



# sinamics



SINAMICS S120  
Drive System  
0.12 kW to 1200 kW

**SIEMENS**

## Related catalogs

**SINAMICS G110** D 11.1  
 Inverter Chassis Units  
 0.12 kW to 3 kW  
 Order No.:  
 E86060-K5511-A111-A2 (German)  
 E86060-K5511-A111-A2-7600 (English)



**SINAMICS G130** D 11  
 Drive Converter Chassis Units  
**SINAMICS G150**  
 Drive Converter Cabinet Units  
 Order No.:  
 E86060-K5511-A101-A3 (German)  
 E86060-K5511-A101-A3-7600 (English)



**SINAMICS S150** D 21.3  
 Drive Converter Cabinet Units  
 75 kW to 1200 kW  
 Order No.:  
 E86060-K5521-A131-A1 (German)  
 E86060-K5521-A131-A1-7600 (English)



**SINUMERIK & SINAMICS** NC 61  
 Automation Systems for  
 Machine Tools  
 Order No.:  
 E86060-K4461-A101-A1 (German)  
 E86060-K4461-A101-A1-7600 (English)



**SIMOTION** PM 10  
 Motion Control System  
 Order No.:  
 E86060-K4910-A101-A5 (German)  
 E86060-K4910-A101-A5-7600 (English)



**SIMATIC** ST 70  
 Products for Totally Integrated  
 Automation and Micro Automation  
 Order No.:  
 E86060-K4670-A101-B1 (German)  
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**SITRAIN** ITC  
 Training for Automation and  
 Industrial Solutions  
 Order No.:  
 Paper: E86060-K6850-A101-B6 (German)  
 E86060-K6850-A101-B6-7600 (English)  
 CD-ROM: E86060-D6850-A100-C4-7400



**Catalog CA 01** CA 01  
 The Offline Mall of Automation and Drives  
 Order No.:  
 CD-ROM: E86060-D4001-A100-C4 (German)  
 CD-ROM: E86060-D4001-A110-C4-7600 (English)  
 DVD: E86060-D4001-A500-C4 (German)  
 DVD: E86060-D4001-A510-C4-7600 (English)



## A&D Mall

Internet:  
<http://www.siemens.com/automation/mall>

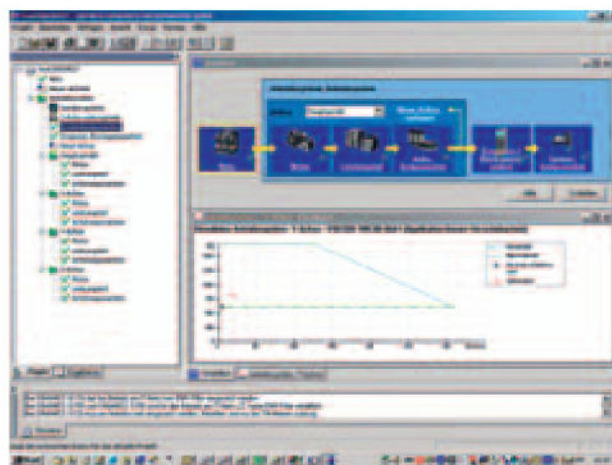


## SINAMICS MICROMASTER SIZER configuration tool

SIZER speeds up and simplifies the configuration of **SINAMICS G110, SINAMICS G130, SINAMICS G150, SINAMICS S120, SINAMICS S150** and **MICROMASTER 4** drives.

The tool will support you during the technical configuration of all components required to complete a drive task. SIZER will guide you through all stages of the configuration process, from the line supply through the drive components and beyond to the motors.

Motors are configured by means of standardized load characteristics, cyclic drives or free duty cycles. The drive components required (e.g. power units, power supplies) are calculated. The configuration completes the drive system by adding the supplementary components (e.g. Sensor Modules, Terminal Expansion Modules, cables, reactors, filters).



Menu driven configuration makes it easier for beginners to use the tool. Status information keeps you continually informed of the progress of the configuration process. The online help provides support during configuration. In addition to the data calculated, characteristics are also displayed to assist optimization and highlight reserves.

The export function can be used to forward the parts list to the SAP-VSR ordering system where available.

### Minimum hardware and software requirements

PG or PC with Pentium™ II 400 MHz (Windows™ 2000), Pentium™ III 500 MHz (Windows™ XP)  
 256 MB RAM (recommended 512 MB RAM)  
 At least 990 MB of free hard disk space  
 An additional 100 MB of free hard disk space on Windows system drive  
 Monitor resolution 1024 x 768 pixels  
 Windows™ 2000 SP2, XP Professional SP1, XP Home Edition SP1  
 Microsoft Internet Explorer 5.5 SP2

### Use

The SINAMICS MICROMASTER SIZER can be used free of charge. A minimal fee is charged for processing CD delivery.

The user interface is available in English and German.

The SINAMICS MICROMASTER SIZER configuration tool can be ordered from your Siemens representative under Order No. **6SL3070-0AA00-0AG0**.

# SINAMICS S120 Drive System 0.12 kW to 1200 kW

Catalog D 21.1 · 2006

Supersedes:  
Catalog D 21.1 · 2005  
Catalog D 21.2 · April 2004

The products contained in this catalog  
are also part of the CA 01 Catalog  
Order No.:  
E86060-D4001-A110-C4-7600 (CD-ROM)  
E86060-D4001-A510-C4-7600 (DVD)

Please contact your Siemens branch  
office for further information

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# SIEMENS

|                                 |   |  |          |
|---------------------------------|---|--|----------|
|                                 | <b>Introduction</b>                       | Welcome to Automation and Drives<br>Totally Integrated Automation<br>SINAMICS<br>SINAMICS S120   | <b>1</b> |
| <b>Drive system</b>             | <b>SINAMICS S120</b>                      | System overview<br>Communication<br>Engineering Software<br>Control Units<br>Power Modules<br>Line Modules, Motor Modules<br>System components | <b>2</b> |
| <b>Motors</b>                   | <b>AC motors</b>                          | Synchronous motors<br>Geared motors<br>Asynchronous (induction) motors<br>Dimension drawings   | <b>3</b> |
| <b>Supplementary components</b> | <b>SIMODRIVE sensor measuring systems</b> | Optoelectronic rotary encoders<br>Hollow-shaft measuring system  | <b>4</b> |
|                                 | <b>MOTION-CONNECT Connection system</b>   | Power cables<br>Signal cables<br>Length code   | <b>5</b> |
| <b>Additional information</b>   | <b>System description</b>                 | SIZER configuration tool<br>Configuration  | <b>6</b> |
|                                 | <b>Services and documentation</b>         | Applications<br>Training<br>Service & Support<br>Documentation   | <b>7</b> |
|                                 | <b>Appendix</b>                           | Glossary<br>Siemens contacts worldwide<br>A&D online services<br>Index<br>Terms and conditions of sale and delivery<br>Export regulations      | <b>8</b> |

## Welcome to Automation and Drives

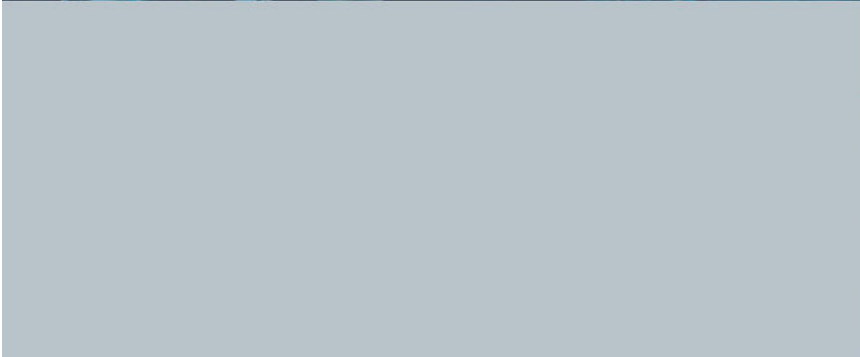
We would like to welcome you to Automation and Drives and our comprehensive range of products, systems, solutions and services for production and process automation and building technology worldwide.

With Totally Integrated Automation and Totally Integrated Power, we deliver solution platforms based on standards that offer you a considerable savings potential.

Discover the world of our technology now. If you need more detailed information, please contact one of your regional Siemens partners.

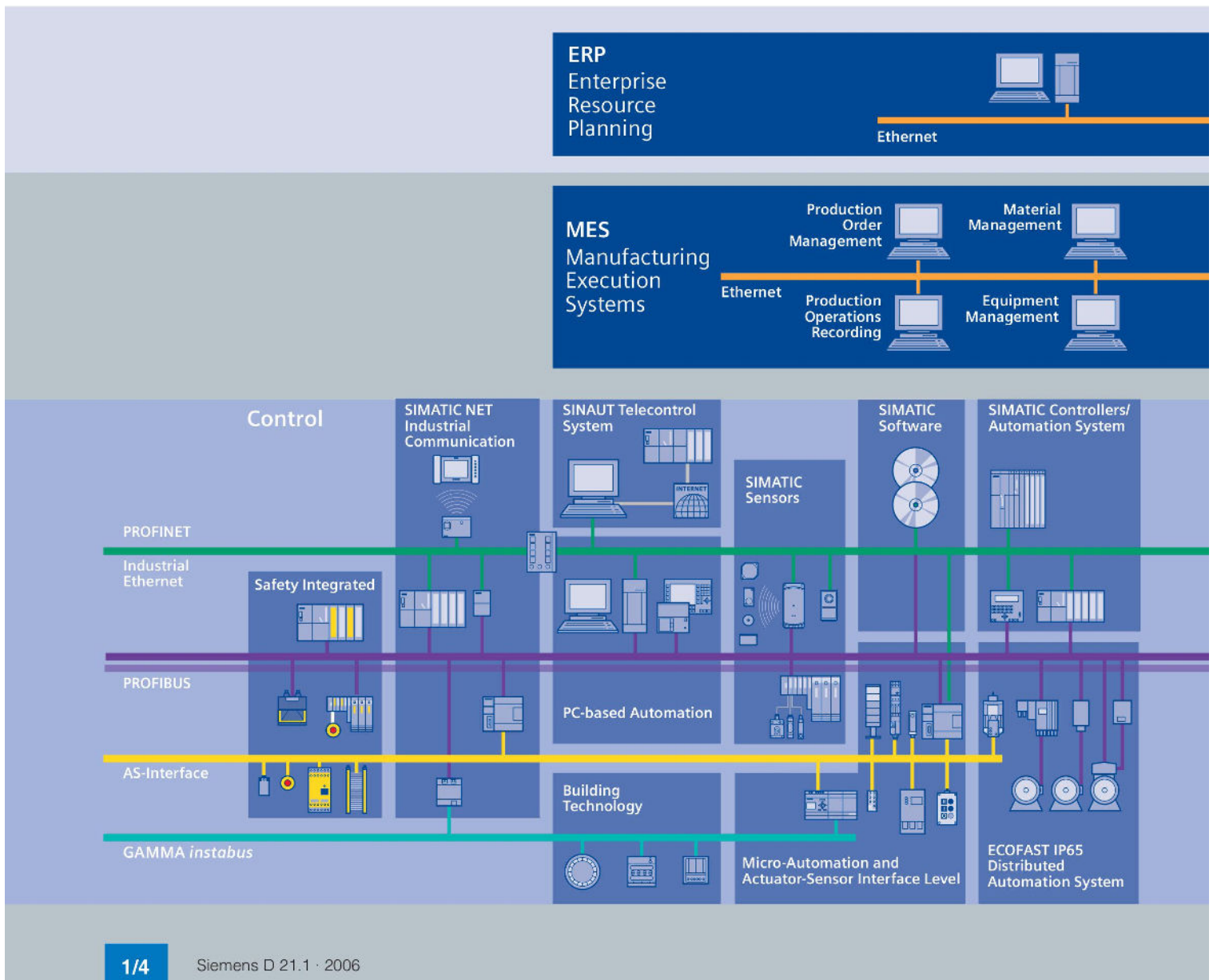
They will be glad to assist you.



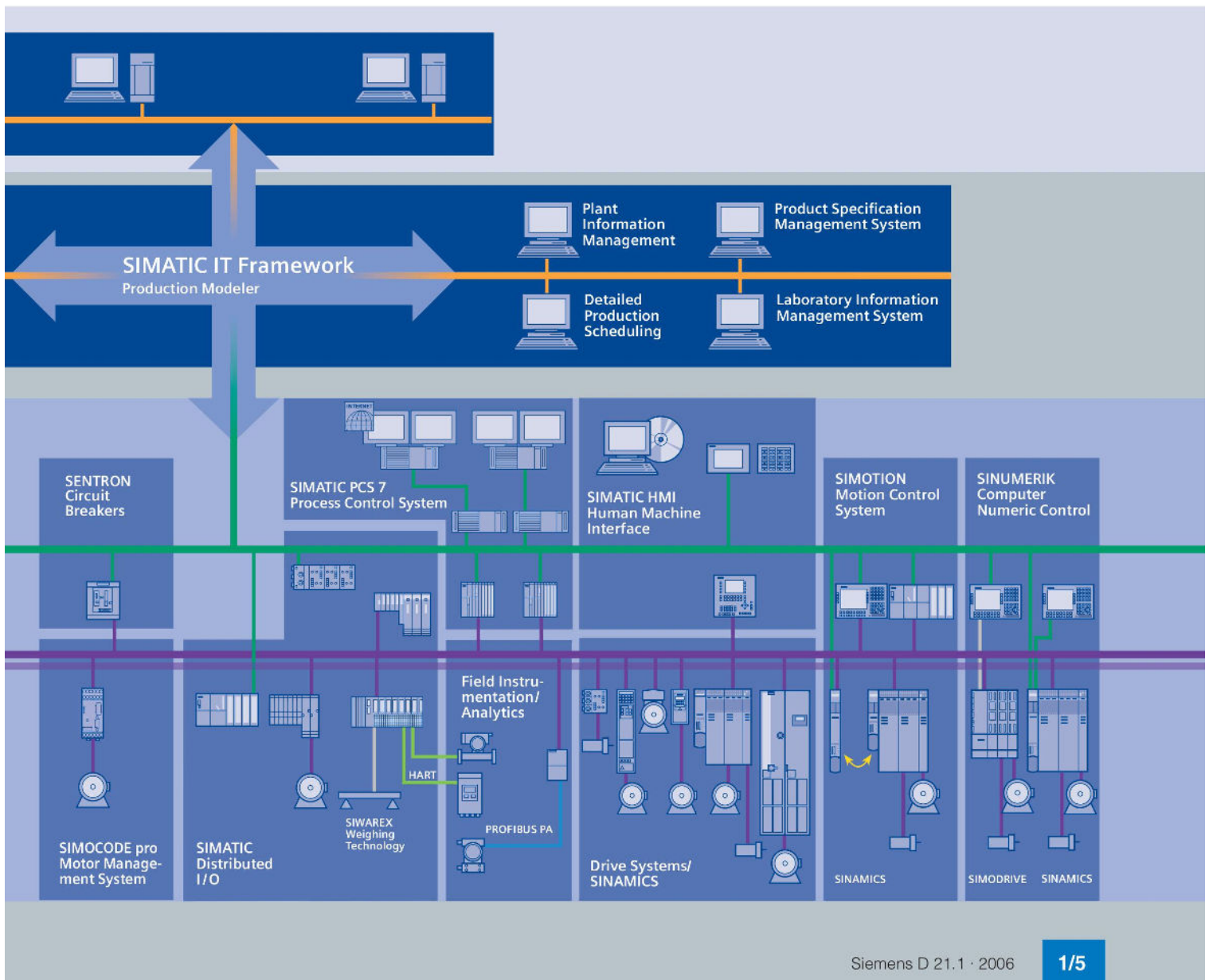


# Totally Integrated Automation – innovations for more productivity

With the launch of Totally Integrated Automation, we were the first ones on the market to consistently implement the trend from equipment to an integrated automation solution, and have continuously improved the system ever since. Whether your industry is process- and production-oriented or a hybrid, Totally Integrated Automation is a unique "common solution" platform that covers all the sectors. Totally Integrated Automation is an integrated platform for the entire production line - from receiving to technical processing



and production areas to shipping. Thanks to the system-oriented engineering environment, integrated, open communications as well as intelligent diagnostics options, your plant now benefits in every phase of the life cycle. In fact, to this day we are the only company worldwide that can offer a control system based on an integrated platform for both the production and process industry.



## The SINAMICS drive family



Application areas of the SINAMICS drive family

**Application**

SINAMICS is the new family of Siemens drives designed for machine and plant engineering applications. SINAMICS offers solutions for all drive tasks:

- Simple pump and fan applications in the process industry
- Applied single drives in centrifuges, presses, extruders, elevators, as well as conveyor and transport systems
- Drive line-ups in textile, plastic film, and paper machines, as well as in rolling mill plants
- Highly dynamic servo drives for machine tools, as well as packaging and printing machines

**Versions**

Depending on the application, the SINAMICS range offers the ideal variant for any drive task.

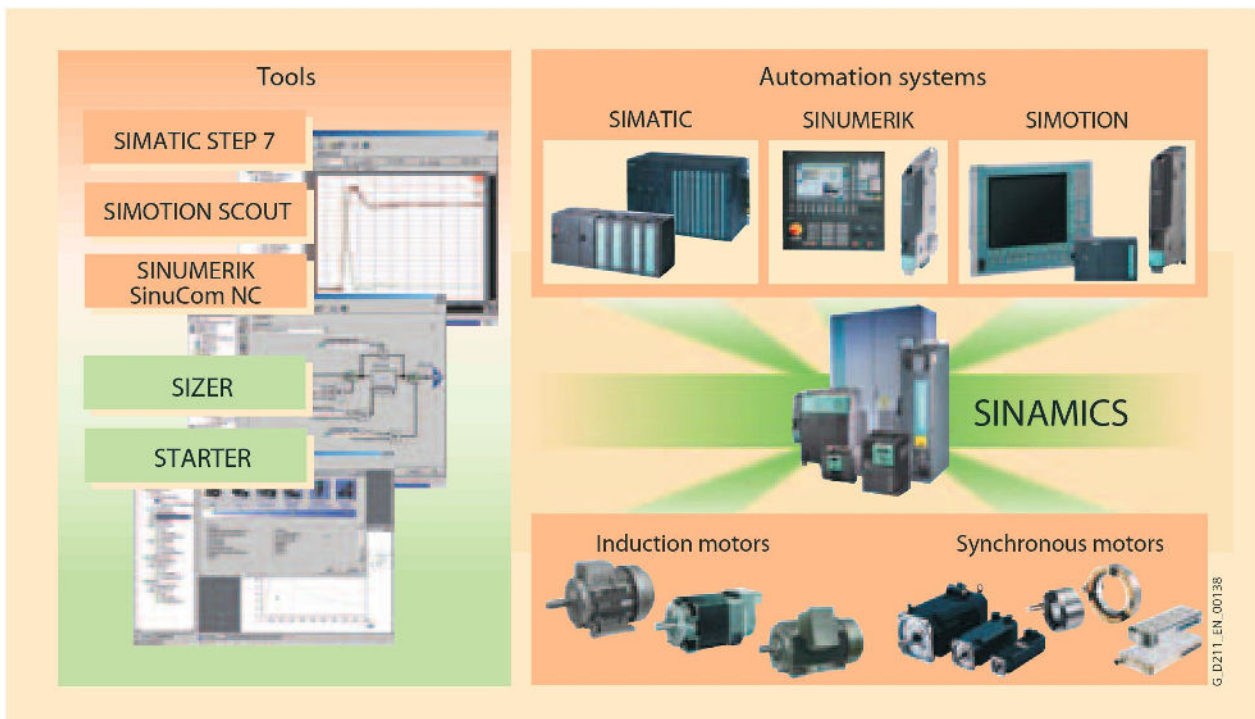
- SINAMICS G is designed for standard applications with asynchronous (induction) motors. These applications have less stringent requirements regarding the dynamics and accuracy of the motor speed.
- SINAMICS S handles complex drive tasks with synchronous and asynchronous (induction) motors and fulfills stringent requirements regarding
  - dynamics and accuracy,
  - integration of extensive technological functions in the drive control system

**Platform concept and Totally Integrated Automation**

All SINAMICS versions are based on a platform concept. Common hardware and software components, as well as standardized tools for design, configuration and commissioning tasks, ensure high-level integration across all components. SINAMICS handles a wide variety of drive tasks with no system gaps. The different SINAMICS versions can easily be combined with each other.

SINAMICS is a part of the Siemens "Totally Integrated Automation" concept. Integrated SINAMICS systems covering configuration, data storage and communication at the automation level, ensure low-maintenance solutions with the SIMATIC, SIMOTION and SINUMERIK control systems.





SINAMICS as part of the Siemens modular automation system

#### **Quality in accordance with EN ISO 9001**

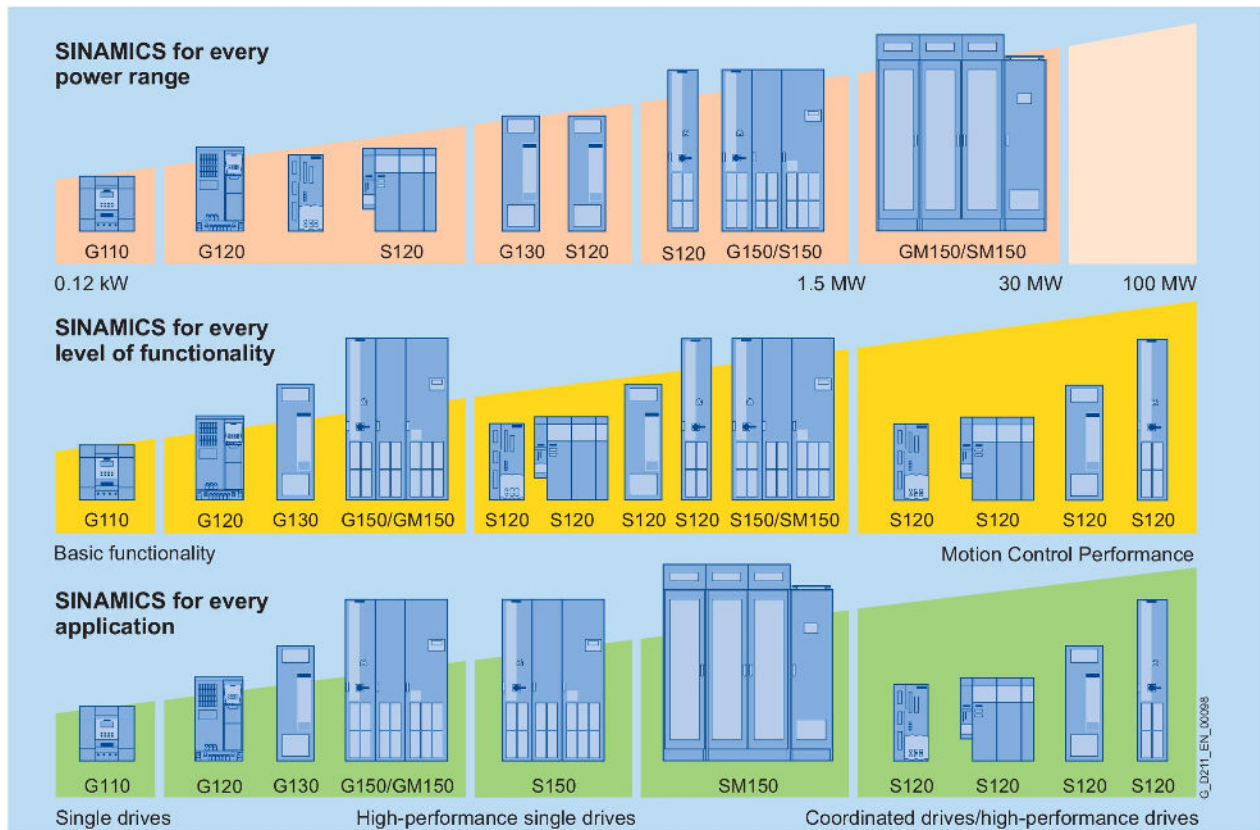
SINAMICS conforms to the most exacting quality requirements. Comprehensive quality assurance measures in all development and production processes ensure a consistently high level of quality.

Of course, our quality assurance system is certified by an independent authority in accordance with EN ISO 9001.

#### **Suitable for global use**

SINAMICS meets the requirements of relevant international standards and regulations – from the EN standards and IEC standards to UL and cULus regulations.

## The SINAMICS drive family



Tailored to the respective areas of application, SINAMICS is divided into the following family members:

#### Low-voltage drives (line supply < 1000 V)

- **SINAMICS G110** – the versatile drive for low outputs
- **SINAMICS G120** – the modular single drive for low to medium power ranges
- **SINAMICS G130** and **SINAMICS G150** – the universal drive solution for high-power single drives
- **SINAMICS S120** – the flexible, modular drive system for demanding tasks
- **SINAMICS S150** – the sophisticated drive solution for high-performance single drives

#### Medium-voltage drives (line supply > 1000 V)

- **SINAMICS GM150** – the universal drive solution for single drives
- **SINAMICS SM150** – the sophisticated drive solution for single and multi-motor drives

The SINAMICS range is characterized by the following system features:

- uniform functionality based on a single platform concept
- standardized engineering
- high degree of flexibility and combination
- wide power range
- designed for global use
- SINAMICS Safety Integrated
- greater efficiency and effectiveness
- multiple communications options
- Totally Integrated Automation

## SINAMICS S120 drive system

**Flexibility for successful machine design**

As part of the SINAMICS drive family, the SINAMICS S120 drive is a modular system for high-performance applications in machine construction and plant engineering. SINAMICS S120 offers high-performance single-axis and multi-axis drives for a very broad range of industrial applications. By virtue of its scalability and flexibility, SINAMICS S120 is the ideal system for satisfying the ever increasing demand for more axes and better performance. SINAMICS S120 supports flexible machine designs and faster implementation of customized drive solutions.

**The response to ever increasing demands**

Today modern machines must be built at lower cost, but deliver greater productivity. The SINAMICS S120 drive concept meets both these challenges! It is easy to configure and thus helps to reduce project completion times. Its excellent dynamic response and accuracy permit higher cycle rates for maximum productivity.

**Applications in machine and plant engineering**

Regardless of whether the application involves continuous material webs or cyclic, highly dynamic processes – SINAMICS S120 means increased machine performance in many sectors:

- Packaging machines
- Plastics processing machines
- Textile machines
- Printing machines
- Paper machines
- Hoisting equipment
- Handling and assembly systems
- Machine tools
- Rolling mills
- Test stands

**Modularity for machine construction**

SINAMICS S120 is designed to allow free combination of power and control performance. Multi-axis drives with higher-level motion control can be implemented with the SINAMICS S120 modular system as easily as single-drive solutions.

**Greater flexibility with central control intelligence**

On the SINAMICS S120, the drive intelligence is combined with closed-loop control functions in Control Units.

These units are capable of controlling drives in Vector, Servo and V/f modes. They also perform the speed and torque control functions plus other intelligent drive functions.

**Free performance selection for Vector and Servo control modes**

The use of a SINAMICS S120 in Vector control mode is recommended for drive solutions with continuous material webs, for example, wire-drawing machines, film and paper machines, as well as for hoisting gear, centrifuges and marine drives.

Servo control with SINAMICS S120 is employed for cyclic processes with precise, highly dynamic position control and servo motors, e.g. in textile, packaging, printing machines and machine tools.

**SINAMICS S120 – functions for better efficiency**

- Basic functions: Speed control, torque control, positioning functions
- Intelligent starting functions for independent restart after power supply interruption
- BICO technology with interconnection of drive-related I/Os for easy adaptation of the drive system to its operating environment
- Integrated safety functions for realizing the implementation of safety concepts
- Regulated infeed/regenerative feedback functions for preventing undesirable reactions on the supply, allowing recovery of braking energy and ensuring greater stability against line fluctuations.

**DRIVE-CLiQ – the digital interface between all components**

All SINAMICS S120 components, including the motors and encoders, are interconnected by a shared serial interface called DRIVE-CLiQ. DRIVE-CLiQ forms the backplane for the complete drive system. The standardized cables and connectors reduce the variety of different parts and cut storage costs. Converter boards (Sensor Modules) for converting standard encoder signals to DRIVE-CLiQ are available for third-party motors and retrofit applications.

**Swift and automatic: The electronic rating plate**

An important digital linkage element of the SINAMICS S120 drive system is the electronic rating plates integrated in every component. They allow all drive components to be detected automatically via a DRIVE-CLiQ link. As a result, data does not need to be entered manually during commissioning or component replacement – helping to ensure that drives are commissioned quickly and successfully! The electronic rating plates of the motors contain, for example, the parameters of the electrical equivalent circuit diagram and the characteristic data of the built-in motor encoder, information such as order and identification numbers.

# Introduction

## SINAMICS S120 drive system

### Modular design ensures flexibility and scalability

The multi-axis design, also, referred to as common DC bus, is very modular with a power offering of Line Modules and Motor Modules – both available in booksize and chassis formats. Line Modules function as the central energy supply to the voltage-source DC link. Line Modules are optionally available with regulated infeed/regenerative feedback to provide a constant DC link voltage. Motor Modules (DC/AC units) supply the motors with energy from the DC link. All the drive intelligence is organized into Control Units. The control units perform all the closed-loop control functions for the drive grouping. They also handle all other drive functions such as the interconnection of drive related I/O's, positioning functions, etc. and feature PROFIBUS DP or PROFINET as the central interface for linking to higher level automation systems.

On single axis units, also referred to as AC drives, the rectifier and inverter power section are contained in one device, the Power Module – available in blocksize and chassis formats. For single axis applications, drive control functions are performed by a single axis Control Unit (e.g. CU310) mounted on to the Power Module. This separation of power and intelligence allows for maximum flexibility and scalability. Integration into multi-axis applications is easily accomplished by connecting a DRIVE CLiQ link to a multi-axis Control Unit (e.g. CU320). This is accomplished by mounting a CU adapter (CUA31) on a block size Power Module in place of the single axis Control Unit.

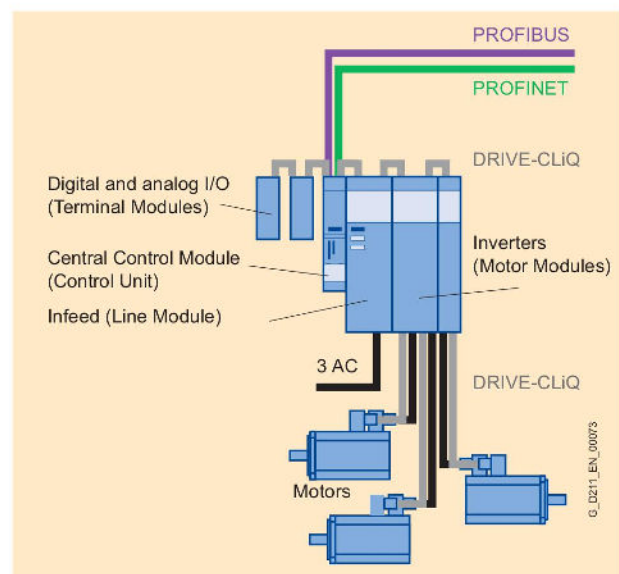
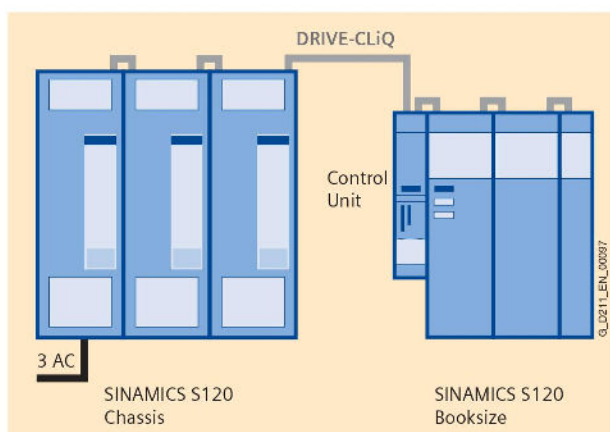
Together this integrated line offers the most optimal drive solution for any application servo or vector.



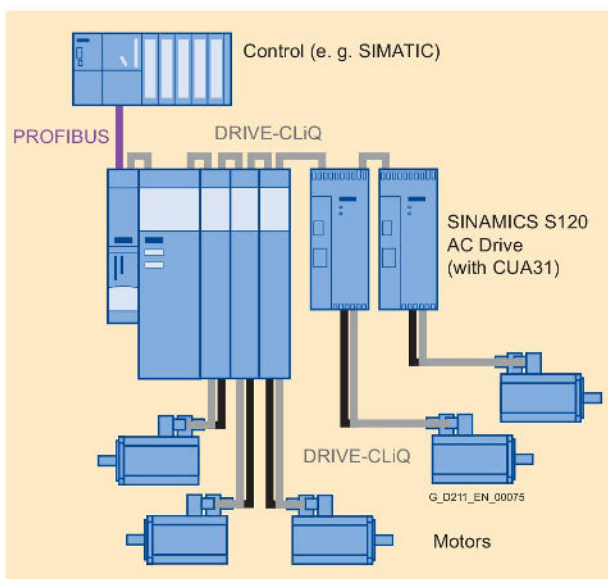
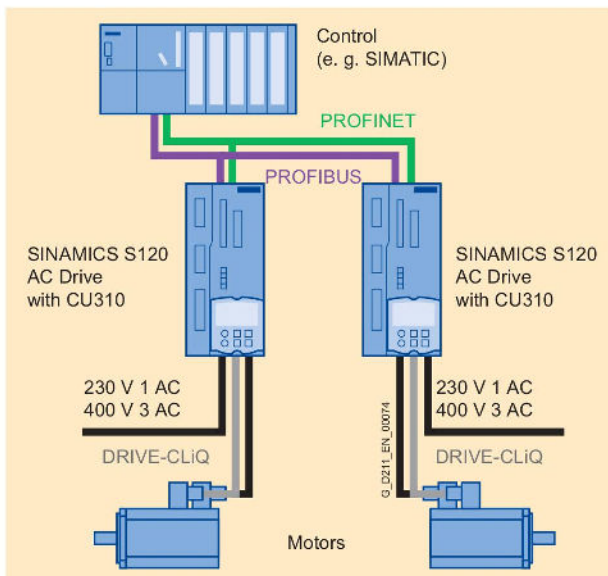
Blocksize, booksize and chassis formats

### All formats can be combined freely

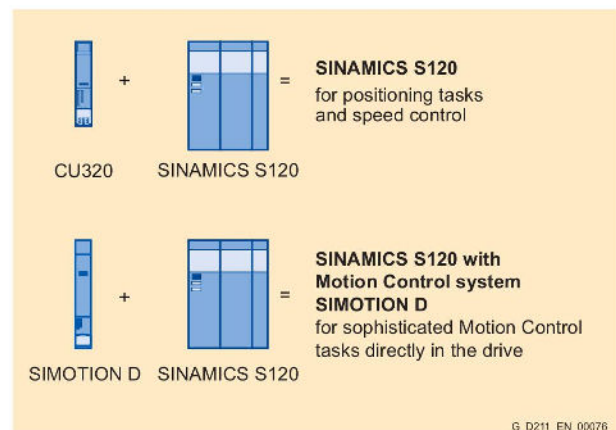
The different SINAMICS S120 formats can be combined freely thanks to their DRIVE-CLiQ interfaces, e.g. Line Modules in chassis format can be freely combined with Motor Modules in booksize format for multi-axis applications with high or varying total output requirements.



## SINAMICS S120 drive system

**SINAMICS S120 and SIMOTION – the perfect team**

Modern machines must be capable of handling ever more complex motion control tasks and performing the task with increasing accuracy and speed. In regards to this requirement, the SIMOTION Motion Control System and high-performance SINAMICS S120 drive system form a perfect team. The SIMOTION D variant, which is physically integrated in the SINAMICS S120 drive, is the ideal solution for machines with a large number of axes and stringent precision requirements. This distributed automation structure allows the machine to be segmented into various axis groupings, with each grouping controlled by a separate SIMOTION Motion Control System. The SIMOTION systems communicate either via PROFIBUS DP or PROFINET. Another important aspect: The compact machine design, thanks to the distributed automation structure and a Control Unit directly in the drive.

**Totally Integrated Automation – the unique automation platform**

With Totally Integrated Automation (TIA), Siemens is the only single-source provider to offer an integrated spectrum of products and systems for all sectors. Tailored to meet individual customer requirements, sector-specific automation solutions can be implemented efficiently on the basis of TIA. Lower life-cycle costs for plant operation and a significant reduction in the time to market result in a marked improvement in productivity and greater investment security.

**Easy – Totally Integrated Automation with SINAMICS S120**

Apart from SIMATIC, SIMOTION and SINUMERIK, SINAMICS is also one of the core components of TIA. The STARTER commissioning tool is therefore an integral element of the TIA platform. It is thus possible to parameterize, program and commission all components in the automation system using a standardized engineering platform and without any gaps. The system-wide data management functions ensure consistent data and simplify archiving of the entire plant project.

**PROFIBUS – the No. 1 fieldbus**

PROFIBUS DP, the standard fieldbus of the TIA system, is supported by all SINAMICS S120 variants. It provides a high-performance system-wide communication network which links all automation components: HMI, controls, drives and I/O devices.

**PROFINET – for enhanced performance and open IT communication**

SINAMICS S120 is also available with a PROFINET interface. This Ethernet-based bus enables control data to be exchanged at high speed via PROFINET IO with IRT or RT and makes SINAMICS S120 a suitable choice for integration in top-performance multi-axis applications.

At the same time, PROFINET also uses standard IT mechanisms (TCP/IP) to transport information, e.g. operating and diagnostic data, to higher-level systems. A SINAMICS S120 with this interface can thus easily be integrated into factory IT networks.

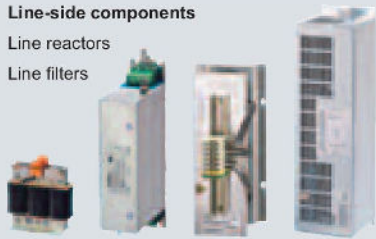
## SINAMICS S120 drive system

## The components of the SINAMICS S120 drive system

## SINAMICS S120 drive system

## Line-side components

Line reactors  
Line filters



## Line Modules

Basic Line Modules  
Smart Line Modules  
Active Line Modules  
Active Interface Modules



## Power supply

For applicable 24 V device,  
see Catalog KT 10.1



## DC link components

Braking Module  
Braking resistors  
Capacitor Module  
Control Supply Module



## Control Units

CU310  
CU320



## SIMOTION Control Units

D425  
D435  
D445  
CX32



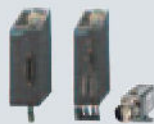
## Motor Modules

Single Motor Modules  
Double Motor Modules

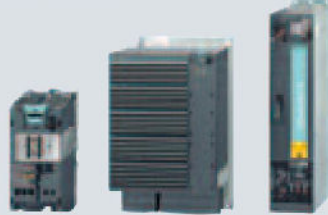


## Sensor Modules

SMC10/SMC20  
SMC30  
SME20/SME25

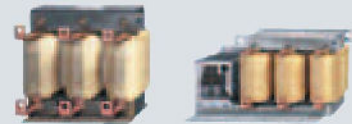


## Power Modules



## Load-side components

Motor reactors  
Sinusoidal filters



## AC motors

## Synchronous motors

1FT6 motors  
1FK7 motors  
1FS6 motors  
1FW3 torque motors  
Gear units  
Geared motors

## Asynchronous motors

1PH7 motors  
1PL6 motors  
1PH4 motors

## Connection system

## MOTION-CONNECT

Power cables  
Signal cables



|             |   |              |  |
|-------------|---|--------------|--|
| <b>2/2</b>  | <b>System overview</b>                        | <b>2/105</b> | <b>Motor Modules</b>                       |
| <b>2/6</b>  | <b>General technical data</b>                 | 2/105        | Single Motor Modules in booksize format    |
| <b>2/7</b>  | <b>Communication</b>                          | 2/114        | Single Motor Modules in chassis format     |
| 2/8         | PROFdrive                                     | 2/126        | Double Motor Modules in booksize format    |
| 2/10        | PROFIBUS                                      | <b>2/133</b> | <b>DC link components</b>                  |
| 2/11        | PROFINET                                      | 2/133        | Braking Modules in booksize format         |
| <b>2/14</b> | <b>Control Units</b>                          | 2/135        | Braking Modules in chassis format          |
| 2/17        | CU310 DP Control Unit                         | 2/138        | Braking resistors for blocksize format     |
| 2/20        | CU310 PN Control Unit                         | 2/140        | Braking resistors for booksize format      |
| 2/23        | CU320 Control Unit                            | 2/141        | Braking resistors for chassis format       |
| 2/26        | CompactFlash Card for CU310/CU320             | 2/143        | Capacitor Modules in booksize format       |
| 2/28        | SIMOTION D Control Units                      | 2/144        | Control Supply Modules in booksize format  |
| 2/31        | SIMOTION CX32 Controller Extension            | 2/146        | DC link supply adapter for booksize format |
| <b>2/32</b> | <b>Engineering software</b>                   | 2/147        | Voltage Clamping Module in booksize format |
| 2/32        | STARTER drive/commissioning software          | <b>2/148</b> | <b>Load-side power components</b>          |
| 2/33        | Drive ES engineering system                   | 2/148        | Motor reactors for blocksize format        |
| 2/34        | SIMOTION SCOUT engineering software           | 2/151        | Motor reactors for booksize format         |
| <b>2/35</b> | <b>Power Modules and line-side components</b> | 2/153        | Motor reactors for chassis format          |
| 2/35        | Power Modules in blocksize format             | 2/157        | Sinusoidal filter for chassis format       |
| 2/47        | Line reactors                                 | <b>2/159</b> | <b>Supplementary system components</b>     |
| 2/50        | Line filters                                  | 2/159        | BOP20 Basic Operator Panel                 |
| 2/51        | Recommended line-side components              | 2/160        | CBC10 Communication Board                  |
| 2/52        | Power Modules in chassis format               | 2/161        | CBE20 Communication Board                  |
| 2/57        | Line reactors                                 | 2/162        | CBE30 Communication Board                  |
| 2/58        | Line filters                                  | 2/163        | CUA31 Control Unit Adapter                 |
| 2/59        | Recommended line-side components              | 2/165        | DMC20 DRIVE-CLiQ Hub Module                |
| <b>2/60</b> | <b>Line Modules and line-side components</b>  | 2/166        | TB30 Terminal Board                        |
| 2/60        | Basic Line Modules in chassis format          | 2/168        | TM15 Terminal Module                       |
| 2/66        | Line reactors                                 | 2/170        | TM31 Terminal Module                       |
| 2/67        | Line filters                                  | 2/172        | TM41 Terminal Module                       |
| 2/68        | Recommended line-side components              | 2/174        | VSM10 Voltage Sensing Module               |
| 2/69        | Smart Line Modules in booksize format         | 2/176        | Brake Relay/Safe Brake Relay               |
| 2/76        | Line reactors                                 | <b>2/178</b> | <b>Encoder system connection</b>           |
| 2/77        | Line filters                                  | 2/179        | SMC10 Sensor Module Cabinet-Mounted        |
| 2/78        | Recommended line-side components              | 2/180        | SMC20 Sensor Module Cabinet-Mounted        |
| 2/79        | Active Line Modules in booksize format        | 2/181        | SMC30 Sensor Module Cabinet-Mounted        |
| 2/85        | Line reactors                                 | 2/182        | SME20/SME25 Sensor Modules External        |
| 2/87        | Wideband Line Filters                         |              |  |
| 2/88        | Basic Line Filters                            |              |  |
| 2/89        | Recommended line-side components              |              |  |
| 2/91        | Active Line Modules in chassis format         |              |  |
| 2/98        | Active Interface Modules                      |              |  |
| 2/104       | Recommended line-side components              |              |  |

# SINAMICS S120

## System overview

### Overview

With its separate power unit and Control Unit, the SINAMICS S120 drive system can be perfectly adapted to a wide variety of different drive tasks.

The Control Unit is selected according to the number of drives to be controlled and the required performance level, while the power unit must be rated to meet the energy requirements of the system. The connection between the Control Unit and power unit is made very simply using the digital system interface DRIVE-CLiQ.

### Control Units



CU310 DP, CU320 and SIMOTION D Control Units

### CU310 DP and CU310 PN Control Unit

CU310 Control Units are designed to control a single drive. They feature as standard a PROFIBUS interface (CU310 DP) or PROFINET interface (CU310 PN) and a TTL/HTL encoder evaluation circuit.

### CU320 Control Unit

The CU320 Control Unit has been designed to control multiple drives. A CU320 is capable of operating up to

- 8 drives in V/f control mode or
- 6 drives in Servo control mode or
- 4 drives in Vector control mode.

The CU320 Control Unit can be used to create links between individual drives and implement simple technology functions.

### SIMOTION D425, D435, D445 Control Units

A SIMOTION D Control Unit is used for applications requiring coordinated motion control such as synchronous operation, electronic gear, cam disk or complex technology functions. SIMOTION D Control Units are available in a range of performance variants:

- A SIMOTION D425 Control Unit can control up to 16 axes,
- A SIMOTION D435 Control Unit can control up to 32 axes,
- A SIMOTION D445 Control Unit can control up to 64 axes.

The STARTER commissioning tool is used to commission and diagnose the various types of Control Units. The SCOUT engineering system, which includes the STARTER tool, is required for SIMOTION D Control Units.

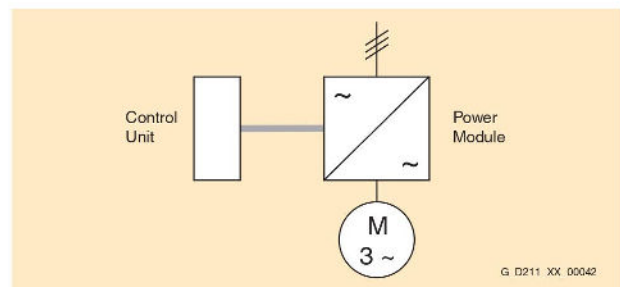
For further information about STARTER and SCOUT, see Engineering Software.

### Power Modules

The stand alone version of a SINAMICS S120 drive system consists of a CU310 Control Unit and a Power Module. A mains rectifier, a voltage-source DC link and an inverter for supplying a motor are integrated in the Power Module.



Power Module in blocksize format with CU310 DP Control Unit



Power Modules are designed for single drives which are not capable of regenerating energy to the supply. Generated energy produced during braking is converted to heat via braking resistors.

Power Modules can also be operated by a CU320 or a SIMOTION D Control Unit, e.g. in configurations where a single drive has been added to a multi-axis drive grouping. In this case, the Power Modules in blocksize format must be equipped with the CUA31 Control Unit Adapter. This is connected with the CU320 or SIMOTION D Control Unit using DRIVE-CLiQ. Power Modules in chassis format can be directly connected to the multi-axis Control Unit using a DRIVE-CLiQ cable.



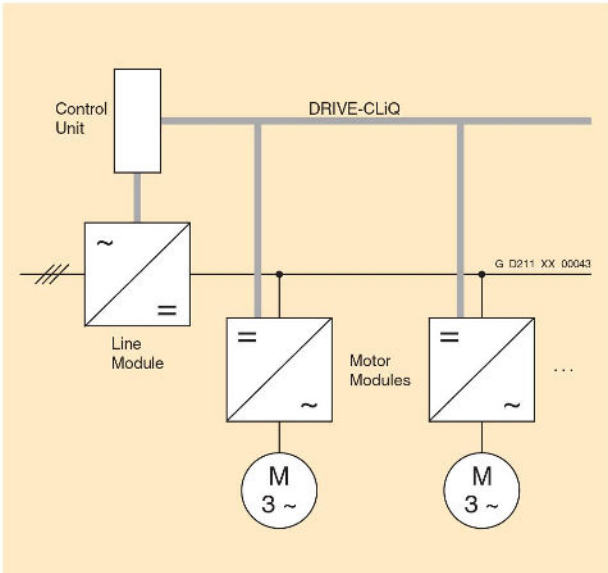
### Overview (continued)

#### Motor Modules

A voltage-source DC link and an inverter for supplying a motor are integrated in the Motor Module.



CU320 Control Unit, Line Module and two Motor Modules in booksize format



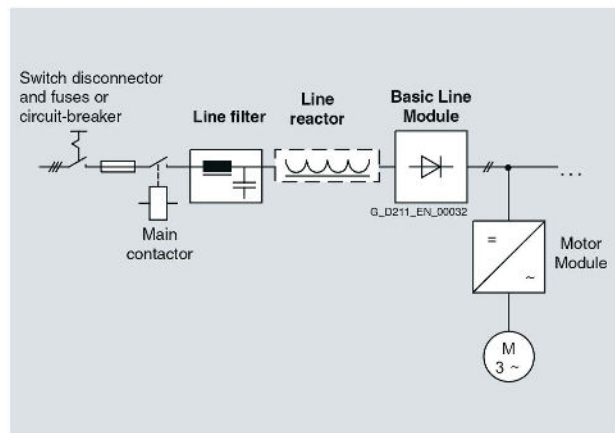
Motor Modules are designed for multi-axis drive systems and are controlled by either a CU320 or a SIMOTION D Control Unit. Motor Modules are interconnected by means of a shared DC busbar. Since the Motor Modules share the same DC link, they can exchange energy with one another, i.e. if one Motor Module operating in generator mode produces energy, the energy can be used by another Motor Module operating in motor mode. The voltage-source DC link is supplied with mains voltage by a Line Module.

#### Line Modules

Line Modules generate a DC voltage from the line voltage and supply Motor Modules with energy via the voltage-source DC link.

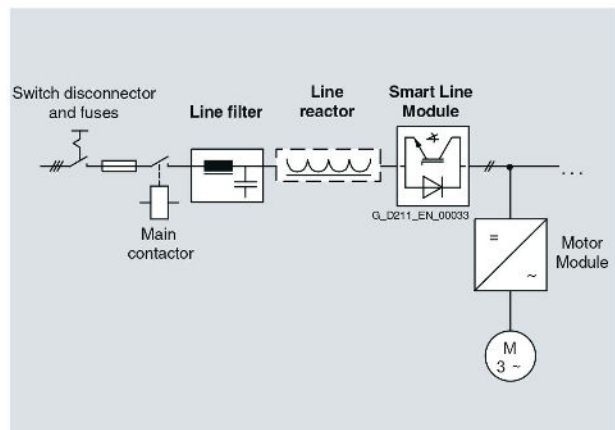
##### Basic Line Modules

Basic Line Modules are designed only for infeed operation, i.e. they are not capable of recovering regenerative energy to the supply system. If regenerative energy is produced, e.g. when drives brake, it must be converted to heat by means of a Braking Module and a braking resistor. When a Basic Line Module is used as the infeed, the matching line reactor must be installed. A line filter can be installed optionally to restrict conducted interference to Class C2 limits (EN 61800-3).



##### Smart Line Modules

Smart Line Modules can supply energy and return regenerative energy to the supply system. A Braking Module and braking resistor are required only if the drives need to be decelerated in a controlled manner after a power failure (i.e. when energy cannot be recovered to the supply). When a Smart Line Module is used as the infeed, the matching line reactor must be installed. A line filter can be installed optionally to restrict conducted interference to Class C2 limits (EN 61800-3).



## System overview

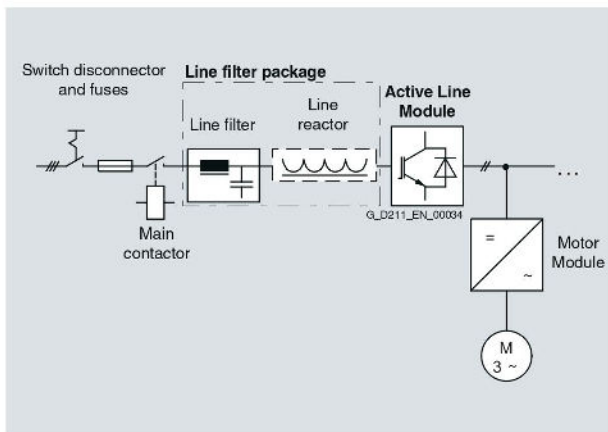
### Overview (continued)

#### Active Line Modules

Active Line Modules can supply energy and return regenerative energy to the supply system. A Braking Module and braking resistor are required only if the drives need to be decelerated in a controlled manner after a power failure (i.e. when energy cannot be recovered to the supply). In contrast to Basic Line Modules and Smart Line Modules, however, Active Line Modules generate a regulated DC voltage which remains constant despite fluctuations in the line voltage. In this case, the line voltage must remain within the permissible tolerance range. Active Line Modules draw a virtually sinusoidal current from the supply which limits any harmful harmonics.

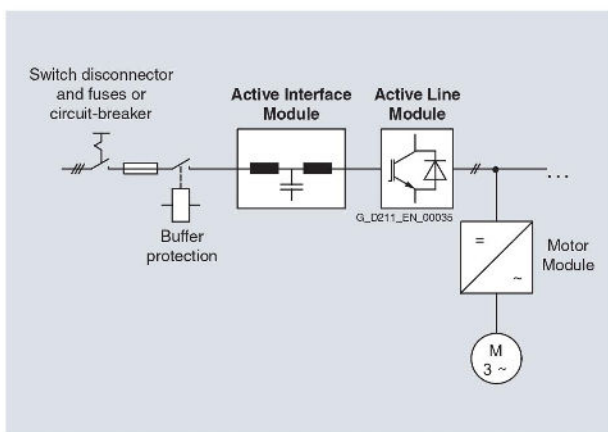
- Active Line Modules in booksize format

When an Active Line Module is used as the infeed, the matching line reactor must be installed. To minimize interference emission, the Active Line Module should always be operated with a combination of line filter and line reactor.



- Active Line Modules in chassis format

All the components required to operate an Active Line Module are integrated in the Active Interface Module. An external bypass contactor is required in addition for sizes HX and JX.



Please refer to the System Description for more information about designing a drive system with SINAMICS S120.

Power Modules, Motor Modules and Line Modules are available in formats "booksize", "blocksize" and "chassis"

- Power Modules in blocksize and chassis formats for single axis,
- Motor Modules and Line Modules for multi axis in booksize and chassis formats.

#### Booksize format

Booksize format units are optimized for multi-axis applications and are mounted adjacent to one another. The connection for the shared voltage-source DC link is an integral feature.



The booksize format offers a greater range of cooling options:

#### Internal air cooling

In this standard solution, the power loss from the electronics and power units of the drive components is removed by natural cooling or by a forced-ventilation system and routed to the interior of the control cabinet.

#### External air cooling

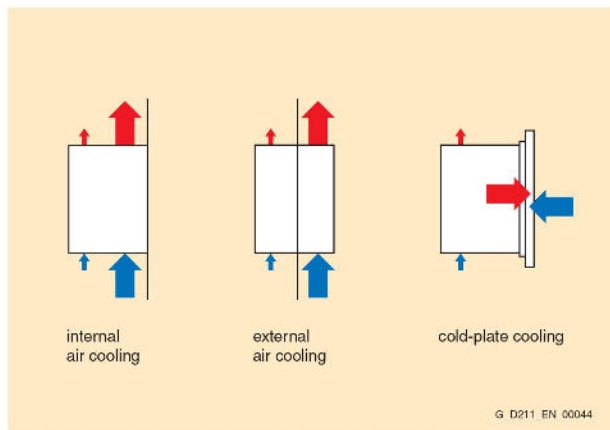
External air cooling uses the "through-hole" method. The components' power unit heat sinks pass through the mounting surface in the control cabinet and can thus release the heat losses of the power circuit to a separate external cooling circuit. The only heat loss that remains in the cabinet is emitted by the electronics. Degree of protection IP54 can be achieved at this "mechanical interface". The heat sink, with its cooling fins and the fan unit (part of the scope of supply), protrudes through the back into a separate ventilation area, which can also open outwards.

### Overview (continued)

#### Cold-plate cooling

Units designed with cold-plate cooling can pass the power unit heat losses to an external heat sink via a thermal interface on the unit's rear panel. This external heat sink is water-cooled, for example. For further information about cold-plate cooling, please contact:

Siemens A&D  
TCC Cabinet Cooling  
E-mail: cc.cabinetcooling@siemens.com



#### Blocksize format

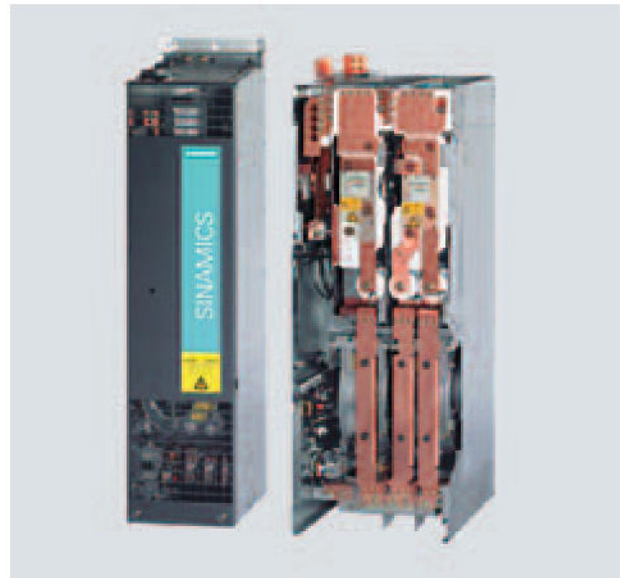
Blocksize format units are optimized for single-axis applications and are available only as Power Modules.

The CU310 Control Unit can be snapped onto them directly. The units are cooled by an internal air cooling circuit.



#### Chassis format

Higher-output units (approximately 100 kW (150 HP) and above) are constructed in chassis format. These are available as Line Modules, Power Modules and Motor Modules. Chassis format units are cooled by an internal air cooling circuit. The CU310 Control Unit can be integrated in the Power Modules.



#### Varnished modules

The following units are equipped as standard with varnished coating:

- Blocksize format units
- Booksize format units for external air cooling
- Booksize format units with cold-plate cooling
- Control Units (SIMOTION D345 and SIMOTION D445 in preparation)
- Sensor Modules
- Terminal modules

All booksize format units for internal air cooling are available with varnished modules.

The varnish coating protects the sensitive SMD components against corrosive gases, chemically active dust and moisture.

The selection of Control Unit and Power section defines the structure of the drive system. The range of system components provided allows optimum adaptation of the drive system to the application.

System components are divided into the following categories:

- **DC link components**  
e.g. Braking Modules and braking resistors,
- **Load-side power components**  
e.g. motor reactors,
- **Supplementary system components**  
e.g. Terminal Modules, operator panels and communication boards
- **Encoder system interface**  
for connecting various types of encoder to SINAMICS S120.

# SINAMICS S120

## System data

### General technical data

#### Technical data

Unless specified otherwise, the following technical specifications are valid for all the following components of the SINAMICS S120 drive system.

| Electrical data  |  |
|--|--|
| Electronics power supply   | 24 V DC, 15/+ 20%  |
| Mechanical data  |  |
| Vibratory load   |  |
| • Transport <sup>1)</sup>  | Class 2M3 to EN 60721-3-2  |
| - All units and components except for chassis format                                     |  |
| - Chassis format units   | Class 2M2 to EN 60721-3-2  |
| • Operation  | Test values in accordance with EN 60068-2-6 test Fc:<br>10 Hz to 58 Hz: Constant deflection 0.075 mm (0.003 in)<br>58 Hz to 150 Hz: Constant acceleration = 9.81 m/s <sup>2</sup> (3.2 ft/s <sup>2</sup> ) (1 × g) |
| Shock stressing  |  |
| • Transport <sup>1)</sup>  | Class 2M3 to EN 60721-3-2  |
| - All units and components except for chassis format                                     |  |
| - Chassis format units   | Class 2M2 to EN 60721-3-2  |
| • Operation  | Test values in accordance with EN 60068-2-27 test Ea:<br>147 m/s <sup>2</sup> (482 ft/s <sup>2</sup> ) (15 × g)/11 ms  |
| - Booksize and blocksize formats FSA to FSC  |  |
| - Blocksize format FSD to FSF  | 49 m/s <sup>2</sup> (161 ft/s <sup>2</sup> ) (5 × g)/30 ms   |
| - Chassis format   | 98 m/s <sup>2</sup> (321 ft/s <sup>2</sup> ) (10 × g)/20 ms  |
| Ambient conditions   |  |
| Protection Class   | Class I (with protective conductor system) and class III (PELV) to EN 61800-5-1  |
| Shock protection   | DIN VDE 0106 Part 100 and BGVA 3 when used properly  |
| Permissible ambient/coolant temperature (air) during operation                           |  |
| • for line-side components, Power Modules, Line Modules and Motor Modules                | 0 °C to + 40 °C (32 °F to +104 °F) without derating, >40 °C to + 55 °C (>104 °F to +131 °F) see derating characteristics   |
| • for Control Units, additional system components, DC link components and Sensor Modules | 0 °C to + 55 °C (32 °F to +131 °F) up to 2000 m (6562 ft) above sea level  |
| Climatic ambient conditions  |  |
| • Storage <sup>1)</sup>  | Class 1K3 to EN 60721-3-1<br>Temperature: - 40 °C to + 70 °C (- 40 °F to + 158 °F)   |
| • Transport <sup>1)</sup>  | Class 2K4 to EN 60721-3-2<br>Temperature - 40 °C to + 70 °C (- 40 °F to + 158 °F)<br>Max. air humidity 95% at 40 °C (104 °F)   |
| • Operation  | Class 3K3 to EN 60721-3-3<br>Condensation, splashwater and ice formation are not permitted (EN 60204, Part 1)  |
| Environmental class/harmful chemical substances  |  |
| • Storage <sup>1)</sup>  | Class 1C2 to EN 60721-3-1  |
| • Transport <sup>1)</sup>  | Class 2C2 to EN 60721-3-2  |
| • Operation  | Class 3C2 to EN 60721-3-3  |
| Organic/biological influences  |  |
| • Storage <sup>1)</sup>  | Class 1B1 to EN 60721-3-1  |
| • Transport <sup>1)</sup>  | Class 2B1 to EN 60721-3-2  |
| • Operation  | Class 3B1 to EN 60721-3-3  |
| Degree of contamination  | 2 to EN 61800-5-1  |

<sup>1)</sup> In transport packaging

| European Standards       |  |
|--------------------------|--|
| EN 954-1                 | Safety of machinery – safety-related parts of control systems; Part 1: General design principles                                     |
| EN 61508-1               | Functional safety of electrical/electronic/programmable electronic safety-related systems Part 1: General requirements               |
| EN 50370-1               | Electromagnetic compatibility (EMC) – Product family standard for machine tools Part 1: Emissions                                    |
| EN 55011                 | Industrial, scientific and medical high-frequency devices (ISM devices) – radio interference – limit values and measuring techniques |
| EN 60204-1               | Electrical equipment of machines Part 1: General definitions   |
| EN 61800-3               | Variable-speed electric drives Part 3: EMC product standard including specific test methods  |
| EN 61800-5-1             | Adjustable-speed electrical power drive systems Part 5: Safety requirements Main section 1: Electrical and thermal requirements      |
| North American standards |  |
| UL508C                   | Power Conversion Equipment   |
| CSA C22.2 No. 14         | Industrial Control Equipment   |

| Approvals |   |
|-----------|---|
| cULus     | Testing by UL (Underwriters Laboratories) <a href="http://www.ul.com">http://www.ul.com</a> according to UL and CSA standards |

### Overview

Most production machines use digital communication bus systems. These handle the communication between the control level, the machine control and the executing components, i.e. the sensors and actuators. There are two types of communication: process communication and data communication.

#### Process communication

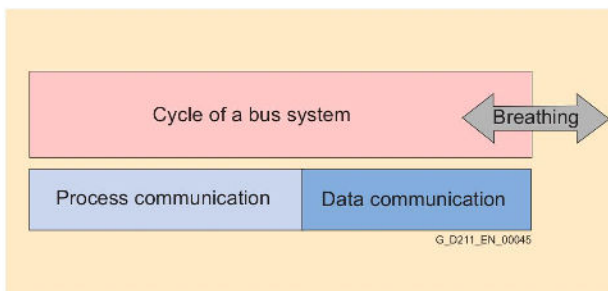
Process communication involves cyclically transmitting control data and setpoints. The quantity of transfer data is comparatively small. For example, a drive can communicate with between 4 and 32 bytes. The number of connected sensors and actuators is usually specified by the configuration which makes the bus cycle of process communication very constant.

#### Data communication

Data communication is often required for engineering and is not directly linked to the execution of the production process. Data are sporadically (acyclically) exchanged with connected devices. The volume of this communication can be very large with over 100 bytes per device and communication task.

#### Bus cycle

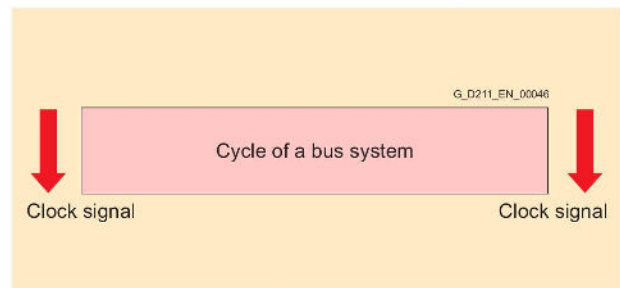
The bus cycle comprises of process communication and data communication. The cycle of the bus system is much shorter without data communication. Some say: the bus cycle breathes. However, this breathing is unsuitable for highly accurate applications in drive technology.



Communication types of a bus system

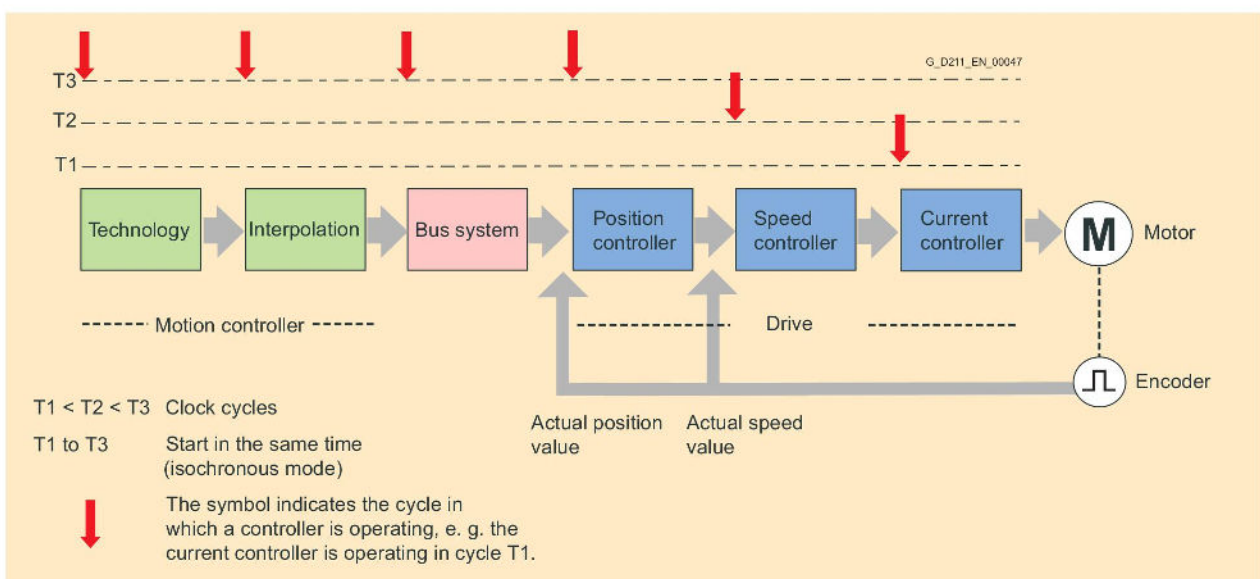
#### Requirements of drive controls

Most modern drives have a digital closed-loop control. This closed-loop control ensures that the controlled variable of the drive, for example the speed or position, are achieved and maintained. This type of digital closed-loop control comprises several intertwined controls (position, speed, current, ...). These must be matched to one another, i.e. they must be synchronized. This synchronization is important to keep the controls stable and to accurately maintain the controlled variable and/or to achieve it quickly. If some of the components of the closed-loop control are located outside the drive, a bus system must be used to manage the communication between these components. This bus system must be as synchronized as the closed-loop controls. This is referred to as isochronous operation. For drives in the area of Motion Control Systems isochronous operation must be extremely quick and very accurate. It ensures that the length of the bus cycle deviates only very slightly. This is then no longer referred to as the breathing of the bus cycle (large deviations), but as jitter (small deviations). Acceptable values are  $<1 \mu\text{s}$ . This synchronization is achieved through clock signals.



Constant bus cycle

So that a bus system can be used for Motion Control applications it must permit process communication and isochronous operation. An additional bus system is often used for data communication. PROFIBUS and PROFINET can combine all of these requirements in a single bus system. Industrial Ethernet, the predecessor of PROFINET, does not fulfill the requirements with respect to real-time communication.



The principle of digital drive controls

# SINAMICS S120

## Communication

### PROFIdrive

#### Overview

##### *What are profiles?*

Profiles used in automation technology define certain characteristics and responses for devices, device groups or whole systems which specify their main and unique properties. Only devices with manufacturer-neutral, identical profiles can "interoperate" on a fieldbus and thus fully exploit the advantages of a fieldbus for the user.

Profiles are specifications defined by manufacturers and users for certain characteristics, performance features and behaviors of devices and systems. They aim to ensure that devices and systems which belong to one product family by virtue of their "product-compliant" development are interoperable and, to a certain degree, exchangeable in bus operation.

##### *Profile types*

Different types of profile can be distinguished as so-called application profiles (general or specific) and system profiles:

- Application profiles mainly refer to devices (drives) and contain an agreed selection of bus communication modes, as well as specific device applications.
- System profiles describe system classes and include the master functionality, program interfaces and integration methods.

##### *PROFIdrive*

The PROFIdrive profile is a specific application profile.

#### Design

##### *PROFIdrive in drive applications*

The PROFIdrive profile defines the device behavior and the access procedure to drive data for electrical drives on PROFIBUS, from simple frequency converters up to high performance servo controllers.

It contains a detailed description of how the communication functions "slave-to-slave communication", "equidistance" and "isochronous operation" are used meaningfully for drive applications. In addition, it specifies all device characteristics which influence interfaces connected to a controller over PROFIBUS or PROFINET. This includes the sequence control system, encoder interface, standardization of values, definition of standard messages, and access to drive parameters, etc.

The PROFIdrive profile supports both central and distributed Motion Control concepts.

##### *The basic philosophy: Keep it simple*

The PROFIdrive profile tries to keep the drive interface as simple as possible and free from technology functions. This philosophy ensures that reference models, as well as the functionality and performance of the PROFIBUS/PROFINET master, have no or very little influence on the drive interface.

##### *Segmentation into application/utilization categories*

The integration of drives into automation solutions depends heavily on the drive task. To cover the extensive range of drive applications from the most simple frequency converter up to highly dynamic, synchronized multi-axis systems with a single profile, PROFIdrive defines six application categories which cover most drive applications.

- Category 1 – Standard Drives (such as pumps, fans, stirring units, etc.)
- Category 2 – Standard Drives with Technology Functions
- Category 3 – Positioning Drives
- **Category 4 – Motion Control Drives with Central, Higher-Level Motion Control Intelligence**
- Category 5 – Motion Control Drives with Central, Higher-Level Motion Control Intelligence and the Patented "Dynamic Servo Control" Position Concept
- Category 6 – Motion Control Drives with Distributed Motion Control Intelligence Integrated in the Drives

### Design (continued)

PROFdrive defines a device model based on function modules which cooperate in the device and generate the intelligence of the drive system. These modules have objects assigned to them which are described in the profile and are defined with respect to their functions. The overall functionality of a drive is therefore described through the sum of its parameters.

In contrast to other drive profiles, PROFdrive defines only the access mechanisms to the parameters as well as a subset of profile parameters (about 30) such as the fault buffer, drive control and device identification.

All other parameters are vendor-specific which gives drive manufacturers great flexibility with respect to implementing control functions. The elements of a parameter are accessed acyclically over the so-called DP-V1 parameter channel.

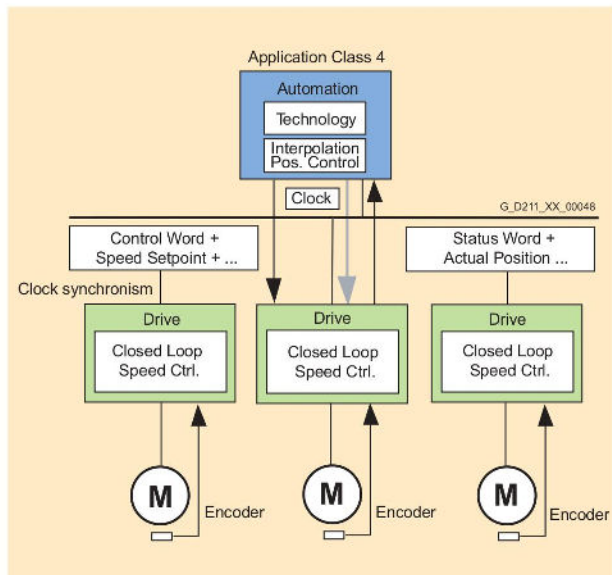
As a communication protocol, PROFdrive uses DP-V0, DP-V1, and the DP-V2 expansions for PROFIBUS including the functions "Slave-to-Slave Communication" and "Isochronous Operation", or PROFINET IO with real-time classes RT and IRT.

### PROFdrive and SINAMICS

Utilization category 4 is the most important category for highly dynamic and highly complex Motion Control tasks. This application category describes in detail the master/slave relationship between the controller and the drives which are connected to each other over PROFIBUS and PROFINET.

The DSC (Dynamic Servo Control) function significantly improves the dynamic response and stiffness of the position control circuit by minimizing the dead times which usually occur for speed setpoint interfaces with an additional, relatively simple feedback network in the drive. The position control circuit is closed in the drive which permits very fast position control cycles (e.g. 125 µs for SINAMICS S) and thus limits dead times exclusively to the control behavior.

In SINAMICS S the drive interface has been implemented according to the PROFdrive profile V4 and Utilization Categories 1 to 4 (Category 4 with and without DSC) and is referred to below as the PROFdrive interface.



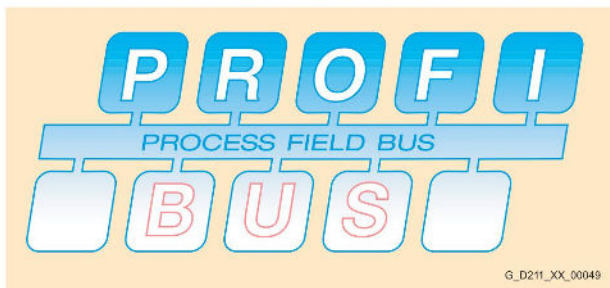
# SINAMICS S120

## Communication

### PROFIBUS

#### Overview

2



#### What is PROFIBUS?

PROFIBUS is the most successful open fieldbus used for automation technology which can be used for a wide range of applications. Standardization to IEC 61158 / EN 50170 provides future protection for your investment.

PROFIBUS defines the technical and functional features of a serial fieldbus system with which distributed programmable field controllers of the low-end (sensor/actuator level) to mid performance range (cell level) can be networked.

The demands of users for an open, vendor-independent communication system resulted in the specification and standardization of the PROFIBUS protocol.

#### Multi-vendor installations

Through the conformity and interoperability test performed by the test laboratories authorized by the PROFIBUS user organization (PNO) and the certification of the devices by the PNO, the user can rest assured that quality and functionality are also ensured for multi-vendor installations.

#### PROFIBUS variants

PROFIBUS FMS (Fieldbus Message Specification) – The universal solution for communication tasks on the field and cell level of the industrial communication hierarchy.

PROFIBUS PA (Process Automation) – The variant for applications in process automation. PROFIBUS PA uses the intrinsically safe transmission technology specified in IEC 61158-2.

PROFIBUS DP (Distributed Peripherals) – This variant, which is optimized for speed, is tailored especially for the communication of automation systems with distributed I/O stations and drives. The outstanding features of PROFIBUS DP are

- Very short response times
- High interference immunity

PROFIBUS replaces cost-intensive parallel signal transmission with 24 V and the measured value transmission with 0/4 mA to 20 mA technology.

#### PROFIBUS and SINAMICS

SINAMICS uses the PROFIBUS protocol PROFIBUS DP.

#### Design

##### Bus station

PROFIBUS DP distinguishes between two different master classes and one slave class:

##### Class 1 DP master

The DP master Class 1 is the central component in PROFIBUS DP. The central master station exchanges information with distributed stations (DP slaves) in a fixed, repeated message cycle.

##### Class 2 DP master

Devices of this type are used (programming, configuration or control devices) during start-up, for configuring the DP system, for diagnostics or controlling the plant during normal operation. A DP master Class 2 can be used, for example, to read the input, output, diagnostic and configuration data of the slaves.

##### DP slave

A DP slave is an I/O device which receives output information or setpoints from the DP master and sends input information, measured values or actual values to the DP master in response. A DP slave never sends data independently, it must always be prompted by the DP master.

The volume of input and output data depends on the device and can be up to 244 bytes per DP slave and transfer direction.

#### Function

##### Functions on PROFIBUS DP

The functional scope can differ between DP masters and DP slaves. The functional scope is different for DP-V0, DP-V1 and DP-V2.

##### DP-V0

The DP master functions (DP-V0) comprise of the functions "Configuration", "Parameter assignment", "Read diagnostic data", as well as "Cyclic reading of input data/actual values" and "Writing output data/setpoints".

##### DP-V1

The additional DP function expansions (DP-V1) make it possible to perform non-isochronous read and write functions, as well as processing cyclic data communication. This type of slave must be supplied with extensive parameterization data during start-up and normal operation. These acyclically transferred parameterization data are only rarely changed in comparison to the cyclic setpoints, actual values, and measured values, and are transferred at lower priority in parallel with the cyclic high-speed useful data transfer. Detailed diagnostic information can be transferred in the same way.

##### DP-V2

The extended DP master functions (DP-V2) mainly comprise functions for isochronous operation and direct data exchange between DP slaves.

Isochronous mode is implemented by means of a signal with a constant bus cycle for the bus system. This isochronous, constant cycle is sent by the DP master to all bus stations in the form of a global control message. The master and slaves can then synchronize their applications with this signal. The signal jitter between cycles is less than 1  $\mu$ s.

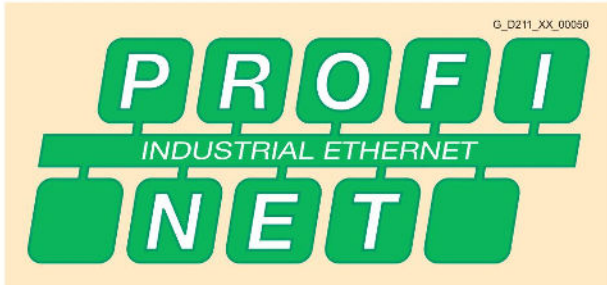
The so-called publisher/subscriber model is used to implement direct slave-to-slave communication. Slaves declared as publishers make their input data/actual values and measured values available to other slaves, the subscribers, for reading. This is performed by sending the response message to the master as a broadcast. Slave-to-slave communication is therefore a cyclic process.

##### SINAMICS systems and PROFIBUS DP

SINAMICS S drives can operate only as DP slaves and support all communication functions, i.e. DP-V0, DP-V1 and DP-V2.



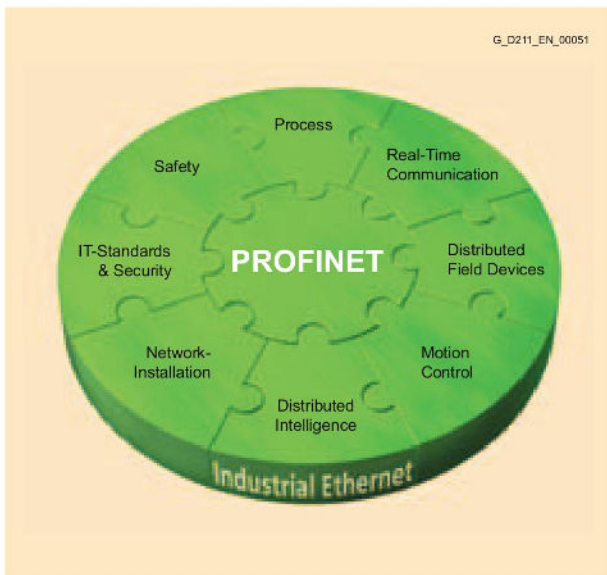
### Overview



PROFINET is the innovative and open Industrial Ethernet standard (IEC 61158) for industrial automation. With PROFINET, devices can be linked up from the field level through to the management level.

PROFINET enables system-wide communication, supports plant-wide engineering and applies IT standards right down to the field level. IT communication, data communication and cyclic process communication are combined on the basis of Industrial Ethernet.

Existing fieldbus systems such as PROFIBUS can be easily integrated without any modification of existing devices.

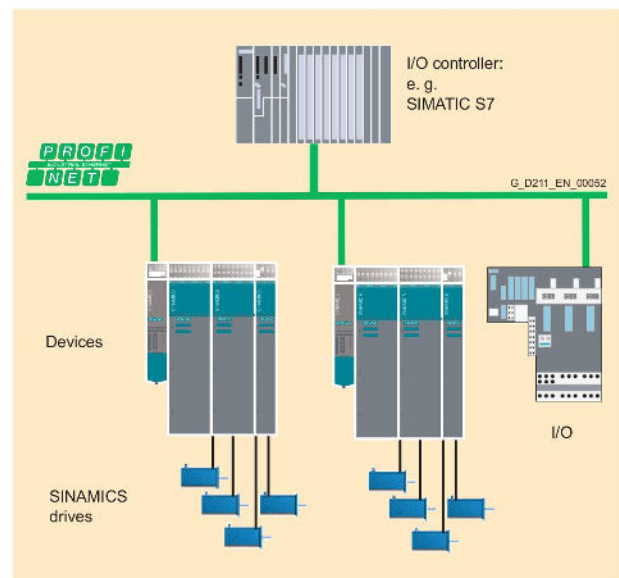


### Design

#### PROFINET device concept

PROFINET distinguishes between the controller and devices assigned to it. These are initialized and parameterized by the controllers on power-up. The controller and its devices together constitute a PROFINET I/O system (compare master/slave system for PROFIBUS).

For PROFINET, cyclic communication between an I/O controller and its I/O devices is performed in the same way as for PROFIBUS over the process image. The process image is updated cyclically, depending on the requirements and device characteristic this takes place in real-time (RT, devices are typically distributed I/O devices) or isochronous real-time (IRT, devices are typically servo drives). In addition, PROFINET permits communication between controllers and devices of different I/O systems.



#### PROFINET IO with RT for simple standard drive applications

With typical cycle times of between 4 ms and 10 ms, PROFINET IO with RT offers the same performance characteristics as PROFIBUS as regards cyclic data transmission.

With this performance level, all standard drive applications belonging to PROFIdrive application categories 1 to 3 can be automated, i.e. those categories requiring the specification of speed, torque and current setpoints or target positions which do not need to be linked isochronously.

# SINAMICS S120 Communication

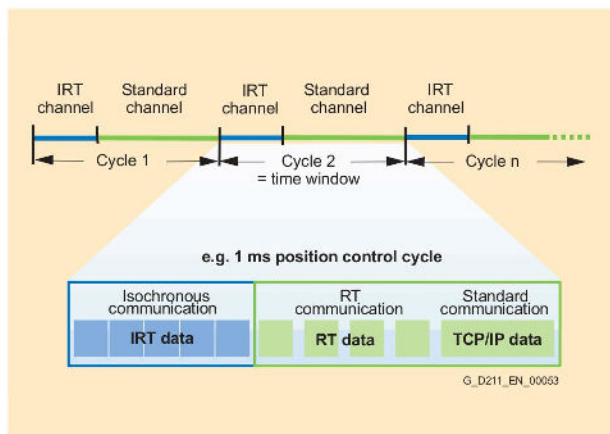
## PROFINET

### Design (continued)

#### PROFINET IO with IRT for Motion Control

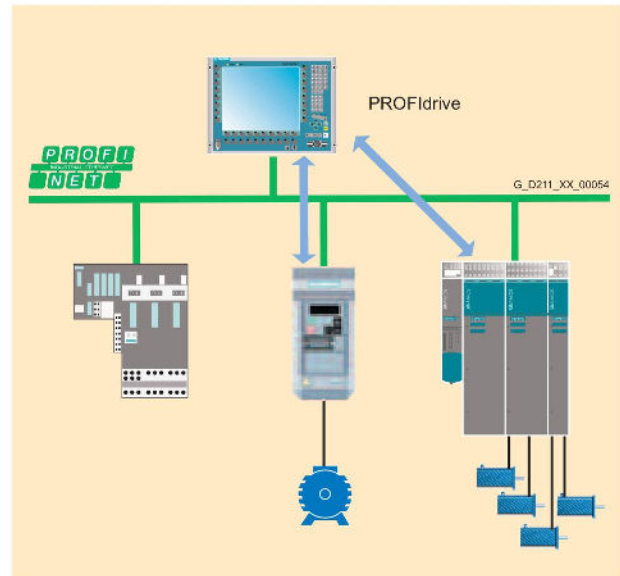
In this case, a Motion Control system (e.g. SIMOTION) controls or synchronizes axes using the PROFINET network. This requires cyclic, isochronous data exchange with the drives. PROFINET IO with IRT fulfils this requirement. The communication cycle is subdivided into different, time-specific channels for this purpose. The first channel is used for isochronous real-time communication (IRT), followed by real-time communication (RT) and standard TCP/IP communication. By configuring the application, e.g. synchronous operation of two axes, the IRT messages are determined implicitly and the corresponding configuration data are generated.

The optimum time sequence of the individual messages for each network section is calculated with a special algorithm which takes the topology into account. This permits a switch to forward the IRT messages without delay from the input port to the specified output port and then to the target device.



#### Transition from PROFIBUS to PROFINET

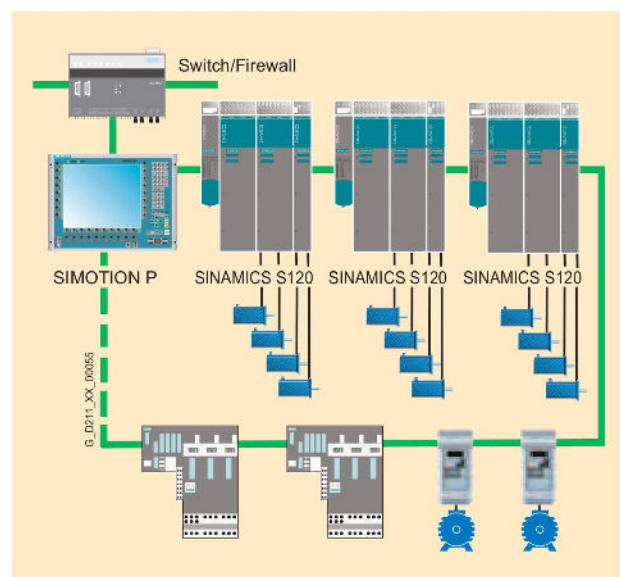
The functional interface between the controller and the SINAMICS drives for PROFINET and PROFIBUS is defined by the PROFdrive drive profile V4 of PROFIBUS International. It is not necessary to change an application program for the transfer between PROFIBUS and PROFINET.



PROFINET with PROFdrive

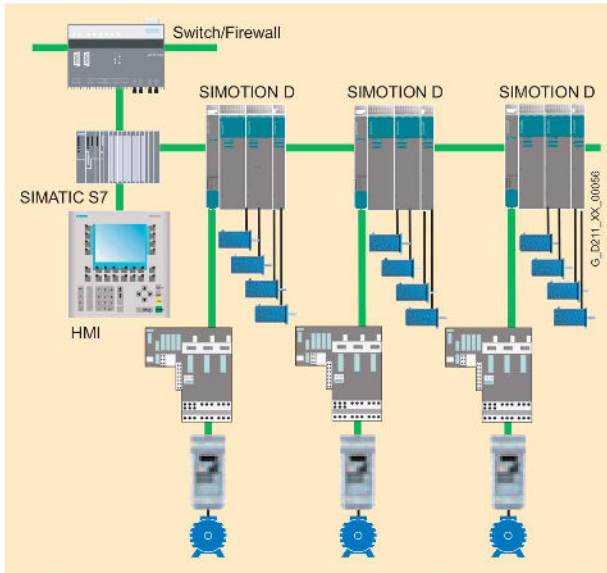
#### Motion Control concepts with PROFINET

With SINAMICS, PROFINET supports the implementation of different automation structures. Distributed drive-based Motion Control concepts (e.g. with SIMOTION D) or central architectures with a control (e.g. SIMOTION P) are supported in the same way as distributed automation solutions with modular automation components.



Central Motion Control architecture

### Design (continued)



Distributed Motion Control architecture

### PROFINET interface on SINAMICS

- SINAMICS S with a CU320 Control Unit and a CBE20 Communication Board  
The CU320 Control Unit on SINAMICS S is linked to the PROFINET IO network via the CBE20 Communication Board. The CBE20 Communication Board includes the PROFINET ASIC ERTEC400.
  - 4 ports with one RJ45 socket each
  - Integrated 4-port switch
  - 100 Mbit/s full duplex
  - PROFINET IO device
  - PROFINET IO with RT and IRT
  - TCP/IP communication to engineering
- SIMOTION D  
The SIMOTION D4x5 are linked to the PROFINET IO network via the CBE30 Communication Board. The CBE30 Communication Board includes the PROFINET ASIC ERTEC400.
  - 4 ports with one RJ45 socket each
  - Integrated 4-port switch
  - 100 Mbit/s full duplex
  - PROFINET IO controller
  - PROFINET IO with RT and IRT
  - Standard TCP/IP, UDP communication
  - PG/OP communication for connection of HMI and PG, IT communication

### Function

#### Real-time communication with PROFINET IO

PROFINET uses standard TCP/IP for parameter assignment, configuration and diagnostics. Real-time communication for the transmission of process data is performed on the same line. PROFINET has the following real-time features:

- Real-time (RT)  
uses the option of prioritizing the communication stack of the stations. This permits high-performance data transmission with standard network components.
- Isochronous Real-Time (IRT)  
permits strict deterministic, cyclic data transmission with short response times and minimum jitter for high performance motion control applications. This feature is implemented with a special ASIC, the so-called ERTEC (Enhanced Real Time Ethernet Controller), in the corresponding interfaces (switch integrated into device) or network components (switch).

#### Automation with PROFINET

With these and other features PROFINET fulfills all automation requirements: Industry-compatible installation technology, real-time capability, deterministic responses, integration of distributed field devices, simple network administration and diagnostics, protection against unauthorized access, efficient vendor-independent engineering as well as isochronous motion control applications.

PROFINET relies on switch technology and has expanded this technology for real-time applications (IRT). This has the advantage that the network topology can be optimally utilized and adapted to the requirements of the machine. Collisions are prevented and an optimal data throughput is achieved.

# SINAMICS S120

## Control Units

### Control Units

#### Overview

##### New system architecture with a central Control Unit

Electronically coordinated individual drives work together to perform your drive tasks. Higher-level controllers operate the drives to achieve the required coordinated movement. This requires cyclic data exchange between the controller and the drives. This exchange usually took place via a field bus, which required a great deal of time and effort for installation and configuration. SINAMICS S120 takes a different approach: A central Control Unit controls the drives for all connected axes and also establishes the technological links between the drives and/or axes. Since all the required data is stored in the central Control Unit, it does not need to be transferred. Inter-axis connections can be established within a Control Unit and easily configured in the STARTER commissioning tool using a mouse.

- Simple technological tasks can be carried out automatically by the SINAMICS S120 Control Unit
- The **CU310 DP** or **CU310 PN** Control Unit are available for single drives
- The **CU320** Control Unit is designed for multi-axis applications
- Sophisticated motion control tasks can be implemented with the support of the more powerful Control Units **D425**, **D435** and **D445** of **SIMOTION D** (graded according to performance)

Each of these Control Units is based on an object-oriented SINAMICS S120 standard firmware which contains all the most popular control modes and can be scaled to meet even the most advanced performance requirements.

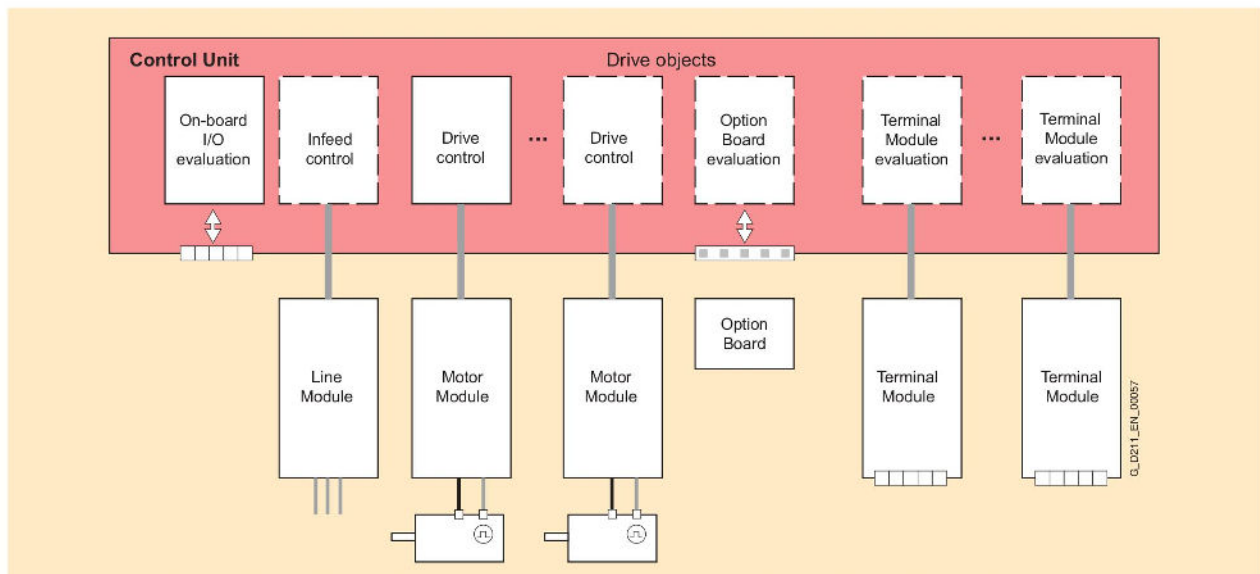
The drive controls are supplied as ready-to-configure drive objects:

- for the "Infeed Control",
- for the broad scope of rugged asynchronous (induction) motor applications "Vector Control" and *V/f* control
- for permanent-field synchronous motors with demanding dynamic requirements "Servo Control".

The most commonly used *V/f* control modes are stored in the "Vector Control" drive object and are ideal for implementing even simple applications such as, for example, group drives with SIEMOSYN motors.

#### Drive objects

A drive object is a self-contained software function with its own parameters and, if necessary, its own fault messages and alarms.



#### Overview (continued)

#### Comprehensive package of open-loop and closed-loop control functions

A wide variety of standard functions such as setpoint input, data set changeover, controller optimization, kinetic buffering, etc. ensure a high degree of operational reliability and excellent flexibility of application.

#### Overview of key open-loop and closed-loop control functions:

|                       | Closed-loop control types S120   | Open-loop control types S120  | Main functions S120 for booksize/chassis  | Comment, note  |
|-----------------------|--|---|---|--|
| <b>Infeed Control</b> | <ul style="list-style-type: none"> <li>• Booksize                             <ul style="list-style-type: none"> <li>- Current control with/without mains sensor</li> <li>- <math>V_{DC}</math> control with/without mains sensor</li> </ul> </li> <li>• Chassis                             <ul style="list-style-type: none"> <li>- Current control with mains sensor</li> <li>- <math>V_{DC}</math> control with mains sensor</li> </ul> </li> </ul>  | <ul style="list-style-type: none"> <li>• Booksize                             <ul style="list-style-type: none"> <li>- Smart Line Modules can be selected</li> </ul> </li> <li>• Chassis                             <ul style="list-style-type: none"> <li>- Basic Line Modules can be selected</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Mains identification</li> <li>• Controller optimization</li> <li>• Harmonics filter</li> <li>• Automatic restart</li> </ul>  | The mains sensor is the VSM 10 Voltage Sensing Module; "current" is the line current; 3-phase with line frequency  |
| <b>Vector Control</b> | <ul style="list-style-type: none"> <li>• Asynchronous motor                             <ul style="list-style-type: none"> <li>- Torque control with/without encoder</li> <li>- Speed control with/without encoder</li> </ul> </li> <li>• Torque motor                             <ul style="list-style-type: none"> <li>- Torque control with encoder</li> <li>- Speed control with/without encoder</li> </ul> </li> <li>• For asynchronous and torque motors                             <ul style="list-style-type: none"> <li>- Position control with encoder</li> </ul> </li> </ul>      | <ul style="list-style-type: none"> <li>- Linear/parabolic characteristic</li> <li>- Fixed-frequency characteristic (textiles)</li> <li>- Independent voltage setpoint input</li> </ul>  | <ul style="list-style-type: none"> <li>• Data set changeover</li> <li>• Extended setpoint input</li> <li>• Motor identification</li> <li>• Current/speed controller optimization</li> <li>• Technology controller</li> <li>• Basic positioner</li> <li>• Automatic restart</li> <li>• Flying restart with/without encoder</li> <li>• Kinetic buffering</li> <li>• Synchronization</li> <li>• Droop</li> </ul> | Mixed operation with $V/f$ control modes is possible; it is for this reason that the $V/f$ control modes are stored only once in the "Vector Control" drive object<br><br>Position control can be selected as a function module from both Servo and Vector mode.<br><br>Synchronous motors (1FK and 1FT) and linear motors can be operated only in Servo mode. |
| <b>Servo control</b>  | <ul style="list-style-type: none"> <li>• Asynchronous motor                             <ul style="list-style-type: none"> <li>- Torque control with encoder</li> <li>- Speed control with/without encoder</li> </ul> </li> <li>• Synchronous motor, linear motor and torque motor                             <ul style="list-style-type: none"> <li>- Torque control with encoder</li> <li>- Speed control with encoder</li> </ul> </li> <li>• For all motor types                             <ul style="list-style-type: none"> <li>- Position control with encoder</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>- Linear/parabolic characteristic</li> <li>- Fixed-frequency characteristic (textiles)</li> <li>- Independent voltage setpoint input</li> </ul>  | <ul style="list-style-type: none"> <li>• Data set changeover</li> <li>• Setpoint input</li> <li>• Motor identification</li> <li>• Damping application</li> <li>• Technology controller</li> <li>• Basic positioner</li> </ul>   | Mixed operation with $V/f$ control modes is possible; it is for this reason that the $V/f$ control modes are stored only once in the "Vector Control" drive object<br><br>Position control can be selected as a function module from both Servo and Vector mode.   |

#### Technology packages

SIMOTION D Control Units support the coordinated motion control of multiple drives. In addition to drive objects, these Control Units also offer technology objects such as, for example, "cam controller", "synchronism", "cam disk" and "temperature control", and these objects are grouped to form technology packages. Users can create their own objects and set up links between all configured objects.

# SINAMICS S120

## Control Units

### Control Units

#### Overview (continued)

##### **BICO technology**

Every drive object contains a large number of input and output variables which can be freely and independently interconnected using Binector Connector Technology (BICO). A binector is a logic signal which can assume the value 0 or 1. A connector is a numerical value, e.g. the actual speed or current setpoint.

##### **Function modules**

The "basic positioner" is used for the absolute/relative positioning of linear and rotary axes (modulo) with motor encoders (indirect measuring system) or machine encoders (direct measuring system). The "technology controller" is designed as a PID controller. It is suitable for implementing controls for regulating variables such as fill level, temperature, tension, pressure, flow rate and dancer position.

##### **Integrated safety functions**

The Control Units support safety functions such as "Safe standstill" (STO = Safe Torque Off)

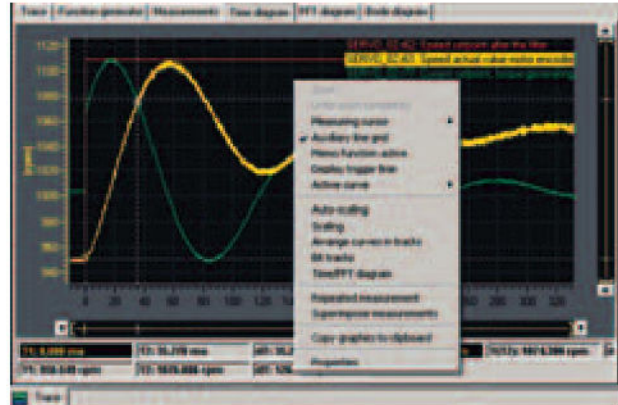
##### **CompactFlash card**

The functions of the SINAMICS S120 drives are stored on a CompactFlash card. This card contains the firmware and parameter settings for all drives in the form of a project. The CompactFlash card can also hold additional projects, which means that the correct project can be accessed immediately when series machines of different types are commissioned. When the Control Unit has booted, the data on the CompactFlash card are read and loaded to the RAM.

The firmware is organized in objects. Drive objects are used to implement open-loop and closed-loop control functions for Line Modules, Motor Modules, Power Modules and other system components connected by DRIVE-CLiQ.

##### **Diagnostics optimally supported by trace function**

The time characteristics of input and output variables associated with drive objects can be measured by the integrated trace function and displayed using the STARTER commissioning tool. The trace can record up to 4 signals simultaneously. A recording can be triggered as a function of freely selectable boundary conditions, e.g. the value of an input or output variable.



### Overview



The CU310 DP Control Unit provides the communications and openloop/closed-loop control functions for a Power Module. The CU310 DP combined with a Power Module and CompactFlash card creates a powerful single axis AC drive with a PROFIBUS interface to a higher-level control.

### Design

CU310 DP Control Units feature the following interfaces as standard:

- 1 DRIVE-CLiQ socket for communication with other DRIVE-CLiQ devices, e.g. Sensor or Terminal Modules
- 1 PM-IF interface for communication with Power Modules in blocksize format
- 1 interface to the BOP20 Basic Operator Panel
- 1 PROFIBUS interface with PROFIdrive V4 profile
- 1 HTL/TTL encoder evaluation circuit
- 4 parameterizable digital inputs (floating)
- 4 parameterizable bidirectional digital inputs/digital outputs (non-floating)
- 1 serial RS232 interface
- 1 slot for the CompactFlash Card on which firmware and parameters are stored
- 3 test sockets and one reference ground for commissioning support
- 1 connection for the electronics power supply via the 24 V DC power supply connector
- 1 PE (protective earth) connection

The status of the CU310 DP Control Unit is indicated via multi-color LEDs.

A BOP20 Basic Operator Panel can also be snapped directly onto the CU310 DP Control Unit for diagnostic purposes.

As the firmware and parameter settings are stored on a plug-in CompactFlash card, the Control Unit can be changed without the need for software tools.

### Selection and ordering data

| Description   | Order No.                 |
|---|---------------------------|
| <b>CU310 DP Control Unit</b><br>(without CompactFlash card) | <b>6SL3040-0LA00-0AA0</b> |

### Accessories

| Description                                    | Order No.                 |
|--|---------------------------|
| PROFIBUS connector<br>without PG/PC connection | <b>6ES7972-0BA41-0XA0</b> |
| PROFIBUS connector<br>with PG/PC connection    | <b>6ES7972-0BB41-0XA0</b> |
| STARTER commissioning tool                     | <b>6SL3072-0AA00-0AG0</b> |

### Integration

The CU310 DP Control Unit drives Power Modules in blocksize format via the PM-IF interface. In this case, other DRIVE-CLiQ components such as Sensor or Terminal Modules, can be connected to the DRIVE-CLiQ socket on the CU310 DP Control Unit.

Power Modules in chassis format are driven by the CU310 DP Control Unit via the DRIVE-CLiQ interface. With this option, Sensor and Terminal Modules must be connected to the free DRIVE-CLiQ sockets on the Power Module.

Parameter settings can be changed with the BOP20 Basic Operator Panel. The BOP20 panel can also be snapped onto the CU310 DP Control Unit during operation to perform troubleshooting procedures.

The CU310 DP Control Unit and other connected components are commissioned and diagnosed with the STARTER commissioning tool.

A CU310 DP Control Unit communicates with the higher-level control system using PROFIBUS and the PROFIdrive V4 profile.

The integrated safety functions such as e.g. "Safe Torque Off" (= "Safe standstill") must be selected in two channels. Two digital inputs on the CU310 DP Control Unit are required for this purpose.

An external 24 V supply can be connected to the CU310 to power the control unit when the incoming supply to the Power Module is not energized.

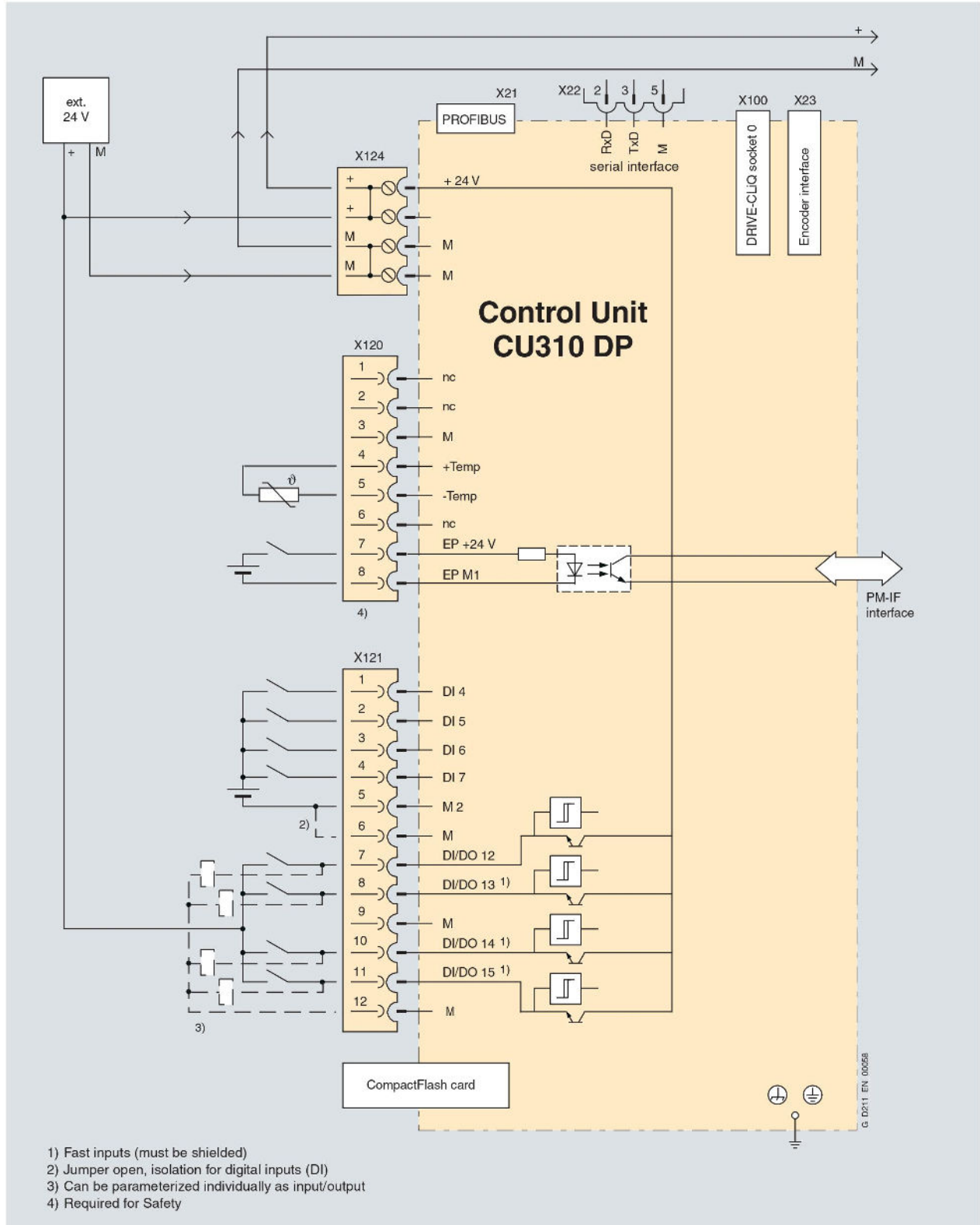
# SINAMICS S120

## Control Units

### CU310 DP Control Unit

#### Integration (continued)

2



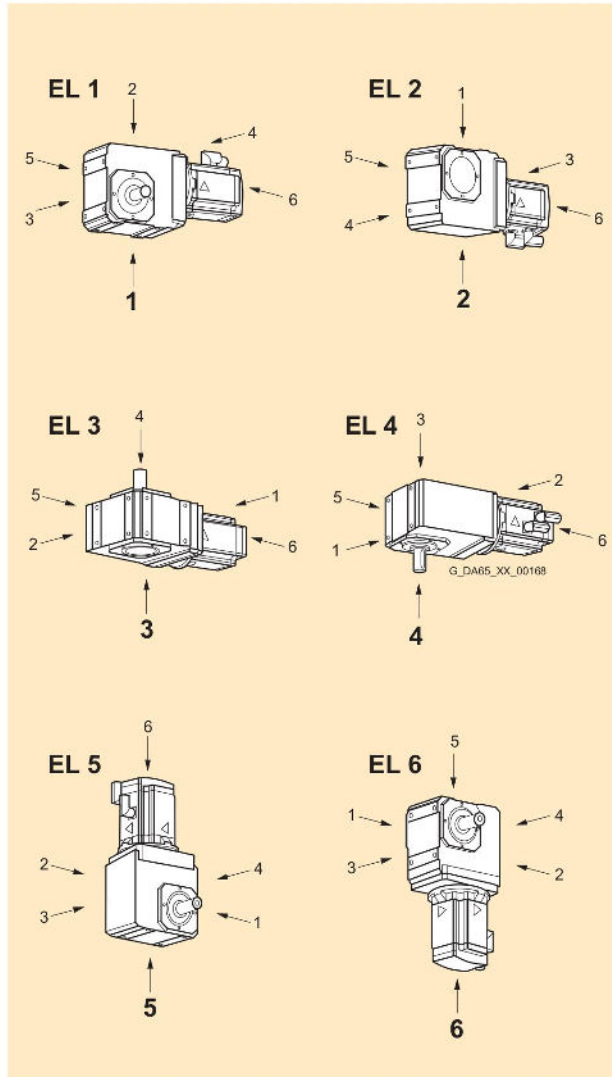
Connection example of CU310 DP Control Unit



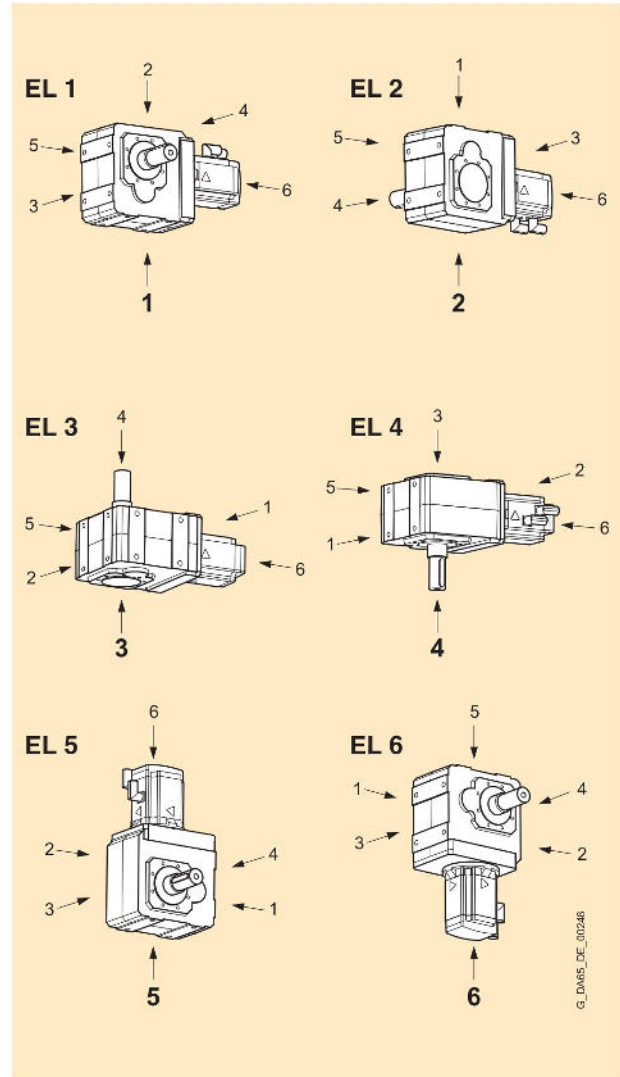
Selection and ordering data

Bevel geared motors - mounting positions EL 1 to EL 6

Gearbox sizes K1 to K4



Gearbox sizes K5 to K8



# AC motors

## Geared motors

### 1FK7 geared servomotors

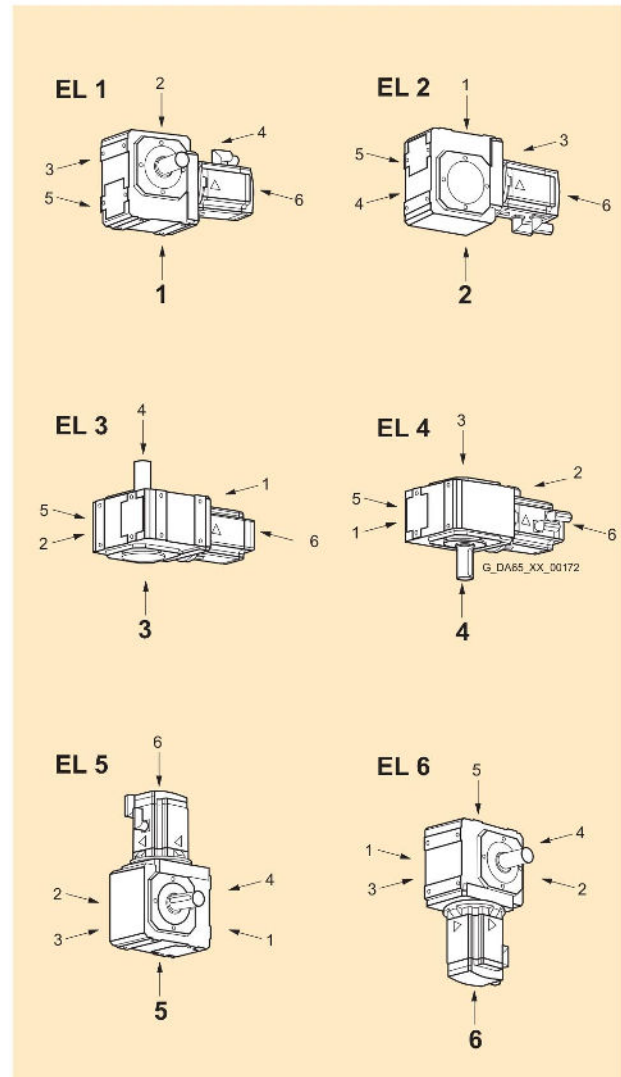
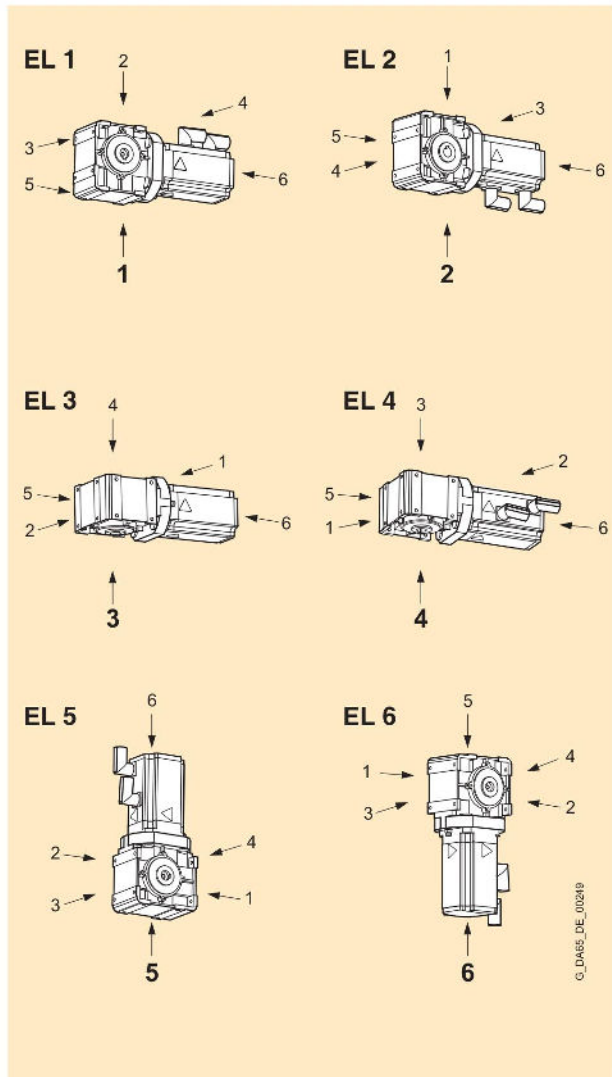
#### Selection and ordering data

##### Worm geared motors - mounting positions EL 1 to EL 6

Gearbox size S0

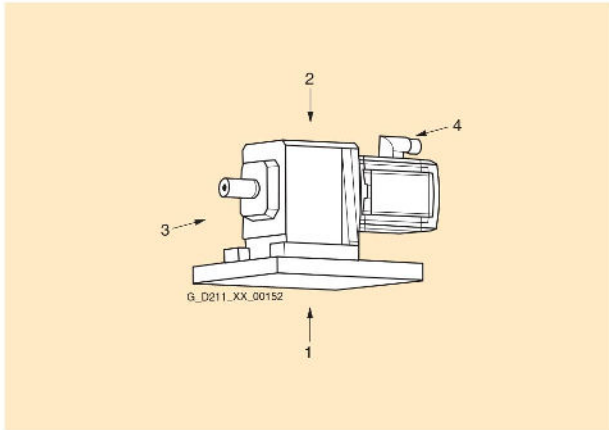
Gearbox sizes S1 to S4

3



Selection and ordering data

Connector mounting position



# AC motors

## Synchronous motors

1FS6 motors, explosion-protected  
Natural cooling



### Overview



1FS6 explosion-protected synchronous servomotors

1FS6 motors are permanent-magnet synchronous motors for use in Zone 1 hazardous areas.

They are designed in compliance with the EEx de IIC T3 type of protection, certified in accordance with ATEX guidelines 94/9/EG, and also have CSA approval for Class 1, Zone 1, Temperature Class T3 (CAN/CSA-79-1-95 "Flameproof enclosure").

In addition to compliance with the applicable standards and regulations (ATEX) for potentially explosive environments, these motors also conform to the following European guidelines:

- EN 50014  
General Conditions for Electrical Equipment for Potentially Explosive Atmospheres
- EN 50018  
Standard referring to EEx d type of protection
- EN 50019  
Standard referring to EEx e type of protection
- EN 50021  
Standard referring to Ex nA type of protection

1FS6 motors can be combined with the SINAMICS S120 drive system to create a powerful, high-performance system. The integrated encoder systems for speed and position control can be selected.

The motors are designed for operation without external cooling as the heat is dissipated through the motor surface.

### Benefits

- Winding insulation for Thermal Class H
- High cantilever force loading
- Naturally cooled motors with terminal box for power connection
- Additional terminal box for connection of encoder system and temperature sensors
- Monitoring of motor temperature with KTY 84-130 and PTC thermistor (triggering device must be certified according to test mark PTB 3x PTC-01 ATEX 3218, e.g. SIMIREL 3RN10 thermistor-motor protection)

### Applications

1FS6 motors with explosion protection are suitable for operation in Zone 1 hazardous areas in any industrial sector or machine type, including,

- Flexographic printing and platen-printing machines
- Filling plants with potentially explosive vapors
- Film coating plants

# AC motors Synchronous motors

1FS6 motors, explosion-protected  
Natural cooling



## Technical data

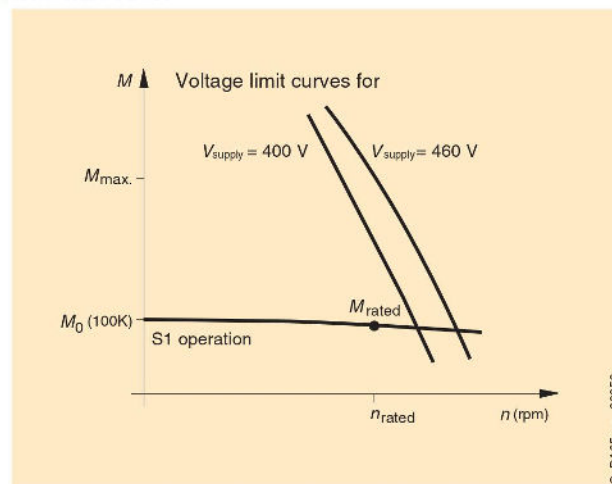
|  |  |
|--|--|
| Type of motor  | AC servomotor (permanent-magnet synchronous motor)   |
| Magnet material  | Rare-earth magnet material   |
| Insulation of the stator winding in accordance with EN 60034-1 (IEC 60034-1)                         | Thermal Class H for a winding temperature rise of $\Delta T = 100$ K at an ambient temperature of $40$ °C ( $+104$ °F).  |
| Type in accordance with EN 60034-7 (IEC 60034-7)   | IM B5 (1FS6074 and 1FS6096)<br>IM B35 (1FS6115 and 1FS6134)  |
| Degree of protection in accordance with EN 60034-5 (IEC 60034-5)                                     | IP64   |
| Cooling  | Natural cooling  |
| Temperature monitoring   | 3 PTC thermistors + KTY 84 temperature sensor in stator winding  |
| Paint finish   | Anthracite RAL 7016  |
| Shaft end on the drive end in accordance with DIN 748-3 (IEC 60072-1)                                | Plain shaft  |
| Radial eccentricity, concentricity and axial eccentricity in accordance with DIN 42955 (IEC 60072-1) | Tolerance N (normal)   |
| Vibration severity in accordance with EN 60034-14 (IEC 60034-14)                                     | Grade N (normal)   |
| Bearings   | Permanently lubricated deep-groove ball bearings   |
| Built-in encoder systems   | <ul style="list-style-type: none"> <li>• Incremental encoder sin/cos <math>1 V_{pp}</math> 2048 S/R</li> <li>• Absolute encoder EnDat 2048 S/R <sup>1)</sup></li> </ul>  |
| Connection   | 2 terminal boxes   |
| Options  | <ul style="list-style-type: none"> <li>• Shaft extension with fitted key and keyway (half-key balancing)</li> <li>• Rotational accuracy, concentricity and axial eccentricity Tolerance R</li> <li>• IP65 degree of protection with radial shaft seal</li> </ul> |

## Notice

A PTC thermistor triggering device, such as SIMIREL 3RN10 thermistor motor protection, is mandatory for operating these machines in potentially explosive environments. The connection cables must be able to withstand temperatures of at least  $+100$  °C ( $+212$  °F).

The motors can be connected to SINAMICS S120 converters only by way of a terminal box. It is not permissible to use connector plugs in Zone 1 areas. Encoders must be connected by means of an SMC20 Sensor Module Cabinet-Mounted.

## Characteristics



Speed-torque characteristic

3

<sup>1)</sup> If the absolute encoder is used,  $M_{rated}$  is reduced by 10%.

# AC motors

## Synchronous motors

1FS6 motors, explosion-protected  
Natural cooling



### Selection and ordering data

| Rated speed | Shaft height | Rated power                     | Rated torque <sup>1)</sup>      | Rated current                   | Static torque             | 1FS6 synchronous motors<br>Explosion-proof<br>Natural cooling | Number of pole pairs | Rotor moment of inertia (without brake)                          | Weight (without brake) |
|-------------|--------------|---------------------------------|---------------------------------|---------------------------------|---------------------------|---|----------------------|--|------------------------|
| $n_{rated}$ |              | $P_{rated}$ at $\Delta T=100$ K | $M_{rated}$ at $\Delta T=100$ K | $I_{rated}$ at $\Delta T=100$ K | $M_0$ at $\Delta T=100$ K | Order No.<br>Core type  |                      | $J$  |                        |
| rpm         | SH           | kW/HP                           | Nm/lb <sub>f</sub> -ft          | A                               | Nm/lb <sub>f</sub> -ft    |   |                      | $10^{-4}$ kgm <sup>2</sup> /<br>lb <sub>f</sub> -in <sup>2</sup> | kg/lb                  |
| 1500        | 112          | 5.8/7.8                         | 37/27.3                         | 13                              | 40/29.5                   | 1FS6115-8AB73 - ■■■■  | 4                    | 168/0.1487   | 87/191.84              |
|             | 132          | 10.7/14.4                       | 68/50.1                         | 22                              | 76/56                     | 1FS6134-6AB73 - ■■■■  | 3                    | 547/0.4841   | 149/328.55             |
| 2000        | 71           | 1.5/2.0                         | 7.2/5.3                         | 3.4                             | 7.6/5.6                   | 1FS6074-6AC71 - ■■■■  | 3                    | 13/0.0115  | 29/63.95               |
|             | 90           | 4.2/5.6                         | 20/14.7                         | 9.8                             | 22/16.2                   | 1FS6096-8AC71 - ■■■■  | 4                    | 66.5/0.0589  | 55/121.28              |
|             | 112          | 7.1/9.5                         | 34/25.1                         | 16                              | 40/29.5                   | 1FS6115-8AC73 - ■■■■  | 4                    | 168/0.1487   | 87/191.84              |
|             | 132          | 12.4/16.6                       | 59/43.5                         | 24                              | 76/56                     | 1FS6134-6AC73 - ■■■■  | 3                    | 547/0.4841   | 149/328.55             |
| 3000        | 71           | 2/2.7                           | 6.3/4.6                         | 4.4                             | 7.6/5.6                   | 1FS6074-6AF71 - ■■■■  | 3                    | 13/0.0115  | 29/63.95               |
|             | 90           | 5.3/7.1                         | 17/12.5                         | 12                              | 22/16.2                   | 1FS6096-8AF71 - ■■■■  | 4                    | 66.5/0.0589  | 55/121.28              |
|             | 112          | 8.8/11.8                        | 28/20.6                         | 20                              | 40/29.5                   | 1FS6115-8AF73 - ■■■■  | 4                    | 168/0.1487   | 87/191.84              |
| 4500        | 71           | 2.1/2.8                         | 4.5/3.3                         | 5                               | 7.6/5.6                   | 1FS6074-6AH71 - ■■■■  | 3                    | 13/0.0115  | 29/63.95               |
|             | 90           | 5.2/7.0                         | 11/8.1                          | 11.5                            | 22/16.2                   | 1FS6096-8AH71 - ■■■■  | 4                    | 66.5/0.0589  | 55/121.28              |
| 6000        | 71           | 1.2/1.6                         | 1.9/1.4                         | 3.2                             | 7.6/5.6                   | 1FS6074-6AK71 - ■■■■  | 3                    | 13/0.0115  | 29/63.95               |

|   |   |                  |
|---|---|------------------|
| <b>Type:</b>  | IM B5 (only for 1FS607 and 1FS609)<br>IM B35 (only for 1FS611 and 1FS613)   | 1<br>3           |
| <b>Terminal box for power and encoder connection:</b>   | Cable entry transverse right<br>Cable entry transverse left<br>Cable entry axial NDE<br>Cable entry axial DE            | 5<br>6<br>7<br>8 |
| <b>Encoder system without DRIVE-CLiQ interface:</b>   | Incremental encoder sin/cos 1 V <sub>pp</sub> 2048 pulses/rev.<br>Absolute encoder EnDat 2048 pulses/rev. <sup>1)</sup> | A<br>E           |
| <b>Shaft extension:</b><br>Plain shaft<br>with fitted key and keyway<br>Plain shaft<br>with fitted key and keyway | <b>Radial eccentricity tolerance:</b><br>N<br>N<br>R<br>R   | G<br>A<br>K<br>D |
| <b>Vibration severity grade:</b><br>N<br>N  | <b>Degree of protection:</b><br>IP64<br>IP65 with radial shaft seal   | 0<br>1           |

3

# AC motors Synchronous motors

1FS6 motors, explosion-protected  
Natural cooling



3

## Selection and ordering data

| Motor type<br>(continued) | Static current<br><br>$I_0$<br>at<br>$\Delta T=100\text{ K}$<br><br>A | SINAMICS Motor Module                            |   | Power cable with complete shield               |   |
|---------------------------|---|--|---|--|---|
|                           |   | Rated current<br><br>$I_{\text{rated}}$<br><br>A | Order No.<br>For complete Order No.,<br>see "SINAMICS S120" | Motor connection<br>via terminal box           | Motor connection<br>via terminal box                                    |
|                           |   |  |   | Cable cross<br>section,<br>Motor <sup>2)</sup> | Order no.<br>Pre-assembled cable<br>No connector,<br>prepared wire ends |
|                           |   |  |   | mm <sup>2</sup>                                |   |
| 1FS6115-8AB73-....        | 13  | 18   | <b>6SL312</b> - <b>TE21-8 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6134-6AB73-....        | 22  | 30   | <b>6SL312</b> - <b>1TE23-0 AA</b> .                         | 4 x 4  | <b>6FX5002-5XA20-....</b>   |
| 1FS6074-6AC71-....        | 3.4   | 5  | <b>6SL312</b> - <b>TE15-0 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6096-8AC71-....        | 9.2   | 18   | <b>6SL312</b> - <b>TE21-8 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6115-8AC73-....        | 18  | 18   | <b>6SL312</b> - <b>TE21-8 AA</b> .                          | 4 x 2.5  | <b>6FX5002-5XA10-....</b>   |
| 1FS6134-6AC73-....        | 29  | 30   | <b>6SL312</b> - <b>1TE23-0 AA</b> .                         | 4 x 4  | <b>6FX5002-5XA20-....</b>   |
| 1FS6074-6AF71-....        | 4.8   | 5  | <b>6SL312</b> - <b>TE15-0 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6096-8AF71-....        | 14  | 18   | <b>6SL312</b> - <b>TE21-8 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6115-8AF73-....        | 26  | 30   | <b>6SL312</b> - <b>1TE23-0 AA</b> .                         | 4 x 4  | <b>6FX5002-5XA20-....</b>   |
| 1FS6074-6AH71-....        | 7.2   | 5  | <b>6SL312</b> - <b>TE15-0 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6096-8AH71-....        | 19  | 18   | <b>6SL312</b> - <b>TE21-8 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |
| 1FS6074-6AK71-....        | 9.6   | 5  | <b>6SL312</b> - <b>TE15-0 AA</b> .                          | 4 x 1.5  | <b>6FX5002-5XA00-....</b>   |

### Cooling:

Internal air cooling  
External air cooling

0  
1

### Motor Module:

Single Motor Module  
Double Motor Module

1  
2

For length code as well as power and signal cables, see "MOTION-CONNECT cables and connections".

## Ordering data for signal cables

| Pre-assembled signal cable<br>with complete shield              | Order No.                 |
|---|---------------------------|
| • Incremental encoder sin/cos 1 V <sub>pp</sub>                 | <b>6FX5002-2XA00-....</b> |
| • EnDat absolute encoder  | <b>6FX5002-2XQ10-....</b> |
| • PTC thermistor (for connection to<br>3RN10 triggering device) | <b>6FX5002-1XA04-....</b> |

1) If the absolute encoder is used,  $M_{\text{rated}}$  is reduced by 10%.

2) The current carrying capacity of the power cables corresponds to IEC 60204-1 for type of routing C under continuous operating conditions with an ambient air temperature of +40 °C (+104 °F), designed for  $I_{\text{rated}}$  (100 K), PVC/PUR-insulated cable.

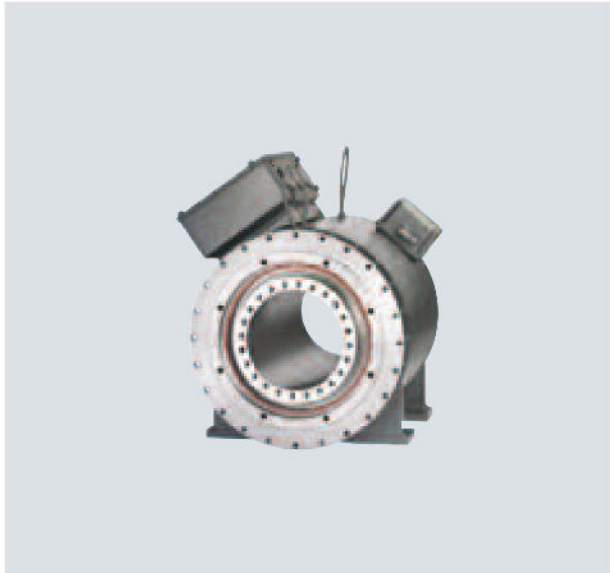
# AC motors

## Synchronous motors

### 1FW3 torque motors

#### Water cooling

#### Overview



1FW3 torque motors

1FW3 torque motors are liquid-cooled, high-pole (slow running) permanent-magnet synchronous motors with hollow-shaft rotor. The operating characteristics are similar to those of regular synchronous motors.

1FW3 torque motors are supplied as fully assembled units. The range includes 3 outer diameters with various shaft lengths. The stator and the rotor in shaft heights 150 and 200 have a flange with centering surfaces and tapped holes per construction type IM B14 at the drive end (A end) allowing them to be integrated into the customer's machine. In shaft height 280, the flange is designed with centering surfaces and through-holes per construction type IM B35.

1FW3 torque motors can be combined with the SINAMICS S120 drive system to create a powerful, high-performance system. The integrated encoder systems for speed and position control can be selected.

#### Benefits

- High torque for a compact design and small size
- High overload capability
- No elasticity in the drive train
- No torsional backlash
- High availability, since there are no mechanical transmission elements subject to wear in the drive train
- Low moment of inertia
- Direct coupling to the machine using flanges
- Hollow-shaft rotor design allows for flexible installation concepts
- Energy savings through reduction in mechanical losses

#### Applications

The 1FW3 series was developed as a direct drive. This is a compact drive unit where the mechanical motor power is transferred directly to the driven machine without any mechanical transmission elements.

- Extruder main drives
- Worm drives for injection molding machines
- Pull-roll drives for foil-stretching machines
- Stretch and calender rollers, continuous casting and rolling, chill roller stands
- Dynamic positioning tasks, e.g. rotary tables, cyclic conveyor belts
- Substitute for hydraulic motors
- Roller drives in paper machines
- Cross-cutter drives for continuous material webs, e.g. paper, textiles, sheet metal, etc.
- Wire-drawing machines
- Choppers





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