



XII. Gauge calculation program QMSOFT / GAUGEAL

XII.1. Characteristics of the program GAUGEAL

The GAUGEAL program has been designed as a support system for the computer aided calculation of nominal values and tolerances for fixed gauges. Currently the program does include the option "Thread gauges" and the option "Plain gauges".

All thread nominal values can be generated through this program in accordance with the following standards:

- ISO metric screw threads according to ISO 1502:1996 (DIN ISO 965:1998) / BS 3643
- Unified threads and thread gauges according to ANSI/ASME B1.1-1982/ B1.2-1983
- Gauges for unified threads (ANSI/ASME B1.1-1982) according to BS 919:Part1:1960
- Gauges for Metric M Screw Threads according to ANSI/ASME B1.16M-1984
- NPSM pipe threads according to ANSI/ASME B1.20.1-1983
- Screw taps according to DIN 802:1982
- Pipe threads and gauges according to ISO 228:2000 (BS 2779:1986)
- Pipe threads and gauges according to (the older) DIN 259:1979
- Steel conduit threads according to DIN 40431:1972
- ISO metric trapezoidal screw threads according to DIN 103:1997
- Parallel screw threads of Whitworth form according to BS 84:1956/ BS 919:Part2:1971
- Metrical thread inserts according to DIN 8140:1999 (EG threads)
- HELICOIL threads according to Boellhoff factory standard
- Knuckle threads according to DIN 405:1997
- Buttress threads according to DIN 513:1985 (factory standard for gauge values)
- Threads for valves according to DIN 7756:1979 and ETRTO V.7
- ACME Threads according to ASME / ANSI B 1.5 – 1988
- Stub ACME Threads according to ASME / ANSI B 1.8 – 1988
- Hot-dip galvanised threads according to DIN 965:1999

Plain gauges may be calculated in accordance to:

- DIN ISO 286
- British standard BS 969 : 1982
- ANSI / ASME B89.1.6M

Only a basic knowledge of computers is necessary in order to use the QM-THREAD program.

The primary function of the program is to calculate all of the required gauge sizes and tolerances according to the supported standards and type of gauge being applied (for example: Screw thread GO ring gauge).

After selecting the standard, the type of gauge, (for example: Screw thread GO ring gauge) and entering the gauge designation, for example: M20x1, all of the required gauge nominal values and tolerances will be calculated automatically. The limitations and restrictions of the norms being applied will be indicated.

The program supports the nominal value generation and the measurement process for all types of thread gauges being standardised and also for all types of plain gauges used to check the minor or major diameter of screw threads. The results of the evaluation can be produced on the screen and/or on the printer and/or in a file.

XII.2. Starting the program GAUGEAL and program settings

You can start the QM-THREAD program directly from the QMSOFT-command-Shell (click the corresponded symbol in the shell).

Before working with the program you have the possibility to customise some things according your individual needs and wishes.

XII.2.1. "Settings | General settings"

Using this option you have the following registers to change program settings:

Register "General"

Here you can choose the program language and the thread standards which you want to use as default.

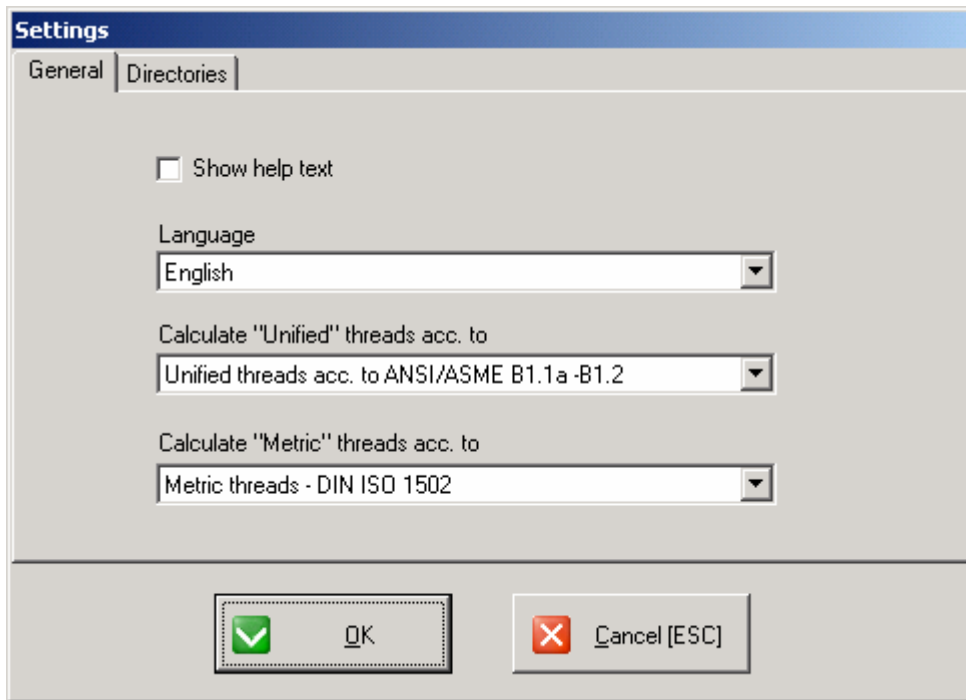


Figure: General program settings

IMPORTANT: For unified threads and also for metric threads of each there are different options to calculate the gauge tolerances. For unified threads you can use the **ANSI/ASME B1.2** or the **BS919** standard. For metric threads the **DIN ISO 1502**, the **ANSI B1.16M** or the French **NF E 03-152** standard.

In case that the thread designation does not differ, please select here the default standard should be used to calculate the gauge tolerances.

Register "Directories"

For some functions (probe and wire management; creation and edit of calibration certificates) external programs will be used. Here you can enter the directory where the corresponded program can be found. Additional you can set a directory to save your calibration certificates.

While doing the program installation all directories will be set to a correct value !

ATTENTION: Make sure that this entries are correct. Errors may be happen while operating the program caused by incorrect settings in the screen "Directories"

XII.2.2. "Settings | Evaluation options"

The "Evaluation options" will set special parameters which are used to calculate the reading over wires (for external threads) or the reading between balls (for internal threads). You can also set the default certificate layouts.

This "Calculation" and "Measuring" parameters does not interest if you do not use the program option "calculation of reading limits".

QMSOFT / GAUGEAL Set evaluation options

Algorithm of calculation
 Classic method (acc. to Prof. Berndt)

"Measuring" method for internal threads:
 Three balls method

Ball diameter
 Table T-shaped ball probes

"Measuring" method for external threads:
 Three wires method

Wire diameter
 Customised wires

Unit for evaluation
 Metric

Unit for measuring force
☒ Newton ☐ Pound (lb) ☐ Ounce (oz)

Default certificate layout file for

Certificate for "metric" values
 GAUGEAL_Norsk

Certificate for "inch" values
 GAUGEAL_Norsk

OK Cancel [ESC]

Figure: Evaluation options

The setting of the "Algorithm of calculation" is very important for calculating the readings over wires or balls !

Algorithm of calculation: Here, you can choose the algorithm used to calculate the effective diameter. The most common algorithm is the calculation with the "Classical method (Prof. Berndt)". This means the using of the general known formulas (see also the related ISO and DIN standards). Using this formula the compensation of deformation caused by the used measuring force is included !

In U.S.A. often the "simplified formula for pitch diameter" is used.

If you want to use this option, make sure the following conditions:

- use only wires which are closed to the "best size";
- be sure that the wires diameter was measured under the recommended conditions (see ANSI B1.16M, section B4).

The "simplified formula" should only be used for external measures on 60 deg. Threads (Unified and Metric Threads).

For some reasons, for example threads with large pitch or non symmetric thread, it may be better to choose the real three dimensional calculation called "Vector method". This method is based on research results of the University Dresden, Germany and is more accurate for such types of threads.

Settings for “Thread ring gauges”

“Measuring” method: Here, choose the measuring method for measurement of internal threads. You can choose either the "Three ball method", the "Two-ball method" or the “Cone-V-method”.

Note: In the program context the “Three ball” method means the internal thread measurement using a T-shaped ball probe and contacting three points on the threads surface to calculate an effective diameter. It is different from the “Three ball method” described in the ANSI/ASME standards.

Used series of ball diameters: Choose here, from the list provided, the table with the balls should be used for the automatically selection of a ball diameter. Measuring an internal thread the ball diameter (or the related probe) will be selected from the chosen table. Otherwise you can enter a ball diameter manually if you set the specific measuring conditions.

Note: A “Three ball” measurement in the programs meaning can be done only with a “T probe”.

Settings for “Thread plug gauges”

“Measuring” method: Here, choose the measuring method for measurement of external threads. You can choose either the "Three-wire method" or the "Two-wire method".

Used series of wire diameter: Select the table with thread wires should be used for the automatically selection of a thread wire diameter. Measuring a external thread the wire will be selected from the chosen table. You can also select a thread wire diameter manually if you set the specific measuring conditions. Using the "best wire" option the calculated "best wire" diameter will be set automatically.

Unit for measuring force: Select the unit you will use for entering the measuring force. The “measuring force” value will be used to calculate thread corrections and to compensate deformations.

Default certificate layout file for...: Here, you can enter the name of the "Certificate layout" file used to create the layout of your calibration certificate. This file includes all information about the layout and the content of the record list being created. For "mm" and "inch" measurements different files are used.

NOTE: Because the program will be installed to support different languages you will find serious “L32” files in the related directory. The file name (for example “**QMTHREAD_English.L32**”) will show you the language related. Using the related program functions you can delete all certificate layout files you do not use.

XII.2.3. "Settings | Probes”

Using this option you can start the probe and masters management program QM-PROBE. Here you can insert new probes to a list and calibrate this.

Remember that “T-shape ball probes” and “Single (stylus) ball probes” used for internal measurements should be calibrated before you can use it

See the manual for the probe management program (Appendix E) for more detailed information.

XII.2.4. Certificate layouts

The program QM-THREAD gives you the possibility to customise the layout of your calibration certificate. The layout of the calibration certificate is based on the so called "Certificate layout file". This file contains all information about the form of the certificate and the values should appear in this. By editing this certificate layout file you can change the layout. Saving this file with another file name give you the possibility to work with different certificate layouts.

All this certificate layout files you have created will be saved in the working directory of the QM-THREAD program. The files have the extension ".L32".

Using the option "**Certificate layouts | Show/edit..**" you can load a certificate layout file into the QMSOFT editor program.

NOTE: Do never open a "L32" certificate file outside of the program. In this case you will loose all "placeholders" representing the "actual values" when the certificate will be created !

A certificate layout file is consisting of three different types of information:

- **standard text:** is text information just like in a known text processing application; you can change the text as you want and you can set the different text parameters;
- **"Placeholders" ("Fields"):** a "Field" is including a variable information about the gauge, the measuring process or the measuring environment. A "field" will be fulfilled with the actual information while executing the program. While editing a certificate layout file you can change "field" positions, delete "fields" (if you do not need the related information) and insert new "fields".
- **"Text conditions":** A text condition gives you the possibility to control the certificate layout in dependence of different program situations. A text or field following to a text condition will be print out on the certificate only if the condition is "true". For example you can print a special text only if an "External measurement" was done. Please open an existing certificate layout and see the comments for the "Line conditions" available.

XII.2.4.1 The usage of "Place holders" (fields):

To insert a new "Place holder" in your certificate layout use the menu "**Insert | Fields**".

Using this menu you can also see all available "Place holders" (Fields) and the related information. The fields are grouped to different categories (e.g. Gauge nominal values). If you select a field (click on it) you can see the field designation.

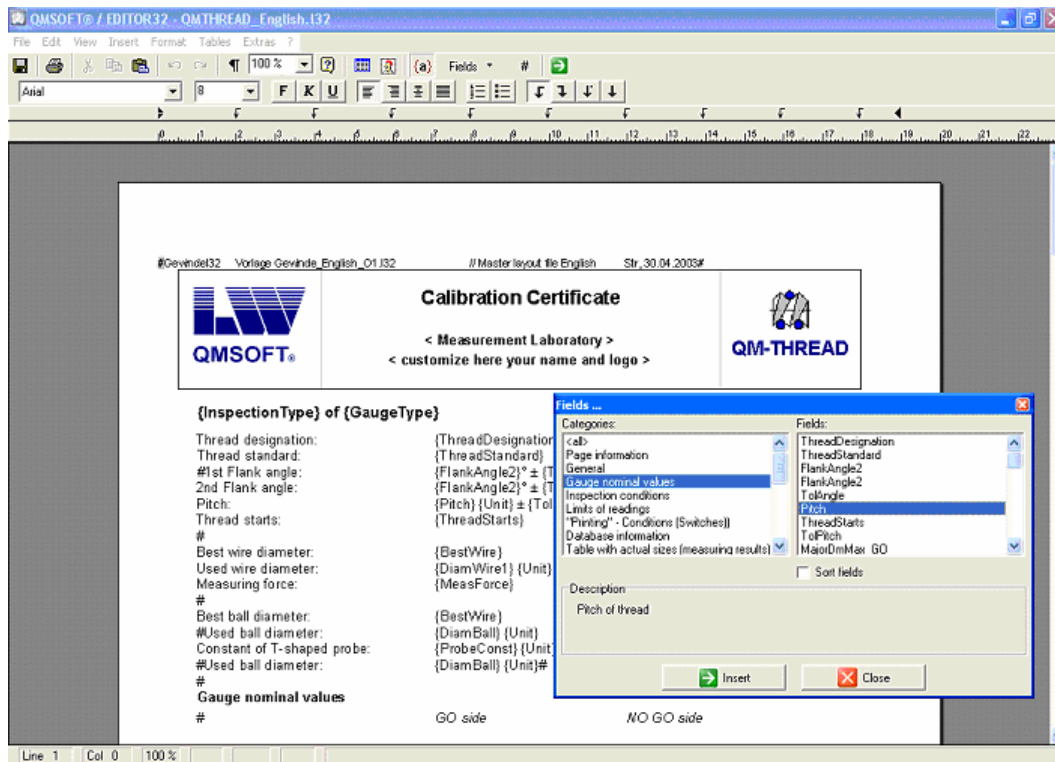


Figure: Inserting of fields into a Certificate layout file

Note: Fields which does contain text information can have a property “Language”. To open the “Field property” dialogue click the right mouse key on the related field. If this dialogue have an field “Language” (see figure) you can change it to create “Multilingual” certificates.

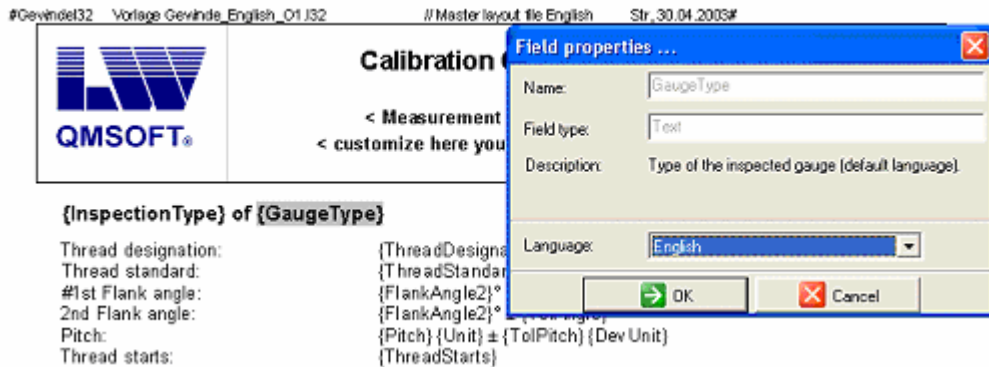


Figure: Field property “Language”

XII.2.4.2 The usage of “Line conditions”:

Use the menu "**Insert / Fields**" to show the "Line conditions (Switches)" available (see figure).
Select a line condition in the shown list to get there description.
Use the "Insert" button to insert the selected condition in your certificate layout.

Note: A "Line condition" is not restricted to one line in your layout. The condition is active until a new "Line condition" is defined. To "remove" a condition set an "empty" condition at the end of the related text block. The text after an "empty" condition will appear on your certificate in any cases.

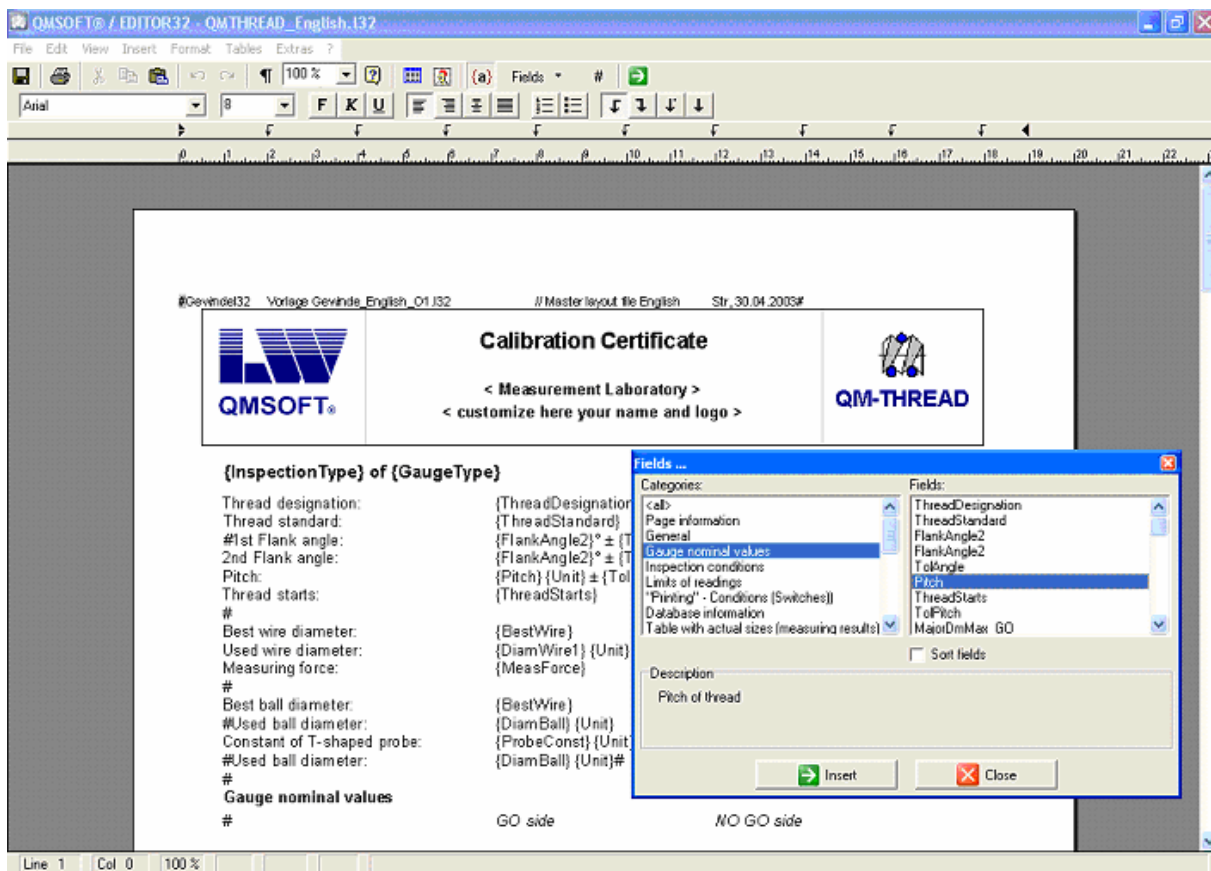


Figure: Inserting of conditions into a Certificate layout file

The fields you can select are divided into different sections. The section “Printing” – Conditions (Switches)” is defining a list a simple “logical” switches which can have the property “true” or “false”. The other sections will show properties of the gauge or the measuring process.

Select a text condition from the shown list to insert it in the “Field name” column.

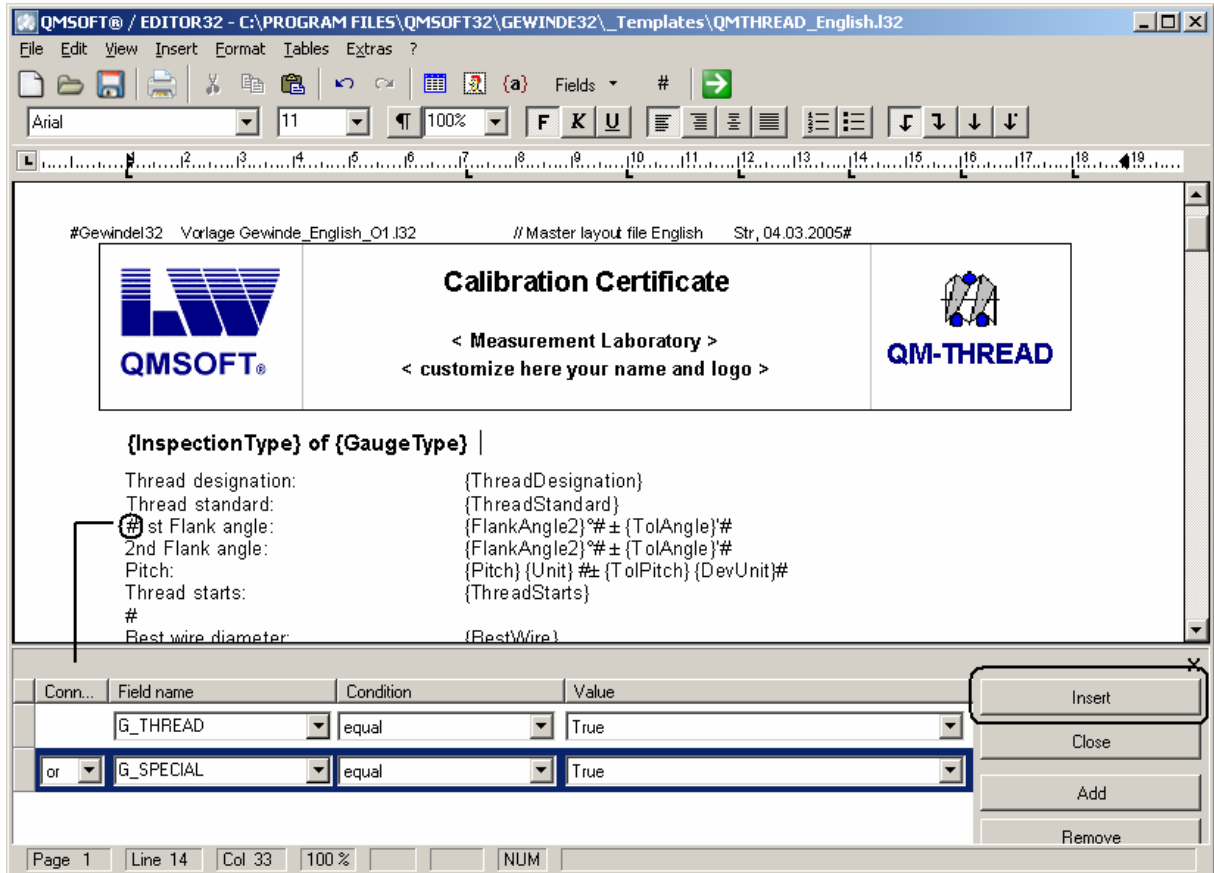


Figure: defining a text condition

After selection of a text condition (in the example the first condition "G_Thread" - means that the selected gauge is a thread) that the related “Condition” and “Value” of the selected field. Using the "Add" you can now add the next condition.

This procedure will give you the possibility to combine two or more conditions to define more complex conditions. Please pay attention to the field "Connection" (see the first column) which define the type of the combination of the single conditions. Using the "AND" operator is meaning that all single conditions has to be "true" to get the result "true". If you are using "OR" to join the conditions, only one of these conditions needs to be "true" to get the result "true".

If your "list of conditions" is finished (in the most cases you will need only one condition) use the "Insert" button to insert the condition(s) in your certificate layout.

Note: A “Text condition” is not restricted to one line in your layout. The condition is active until a new “Text condition” is defined or an “empty” condition is set. The text after an “empty” condition will appear on your certificate in any cases.

XII.3. Thread Gauges - Calculating of gauge values and readings over wires (or balls)

Clicking on the “Thread” Icon on the programs start screen you will get the list of all thread standards supported. Select a standard and click the “Continue” button.

XII.3.1. Calculating gauge nominal data

Enter the thread designation and select the type of gauge. The Function “[F2] Explanation” will show you a help text which explain the different forms of entering the thread designation in accordance to the standard selected. If the “Automatic standard recognition” is switched on the standard will be determined automatically by using the threads designation (e.g. designation “M..” -> does mean Metric thread”).

The figure is showing the dialog for a double sided GO/NO GO screw plug gauge).

QMSOFT / GAUGEAL Entering of gauge parameters

Thread designation: Explanation [F2]

☒ Automatic standard recognition

Thread standard:

Type of gauge:

Unit:

Pitch: 1st flank angle:

Thread starts: 2nd flank angle:

GO side		NO GO side	
Max. major diameter	<input type="text" value="12,0230 mm"/>	Max. major diameter	<input type="text" value="11,4305 mm"/>
Min. major diameter	<input type="text" value="12,0010 mm"/>	Min. major diameter	<input type="text" value="11,4085 mm"/>
Minor diameter	<input type="text" value="9,8540 mm"/>	Minor diameter	<input type="text" value="9,8540 mm"/>
Max. effect. diameter	<input type="text" value="10,8815 mm"/>	Max. effect. diameter	<input type="text" value="11,0750 mm"/>
Min. effect. diameter	<input type="text" value="10,8705 mm"/>	Min. effect. diameter	<input type="text" value="11,0640 mm"/>
Wear limit of effect.diameter	<input type="text" value="10,8585 mm"/>	Wear limit of effect.diameter	<input type="text" value="11,0580 mm"/>

Back [ESC] Calculate tolerances [F7] Continue

Figure: Entering of gauge designation, calculation of gauges nominal values

Thread designation:

Enter here the standardised designation of the thread you want to inspect. The program is checking this designation and will calculate all related sizes and tolerances. In case that the designation is not valid for the standard selected it may be that you get back an different (but valid) designation. This may happen especially for Unified threads because there are only defined “diameter / pitch” combinations are allowed.

Automatic standard recognition:

Marking this option the program recognise the thread standard automatically based on the entered designation. Necessary for this is, that the designation includes the required characters (e.g. "Tr" means trapezoidal thread acc. to DIN 103).

XII.3.2. Calculation of reading values

If you continue the program after calculating the gauge nominal values you will get the screen "Calculation of reading limits".

QMSOFT / GAUGEAL Calculation of reading limits - external thread

"Measuring" method for external threads: Three wires method

Selected wire diameter: Customised wires

"best" thread wire diam.: 1,0103 mm

Current wire diameter: 1,0100 mm

Measuring force: 10,00 N

Probes&Wires [F3]

Method of calculation - used correction factors:

☒ Lead angle and wire deform. ☐ Only lead angle ☐ No corrections

Lead angle: 2° 53 Min.

Value of lead angle correction (A1): -1,84 µm

Value of wire deformation (A2): 2,92 µm

Limits of readings	min	max	wear limit
GO side	12,3839 mm	12,3949 mm	12,3719 mm
NO GO side	12,5774 mm	12,5884 mm	12,5714 mm

Back [ESC] Continue

Figure: Calculating the reading values

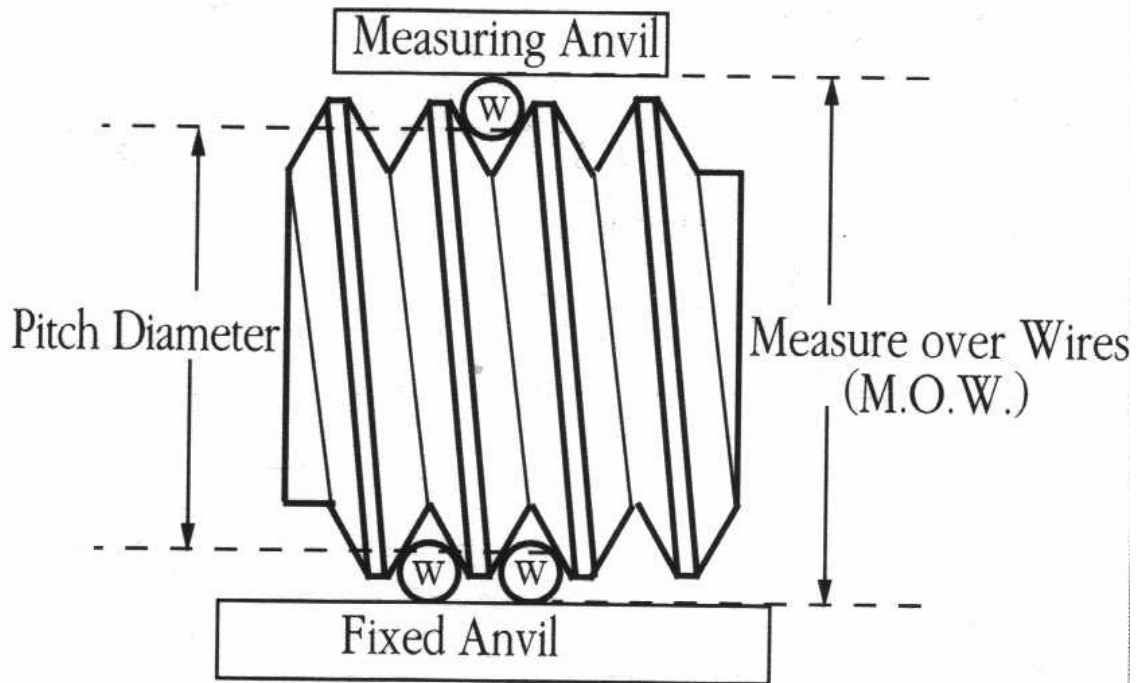
In this figure are shown the readings over wires in dependence of the program settings (see section XII.2.2). The current wire diameter and the measuring force are shown. The measuring force is used to calculate the wire deformation.

Note: If you have set the "Algorithm of calculation" to "Simplified formula acc. to ANSI" or "General ANSI formula" the wire deformation will not be calculated.

If you want to change the wire or to calibrate or recalibrate a probe used for internal threads use the "Wires/Balls" button to do this.

XII.3.2.1 Measure over wires - External Thread Measurement

The measurement of the effective diameter of external threads is relatively simple. According to the selected "Measuring method", three or two wires can be used.



Attention: Depended on the selected list of thread wires (see the menu "*Settings / Inspection conditions*") the wire with the smallest difference to the calculated "best" wire diameter will be set automatically. If you want to change the pre set values use the button "Wires/Balls" to select an other wire from the defined lists.

XII.3.2.2 Readings over balls - Internal Thread Measurement

For the internal thread measurement, two measurement methods are applicable that are seen differently by the required measurement procedure. For two-point measuring requires only minimal technology and is a quicker measurement procedure. Three-point internal measuring requires a special measuring application and is commonly used for small Screw thread ring gauges in which a ball support bracket cannot be inserted. Additionally, with this procedure there is smaller room for errors (smaller measurement circle, no deformation of brackets, etc.).

a) "Two Ball" - Internal measurement

As we have already mentioned, this measurement is done between two ball support brackets and is analogous to the measurement of a plain ring gauge. Both brackets should have suitable thread balls with comparable diameters for the thread inspection (depending on the pitch).

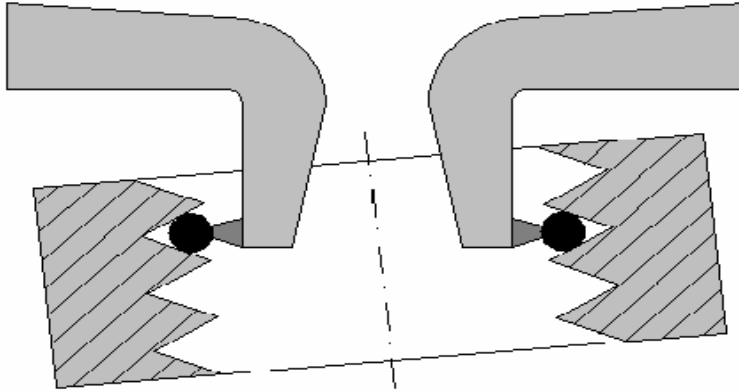


Figure : Two-ball-method for internal thread measurement

The reading limits you will get in the program does represent the measure over the balls.

b) "Three Ball" - Internal Measurement

"Three-ball" internal measuring is done using a special internal measuring application and "T-shaped" ball probes.

The corresponding values of the probes (ball diameter d_k and probe constant c) must be known to program.

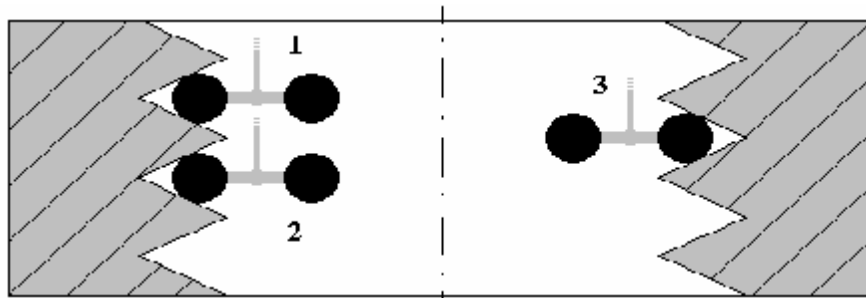


Figure : Three-ball-method for internal thread measurement

At the certificate you can get the measures over balls ore between the ball middle points.

XII.4. Plain Gauges - Calculating the gauge values

After entering the “Nominal value” and selecting the standard and the type of gauge you can activate the gauge calculation with the function “Calculate tolerances” (F7 key).

XII.4.1. Entering gauge nominal data – ISO conform

Calculating the values according to ISO 286 or BS 969 the product limits will determine the gauge sizes and tolerances. In case that the gauge tolerances are directly depended from the product tolerance the calculation requires the upper and the lower limit of the product.

The most simple way to enter the product limits is using a standard ISO designation. This will be done by entering the basic size and the tolerance class. A tolerance class shall be designated by the letter(s) representing the fundamental deviation followed by the number representing the standard tolerance grade. Examples: H7, G8

If you have entered an ISO designation you can click on the “Nominal size” button (or press function key “F7”) to get the gauges deviation. Now you will get also the explicit deviations constituting the product limits.

The screenshot shows a software window for entering gauge data. The top section contains the following fields:

- Nominal value:** 40H7
- Standard:** Plain gauges - DIN ISO 286
- Type of gauge:** Plain GO/NO GO plug gauge
- Unit:** Metric
- Upper deviation of nominal value:** 25,00 µm
- Lower deviation of nominal value:** 0,00 µm

The bottom section is divided into two columns: **GO - side** and **NO GO - side**.

	GO - side	NO GO - side
Maximum value	40,0055 mm	40,0270 mm
Minimum value	40,0015 mm	40,0230 mm
Wear limit	39,9970 mm	

At the bottom, there are three buttons: **Back [ESC]**, **Calculate tolerances [F7]** (with a calculator icon), and **Continue** (with a right arrow icon).

Figure: Entering a gauge designation according to ISO rules

If there is no ISO designation given you can also enter the explicit deviations.

For example if your gauge is marked as “100 –0,050 –0,100” then enter:
 the “Nominal gauge size” = “100”; the “Upper deviation “ = “-50” [µm] and
 the “Lower deviation “ = “-100” [µm]

XII.4.2. Entering gauge nominal data for ANSI gauges

The tolerances of a gauge calculated according to the ANSI B89.1.6M standard are depended from the nominal size and the tolerance class. The product limits are not required to calculate the tolerances.

Naturally for a double sided GO/NO GO gauge the entering of the product limits is useful because it does not make sense to calculate both gauge sides for an identical diameter. For example you can enter **"1.00 / 1.02 inch"** for the "Nominal size" to define the product limits.

The program will calculate the gauge tolerances and give you also the "Upper" and "Lower" deviation in relation to the products basic size (in this case 10.00 ")

As described for the entering of ISO gauges you can also enter an ISO designation (for example 30K8) to calculate gauge tolerances.

Nominal value	1.00000 '' / 1.02000 ''		Tolerance class	Y
Standard	Plain gauges - ANSI/ASME B89.1.6M			
Type of gauge	Plain GO/NO GO plug gauge			
Unit	Inch			
Upper deviation of nominal value	20,0000 thou. Inch			
Lower deviation of nominal value	0,0000 thou. Inch			

	GO - side	NO GO - side
Maximum value	1,000060 Inch	1,020000 Inch
Minimum value	1,000000 Inch	1,019940 Inch
Wear limit	1,000000 Inch	

Figure: Entering parameters for an ANSI/ASME gauge

After you have completed the gauge calculation, press the "continue button" to get the certificate.

XII.5. Output of results

After calculating the measures over wires/balls you will get the shown screen.

QMSOFT / GAUGEAL Create certificate

Customer name
LW GmbH

Identity or Certificate number

Remarks

Selected certificate layout file
GAUGEAL_Norsk

Edit certificate layout

Certificate

Print certificate

Back [ESC]

Go to main menu

Figure: Creating a certificate

Here you can enter the name of the customer and also some remarks to the calculation.

Before creating the calibration certificate you can change the "certificate layout file" will be used. To start the output of the results press the "Show certificate" button.

All functions for the editing and the output of calibration certificates will be controlled by the EDITOR - program. See the manual of this program (Appendix B) to see how to operate it.

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