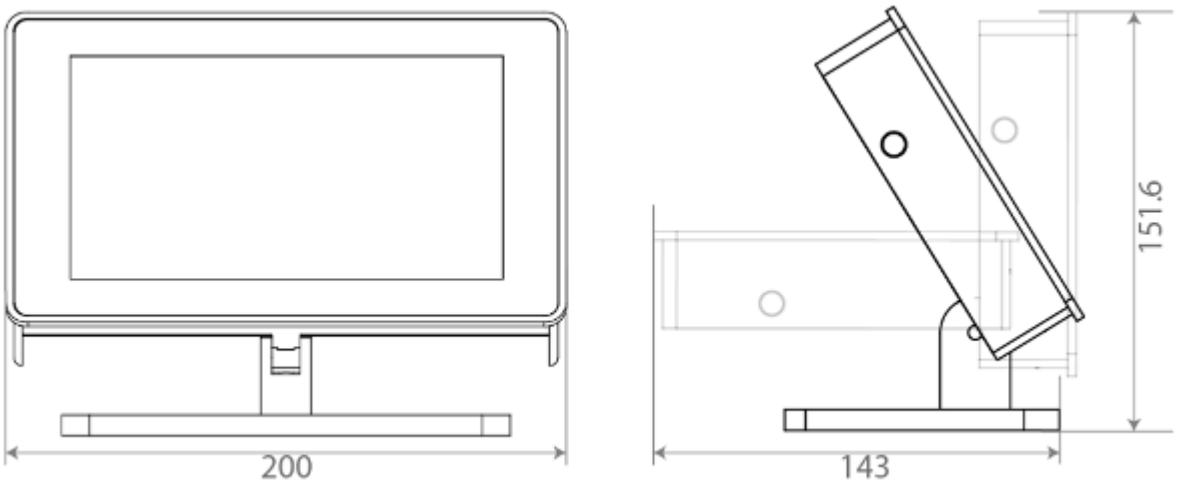
- Static and dynamic measurements (mini, maxi, maxi-mini, average, median)
- Trigonometrical measurements
- Analogical and digital display
- Manage up to 32 fixtures (fixture= pages in the M400) with possible automatic fixture detection by probe motion
- Up to 32 characteristic (32 characteristics in 1 screen or shared out in up to 32 screens)
- Up to 64 part references
- Calibration (1 or 2 points), calibration control, calibration validity
- Individual probe display
- Displays resolution up to 5 decimals
- Statistic functions (Machine and SPC)
- Measurement transfer by USB, RS232 or Ethernet
- Data storage on the internal memory (up to 30000 measurement by part reference), or on a USB stick
- PLC programming through I/O modules (up to 4 * 8 I/O) and a script language.


7'' touch screen display

On-Off switch

Adjustable stand that can be attached by 4*M5 screws. The M400 can be delivered without the stand for panel mounting.

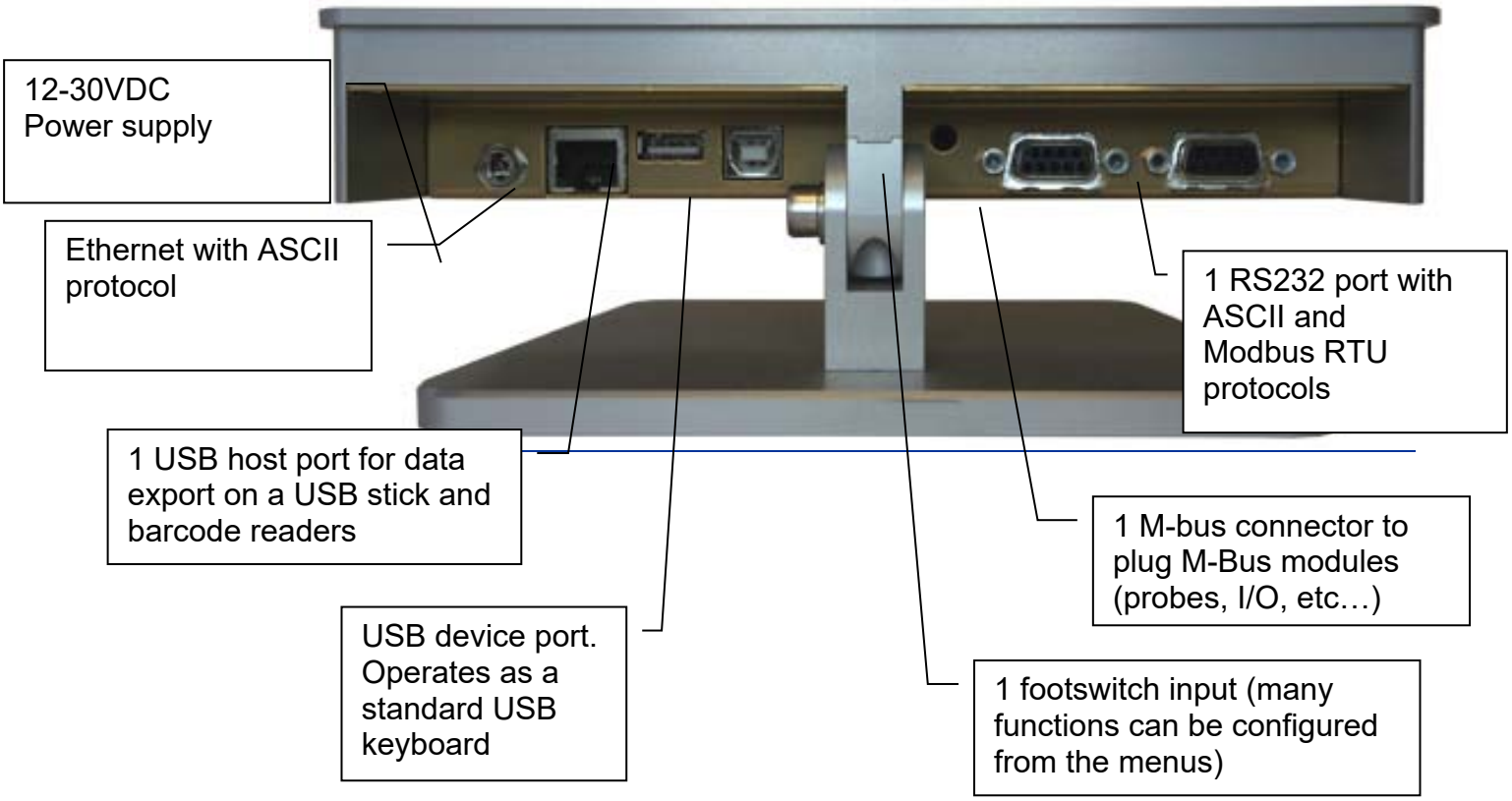
### 3.2.2. Dimensions




The stand of the M40 can be removed allowing to panel mount the device.

Rear view of the M400 – panel mounted

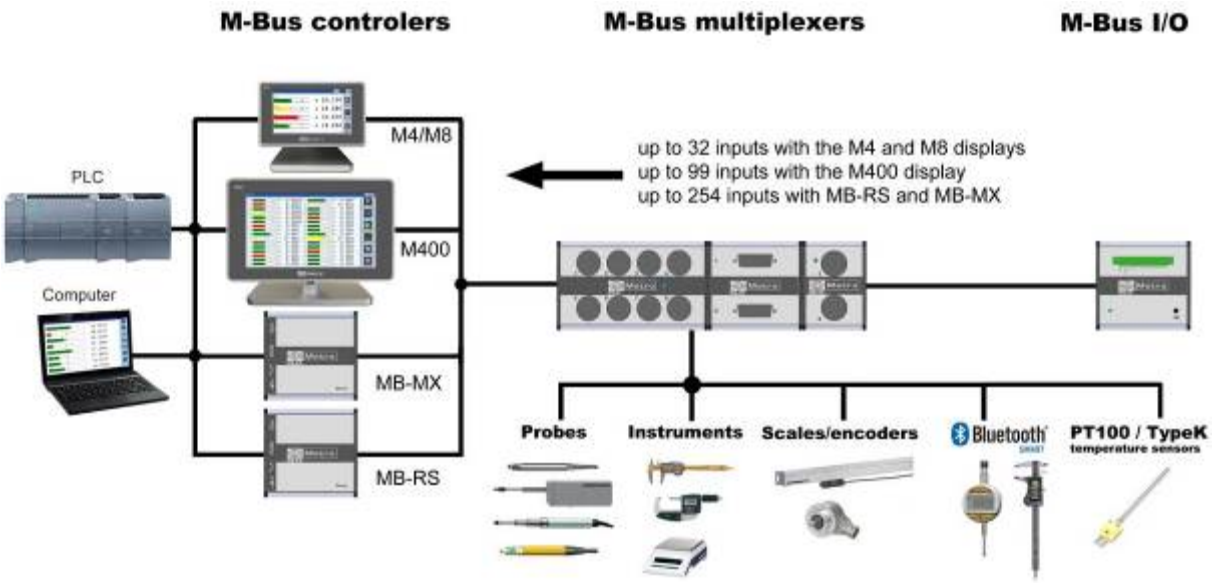
### 3.2.3. Connectivity



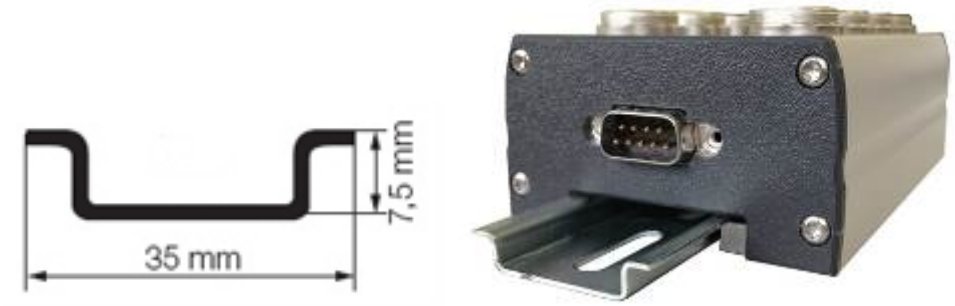

Note : Connectors are oriented to the bottom in order to limit the liquid infiltrations. In order to facilitate the cables installation, it is recommended adjusting the M400 like on the above picture.

## 4. INSTALLATION OF M-BUS MODULES

The M400 display unit is not fitted with probes inputs. It is therefore necessary to use M-Bus modules for connecting probes or instrument onto the device.




M-Bus modules must be mounted on a standard DIN Rail 7.5*35mm.




Modules can be connected directly between each other's or through the M-Bus cables (3 standard length 2, 5 or 10m)

| M-Bus cable reference | Length |
|---|---|
| 81210-2 | 2m |
| 81210-5 | 5m |
| 81210-10 | 10m |

A large range of M-Bus module is available allowing to connect:

## 4.1. List of M-Bus modules

| Reference | Description |
|---|---|
| MB-4i | Connection of 4 inductive (half bridge) probes from Metro |
| MB-4IT | Connection of 4 inductive (half bridge) probes Tesa compatible |
| MB-8i | Connection of 8 inductive (half bridge) probes from Metro |
| MB-8IT | Connection of 8 inductive (half bridge) probes Tesa compatible |
| MB-4IM | Connection of 4 inductive (VLDT) probes from Mahr (ex. P2004M or 13XX)) |
| MB-4A11 | Connection of 4 Marposs A11 probes |
| MB-8µE | Connection if 8 laser probes from Micro Epsilon ref optoNCDT 1320/1420 |
| MB-33 | Connection of 1 bench SIPµ33 |
| MB-2S | Connection of 2 Heidenhain probes with 11µA or 1Vpp output signal |
| MB-4C | Connection of 4 Sylvac capacitive probes (ex.P10, P25) |
| MB-4M | Connection of 4 Magnescale (ex Sony) probes |
| MB-2T | Connection of 2 TTL encoders |
| MB-IO | Module with 8 optocoupled I/O |
| MB-4D & 8D | Connection of 4 to 8 measuring instruments (caliper, micrometer, digital indicator, weight scale etc.) |
| MB-BT | Connection of 8 Sylvac Bluetooth instruments (calipers, indicators, micrometers, bore gage, PS16 bench) |
| MB-TP | Input for PT100/1000 sensor or type K thermocouple for temperature compensation |
| MB-AG | 1 input for air gage |
| MB-FP | 1 input for piezo sensor from Kistler, 1 input for resistive position sensor (Gefran, Novotechnick…) |
| MB-1A | 1 analogue device |
| MB-SG | 1 strain gage |

Digital probes from Solarton (Orbit 3) can be connected directly on the M-Bus without intermediate module.
New modules are regularly added; please visit our website to keep you updated: www.metro-fr.com

## 4.2. Connection principle

It is either possible to use a cable to connect the first module to the M400 (standard length 2, 5 or 10m) :

… or to use the optional rear mounting kit ref 45511 like on the above picture.

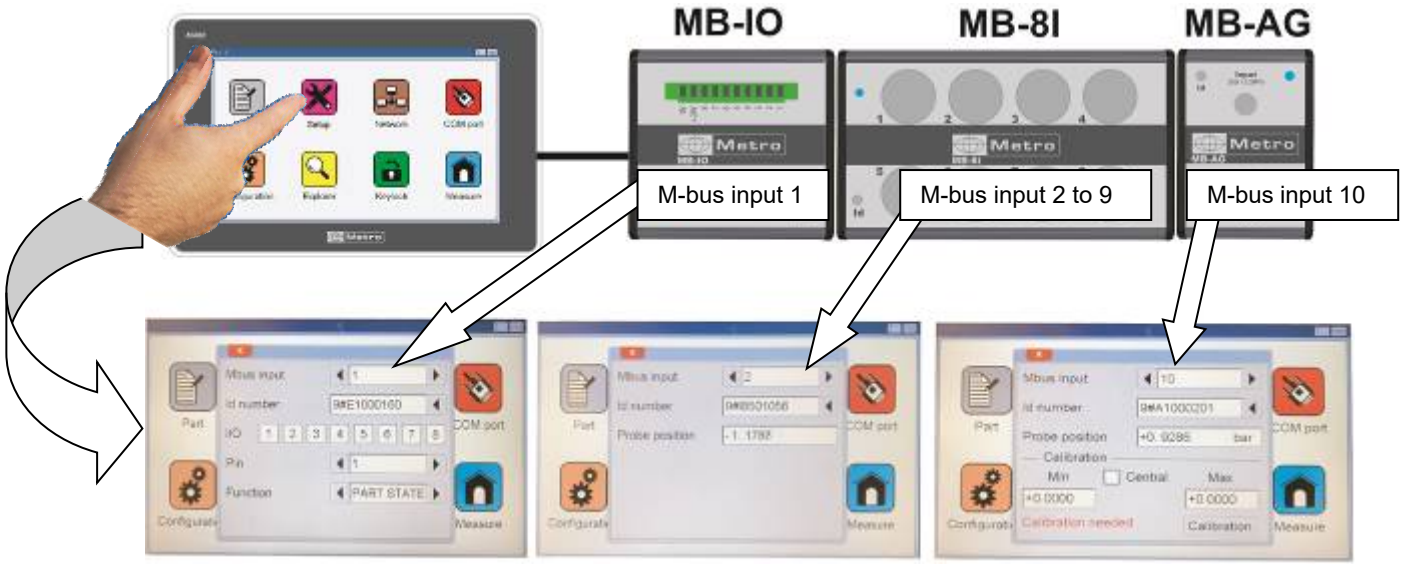
Each M-Bus module connected on the M400 has to be identified.

## 4.3. M-Bus modules - Identification procedure

IMPORTANT :

The first step when installing a new M400 is to identify the modules.
The M400 has the possibility to use 99 inputs (not 99 modules).
The input number where you identify the modules is important because you will use it on a calculation formula after.

If you use one or several (max 4) MB-IO modules, they must be identified on the input 1 to 4. Except this case, there is no restriction for the other modules.




### General Identification procedure

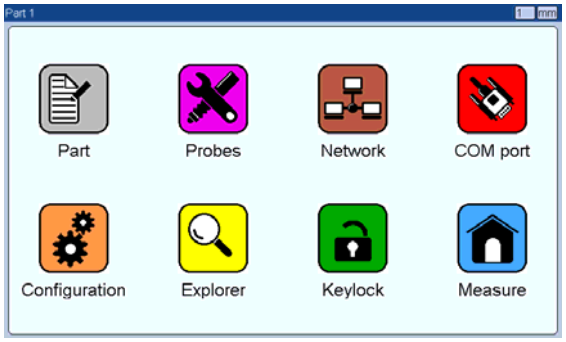
**Always connect the modules and the probes when the M400 is off**

1 – M400 off, Connect the first module to the M400 with an M-BUS Cable (see §4.1)
One probe shall be connected on the module.

2 – Start the M400

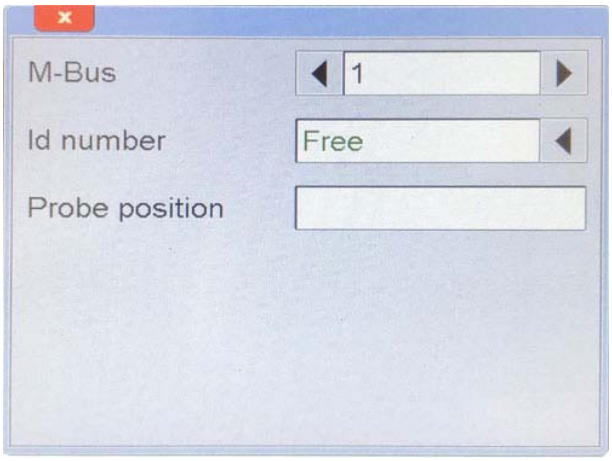
3 – The M400 starts on the measuring screen. Go the configuration screen by pressing the « Definition » key.


4 – The icon desktop appears :




Click on this button

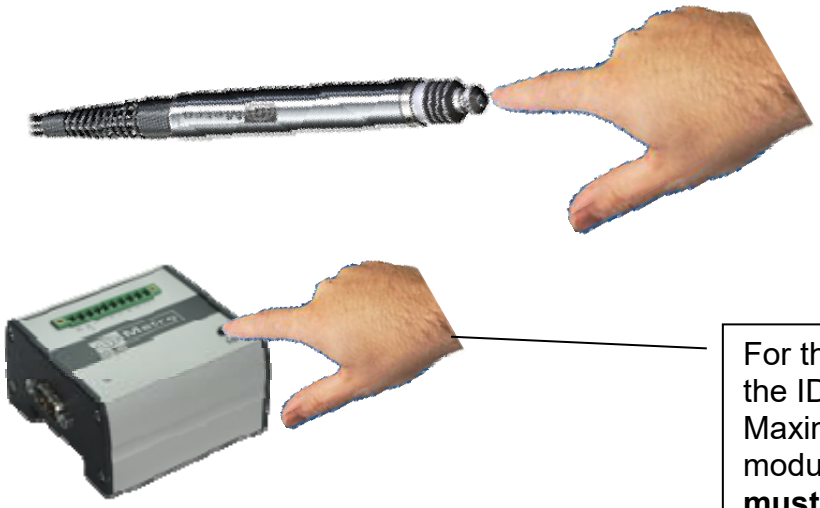
5 – This window appear, no module is identified (message “**Free**”):




You are now ready to identify the modules.
There are 2 ways to identify a M-Bus module, depending on the version and model.

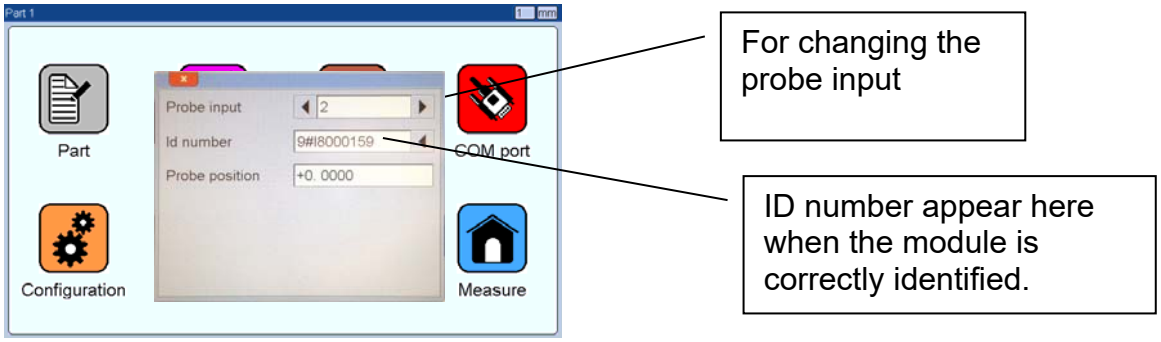
- By moving the probe or instrument #1 or
- By Pushing the “ID” button of the module.

6 – Move the probe tip that is connected on the input nr 1 of the first module.



For the MB-IO module press the ID button for identification. Maximum 4 of these I/O modules can be used **and must be placed on the first 4 positions**

7 – An ID number appears **and each channel of the module is automatically detected and identified.** For example if you identify a MB-8I (module for 8 inductive probes), you just need to select the first input and press on the ID button for identifying all the 8 channels even if not all the channel are used. It means that if you identify a module after the MB-8I it can be identified from the input #9.

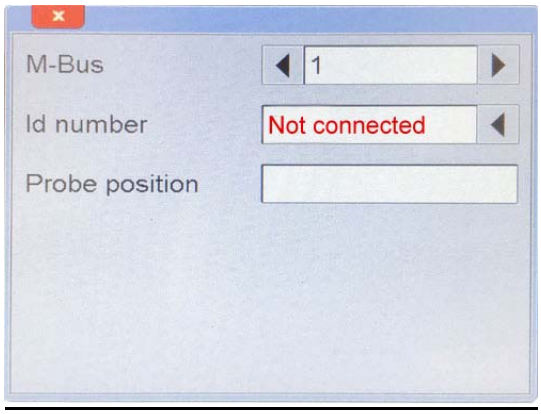



8 – To identify the next module, select the next free M-Bus input (for example the input nr 9 if the first module was a MB-8I for 8 inputs) and identify it.

9 – Each channel of this second module is now identified.

10- Probes or instruments can now be used. For using the input nr. 1 on a measurement, the formula will be C(1) on the formula editor (see §6.2)

If a module was connected, then disconnected, the message "**Not connected**" appears on the Id number area :

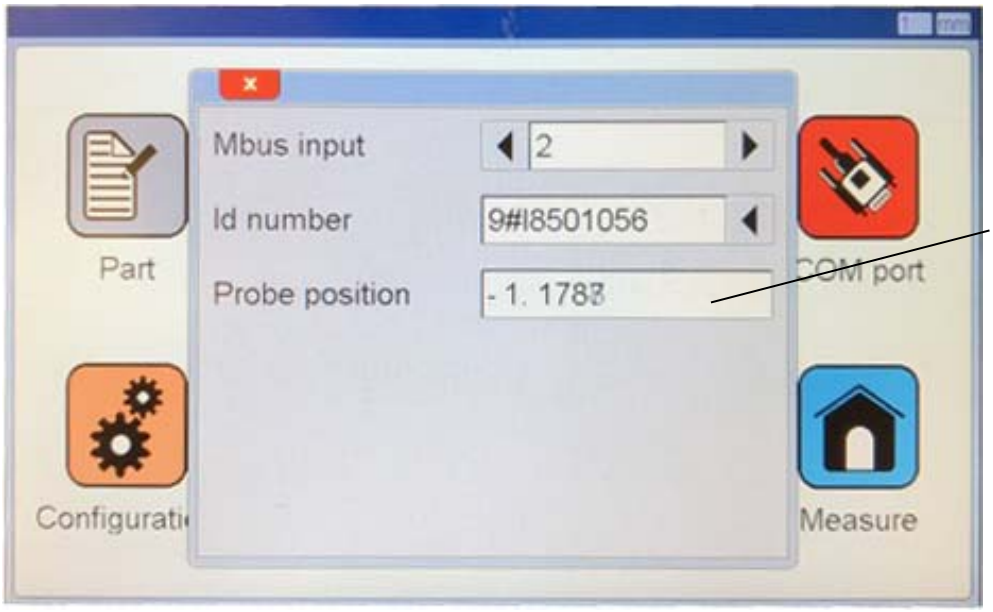


### 4.3.1. MB-4i and MB-8i for Inductive probes


This familly of modules allows to connect inductive probes. Several version are available :

| Reference | Number of inputs | Type of probes |
|---|---|---|
| MB-4i | 4 | Metro probes |
| MB-4iT | 4 | Tesa compatible probes |
| MB-4iM | 4 | Mahr/Feinprüf compatible probes |
| MB-4IMPS | 4 | Marposs LVDT probes |
| MB-4A11 | 4 | Marposs A11 probes |
| MB-8i | 8 | Metro probes |
| MB-8iT | 8 | Tesa compatible probes |

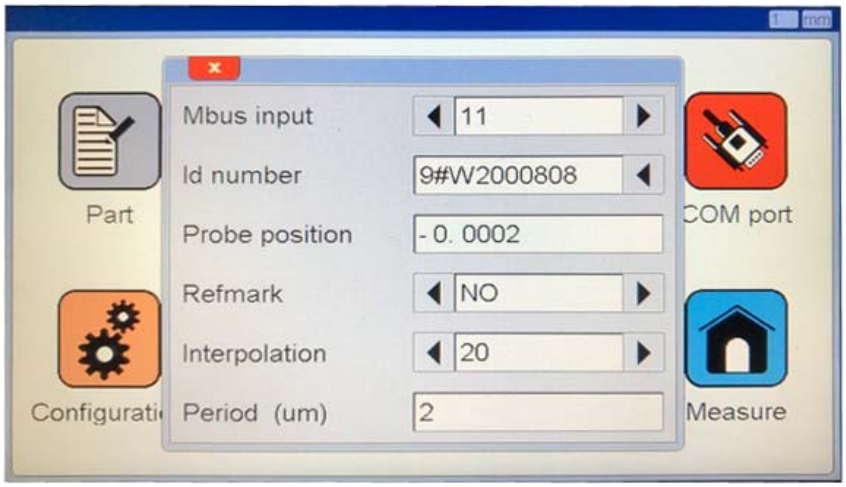
The inductive probes are not linear. They are adapted for comparative measurement.
It is interesting to adjust the probes arround the electrical zero.
The electrical position is displayed on the setup menu.
For adjusting the probe, place the master part in measuring position and adjust the probe at 0 on the display.




Metro probes can be linearized. Contact Metro for information about this subject.

### 4.3.2. MB-2S for Heidenhain probes


In the case of Heidenhain (11µA or 1Vpp) probes, 3 additional lines appear: **Ref Mark, Step and interpolation**. You have to set the correct value for having a correct measurement.




- The step defines the grating period of the probe's glass scale. The different values are defined on the following table :

| Type of probe | Step |
|---|---|
| Specto (ST) 12 or 30 | 20 µm |
| Metro (MT)12XX or 25XX | 2 µm |
| Metro (MT) 60 or 101 | 10 µm |
| Certo (CT) | 2 µm |

- The interpolation defines the division rate of the scale step, and therefore the measurement precision :

Example for a probe type Heidenhain Specto ST12 :
The glass scale of this probe is grated at 20µm, therefore if the interpolation is set at 200, you will have a precision of 20/200 = 1/10 µm.

### 4.3.3. MB-BT for Sylvac-Bluetooth instruments


The MB-BT module allows to connect 8 Bluetooth instruments from Sylvac or Bowers.
In standard conditions, you can expect to use your instruments up to 10 to 15m from the module.

To identify an instrument:
- reset the instrument by pressing simultaneously on the 2 keys until the “RESET” message appears

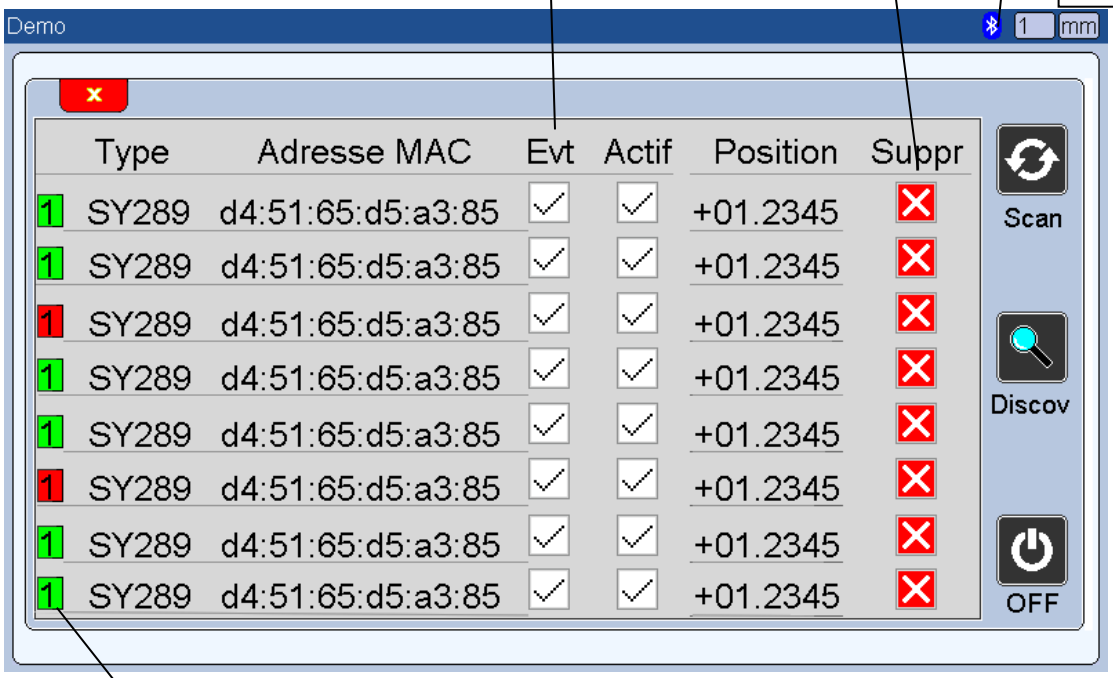
Press the 2 keys for 3 seconds to reset

Press on “discov” button on the M400.
Wait about 2 seconds and the instrument will be added on the list.

User Event: Refresh the characteristic value on the M400 only when pressing the data button of the instrument. It allows to save the instrument’s battery. If the M400 is connected on a computer, the data is also sent to the computer at the same time.

De-identify an instrument

The Bluetooth logo is blue when all the instruments are connected and operational, orange when at least 1 is not connected and red when the connection is not working




Green when connected, Red when not connected

### 4.3.4. MB-IO (8 Inputs/outputs)


The MB-IO is fitted with 8 pins that can either be configured in input or in output from this window.
After identifying a MB-IO module, the following window appear.

From this window 3 actions are possible:

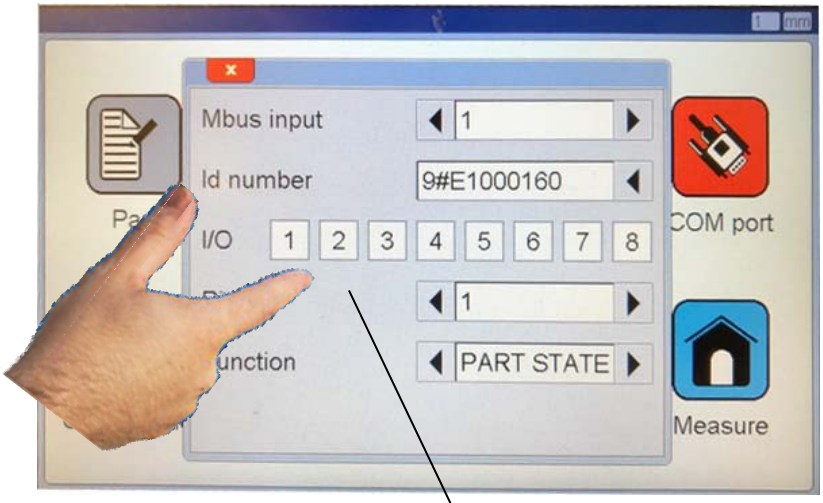
A - Test the outputs by touching the button 1 to 8 (the buttons become green when the output is activated)

B – Tests the inputs. By activating any of the 8 inputs, the corresponding button will become green.

C – Assign a function to a pin of the terminal. Select a pin from 1 to 8, and assign a function from the menu “Function”.

Note: the I/O module can also be used thanks to the script that can be edited with the M400 display manager software. Maximum 4 modules can be installed on the M400, and must be identified on the probe input number 1 to 4.

If you use an input, the requested pulse time is about 50ms. It could be shorter depending on the application. Please contact Metro for any question about this.




If you touch this button it will activate the output 1. The button will be then become green. It allows to test your wiring.

At the opposite, if you activate an input from your external system, the corresponding button will also become green.

List of the MB-IO functions :

| Text | Type | Function |
|---|---|---|
| Part state | Output | Active when the part is OK. For having this function available you must activate the function “part state = yes” from the menu “configuration”. |
| Char state | Output | Active when the characteristic is OK (you have to choose the characteristic number from the list which appeared bellow the function list) |
| Class | Output | Active when the class X is active (you have to choose the class number from the list which appeared bellow the function list) |
| Preset | Input | Preset the active page. |
| Dyn Meas. | Input | Start the dynamic measurement |
| MEM | Input | Save the displayed values on the M400 memory |
| Transfer | Input | Transfer the measurement to the selected way from the configuration menu |
| Fixture | Input | Display the next screen/page |
| OUT TOL (x) | Output | Active when the characteristic (x) is out of tolerance |
| Stop | Input | Freeze the display while the input is active |
| Part | Output | Change the active fixture/screen |
| Out of Ctrl (x) | Output | Active when the characteristic (x) is under the warning zone (control limits) |
| Clear | | Only for the char.by char. display mode. Make a Zero of the active characteristic. |

### 4.3.5. MB-AG (1 Air gage)


The MB-AG allows to connect an air gage to you M400.
Several modules can be connected together in order to connect several air gages, or multi-level air gages.

The MB-AG module requires a 2 points calibration with a MIN and a MAX master, corresponding to the tolerance limits of the part. Once the 2 points calibration is made, the M400 requires only 1 master for presetting during the measurement process.
The user has the possibility to perform a 3 masters calibration. This functionality must be used with care. But it could be useful when the measured part has a wide tolerances interval (<100µm)

Air gaging is very adapted to control parts with small tolerances, highly polished or delicate materials, small internal diameters.
Certain rules have to followed to guarantee a good measurement performance:

- Using a high stability air preparation with a precision regulator.

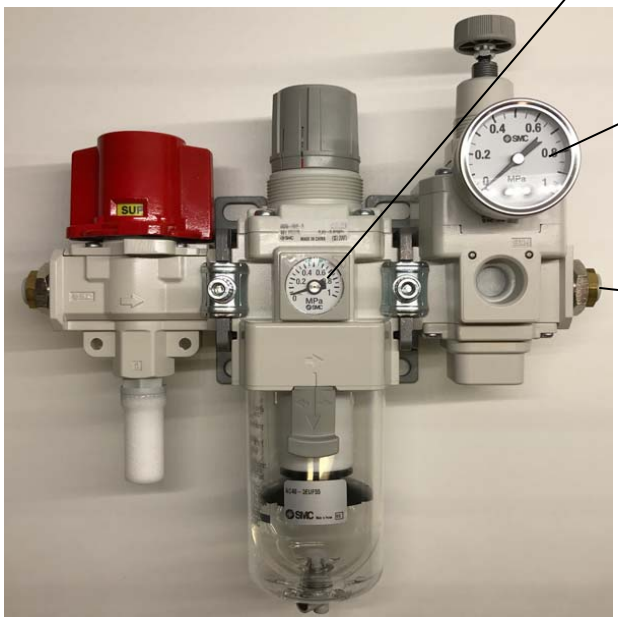
This is mandatory. **Using a standard regulator will lead to an unstable measurement**.
We recommend to use a Festo or SMC preparation:
You can purchase this item from Metro, this is the ref ACS-PNE-003


Standard regulator :
Pressure 5 BAR / 0.5 Mpa

Precision regulator :
Pressure = 3 BAR / 0.3 Mpa

Connector for 8mm ext. diameter tube

Festo




Standard regulator :
Pressure 5 BAR / 0.5 Mpa

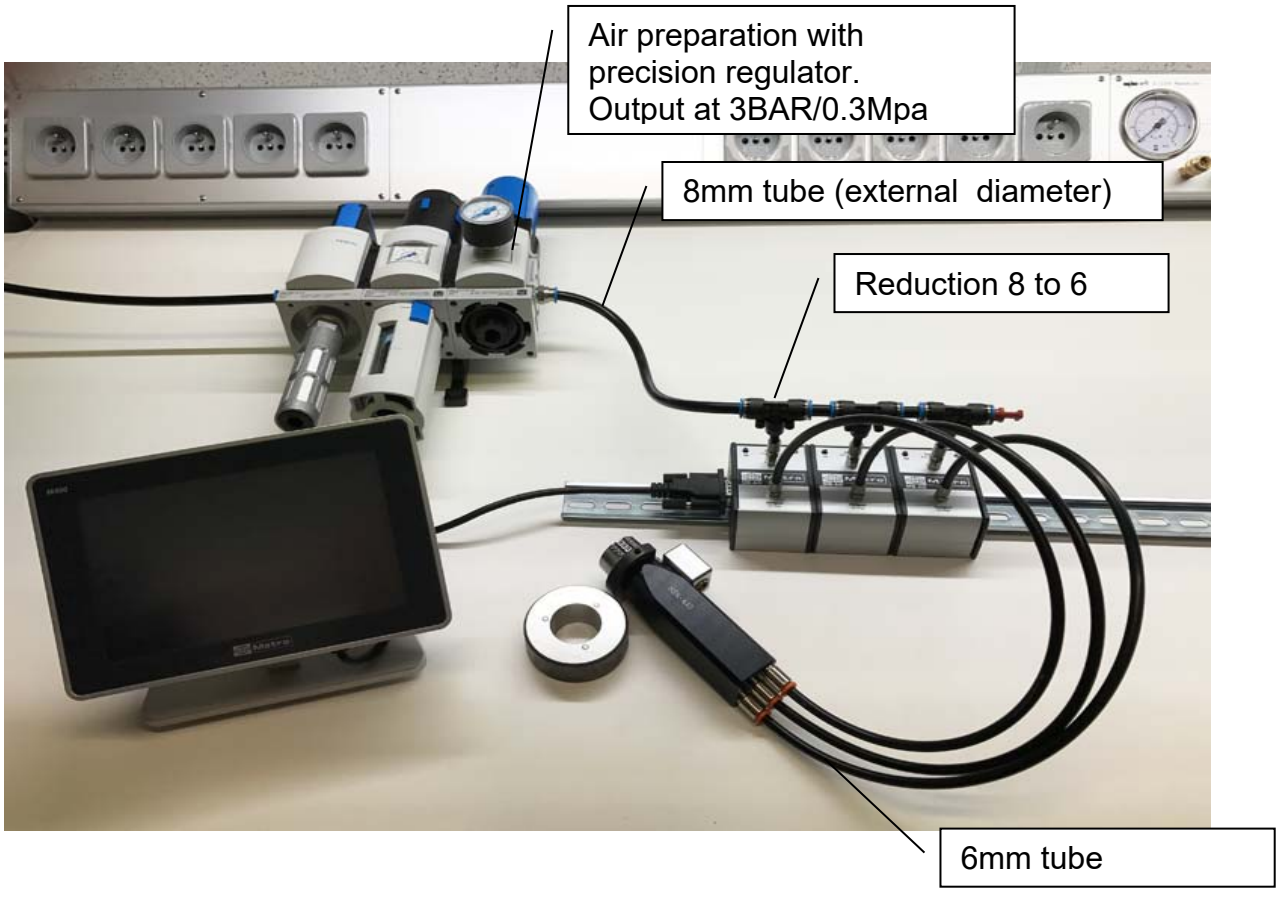
Precision regulator :
Pressure = 3 BAR / 0.3 Mpa

Connector for 8mm ext. diameter tube

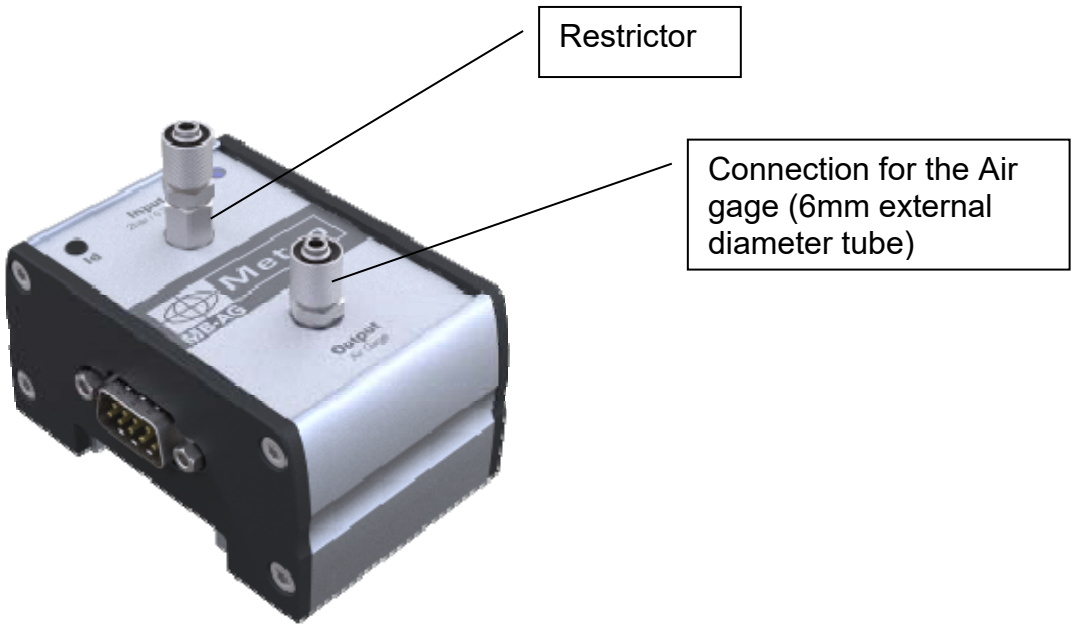
SMC

It is recommended to have a 2 BAR / 0.2Mpa pressure difference between the standard regulator and the precision regulator.
Because the MB-AG requires a 3BAR/0.3Mpa pressure, we recommend to adjust the standard regulator at 5BAR/0.5Mpa.

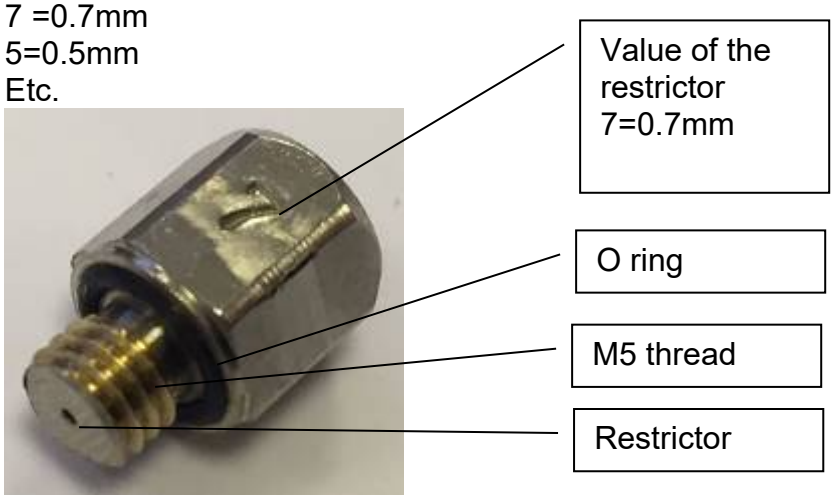
MB-AG modules are fitted with connexion facilities for 6mm ext. diameter tubes.
In order to keep a correct air flow, it is recommended to keep the main air bus with a 8mm ext. diameter, and to reduce to 6mm on the module. This point is particularly important when more than 3 modules are used simultaneously.
If the air flow is not enough each level of the air gage would have an influence on others.

- Restrictor




The MB-AG are delivered with 1 restrictors of 0.5mm on the air input + a set of restrictors as spare parts. The value of the restrictor is indicated as below :
7 =0.7mm
5=0.5mm
Etc.




**GOOD RESTRICTOR = GOOD LINEARITY = STABILITY**

The following table shows some frequent cases to define which restrictor will be the most adapted to your application.
If you order a turnkey solution at Metro, we will deliver the display with the adapted restrictor. But if you want to use the MB-AG together with your existing air gage, you will have to use the adapted restrictor.

**It is adviced to contact Metro or one of its distributors for advices or confirmation arround this subject.**
**When ordering it is adviced to give the characteristics of the air gage you will use with the MB-AG.**

| Nozzle diameter in mm | number of nozzles | total flow surface in mm² | Restrictor |
|---|---|---|---|
| 0,3 | 2 | 0,14 | 0,3 |
| 0,4 | 2 | 0,25 | 0,4 |
| 0,5 | 2 | 0,39 | 0,4 |
| 0,6 | 2 | 0,57 | 0,5 |
| 1 | 2 | 1,57 | 0,7 |
| 2,07 | 2 | 6,73 | 0,9 |
| | | | |
| 0,3 | 3 | 0,21 | 0,3 |
| 0,4 | 3 | 0,38 | 0,4 |
| 0,5 | 3 | 0,59 | 0,4 |
| 0,6 | 3 | 0,85 | 0,5 |
| 1 | 3 | 2,36 | 0,7 |
| | | | |
| 0,3 | 4 | 0,28 | 0,4 |
| 0,4 | 4 | 0,50 | 0,4 |
| 0,5 | 4 | 0,79 | 0,5 |
| 0,6 | 4 | 1,13 | 0,5 |
| 1 | 4 | 3,14 | 0,7 |

Example :

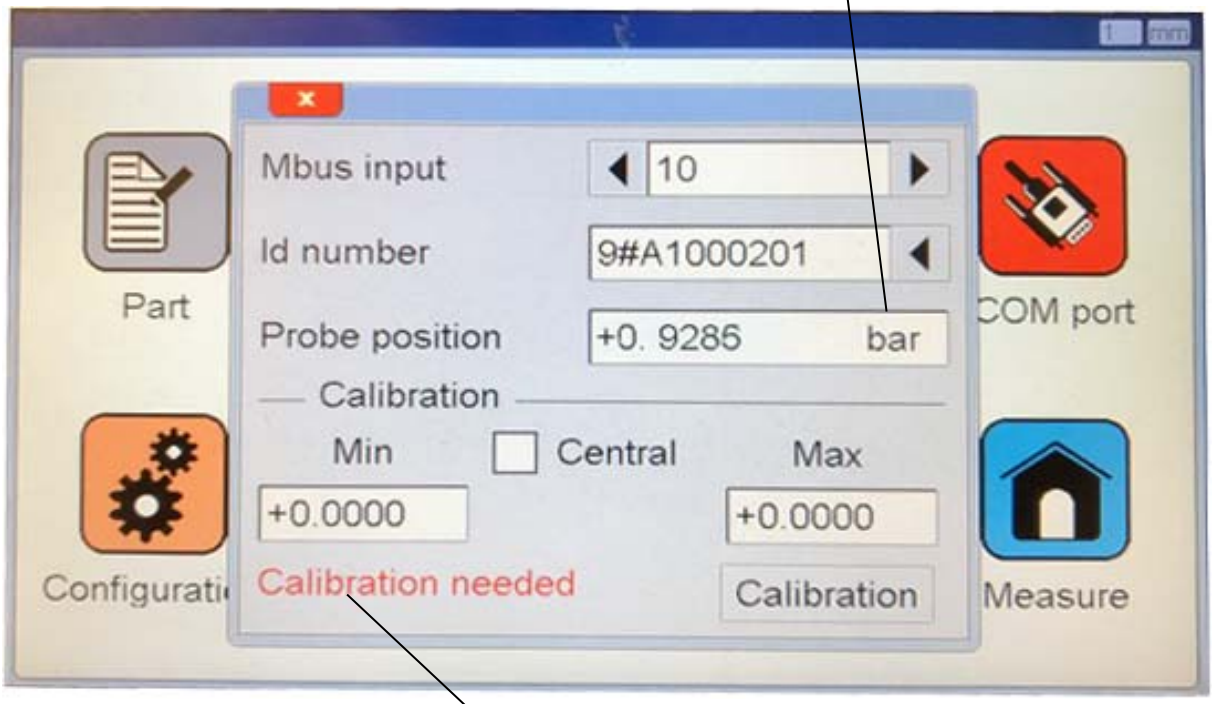

Diameter 2.07mm
2 nozzles of 2.07mm
= 0.9 Restrictor
Diameter 0.6mm
2 nozzles of 0.6mm
= 0.5 Restrictor

Identification / Calibration:

To be used, the MB-AG module has to be calibrated with 2 or 3 masters.
When the module is not identified, the LED located on the module is blue and blinking.
When it is not calibrated the LED becomes purple and fixed.
When it is calibrated the LED becomes blue and fixed.

To identify the MB-AG module, follow the standard identification procedure, and the following screen appears on the SETUP menu :

When the MB-AG is not calibrated, this field displays the pressure in BAR. After the calibration, this field will display millimeters. It is however possible to see the pressure by pressing on the « probe position » text



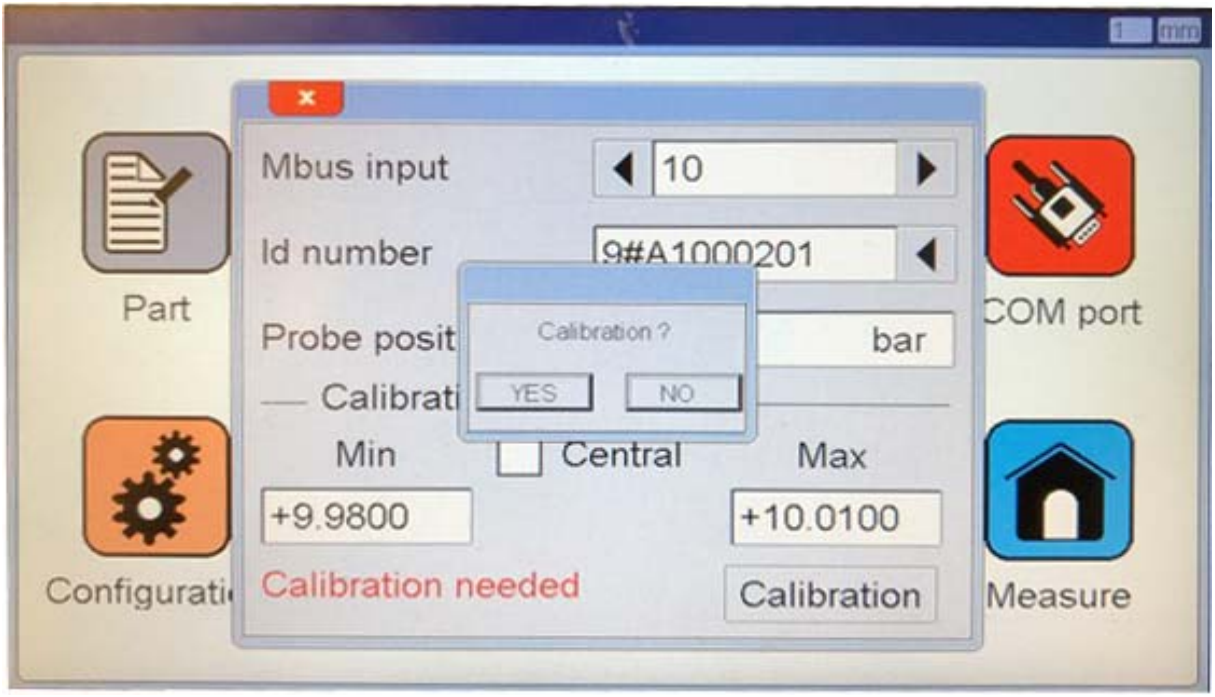

When the MB-AG is not calibrated, the indication « Calibration needed » is displayed here

Calibration procedure with 2 masters:

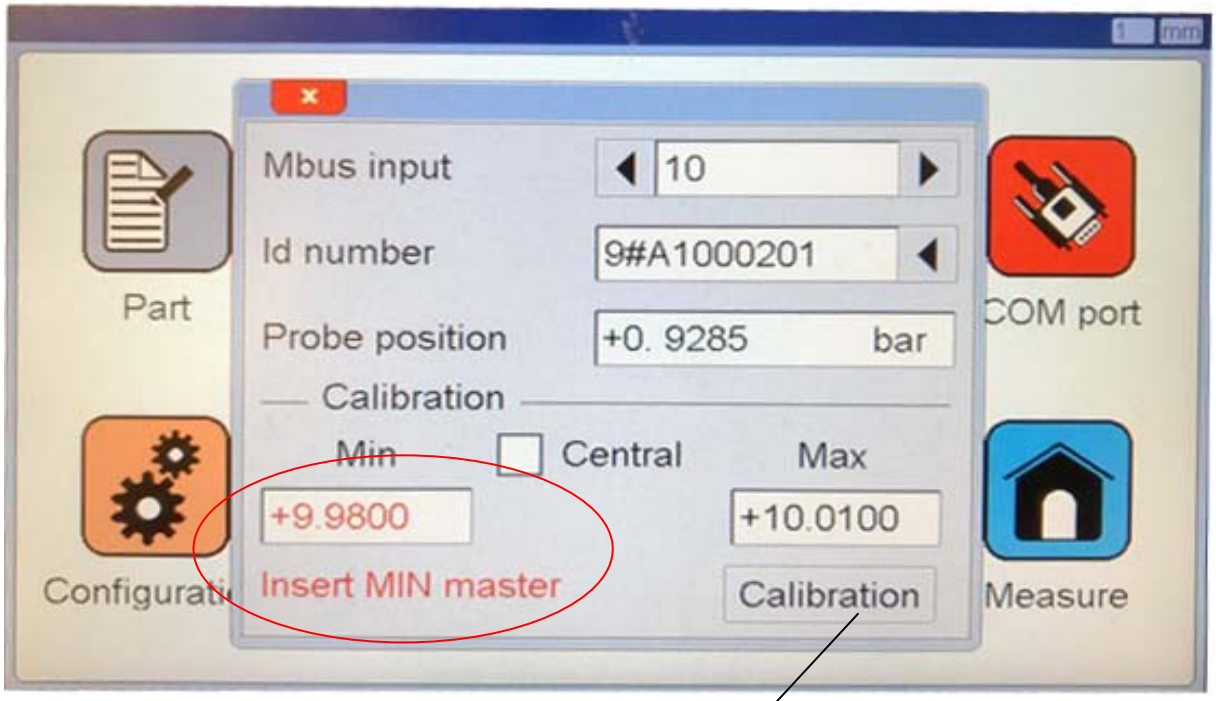
Enter the value of your masters on the “Min” and “Max” field.
The value are the real values of the master in mm.

→ Press on the corresponding field, and write the value with the keyboard, then press on Enter.

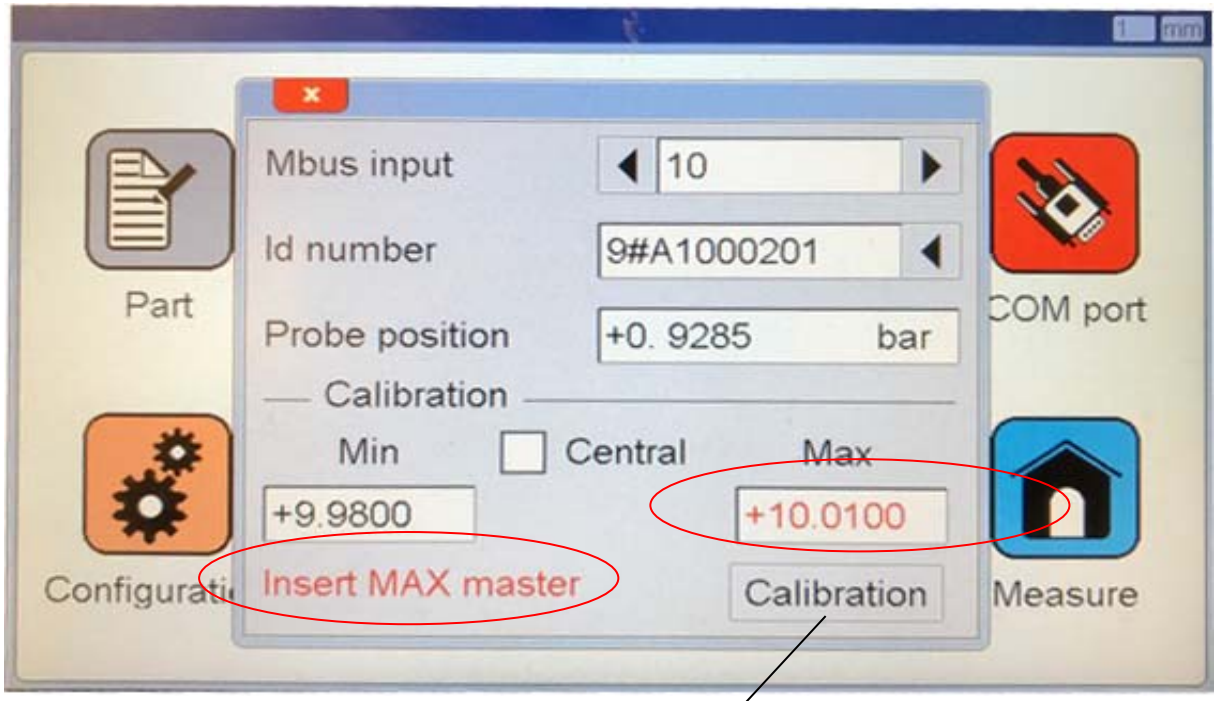
Once the MIN and MAX values are entered, press on the “Calibration” button.
When you are ready, confirm by “YES” ….




…. Then the calibration procedures starts…

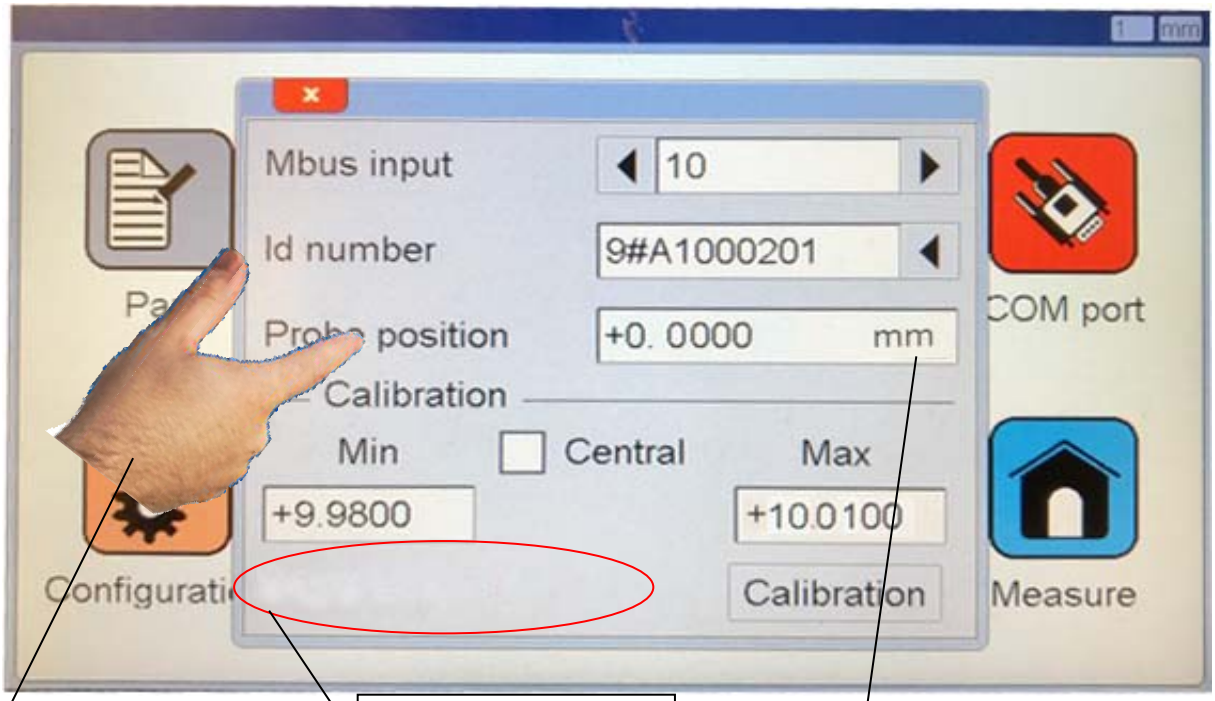



Just follow the indication. « Insert Min master » and the value of the master, here 9.9800mm.
When the min master is on the air gage, confirm by pressing on the « Calibration » button ….




Then do the same for the Max master here 10.0100mm.
When the max master is on the air gage, confirm by pressing on the « Calibration » button ….

When the module is calibrated, the screen is like the following picture, and the LED of the module becomes blue.




If no text in this area, the module is calibrated.

When the module is calibrated, the position is in millimeters.
When the MIN master is placed on the air gage, the value will be at 0.0000mm.
When the MAX master is placed on the air gage, the value will correspond to the dimensionnal difference between the 2 masters. Here 10.0100-9.9800 = 0.0300mm

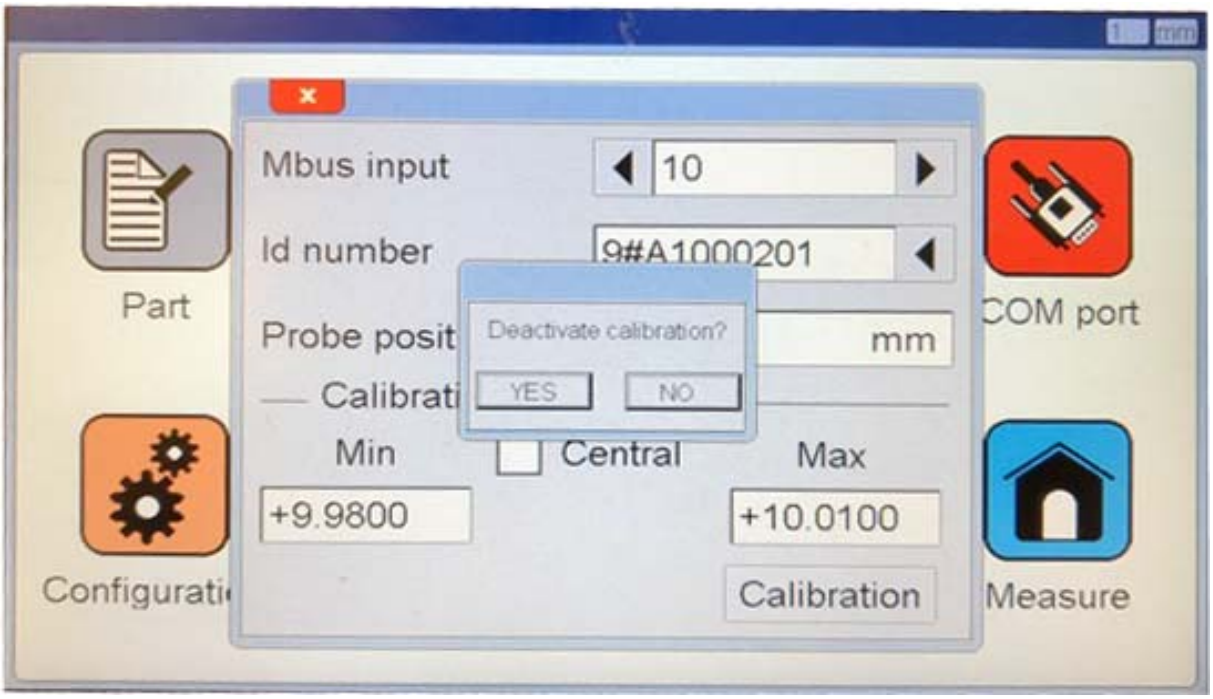
After the calibration, if you touch the « probe position » text, the unit will change to BAR and return to mm after 10s.
Generally the best linearity is achieved at arround 2.8BAR at the nominal value (=1.8BAR over the atmospherical pressure).
Changing the restrictor size will change the pressure value.

Calibration procedure with 3 masters:

Air gage is very adapted for small tolerance interval <100µm
If the air gage is of good quality, the linearity is generally good enough for a 2 points calibration.
Over 100µm of tolerance interval it could be in certain cases useful to use a 3 points calibration.

The calibration procedure is the same than for 2 masters.
Before calibrating, you just need to validate the “Central” checkbox.

If you already calibrated with 2 masters and you need to add a third master, when you will activate the “central” checkbox, a message will appear on the screen, asking you if you confirm that you will deactivate the calibration. Because after your confirmation, the complete calibration procedure will restart.




Once the calibration is done, you will need only 1 master for presseting during the measuring phase.

→ For preseting, it is recommended to use the MIN master in case of internal diameter measurement, and to use the MAX master in case of external diameter measurement.

→ The preset value has to be defined from the part→ characteristic menu.

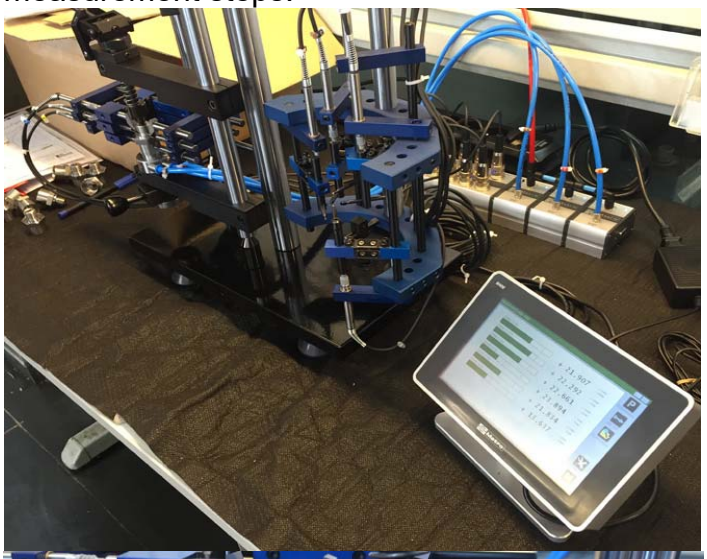
Application examples :

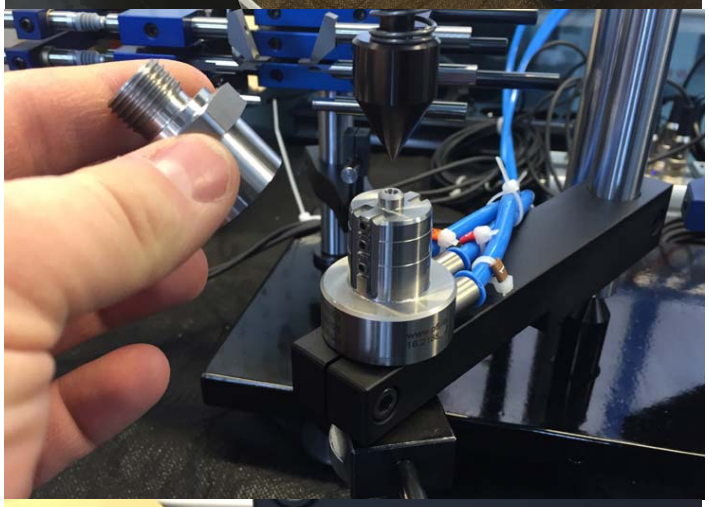
1 - M400 with 3 single level air gages :
The operator places the part of the air gage, and the corresponding screen change automatically as soon as the part is inserted on the air gage.
The footswitch is used to transfer the measurement values to Q-DAS® / qs-STAT®

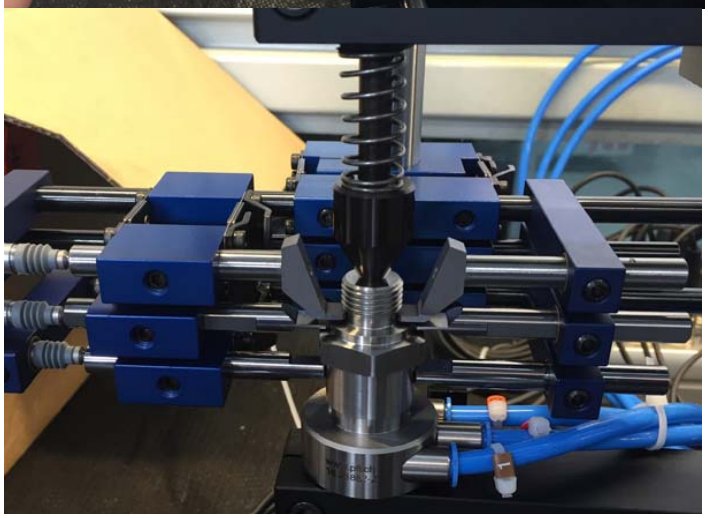

2 - M400 with a 5-levels air gage :
Here the operator measures the 5 diameters of the part in 1 time. But the preset operation is done level by level.

3 - M400 with a 3-levels air gage combined to inductive probes :

This manual multi-gauging station measures on a first step simultaneously 3 internal diameters by air gage and 3 external diameters by inductive probes. Then on a second step 4 lengths are measured. There is an auto-switch between the 2 measurement steps.



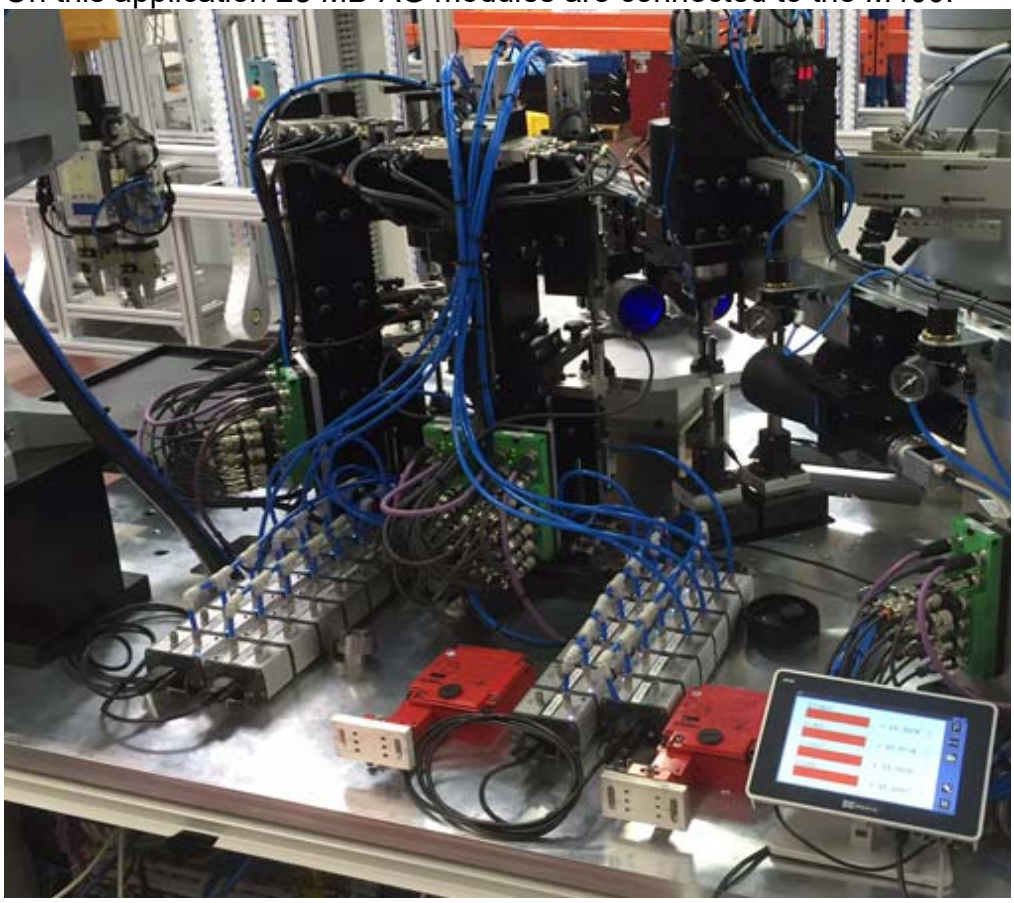




4 - M400 with 7 * 4-levels air gage on a fully automated machine :

The machine measure 7 parts on a rotative table. Each part is measured by one 4-level air gages. Total 28 diameters. The M400 communicates the measurement results with the main PLC with the Modbus RTU protocol.

On this application 28 MB-AG modules are connected to the M400.

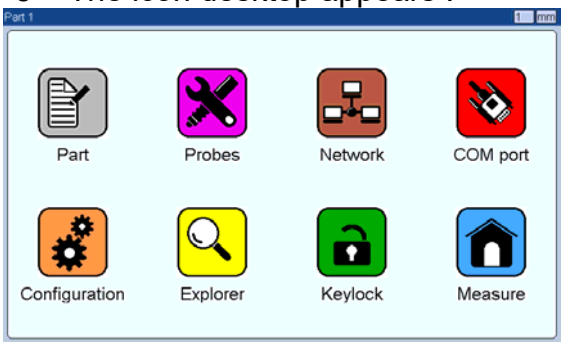


## 4.4. Procedure to change a M-Bus module

Due to the fact the each module has a unique ID number, it is necessary to de-identify a module if you need to replace it or to remove it.

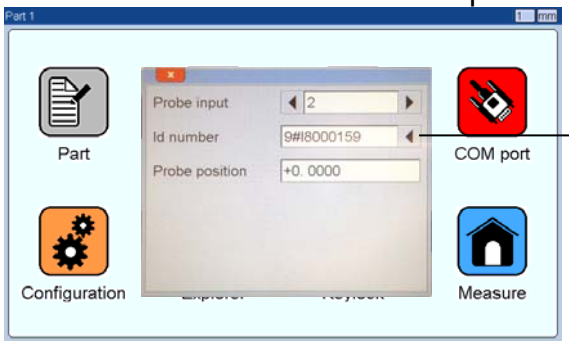
1 – Shut down the M400
2 – Remove the M-Bus module
3 – Power up the M400
4 – The M400 starts on the measuring screen. Go to the configuration screen by pressing the « Definition » key.


5 – The icon desktop appears :

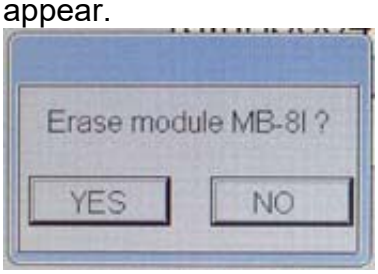



Click on this button


6 – Select any input of the module that has been removed.
7 – Press on the arrow located at the right side of the ID number. A message of the following form appear “erase MB-8I module?”. After pressing “Yes” The ID numbers of all the module’s input disappears.




Press on this arrow to de-identify the corresponding module. The, a confirmation message appear.



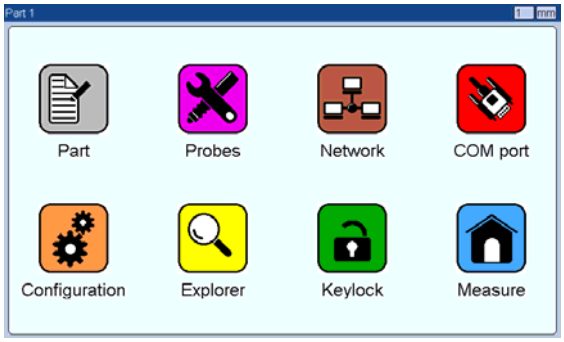
# 5. GRAPHICAL INTERFACE

This section gives you a preview of the different screens and commands available.

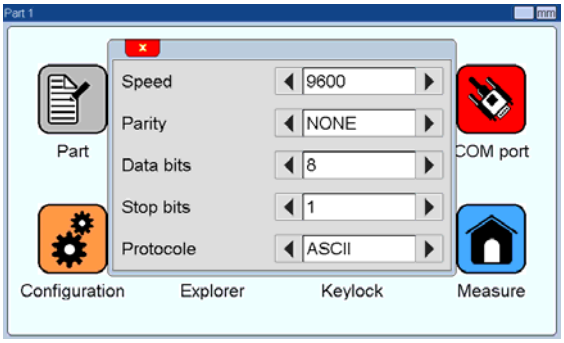
## 5.1. 2 MAIN PARTS

The graphical interface of your M400 is divided in 2 main parts:

1. A part that allows configuring the device and the measurement. It consists of an icon desktop with windows.



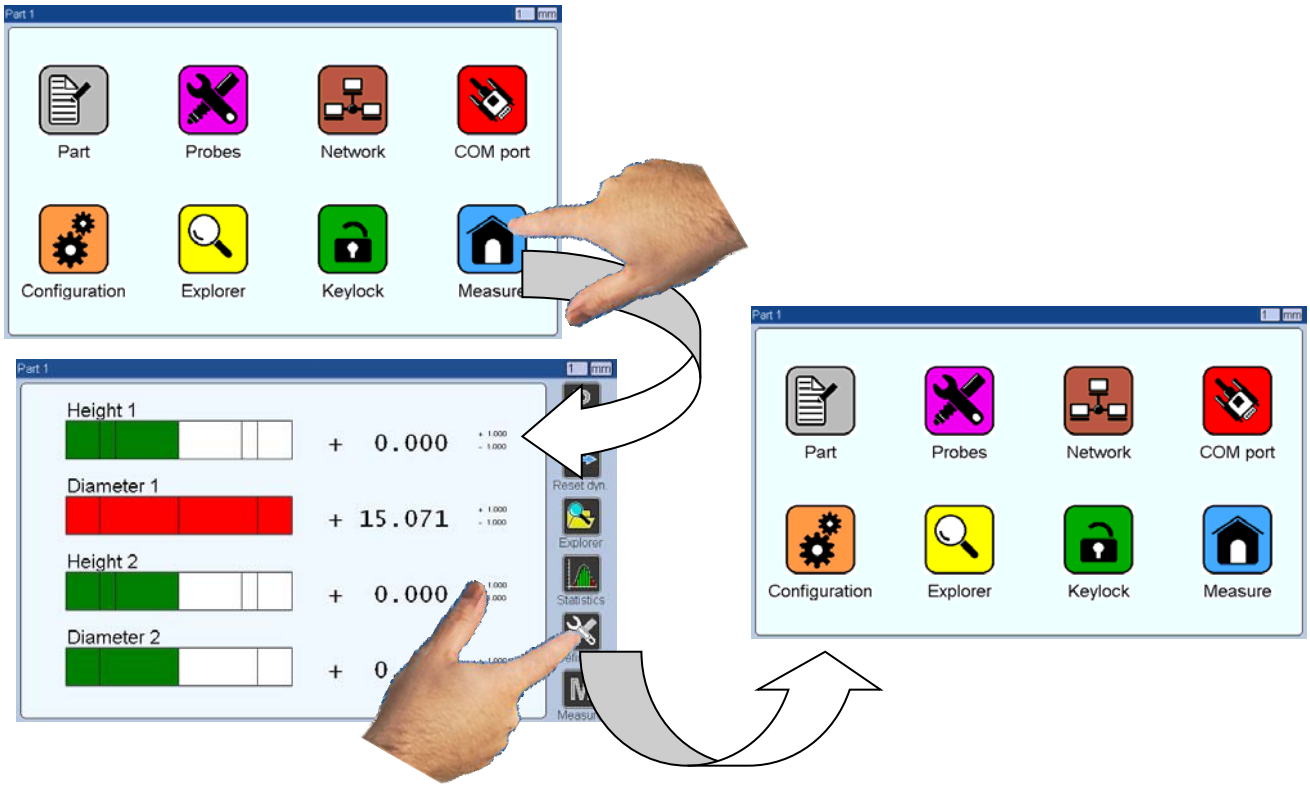

icon desktop




icon desktop with configuration windows

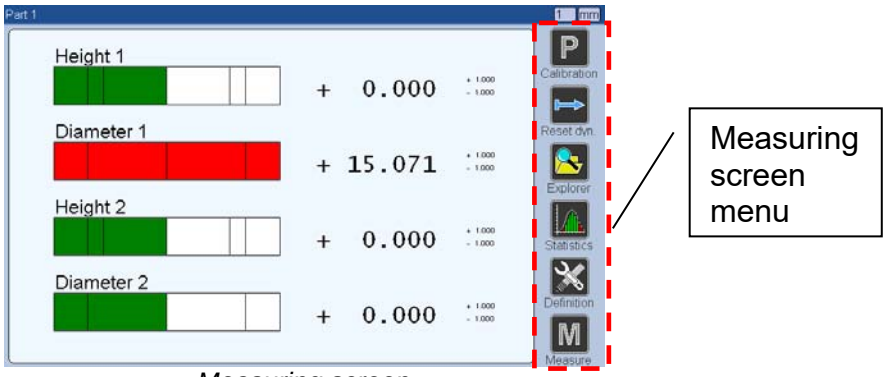
The second part (measuring screen) can be reached by pressing the 

button :



2. The measuring screen allows to see the measurement results and to use them. The M400 starts on this screen. For reaching the configuration screens, press on the 

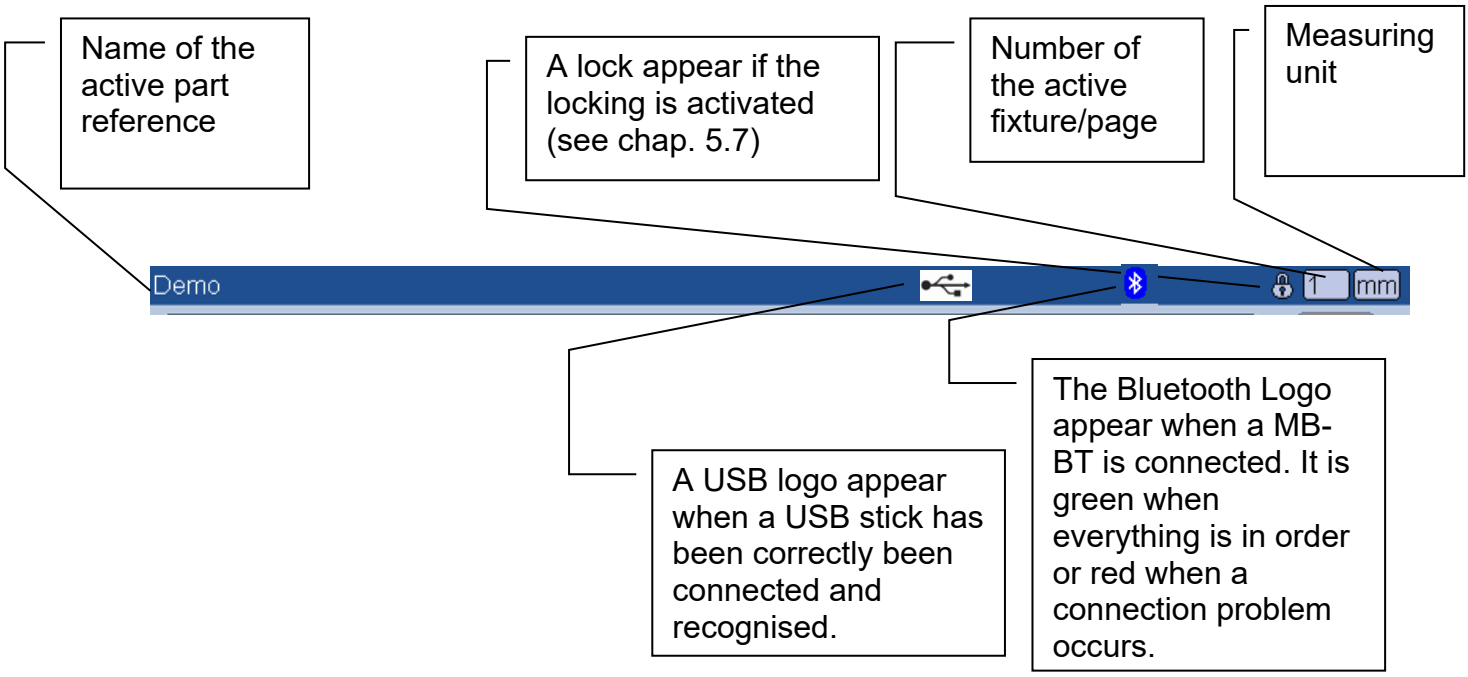
button.




*Measuring screen*

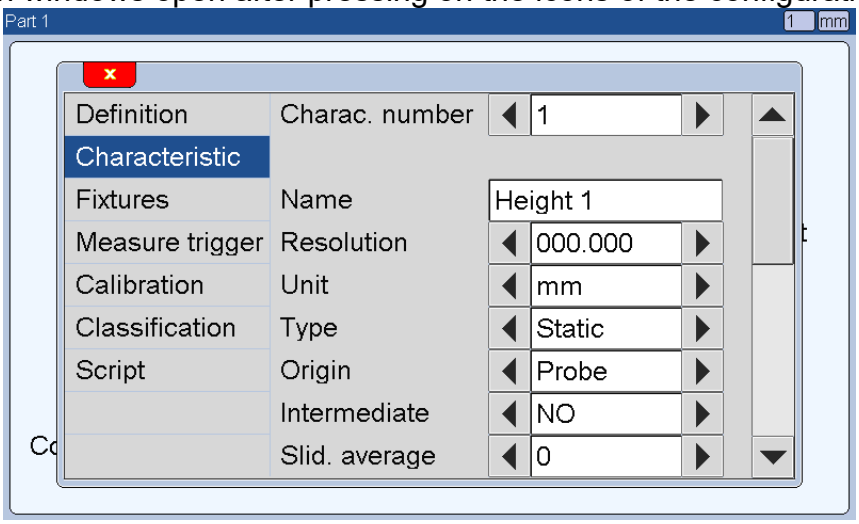
## 5.2. GENERALITIES

The following information can be seen of the upper part of the screen.




## 5.3. CONFIGURATION WINDOWS

Configuration windows open after pressing on the icons of the configuration screen.

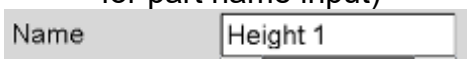



*Example of configuration windows*

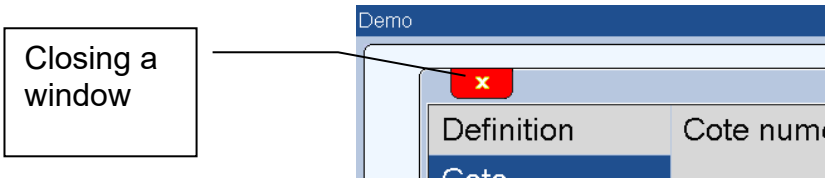
Data are typed by different ways and **are saved after validating while quitting the window by pressing on the white cross**.
Here after are the different ways to input data :

- Multiple selection box. Press on the black arrows to change the pre-defined value.

- Edit box. A virtual keyboard appears after clicking on the edit box. Several types of virtual keyboards are available and the one you need will appear. (example numerical keyboard for tolerance input or alpha-numerical keyboard for part name input)



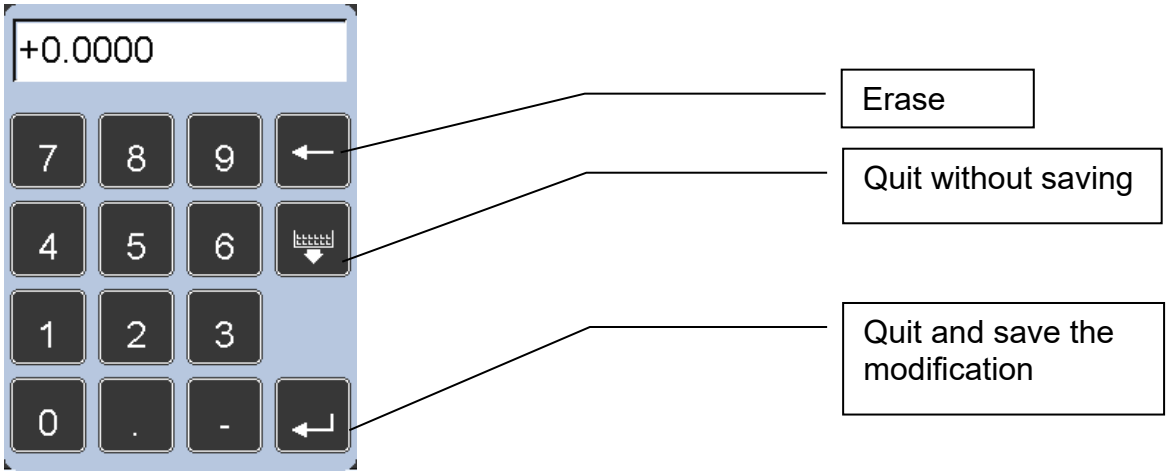

- Closing a window : All the windows can be closed by clicking on the white cross on a red backgroung on the top left corner on each window.



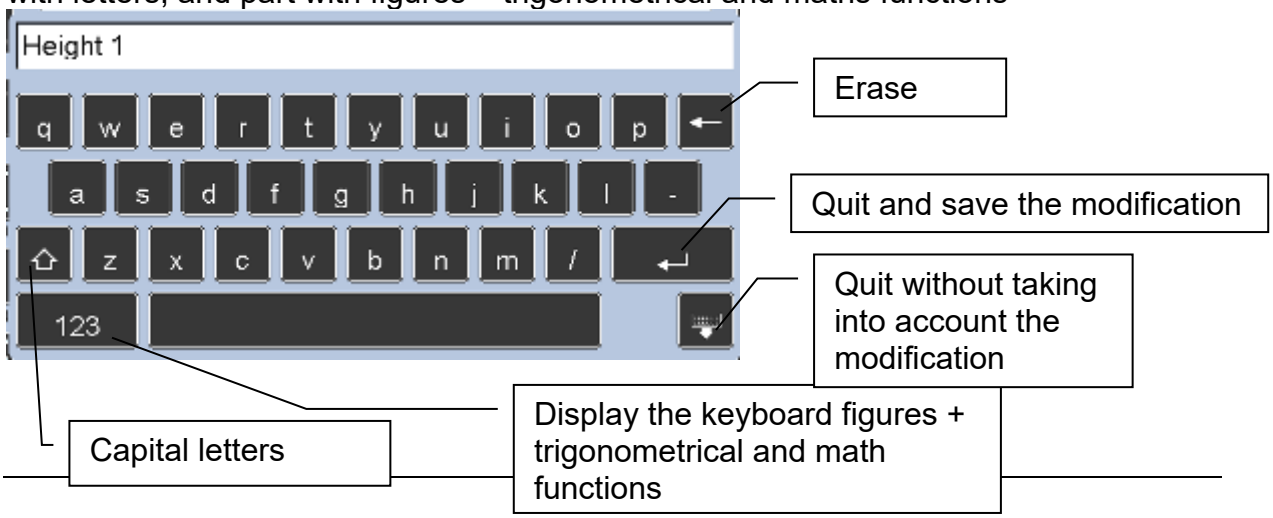

## 5.4. VIRTUAL KEYBOARDS

2 types of virtual keyboards are available

1. **Numerical keyboard**




2. **Alpha-numerical keyboard.** This keyboard is divided in 2 parts : parts with letters, and part with figures + trigonometrical and maths functions




Quit without taking into account the modification

Display the keyboard with letters

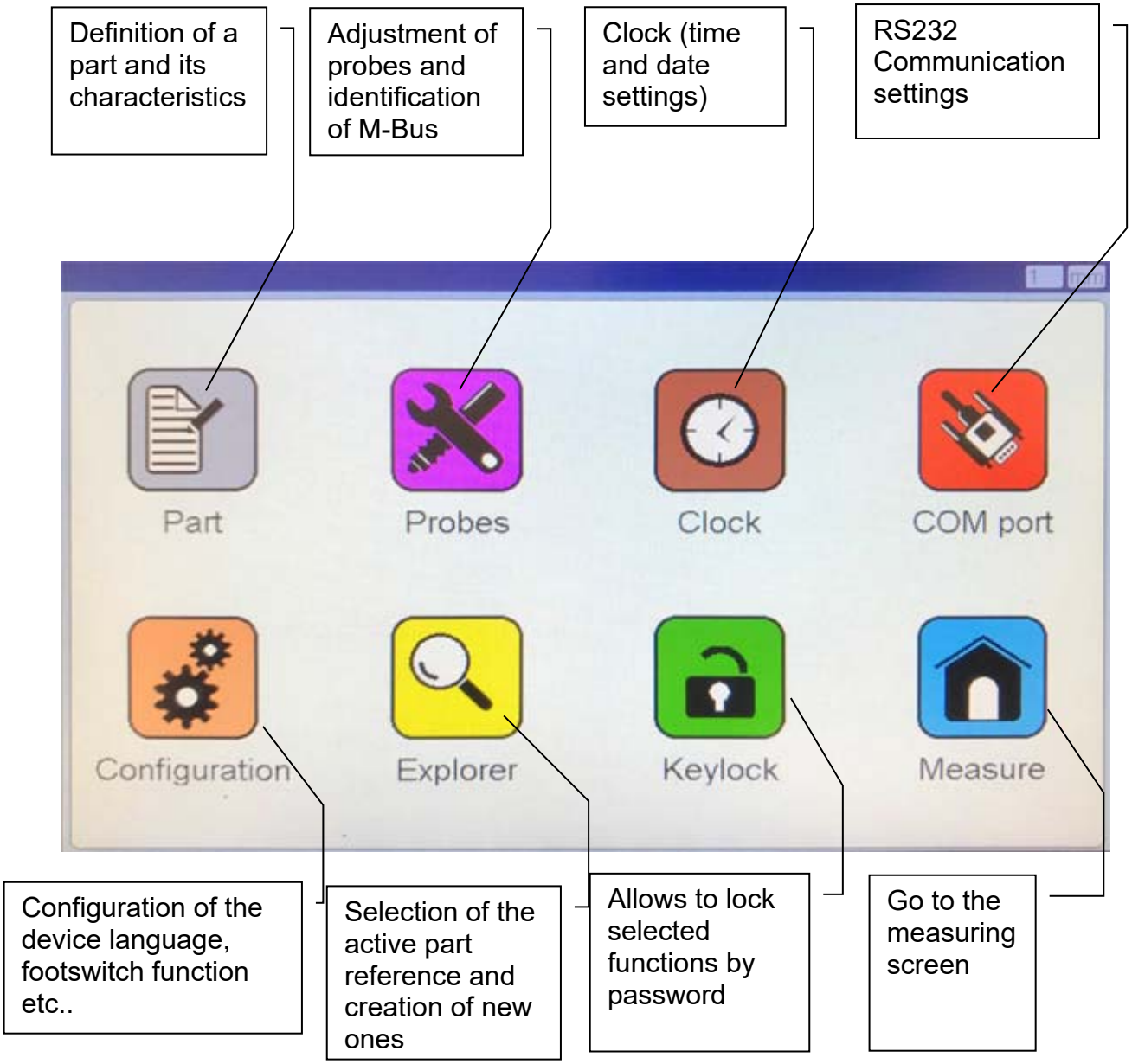
C( means « channel » in a calculation formula.
Example C(1) means channel or probes Nr 1.
The probe nr 1 is the probe nr1 of the module nr1 that has been identified. For example the probe nr.1 of the module nr. 2 could be on the formula C(9), if the first module was a MB-8I with 8 inputs.

→ if you don't know the probe number, just push the probe tip and the corresponding formula C(x) will appear automatically.

## 6. CONFIGURATION OF THE DEVICE AND THE MEASUREMENT

This section describes the different windows that are accessible from the icon desktop.
If you are on the measuring screen, you can reach the icon desktop by cliking on the


button.
Your M400 can be entirely configured (language, IP addresses, communication etc…) from this window.
The measure (definition of part reference, tolerances, characteristics etc…) is also configured from this window.

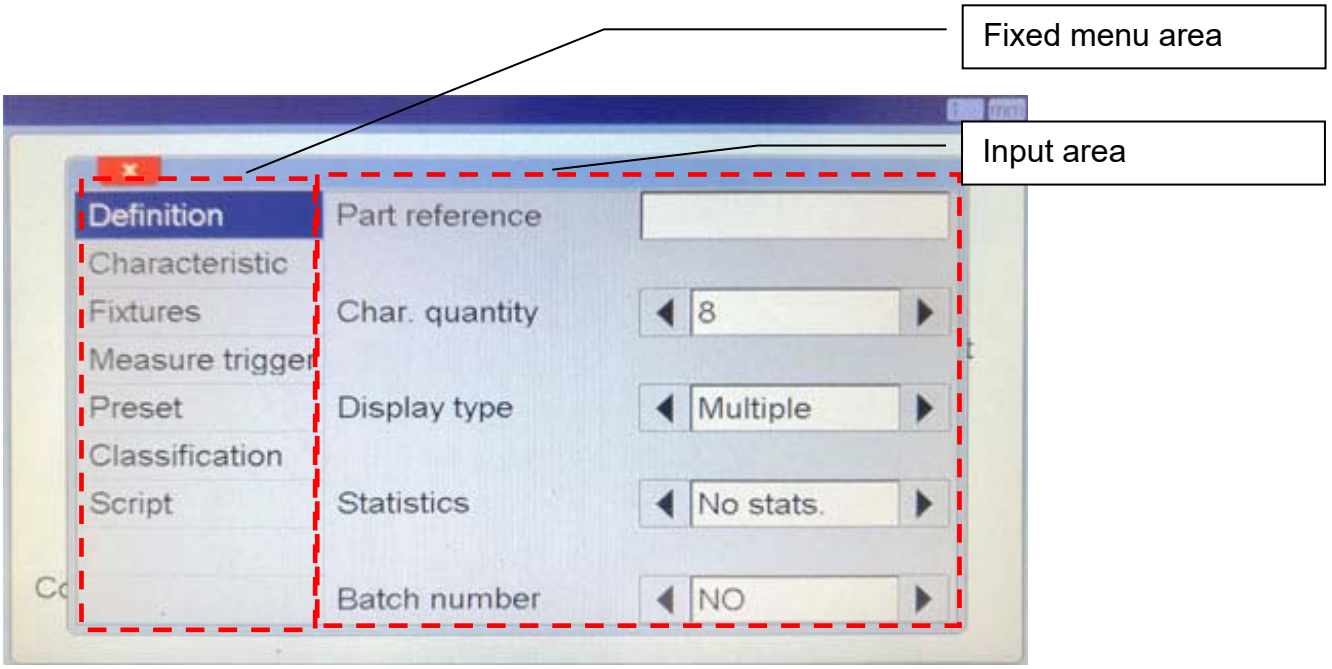



The 8 following sections describe the 8 icons of this screen.

## 6.1. PART

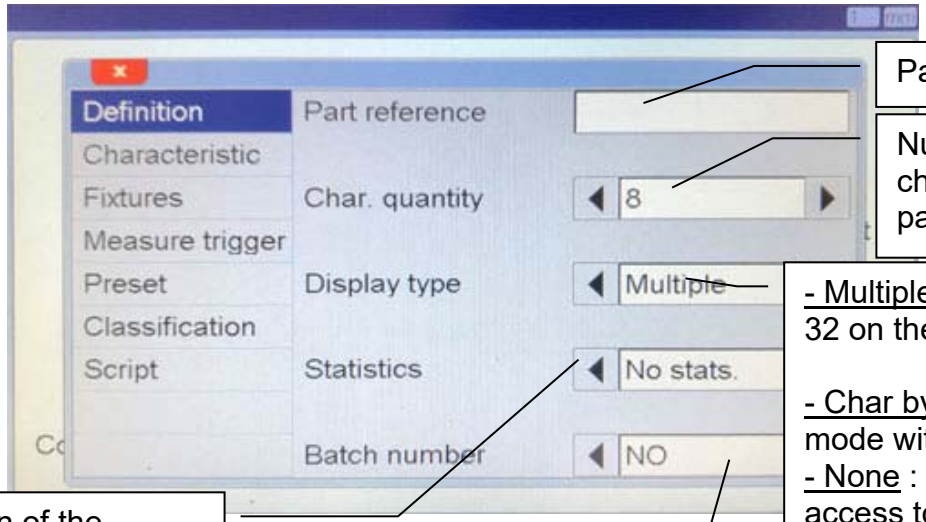

After clicking on this icon, the bellow window appears:
**It gives the possibility to define all the characteristics of the active part reference.**
This window is divided in 2 areas

- A fixed menu area. The active menu is displayed on a blue background
- An input area changing in function of the active menu.




The following 8 sub-sections describe the 8 menus of the fixed area.

## DEFINITION




Part name

Number of characteristics of the part. From 1 to 32

- Multiple : horizontal bargraphs, up to 32 on the same screen

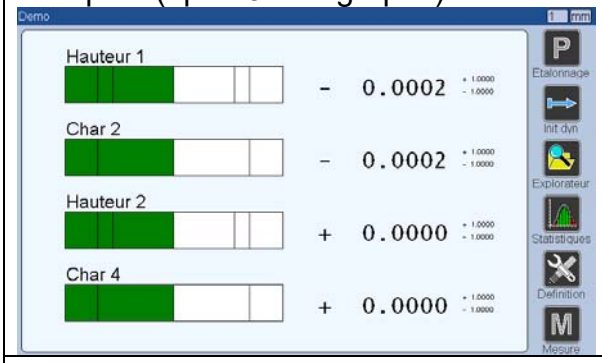
- Char by Char : Single characteristic mode with needle indicator
- None : Digital values only and direct access to some functions

Selection of the statistic mode : SPC (process), Machine or no statistic.

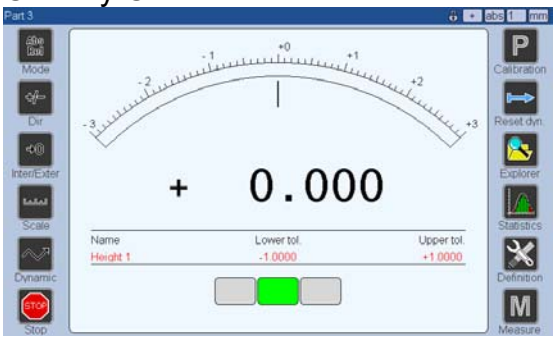
Adds a button on the measuring screen allowing to input a batch number. The batch number is then used for the export file name. (batch.csv)

Display types preview :

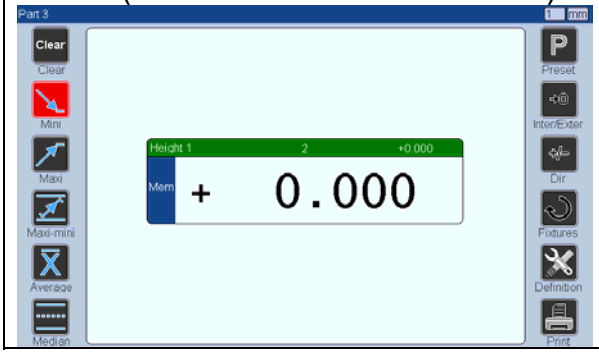
Multiple : (up to 32 bargraphs)



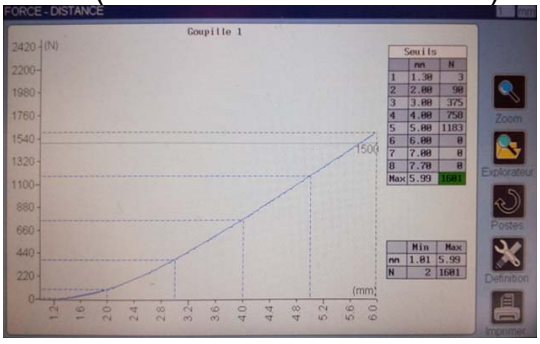

Char by Char :




None : (= without tolerance indication)

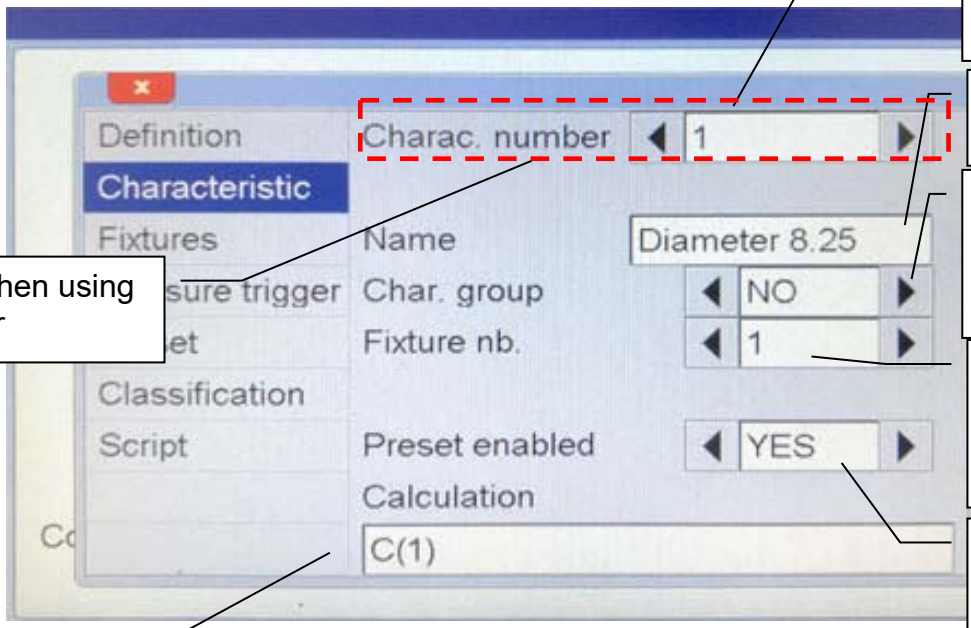



Force (Force VS Distance or Time)



## CHARACTERISTIC

The « Characteristic » menu is divided in 3 parts
- First part (1/3)




Selection of the characteristic that will be configured with the bellow commands

Name of the characteristic.

A group of characteristics can be defined for example preseting only the group

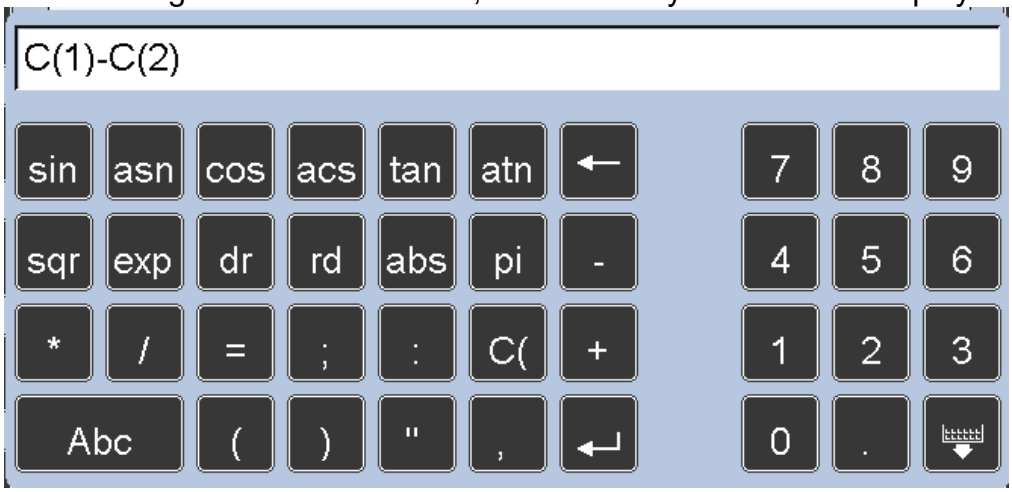
Fixed part when using the scroll bar

The characteristics can be share out on up to 32 fixtures (32 pages on the screen)

If “no”, the preset value will not be applied to this characteristic when preseting from the measuring screen

The calculation formula defines the probes combination.

After clicking on the formula area, a formula keyboard will be displayed:




The M400 has 2 types of data input.
2 types of variables can be used according to the source of measurement:

- Probes (m-bus Channel): **C(n)** where ‘n’ is the number of the probe (n≤99)
- Other characteristic: **M(n)** where ‘n’ is the number of the other characteristic (result of a previously calculated characteristic) (1≤n≤32)
  **For using the M(n), the characteristic’s origin has to**

**be declared as "maths" in the part→ characteristics menu**

→ You can either write with the keyboard "C(2)" or just press the corresponding probe and the value "C(2)" will be written automatically on the field.

The sequence of calculation is as follows:

- Characteristics measured by a M-bus channel : C(x)
- Characteristics calculated with other characteristics. : M(x)

For each origin, calculations are made in chronological order (i.e. characteristic 1 then 2 etc.).

*OPERATORS*

The following operators are allowed in the calculations: **+ - * / ( )**

As well as:

| | |
|---|---|
| **SIN (x)** | = sine of x |
| **COS (x)** | = cosine of x |
| **TAN (x)** | = tangent of x |
| **ASIN (x)** | = arc sinus of x |
| **ATAN (x)** | = arc tangent of x |
| **SQR (x)** | = square root of x |
| **EXP(x)** | = raises the number e (2,7182818) to the power of the argument x |
| **y ** x** | = raises y to the power x |
| **LN (x)** | = natural logarithm of x |
| **LOG (x)** | = 10 base logarithm of x |
| **ABS (x)** | = absolute value of x |
| **PI** | = 3,1415926 |
| **RD** | = coefficient of conversion from radians → degrees (180/PI) |
| **DR** | = coefficient of conversion from degrees → radians (PI/180) |

- For trigonometric functions, "x" is expressed in radians
- You have the possibility of using integer or real coefficients, which can be expressed as scientific expression (Ex. 2.2E-6 for 0.0000022).
- We recommend not using a trigonometric function directly on the value provided by an inductive probe. E. g. ABS(C(1)).

*PRECEDENCE OF OPERATORS*

The hierarchy of operators in calculations is as follows:

1 parentheses ( )
2 EX (x)
3 negations -
4 multiplication and division * /
5 addition and subtraction + -

For calculations on tables of values (ORIGIN "maths") allowed operators are :

- **C (x..y)** = performs the calculations for the table of probes x through y
- **M (x..y)** = performs the calculations for the table of characteristics x through y

**Syntax errors:**

- one or more opening parentheses missing. Ex. COS (25*C(2)+5))
- one or more closing parentheses missing. Ex. COS (25*C(2)+5
- one or more non useful letters. Ex. C(5)-COS2/pi
- writing error concerning an exponent. Ex. -25E++5 or 5.E2
- one or more operations missing. Ex. C(2)5 or C(1)C(2)
- one or more functions without argument. Ex. COS() or C()
- one or more operations without argument. Ex. C(2)+ or C(21)--C(5)
- incorrect use of a table of variables (more than one table declared or use of a table in an operation) Ex. C(2..5)+C(1..3) or COS(1..2)
  *Note*: the - sign is authorized before a table of variables
- non integer values in a table of variables. Ex. C(+1.2) or C(1E2)

**Impossible calculation:**

- inconsistent arguments Ex. C(0), C(105) (→must be between 1 and 99)
- 1st term of a table of variables exceeds or equals the second Ex. C(12..3)

**Combination to be reconsidered:**

- when using other characteristic for a dynamic measurement, the use of tables of variables is compulsory. (i. e. C(1) cannot be used, while C(1..3) can)

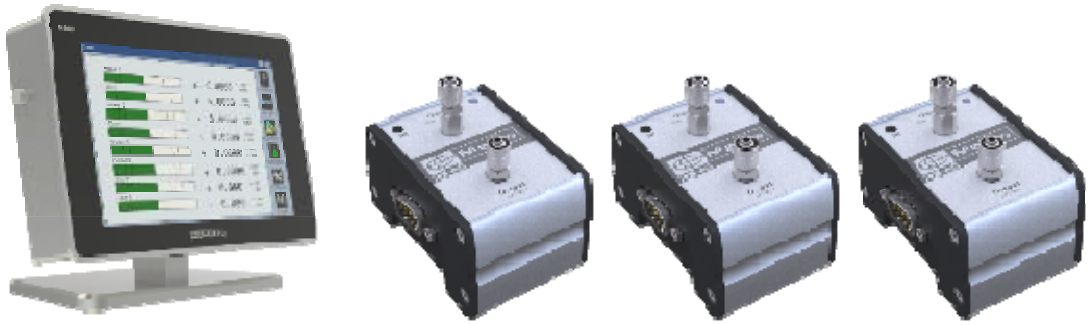
Examples using both C(x) and M(x) formulas:

→ Example 1 : Cone HSK-A40 : Measurement of taper angle in degree and the straightness with a 3-levels air gage

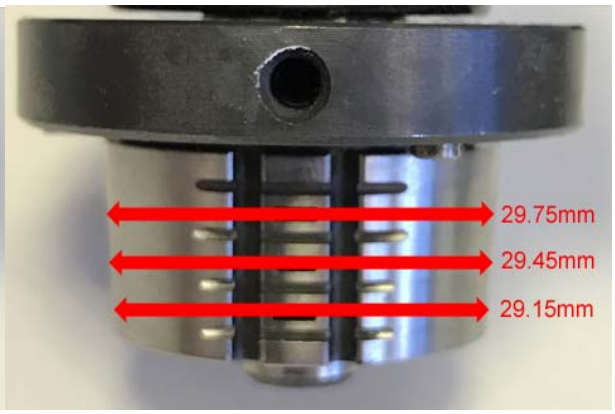
Equipements required :

1 * 3-level taper air gage:


1 * M400 + 3 * MB-AG modules



Characteristics of the air gage :

Step 1 – identify the 3 MB-AG modules on the MBUS number 1 to 3, and calibrate with the MIN and MAX position. (see chapter 4.3.5)

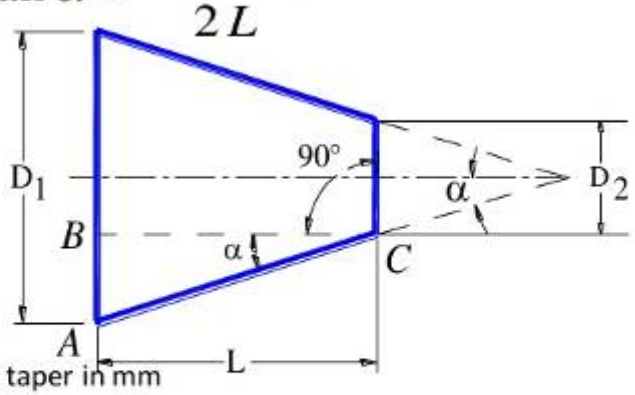
Step 2 – create 7 characteristics using the multi-gauging display mode:

- 3 diameters corresponding to the 3 levels of the air gage
- 3 tapers
  - 1 total between the small and the big diameter
  - 1 between the small and the medium diameter
  - 1 between the medium and the big diameter
- 1 straightness

| Char. name | Origin | Formula | Mode |
|---|---|---|---|
| Big diameter | Probe | C(1) | Static |
| Med. Diameter | Probe | C(2) | Static |
| Small. Diameter | Probe | C(3) | Static |
| Total taper | Maths | 2*ATAN((M(1)-M(3))/2/6.5)*RD | Static |
| Taper 1 | Maths | 2*ATAN((M(2)-M(3))/2/3.25)*RD | Static |
| Taper 2 | Maths | 2*ATAN((M(1)-M(2))/2/3.25)*RD | Static |
| Straightness | Maths | M(1..3) | Max-Min |

Note : " * RD" at the end of the taper formula means Radian to Degree. It is to display the angle in decimal degrees.
Note : Origin = "Maths" was called Origin ="Other" before the software version 1.24

- Taper: $\tan\alpha = \frac{D_1 - D_2}{2L}$




D= larger diameter of taper in mm
d= smaller diameter of tapered in mm
L= length of tapered part in mm
2α= full taper angle
α=angle of taper or half taper angle

On this example we see that we have used 3 standard formula type C(x) for calculating the 3 diameters.
Then we have used these 3 first characteristics on type M(x) formula.

→ Example 2 : Flatness : Measurement of the flatness of a Hard disc drive with 12 inductive probes

Equipements required :

1 fixture with 12 inductive probes

1 M400 + 1MB-8I + 1 MB-4I

Step 1 – identify the 2 M-BUS modules : MB-8I on the M-BUS inputs 1 to 8, and the MB-4I on the M-BUS inputs 9 to 12

Step 2 – Create 13 characteristics with the multi-gauging mode.

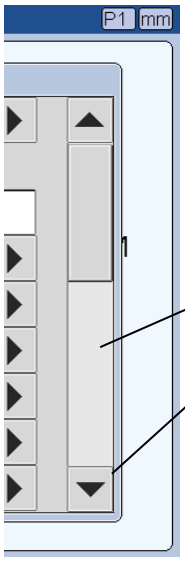
- ➔ Why 13 characteristics ? Because the 12 first characteristics will measure directly the position of the 12 probes and the 13th characteristics will show the MAX-MIN of the 12 first characteristics.

We have the possibility to display only the flatness result.

- ➔ The 12 first characteristics relative to the 12 probes positions must be configured as “intermediate = YES”. It means that the characteristics is calculated but not displayed.

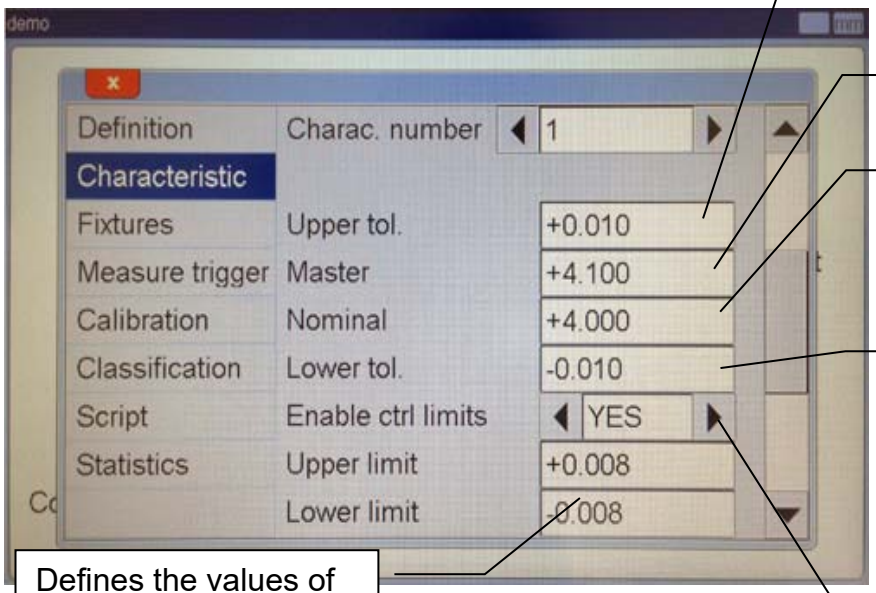
| Char. name | Origin | Formula | Mode | Intermediate |
|---|---|---|---|---|
| Probe 1 | Probe | C(1) | Static | YES |
| Probe 2 | Probe | C(2) | Static | YES |
| Probe 3 | Probe | C(3) | Static | YES |
| Probe 4 | Probe | C(4) | Static | YES |
| Probe 5 | Probe | C(5) | Static | YES |
| Probe 6 | Probe | C(6) | Static | YES |
| Probe 7 | Probe | C(7) | Static | YES |
| Probe 8 | Probe | C(8) | Static | YES |
| Probe 9 | Probe | C(9) | Static | YES |
| Probe 10 | Probe | C(10) | Static | YES |
| Probe 11 | Probe | C(11) | Static | YES |
| Probe 12 | Probe | C(12) | Static | YES |
| FLATNESS | Maths | M(1..12) | MAX-MIN | NO |

For going to the next part (2/3) press on the arrow of the vertical scroll bar.




Allows moving to the next part of this window.

- Second part (2/3)




Definition of the upper tolerance of the selected characteristic. In relative from the nominal

Definition of the master part

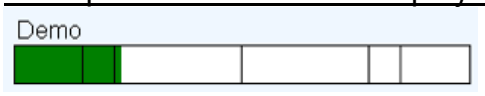
Definition of the nominal characteristic (like written of the part drawing)

Definition of the lower tolerance of the selected characteristic. In relative from the nominal

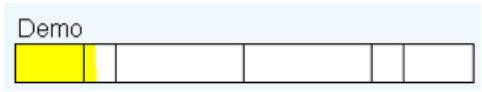
Control limits are warnings activated when the value is close to the tolerance limits.

Defines the values of the warnings

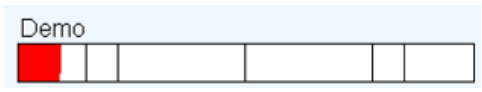
Example of characteristic displayed with control limits




Good part

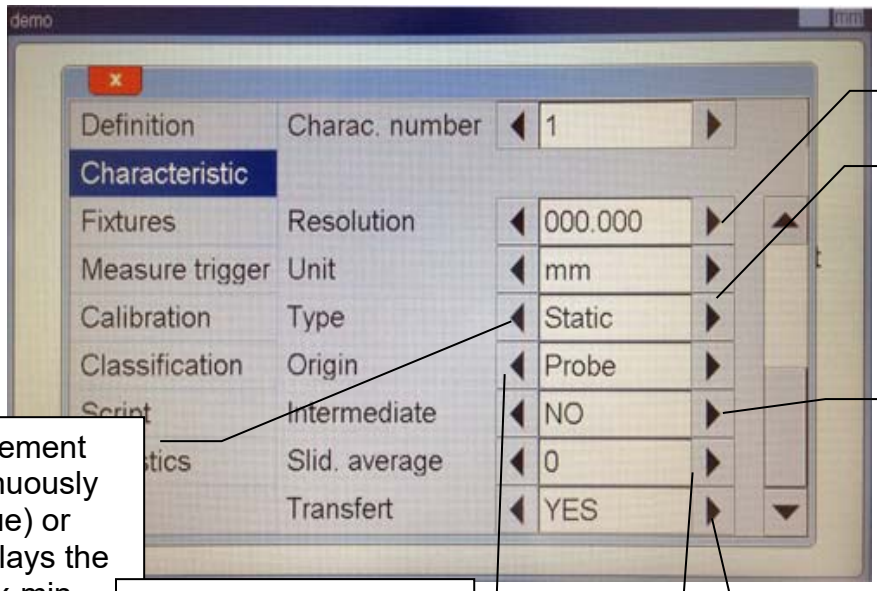



Good part with warning




Bad part

- Third part (3/3)




Resolution

Unit : mm, inch or DMS (degrees – Minutes- Seconds)

If the characteristic is intermediate, it will only be used for the calculation of another characteristic, and therefore not displayed and without tolerances

Static measurement (display continuously the probe value) or dynamic (displays the min, max, max-min (TIR), average or median value seen from the reset of the dynamic measurement memory)

Defines if the characteristic is calculated from a probe or from the result of another calculation. Read the next pages for additional information

Select if this characteristic will be transferred or not

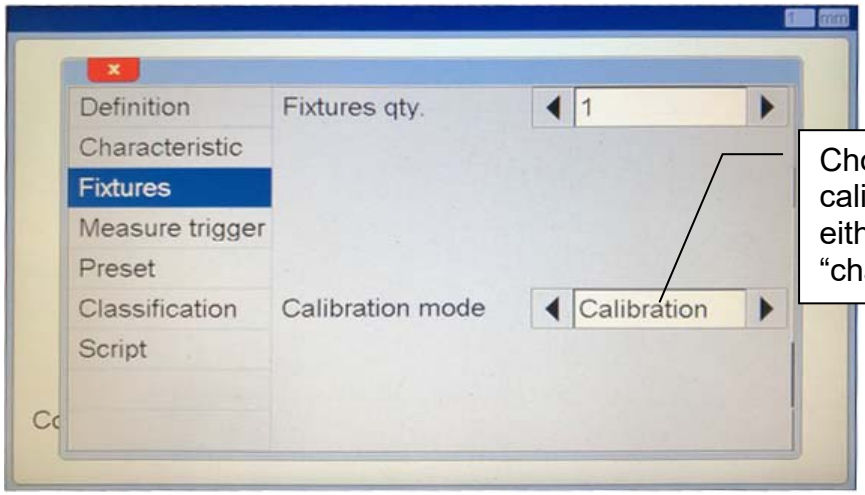
Allows to average the probe's refreshment rate on the screen in order to limit the blinking of the last decimals.

## FIXTURES

According to the complexity of the part being measured, it is sometime necessary to use several fixtures to control one part.
It is therefore possible to define up to 32 fixtures by part reference. Practically it creates several pages on the M400. Fixture = Page.

The fixture can be either selected by pressing in the middle of the measuring screen, or by a footswitch action, or through the I/O, or automatically selected by a detection of a probe motion. It this case is necessary to indicate which characteristic triggers this fixture/page and which value must the probe have to trigger.

As a standard, the screen is the following, with only1 fixture.
Even if you want to display all your characteristics in one single page, you can define here the calibration mode.



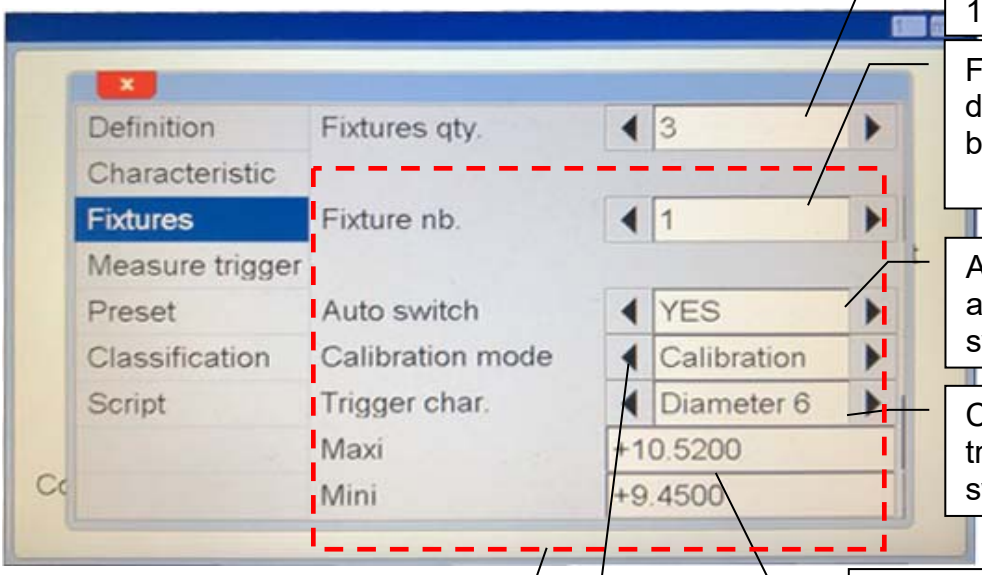

If you choose the calibration mode = ”calibration”, after touching the “preset” button of the measuring screen, all the characteristic of the active page (fixture) will be preseted.

If you choose the calibration mode = “char. By char”, after touching the “preset” button of the measuring screen, the characteristics will be preset one by one. (can be useful for air gage principally)

It also means that one the same part, you can have some fixtures using the “calibration” mode and some other the “char. By char” mode.

If you change the value “Fixture quantity” , the following additional fields will appear:

If you change the value “Fixture quantity” , the following additional fields will appear:




Number of fixture from 1 to 32

Fixture number to be defined with the bellow commands

Activate or not the automatic fixture switch

Characteristic that triggers the auto switch

Min and Max value of the characteristic that triggers the auto switch.

With this example it means that the fixture/page nr.1 will be called when the characteristic “diameter 6” will reach 9.45 mm if the value is increasing when the part is inserted in the fixture, or 10.52 mm if the value is decreasing.

This part does not appear if the fixture number is 1

**Calibration :** presets all the characteristics of a fixture in 1 time.
**Char/Char :** allows to preset the characteritics 1 by 1 on the same fixture

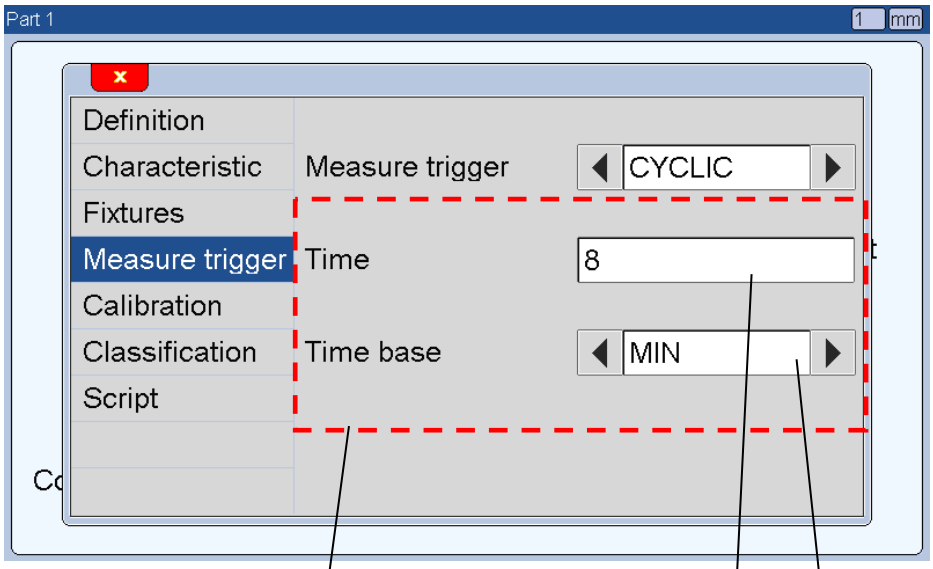
Important: You must assign each of your characteristic to a fixture, from the menu characteristic (see previous chapter)

→ you can use the same probe or instrument (eg. Caliper) on several fixtures.
Example : You use 1 caliper to measure 3 diameters on the same part.
You can display 3 screens for the 3 diameters, and each screen can be reached automatically according the position of the caliper (and so according to the characteristic being measured)

## MEASURE TRIGGER

As a standard, the M400 measures continuously. It means that the characteristic values are refreshed continuously.
Measurements can however been triggered by 2 ways:

A - Cyclic




This part does not appear if the measure is continuous

Time between 2 measures

Unit of the time between 2 measures

Principle : After selecting the appropriates values, return to the measuring screen.

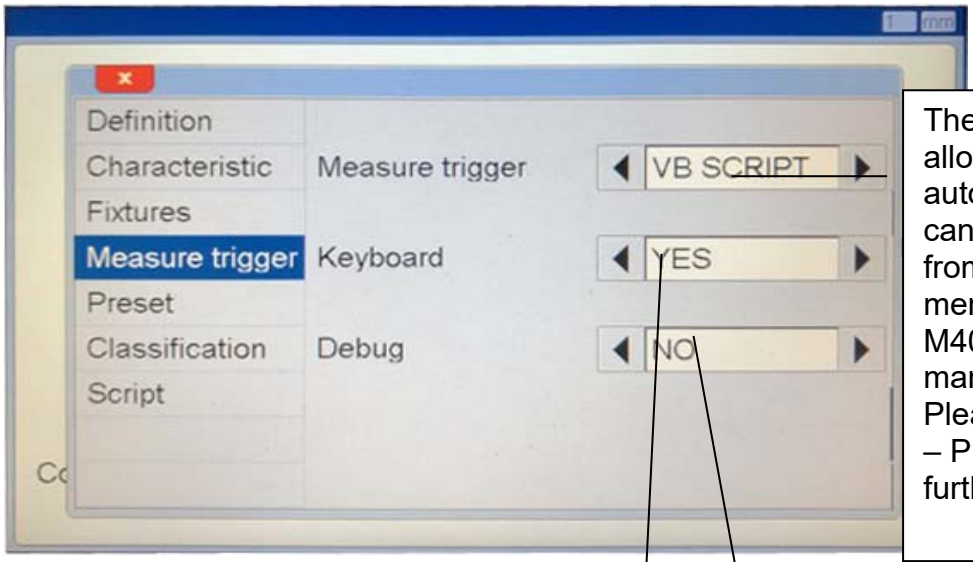
You can start the record / transfer by pressing the “Measure” button 

.

After pressing this button, it becomes green : 

. While this button is green, it records or transfers periodically at the indicated frequency. For stopping the process, press again on the measure button. It becomes black again.

B – VB script (be careful – only for expert users)




The VB script mode allows to run an automated script that can be written either from the "script" menu, or through the M400 display manager software. Please refer to the §9 – PLC script for further information.

Allows to hide the right-hand-side button bar of the measuring screen. In this way, in automated machines, nobody can interrupt the measurement.

If « Yes » is selected the program lines appear in the top bar, for debug purpose.

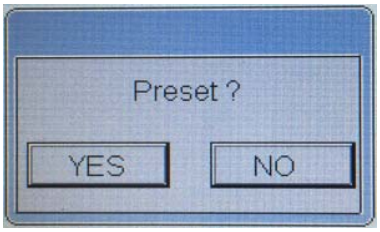
Important : If the option « Keyboard » → " no" has been selected, when you will return to the measuring screen, it will not be possible to come back again simply to the definition screen, because the "definition" button will not be displayed.
So it is recommended to use this function just at the time of the commissioning.

In case you would like to display again the menu, follow this procedure:
1 – Shut down the M400
2 – Power the M400 on
3 – While the "Metro" logo and the indication "loading xx %" appear, press on the Metro logo.
4 – At the end of the loading, a message will appear


Press "Yes" to have the menu button again.

## CALIBRATION

Before starting to measure, you must apply a preset to your M400.
For preseting the M400, press on the “Preset” button of the measuring screen.
A confirmation message will appear. Select “Yes” or “No”. If you press “Yes” the actual indicated value will be replaced by the “master” value defined in the “part” menu.




It is then possible to control if the value measured on the master is still in conformity with the first calibration. This mode is called “calibration → control”.
If this mode is selected from the menu “part”→ “calibration”, when you will press on the “Preset” button of the measuring screen, the function will just check is the preset has moved from the defined value.

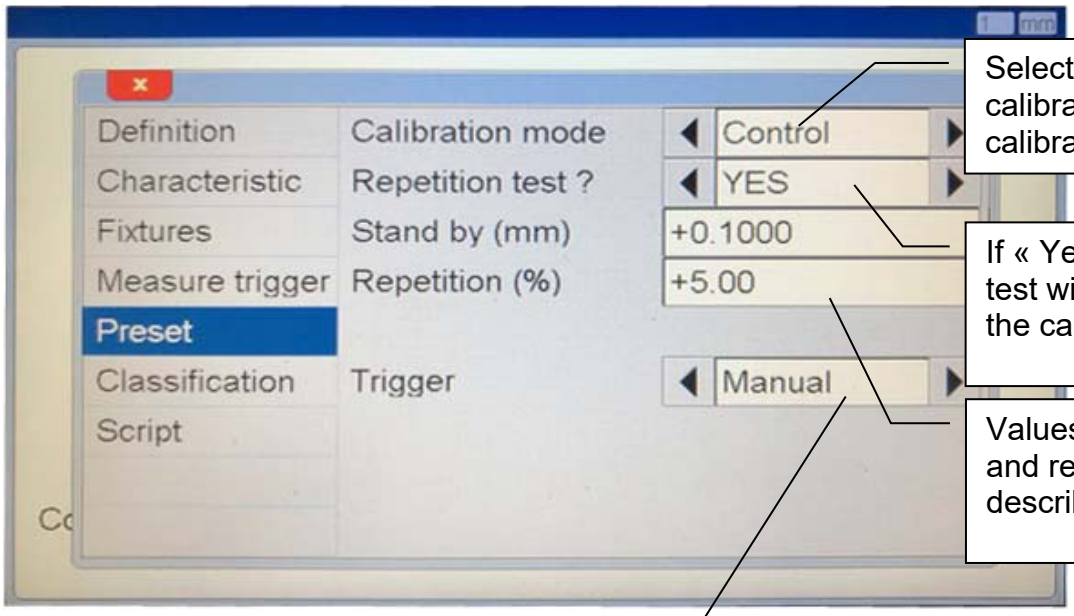
The Preset sequence is very important, because it defines the quality of the measurements. The M400 allows to check if the preset has been done in correct conditions, this is the repetition test that checks 2 parameters:

### *STAND BY*

The stand-by test is done to control if the probes are in good position and in normal operating conditions.
With this option selected, while doing the preset sequence, the M400 will compare the probe position with and without the master and check if the difference between the 2 probes position is bigger than the stand by value.
For example if the 2 value are the same, I would mean that either the probe does not touch the part, or either the probe is not connected, or the probe is damaged.

### *REPETITION*

This test aims to check the correct position of the master part as well as the correct state of the fixture, or if no metal dust was in-between the master and the probe during the preset sequence.
The master part is measured 2 times and the M400 checks if the difference between the 2 measurements is not greater than the repetition value;
This value is a percentage (max 25%) of the tolerance interval. The repetition value is therefore different for each characteristic.

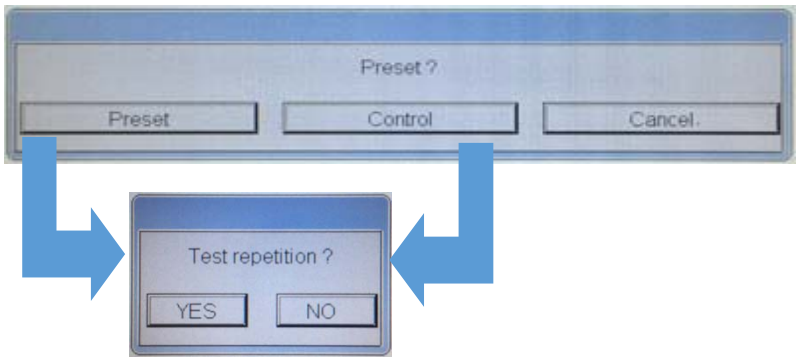



Selects a standard calibration or a calibration control

If « Yes » a stand-by test will be asked after the calibration.

Values of the stand by and repetition tests described above.

If trigger=manual, the operator will decide when to calibrate by pressing the “calibration” button of the measuring screen. Otherwise the calibration will be asked automatically with a defined frequency.



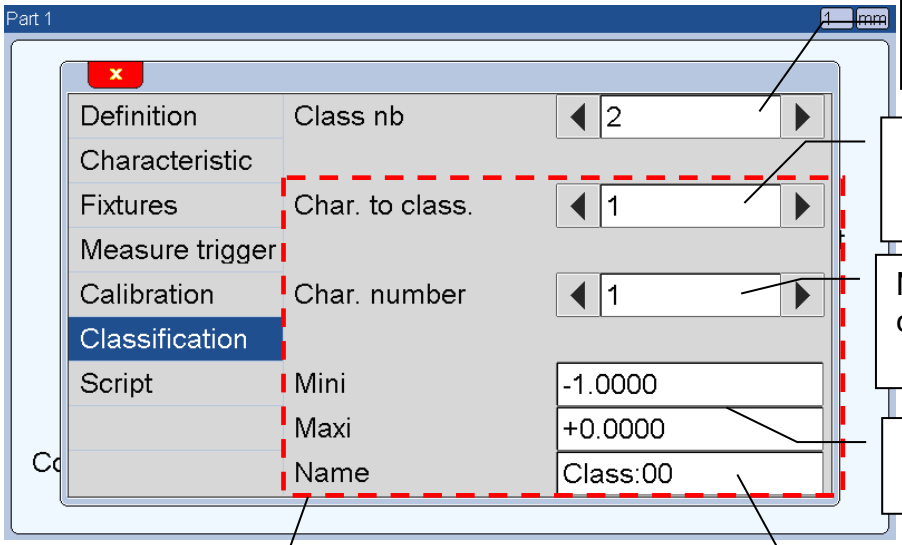
## CLASSIFICATION

The M400 offers the possibility to sort one of the characteristic by dimensional classes.

For using this functionality, you must enter the number of classes (up to 16) and on which characteristic the sorting will be done.

If you want to use N classes, you must define
- the upper limits of the classes 1 to N (decreasing values from 1 to N)
- the lower limit of the class 'N',
- a name for each class.

In this case, the class (number and name) will be displayed together with the value. The class is also available on the output of the IO modules.




Number of classes (up to 16)

Choice of the characteristic to classify

Number of the class configured below

Upper and lower limit of the class

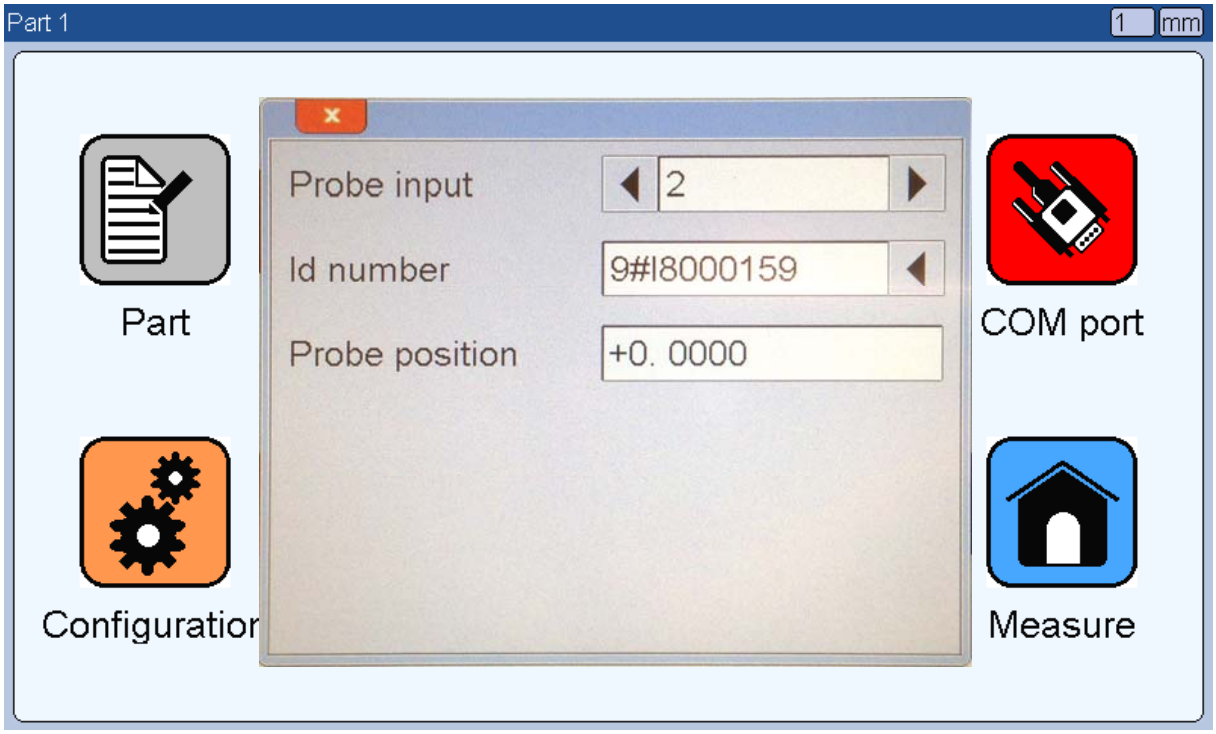
This part does not appears if the number of class is 1

Name of the class wich will appear in the top bar of the measuring screen.

The part is now configured. After quitting this windows (by pressing on the white cross on red background) a message appears asking if you want to save the modification. Press yes or no.

## 6.2. PROBES

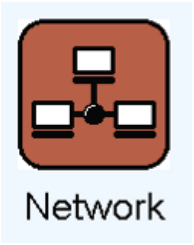

After clicking on this button, the below window appears.



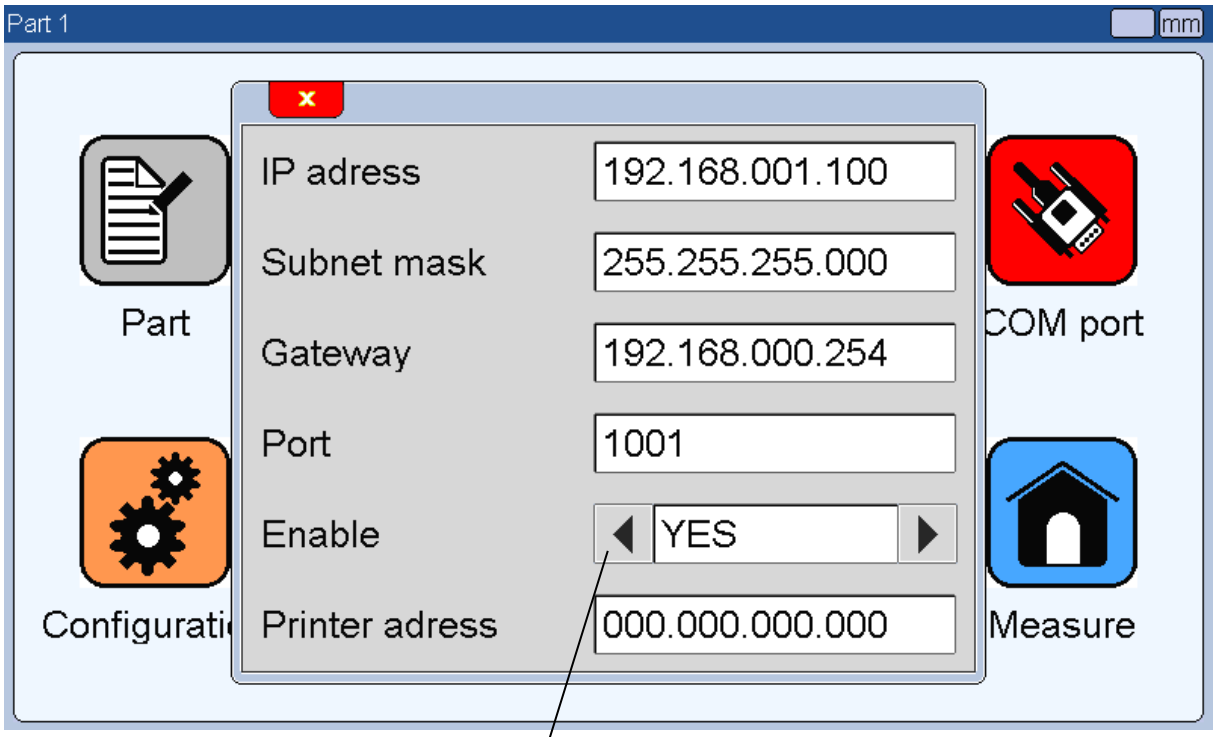

This window allows identifying a M-Bus module for probes connection and displays the probe value for checking his state or adjusting its position on the fixture.

Digital probes and M-Bus modules are connected on a Bus. It is therefore necessary to identify them. The identification procedure is described on the chapter 4.3 « installation of M-Bus modules ».

## 6.3. NETWORK SETTING




After clicking on this button, the below window appears.

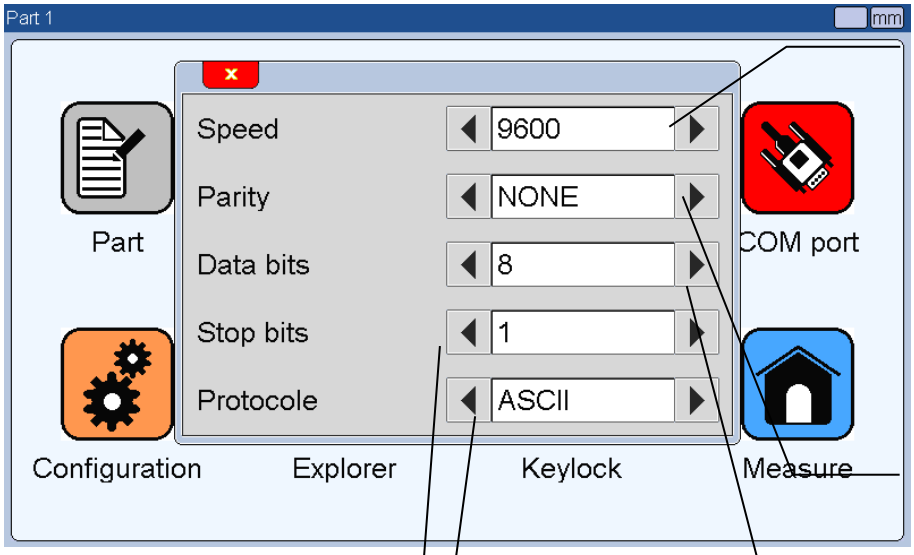



This window allows configuring the network settings of your M400.

If you do not use the network, it advised to de-active it in order not to slow down the system.

## 6.4. COM PORT


After clicking on this button, the below window appears.
This window allows configuring the communication settings of your M400.




Communication speed.
Choice between
- 1200 bauds
- 2400 bauds
- 4800 bauds
- 9600 bauds
- 19200 bauds
- 38400 bauds
- 115200 bauds

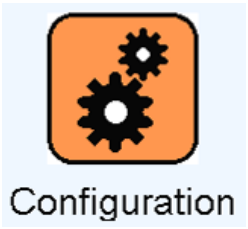
Parity :
Choice between
- None
- Odd
- Even

7 or 8 data bits

1 or 2 stop bits

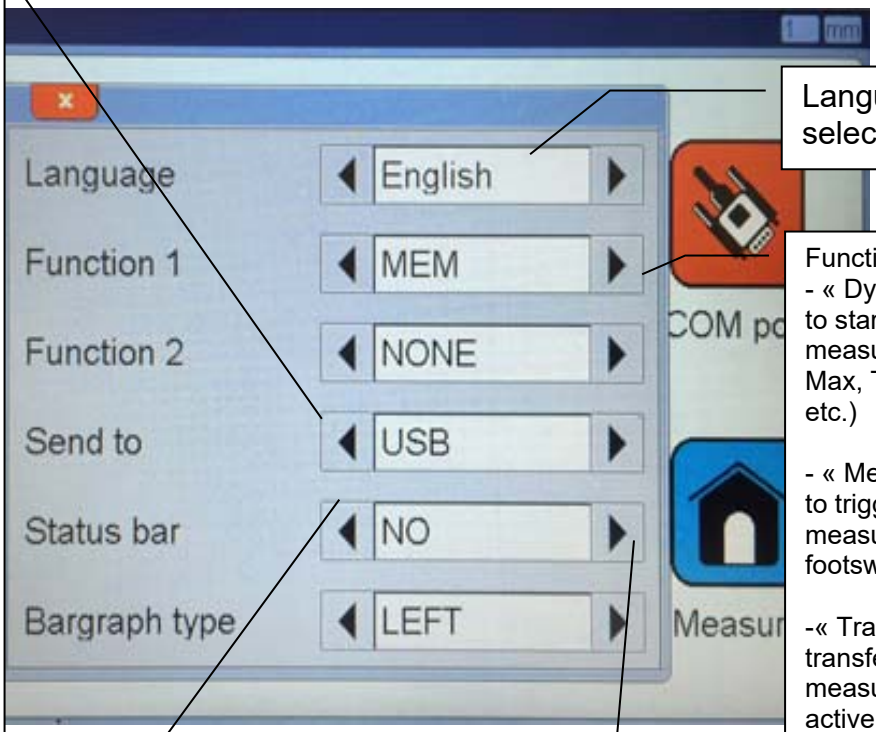
Choice of the communication protocol on the RS232
- ASCII
- MODBUS RTU
- DMX16 (Mitutoyo)
- Mux-AM
- SPC400

## 6.5. CONFIGURATION




After clicking on this button, the below window appears.
This window allows configuring the general settings of your M400.
“Function 1” and “Function 2” are the function made after a footswitch action or after cliking on the “Measure” button. Functions are executed chronologically, Function 1 first, then Function 2.

If function 1 or 2 is set to “Transfer”, the data can be sent to either :
**- RS232** (with a ref 45160 cable)
**- USB** (=to USB stick. It will create a *.csv file ; * = your part name.)
**- Ethernet**
**- Keyboard :** With this option the M400 must be connected to the computer with a standard USB-A USB-B cable. When transferring the data, it will be written where your cursor is. The M400 is actually detected as a standard USB keyboard in your PC. (see chap. 8 for details)




Language selection

Function :
- « Dyn Meas» allows to start a dynamic measurement (Min, Max, TIR, Average etc.)

- « Measure » allows to trigger the measurement by a footswitch action

-« Transfert » : transfers the measurement of the active fixture on the RS232 or USB

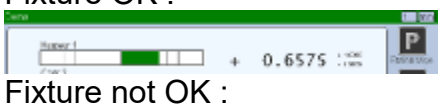
-“Preset” : Calibrate the active fixture

-“ Press all” : Starts the calibration sequence for all fixtures

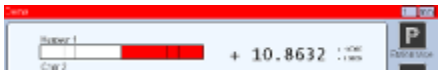
-“Mem” : Save the measurements in the M400’s memory. Measurements saved are then available on the “statistics screens”.

Allows to change the title bar in green or red if the characteristics of a fixtures are good or not. (important when used with I/O = Part state)

Fixture OK :

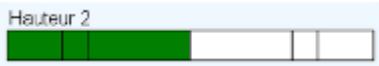


Fixture not OK :

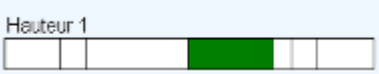


Bargraph type in multi gauging mode. :

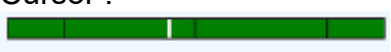
Left :



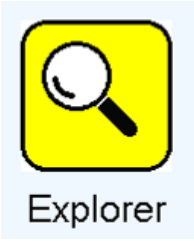

Center :




Cursor :

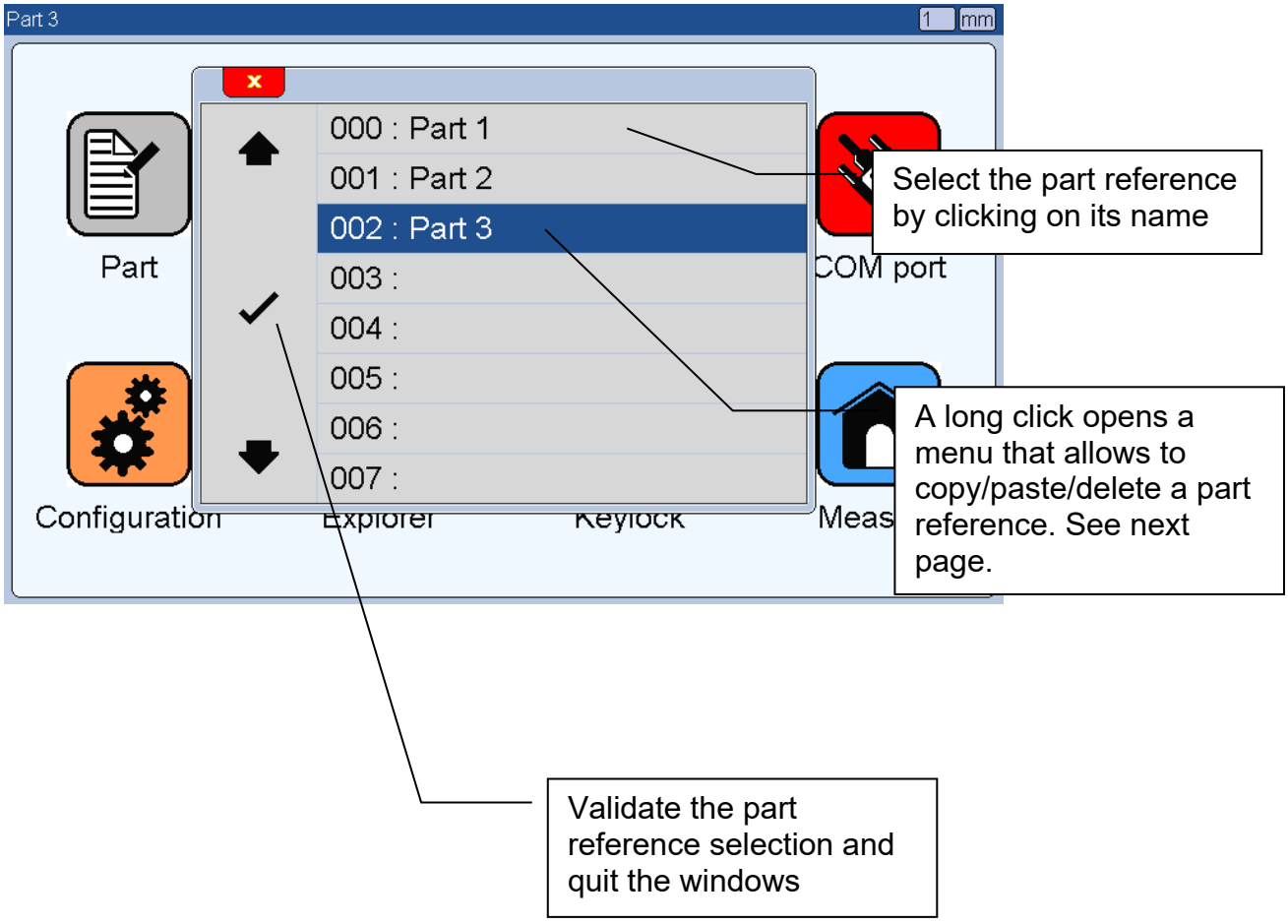


## 6.6. EXPLORER




After clicking on this button, the below window appears.
The explorer allows selecting the active part reference, and create/erase/copy/paste other.
Note: another “Explorer” icon is on the measuring screen. It is only used to select the active part, not to create or erase others.

Up to 64 part references can be stored on the M400.

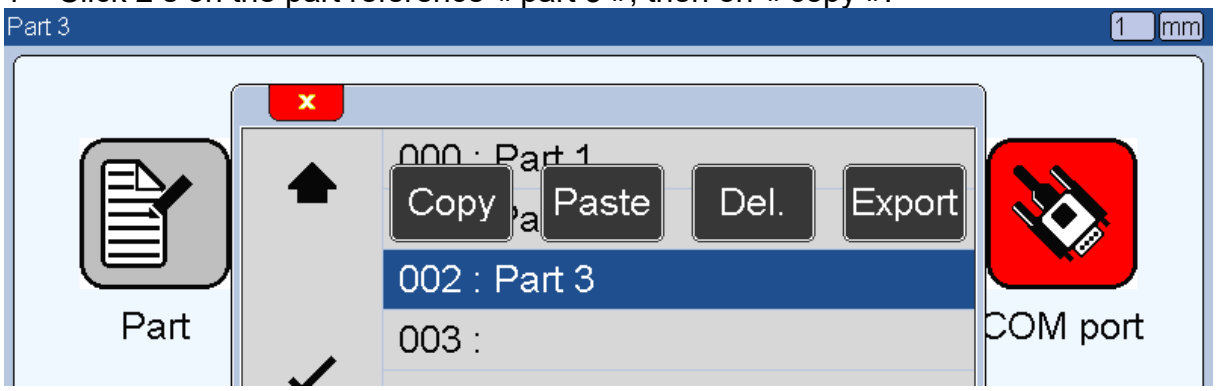



It is possible to copy/paste and delete a part reference.
Click during 2s on a part reference name and a menu with the available option will appear.

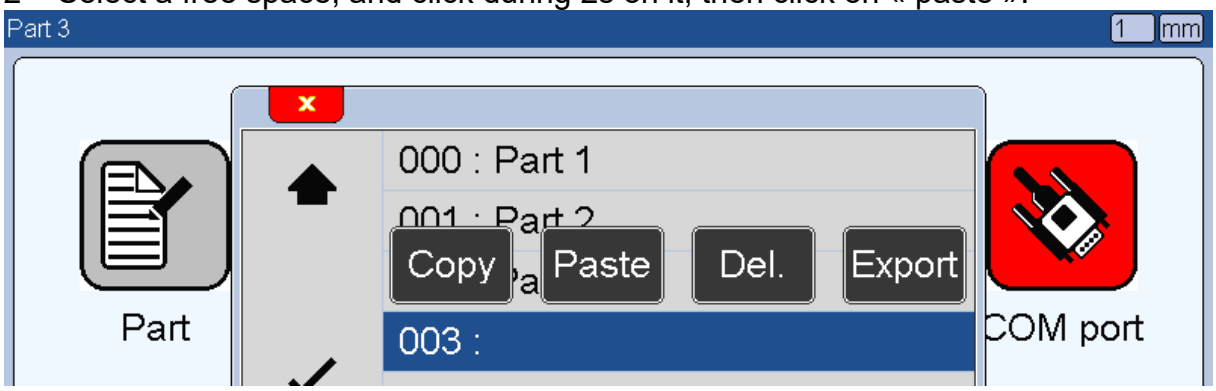
For copying a part reference, select copy, then click on an empty place, then click on the paste button.

Example : Copying a part reference :

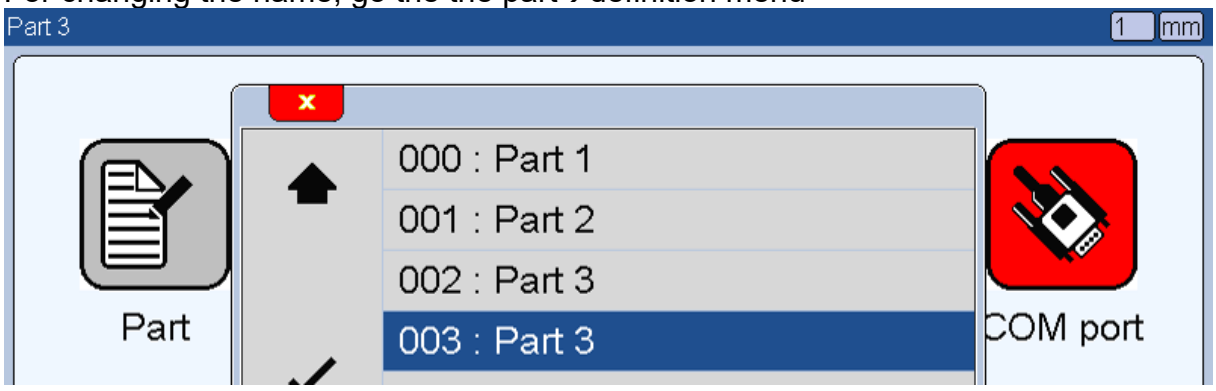
1 – Click 2 s on the part reference « part 3 », then on « copy ».




2 – Select a free space, and click during 2s on it, then click on « paste ».

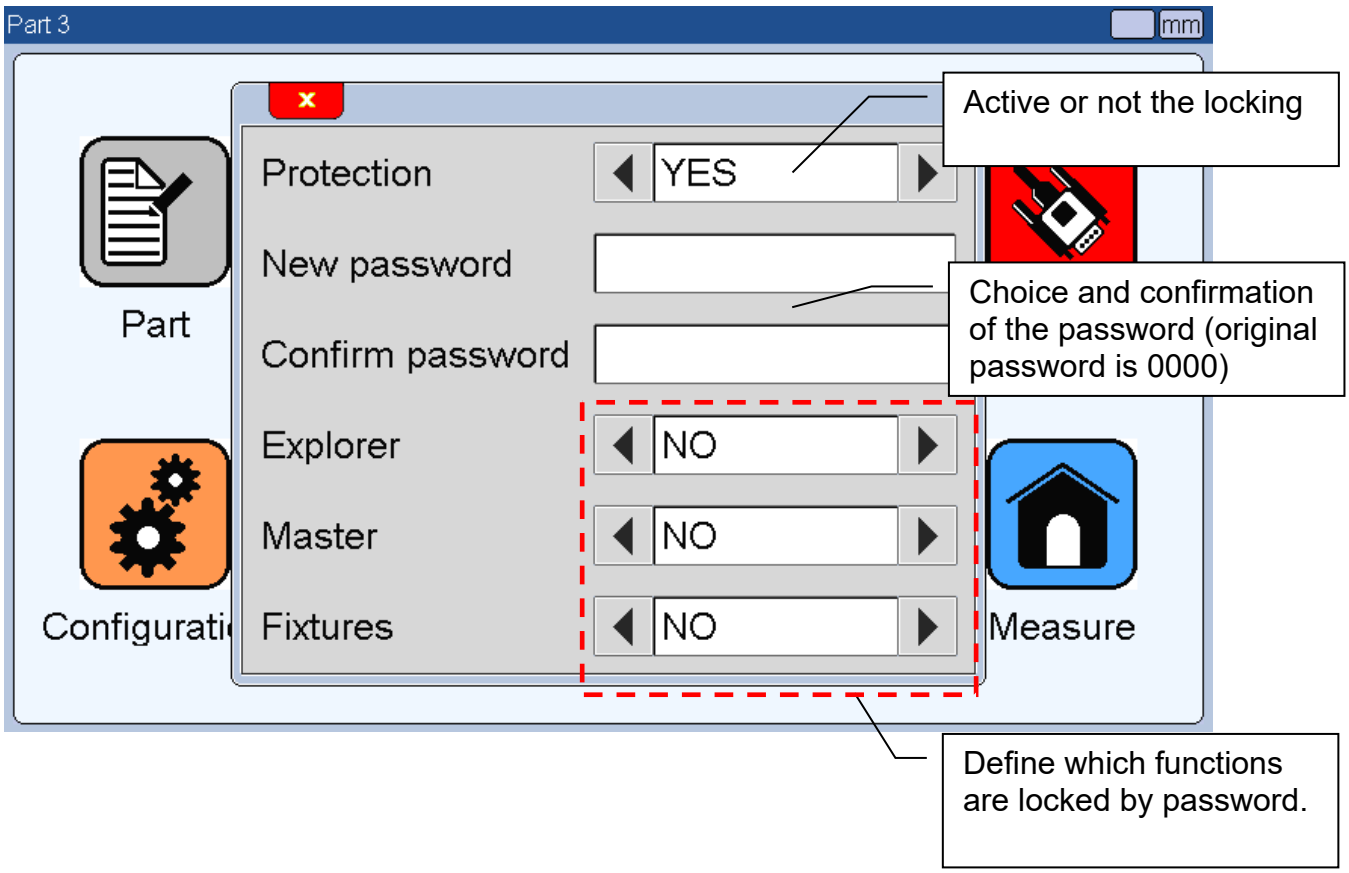



3 – The new part reference has been created with the same name (it takes about 4 s to operates)
For changing the name, go the the part→definition menu



## 6.7. LOCKING


After clicking on this button, the below window appears.
This screen allows to lock by password some functions of the M400.




When the locking is activated, a lock appears on the title bar.

## 6.8. MEASURE


After clicking on this button, the measuring screen appears.
Please read the chapter 7 for the presentation of the measuring screen.

# 7. MEASURING SCREEN

The M400 starts on this screen.
The measuring screen allows seeing the characteristics of the part that has to be controlled and allows accessing to the statistic functions.

## 7.1. GENERAL PRESENTATION

The measuring screen is divided in 3 parts

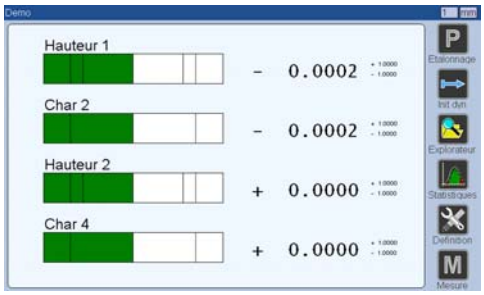
## 7.2. DISPLAY MODES

The M400 can display the characteristics with horizontal bargraphs in case of multi-gauging measurement or with a needle indicator in the case of single characteristic measurement, or only with the numerical value in case of the display mode “None”.

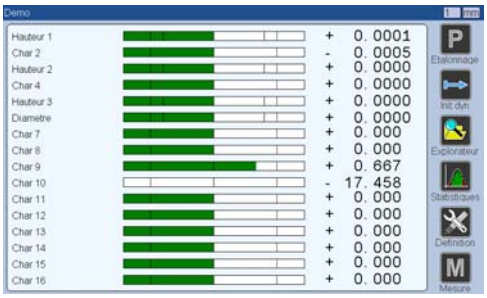
### Bargraphs (Multi-gauging mode)

The bargraph’s size changes according to the characteristics number:

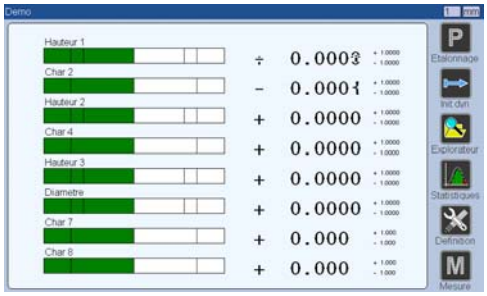
From 1 to 4 characteristics :



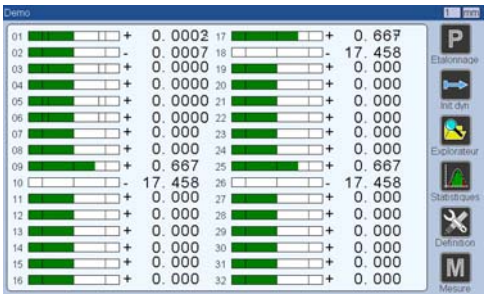

From 9 to 16 characteristics:




From 5 to 8 characteristics :



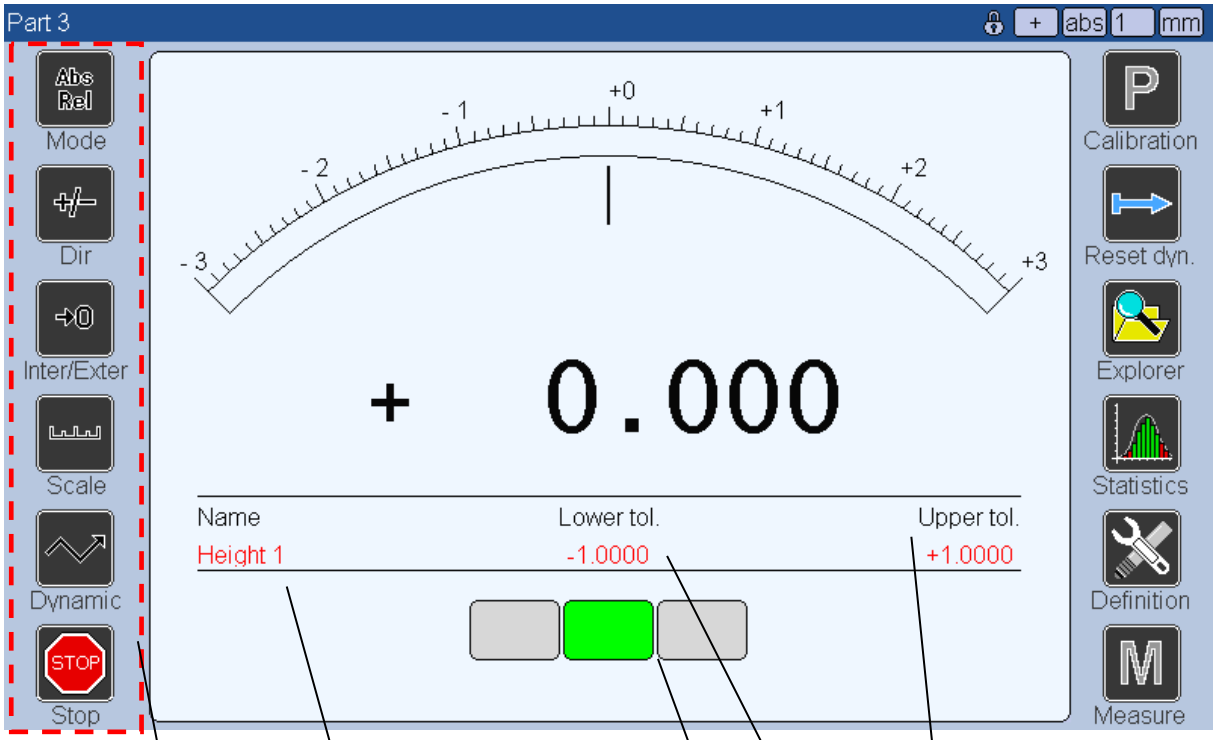

From 17 to 32 characteristics :




Up to 8 characteristics by screen, the tolerances are indicated at the right hand side of the characteristic.
Up to 16 characteristics by screen, the part name is written at the left hand side of the bargraph.
With more than 16 characteristics only the characteristic number is displayed.

## Needle indicator (mode char. by char.)

With this mode, only one characteristic is displayed on the screen and its position is represented by a needle.
Particular functions are then available on the left hand side menu. See next page for details.



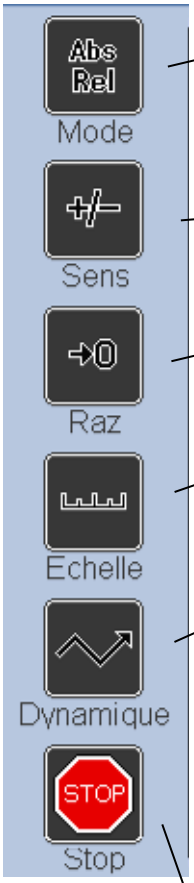

Name of the characteristic

Tolerances values

Access to the functions of the char. By char. Mode. See next page for details.

Colored indicator. GO / NOGO

### 7.2.1.1. Functions of the char. By char. mode



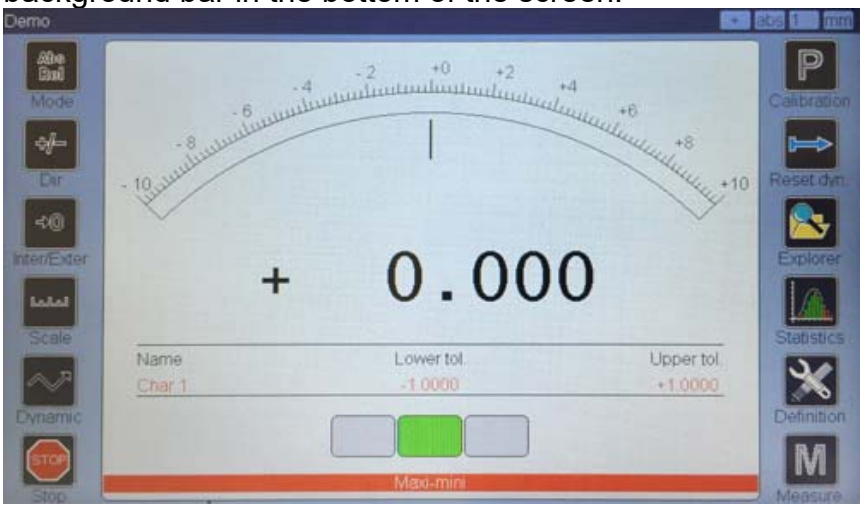

Relative or absolute mode. Allows to create a reference at a certain position

Allows to invert the measuring direction

Set at 0 the displayed value.

For changing the needle indicator scale.

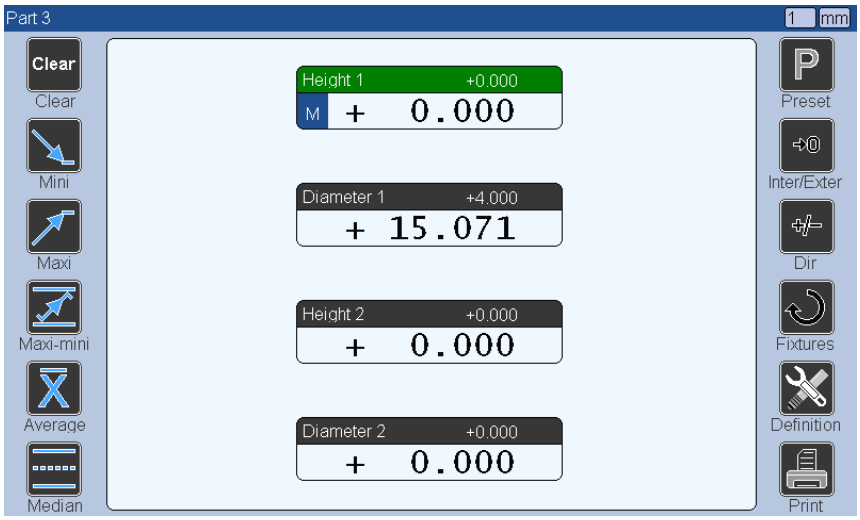
Allows to access temporarily to dynamic measurement modes.
Each push of button allows to select either max, min, max-min (TIR), or average. The mode is indicated on a red background bar in the bottom of the screen.



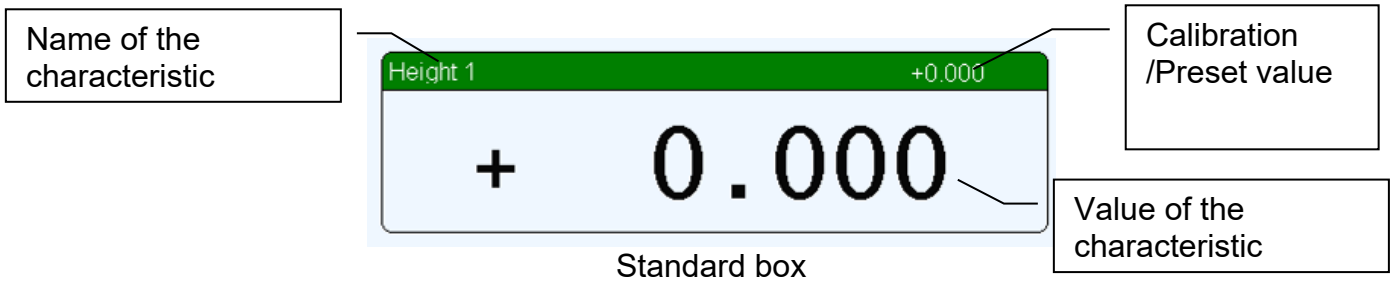

Allows freezing temporarily the measurement. When active, the background colour changes to red.

## Display mode « None » (without tolerance indication)

This display mode allows displaying one or several characteristic in the same time. “None” stands for “No tolerance indication”, so the tolerance will not be displayed or taken into account.




Each characteristic is displayed on a box that contains the following information:

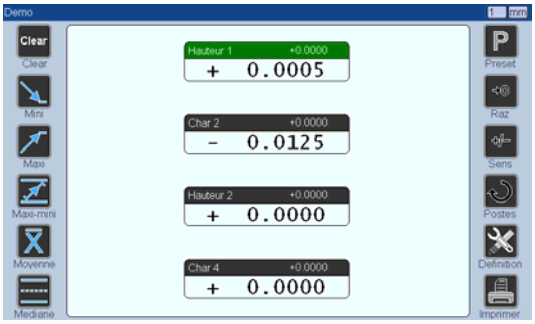



Standard box

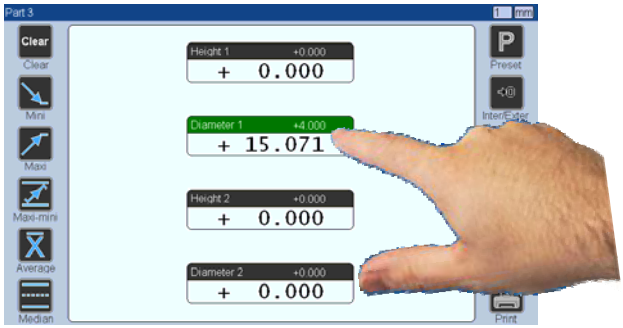
Up to 12 characteristics can be displayed on the same screen and up to 32 characteristics in total, shared out on different fixtures (max 32 fixtures)

If several characteristics are displayed simultaneously, it is possible to make dynamic measurement (min, max …) on only 1 selected characteristic. For doing this it is necessary to select the characteristic by clicking on its box. The selected box has a green bar on its upper part.

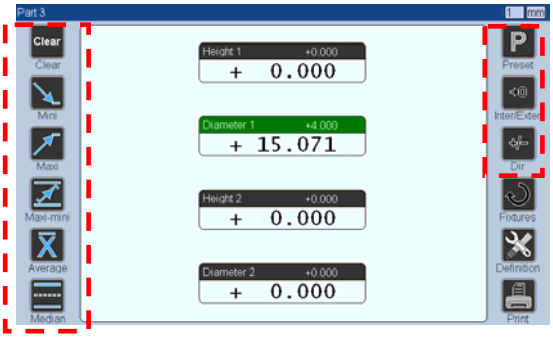
Example :
1 – the characteristic 1 is selected.




2 – Click on the characteristic number 2. The upper part of the box become green.




3 – The following functions are then available for the characteristic number 2

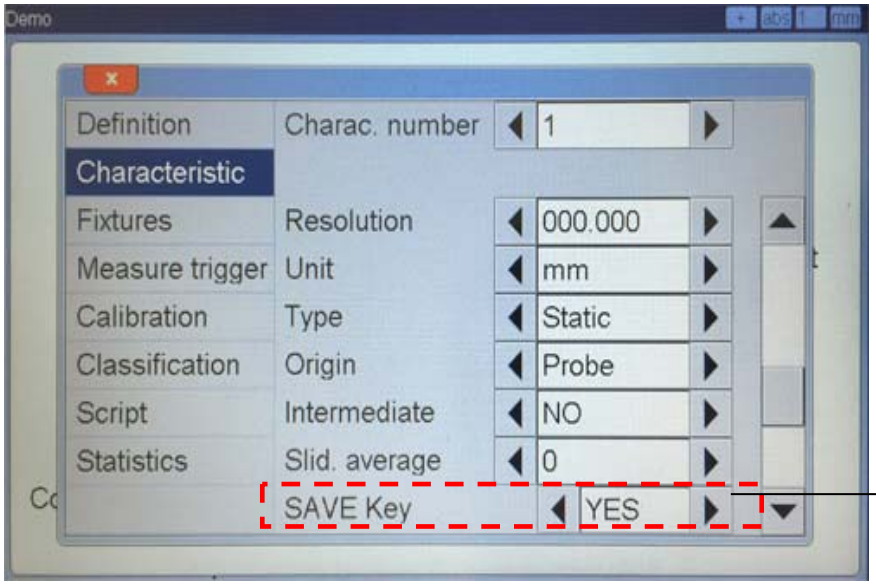



See chapter 7.2.3.2 for further details.

### 7.2.1.2. The « MEM » button

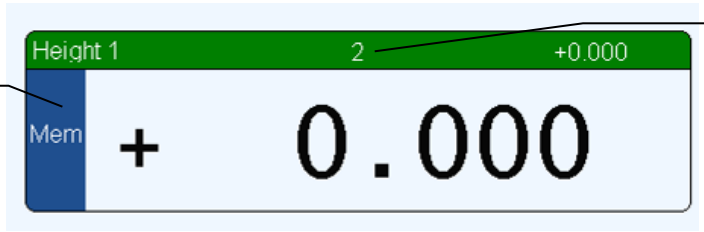
It is possible to add a blue button for saving measurement points (up to 256), and using them for dynamic functions.

For having this button on a characteristic box, you have to select “yes” on the menu Part→ characteristic → SAVE key




This section is available only in the display mode “None”

Each time you will click on the blue area, the saved value counter will increment.
Then you can select a function on the left hand side menu.




Memorisation button

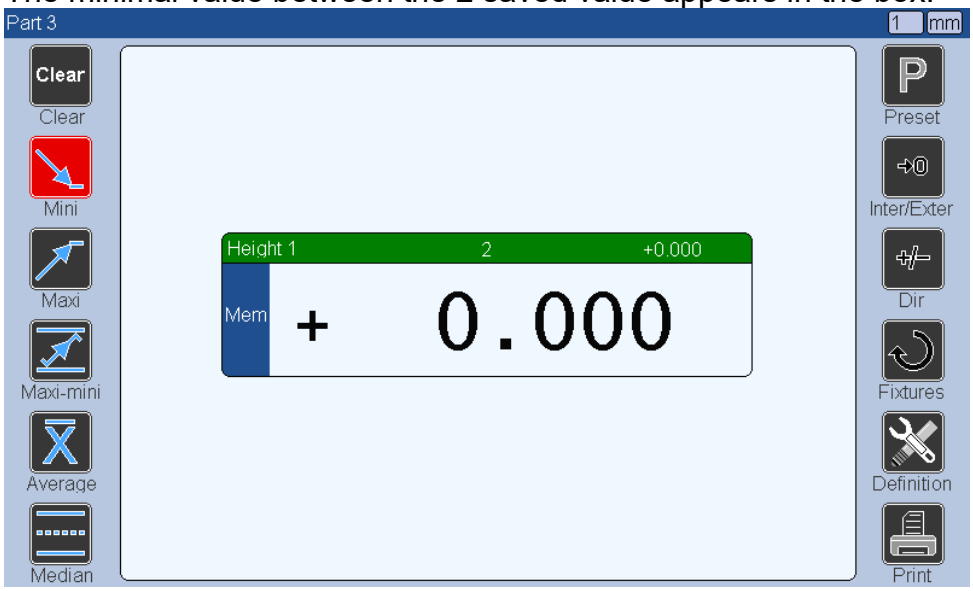
Number of saved values

Box with the « memorisation » button

**Example:**
2 measurements are made and saved.

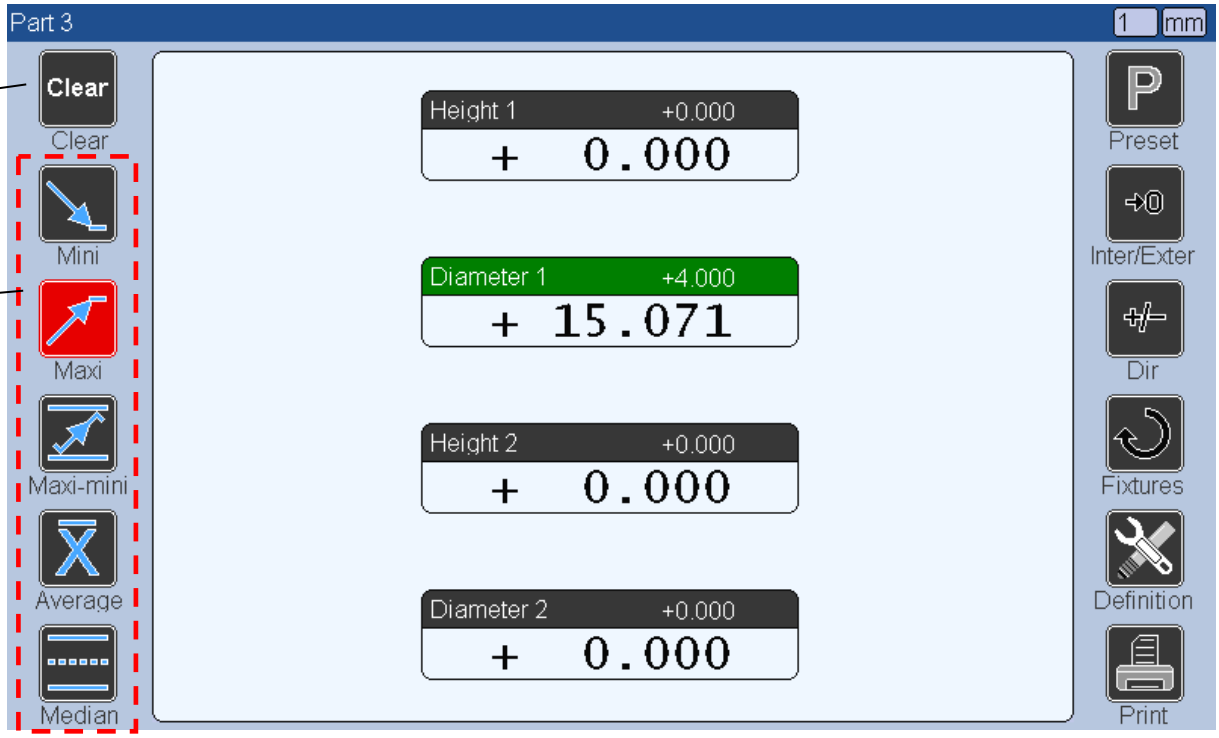
Saved value 1 = 0.000 mm
Saved value 2 = 4.000 mm

After saving the 2nd value, press on the “mini” button.
The minimal value between the 2 saved value appears in the box.




For restarting, click on the “clear” button, and the counter value will restart.
For de-selecting a mode, click again on it or select another one.

### 7.2.1.3. Temporary dynamic measurement modes

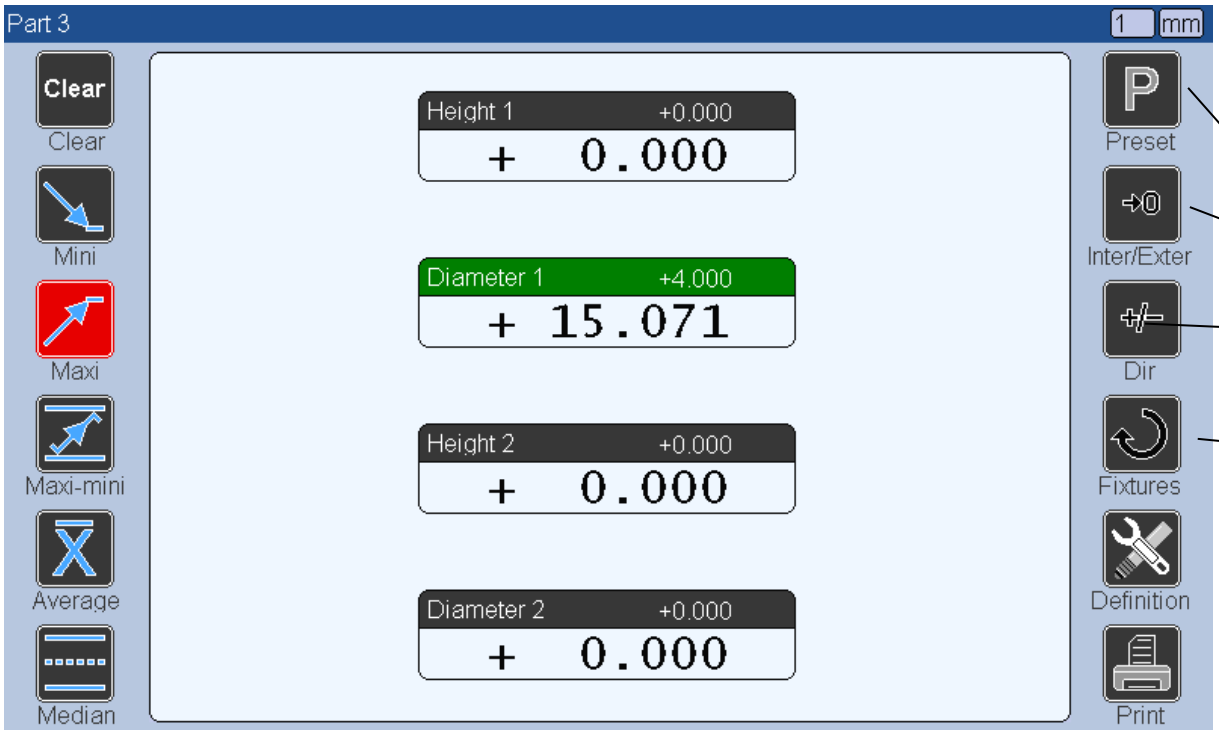



Dynamic measurement modes. The active mode become red. For de-selecting a mode, click again on it or select another one.

Note: the “average” button is normally hidden. For having it, please select “yes” on the menu Configuration→Average.

Press here to start a dynamic measurement.

### 7.2.1.4. Other functions

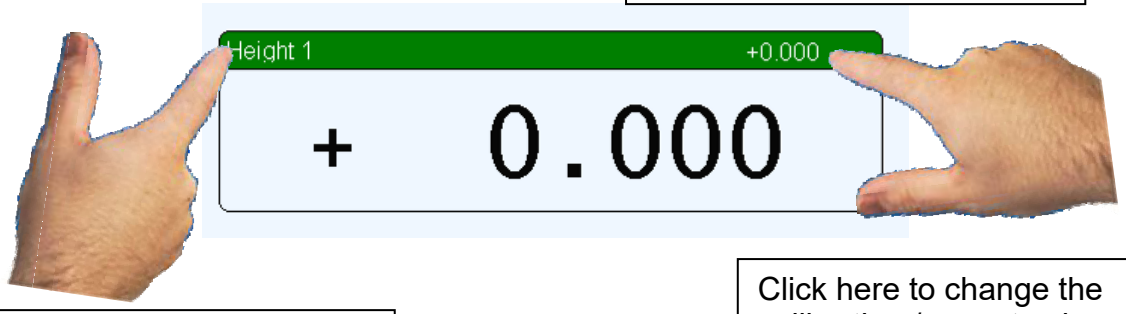



Change the active fixture

Change the measurement direction

Set at zero (0) the measurement

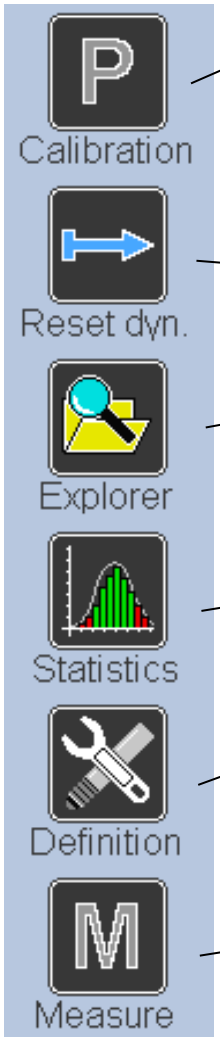
Preset the active characteristic




Click here to change the characteristic's name

Click here to change the calibration / preset value

## 7.3. MEASURING SCREEN MENU




Before starting to measure, you must preset the M400. Place a master part below your probe and press this button. If you have selected the calibration control mode, the control test will be asked right after the calibration.

Start the dynamic measurement (Mini, Maxi, Maxi-Mini (TIR), Average, Median)

Allows to display the explorer and to select another part reference (for erasing, copying or creating a part reference, go to the explorer of the icon desktop)

Allows accessing to the statistic functions, see chapter 9.

Access to the icon desktop for the device and part configuration.

Transfert and/or save the measurements to the RS232 or to the USB

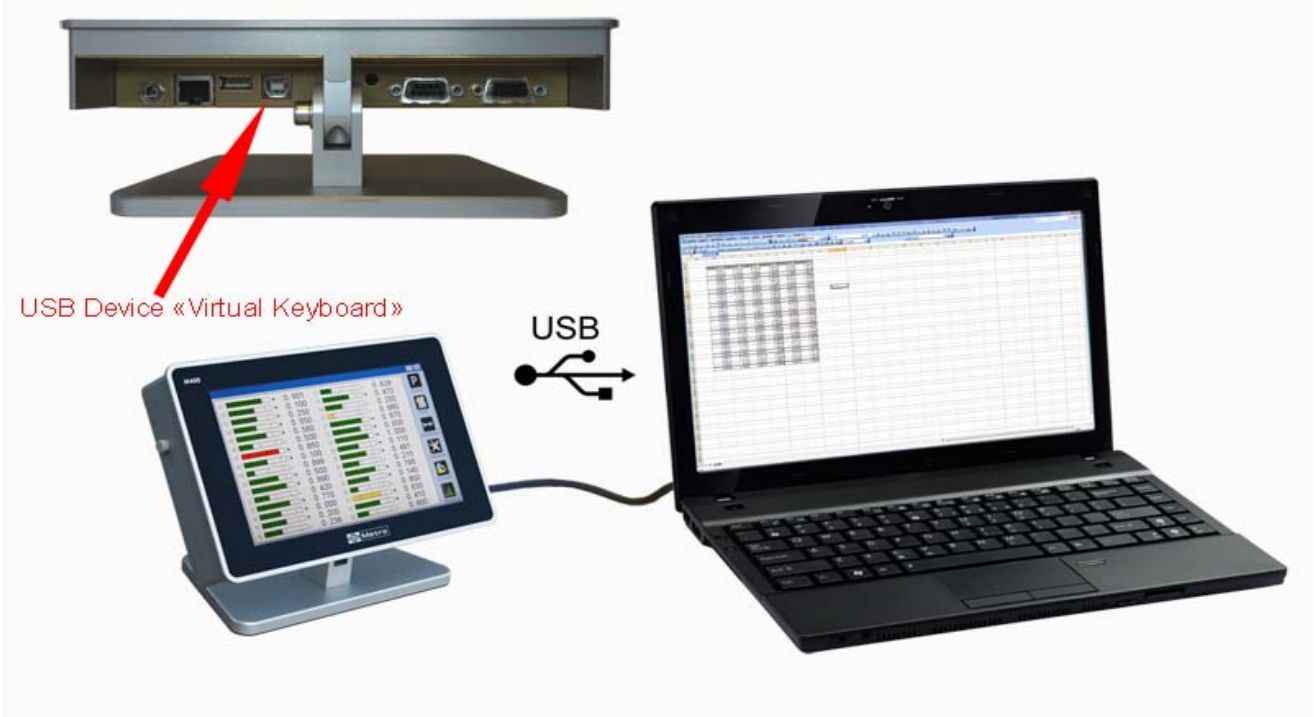
# 8. DATA EXPORT

The M400 allows to save and/or export the measurement data.
Several possibilities:

## 8.1. USB device class “virtual keyboard”

This method is the most simple to carry out.
No driver or specific software is required.

Connect the M400 on the USB device connector onto your computer with a standard USB-A / USB-B cable.




Go to the configuration Windows from the icon Desktop :


Then select :

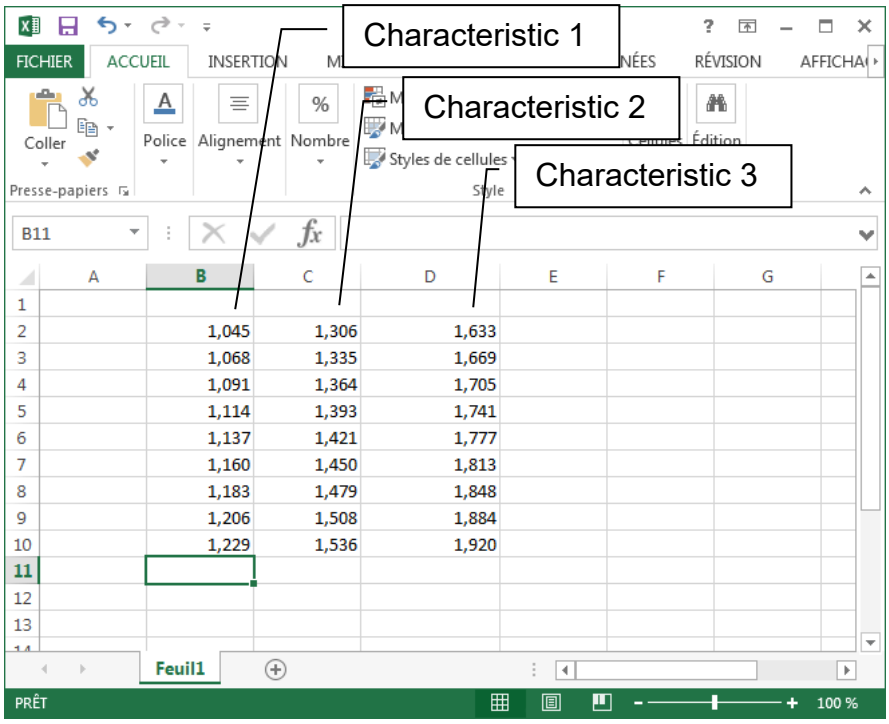
- Function 1 : « Transfert »
- Transfert : Keyboard

Close this window and come back to the measuring screen. The M400 is ready to transfert.

Open an Excel sheet, or any other spreadsheet software.
Position your computer's cursor where you want to have the data.

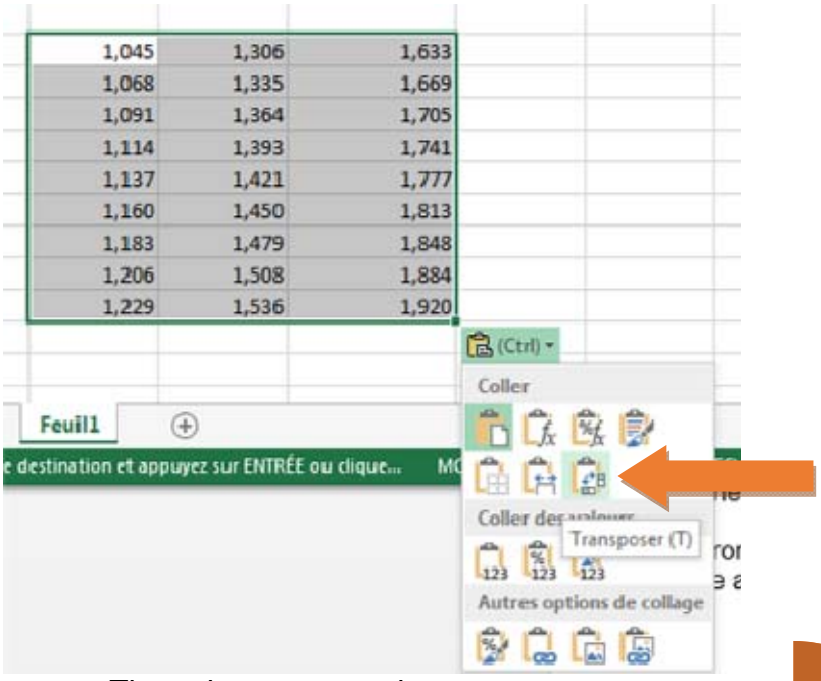
Press on the "Measure" button of the measuring screen or press on the footswitch.

The measurement(s) will appear in your computer, in column:

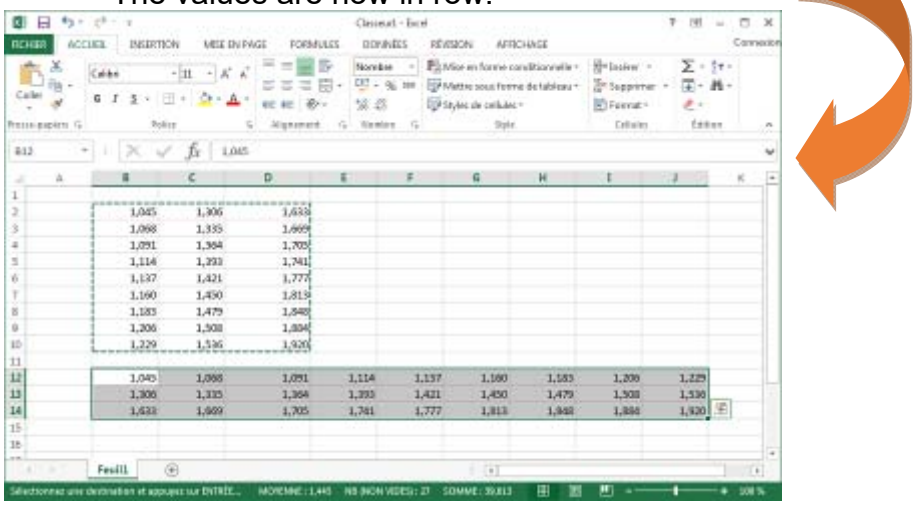



Note : Excel allows easily to convert columns to rows, if you would prefer to have it in row. Procedure :

- Select the values.
- Copy the values.
- Position your cursor on a cell.
- Past the values. After pasting the value a menu appear close to the cursor
- Click on the  icon




- The values are now in row.



From the configuration windows, if you select " function 2 : MEM", the same data will be also stored on the M400 Memory (see chap 9)

You have the possibility to choose for each characteristic if you want to transfer it or not. It must be defined from the menu: PART→ Characteristic→ Transfer = Yes or No

## 8.2. Direct record the measurements on a CSV file on a USB Stick

With this function it is possible to save the measurements directly on a USB stick. So you are not limited with the M400 memory, but by the capacity of the USB stick.
**The M400 supports the FAT-32 or FAT-16 formatted USB stick.**

Connect your USB stick on the USB host connector.
A USB logo will appear in the information bar, confirming that your UBS stick has correctly been installed.


The USB logo appears when the USB stick has been detected.

Then configure the Configuration menu the following way :

- Function 1 : « Transfert »
- Transfert : USB

Close this window and come back to the measuring screen. The M400 is ready to save the measurement on the USB stick.

Press on the “Measure” button of the measuring screen or press on the footswitch.

A M400.CSV file will be created on the USB file.
If you have a part reference name, the name of the CSV file will be partreference.csv”.
If you have entered a batch number (see chap 6.1), the name of the CSV file will be batchnumber.csv”.

The file has a header with the name of the characteristics and the tolerances of each characteristics
1 line by measurement is created. At the end of each line a GO/NG indication is written + the date and time.

Each time you will press the “Measure” button or the footswitch, a line will be added on this file. The “Measure” button becomes green while the data is saved.

From the configuration windows, if you select “ function 2 : MEM”, the same data will be also stored on the M400 Memory.

Note : A *.csv "***Comma-separated value***“, file stores tabular data (numbers and text) in plain text. Each line of the file is a data record. Each record consists of one or more fields, separated by commas ( **by a semicolon “ ; “ on the M400**).
This file can be opened easily on Excel or any other spreadsheet software.
On Excel, open the file, select the values (all the values are be on the same cell), then chose Data→Convert. On the window select “delimited”, and “ **;** “ as a separator.

# 9. STATISTICS

## 9.1. Forewords about statistics

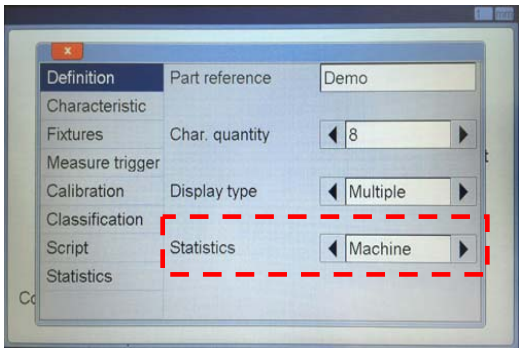
The M400 is able to store up to 30'000 measurements by part reference (up to 64 part references can be stored on the M400).
These measurements can then be processed locally for statistical analysis.

2 statistics mode are available: Machine or SPC (process)

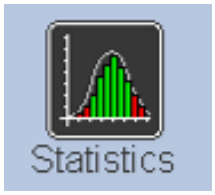
Attention: The M400 cannot be compared or cannot replace a full SPC software on a computer.
It shall be considered as a local tool for small series and for information only. It gives an information that can be useful to adjust the machine.
Calculations are made and have been successfully tested according to the FORD QS9000 standards.

## 9.2. Machine Statistics

First it is necessary to set the menu “PART→Definition→Statistic” with the parameter “Machine”



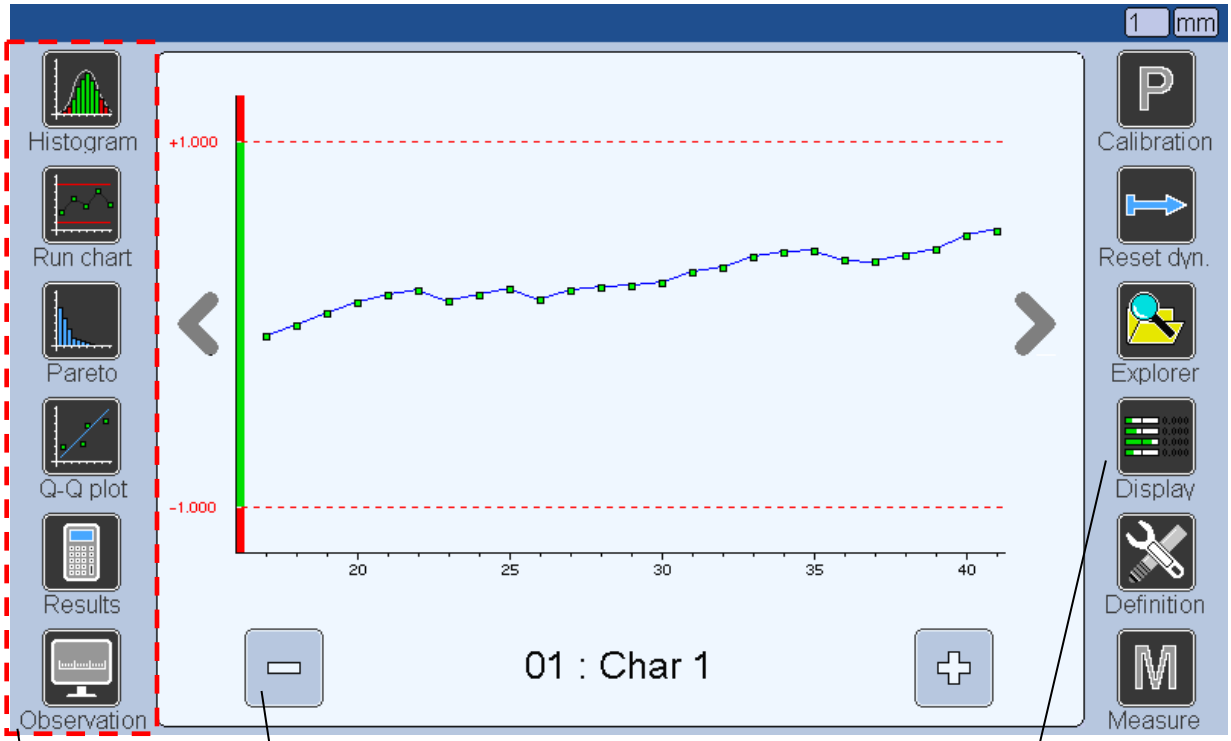

The statistic screens can be reached by clicking on the




button (located on the measuring screen)

Several screens are then available and are described on the next chapters:

**General presentation of the Statistic screen :**

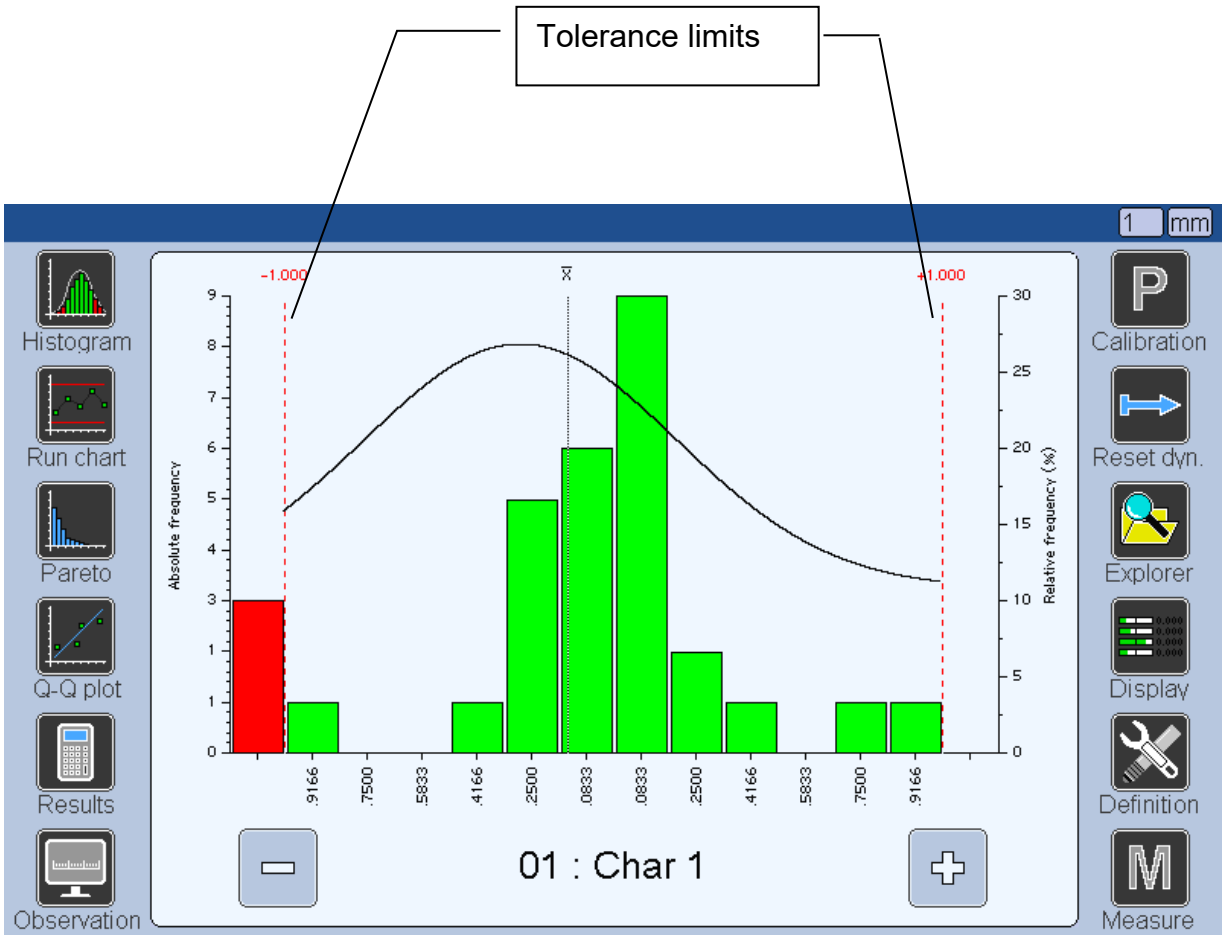



Characteristic change

Back to the measuring scren

Selection of the different statistic screens. See the next chapter for further details.

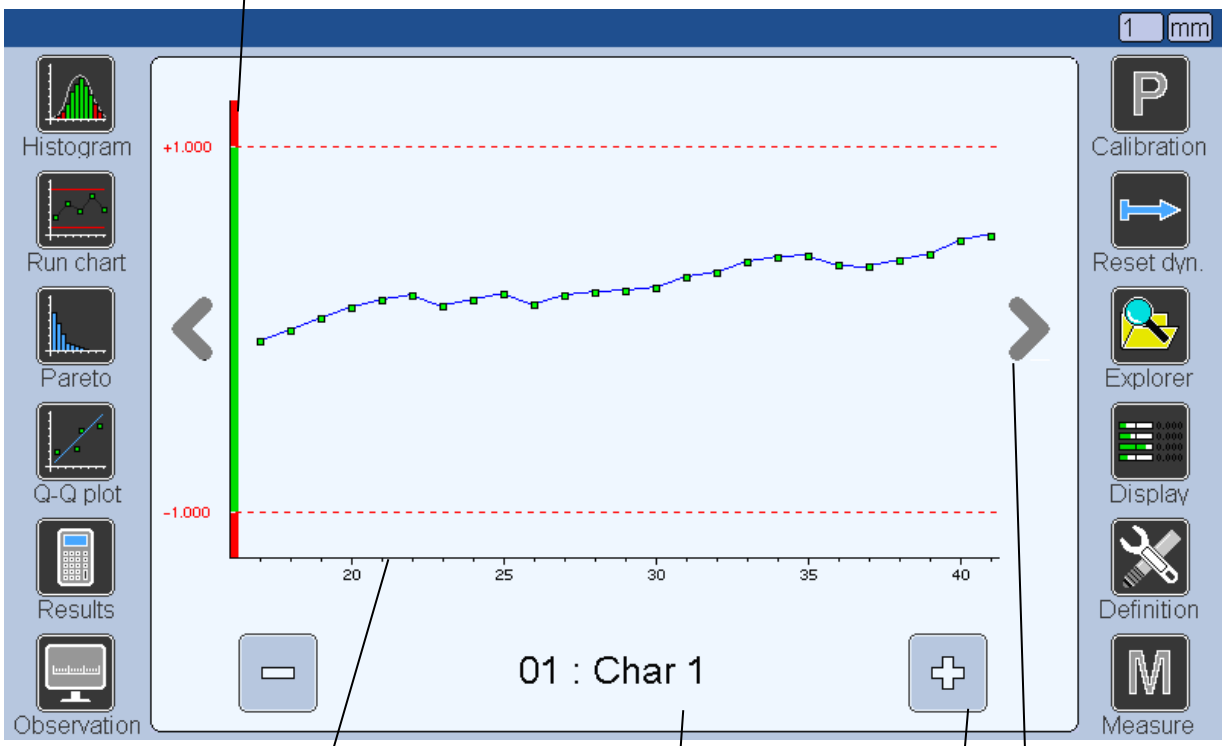
## Histograms with Gauss curve




The number of bars of the histogram is the square root of the sample number.
The measured parts are then classified on a Histogram in function of their position in the tolerance interval.
A curve helps to see if the repartition is Gaussian and shows the relative frequency in percentage.

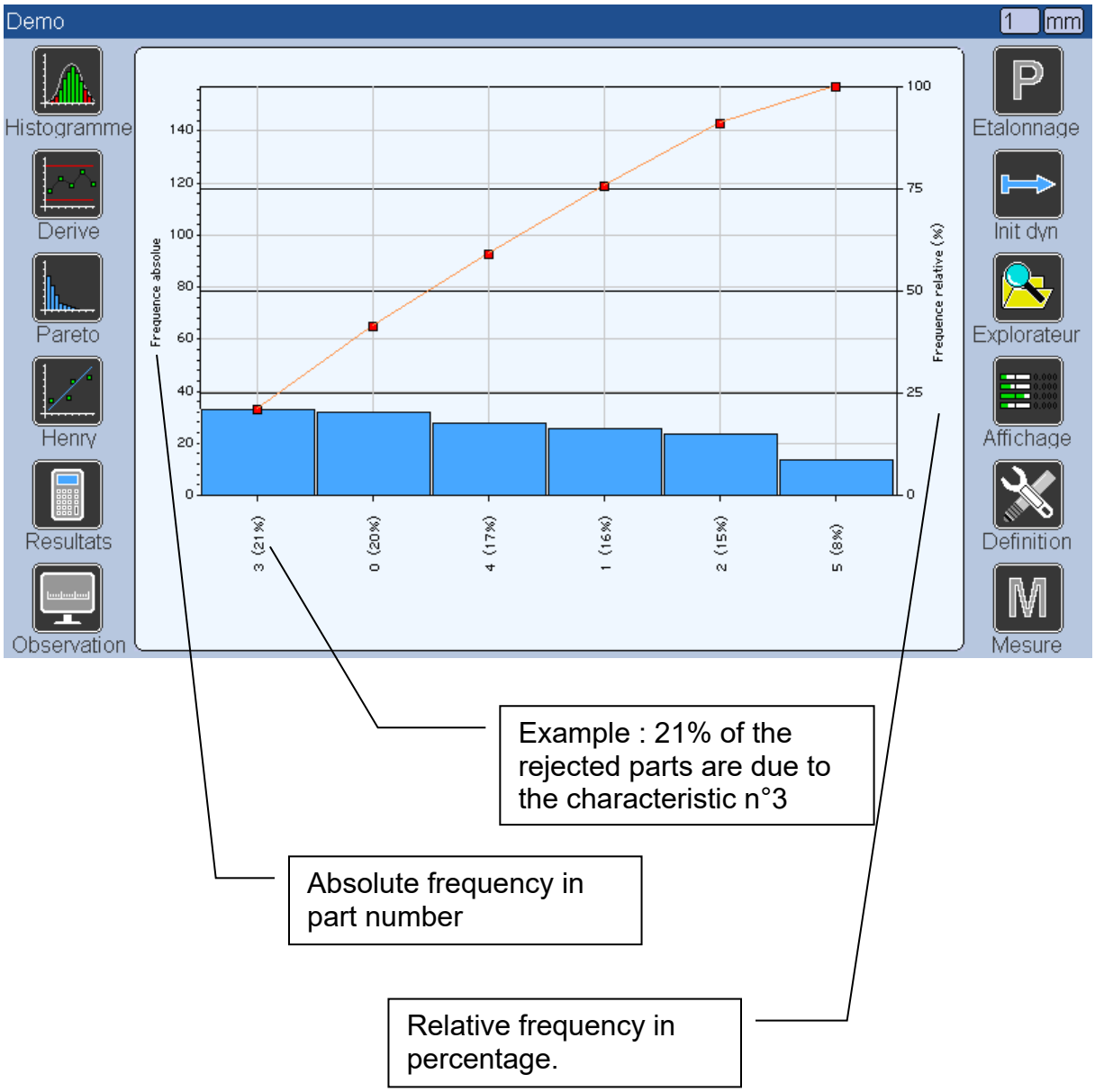
## Evolution of the characteristic in the time (RUN CHART)

This screen allows to see the evolution of a characteristic in the time and to see its position from its tolerances.
Tolerance limits are represented by red lines.
Each measurement is represented by a square that become red, yellow or green depending on its value compared with its tolerances.



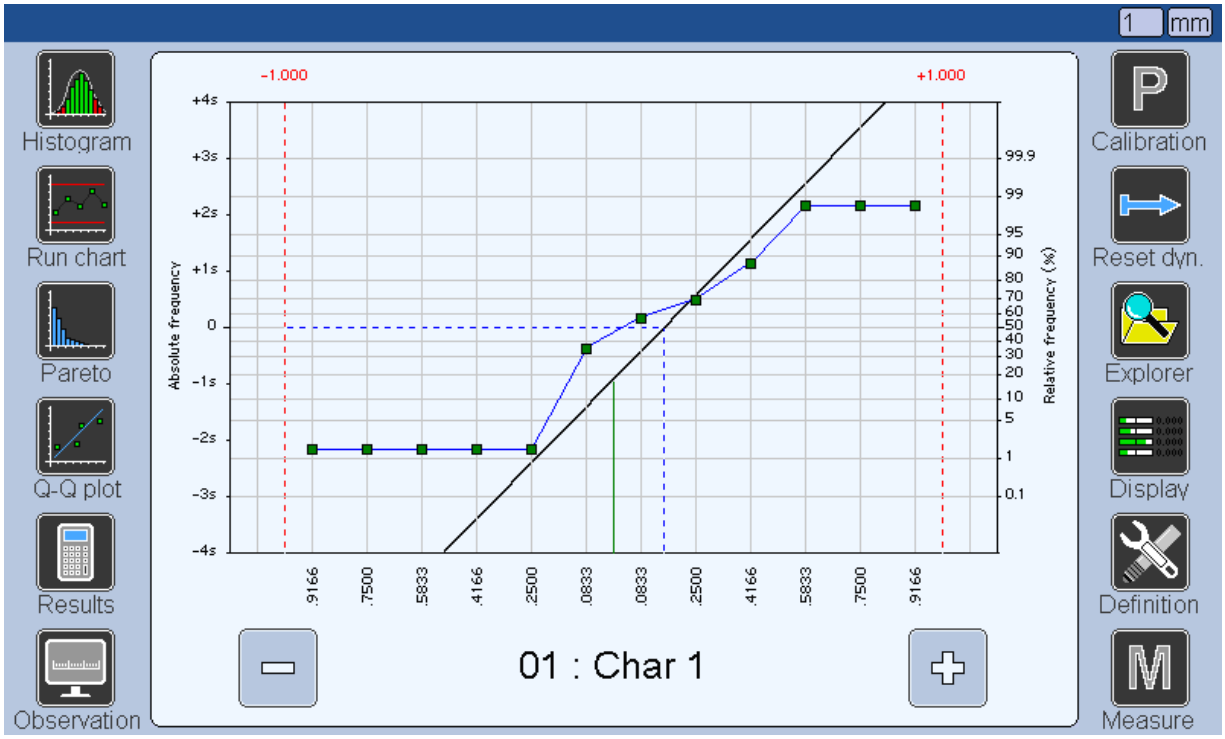
## Pareto chart

The Pareto analysis is statistical technique that is used for selection of a limited number of tasks that produce a significant overall effect. It uses the Pareto principle – the idea that a large majority of problems (80%) are produced by few key causes (20%)
For our dimensional control applications, this chart allows sorting the characteristics by frequency of apparition in the out-of-tolerance zone. This method allows knowing which characteristic generates the most problems on a part and therefore facilitates carrying out the most effective corrective actions.



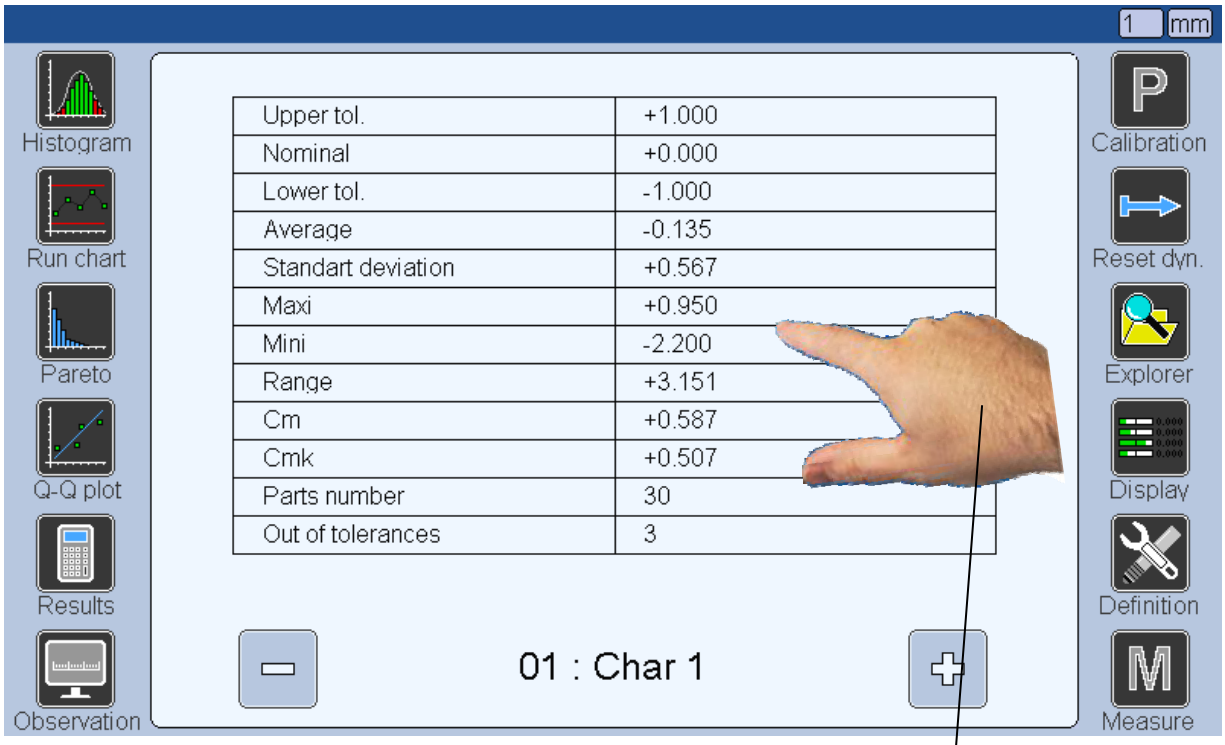
## Q-Q plot

A Q-Q plot (Q stands for Quantile) is a probability plot, which is a graphical method for comparing 2 probability distributions by plotting their quantile against each others.

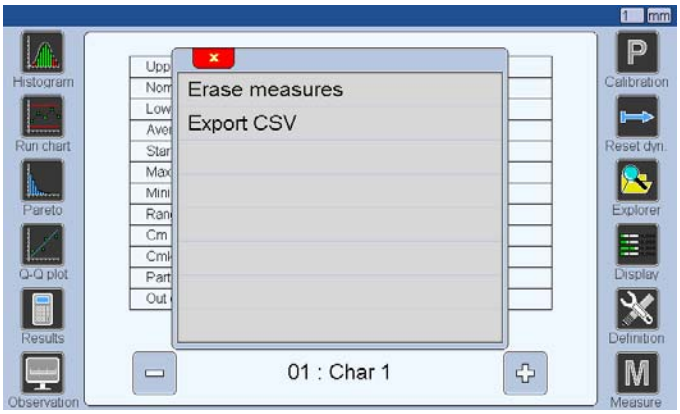


## Results

This screen allows seeing the measurement results by characteristics.



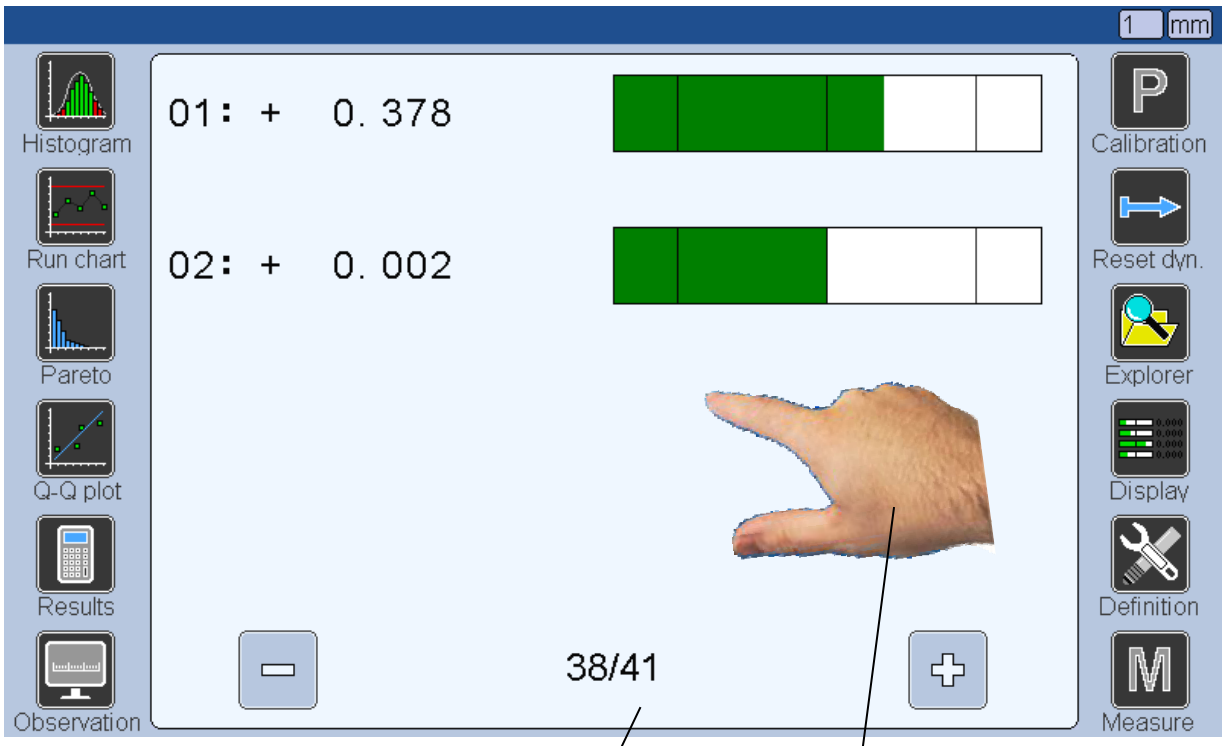

By touching this table you have the possibility to either erase all the measurement and come back to the measuring screen or to save the measurements on a CSV file if a USB stick is connected. A *.csv file will be created on the USB Stick. The file will take the name of the part reference.




Screen that appears after touching the table

## Observation

This screen allows seeing all the saved measurement with bargraphs and numerical values.

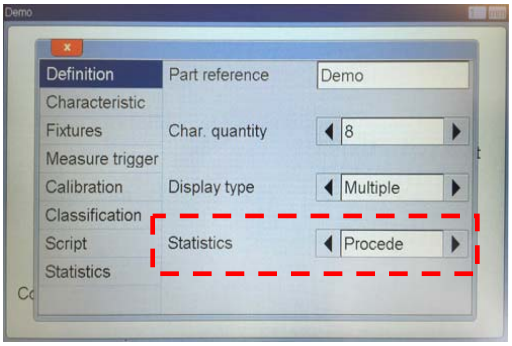



Part number

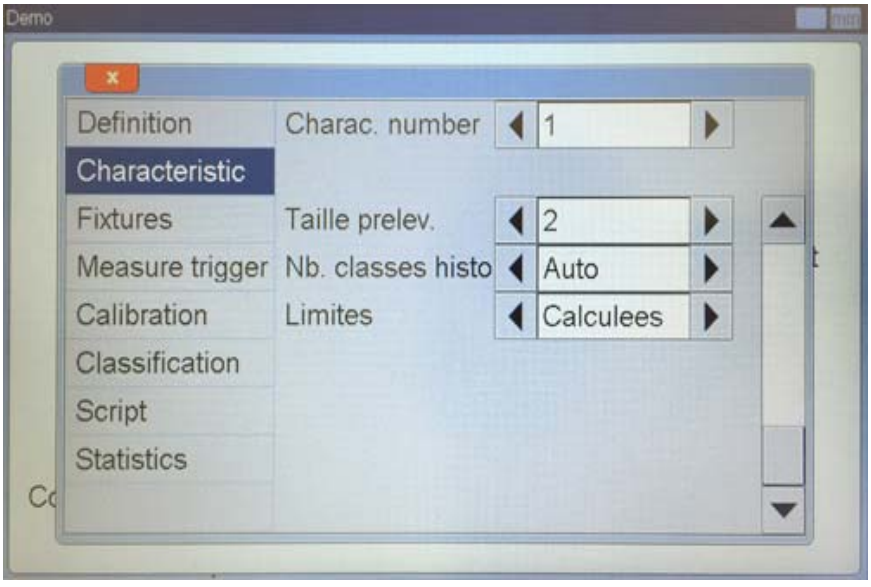
In case of several fixtures just touch the screen to change the fixture

## 9.3. SPC Statistics

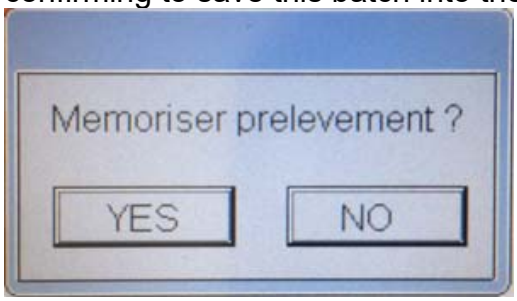
First it is necessary to set the menu “PART→Definition→Statistic” with the parameter “Process”



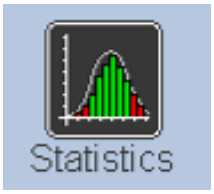

Then a batch size (number of samples) must be defined on the Menu PART→Characteristic




From the measuring screen, you must press on the “Measure” button to save one sample. After reaching the defined number of samples, a message will appear for confirming to save this batch into the M400 Memory.



The statistic screens can be reached by clicking on the




Button (located on the measuring screen)

The same screens than for the “Machine” statistics are available except the Run Chart replaced by the SPC :

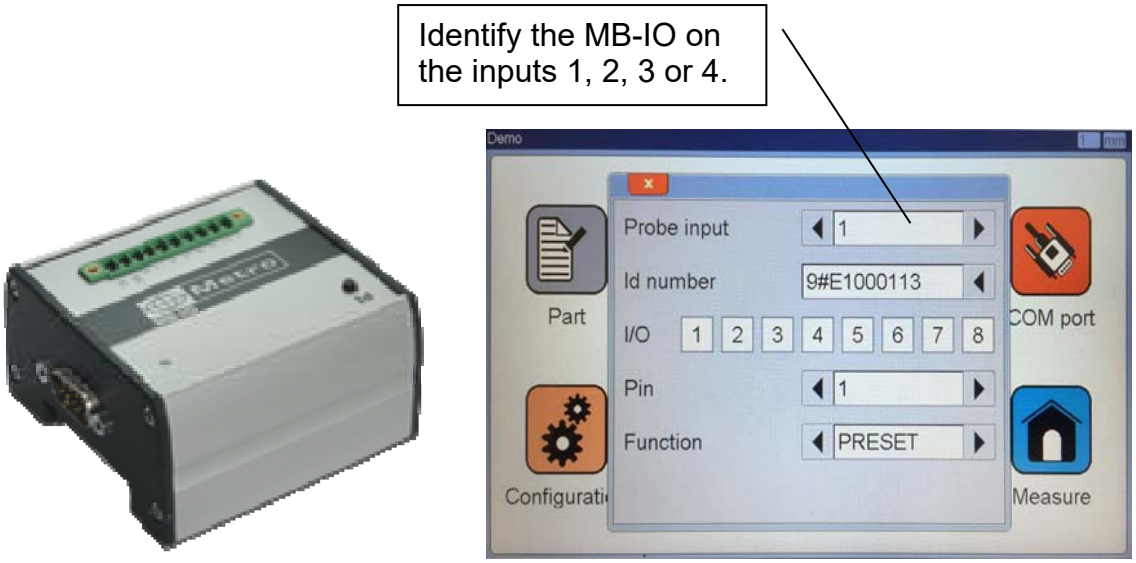
On this screen you can display an $\bar{X}$ / s chart (Average and Standard deviation) or an $\bar{X}$ / R chart (Average and Range). This choice can be made by touching the Title “X-bar / s chart” as shown on the above image.
Each point of the curves corresponds to one batch.

# 10. PLC scripts

## 10.1. Presentation

*~ An example of script can be seen on the APPENDIX section. ~*

Your M400 can be programmed with PLC functions using MB-IO modules (M-Bus modules with 8 inputs/outputs). Maximum 4 MB-IO modules can be used, so 32 I/O are potentially available.
I/O modules have to be connected on the first 4 M-Bus IDs. They have to be identified before the probes on the Bus.
To identify a MB-IO module, follow the same procedure as for a probe (see chapter 4.3), but instead of moving the probe tip, press on the ID button located on the module.




These functions give the following possibilities:

- Direct automation of a machine by the M400
- Automation of the measurement by an external system (PLC)
- Transmission of message on the serial link, or display of messages on the screen in function of programmable events.

The « Basic » programming language allows to define action in functions of inputs or internal status of the M400. A PLC program has therefore to be defined.

## 10.2. Program architecture

A PLC script is composed by a number of sequences executed one after each others. At the end of the cycle it starts again from the beginning.

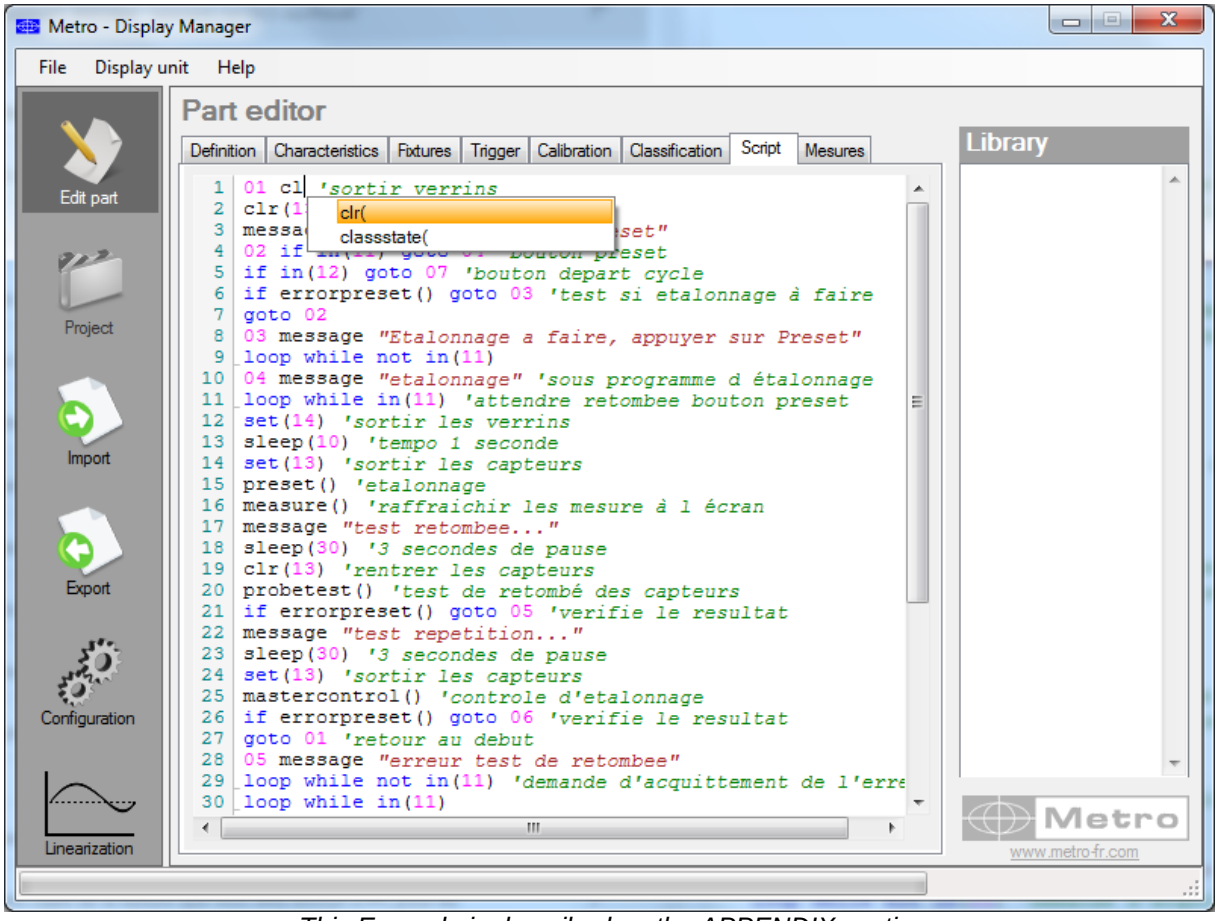
A sequence is a row of instructions that are executed in a sequential way until the last instruction of the list has been executed. Inside a sequence, it is possible to read inputs, to define output status, to test the M400 status, to make loops and conditional calls. It is also possible to send information on the screen or on the RS232 port.

## 10.3. Editor

The script has to be entered from the M400 display manager software.

An editor with a coloured syntax allows to input the sequences.

For transferring the script into the M400, just press on the EXPORT button, like for a part configuration.




*This Example is described on the APPENDIX section*

When your script is finished, you have to select the option “PLC” in the menu part→measure trigger.

A syntax control is done at each line. This feature checks the input errors (missing brackets, instruction position, wrong instructions…) and correct them.

For example if you enter :
- sceen(01), the editor will correct it to screen(01).
- screen(01, the editor will correct it to screen(01)
- etc…

## 10.4. Structure of a sequence line

*[label] [test condition] action if condition true (#0) [action if condition wrong (=0)]*

Part between [ ] are optionnal
Each of the 4 parts is separed by a space.
A label is a decimal number with 2 figures from 01 to 32.

## 10.5. Loops

The following instructions can be used :

- loop while : Loop « while the instuction is true »
- loop until : Loop « until the instruction become true »

Examples :
**loop while footswitch()** : wait until the de-activation of the footswitch
**loop until footswitch()** : wait a footswitch action

## 10.6. Tests

- if … else … : Test « if condition true… else…
- not : negation

Examples :

if not in(12) preset() else goto 01: if input 12 de-activated calibrate else go to sequence 01

9.4 Labels

Located in the beginning of a line, they allow to come back to the next instruction thanks to a goto instruction . From (01 to 09).

Example :
**01 measure()**
**If not footswitch goto 01**

9.5 Inputs / Outputs

in(nm) : test of the input “m” of the MB-IO module number “n”
set(nm) : activate the output “m” of the MB-IO module number “n”
clr(nm) : : de- activate the output “m” of the MB-IO module number “n”
Footswitch() : test of the footswitch input (return true if footswitch is activated)

Example :

**set(13)** : activate the output “3” of the MB-IO module number “1”(M-Bus ID n°1)
**if footswitch()** : test of the footswitch input status

## 10.7. Functions

Predefined function that can be used :

| | |
|---|---|
| measure() | : function for characteristic calculation and display refresh |
| display() | : function to display a dialog box on the screen |
| print() | : function to send message on the RS232 port |
| initdyn() | : function to initialize dynamic measurement |
| preset() | : function to calibrate the active fixture |
| screen() | : function to call a fixture |

Examples :

```
screen(01)
if in(11) preset()
if in(12) initdyn()
measure()
print “end of cycle”
```

function “print”

For sending a text on the RS232 port, the instruction has to be used in the following way : **print “your text“**
The text must be between brackets.

It is also possible to send an ASCII character between 00 and 99 : **print(13)**

It is also possible to send a characteristic value (see chapter 9.6, internal status) : **print(charvalue(01))**

function “display”

This function use the same principle than the « print » function

function “screen”

The fixture number from 01 to 32 must be between brackets.

9.6 Internal status

- charvalue(n) : return the value of the characteristic « n »
- charstate(n) : return the status of the characteristic « n »
- classstate(n) : return the status of the class « n »
- partstate() : return the part status

n = characteristic number 01 to 32

Example :
**if partstate() set(11) else clr(11)**

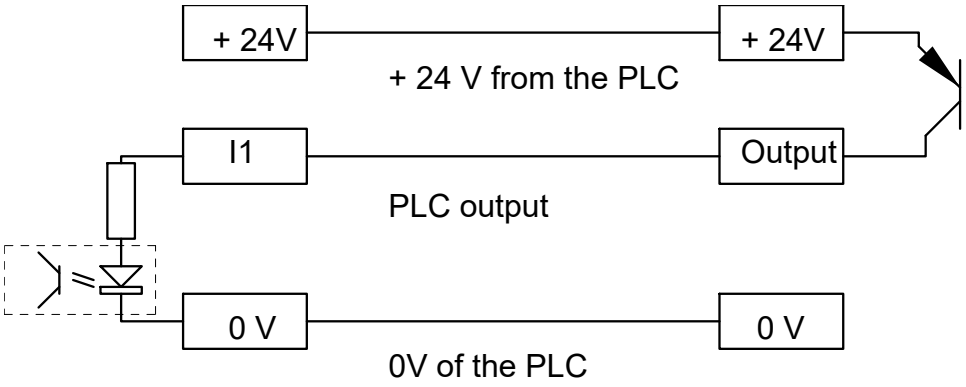
## 10.8. Module I/O ref. MB-IO

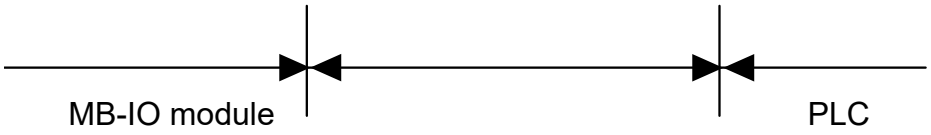
MB-IO modules are fitted with 8 optocoupled inputs/.
Modules (max 4) must be identified on the M-Bus ID 1 to 4.

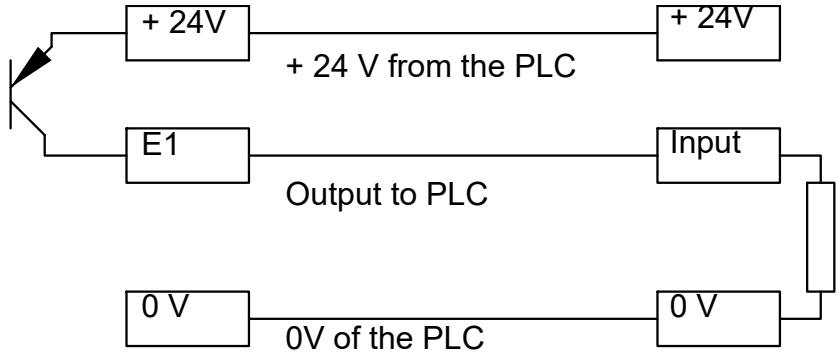
The 8 outputs are similar to the « open collector PNP » type. They can be used with an external power supply 12 to 30 VDC maximum. The maximal output current drained by each output is 50mA

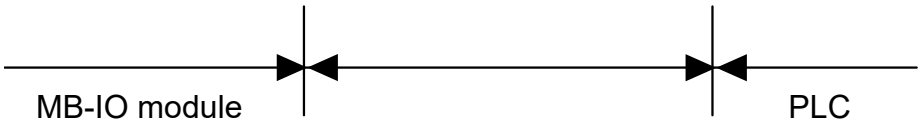
The 8 inputs represent a 2.2kOhms load connected to the 0 volt.

The inputs and outputs are isolated by optocoupler.




Examples of connection between a PLC and a M400

# 11. COMMUNICATION

## 11.1. ASCII Protocol (Ethernet and RS232)

### Presentation

All the instructions are ended by a « carriage return » character (ASCII code $0D).
This character will be represented in the next pages of this manual by <CR>

### Simplified commands

These commands return the displayed value of the characteristics.

Format: nn <CR> with nn = characteristic number 01 to 32.

Example to read the characteristic number 1:

We send 01<CR> and the M400 return a value in the following format:
+000.00000<CR>

### Format

The ASCII protocol consists of exchanging reading or writing messages on the following general principle:

| | |
|---|---|
| General status reading | **PnnEkkk? <CR>** |
| General status writting | **PnnEkkk=x<CR>** |
| Reading of Real number | **PnnRkkkk ? <CR>** |
| Writing of Real number | **PnnRkkk=±eee.ddddd<CR>** |

*Parameters*:

**n** = characteristic number 0 to 31
**E** = Status
**R** = Real
**kkk** = function number
**e/d** = real value with fixed presentation :valeur ±000.00000
Each message ends by **<CR>**

*The transmission format is defined in the menu "COM port" see chapter 6.4*

| | |
|---|---|
| Speed | 9600 by default |
| Start bit | 1 by default |
| Bits number | 8 by default |
| Parity | Without parity by default |
| Stop bit | 1 by default |

In writing, the M400 returns each message for acknowledgment at the end of the requested action (50 to 700ms depending on the action and the configuration).
If the function does not exist, le M400 returns the message header followed by "=ERR".

For example if you try to write in the function 35 that does not exists, the answer will be PnnE050=ERR<CR>

## List of the status instructions

| Function | Direction | Description |
|---|---|---|
| **General instructions :** | | |
| 000=txt | RW | Name of the characteristic (20 characters) |
| 001=1 to 5 | RW | Resolution : number of decimals |
| 002=0 to 1 | RW | Intermediate characteristic 1 = yes et 0 = no |
| 003=0 or 1 | RW | Characteristic origin : 0 = probe et 1 = other |
| 004=0 or 5 | RW | Characteristic type :<br>0 = static<br>1 = mini<br>2 = maxi<br>3 = maxi-mini<br>4 = average<br>5 = median |
| 006=0 or 1 | RW | Control limits activated : 1 = yes, et 0 = no |
| 007=0 to 2 | RW | Unit : 0 = mm ; 1 = inch ; 2 = DMS |
| 008=txt | RW | Formula : max 49 characters |
| 009=txt | RW | Part reference : max 20 characters |
| 012=1 to 32 | RW | Number of characteristics |
| 017=1 to 16 | RW | Number of classes |
| 018=0 to 31 | RW | Classified characteristic |
| 019=0 or 1 | RW | Calibration mode : 0 = calibration et 1 = control |
| 024=0 to 31 | RW | Fixture number |
| 027=0 to 2 | RW | Trigger : 0 = continuous, 1 = PLC et 2 = Cyclic. |
| 031=1 | W | Refresh the display |
| 032=0 or 1 | RW | Stop mode |
| 033=1 | W | Calibration |

## List of real values

| Function | Direction | Description |
|---|---|---|
| 000 | RW | Upper tolerance |
| 001 | RW | Lower tolerance |
| 002 | RW | Upper contro l limit |
| 003 | RW | Lower control limit |
| 004 | RW | Master |
| 005 | RW | Nominal |
| 006 | RW | Mini class |

| | | |
|---|---|---|
| 007 | RW | Maxi class |
| 008 | RW | Fixture threshold min |
| 009 | RW | Fixture threshold max |
| 010 | RW | Stand-by value (for calibration control) |
| 011 | RW | Repetition value (for calibration control) |
| 012 | W | Displayed value |

## Examples

- Asking the displayed value of the characteristic number 1:
  Question : P01R012 ?CR
  Answer : P01R012=+012.49500CR

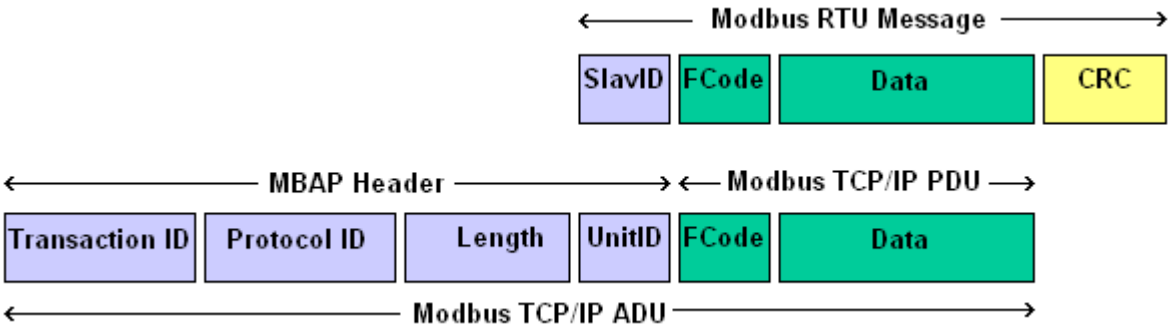
- Asking the resolution of the characteristic number 2 :
  Question : P02E001 ?CR
  Answer : P02E001=2CR (3 décimales)

- Change the resolution to 4 decimals :
  Question : P02E001=3CR
  Answer : P02E001CR

## 11.2. MODBUS protocols (TCP and RTU)

This protocol allows to connect the M400 on a compatible PLC.

This protocol allows to control the entire functionalities of the M400 with numerous registers. (up to 256 registers can be read by Modbus telegram)
The M400 is the TCP server. It is accessible through the 502 port (adjustable on the menu “Network” in the icon desktop.).




The SlavID adress is always 1.
The M400 can deal with the codes “3” and “16” in writing.

**The following functionalities are available:**

- Reading of the 99 probes position
- Instantaneous reading of the 32 characteristics value
- Calibration
- Reading / programming of the tolerance, master, formula…

*Registers are composed by 1 or several 16 bits words.*

| Function | Adresse | Size (word) |
|---|---|---|
| Calibration (R/W) | 0 | 1 |
| Start dynamic measurement (W) | 1 | 1 |
| Rs232 Transfert (W) | 2 | 1 |
| Active fixture | 3 | 1 |
| Acitve program | 4 | 1 |
| Number of characteristics | 5 | 1 |
| Life word (change every 100ms) | 6 | 1 |
| Stop | 7 | 1 |
| M400 active | 8 | 1 |
| Part reference (R/W) | 10…19 | 1 |
| Print header (R/W) | 20…29 | 1 |
| Formula (R/W) | 100...119 | 20 |
| Unit (R/W) | 120 | 1 |
| Control limit activated (R/W) | 121 | 1 |
| Intermediate characteristic (R/W) | 122 | 1 |
| Resolution (R/W) | 123 | 1 |

| | | |
|---|---|---|
| Characteristic status : (read only) -> 0 = ok / 1= inf tol / 2 = sup tol | 124 | 1 |
| Characteristic origin (R/W) | 125 | 1 |
| Characteristic type (R/W) | 126 | 1 |
| Nominal (R/W) | 127 | 2 |
| Lower tolerance (R/W) | 129 | 2 |
| Upper tolerance (R/W) | 131 | 2 |
| Master (R/W) | 133 | 2 |
| Measure (R) | 135 | 2 |
| Lower control limit (R/W) | 137 | 2 |
| Upper control limit (R/W) | 139 | 2 |
| Max of a dynamic characteristic (R/W) | 141 | 2 |
| Min of a dynamic characteristic (R/W) | 143 | 2 |
| Characteristic name (R/W) | 145...154 | 10 |

| | | |
|---|---|---|
| Probes | 7000 … 7196 | 2 |
| | | |

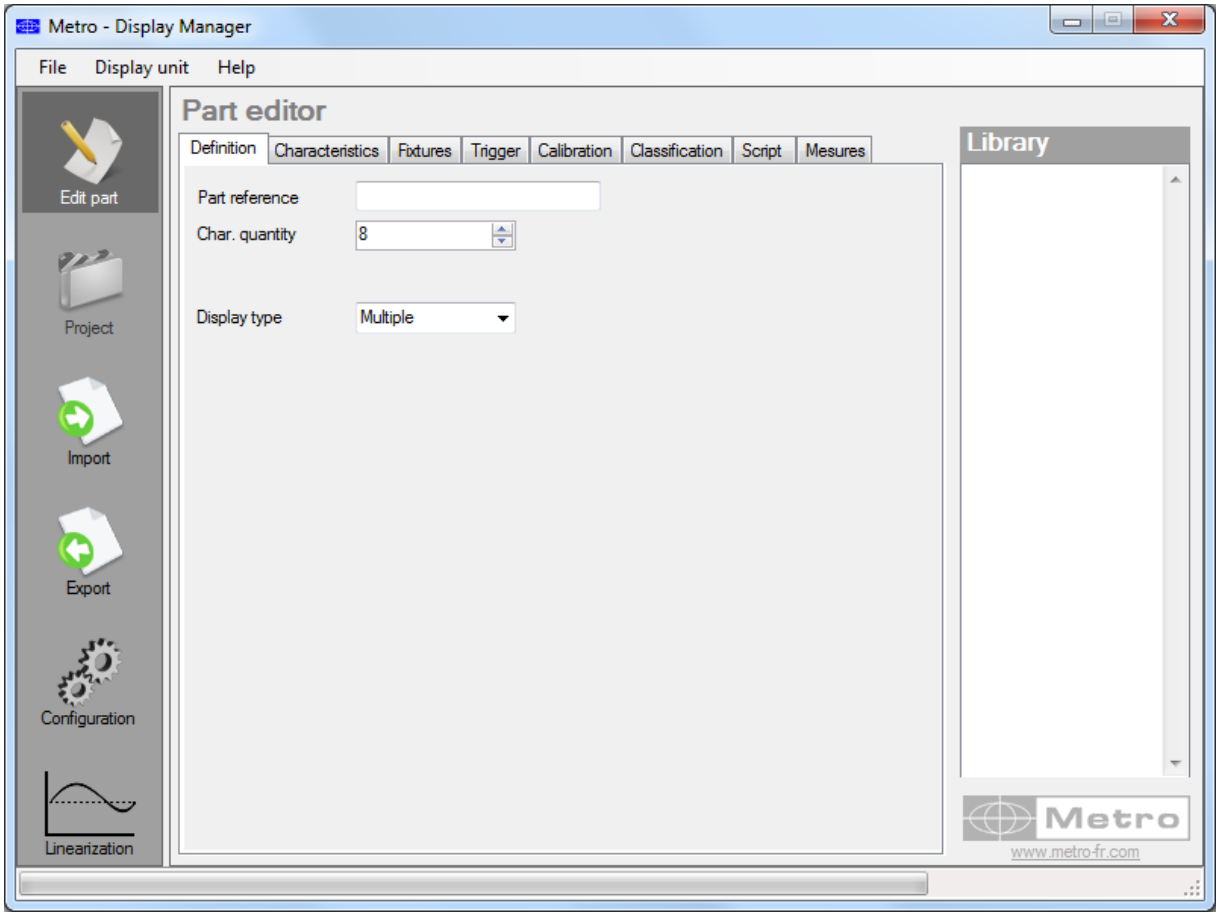
## 12. UTILITY SOFTWARE M400 display manager

The M400 is delivered with a software allowing to edit the part references, import or export the configurations from/to the M400.

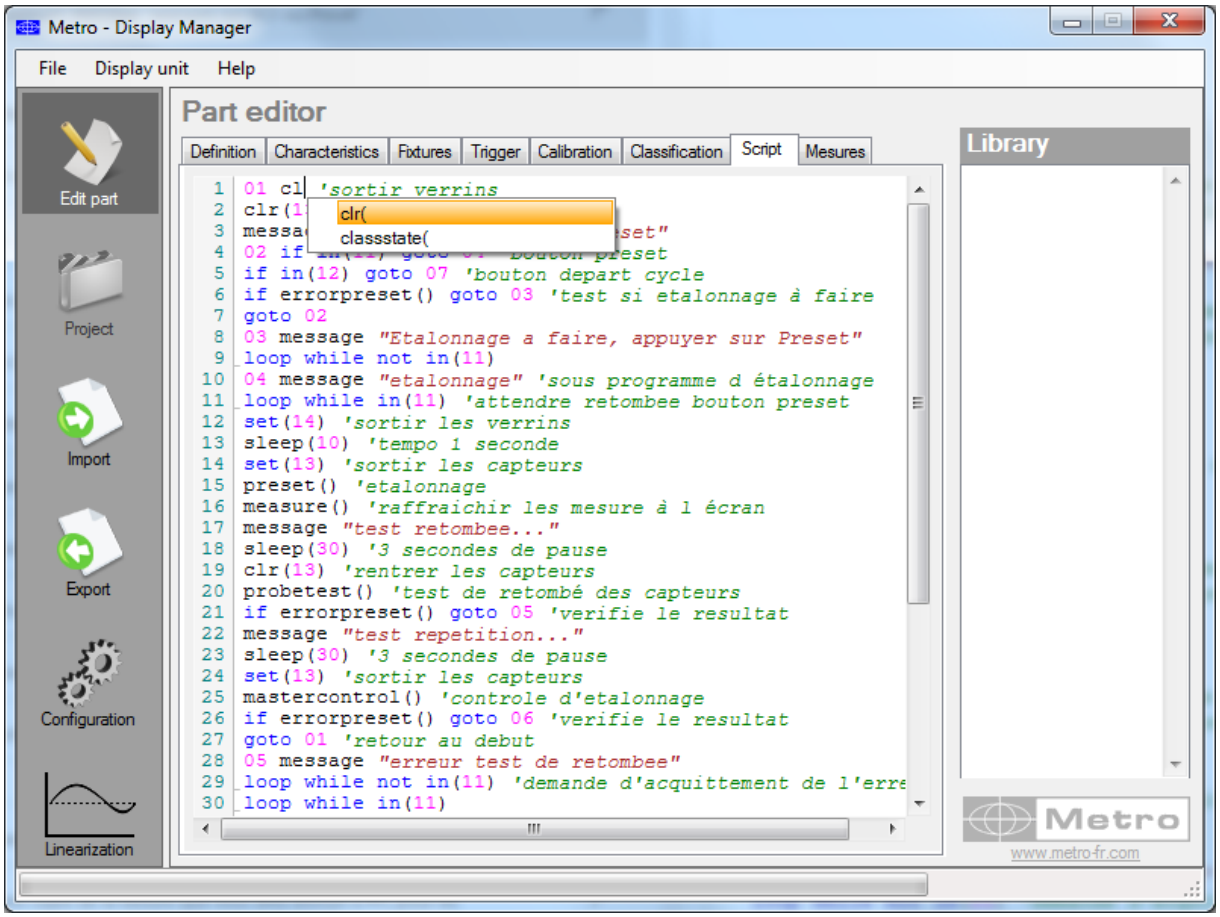
Connect the M400 to your computer with the cable ref 45160.

Launch the M400.exe file located in the CD.
It starts on the part editor.
You can simply edit the part reference, the characteristics etc. as it would have been done directly on the M400. When done, you can save the configuration on a .gm4 file.
After restarting the different .gm4 files will be listed on the library column.

For exporting the configuration to the M400, just click on the “EXPORT” button. A message confirming the success will appear at the end of the transfer.



From this software, you can also write a PLC script :
The editor is fitted with lines numbers, and intuitive tipping function, which proposes choices among the available functions depending the first letters you entered.



## 13. FACTORY SETTINGS RESET

This function allows coming back to the factory setting of your M400.

Warning :

After this procedure, ID numbers of M-Bus modules as well as part reference settings will be erased.

Please follow the following procedure:

1 – Shut down the M400
2 – Power up the M400
3 – When the text « loading : xx % » appears, press on the top left corner of the screen
4 – A blue screen appears with the message « initialization?».
5a – If you want to cancel, shut down the M400.
5b – Confirm by pressing the top right corner. The procedure starts and it take about 5 minutes.

**3**

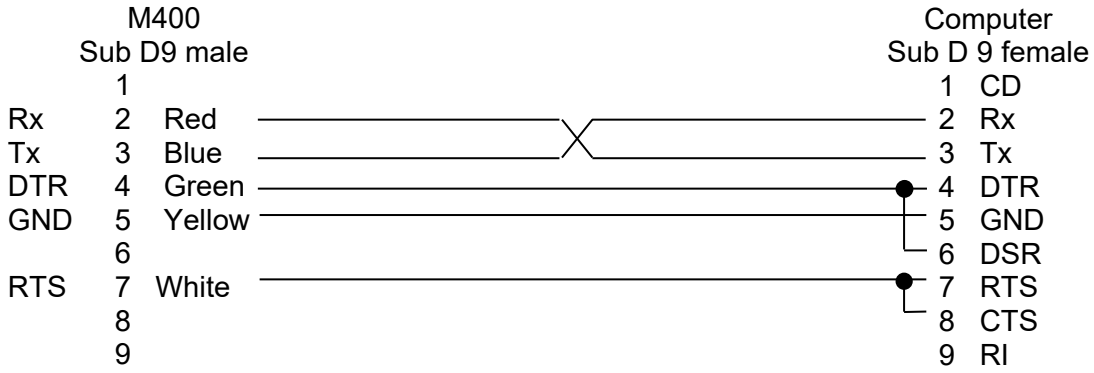

**4**

**5b**

## 14. FIRMWARE UPDATE

The M400 firmware can be upgraded if new functions have been added or a bug has been fixed.

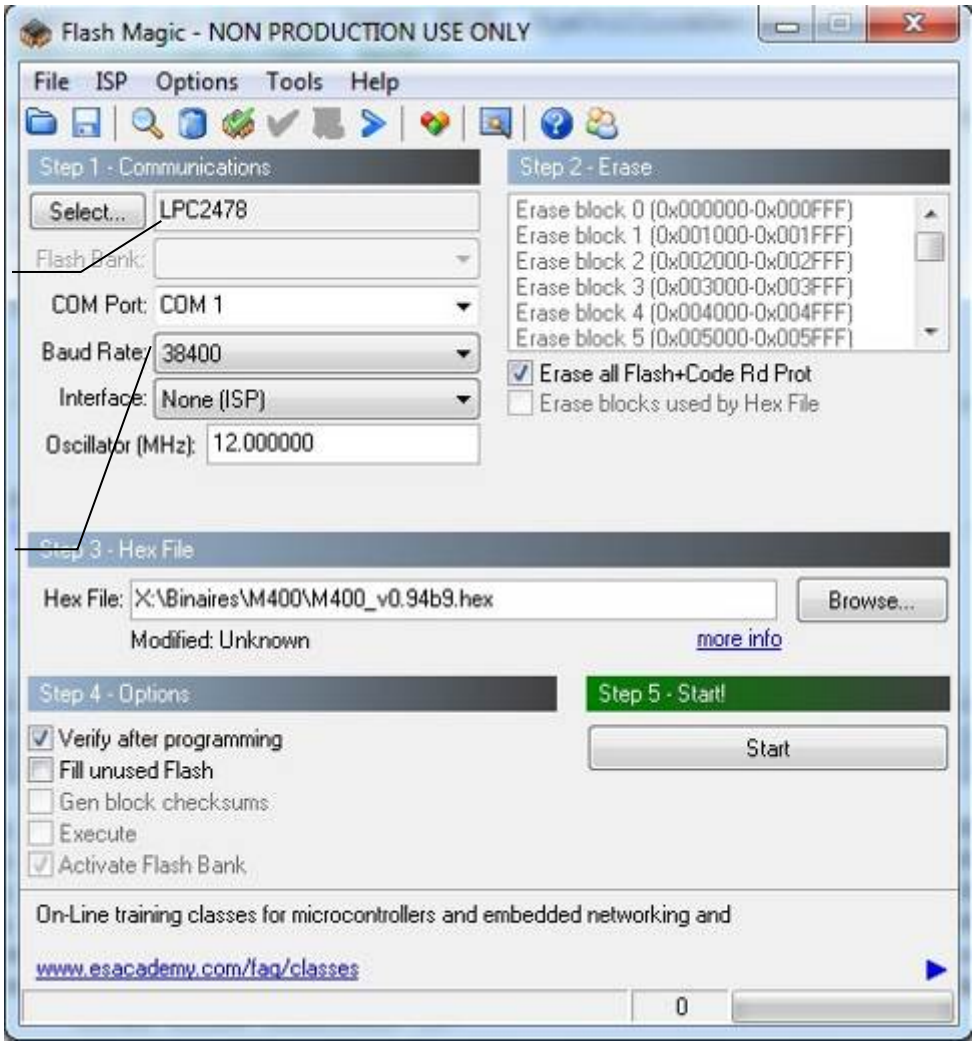
The firmware upgrade requires a RS232 cable (Metro ref 18060). It is possible to connect this cable on a RS232/USB converter if your computer is not equipped with a RS232 port.
The ref 18060 cable can be ordered to any Metro distributor. Otherwise the cable schematic is as following:



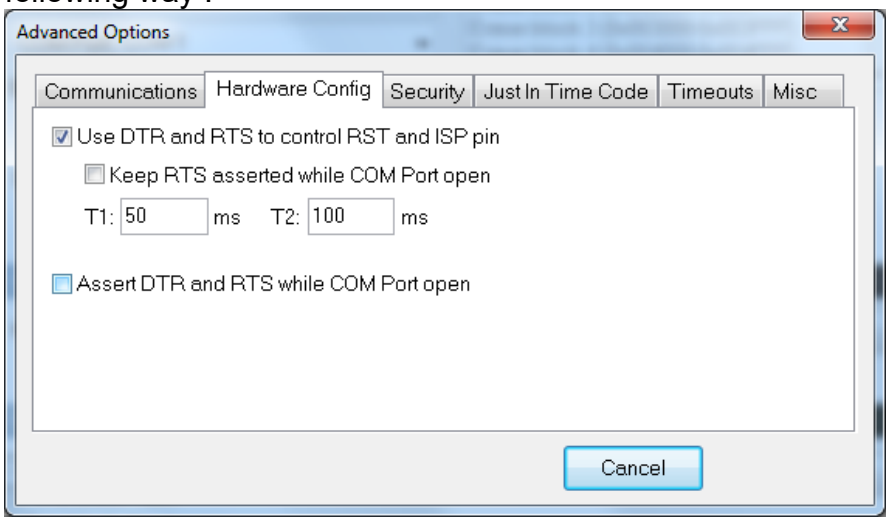

The firmware upgrade requires the “flash magic” software that can be downloaded from this address: www.flashmagictool.com
After installation, please configure the software as following:

The LPC2478 can be found in the ARM section after clicking on « select »

Speed can be up to 115200 bauds for a faster upgrade




The menu “Option→ advanced option→ hardware config” must be configured in the following way :




**<u>Procedure</u>:**

1- Connect the M400 with the 18060 cable on the “COM PORT” connector

2 - Starts your M400

3- Configure the flash magic software like on the above screen shots.

4- Click on the “Start” button

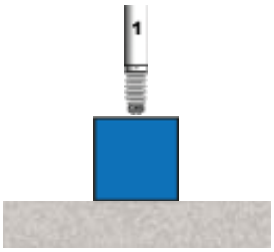
It takes about 3 to 7 min depending on the speed you selected and if you are using a USB converter or not. During the procedure the screen of the M400 become blurred.

5- The M400 restarts automatically when the procedure is finished.

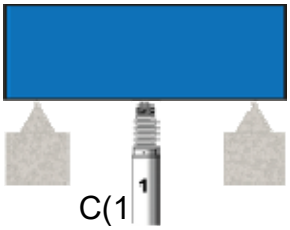
6- If this is a major upgrade it is mandatory to reset the device (follow the procedure described in the chapter 13)

# 15. EXEMPLES OF PROBE COMBINATIONS

## 15.1. SIMPLE MEASUREMENTS WITH ONE PROBE

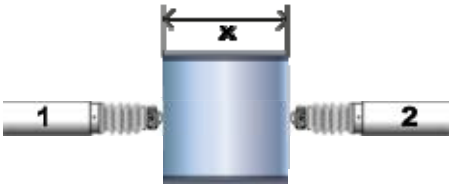



C(1)
Thickness

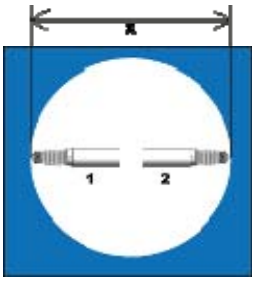



C(1
Flatness

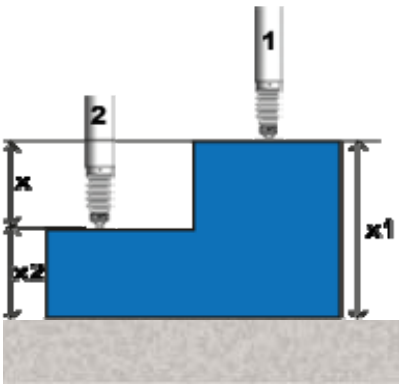
## 15.2. COMBINED MEASUREMENTS WITH TWO PROBES




C(1) +C(2)
Thickness or external diameter

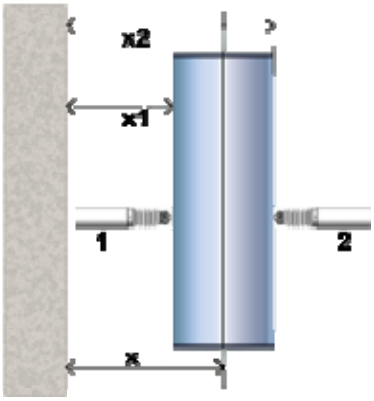



-C(1)-C(2)
Width or internal diameter



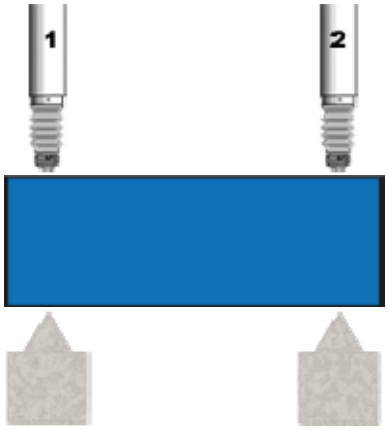

X1= C(1)
X2= C(2)
X = C(1)-C(2)

Thrust



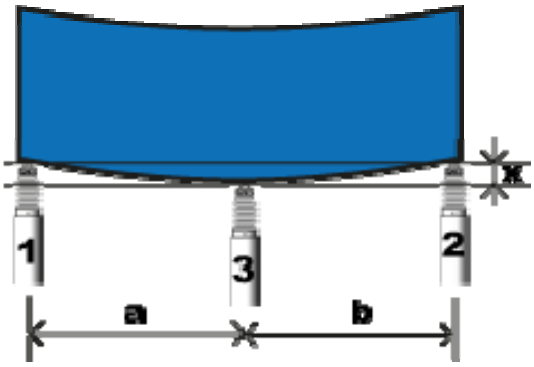

X1= -C(1)
X2= C(2)
X = -0.5*C(1)+0.5*C(2)

Position



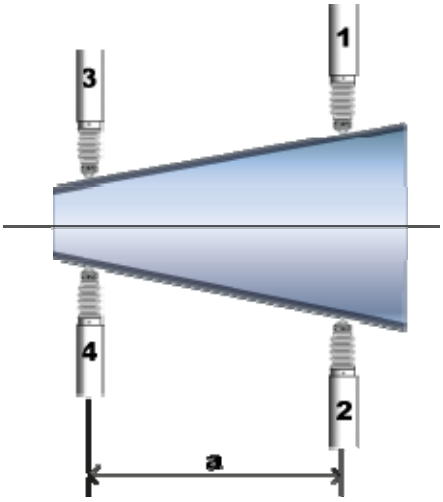

Parallelism X= C(1) –C(2)

## 15.3. MEASUREMENTS WITH THREE PROBES



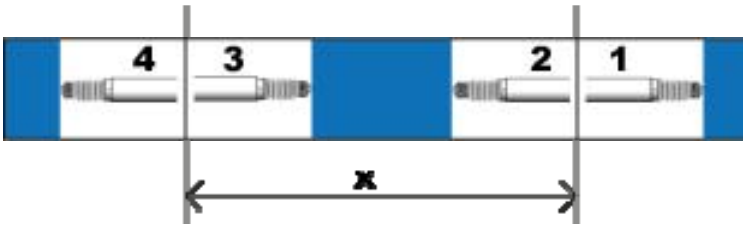

Straightness X= C(3)-b/(a+b)*C(1)-a/(a+b)*C(2)
If a = b X= C(3)-0.5*C(1)-0.5*C(2)

## 15.4. MEASUREMENTS WITH FOUR PROBES

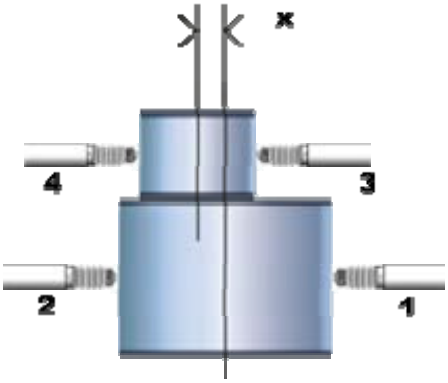



Taper ratio X= C(1)+C(2)-C(3)-C(4)

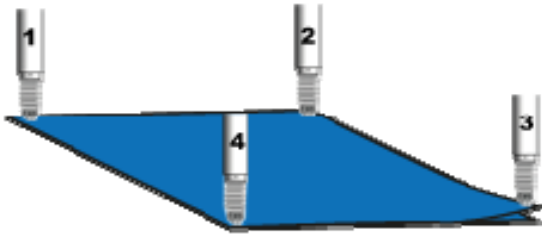
dV= 1/a*C(1)+1/a*C(2)-1/a*C(3)-1/a*C(4)




Distance between axes X= -0.5*C(1)+0.5*C(2)+0.5*C(3)-0.5*C(4)




Concentricity X= 0.5*C(1)-0.5*C(2)-0.5*C(3)+0.5*C(4)

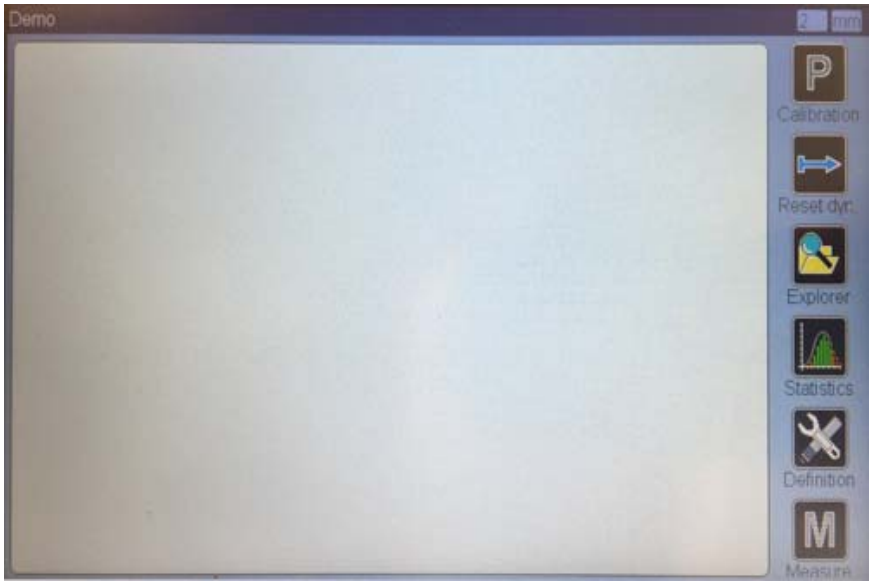



Flatness X = C(1)–C(2)+C(3)–C(4)
IMPORTANT : The 4 probes are placed in the angles of a square

# 16. TROUBLESHOOTING

## 16.1. White screen

Problem : The measuring  screen has no characteristics, the screen Is white :




Solution : More than 1 fixture has been defined from the menu PART->Fixtures, but no characteristic is on the displayed fixture. (menu PART→ Characteristic→ Fixture nr . xx).
The actual fixture number is indicated on the top right corner of the screen.
You can change the actual fixture by touching in the middle of the screen.
Then return to the Menu→Part and either remove this fixture, or

# 17. APPENDIXES

## 17.1. Example of script

Here after is an example of application.
On this application the M400 was installed on an automatic bench, entirely controlled by the M400. The measurement was done through pneumatic pushed inductive probes. Pneumatic cylinders was installed to hold or release the part. 3 button was installed : Start, Preset and End. A calibration control with stand by and repetition test is also done.

```
01 clr(14) 'returns the pneumatic cylinder
clr(13) returns the pneumatic-pushed-probes
message "Press on Start or Preset"

02 if in(11) goto 04 'preset button
if in(12) goto 07 'start button
if errorpreset() goto 03 'test if the preset has to be done
goto 02

03 message "Preset must be done, press on Preset »
loop while not in(11)

04 message "Preset" 'Preset subroutine
loop while in(11) 'wait release of the Preset button
set(14) 'extend the pneumatic cylinders
sleep(10) 'wait 1 second
set(13) 'extend the pneumatic probes
preset() 'preset
measure() 'refresh the measurement on the M400 screen
message "stand by test..."    (see chap 6.1.5)
sleep(30) 'wait 3 secondes
clr(13) 'returns the pneumatic-pushed probes
probetest() 'stand by test
if errorpreset() goto 05 'check the result
message "repetition test..."    (see chap 6.1.5)
sleep(30) 'wait 3 seconds
set(13) 'extend the pneumatic pushed probes
mastercontrol() 'preset control
if errorpreset() goto 06 'check the result
goto 01 'return at the beginning

05 message "error during the stand by test"
loop while not in(11) 'ask for error acknowledge
loop while in(11)
goto 01 'return at the begining

06 message "error during repetition test"
loop while not in(11) 'ask for error acknowledge
loop while in(11)
goto 01 'end of preset, return at the beginning

07 message "measurement in progress..."
loop while in(12) 'wait the release of the Measure button
set(14) 'extend the pneumatic cylinders
sleep(10) 'wait 1 second
set(13) 'extend the pneumatic probes

08 measure() 'measure
if not in(12) goto 08
loop while in(12) 'wait the release of the End button
```