

Circularity test in SINUMERIK Operate (828D and 840D sl)

The “built-in” circularity test of SINUMERIK Operate is used to check the interpolation of axes that will work together. The tool measures a circle with reference to the motor or direct measuring system. Machine mechanical alignment is not considered in the result. This gives the commissioning engineer the ability to clearly separate controller Optimization issues from mechanical issues.

Axis MD32200, MD32400, MD32402, MD32410, MD32490, MD32500, MD32510, MD32520, MD32540, MD32620, MD32640, MD32810, MD32900, MD32910, MD32930, MD32940 and drive P1421 to P1426, P1400, P1433, P1434 are checked via this procedure.

The following positional error compensations should be switched off when this procedure is carried out.

Backlash Comp
MD32450, Encoder Comp MD32700, CEC Comp MD32710, Temperature Comp MD32750, Friction Comp MD32500.

Note

Backlash MD32450 must be adjusted using an external device e.g ballbar or dial gauge.

The best overall contouring results are achieved when the circle test results in the correct actual size, shape and minimum p/p deviation between combinations of interpolating axis, (X-Y, X-Z, Y-Z).

A circle test part program and the circularity test start-up tool can be used to measure and evaluate these results. The “worst case” test circle radius and path feedrate must result in a realistic radial acceleration that the machine is capable of.

Machine builders typically have specifications for test circle radius and feedrate

Standard machine tool builder circle tests typically use a radius of 100mm or 150mm at feedrates determined by the OEM. The OEM defines the acceptable result specifications.

High-speed cutting requirements are usually more stringent and test circles for high-speed cutting machines might be in the range of 10 to 25mm radius at feedrates of 5 m/min to 10 m/min. For high-speed cutting machines, the results are normally acceptable when the p/p deviation ≤ 0.010 mm, and the actual size is equal to the programmed radius at the worst case path feedrate.

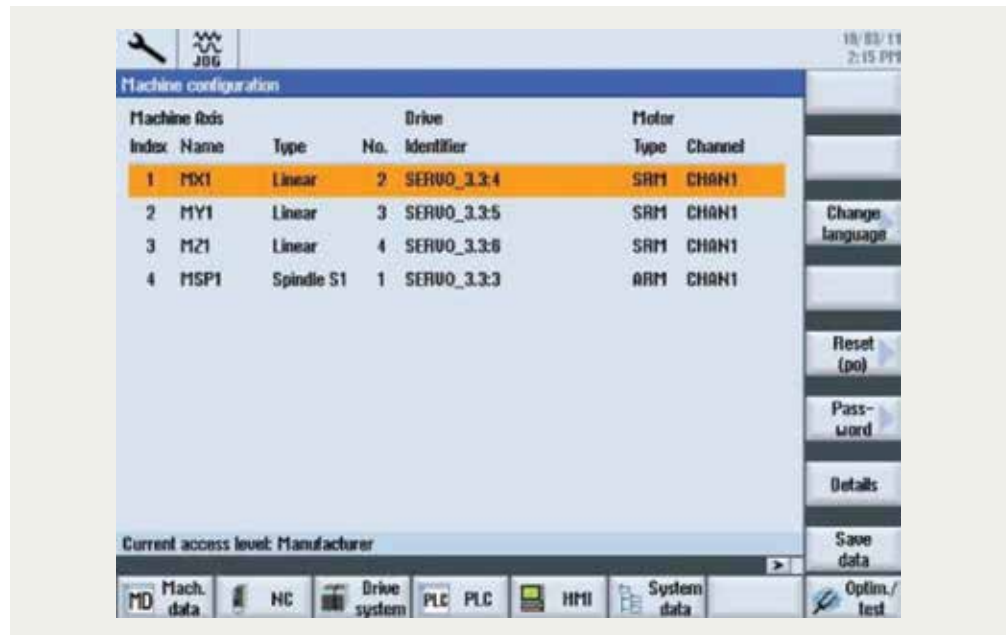
Example of an X-Y circle part program

Position, feedrate and active plane must be adapted to the machine

Figure 1

```
FFWON  
SOFT  
G90 G71 G01 F1000 X150 Y50 Z-100  
LAB:  
G91 G64 G02 X0 Y0 I10  
GOTOB LAB  
M30
```

Figure 2



Select "Optim./test"



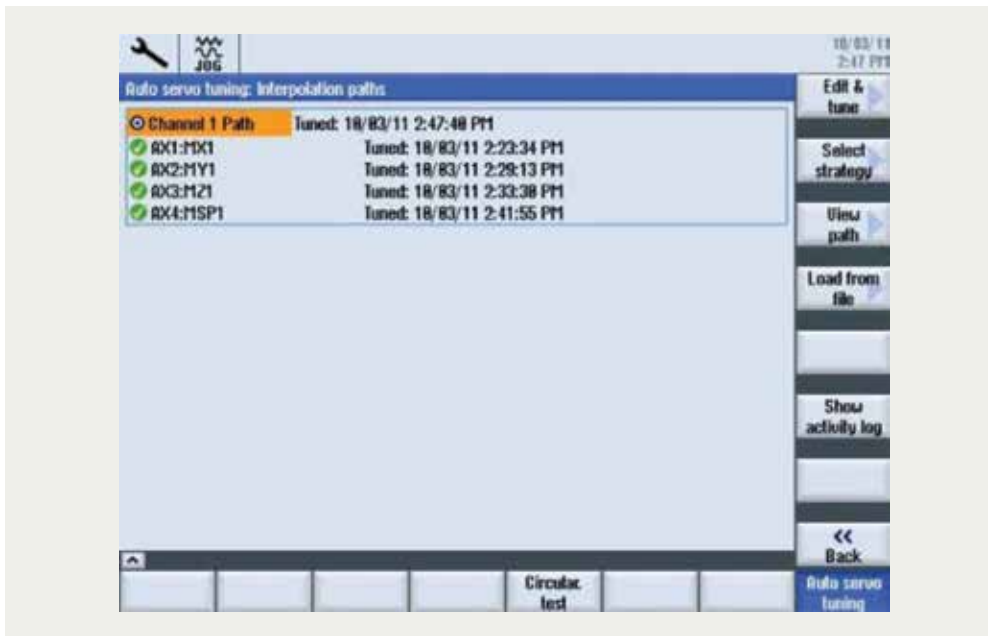
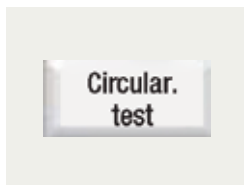


Figure 3

Select the "Circular. Test" softkey.



Setting the "Circularity test" parameters:

Set the desired measuring parameters to match the programmed circle	
Measurement	Select the relevant axes and the "active" measuring system
Parameter	Enter the programmed radius and feedrate — the multiplier should remain at 1
Resolution	Set the resolution as desired, e.g. 0.010 mm/grad
Representation	Select "Mean radius"

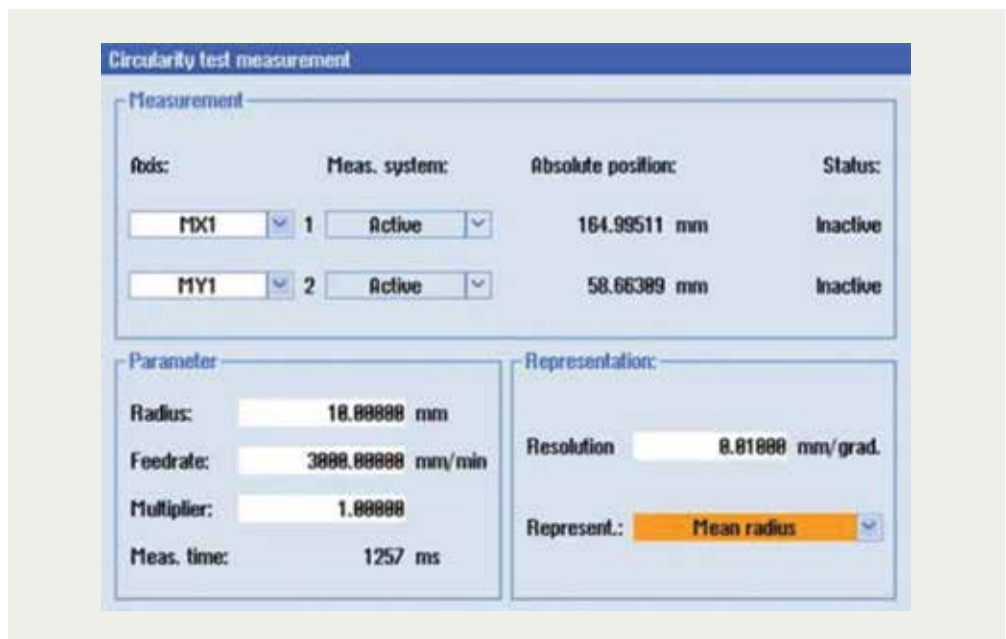
The example program should first be modified to fit the machine positions, feed rates and plane, if necessary. The example program uses circular interpolation and runs the programmed circle continuously. Follow the specific machine procedures to run the test part program.

Important

The circularity test must be activated manually by pressing the “Start” softkey after the test program is started.



Figure 4



The machine data below is from an actual machine tool, which was used for the following circularity test examples:

Figure 5

Data	Description	X	Y
32200	POSCTRL_GAIN	8.50	8.50
P1460	SPEEDCTRL_GAIN1	3.01	3.89
P1462	SPEEDCTRL_INTEGRATOR_TIME_1	6.18	6.18
P1433	SPEEDCTRL_REF_MODEL_FREQ	106.3	106.3
P1440	NUM_SPEED_FILTERS	0	0
32610	VELO_FFW_WEIGHT	1.0	1.0
32620	FFW_MODE (Speed or Torque)	3 or 4	3 or 4
32810	EQUIV_SPEEDCTRL_TIME	0.0022	0.0022
32400	AX_JERK_ENABLE	0	0

As a general rule, with feed forward optimized, the actual radius will be too large.

This can be corrected using a time constant (MD32410 AX_JERK_TIME).

If necessary, enable the time constant in all axes.

The circle below shows the results after feed forward has been optimized; however, the mean radius is **0.0019mm** too large.

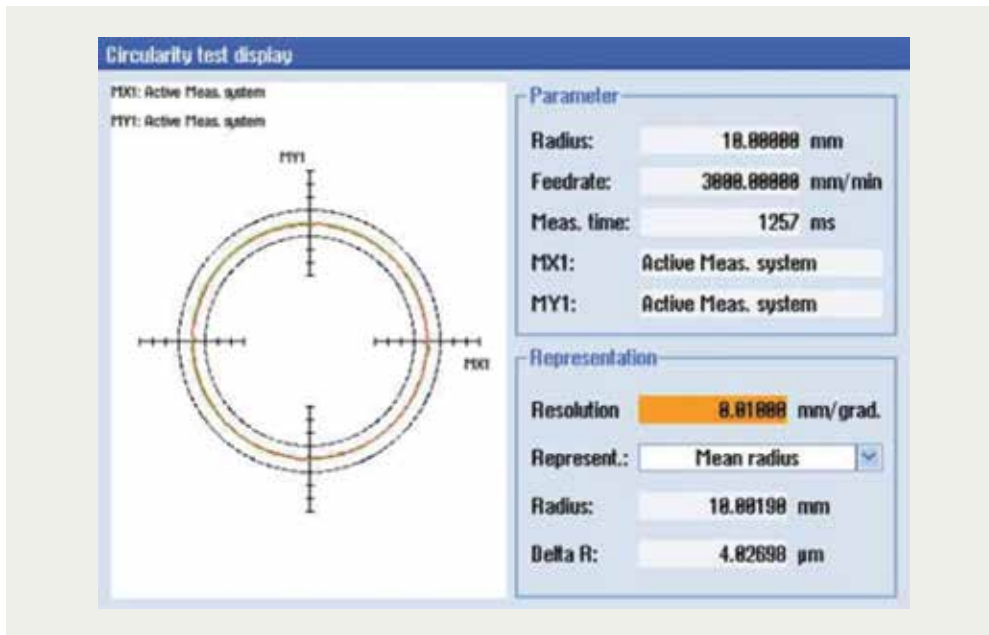


Figure 6

The circle size is now corrected using **MD32410 AX_JERK_TIME**.

The Jerk Time should be enabled and the jerk mode selected.

It is recommended to use **MD32402 AX_JERK_MODE =2**

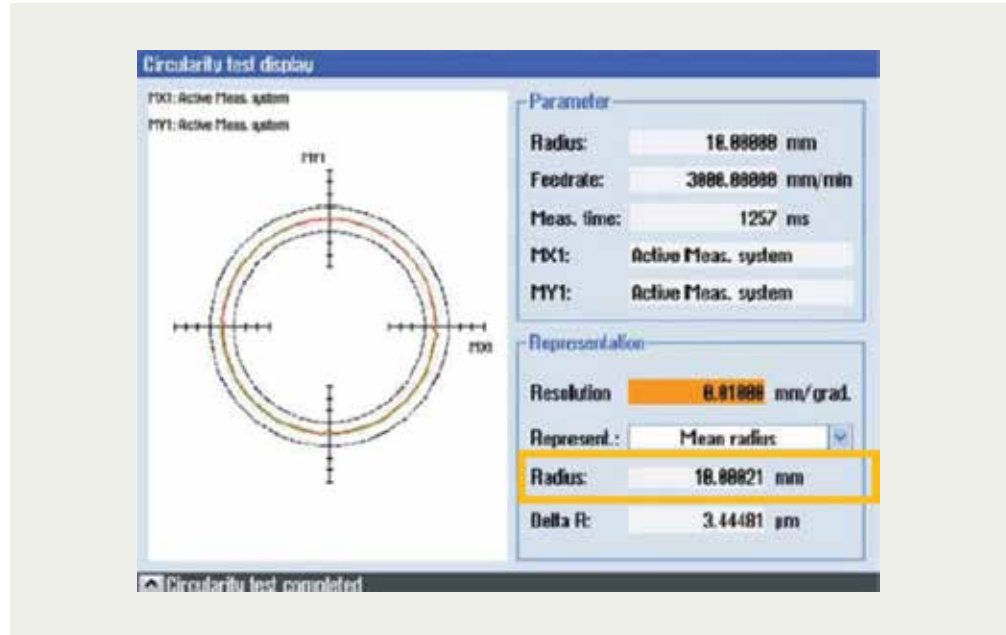
A Power on Reset is required to activate the new setting.

Data	Description	X	Y
32200	POSCTRL_GAIN	8.50	8.50
P1460	SPEEDCTRL_GAIN1	3.01	3.89
P1462	SPEEDCTRL_INTEGRATOR_TIME_1	6.18	6.18
P1433	SPEEDCTRL_REF_MODEL_FREQ	106.3	106.3
P1440	NUM_SPEED_FILTERS	0	0
32610	VELO_FFWEIGHT	1.0	1.0
32620	FFW_MODE (Speed or Torque)	3 or 4	3 or 4
32810	EQUIV_SPEEDCTRL_TIME	0.0022	0.0022
32400	AX_JERK_ENABLE	1	1
32402	AX_JERK_MODE	2	2
32410	AX_JERK_TIME	0.012	0.012

Figure 7

The circle is now just **0.00021 mm** oversize.

Figure 8

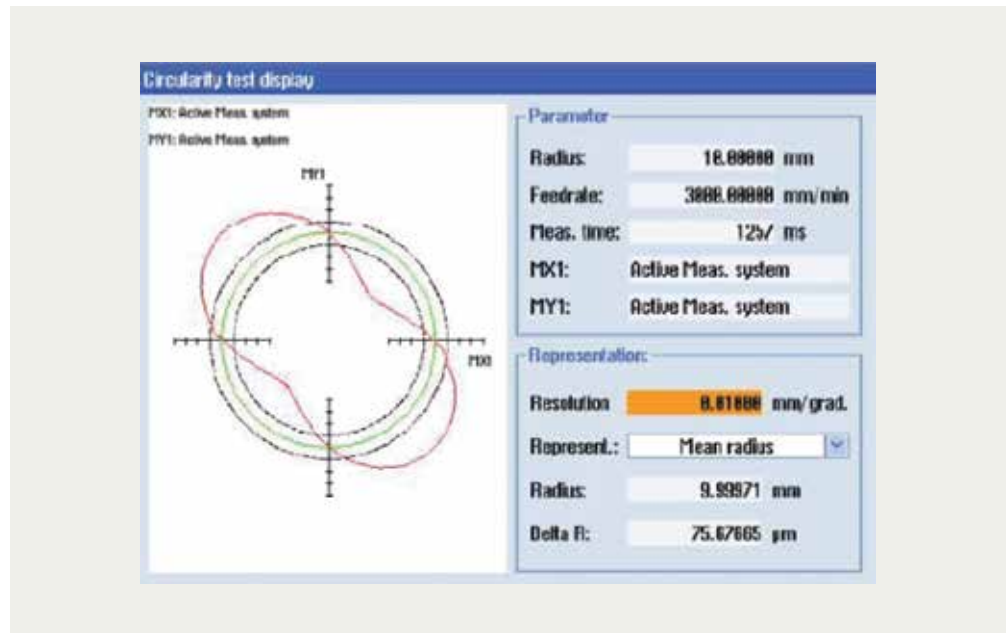


If the Jerk Time of interpolating axes is different, the circle shape will be affected.

Figure 9

Data	Description	X	Y
32400	AX_JERK_ENABLE	1	1
32402	AX_JERK_MODE	2	2
32410	AX_JERK_TIME	0.015	0.012

Figure 10



In some situations, different jerk values can be used correct circle errors.

Data	Description	X	Y
32400	AX_JERK_ENABLE	1	1
32402	AX_JERK_MODE	2	2
32410	AX_JERK_TIME	0.012	0.0125

Figure 11

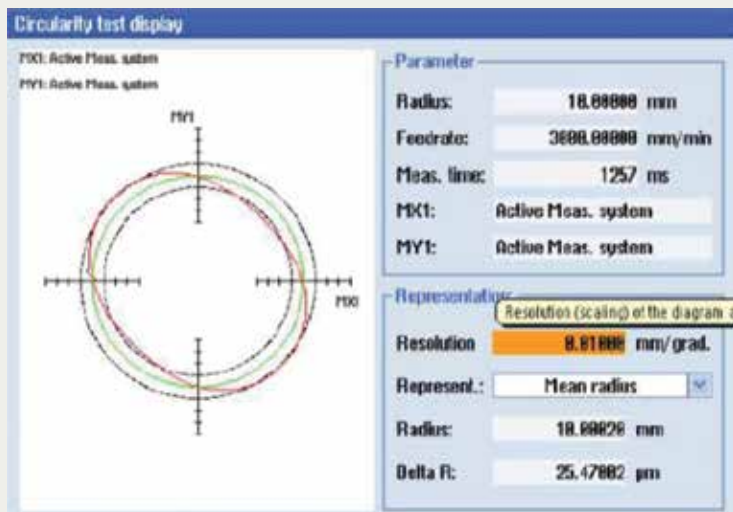


Figure 12

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