SINUMERIK Operate - Milling

Control system overview for machine tools' sales people
Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

**DANGER**

indicates that death or severe personal injury will result if proper precautions are not taken.

**WARNING**

indicates that death or severe personal injury may result if proper precautions are not taken.

**CAUTION**

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

**CAUTION**

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

**NOTICE**

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

**WARNING**

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.
Preface

Scope of validity
This document provides you with an overview of the range of functions included in the SINUMERIK 840D sl Version 2.6 for milling machines.
The document is focusing on vendors and dealers of machine tools.

Organization of the information
• Of the varied functional features of the SINUMERIK products, only those are listed which are of direct value to the machine user.
• All functions contained in the machine's basic configuration will be identified as follows:
  ☑ Basic configuration
• All functions not contained in the machine's basic configuration will be identified as follows:
  ☑ Option: ...
• You can find a summary of the most important unique selling points of the SINUMERIK 840D sl in the chapter "Summary of highlights".
• For information on marketing options through the machine manufacturer, please see the technical description of each machine.

Subject to change without prior notice

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Introduction

1.1 Application

With SINUMERIK 840D sl and the milling technology packages, SINUMERIK MDynamics, you have a tailored solution for all of the CNC milling machines and machining centers that are used worldwide.

When operating the machine tool, you are supported by graphic help screens and Animated Elements.

The functions in the manual mode enable a quick, practical machine set-up. More specifically, this consists of calculating the workpiece position in the machine, as well as the maintenance and dimensioning of the tools in use.

You have three different options when programming:

- programmGUIDE and SINUMERIK CNC programming, with a wide selection of technology cycles for medium series and large series production.
- ShopMill, with automatic cascading (linking) of associated machining steps for small series production.
- ISO dialect and SINUMERIK CNC programming language with ISO dialect interpreter.

SINUMERIK 840D sl with SINUMERIK MDynamics offers a control configuration that covers all of the required application areas without subsequent commissioning and training costs:

- Easy-to-use interface for all machine functions
- DIN/ISO programming offline via CAD/CAM system (e.g. mold making applications)
- DIN/ISO programming on the machine
- Graphic programming
- Measuring functions for workpieces and tools

1.2 Machine spectrum

SINUMERIK 840D sl with SINUMERIK MDynamics, the milling technology packages (3-axis and 3+2-axis / 5-axis) are suitable for the following specific machine types:

- Vertical machining centers with three geometry axes
- Vertical machining centers with additional reversible clamping device
  - Machining cylindrical workpieces (peripheral surface transformation)
  - Machining on multiple sides (swiveled plane)
- Vertical machining centers with additional swivel equipment, also for 5-axis simultaneous milling
  - Swivel head, swivel table or mixed kinematics
Introduction

1.2 Machine spectrum
2.1 SINUMERIK 840D sl

The new SINUMERIK 840D sl is open, flexible and powerful and offers a standard and integrated structure for operator control, programming and visualization. Integrated into the new, especially compact and reliable SINAMICS S120 drive system, it constitutes a completely digital system. It is best-suited for medium and high performance ranges.

- Digital drive controller
- Modular design for drive controller and power unit
- Up to 31 axes/spindles in up to 10 processing channels
- Intelligent control functions meeting the highest standards of machining technology

You can find further information in catalog NC 61

Highlights

- Flexible application and guaranteed future through modular design and comprehensive CNC functions
- Best dynamics, precision and surface quality through use of high performance processors
- Integrated, certified safety functions for man and machine are possible with Safety Integrated
2.2 Operator panel fronts

**OP 010C**
Operator panel 483mm wide, 10.4" display, integrated CNC keyboard, with frontal USB port for memory stick, version with mechanical keys, separate machine control panel

---

**Highlights**

- All relevant functions at a glance, thanks to horizontal and vertical softkeys
- Brilliant color display, balanced and high-quality design of operator components
- Simple data handling with easily accessible USB memory stick

---

1PH7 spindle motor, 1FK7 servo motors
OP 010

Operator panel 483mm wide, 10.4" display, integrated CNC keyboard, with frontal USB port for memory stick, version with **membrane-type keys**, separate machine control panel

---

**Highlights**

- All relevant functions at a glance, thanks to horizontal and vertical softkeys
- Brilliant color display, balanced and high-quality design of operator components
- Simple data handling with easily accessible USB memory stick
OP 010S

Operator panel 310mm wide, 10.4” display, mechanical keyboard, with frontal USB port for memory stick, separate CNC keyboard and machine control panel

Highlights

- Option of especially slim design
- All relevant functions at a glance, thanks to horizontal and vertical softkeys
- Brilliant color display, balanced and high-quality design of operator components
- Simple data handling with easily accessible USB memory stick
OP 012

Operator panel 483mm wide, 12” display, membrane keys, integrated mouse, with USB port for a memory stick at the front.

Highlights

- User-friendly operator control and monitoring thanks to 12” display
- Easy to operate thanks to integral keyboard and mouse
- All relevant functions at a glance, thanks to horizontal and vertical softkeys
- Simple data handling with easily accessible USB memory stick
2.2 Operator panel fronts

OP 015

Operator panel 483mm wide, 15" display, membrane keys, with frontal USB port for memory stick, separate CNC keyboard and machine control panel

- Option of especially large display for better readability and graphic display for high-class machines
- All relevant functions at a glance, thanks to horizontal and vertical softkeys
- Brilliant color display, balanced and high-quality design of operator components
- Simple data handling with easily accessible USB memory stick
2.3 Operator panel equipment

TCU

The Thin Client Unit (TCU) for a distributed configuration allows the SINUMERIK operator panel front to be spatially separated and/or permits several operator panels to be connected to one SINUMERIK NCU.

- Fewer parts for specifically flat design
- Competitive purchase price and inexpensive replacement parts

Highlight

- Rugged and cost-optimized solution, as there is no hard disk
- Signal transmission between PCU/NCU and operator panel front via Industrial Ethernet
PCU 50

We offer the PCU 50 for customers who specify a hard disk and/or supplementary Windows-based software.

- Windows XP operating system
- Additional CNC memory through hard disk
- Additional PCI slots
- Additional CF card slot
- DVI interface

Highlights

- Flexible software expansion on Windows platform
- Flexible hardware expansion via PCI slots
2.4 Handheld units

Mini-handheld unit

The following mini-handheld unit is suitable for the machine setup:

- Operation as close as possible to the workpiece via mobile handheld units
Handheld unit

The SINUMERIK HT 2 is designed to allow machine tools to be manually operated if you must remain mobile during operation (e.g. for setup activities). It has been developed specifically with the focus on easy handling, ruggedness and to address the actual requirements met in practice.

Highlight

- An ergonomic design allows operators to work for long periods of time without getting tired
CNC operation in manual mode (JOG)

3.1 TSM universal cycle

- Basic configuration

A universal cycle is available in the setup for the most commonly used machine functions:

- Tool change with direct access via the tool table (T)
- Spindle speed and direction (S)
- M functions (M)
- Activation of work offsets

- Take over and change in tools directly from the tool table
3.2 Face milling cycle

Basic configuration

A face milling cycle for preparation of the blank for machining is available directly in setup mode. You can select the tool directly from the list. Input the feedrate and the spindle speed / cutting speed.

You can specify the following parameters:

- Machining strategy and direction
- Machining limitations

The input values are retained even after switching off and on again, so that the user can always restart his face milling operation with minimum manpower.

Highlight

- Preparation of workpiece without having to create a part program
3.3 Measure tool

☑ Basic configuration

The tool compensation value can be directly determined in the machine set-up.

The following variants are supported:

- Manual or switching probe
- Scratching with tool at known workpiece geometry

Highlight

- User-friendly functions for determining the tool dimensions directly in the machine
3.4 Measure workpiece

The workpieces can be measured as follows:
- Edge finder, dial gage, reference tool,
- 3D switching probe.

The following measuring variants are available (also if only measuring):
- Point measurement for edges
- Orienting the edge (angle)
- Inner/outer corner (3 or 4 points),
- Orienting the edge by means of 2 holes/pins
- Rectangular or circular pockets, rectangular or circular pins
- Center point of 3 or 4 holes or pins
- Orienting the plane with three points

**Highlight**
- Time saving due to user-friendly determination of the workpiece's clamping position instead of orienting the workpiece by hand
3.5 Work offsets

☑ Basic configuration

The following adjustable work offsets are available to you:

- A basic offset
- Maximum of 99 work offsets (G54, G55 ...)
- Each work offset with axis rotation and fine offset

Highlights

- Flexible machining due to great number of adjustable work offsets
- Optimum overview of all active work offsets incl. swiveling
- Unlimited possibilities of programmable work offsets
3.6 Swiveling in setup mode

Basic configuration

You can swivel the machining plane to any angle in setup mode:

- Machining inclined surfaces
- Measure with inclined tool or table

The plane can be swiveled directly including rotation of coordinates or axial swiveling.

Highlights

- Swivel the machining plane in setup mode by dialog
- Simple setup of the workpiece for machining with swivel axes
Tool management

4.1 Tool table

☐ Basic configuration

Tools with their complete operating data can be managed in the tool list.
- Tools are assigned to the desired magazine locations with the load function.
- For each tool, you can store the following data:
  - Tool type: e.g. face milling cutter, taps and 3D probes
  - Clear tool name in plain text, example: CUTTER_HEAD_63MM
  - Max. of 9 cutting edges per tool
  - Tool length and diameter,
  - Nose angle for drills or number of teeth for milling tools
  - Spindle direction and coolant (level 1 and 2) and up to four additional functions
- Direct transfer of the tool from the list in the program or for measurement

Highlights

- All tool data at a glance
- Simple and secure handling via unmistakable tool names
4.2 Monitoring of tool life and workpiece count

☑ Basic configuration

You can use SINUMERIK 840D sl to monitor the service life of your tools and the number of tool changes. You can give your tools meaningful names instead of cryptic numbers. You will come to appreciate this convenience when you read the CNC program, if not before.

- Monitor cutting time (T) in minutes or number of exchanges (C)
- Prewarning limit for timely preparation of new tools
- If the desired tool is not in the magazine, the SINUMERIK 840D sl will request a manual tool change.

Highlights

- Reduction of machine standstill times via tool monitoring
- Support of tool life monitoring or job time monitoring as standard

4.3 Replacement tools

☑ Basic configuration

If needed, you can even use the SINUMERIK 840D sl to manage replacement tools (sister tools). Tools with the same name are created as replacement tools. The replacement tools are identified with an incrementing number in the ST column.

Highlight

- Automatic tool exchange for unmanned operation
5

User memory

5.1 Buffered CNC work memory

- SINUMERIK 840D sl
  - NCU 710: Basic configuration: 3 MByte, expandable to 9 MByte
  - SINUMERIK 840D sl
  - NCU 720 and NCU 730: Basic configuration: 3 MByte, expandable to 15 MByte

**Highlight**

- Exceptionally large storage space in basic configuration already

5.2 CompactFlash Card

☑ Option: Additional user memory on the CompactFlash card of the NCU

You can find a CompactFlash Card for the system software as standard in the SINUMERIK 840D sl control cabinet. An additional minimum 256 MB may be used as additional user memory. This option is possible in conjunction with the TCU and offers an alternative to the PCU 50 hard disk.

Executing the part program directly from the CompactFlash Card is possible. Additionally, Ethernet linking is recommended.

**Highlight**

- Efficient and reliable solution for handling a large volume of user data
5.3  Hard disk

☑ Option: PCU 50

A hard disk with 12GB of user memory is available on the PCU 50 for expansion of the CNC memory.

**Highlights**

- Hard disk can still be used as a data carrier

5.4  Floppy disk drive

☑ Option: Only a disk drive required

TCU and PCU 50 come ready for connection to a USB disk drive as standard. The floppy disk drive can be directly accessed from the program manager.

**Highlight**

- Data transfer via floppy disk is still possible
5.5 Card reader

☑ Option: Card reader

Using the SINUMERIK card reading unit in combination with CF, SD and MMC cards, data can be archived and user data exchanged. The connection is made via a USB interface. The card reader can be booted. Cards can be inserted and removed during operation.

Highlights

- Insertion and removal of cards during operation possible
- Simple data exchange without opening the control cabinet

5.6 USB Hub 4

☑ Option: USB Hub 4

Using the Industrial USB Hub 4, you can connect up to four I/O devices such as e.g. USB stick and keyboard. The Industrial USB Hub 4 differs from commercially available USB hubs mainly in the fact that it is suitable for use in rugged industrial environments (IP65).

Highlight

- The system to be operated can be more easily, safely and reliably handled
User memory

5.6 USB Hub 4
Data transfer

6.1 Program manager

☑ Basic configuration

The program manager offers you an optimum overview of the directories and programs, and very easy-to-use file handling. It supports plain names of up to 24 characters for directories and files. Subdirectories can also be managed on external storage media such as CF cards and USB sticks.

All storage media including the network drives are displayed in the program manager. The part programs can be edited in all media.

Highlight

- Easy and open exchange of data between the various storage media and the network
- User-friendly data handling in typical PC style with copy, paste, rename, etc.
- Preview window permits quick identification of programs without having to open them
6.2 Data transfer using the USB memory stick

☑ Option: Only USB memory stick required

A USB memory stick can be used on the front side of the operator panel. User data stored on the PC can be quickly transferred to the internal CNC memory. Execution from USB memory sticks is not possible for security reasons. Instead, we offer a CompactFlash Card solution.

**Highlights**

- User-friendly solution, as memory slot is located at front
- Extremely cost-efficient, as no software option required

6.3 RCS Commander

☑ Option: RCS Commander on CD-ROM
☑ Option: RCS Host remote diagnostics function

The RCS Commander is a powerful free-of-charge tool for the PC. It allows you to move data easily into the CNC controller using drag & drop. In addition, it offers a convenient means of viewing the contents of the CNC screen display on the PC. Simply connect your PC or Notebook on which the RCS Commander is installed to the Ethernet interface on the front panel. SINUMERIK 840D sl automatically configures the network. No knowledge of networks is required.

The SINUMERIK 840D sl also supports remote diagnostics via the Ethernet (see options). When connecting the PC to several machines, only one PC license is necessary for remote diagnostics via Ethernet. All machine tool controller diagnostic functions are also available in remote diagnostics.

**Highlight**

- Simple data transfer by drag & drop
- Remote diagnostics means shorter response times and reduced service costs
- Easy transfer of the contents of the screen display from the CNC to the PC; ideal for training purposes etc. (connecting a projector to the PC)
6.4 Ethernet networking

☑ Basic configuration

The SINUMERIK 840D sl is set up for Ethernet (TCP/IP) networking (RJ45 connection).

- The data transfer rate is 10/100 Mbps.
- Remote access to the controller via the RCS Commander, e.g. for commissioning and remote diagnostics
- Access to the network drives is available directly from the program manager. No additional software is required on the server.

Highlight

- Easy and economical connection via Ethernet (TCP/IP) to Windows PCs or Unix workstations
- No software needs to be installed on the servers
Data transfer

6.4 Ethernet networking
Graphical support functions

7.1 Animated elements

☑ Basic configuration

For indication of which parameters affect what in the machining, the SINUMERIK 840D sl offers a new input support function with animated element sequences. For instance, the difference between chip breakage and chip removal when drilling or the precise probe sequence for a corner measurement can be shown.

- Process reliability during the setup
- Increased reliability at program input by easily understood depiction of selection options
7.2 Onboard documentation

☑ Basic configuration

For each input field in the operating screens, SINUMERIK 840D sl automatically displays help in the form of a "cursor text". The SINUMERIK 840D sl provides further information in the form of a complete context-sensitive help system with many useful details and graphics.

- Programming on the machine without a handbook
- Help button to toggle between the editor and help screens
CNC operation in automatic mode (AUTO)

8.1 Block search

Basic configuration

A block search may be executed in machine status RESET, e.g. after a program interruption or to specifically return to machining. The program data are prepared in such a way that all relevant parameters (tool, work offsets, M functions etc.) are available when accessing the program.

The following search variants are available:

- Specifically to the interruption point
- To any CNC block in the DIN/ISO programs
- To any subroutine levels in DIN/ISO programs
- In work plan programs
- In position patterns when programming work plans
- Accelerated block search in large mold making programs

Highlights

- Time-saving and secure restart at any program point, as no editing of the part program is required
- An extremely quick block search is also available for large part programs through the "External block search without calculation" function; overstore, if necessary
8.2 Program control

☑ Basic configuration

Single block
Single block mode can be activated for startup of the program. For this purpose a program stop occurs after each traversing block. Work plan programs maintain the alternative of stopping processing after each plane infeed.

Program test
Programs can be checked before processing in a program test mode. The program is executed to completion with stationary axes. This is especially meaningful in connection with the simultaneous recording option (real-time simulation).

Reduced rapid traverse
You have the facility of additionally limiting the traversing speed for rapid traverse so that when running-in a new program with rapid traverse, no undesirable high traversing speeds occur. In the rapid traverse mode, the traversing speed of the axes is reduced to the percentage value (0-100%) entered in RG0.

Program editing
In machine condition STOP, the program can be edited directly at the location of the fault, e.g. erroneous DIN/ISO blocks or wrongly parameterized sequences. After correcting the program you can continue machining.

Repositioning to the contour (REPOS)
In machine condition STOP, the machining axes may be moved to and away from the workpiece surface with the handwheel or the direction keys.

Highlights
- Secure positioning of new part programs
- Continue machining quickly after interruptions
8.3 Execution from external source

☑ Basic configuration

SINUMERIK 840D sl allows you to select and execute part programs directly from the CompactFlash card or via the network.

- Quick and easy access to part programs on external storage media
8.4 Simultaneous recording

Option: Simultaneous recording
(simulation of current machining)

During machining, the tool paths can be simultaneously recorded on the display of the controller in plan view, three-side view or in 3D view (with the 3D simulation option). Workpiece depiction and views correspond to the graphic simulation.

Highlight

- Machining can also be monitored in a complex machine room
8.5 Basic block display

☑ Basic configuration

The individual traversing blocks are displayed as DIN/ISO commands during execution of machining steps or machining cycles.

The basic block display guarantees an especially high process security while running-in programs in single block mode.

This function is available to you for programGUIDE (screenshot on left) and also for ShopMill (screenshot on right).

- Optimal control of the program execution, as well in complex sequences or machining cycles, especially in single block mode
CNC operation in automatic mode (AUTO)

8.5 Basic block display
CNC performance capability and optimization functions

9.1 80bit NANO<sup>FP</sup> accuracy

☑ Basic configuration

The accuracy of the workpiece is determined by more factors than just the mechanical characteristics of the machine. The CNC controller also contributes to a critical degree towards the precision of the workpieces. The SINUMERIK 840D sl offers a multitude of CNC functions for this purpose.

The SINUMERIK 840D sl and the SINAMICS drive calculate using 80-bit floating point accuracy. This enables a calculation accuracy much less than a nanometer. This exactness is available not only for closed loop position control but also for power and closed-loop speed control and also for sensor evaluation of the drive.

- Maximum precision in the workpiece results based on extremely high calculation accuracy
9.2 Block change times

☑ Basic configuration

The classic block cycle time plays a secondary role in the SINUMERIK 840D sl due to the high-performance velocity control functions.

Grouping linear blocks to splines greatly lowers the internal amount of data. This, in turns, greatly reduces the block change time.

This is demonstrated by a specific test situation: A SINUMERIK 840D sl (NCU 730) with an active online compressor processes 10,000 G01 blocks in approx. 1 second. This corresponds to a block change time of approx. 0.1 msec.

Highlight

- Internal reduction of block change times by reducing the data volume

9.3 Jerk limiting

☑ Basic configuration

The control calculates a steady acceleration profile instead of jumps in acceleration. This enables jerk-free velocity characteristics for the involved path axes. The jerk limitation can also be directly activated in the part program with the »SOFT« NC language command.

Highlights

- Longer machine lifespan through protection of the mechanical components
- Higher path accuracy through softer acceleration
9.4 Dynamic feedforward control

☑ Basic configuration

Inaccuracies in the resulting workpiece contour due to following errors can practically be eliminated using dynamic feedforward control FFWON. The result is excellent machining precision even at high tool path feedrates. This is clarified with a circularity test on the machine.

Example:

![Diagram showing comparison between Without pre-control and With pre-control](image)

- Highlight

  - Higher path accuracy through compensation of contouring errors
CNC performance capability and optimization functions

9.4 Dynamic feedforward control
Mold making

10.1 Advanced Surface

☑ Option: Advanced Surface

The SINUMERIK 840D sl Advanced Surface function allows you to generate high-quality surfaces on mold making workpieces.

- **Perfect surface**
  The SINUMERIK 840D sl can even cope with inadequate CNC block sequences in mold making programs: New forward-thinking, mathematical algorithms perform fully identical calculations for the movement paths in forward and reverse directions. This means that reverse paths on molds yield mirror-finish workpiece surfaces.

- **Minimum machining time**
  In addition, Advanced Surface ensures shortest machining times. A brand new type of motion control calculates an ideally smooth surface, for which it keeps the tool within the optimum speed range at all times.

- **One-off optimization**
  The tolerant Advanced Surface filter algorithms guarantee you the best workpiece surfaces and shortest machining times, after just a single optimization of the system.

![Image of conventional CNC vs. Advanced Surface comparison]

**Highlight**

- Improved workpiece surface with reduced machining time
10.2 Look Ahead

☑ Basic configuration

The »Look Ahead« function is a means of optimizing the machining speed by »looking ahead« over a parameterizable number of traversing blocks. With tangential block transitions, the axis is accelerated and decelerated beyond block boundaries, so that no drops in velocity occur.

<table>
<thead>
<tr>
<th>Block cycle time with compressor</th>
<th>840D sl / NCU 710</th>
<th>840D sl / NCU 720</th>
<th>840D sl / NCU 730</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;= 1ms</td>
<td>&gt;= 0.5ms</td>
<td>&gt;= 0.1ms</td>
</tr>
<tr>
<td>Lookahead blocks ¹)</td>
<td>150</td>
<td>250</td>
<td>500</td>
</tr>
</tbody>
</table>

¹) Recommended values

Highlight

• Shorter machining times through optimum velocity control
The SINUMERIK 840D sl offers you a choice of the following programming methods:

programGUIDE and SINUMERIK CNC programming

With programGUIDE you obtain the perfect combination of the SINUMERIK CNC programming language and the parameterization of technology cycles. The wide choice of technology cycles and the ease of parameterization allows you to reduce the programming time. The parameter input is supported by Animated Elements.

The SINUMERIK language statements with CNC high-level language elements offer you a very high degree of flexibility and guarantee minimum machining time.

programGUIDE and SINUMERIK CNC programming are particularly suitable for medium series and large series production.

ShopMill - sequence programming

Machining operations such as drilling, centering or pocket milling are shown in ShopMill in the form of sequences. In this way CNC programs – even for complex machining operations – are very compact and easily read. Associated sequences are automatically interlinked and can be assigned any position patterns. ShopMill offers you the shortest programming times even for highly demanding machining tasks. The parameter input is supported by Animated Elements.

ShopMill is particularly well suited to small series production.

ISO dialect and SINUMERIK CNC programming language

The SINUMERIK 840D sl allows you to perform ISO programming using the SINUMERIK CNC programming language combined with or exclusively in ISO dialect.

The online ISO dialect interpreter offers you the opportunity to use CNC programs from other manufacturers.

Step for step you can increase the performance capability by using SINUMERIK CNC programming.

Highlights

- Whether you use programGUIDE or ShopMill – in either case the full range of technological cycles, position patterns and geometries is available to you
- Compatibility with the ISO dialect of other controller manufacturers is feasible
11.1 programGUIDE and SINUMERIK CNC programming

11.1.1 Introduction

☑ Basic configuration

Below is an overview of the characteristic functions of programGUIDE and SINUMERIK CNC programming. This includes:

- DIN/ISO editor
- Languages
- programGUIDE input support

Programming with programGUIDE is available in the basic scope of the SINUMERIK 840D sl.

11.1.2 Program editor

A line-oriented program editor is available to you for DIN/ISO programming. The editor enables you to input CNC language commands directly or to edit them. Thereby, the complete range of CNC functions are available for the most complex machining.

The following functions are included in the program editor:

- Contour calculator
- Tool selection directly from tool list
- Support screens for standard machining and measuring cycles
- "Copy", "Insert" and "Cut" key group
- "Find", "Replace" and "Replace All" character string
- Renumbering a program
- Direct execution from any NC program block (block search)
- Jump to program start or program end

Highlights

- Time saving by using a powerful editor when programming
- Even large part programs allow extremely fast editing in MB size
11.1.3 Languages

The SINUMERIK 840D sl’s CNC interpreter can also process more complex CNC commands, in addition to DIN 66025 standard commands. The commands are presented in clearly readable form.

The following commands are available:

- **G-code**
  G-code in accordance with DIN 66025 and in ISO dialect mode

- **G functions**
  G0, G1, G2, G71 ...

- **Language commands (extended G functions)**
  CIP, SOFT, BRISK, FFWON ...

- **Frame operations (programmable work offsets)**
  The workpiece coordinate system can be shifted, scaled, mirrored or rotated with the commands TRANS, SCALE, MIRROR, ROT.

- **R parameters (arithmetic parameters)**
  300 predefined R parameters are available as arithmetic parameters (floating point format).

- **User variables**
  The user can define his own variables by name and type.

- **System variables**
  System variables can be read/written in all programs. They enable access to work offsets, tool offsets, axis positions, measurement values, control conditions etc.

- **Calculation operations**
  The following mathematical calculation operations are available for linking the variables: calculation operations + - * / sin cos exp etc.
  logical operations == <> >= etc.

- **Program control structures**
  BASIC-style language commands are available for flexible programming of the user cycles: IF-ELSE-ENDIF, FOR, CASE ...

Highlights

- Established programming according to DIN 66025
- Unbeatable range of commands for flexibility and time saving while programming
11.1.4 programGUIDE input support

The cycle support is an extension of the highly flexible DIN/ISO programming. The input screens are based on the ShopMill cycles input screens, so as to ensure optimum continuity. The calls for tool, feedrate and spindle speed can of course also be input in the DIN/ISO editor.

![Image of programGUIDE interface]

**Highlights**

- Existing DIN/ISO part programs with cycles can continue to be used
- Minimum learning requirements due to the continuity of the input support
11.2 ShopMill

11.2.1 Introduction

☑ Option: ShopMill machining step programming

The following information provides you with an overview of the characteristic functions of ShopMill. This includes:

- Sequence editor
- Interlinking of sequences
- Broken-line graphics

These functions are part of the machining step programming options package in ShopMill.

11.2.2 Sequence editor

The graphical programming is performed via a graphic interactive sequence editor. Each program line represents a technological sequence (such as: face milling, centering, drilling, tapping) or geometric data required for the sequences (position patterns or contours). Graphical programming offers, in comparison to DIN/ISO programming, a compact and comprehensible program overview.

Entering individual sequences requires no knowledge of DIN/ISO. All required technical and geometric parameters are entered in screen forms. Simple, intuitive programming with sequences can always be expanded very flexibly by inputting DIN/ISO blocks and control functions.

Highlights

- Intuitive program input, without knowledge of DIN/ISO or Operating Manual
- Compact, clearly arranged machining programs
- Reducing the programming time by graphical input masks and copying / inserting machining steps
11.2.3 Interlinking of sequences

In ShopMill, associated sequences are interlinked with each other. The interlinked sequences are performed consecutively at the appropriate contours or pattern positions.

In the following example, the sequences centering, deep-hole drilling and tapping are applied to 6 holes on the pitch circle pattern position.

- Reduced programming time due to linking of machining steps
11.2.4 Broken-line graphics

While programming, the previously entered sequences will be continuously displayed to scale. A simulation is not required for this. The switch over between the sequence program and the broken-line graphics is performed by the "Graphics View" softkey.

- Plan view of workpiece
- Front view of drilling operations

- Increased reliability at program input by quickly checking the contour, without having to start a simulation run
11.3 Online ISO dialect interpreter

Basic configuration

It is always useful to be able to speak a foreign language. This is true even for a global player such as the SINUMERIK 840D sl. If you prefer classic ISO programming you can continue to use it. You can even mix ISO programming with the SINUMERIK CNC programming language. This enables you to increase the productivity and flexibility of your machine step by step.

In the controller, G commands from Siemens are interpreted as standard. ISO dialect codes and Siemens codes can be mixed within a part program, but not within an NC block.

The switch over between Siemens operating mode and ISO dialect is performed using the following two G commands:

- G290 - "Siemens" NC programming language active
- G291 - "ISO dialect" NC programming language active

The performance capability of the ISO dialect extends even as far as using the cycles G73 to G89, such as cycle G84 for tapping.

Highlights

- Even first-time users can initially continue programming the way they are accustomed to
- ISO dialect and SINUMERIK CNC programming languages can be mixed within part programs
12.1 2D simulation

☑ Basic configuration

SINUMERIK 840D sl 2D simulation offers you the facility to make optimum and reliable preparations for machining workpieces, including detection of collisions. Calculating the machining time also supports optimum calculation of tooling costs.

- Use of the real geometry values of the tools mounted in the machine
- Simulation in plan view and side view
- Simulation can be interrupted at any time, and the speed is controllable

Highlights

- Maximum process reliability through simulation using real geometry values
- Perfect clarity by showing the workpiece dimensions with a scale
- Parallel simulation (background simulation) is possible in conjunction with the NCU 720 and NCU 730, i.e. simulating a part program while another part program is being simultaneously machined.
12.2 3D simulation

☑ Option: 3D simulation

SINUMERIK 3D workpiece simulation offers you optimum assistance and reliability in programming and in quotation costing.

- Reliability:
  3 viewing planes and solid model of the finished part, with zoom to details and free rotation of the viewing angle

- Support:
  - Simulation speed controllable by override
  - Single block operation and start / stop available at any time

- Checking:
  Automatic calculation of machining time

Highlights

- Particularly realistic simulation through representation of the tool
- Optimum help and reliability in programming and in quotation costing
- Parallel simulation (background simulation) is possible in conjunction with the NCU 720 and NCU 730, i.e. simulating a part program while another part program is being simultaneously machined.
CNC technology cycles

13.1 CNC technology cycles for programGuide and ShopMill

Irrespective of whether you use programGUIDE or ShopMill – in either case the full range of technological cycles, position patterns and geometries is available to you.

SINUMERIK 840D sl offers you a unique range of CNC technology cycles for standard machining – including an engraving cycle. The assignment to the machining positions is performed very simply using a wide selection of ready position patterns, even with swiveled planes for milled workpieces.

The integrated swivel cycle allows the machining plane to be swiveled to any degree – no need for CAD/CAM or pocket calculator. This means that the programming of oblique surfaces is not a problem.

For sustained accuracy of workpieces in an ongoing machining process, the SINUMERIK 840D sl supports you with the measuring cycles’ optional package.

Thanks to the integrated geometry processor, you can create even complex contours directly at the CNC controller. In this case, partially defined contour elements are automatically calculated. In addition you can use the optional CAD reader to process DXF files.

The geometry processor supports you when inputting pocket and island contours. The material removal paths are generated fully automatically by the SINUMERIK 840D sl. So as to achieve maximum productivity, you can pre-machine using a large milling tool. The optional identification of residual material permits selective remachining of the remaining corners using a small tool.

Highlights

- Significant simplification of programming, even for complex jobs, using CNC technology cycles
- Continuity of cycles for programGuide and ShopMill
13.2 Highlights of machining cycles

13.2.1 Engraving cycle

☑ Basic configuration

The engraving cycle is used to engrave a text on a workpiece along a line or arc. You can enter the text as fixed text or assign it via a variable as variable text.

Examples of variable texts:

- Date and time
  The values for the date and time are read from the CNC.
- Quantity
  The "Quantity" variable is available as a pre-defined user variable
- Numbers
  When outputting numbers (e.g. measurement results), you can select the output format (digits before and after the point) of the number to be engraved.
- Text
  Instead of entering a fixed text in the engraving text field, you can specify the text to be engraved via a text variable (e.g., _VAR_TEXT="ABC123").

Highlights

- Reduction of set-up times by complete machining on one machine
- Simple program input of engraving
13.2.2 Trochoidal milling

☑ Basic configuration

Vortex milling (trochoidal milling) of open slots is available as a milling strategy directly on the controller, i.e. NC programs for path motions do not have to be generated by CAM systems as previously.

- It is the preferred strategy for HSC roughing, the tool is never fully inserted and tool paths are smooth and round
- Simple parameterizing per dialog: Roughing, pre-finishing, finish milling, finishing floor and edge
- You can select as milling direction synchronous operation, reverse rotation, and for maximum cutting volume during roughing the combination reverse rotation and synchronous operation

---

- Innovative CAM function now available directly on the controller
- Reduction in the machining time for slot milling by up to 50%
13.2.3  Plunge milling

☑ Basic configuration

For machining deep pockets and slots in thin-walled workpieces, the plunge milling cycle is available for open slots.

- As types of machining you can select roughing, pre-finishing and finishing of the edge and/or floor
- Essentially, forces apply only along the main spindle axis, therefore, hardly any distortion of the tool occurs.

Highlights

- Less vibrations and deeper cutting depth thanks to the new machining strategy plunge milling
- Reduced cutting pressure and distortion enable higher productivity when machining thin-walled workpieces
13.2.4 High speed settings

☑ Option: Advanced Surface

The high speed settings cycle enables easy parameterization of the optimum motion control in relation to the machining type and the part program contour tolerance band.

- This cycle is called up within the DIN/ISO editor or in ShopMill. Calling up this function activates Advanced Surface.
- For simplification, the selection is limited to the roughing, pre-finishing, finishing machining types (or deselection) and the tolerance band from the CAD/CAM system.

Highlight

- Simple and easily understandable parameterization of the required machining type (roughing, pre-finishing or finishing) with an interactive screen
13.3 Residual material identification

☑ Option: Residual material detection and machining

Contour ranges which do not permit milling with large diameters are automatically identified in the cycle for contour pockets and contour pins. These areas can be selectively machined with a suitable smaller tool, rather than having to use this tool for the entire contour pocket or pin.

If you mill several pockets and wish to avoid unnecessary tool changeovers, remove stock from all the pockets first and then remove the residual material. In this case, you must enter the tool used for removing the residual material from the pocket in the "TR reference tool" parameter.

![Image of contour milling]

Highlights

- Shorter machining times through the use of a large tool for the substantial part of the stock removal and a smaller tool for the remaining residual material
- Avoidance of non-cutting movements while achieving extremely simple programming
13.4 Measuring functions for workpieces and tools

Option: Measuring cycles

For measurement tasks in automatic mode, powerful measuring cycles are available both within the sequence and also in DIN/ISO programming. Input screens with dynamic help displays are used for convenient entry of the measuring parameters.

The following measuring tasks can be made:

- Workpiece measurement: Correction of work offsets, correction of tool geometry or only measuring
- Tool measurement: Correction of tool geometries
- Display of measurement results
- Logging of measurement results

The following measuring variants are available:

- Hole, spigot, corner, rectangle, slot, bar, edge, face
- Measure under any surface angle
- Measure in swiveled machining planes
- Orienting the plane with three points

Highlights

- Reliable quality of the manufactured parts by automatic measurement in the machine
- Fast programming for complex measuring tasks thanks to input screens with graphic support
- Measuring cycles are now also available for ShopMill sequence programs
The new kinematics measuring cycle CYCLE996 of the SINUMERIK 840D sl allows the measuring of axis kinematics of machine tools with several rotary axes without great time and cost expenditure as before.

- Application during start-up and commissioning and for the control of the machine: The cycle makes control easier and improves the quality of the process as compensations of the rotary axis vectors - due, for example, to temperature variations, mechanical damage or other influential factors - can be checked automatically.
- Input of compensation values after the measuring process for the digital alignment of the rotary axis or acquisition of the measured values for documentation purposes. Tolerance values are freely selectable.

**Highlight**

- Simplest measuring cycle to measure machines with rotary axes in the shortest time
- Simple measurement or direct correction with freely selectable tolerance values
Complete machining

14.1 Peripheral surface machining (TRACYL)

Option: Peripheral surface transformation

Peripheral surface machining can be executed on machines with an additional part apparatus. It is typically handled with an A axis.
Peripheral surface machining offers a series of additional functions in comparison to simple positioning along the A axis.

Programming in the run-off

The axis behaves like a Y axis while programming in the run-off. All plane machining can also be executed in the run-off.
- Drilling operations at any position patterns
- Milling (pockets, contour pockets)
The Y values are converted while machining along the A axis rotation. The Y axis of the machine does not move.

Milling grooves with parallel walls

Peripheral surface machining offers the possibility of milling grooves on parallel walls with and without groove side offset. This is also possible when the diameter of the milling cutter is smaller than the groove width. In this case, the cutter radius compensation may be used. The required Y axis compensating movements are automatically calculated by the controller.

Highlights

- Additional business through expansion of workpiece spectrum
- Reduction of set-up times by complete machining on one machine
14.2 Swivel machining plane

Basic configuration

Multi-face machining saves setup times and increases the precision of finished adjoining sides because the part must not be reclamped. The swivel cycle is used for easy input of parameters for automatic machining and measuring on the various planes.

- A prerequisite is that the machine is equipped with a swivel device (swivel head and/or swivel table).
- The swivel cycle is available for sequence programming and DIN/ISO programming.
- The planes can be swiveled not only by direct swiveling with rotation of coordinates and swiveling about the axes, but also by specifying a projection or spatial angle for swiveling.
- Flexible combination of shift - swivel - shift.
- Turning or moving are not machine-specific, as they are based on the workpiece coordinate system X, Y and Z.
- Fixed relief positions available

Highlight

- Programming with standard cycles and easy transformation on the inclined plane through the swivel cycle
14.3  5-axis machining package (TRAORI)

☑ Option: 5-axis machining package

In contrast to static transformations (swiveling) in which the tool is perpendicular to the machining plane, the five-axis machining package TRAORI allows the dynamic coupled motion of a tool along the workpiece surface. It is used for five-axis mold making applications and in the aviation industry, for example.

- Any tool orientation
- Remote Tool Center Point function (RTCP)
- Part programs not dependant on kinematics (vector programming)

Highlights

- Shorter machining time while hobbing with face cutters
- Machining the most complex contours, such as turbine blades, for example.
14.3 5-axis machining package (TRAORI)
15.1 CAD reader for PC

Contours and position patterns can be converted on the PC from DXF files into a format understandable to the controller with the software package "CAD Reader for PC". The contours can be remachined in the contour calculator of the controller.

Highlight

• Save time by converting DXF files into contours and position patterns
15.2 SinuTrain

SinuTrain on your PC behaves in exactly the same way as your SINUMERIK 840D sl on the machine. This allows you to prepare part programs on the PC without having to occupy the machine. In addition, SinuTrain is an ideal training system for CNC training.
- Full functional scope
- Networking of several student and trainer units possible

Highlight

- PC software for training and work preparation without occupying the machine

15.3 Computer-based training

Multi-media initial study of milling technology.
- Programming exercises with guided examples
- Multi-lingualism
- Realistic machine

Highlight

- Graphically supported instruction software for beginners
Integrated safety functions

☑ Option: Safety Integrated

SINUMERIK Safety Integrated provides integrated safety functions that support the implementation of highly effective personnel and machine protection. The safety functions comply with the requirements of Category 3 according to EU standard EN 954-1 and safety integrated level SIL2 of IEC 61508, ISO 13849-1 and NRTL. As a consequence, the essential requirements relating to functional safety can be simply and cost-effectively implemented.

The following belong to functional safety for machine tools:

● Safety-relevant monitoring of velocity and standstill (zero speed)
● Safety-relevant work and protective zone demarcation
● Direct connection of safety-relevant sensors/actuators
● Internal logical combination of safety-related signals

Highlights

● High level of flexibility: With Safety Integrated, setup with an open guard door is possible
● High level of security: Complete implementation of the safety functions in Category 3/SIL 2
● Increased availability: Absence of interference-susceptible electromechanical switching elements
● High degree of cost effectiveness: Reducing the hardware
Integrated safety functions
## Option list for the SINUMERIK package

The basic options and their Siemens order numbers are listed in the following:

<table>
<thead>
<tr>
<th>Function</th>
<th>SINUMERIK MDynamics Technology package, milling</th>
<th>Order numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology package, milling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 axes / 3+2 axes</td>
<td></td>
<td>6FC5800-0AS32-0YB0</td>
</tr>
<tr>
<td>5 axes</td>
<td></td>
<td>6FC5800-0AS33-0YB0</td>
</tr>
<tr>
<td><strong>Programming support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ShopMill sequence programming</td>
<td>X</td>
<td>6FC5800-0AP17-0YB0</td>
</tr>
<tr>
<td>Residual material identification and machining for contour pockets</td>
<td>X</td>
<td>6FC5800-0AP13-0YB0</td>
</tr>
<tr>
<td><strong>Simulation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D simulation, machined part</td>
<td>X</td>
<td>6FC5800-0AP25-0YB0</td>
</tr>
<tr>
<td>Simultaneous recording (real-time simulation of current machining)</td>
<td>X</td>
<td>6FC5800-0AP22-0YB0</td>
</tr>
<tr>
<td><strong>Transformations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral surface transformation</td>
<td>X</td>
<td>6FC5800-0AM27-0YB0</td>
</tr>
<tr>
<td><strong>Measuring functions/measuring cycles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring cycles for drilling/milling and turning (calibrate workpiece probe, workpiece measurement, tool measurement)</td>
<td>X</td>
<td>6FC5800-0AP28-0YB0</td>
</tr>
<tr>
<td>Measure kinematics</td>
<td>X</td>
<td>6FC5800-0AP18-0YB0</td>
</tr>
<tr>
<td><strong>Machining package 5 axes</strong></td>
<td>X</td>
<td>6FC5800-0AM30-0YB0</td>
</tr>
<tr>
<td><strong>Advanced Surface</strong></td>
<td></td>
<td>6FC5800-0AS07-0YB0</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional languages for the operating software, without license, e.g. Danish, Finnish, Dutch, Polish, Romanian, Russian, Swedish, Slovakian, Czech, Turkish and Hungarian</td>
<td>X</td>
<td>6FC5800-0AN00-0YB0</td>
</tr>
<tr>
<td><strong>Spline interpolation</strong></td>
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<td>6FC5800-0AS16-0YB0</td>
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<tr>
<td><strong>User memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional user memory or CompactFlash Card</td>
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<td>6FC5800-0AP12-0YB0</td>
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<tr>
<td><strong>Diagnostic functions</strong></td>
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<tr>
<td>RCS Host remote diagnostics function</td>
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<td>6FC5800-0AP30-0YB0</td>
</tr>
<tr>
<td>RCS Commander (viewer function) RCS Commander for PC/PG (on CD-ROM)</td>
<td></td>
<td>6FC5860-7YC10-0YA0</td>
</tr>
</tbody>
</table>
Summary of unique selling points

The SINUMERIK 840D sl control has the following outstanding features for milling technology:

Open

- Standard and integrated operator interface for milling, turning and additional technologies
- Simple handling of tool and magazine data through clear and powerful tool management
- Wide range of programming options using ShopMill machining step programming, programGUIDE and DIN/ISO programming

Flexible

- Optimum milling performance by being able to flexibly select the hardware that matches the machine
- High performance cycles for automatic workpiece and tool measurement
- Optimum functional scope of SINUMERIK MDynamics, milling package for 3-axis and 5-axis machining

Strong

- 80bit NANO<sup>FP</sup> accuracy for the maximum precision in the workpiece results
- Advanced Surface, a unique calculation procedure to improve the workpiece surface and at the same time significantly reduce machining time
- Simplest monitoring of 5-axis machines with a kinematic measuring cycle
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