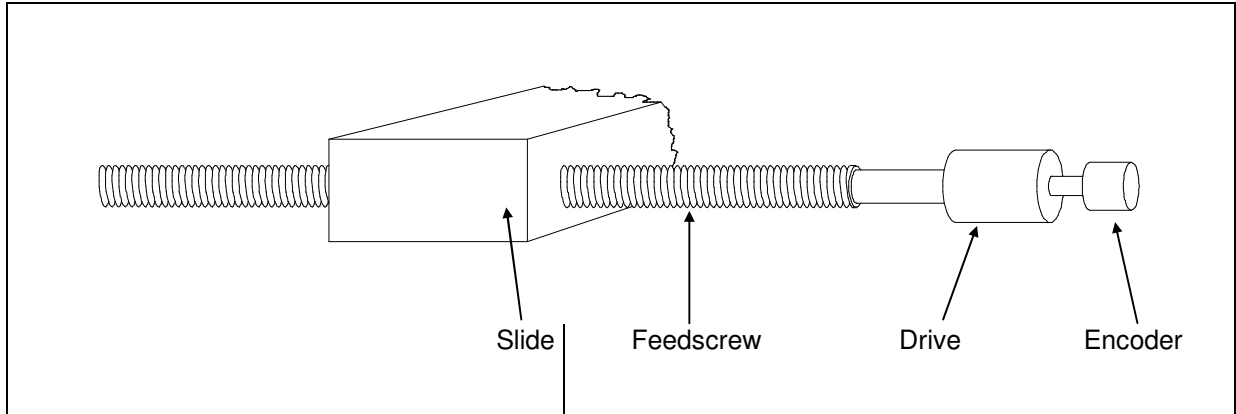


N Feedscrew pitch error compensation for machine-tools featuring “Sinumerik Series 800” controls

For positioning along the machine axes, machine tools usually have feedscrews fitted with incremental rotary encoders that measure position. Since rotary encoders do not register inaccuracies of the screw thread, these inaccuracies deteriorate the positioning accuracy of the machine-tool.



With Sinumerik Series 800 Control Systems, feedscrew errors can be largely compensated. For this purpose, the error curves of the machine axes are established by measurements with a laser interferometer setup. The "ZLM Position" program module determines the compensation values and transmits them to the machine control system.

When a machine-tool thus compensated is being positioned, the respective compensating value is added to the position reading of the encoder, resulting in higher position accuracy.

N 1 **Ascertaining the position errors of the machine axes**

The "ZLM Position" calibration software module of the ZLM 500 Laser Interferometer allows the positioning errors of machine axes to be ascertained. For each axis the program creates a file card with the position errors.

When measuring the position errors, mind the following instructions:

1. **The machine must be measured in non-compensated state.**

In order to inactivate already existing compensation values, set the compensation value for the respective axis to zero (MD 3280 for 1st axis, MD 3281 for 2nd axis etc.).

Whenever you change machine data, be sure to note down the old data.

Certain machine data changes will only become effective after you switch on the machine the next time. Therefore we recommend to turn the machine off and on again after changing any data.

2. Each machine axis has a reference position. The control system assigns to this position the position value "zero". On the command "Travel to reference position", each machine axes homes in to its reference position.

You need not test the full length of the machine axis for errors, but may limit the test to the range in which high positioning accuracy is essential. **In any case, however, the reference position must be within the range tested.**

It is recommendable to set the laser interferometer to zero in the reference position. Otherwise you need to **note down the reading of the laser interferometer in the reference position**. For this purpose the file card contains the item "**Ref(erence) point**".

Moreover, be sure that the **sign of the laser interferometer reading is identical with the machine-internal sign of the machine axis**.

3. In order to avoid later misunderstandings, always enter the designation of an axis just tested into the "**Axis**" field of the file card.

4. In the machine control system, the machine axes are numbered consecutively. For obtaining the compensation you need to find out the correlation between axis designation and axis number.

You also need to find out the axis resolution, i.e. the machine increment in terms of μm for each axis.


The operation of the "ZLM Position" program module is described in detail in section G of the ZLM Software handbook.

N 2 Start of the "ZLM Compensation" program module

A separate program module termed "ZLM Compensation" is available for the computation of compensation data and their transfer to the machine control system.


Look for the "ZLM Compensation" icon in the "ZLM" application window. You can start this module same as any of the measuring program modules.

N 3 Reading in the measurement data

Either click the  button or select the **"Card"** option of the **"Cardfile"** menu to open the card file management.

The loading of cards is equal to the loading of cards in the measuring programs, except for the fact that here you can load several cards into the main memory at a time.

Use of a "Sinumerik Series 800" control requires that the compensation data for all machine axes must be computed and transferred together. Therefore you need to load the file cards of all axes of the machine-tool under test.

To end card selection, click the  button or select the **"End cardfile"** option of the **"Cardfile"** menu. The screen will then display a table with compensation parameters.

N 4 Compensation parameters

To ensure successful compensation, you need to tell the program certain properties of the machine axes (axis number, resolution, reference position, start and end of the travelling range). As the machine control system has a limited storage capacity for compensation data, a number of parameters can be specified that help reduce the storage space required.

The name of the respective machine axis appears in the 2nd column.

In the machine control system, the axes are numbered consecutively. In the 1st column you need to enter which axis has which number.

The entry “-” is only of importance if a storage space problem occurs in the CNC system during compensation. It is then possible with this entry to exclude machine axes from compensation.

To ensure successful compensation, you need to specify in the "Resolution" column the μm equivalent of one machine increment for each axis.

In the "Tolerance" column, enter the width of the permissible tolerance zone for the position errors of the machine axis after compensation. First you should enter the resolution of the axis. If this should cause storage space problems in the CNC system, increase the tolerance for the individual axes depending on their accuracy priorities.

The “Sinumerik Series 800” control systems are capable to effect different compensations for the two travel directions of a machine axis.

In the “**Direction-dependent**” column you can specify whether you want the compensation to be effected depending on direction.

In case of storage space problems you can switch off direction dependence for selected axes.

In the “**Reference point**” column you need to enter the reading of the laser interferometer with the respective machine axis in the reference position.

It is not possible to test a machine axis throughout its length, because a reversing distance must be travelled at either end of the range tested. Compensation data can only be computed for the axis range tested. There remains the question of how the control will respond in the two untested end ranges.

It is desirable that the machine's positioning behaviour in these end ranges should be the same as before compensation. In order to achieve this with a Sinumerik control system, zero compensation values must be entered for these ranges. If you fail to do this, the machine will compensate by the values just contained in the memory for the respective positions. In order to enable the program to fill the end ranges with zero compensation values, you need to tell the program the limits of the compensated range of the respective axis, in terms of **“Start comp(ensation)”** and **“End comp(ensation)”**.

In the “Start comp.” and “End comp.” columns, the program first enters which range of the machine axis has been tested. These values always refer to the readings of the laser interferometer.

Here you should change the compensation range so that the machine axis will be compensated throughout its length.

In cases where the control system instantaneously lacks storage space for compensation data, the beginning and end of compensation can be restricted to a range in which highly accurate positioning is most essential. This may lead, though, to a degradation of positioning accuracy in the other ranges, compared with the non-compensated state.

A few units of the Sinumerik Series 800 controls compensate with signs reversed. Unfortunately it is not possible to identify these units by their serial numbers. Therefore, the following strategy should be adopted:

1. First have the program compute the compensation data the way they are required for most of the Sinumerik Series 800 units.
2. If this is not successful, have the compensation data computed with the signs reversed.

To reverse the signs for compensation, either

click the  button or select the

"CNC make" item of the **"Compensation"** menu. The upper entry in the "CNC make" dialog box applies to the majority of the Sinumerik Series 800 control units.

N 5 Computation of compensation data

To release computation of the compensation data, either

click the 

button or select the **"Compute data"** item of the **"Compensation"** menu.

In the bottom part of the screen you will then see the compensation data in the format used by the control system. Use the scroll bar to page through the data.

When computing the compensation data, the program checks whether the control system has sufficient storage space for the compensation data. In the negative case an error message will be issued.

In such a case you may make either of the following changes in the parameter settings:

1. Broaden the tolerance zone.
2. Select "no" for direction dependence.
3. Exclude one or more machine axes from compensation (enter "-" under **"Axis number"**).
4. Reduce the compensation range under **"Start comp."** and **"End comp."**.

N 6 Transfer of compensation data to the control system

Data transfer is via the RS-232 interface port.

It is important that all interface parameters of the PC and the control system are matched to each other. To select the interface port and interface parameters of the PC, either click the



button or choose the **"RS 232**

parameters" item in the **"Compensation"** menu.

This will open the "RS-232 parameters" dialog box.

In addition, the **Xon/Xoff Protocol** at the control unit must be switched off.

Then either click the



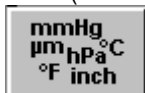
button or select the **"Transfer to CNC"** item of the

"Compensation" menu to start data transfer.

The compensation data will only become effective after the machine has been switched on the next time and made to travel to the reference points. In any case you should check the compensation effect. With some CNC makes, compensation in MD 5016 must be activated via bits 1 and 2 (MD 5016: xxxxx11x).

N 7 Systems of units

To select between metric and imperial units (metres - inches), click the



button or choose the **"Units"** item in the **"Compensation"** menu.

N 8 Quitting the program module

To quit the program module,

either click the



button or select the **"End compensation program"** item of the **"Compensation"** menu.