

SIMATIC FM 357-2

Positioning- and Path Control Module

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Product Brief

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FM-MODULES



SIEMENS

Positioning and Path Control Module FM 357-2

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Applications

General

The FM 357-2 is a path and positioning control module for intelligent motion control of up to four axes. It allows a comprehensive range of applications from independent single positioning axes to interpolatory multi-axis path control.

The programming language for motion control in accordance with DIN 66025 is also widely used in mechanical engineering. It enables programming of simple "to and from" movements as well as complex 3D curve movements with just a few, powerful commands.



The positioning module excels in particular where flexible motion control is required. With its close communication with the PLC system and its integrated independent real-time operating system, motion sequences can be programmed according to any conceivable kind of external factor.

Areas of usage

The module is particularly suitable for the following application fields:

- For the metal, wood, plastics and stone processing
 - Milling, shaping
 - Engraving
 - Cutting, deburring
 - Bending, canting
- In the textile and packaging industry
 - Sewing, embroidering
 - Inserting
 - Cutting to size
 - Erecting, folding
 - Palletizing, stacking
- For winding machines
 - For electronic and electro-mechanical components
 - For ropes and wires
- In handling applications
 - Pick and place
 - Loading machines
 - Storage and retrieval machines

The FM 357-2 is capable of controlling both stepper drives and position-controlled servo drive axes. Installation and start-up is facilitated by a user-friendly tool which is integrated into STEP7. The parameterization wizard guides inexperienced users without the knowledge of "machine data" through to successful installation and start-up.

Three firmware versions – FM 357-2 L, FM 357-2 LX and FM 357-2 Handling – are available to adapt the module's functionality to the individual application field, thus offering an optimum price/performance ratio.

The mechanical design of the module as well as the communication structure contribute to a perfect integration into the SIMATIC S7-300 system.

Design

Hardware components

Item	Components	Remarks
S7-300 PLC-System	S7-CPU	PLC CPU
	I/O components (optional)	Input/output modules, communications processors FM modules
FM 357-2 hardware	S7-300 module	Hardware module without firmware
Drive technology	SIMODRIVE 611 A (analog) or 611 U (analog or via PROFIBUS) POSMO C and POSMO SI (via PROFIBUS) MASTERDRIVES MC (analog or via PROFIBUS) / servo converter or FM STEPDRIVE stepper drive power module	Power converter for position-controlled servo drives or stepper motors
	AC servo motors SIMOSTEP stepper motors	Motors for axis drive
Operator component	Hardware	SIMATIC HMI OP / TP / MP for machine-level operator control and monitoring Particularly recommended: OP 17 Teach-in for FM 357-2 H only
(optional, for FM 357-2 H only)	Handheld programming unit MPI type or Handheld terminal HT 6	

Software components

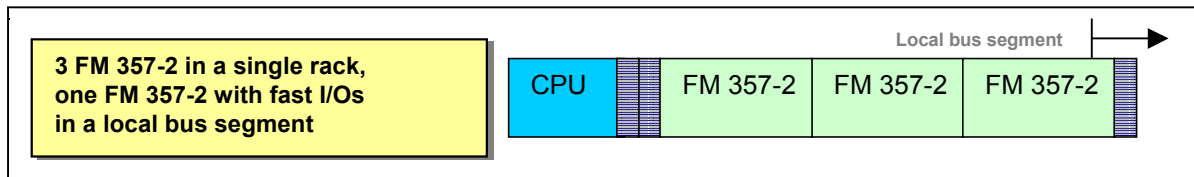
FM 357-2 firmware on coded memory card	System firmware on memory card	Memory card for installing the firmware on to the module and for storing user data
FM 357-2 configuration package (identical for L, LX and Handling)	Documentation	Electronic documentation; paperback manual can be ordered separately
	Parameterization tool "FM Param"	Configuration software; installed into and called from STEP7
	S7 technology blocks	"Basic program" for S7 consisting of FCs, FBs and DBs for data transfer and communication
	NC-VAR selector	Auxiliary program for selection and integration of FM-357-2 (NC-) variables in the S7-CPU
	Sample screen forms for OP 17 / OP 27 and TP 170B / MP 270B	Premade screen forms with standard displays for demonstration of the integration via data server or native protocols
SIMATIC STEP 7	Floppy disks or CD with authorization disk	Programming environment for SIMATIC S7 PLCs ≥ Version 4.02, recommended V5
SIMATIC HMI ProTool/Pro (optional)	Floppy disks or CD	Configuration software for all SIMATIC HMI Panels ≥ Version 2.51, recommended V3
"Edit-FM" program editor	Floppy disk	Stand-alone program editor for editing and management of motion programs on any PC with MPI interface

Hardware design

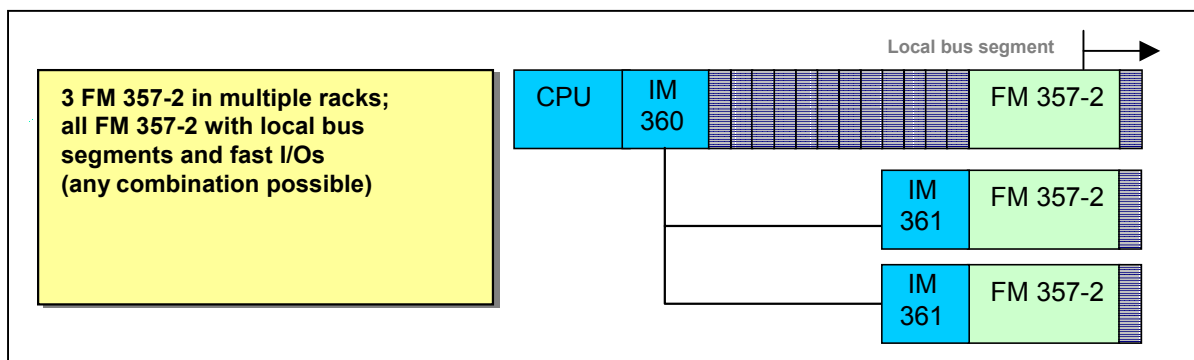
The FM 357-2 is inserted in a **S7-300 system rack** and requires at least an S7-CPU. The FM has 12 digital inputs and 8 digital outputs onboard which can be used freely within the program. If required, these internal I/Os can be expanded by optional I/O modules (digital and/or analog).

In addition to the FM 357-2, further independent FM modules (such as counter modules or additional positioning modules as auxiliary axes) can be inserted in the same rack. Up to three FM 357-2 modules (but only one FM 357-2 Handling) can be inserted in one rack.

To the right of the FM 357-2 **digital and/or analog I/O modules can be used as local I/O** (max. 2 modules). These modules can then be addressed directly as fast I/Os in the motion program in addition to the digital onboard I/O (e.g. with the integrated CAMs or as path-velocity dependent analog output).

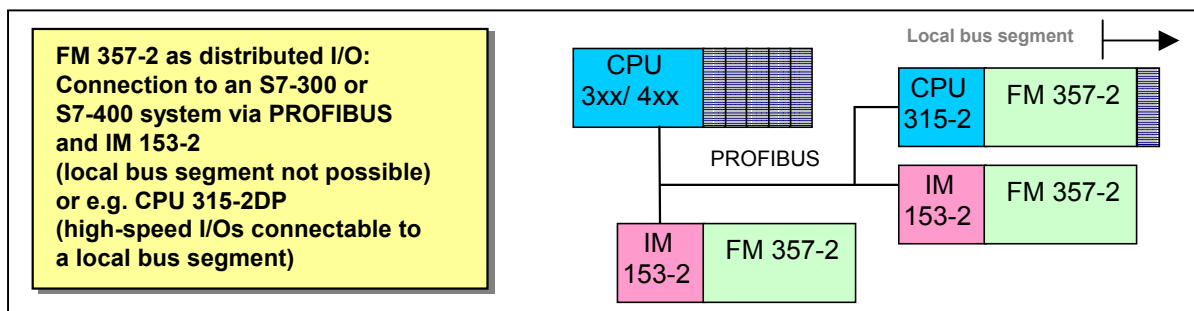


If there is more than one FM 357-2 with local I/O to be used with one CPU, the second or third FM 357-2 needs to be placed in a separate expansion rack using the interface modules IM360/361.



Up to 3 FM 357-2 can also be placed in ET 200M racks as distributed I/O and therefore can also be integrated into an S7-400-System. With such decentralized configuration the performance of a central installation will however not be reached.

With distributed operation it is not possible to implement a local bus segment, therefore no additional high-speed inputs/outputs can be connected to the FM 357-2.



For applications in distributed configurations (via PROFIBUS) the FM 357-2 can also be operated using a rack with a separate CPU (CPU 315-2DP) in line with the concept of "distributed intelligence". All components required for motion control are installed in one place, which keeps data transfer to a minimum and provides a modular software structure.

The S7-300 CPU

The **S7-300 CPU** is the core part of the system. **At least a CPU 315** (or CPU 314C) is required for motion control with the FM 357-2, as approximately 10 KB CPU-memory are needed for the minimum communication with the FM 357-2. For larger configurations we recommend a CPU 316 or CPU 318. Alternatively, a C7-626 system or a C7-3xx can be used instead of the S7-CPU.

In most applications the motion program runs independently on the FM module whereby data and status messages are cyclically exchanged with the CPU. From the motion program of the FM 357-2 "M commands" can be used to trigger actions in the S7-CPU and data can be read and/or written.

The S7-CPU can read out and influence the most important operating parameters of the FM 357-2, providing full control of the traversing movements from the CPU. In this manner, "traversing blocks" can even be written directly into the FM 357-2, for example, to obtain completely independent motion sequences. However, this memory-intensive operating mode, called "PLC positioning axis", is only recommended for simple motion sequences or in exceptional cases.

The powerful transfer of parameters is particularly suited for flexible motion programs. Thus the motion program in the FM 357-2 is controlled via external parameters, for example allowing "scaling" of contour movements from outside the FM without changes being made to the program.

The entire motion control program is generally programmed in the large user memory provided on the FM 357-2 (approx. 770 KB), which offloads the S7-CPU.

The following are some of the functions frequently used within the communication between FM and S7-CPU:

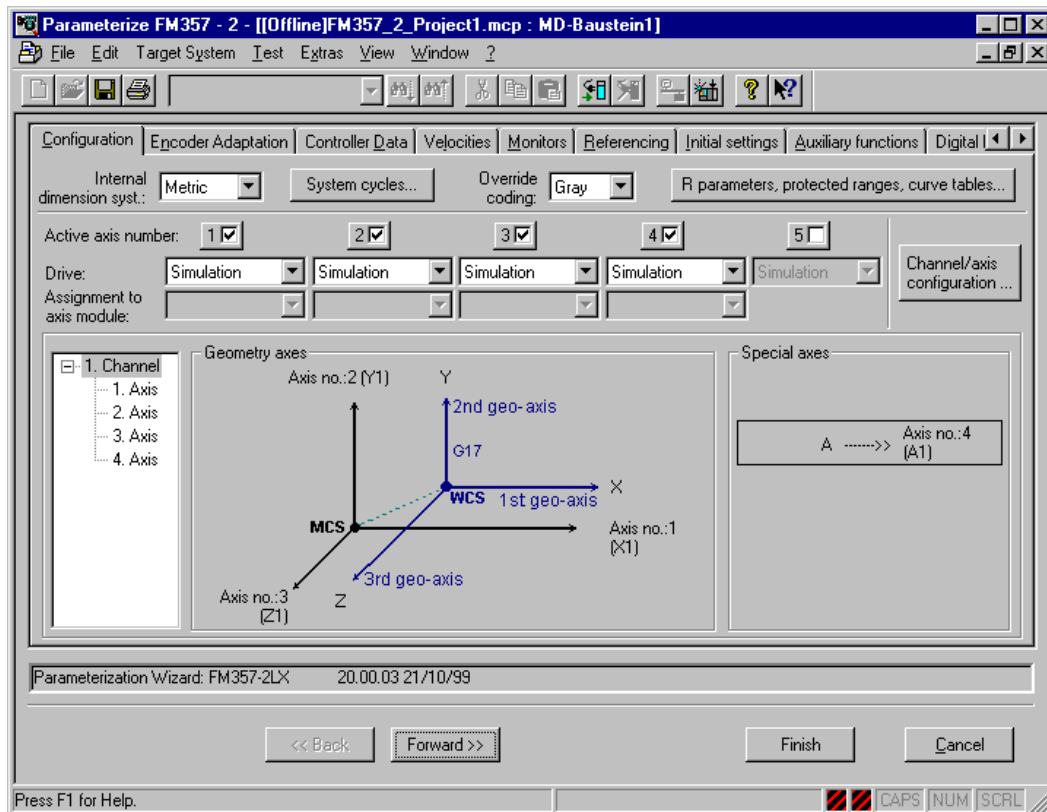
- Start/stop traversing movements
 - Starting and stopping selected motion programs
 - Direct triggering of independent positioning movements
- Specification of target positions
 - Via transfer of parameters
 - Via direct writing of values
- Selection of motion programs
- Setting and reading out operating modes
- Transfer/acceptance of parameters
 - For setting parameters for motion programs
 - For output and further processing of operating parameters

Programming device with parameterization tool

A programming device or PC with MPI interface is required for start-up and maintenance. The STEP 7 basic system forms the core component and is used in the usual way to create the PLC user program.

The FM's configuration package includes a parameterization tool for parameterizing and programming the FM 357-2. It is integrated into STEP 7 and can be called directly from the STEP 7 Hardware configuration.

The FM 357-2 parameterization tool builds on the look and feel of the S7-FM module range and Microsoft Windows. The tool can be used online on the premises or offline in the planning office. A configuration that was created and stored on the PG/PC can be loaded into the module later.



(Parameterization tool - Parameterization wizard)

Various tools are integrated into the parameterization software such as:

- **Parameterization wizard**

A guided start-up routine allowing fast parameterization of the module – no need to input cryptic machine data lists. All input data is preset with realistic empirical values and a technology-oriented online help function completes the system for entry-level users.

- **List-oriented expert mode**

A mode where all parameters and machine data are displayed and processed in a list. Here the experienced user is given the possibility to activate rarely used, system-critical functions.

- **Program editor**

A Windows ASCII editor is used for creating motion programs or importing and exporting existing program code. The standards implemented support the use of third-party DIN code or customized applications (such as export filters from CAD systems).

- **Testing and operator control screen form**

This tool permits offline operation in real-time mode. It allows the user to traverse single axes, test programs and set operating modes. In addition, all main operating parameters are displayed online. Error messages are displayed and saved online with context-oriented acknowledgement.

- **Trace function**

An integrated "storage oscilloscope" for recording positioning operations. If required, this can be used to achieve optimum adaptation of the controller parameters to the mechanics and drive train as well as for extended diagnostics.

Operator control and monitoring with Operator Panels

There are two possible ways to connect HMI components:

- **the indirect connection via the S7-CPU**

As all the important operating parameters of the FM 357-2 can be represented in the S7-CPU (for example in data blocks), they are available in the entire automation system for visualization and operating purposes. Therefore, all components can be used - ranging from a simple text display right up to the visualization system WIN CC. However, due to the communication method there will be a load on the S7-CPU.

- **the direct connection via native protocol or data server**

The OP 7 and OP 17 operator panels support direct communication with the FM 357-2 using a "native protocol driver". By this means, virtually all relevant operating parameters can be displayed and manipulated without loading the CPU, resulting in faster communication rates.

The following functions are supported:

- Stop/start program, control program
- Read, display and write variables directly
- Program list with selection dialog
- Output alarms in plain text
- Indirect axis selection via parameters (expanded multiplexing)
- > 125 R-parameters can be processed.

The functions can be configured directly and easily using ProTool V3.x or higher.

The FM 357-2 features an integrated data server for operator panels OP 27 and greater, allowing them to communicate directly with the FM 357-2. However, this option has a few restrictions (no program selection via lists, max. of 125 parameters, no direct configuration).

With ProTool Version 6 the S7-NC channel for direct communication with the FM is also available for the Windows CE based OP/TP/MP from TP 170B upwards. However, program selection or starting and stopping of programs is not possible directly and must be done via the CPU.

Basically, the SIMATIC HMI components can be used to set parameters for all motion programs, but it is not possible to edit the programs directly from the HMI. For editing and creating motion programs the parameterization tool is required.

PC link

An FM/NC channel DLL is available (on request) providing all important functions for WIN CC users.

The Edit-FM tool is available for linking additional PC applications.

It provides a program editor (like in the parameterization tool) and services for saving and loading NC programs on the PC or into the FM. The use of Edit-FM does not require STEP7 to be installed on the PC.

It can be used for the function modules FM 353/354/357-2 and FM453. For the communication with the controller an MPI or PROFIBUS interface is needed in the PG/PC.

Edit-FM can also be remotely operated as an OLE server via external applications. This requires the "Windows Scripting Host" services (supplied, included in Windows 98). The application can also be remotely operated via customer applications (e.g. VBA) .

The following functions are available with Edit-FM:

- Connection setup with the FM
- Loading and saving/deleting programs on the FM
- Loading and saving/deleting programs on the PC

The control of the production process (e.g. starting/stopping programs) is not possible with Edit-FM. However, it is possible to use the separate driver software "PRODAVE MPI" to establish communication with the S7-CPU, from which the FM can be controlled.

Start-up

General

During Start-up the following steps have to be carried out:

1. Ensure that the electrical and mechanical setup is correct
2. Start up the drive and set the parameters
3. Connect a PG/PC to the MPI interface on the CPU
4. Load the system firmware on the FM 357-2 via memory card
5. Load the S7 Technology blocks on the S7-CPU and call them in the cyclical program
6. Start the FM 357-2 parameterization tool from the S7 Hardware Configuration
7. Use the parameterization wizard to guide you through setting parameters for the FM 357-2
8. After reference point approach (if necessary), test the single axes with the start-up screen and load or create a motion program (if required).

The FM 357-2 also provides a test mode (setting: "Simulation") where the controller is simulated without drive operation.

Operating modes

The FM 357-2 positioning module can be operated in several modes. They can be selected in the S7 user program or in the start-up screen:

- **Automatic mode**
In this mode a program in the FM 357-2 is executed sequentially. A program must be selected before it can be started.
Other programs can be created or edited at the same time using the start-up tool.
- **Automatic single-block mode**
An existing program is selected and then executed line by line, that is in single blocks.
The program stops after each block and must be started again.
- **MDI mode (manual data input, only via parameterization tool)**
Program lines (blocks) can be entered directly via the parameterization tool and immediately executed one by one.
- **Jog mode**
Every single motion axes can be controlled separately by keys.
- **Incremental mode**
Single axes can be traversed manually in incremental mode.
- **Reference point approach (homing)**
This mode allows referencing of the axes (when using incremental encoders or stepper motors).

In conjunction with a handheld programming unit or handheld terminal, the FM 357-2 H version also supports the "teach-in" function commonly used in robotics (for more information, please refer to our separate datasheet).

Drives which are difficult or impossible to control can be operated in the **controlled mode** by specifying a speed setpoint.

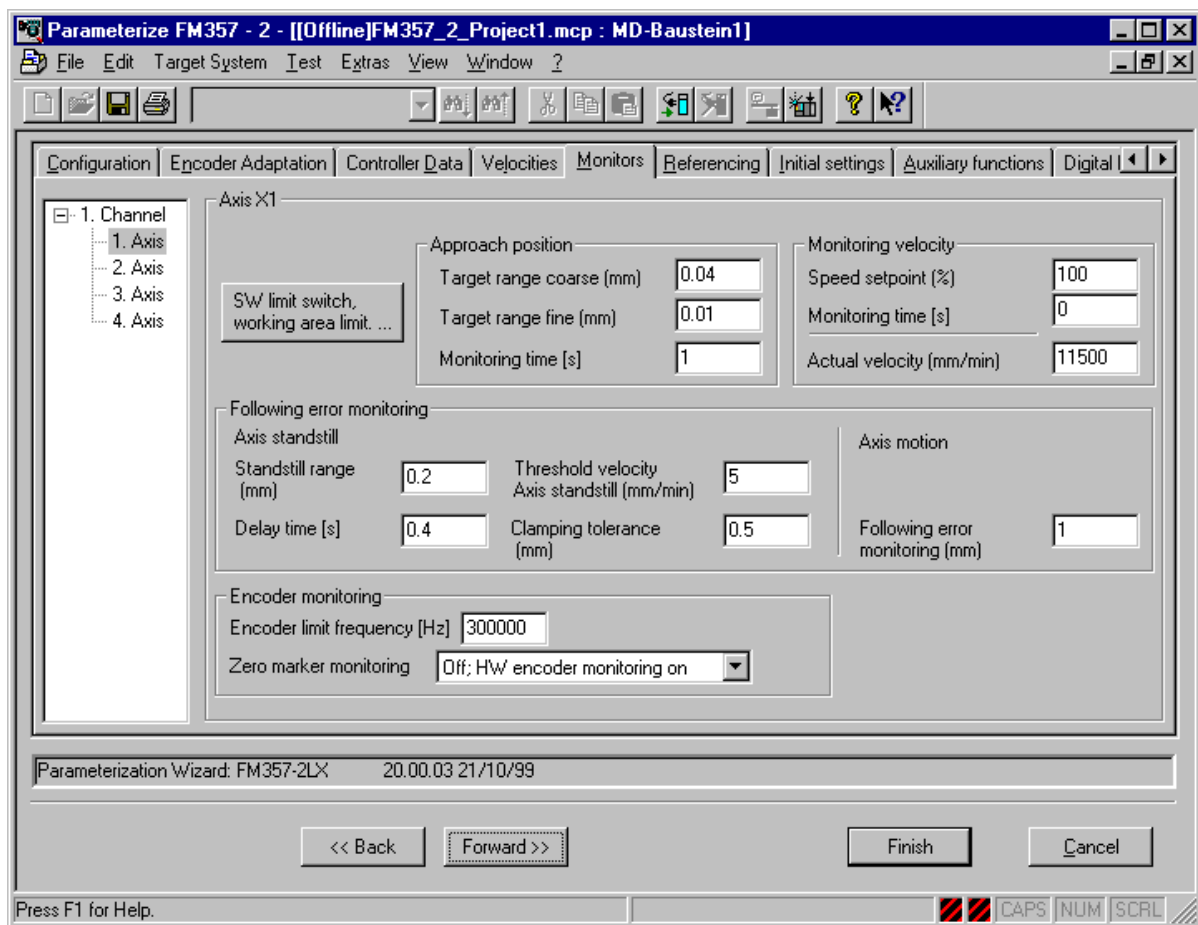
Monitoring functions

Several internal monitoring functions are provided to ensure safe operation. A wide range of settings are available via the parameterization tool or the program:

The following can be monitored:

- Correct approach to the position
- Motions in programmed standstill
- Following error (path deviations during traversal)
- Traversing speed for maximum values
- Encoder hardware
- With stepper motors: rotation monitoring via cyclical signals
- Hardware and software limit switches

Alarm messages can be stored in the S7-CPU in plain text. They can be output, for example, on OPs.



(Parameterization wizard: setting the monitoring functions)

Technical Data

General data

Supply voltage	20.4...28.8 V
Power consumption	24 W
Backplane bus load	100 mA
Dimensions (WxHxD) in mm	200 x 125 x 118
Weight, approx.	1.2 kg
Degree of protection acc. to DIN 40050	IP 20
Certification	CE, UL, CSA
Program memory	approx. 770 KB
Memory type	Retentive, battery backup (> 7 years)
Data backup	On firmware memory card or via parameterization tool
Number of program instructions	Limited by memory capacity only
Max. number of arithmetic parameters	Max. 10,000
Programming language	DIN 66025
Subroutine levels	7
Number of subroutine passes	< 9,999
Cycle time interpolator	9 ms
Cycle time servo	3 ms
Coordinate systems	Cartesian, polar
Dimensions	Inch/metric/degrees
Axes/measuring circuits	4
Documentation	Contained in configuration package; also online help in parameterization tool
Export	The firmware versions FM 357-2 L, LX, H have no export restrictions

Motion control

Interpolation	Max. of 4 axes
Single axis positioning	Max. of 4 independent axes, available soon with interpolation groupings (e.g. 3+1)
Mode groups/channels	4
Maximum traversing velocity	300 m/s
Max. traversing range	± 9 decades
Override functions	0% to 200%
Acceleration	Linear, jerk limitation ($\sin^2$), knee-shaped (stepper drives)

HMI

Native protocol linking with expanded functions	- SIMATIC HMI OP 7 / OP 17 - Windows CE based SIMATIC HMI OP/TP/MP from TP 170B upwards with ProTool V6 (without program interface)
Data server with direct communication	SIMATIC HMI
Connection via S7-CPU	All SIMATIC HMI components
Start-up	"FM Param" tool (configuration package) on PG/PC separate standalone editor "Edit-FM"

SIMATIC system data

Max. number of FM 357-2 modules on one CPU	3 (1 with Firmware Version H)
Communication with S7 user program	S7 technology blocks (FB, FC, DB)
STEP 7	Version 4.02 and higher
Memory requirements (work memory)	approx. 10 KB for minimum, approx. 16 KB for full communication with the FM357-2 for additional FM 357-2: approx. 800 bytes in addition
Supported CPUs	CPU 314C, CPU 315, CPU 315-2 DP, CPU 316, CPU 318, CPU 614 C7-626, C7-626 DP, C7-333, C7-334 S7-400 via PROFIBUS and distributed I/O *) *) Observe restrictions for supported CPUs, a Slot CPU is not supported
Distributed I/Os ET 200	IM 153-2 / ET 200M (reduced performance)
S7 program cycle time	< 10 ms

Drive technology

Supported drives	SIMODRIVE 611U servo drives with clock-synchronous PROFIBUS *) or ± 10 V interface, POSMO C and POSMO SI with clock-synchronous PROFIBUS *) MASTERDRIVES MC with clock-synchronous PROFIBUS *) or ± 10 V interface stepper drives with TTL interface, frequency converter with vector control (on request) hydraulics module with servo valves (on request) *) PROFIBUS not possible with Firmware Version H in combination with a PHG or HT 6
Connectors	50-pin Sub-D connector for all outputs, 4x15-pin Sub-D connector for encoder inputs
Supported encoders	Incremental (RS 422) or absolute (SSI), also in conjunction with stepper drives, EnDat – via SIMODRIVE 611U and PROFIBUS or POSMO C and SI Second encoder with PROFIBUS drives possible
Max. frequency for stepper motors	750 kHz
Voltage level on the stepper motor output	5 V (TTL) for clock pulses and direction signal
Max. cable length for stepper motors	50 m, (35 m in hybrid operation with servo axes)
Number of steps for stepper drives	500–10,000 (FM STEPDRIVE, can be set on power converter)

Ordering data

Components	Order No.
SIMATIC FM 357-2 Hardware	6ES7 357-4AH01-0AE0
Front screw connector	6ES7 392-1AM00-0AA0
Backup-Battery	6ES7 971-1AA00-0AA0
FM 357-2 L, system firmware on coded memory card incl. configuration package (German, English, French, Italian) ^{*)}	6ES7 357-4AH03-3AE0
FM 357-2 LX, system firmware on coded memory card incl. configuration package (German, English, French, Italian) ^{*)}	6ES7 357-4BH03-3AE0
FM 357-2 Handling, system firmware on coded memory card incl. configuration package (German, English, French, Italian) ^{*)}	6ES7 357-4CH03-3AE0
^{*)} The configuration package for the FM 357-2 L, LX, H contains: parameterization tool, S7 technology blocks, screen forms for OP17 and OP27, documentation on CD-ROM	
Printed manual for FM 357-2	
German	6ES7 357-4AH00-8AG0
English	6ES7 357-4AH00-8BG0
French	6ES7 357-4AH00-8CG0
Italian	6ES7 357-4AH00-8EG0
Edit-FM - standalone editor for NC programs	6FC5 263-0AA03-0AB0
FM/NC channel (channel DLL) for WINCC	On request
Supported encoders	
Absolute encoder 6FX2 001-5...	See Catalog NC 60
Incremental encoder 6FX2 001-2	See Catalog NC 60
SIMATIC S7 Components:	
CPU's, Power supplies and accessories	See Catalog ST 70
I/O and Function modules	See Catalog ST 70