1. Description

This description uses the example of a camshaft to illustrate a typical sequence for the machining of a non-circular contour. The cam contour including the wheel radius compensation and velocity profile is not calculated within the framework of this application. The customer must therefore implement the cam contour in a stroke value table considering the grinding wheel radius. The same procedure is also required for a velocity profile (if required).

The program example shows the use of the “Electronic gear” and “Master value coupling” NC functions combined with synchronized actions for workpiece machining.

The virtual cylindrical grinding machine is based on the following axis configuration:

- X axis for radial infeed
- V axis for stroke override
- Z axis for positionings in axial direction
- C axis as workpiece axis

A spindle does not exist as it is not relevant for the representation of the sequence.

A camshaft for a 4-cycle machine is used as a workpiece. This means that four cam pairs are used. All cam pairs consist of one inlet cam and one outlet cam, respectively. Each cam pair is offset by 90° on the radius.

Coupling principle:

The master value coupling works absolutely. This means that the coupled master value following axis approaches the absolute position programmed in the table. In addition to this, an overlay of the master value following axis can neither be programmed nor interpolated. To nevertheless ensure a quasi incremental behavior of the master value coupling and an overlay of the coupled axis, a special coupling structure must be created. The electronic gear function is used in addition to the master value coupling.

Coupling of the C axis to the virtual V axis:

This coupling ensures the lifting motion required for the machining of the workpiece. This intermediate step enables quasi incremental operation with the master value coupling. The required lifting motion may be added to any position of the X infeed axis. The appropriate offset of the tables between the C axis and the V axis allows the machining of cams via the same table despite their different arrangement on the shaft. The table describes the contour from 0° to 360°. The infeed is not realized via the table, but via the interpolation of the radial X infeed axis.

Coupling of the V axis to the X infeed axis:

The coupling of the two axes may be realized at any position of the X axis. Despite the coupling, an overlay of the X following axis may be programmed without influencing the
master value coupling described above. The gearbox link provides an additional advantage as the overlaid motion of the V axis is not considered for the check of the exact stop. A block change may occur at any position of the process despite the continuous motion of the X axis.

Both couplings are defined and switched on via the COUP_ON.SPF program.
2. Special Preparations

The following options are required for implementation:

- Electronic gear
- Master value coupling
- Spline interpolation (if required)

The options are loaded with the series machine start-up file.

The example does not include a PLC program. Only the enables of the axes must be set for test purposes (measuring system, servo enable, pulse enable).

To overlay the infeed motion of the X axis, “Following axis overlay“ must be set to ”1“ at the interface of the X axis DB31.DBX 26.4.

3. Machine Data

The archive file includes all modified machine data and specified option bits which must be paid and ordered separately for use on a machine.

4. Application

A new BSP_CAM.WPD workpiece is generated when loading the series machine start-up file. The corresponding axis configuration is loaded additionally and the drive configuration must be modified in most cases. The archive does not hold a PLC program.

The workpiece includes the following cycles:

- Coup_on(TabNo)  Switch on the coupling and synchronize the C position
- Coup_off  Switch off the coupling
- Cam1_SIN2  Fictitious contour for inlet cam
- Cam2_SIN2  Fictitious contour for outlet cam
- Main_Cam  Main program
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The sequence may be started as soon as the MAIN_CAM main program has been loaded and selected.
The tables are loaded first and the individual cam pairs are machined afterwards. Each cam runs through the following three machining phases: Roughing, finishing cut and sparking out. The required rotations are calculated automatically depending on the process parameters which may be modified in the part program.

5. Modification Options

The following functions have been integrated:

- Velocity profile for process optimization
- Reloading of tables directly from the hard disk
- Communication with higher-level application on HMI
- Incorporation of switching measuring devices
- Fast retraction in case of error
- Extended stop and retraction