

AE040 - Fanuc macro O8503 - set micron compensation value

Function

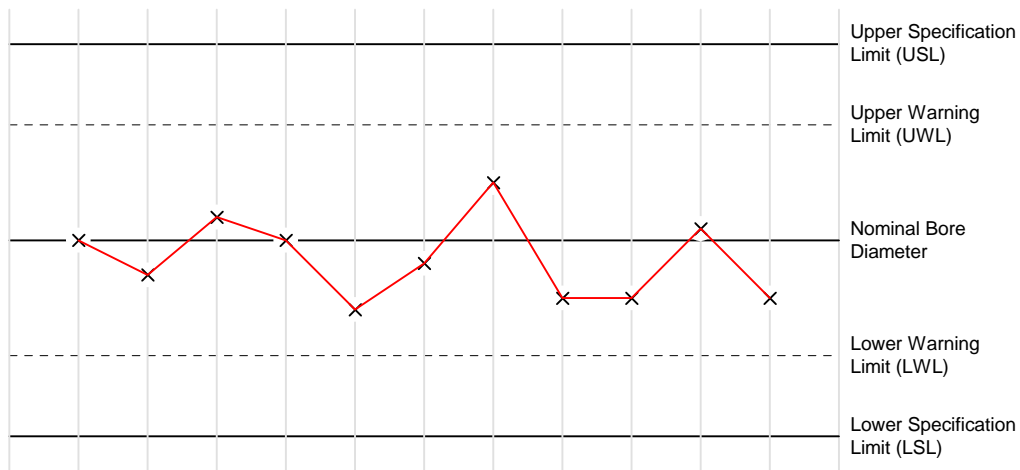
To evaluate multiple bore measurements and determine when a tool compensation is required to maintain a bore diameter within set limits. Then compute a micron compensation value (on diameter) to achieve this.

Use:

G65 P8503 Bb Rr Mm Cc Ss Tt Ww Xx Ee Ff

Structure:

G65P8503 B <bore ID>
 R <tool id>
 M <bore measurement>
 C <nominal bore size>
 S <lower specification limit (LSL)>
 T <upper specification limit (USL)>
 W <lower warning limit (LWL)>
 X <upper warning limit (UWL)>
 E <maximum consecutive LWL incursions (LWL_MAX)>
 F <maximum consecutive UWL incursions (UWL_MAX)>



Functional Description

The macro uses the current bore diameter measurement to assess the bore condition relative to the inspection parameters, for an unlimited number of bores.

The macro retains the outcomes of previous analyses' for each bore, to identify when a tool compensation is required, and the size of compensation needed to ensure that the tool produces a bore of nominal size.

The bores are identified by the numbers 0, 1, 2, 3 etc. The macro sets a bore condition variable and if necessary a compensation value for each bore using the default structure shown in Table 1. The bore condition variable can be used for program branches outside the macro. Several coding examples are given at the end of this document that show how this might work in practice.

A block of 100 variables is generally allocated for use by ActiveEdge. The first 60 are for the exclusive use of Rigibore compensation macros. The remainder are available for use by O8503 to record persistent measurement and compensation data for up to 8 bores. Note that the variable block is offset in accordance with the STATUS variable. The example in Table 1 shows the allocated variables used by O8503 if STATUS was defined as #500.

Table 1 – Bore Variables

Bore ID	Tool ID (copy)	Micron Comp. on dia.	Bore condition
0	#560	#561	#562
1	#565	#566	#567
2	#570	#571	#572
n	#[STATUS+60+[5*n]]	#[STATUS+61+[5*n]]	#[STATUS+62+[5*n]]

The record sheet at the end of this document can be used to clarify which variables are being used in a specific installation.

For each bore ID:

If a bore measurement crosses either the UWL or LWL (without exceeding the bore specification limits), counter variables related to either the upper or lower warning limits are incremented. These variables only increment on consecutive UWL or LWL incursions, otherwise they are set to zero.

If either counter reaches the maximum upper or lower limit UWL_MAX or LWL_MAX, a micron compensation value on diameter is computed and written to the appropriate variable associated with that bore. (Table 1). The compensation value is an integer computed as the nominal bore diameter minus the last bore measurement.

The macro always sets the micron compensation variable to zero unless a compensation event is triggered.

If a bore measurement is outside the specification limits, the macro clears all trend data and immediately sets the bore condition variable and a corrective compensation value based on the current measurement. It is the programmer's responsibility to monitor the bore condition variable after O8503 executes and decide what action to take. For example, with reference to Table 2, a bore condition of 3 (i.e. below the bore LSL) may indicate a broken insert, in which case the programmer may wish to insert a program

branch and automatically swap to a sister tool rather than allowing the original tool to compensate.

When a micron compensation value is generated, a copy of the tool ID is also written to the appropriate variable associated with the bore (Table 1). The copy tool ID does not have to be used, but it can often aid programming flexibility if the 'check comp. status' macro O8506 is not being called immediately after a compensation request. In this case the copy tool ID is available for use much later in the program to query the outcome of the earlier compensation request.

LWL_MAX and UWL_MAX must be set to 1 or more.

If a bore measurement exceeds either the LSL or the USL, the bore status variable is set to either 3 or 4 respectively and the persistent counter variables are zeroed.

The appropriate bore condition variable is set every time the macro is executed. It can be used by the manufacturing program in a variety of ways. For example, to identify whether the bore/part is scrap or re-workable scrap.

Table 2 – Bore condition classifications

Bore Condition	Measurement	Meaning
0	Within the LWL and UWL	In spec.
1	Between the LWL and the LSL	In spec., but +ve comp reqd.
2	Between the UWL and the USL	In spec., but -ve comp reqd.
3	Below the LSL	Out of spec., dia. is undersize
4	Above the USL	Out of spec., dia. is oversize

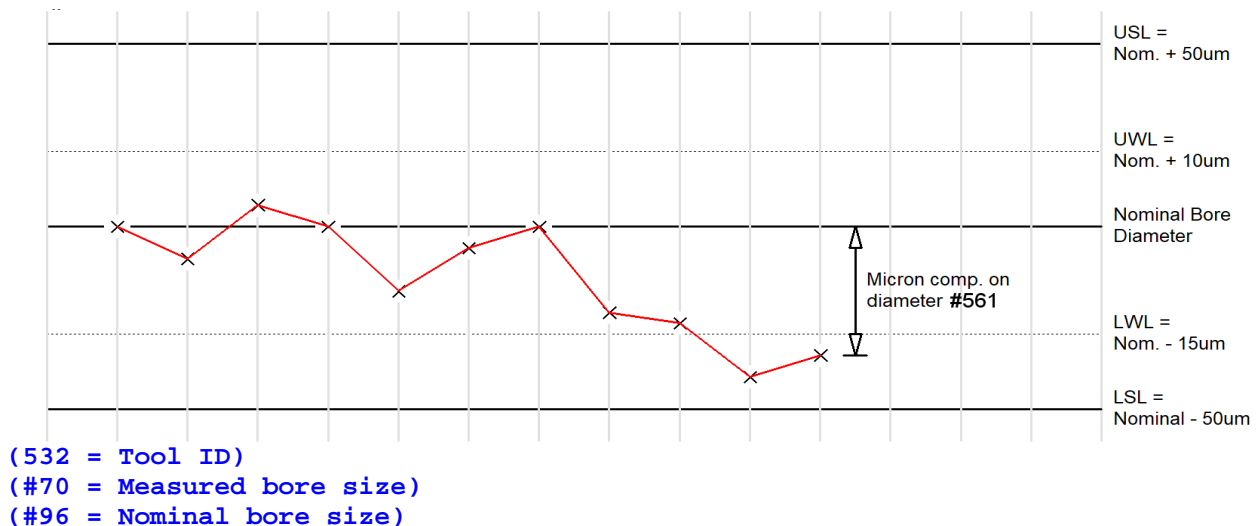
The persistent data variables relating to a specific bore are automatically set to zero in the following cases:

- (1) After a compensation value has been computed.
- (2) If a bore measurement falls outside the bore specification limits.
- (3) If the inspection parameters are not logical. The macro also generates an s329 warning message in this event.
- (4) Forced reset. A reset can be manually forced as shown below. For example if program execution is interrupted and has to be restarted, O8503 can be run with the bore measurement parameter set to -1. The macro must be run explicitly for each bore ID, for example

```
G65 P8503 B0 Rr M-1 Cc Ss Tt Ww Xx Ee Ff
G65 P8503 B1 Rr M-1 Cc Ss Tt Ww Xx Ee Ff
G65 P8503 B2 Rr M-1 Cc Ss Tt Ww Xx Ee Ff
.
.
```

Example 1 - Set compensation value

In this example, O8503 is set to compute and trigger a compensation after the second consecutive LWL incursion. The compensation amount #561 is derived from the last bore measurement, as shown below.



```
G65P8503 B0. R532. M#70 C#96 S[#96-0.05] T[#96+0.05] W[#96-0.015] X[#96+0.01] E2. F2.
```

Example 2

Typical usage of macro O8503. Cutting a single bore with one AE tool

```
(532 = ID of tool used to cut bore 0)  

  (#138 = bore 0 measurement)  

  (#96 = nominal bore size)
```

```
N100 (bore 0 has just been measured)
```

```
N110 G65P8503 B0 R532 M#138 C#96 S[#96-0.05] T[#96+0.05] W[#96-0.015] X[#96+0.01] E2 F2  

  N120 IF[#562GT2.] GOTO160  

  N130 G65P8504 R532. A#561 (comp tool by amount computed in O8503. Skips if #561=0)  

  N140 GOTO300
```

```
N160 IF[#562EQ3.] GOTO200  

  N170 IF[#562EQ4.] GOTO250
```

```
N200 (mark measured part as re-workable scrap)  

  N210 (mark tool for insert damage/inspection then swap to sister AE tool)  

  N220 GOTO300
```

```
N250 (mark measured part as scrap)  

  N260 (investigate reason for oversize bore. Run probe calibration cycle?)  

  N300 (END)
```

Example 3

Program structure to compensate a tool cutting two bores of the same diameter on a single part.

```
(#105 = ID of tool used to cut both bores)
(#70 = first bore measurement)
(#71 = second bore measurement)
(#96 = nominal bore size of both bores)
```

```
N100 (both 'type 0' bores have just been measured)
```

```
N110 G65P8503 B0 R#105 M#70 C#96 S[#96-0.05] T[#96+0.05] W[#96-0.015] X[#96+0.01] E2 F2
N115 G65P8503 B0 R#105 M#71 C#96 S[#96-0.05] T[#96+0.05] W[#96-0.015] X[#96+0.01] E2 F2
```

```
(the program would then continue from N120 in Example 2)
```

In this example the macro is run twice; once for each measurement. This is because the bores are the same size. The tool ID stays the same for each macro call because both bores were made by the same tool.

N.B. This method of monitoring identical bores machined with the same tool should only be used if the pre-bored hole size and material condition is the same for each bore. When machining high tolerance parts, even small variations in these variables can cause size 'hunting', which can adversely affect process capability.

Example 4

In this example, a dual AE cartridge tool is machining 2 different bore sizes.

```
(#105 = ID of tool used to cut both bores)
(#70 = bore 0 measurement)
(#71 = bore 1 measurement)
(#96 = nominal size of bore 0)
(#97 = nominal size of bore 1)

N100 (both bores have just been measured)

N110 G65P8503 B0 R#105 M#70 C#96 S[#96-0.05] T[#96+0.05] W[#96-0.015] X[#96+0.01] E2 F2
N115 G65P8503 B1 R#105 M#71 C#97 S[#97-0.04] T[#97+0.04] W[#97-0.010] X[#97+0.01] E2 F2

N120 IF[[#562GT2]OR[#567GT2]] GOTO150

N130 G65P8508 R#105 A#561 B#566 (comp tool by amounts computed in O8503. O8508
                                doesn't execute if #561 & #566 are both zero)
N140 GOTO200

N150 IF[#562NE3] GOTO160 (bore 0 undersize)
N151 (mark bore 0/part as re-workable scrap)
N152 (check cartridge 1 for insert damage)

N160 IF[#562NE4] GOTO170 (bore 0 oversize)
N161 (mark bore 0/part as scrap)
N162 (investigate reason for oversize bore 0)
N163 (Re-measure bore 0 or run probe calibration)

N170 IF[#567NE3] GOTO180 (bore 1 undersize)
N171 (mark bore 1/part as re-workable scrap)
N172 (check cartridge 2 for insert damage)

N180 IF[#567NE4] GOTO190 (bore 1 oversize)
N181 (mark bore 1/part as scrap)
N182 (investigate reason for oversize bore 1)
N183 (Re-measure bore 1 or run probe calibration)

N190 (swap to sister AE tool)
N200 (END)
```

VARIABLE RECORD SHEET FOR PROGRAMMING WITH SPC MACRO 08503

n	#[STATUS+60+[5*n]]	#[STATUS+61+[5*n]]	#[STATUS+62+[5*n]]									
Bore ID	Copy tool ID	Micron comp. on dia.	Bore condition									
0												