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Avoiding vibration in slewing gear pieces

SINUMERIK 828D, 840D sl

http://support.automation.siemens.com/WW/view/en/78452062

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Table of contents

1 Task

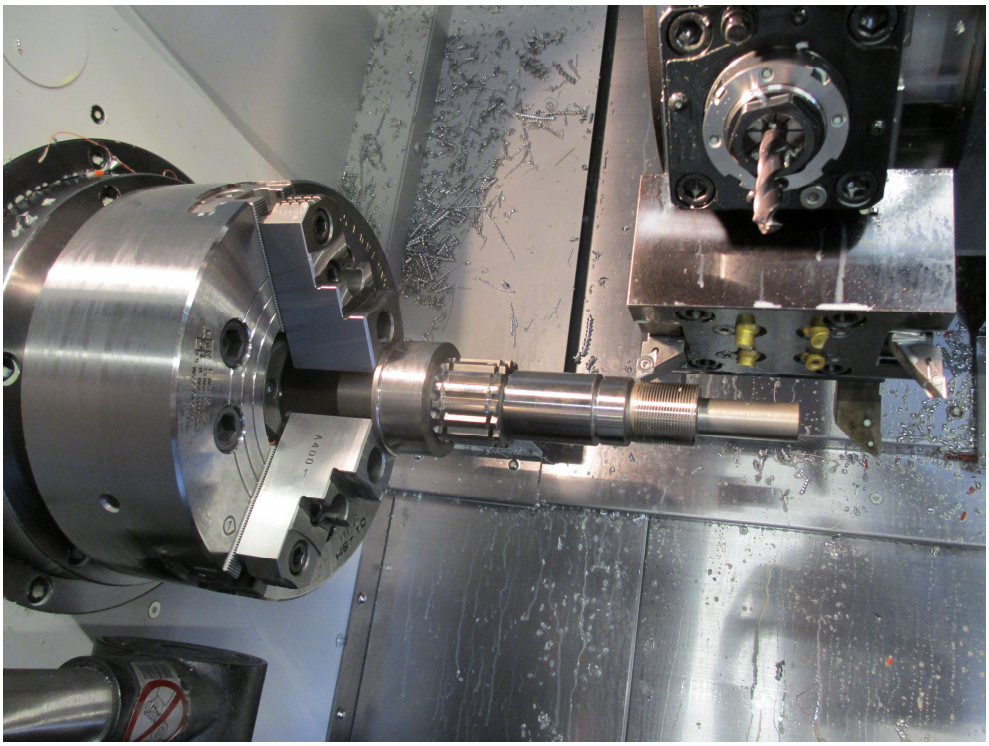
Description of the application

When machining long and slender workpieces which are often very sensitive to vibrations, the speed in critical areas should be set to a harmonic oscillation in a controlled manner during the machining process. The aim should be to change the spindle speed such that the machining process is not impaired and no chatter marks are formed on the rotating surface.

Overview of the automation task

The following figure shows an example of a workpiece, which is set to vibration by the unfavorable tension condition during the rotating process.

Figure 1-1 Clamped shaft



2 Solution

2.1 Overview

Description

Permanent change in speed of the master spindle can eliminate any vibrations occurring in the slewing gear piece. When manually changing the spindle speed by using the override, it is very difficult to create a harmonious vibration speed of the master spindle. Therefore, a cycle which consists of two part subprograms (.SPF files) should be created. By selectively switching the cycle on and off, a harmonic vibration speed of the master spindle is forced. Both subprograms of the cycle form the basis for future use of the "OSZI" command, which can be safely used in the program GUIDE (G-code).

Required knowledge

Basic knowledge of the programGUIDE (G code) programming is required.

Advantages

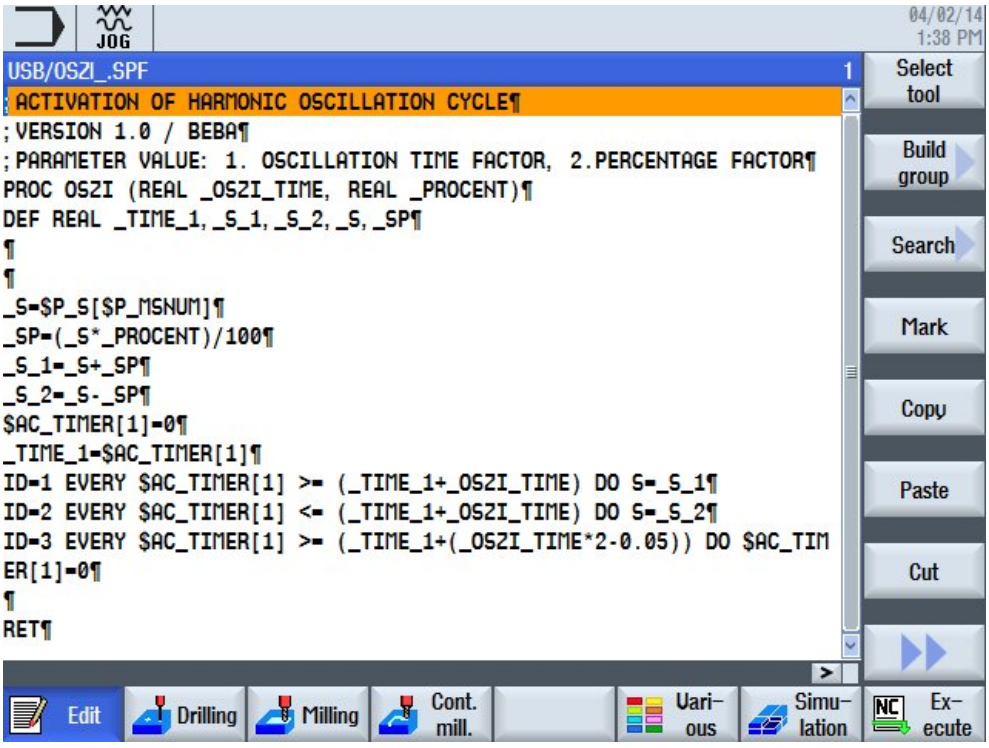
This application provides the following benefits:

- Avoiding chatter marks on the workpiece
- Precision turning process on the workpiece is still possible

2.2 Programming

The subprograms OSZI.SPF (Fig. 2-1) and OSZIOFF.SPF (Fig. 2-2), which are used to turn the harmonic vibration at set speed on and off will be stored in the password-protected area of the system data / user cycles. This area is accessible only to authorized, qualified personnel. The end-user should be responsible, act deliberately and cautiously, as the cycles described require changes to system data.

Figure 2-1 Cycle for turning on harmonic vibrations at set speed



Note The program for turning on harmonic vibrations is provided as a download and it need not be created by you.

For a better overview of the programGUIDE for turning on harmonic vibration at set speed is shown below:

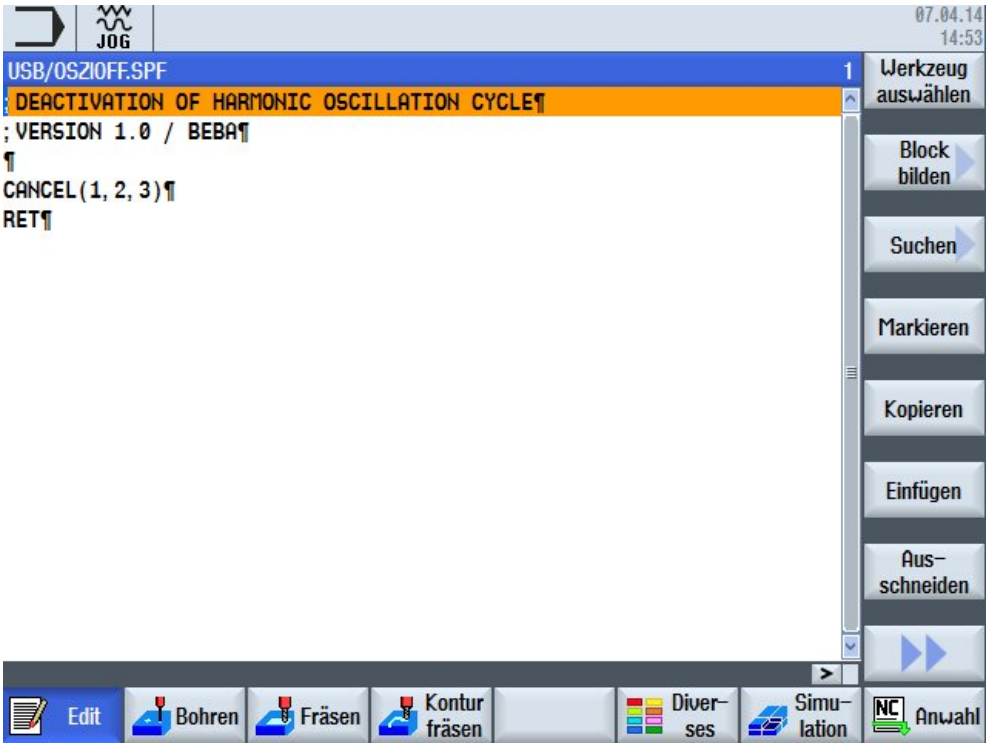
```
1  ;CYCLE FOR TURNING ON HARMONIC VIBRATION
   ;VERSION 1.0 / BEBA
   ;TRANSFER_PARAMETER: 1. OSCILLATION TIME FACTOR,
   2. PROCENTFAKTOR
2  PROC OSZI (REAL _OSZI_TIME, REAL _PROCENT)
   DEF REAL _TIME_1,_S_1,_S_2,_S,_SP
3  _S=$P_S[$P_MSNUM]
4  _SP=(_S*_PROCENT)/100
5  _S_1=_S+_SP
6  _S_2=_S-_SP
7  $AC_TIMER[1]=0
   _TIME_1=$AC_TIMER[1]
8  ID=1 EVERY $AC_TIMER[1] >= (_TIME_1+_OSZI_TIME) DO S=_S_1
   ID=2 EVERY $AC_TIMER[1] <= (_TIME_1+_OSZI_TIME) DO S=_S_2
   ID=3 EVERY $AC_TIMER[1] >= (_TIME_1+(_OSZI_TIME*2-0.05)) DO
   RET
                                                          9
```

Table 2□1 Explanation of the programming steps (turning on the harmonic vibration at set speed)

No.	Action	Note
1	TRANSFER_PARAMETER: 1.OSCILLATION TIME FACTOR, 2. PERCENTAGE_FACTOR	Comments area
2	PROC OSZI (REAL _OSZI_TIME, REAL_PROZENT)	Definition of the procedure name, the transfer parameters and the necessary program runtime variables
3	_S=$P_S[$P_MSNUM]	Query of the current master spindle
4	_SP=(_S*_PROZENT)/100	Calculation of the spindle speed in relation to the percentage value
5	_S_1	Upper speed limit
6	_S_2	Lower speed limit
7	$AC_TIMER[1]=0 _TIME_1=$AC_TIMER[1]	Setting and stopping the timer
8	ID=1 EVERY $AC_TIMER[1] >= (_TIME_1+_OSZI_TIME) DO S=_S_1 ID=2 EVERY $AC_TIMER[1] <= (_TIME_1+_OSZI_TIME) DO S=_S_2 ID=3 EVERY $AC_TIMER[1] >= (_TIME_1+(_OSZI_TIME*2-0.05)) DO	Synchronous actions for changing the set value of the spindle
9	2-0.05	Correction factor of the set timer

Note The correction factor of the set timer is an empirical value. This prevents the harmonic vibration from exceeding the set upper or lower limit of the spindle speed.

Figure 2-2 Cycle for turning off harmonic vibrations at set speed



Note

The program for deactivation of harmonic vibration at set speed is provided as a download and it need not be created by you.

For a better overview of the programGUIDE for turning off harmonic vibration at set speed is shown below:

;CYCLE FOR TURNING OFF HARMONIC VIBRATION AT SET SPEED

;VERSION 1.0 / BEBA

CANCEL(1, 2, 3)

Table 2□2 Explanation of the programming step (turning off the harmonic vibration at set speed)

No.	Action	Note
1	CANCEL (1,2,3)	Stopping the three synchronous actions

2.3 Setup Settings

Prerequisite

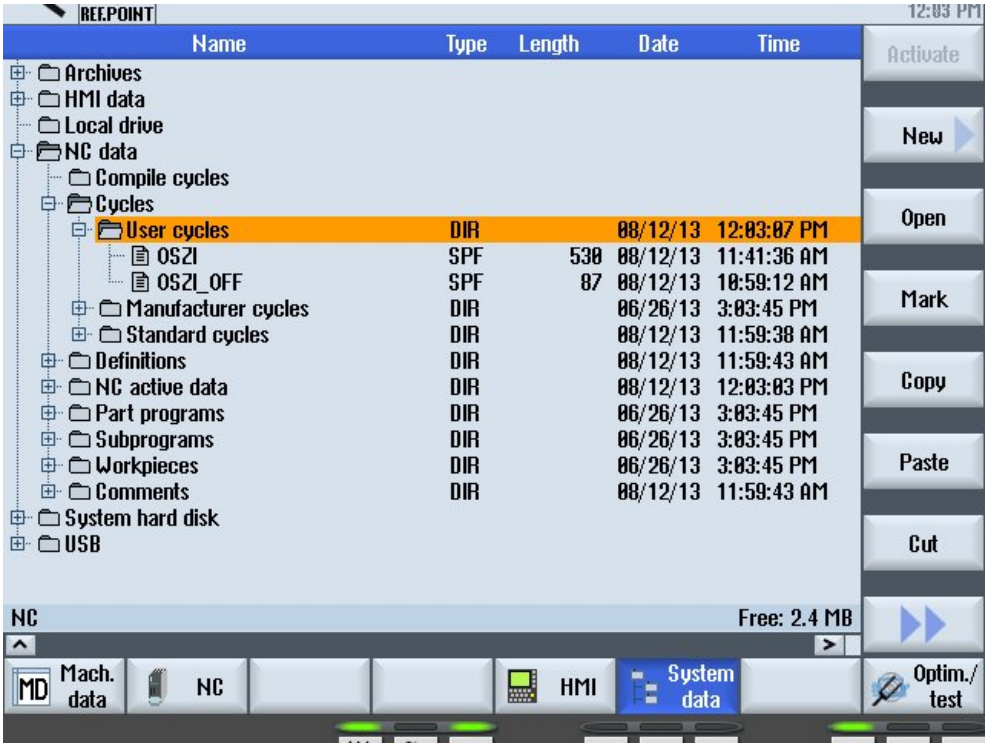
It must be ensured that the names of the used synchronous actions ID1 to ID3 are identical in the startup and shutdown program (OSZI.SPF and OSZIOFF.SPF). Should other synchronous actions have this designation already, you must assign a numbering that is not used yet to these synchronous actions.

Setup Setting

Note the following settings in the setup of the SINUMERIK control:

1. Copy the generated subprograms OSZI.SPF and OSZIOFF.SPF
   to the user cycle area as shown in Figure 2-3.

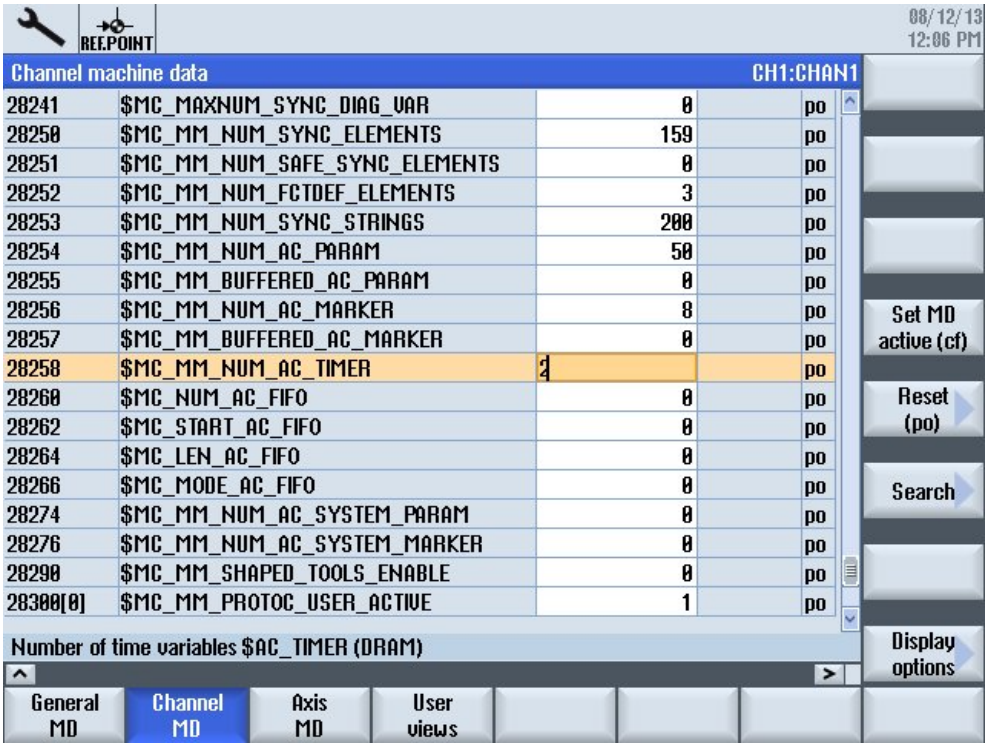
Figure 2-3 Inserting the OSC files in the user cycle area



Note The machine manufacturer or Siemens Service has the permission to access the system data area.

2. Set the timer of the channel machine date MD 28528 (number of timers) to least "2" (Fig. 2-4) and set it effective.

Figure 2-4 Changing the timer in the channel machine date MD 28258



3. Turn the machine off and then on again, so that the installation is completed and the cycle is activated.

2.4 Application

The Figure 2-4 shows the use of the vibration prevention function (OSC) in the SINUMERIK. OSC and OSZIOFF can be inserted into the respective workpiece program as high-level language commands. Only the percentage change in speed is entered within the parentheses. A change in the user cycles is not necessary from the perspective of the machine operator. Please note that this feature is intended only for use in the programGUIDE and does not apply to ShopTurn.

Figure 2-4 Application of the OSC function in programGUIDE

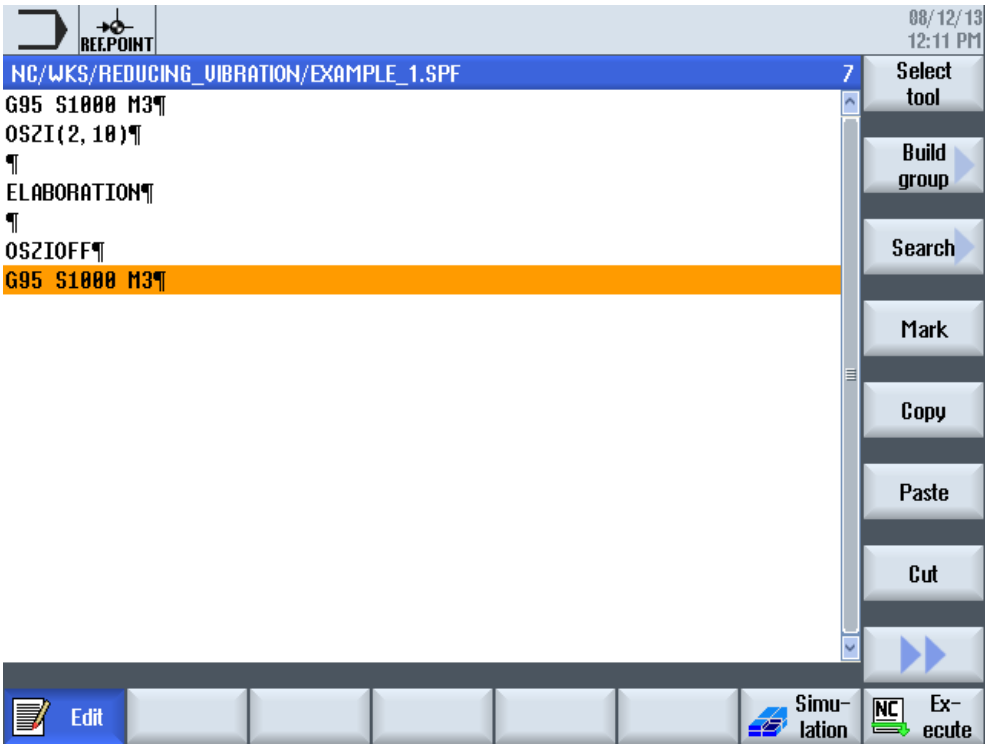


Table 2□3 Explanation of the programming steps (vibration prevention program)

No.	Action	Note
1	G95 S1000 M3	The master spindle turns clockwise at 1000 rpm
2	OSZI(2,10)	The speed is set to 110% for a period of 2 seconds.
3	Machining	Is located here as the dummy for the machining process at the workpiece.
4	OSZIOFF	Turning off the vibration
5	G95 S1000 M3	Set new speed; otherwise, the last speed used will be active. Either the upper or lower speed limit.

Vibrations on the workpiece can be achieved by varying the constant speed. Therefore, the set value of the spindle changes constantly. Thus, the set value of the spindle speed fluctuates between a lower and upper limit back and forth within a defined period of time. In the current example, the selected set value of the spindle speed ranges between 90% and 110% of rated speed selected. The time interval was fixed at 2 seconds at an initial spindle speed of 1000 rpm.

3 Principle of the ideal speed behavior

Vibration and Master Spindle

Vibration acts only on the active master spindle and depends on its dynamics.

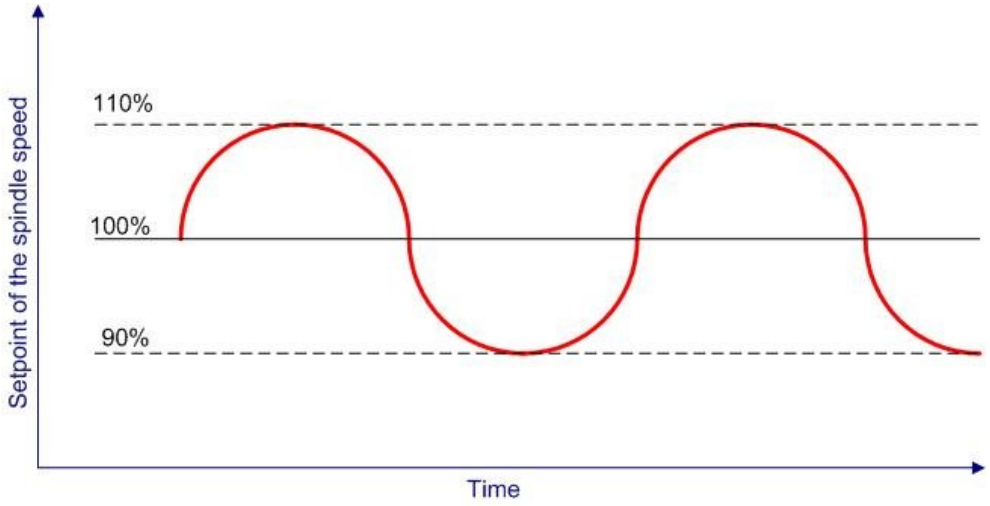
Reducing Vibrations

In order to reduce vibrations, the set value of the spindle speed is reduced or increased by the percent factor after each time factor. The result is a vibration that is strongly dependent on the dynamics of the spindle and the workpiece mass. There are no tables of values for this vibration behavior, thus the required parameters (spindle speed, time factor) for the material used must be determined experimentally.

Ideal Vibration Behavior

The desired spindle behavior is illustrated in Figure 3-1. Constant fluctuation of the spindle speed between upper and lower limits specified by you (Section 2.4) results in a sinusoidal wave.

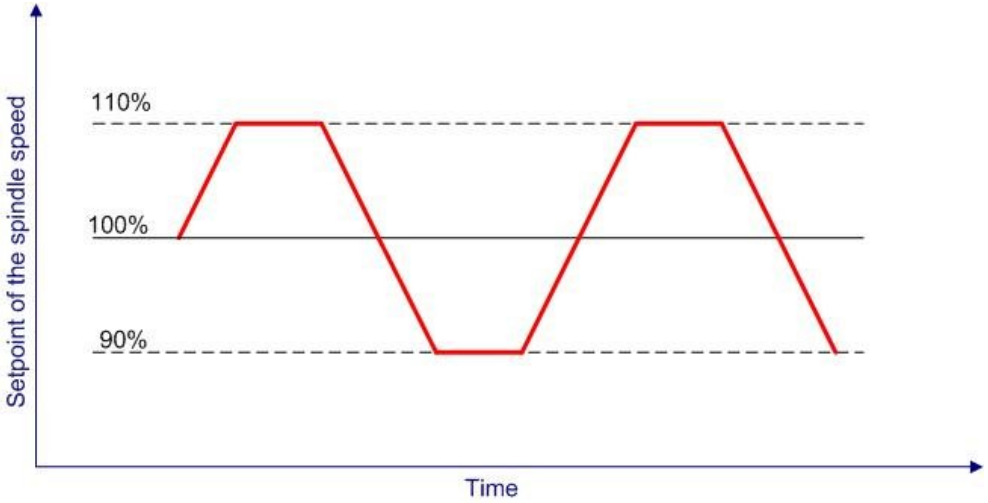
Figure 3-1 Ideal speed curve of the master spindle



Unfavorable Vibration Behavior

The Figure 3-2 shows a change in the spindle speed with a very large time factor selected. The spindle speed lingers for a moment on the upper or lower limit of the selected set value of the spindle speed; this may again lead to the rattling of the workpiece.

Figure 3-2 Unfavorable vibration behavior of the master spindle speed



4 Contact

Siemens AG

Industry Sector
I DT MC MTS APC 1 2
Frauenauracher Straße 80
D - 91056 Erlangen
mailto: MC-MTS-APC-Tech-Team.i-dt@siemens.com

5 History

Table 5-1

Version	Date	Modifications
V1.0	09/2013	First version
V2.0	04/2014	Optimization of the sequence programs OSZI