SIEMENS

Equipment for Machine Tools
WS 620, WF 625
Single-Axis Controls

Description Edition 07.87

Equipment for Machine Tools

WS 620, WF625
Single-Axis Controls

Description

Edition July 1987

This publication was produced on the Siemens 5800 Office System.
Subject to change without prior notice.

Contents

1 WS 600 overview

WS 600 microprocessor control system: Economical–simple–flexible.

For transfer lines or special multiple-access machines, auxiliary motions on milling and turning machines, for drilling and boring machines, woodworking machinery or loading equipment:
Our WS 600 microprocessor control system offers a simple an economical solution wherever fast and highly accurate positioning and programmable machining speeds are required.

Economical, because short set-up times increase the availability of the machine and reduce production costs. This also makes small batch production more cost-effective.
Simple, because complete traversing programs can be entered.
Flexible, because these traversing programs can be repeated as often as desired.

With the WS 600, you have the choice of module or compact version.

The module version: WF 615, WF 625, WF 626, WF 635, WF 655
The individual positioning modules work independently, because the complete program is stored on each module, and each module has its own position control processor. In connection with the SIMATIC S5 (bus-coupling), the operation programs are stored as data blocks for transmission to the individual axes on demand. This considerably extends the individual program memories of the axes.

Compact versions to supplement and extend the product spectrum: WS 610, WS 620, WS 630
All versions of the WS series are single-axis controls. They are self-contained units equipped with operator panels.

The right system for every application, with the choice of module or compact version

WF 625, WF 626 or WS 620
Wherever fast and highly accurate positioning is required: for transfer lines, multiple-axis special machines, auxiliary movements on lathes, milling and drilling machines, loading equipment and robots.

WF 625 or WS 630
Wherever clocked, fast and highly accurate material supply is necessary:
For roller feeds, conveyor feeders to presses and stamping machines.

WF 615 or WS 610
Wherever digital encoders are used for absolute position measurement (rotational or linear movement):
For drum control on presses and stamping machines.

WF 655
Wherever positioning is to be carried out with simple control elements:
Tool axes on machine tools and woodworking machinery.

WF 683
Wherever large quantities of data have to be rapidly input or output:
Operating programs for WF 625, measured values for evaluation in a central computer.
Documentation of limit values.

1.1 Characteristics of WF 625 and WS 620

Construction
- WF 625 integrated in S5-130 W/ 150 K (up to 16 axes) and external operator panel
- WS 620 single-axis control with integrated operator panel

Technical information
- Position control with incremental position encoders
- Input/output resolution 0.001 mm
- Traversing range ± 9999.999 mm
- Traversing speeds from 1 mm/min
- Acceleration and deceleration values separately settable
- Speed gain (K_V-factor) settable
- Standstill supervision
- Following error supervision
- Reversing error supervision
- Actual value register preset
- Reference point approach
- Monitoring routines continuously active
- Data input/output through RS 232 C port (through WF 683 interface module)

Programming (with WS 600 G operator panel)
- Program memory for a maximum of 7 programs, with a total 56 program blocks per axis
- Absolute and incremental programming
- Decimal point programming
- Teach-in
- Program editing at the keyboard directly into memory
- Tool length offset
- Dwell time
- M and S functions (three decades of BCD each)

Operation
- Operator prompted data input
- Possible modes of operation:
  - Reference point approach
  - Set-up
  - Actual value register preset
  - Manual data input
  - Program input (manual)
  - Single block mode
  - Automatic mode
  - Machine data input
  - Controlled mode
  - Follow-up mode

Display (with 600 G)
- Block number
- Position setpoint
- Dwell time
- Auxiliary function
- Traversing speed
- Position actual value
- Following error
- Machine data
- Alarm numbers
- Actual function key

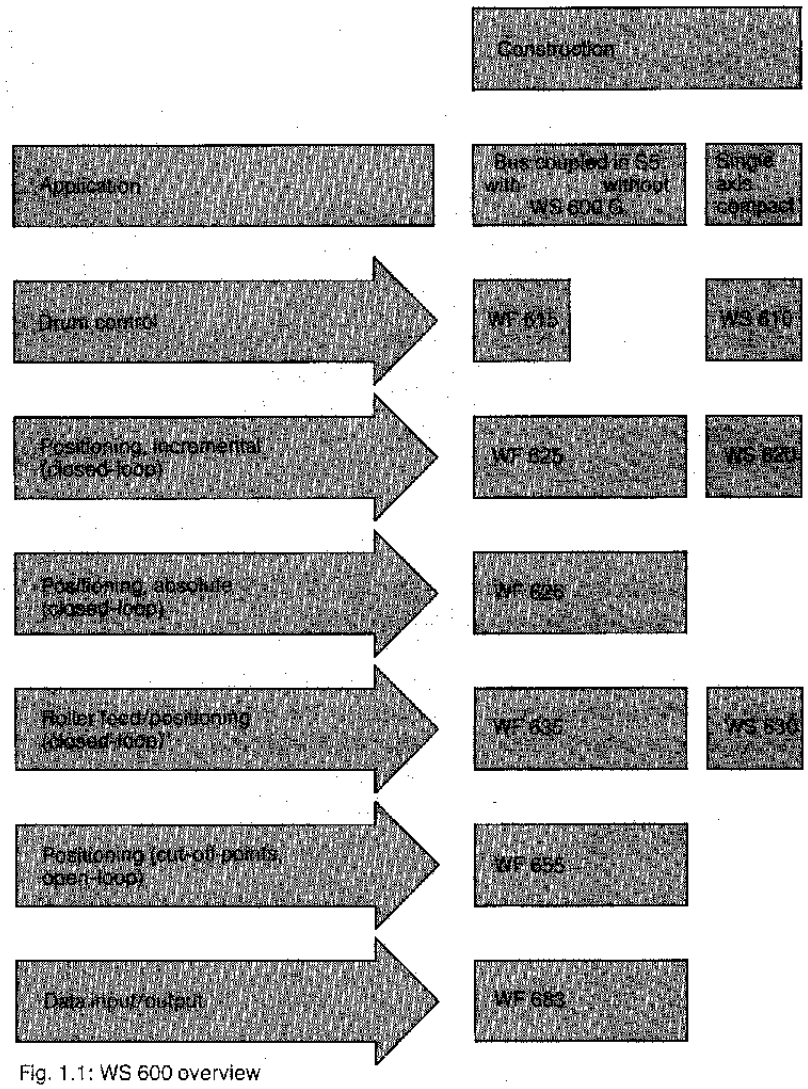


Fig. 1.1: WS 600 overview

2 Design variants

2.1 WF 625 integrated in SIMATIC S5-130 W/150 K/150 S

2.1.1 Introduction

The WF 625 positioning module (Fig. 2.1) makes it possible for the SIMATIC S5-150 and S5-130 W to carry out closed-loop positioning duties.

The WF 625 module is suitable for all positioning tasks requiring higher speed and accuracy. One programmable controller can be used for positioning up to 16 axes.

The individual WF 625 modules can be activated simultaneously or sequentially, because each has its own processor.

The user program and all the associated geometric and process data are stored in the memory of the PC.

2.1.2 Used without the WS 600 G operator panel

Hardware structure

The WF 625 module is inserted in the SIMATIC S5-130 W/150 K/150 S central unit in the same way as a peripheral module. Data exchange (machine data, setpoints) is carried out over the S5 bus (Fig. 2.2). The module is addressed by the periphery byte (PB 128 – PB 255). Plug connectors for setpoints and actual values together with pins for the 24 V DC power supply and binary signals are situated on the front of the WF 625 module (Fig. 2.1).

Software structure

Data traffic between the SIMATIC S5 and the WF 625 is organized by the function block FB "DATANWF".

The data are transferred to the WF 625 via a data block for variables (DBV), which must be situated in the RAM. The basic adjustments (e.g. machine data) are filed in the data block for constants (DK), which can be situated in the EPROM range. Upon restarting, the DBK is copied into the DBV (Fig. 2.3).

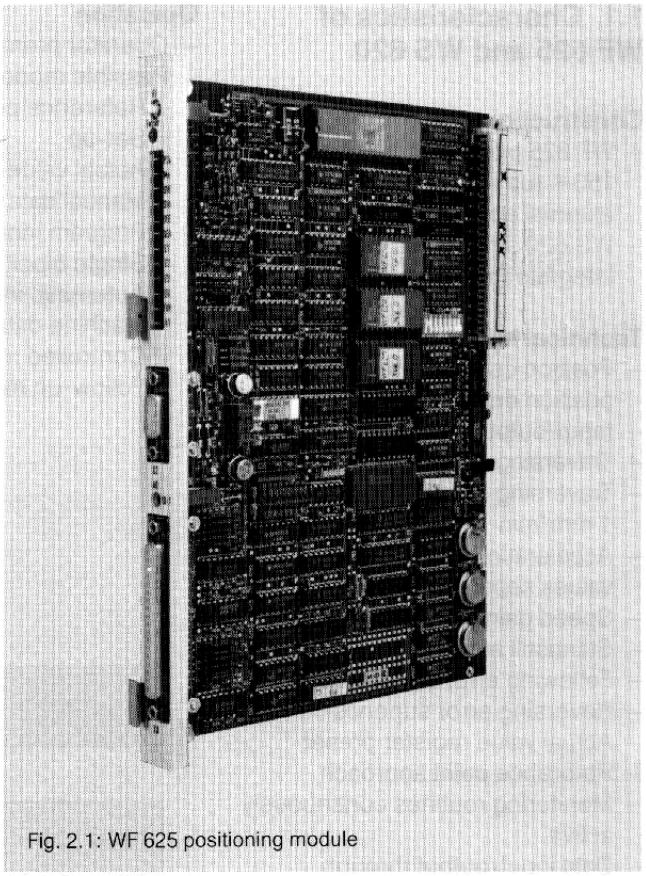


Fig. 2.1: WF 625 positioning module

Variable data (e.g. position setpoints) are transferred from the user program to the DBV and passed on to the WF 625 by setting a flag (Fig. 2.4).

Operating modes and commands for the WF 625 are likewise output from the user program by means of flags. This program also supplies the FB "DATANWF" with parameters on demand.

Checkback signals from the FB "DATANWF" are flagged, data for read-out (e.g. position actual value) are filed in the DBV.

2.1.3 Used with the WS 600 G operator panel

Hardware structure

The WS 600 G external operator panel with keyboard and display is used for data input, editing and display (see Fig. 2.5).

The operator panel is a mini expansion unit and is linked to the SIMATIC S5 in the same way as a local expansion unit. An I/O module can be inserted in the free plug-in location.

If there is a need to archive traversing programs for use at a later date, this can be carried out through an RS 232 C interface. Magnetic tape cassettes or paper tape can be used as data medium (Figs. 2.2 and 2.5).

Software structure

Data traffic between the WS 600 G operator panel, machine control panel and WF 625 positioning module is handled by the programmable controller with data blocks as buffer stores (Fig. 2.6).

The STEP® 5 software in the memory of the SIMATIC S5 PC (Fig. 2.7) consits of:

- Standard program for data traffic between the operator panel and the WF 625 modules
- PC application program

The STEP 5 standard program for data traffic between PC and WF 625 modules is subdivided into several function blocks:

- Keyboard interpretation and display

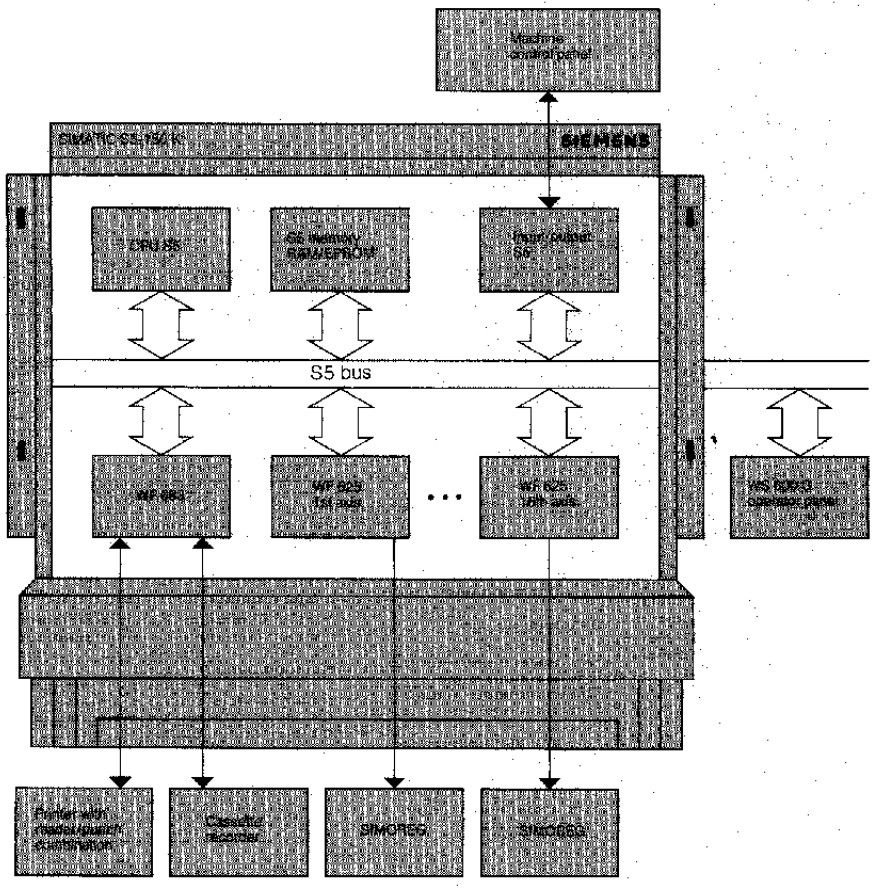


Fig. 2.2: SIMATIC S5-150 K (or 130 W) with components from the WS 600 system (structure)

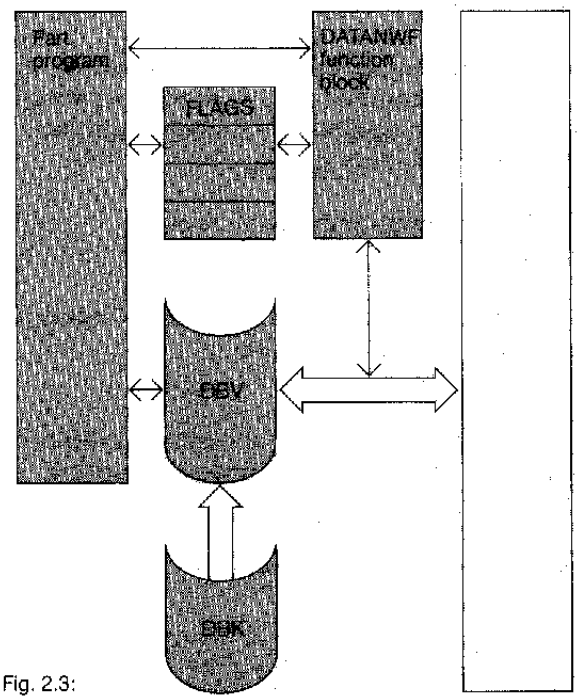


Fig. 2.3:
Interface between part program and "DATANWF" block package

- Storage of part programs and operation data in the RAM memory of the PC (data blocks 101 to 255; (Fig. 2.8).
- Transfer of the part programs and the operation data from the RAM of the PC to the RAM of the WF 625 module. By means of the application program involved, the operator can choose the time and assignment of the part programs for the individual axes. One axis can also be assigned several programs.

Must be supplied by user program	M 249,4 Beginning block of actual value	54	Actual value for beginning block	VZ	10^6	10^5	10^4	0 ... 9999999 µm
		55	Actual value setting	10^3	10^2	10^1	10^0	
	M 248,3 (3/1)	56	Path in increments (BCD)		10^6	10^5	10^4	0 ... 9999999 µm
		57	For beginning block incremental traversing	10^3	10^2	10^1	10^0	
	M 248,7 (3/1)	58	Path in increments (BCD)	VZ	10^6	10^5	10^4	0 ... 9999999 µm
		59	For beginning block, automatic	10^3	10^2	10^1	10^0	
	M 248,6 (3/1)	60	Path in increments (DUAL)	VZ				Processed for S5 0 ... 9999999 µm
		61	For automatic				2^3-2^0	
	M 248,2 (3/21)	62	M-word		10^2	10^1	10^0	0 ... 255
Actual position read-out	M 249,0 (3/26) M 249,2	63	Actual position (BCD)	VZ	10^6	10^5	10^4	
		64	in µm	10^3	10^2	10^1	10^0	
Following error	M 249,1 (3/26) M 249,2	65	Following error in increments				10^4	
		66	(BCD)	10^3	10^2	10^1	10^0	

Fig. 2.4: Part of the data block for variables (DBV)

– Transfer of machine data and reference point feed rates from the operator panel via DB 98, 99 to the selected WF 625.

– Distribution of control signals and evaluation of checkback signals.

The STEP 5 application program consists of:

- Program blocks, step blocks and function blocks for controlling the machine

- Blocks for the supply and evaluation of software interface data block 100
(Figs. 2.6 and 2.7).

Memory requirement S5-130 W/150 K see Fig. 2.10 (page 11).

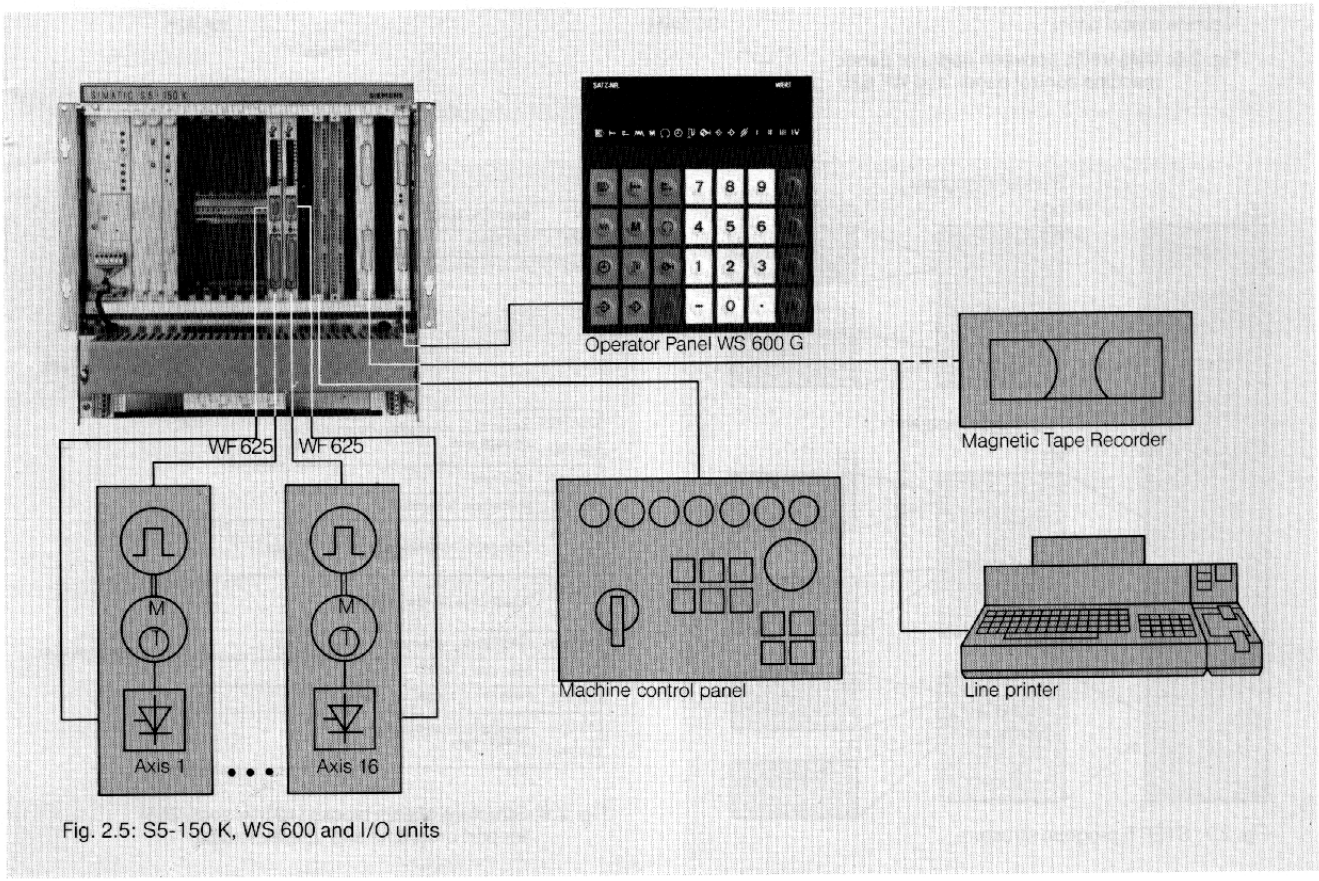


Fig. 2.5: S5-150 K, WS 600 and I/O units

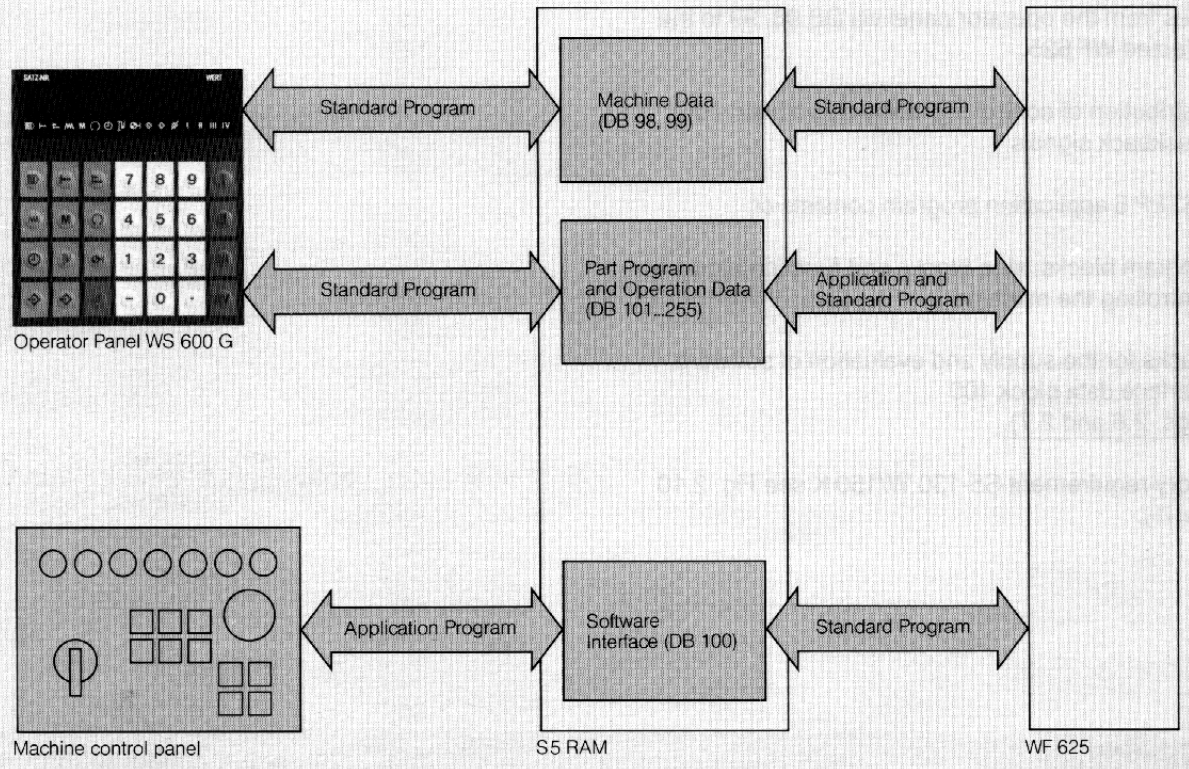


Fig. 2.6: Data traffic between operator panel, machine control panel, and WF 625

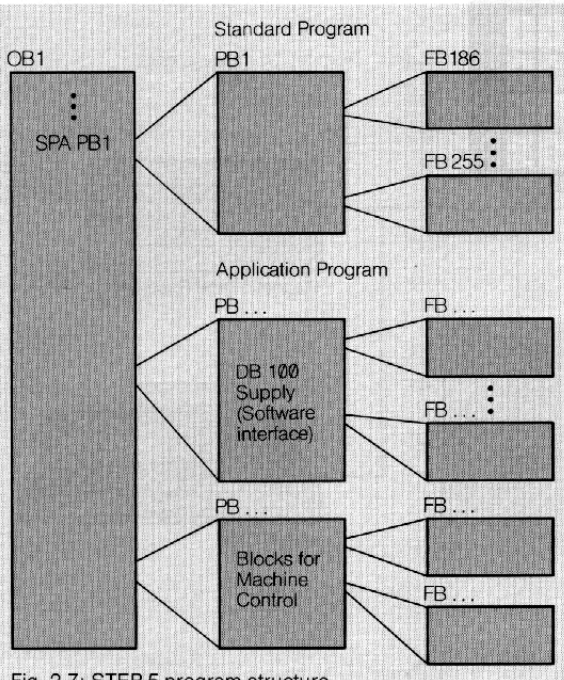


Fig. 2.7: STEP 5 program structure

DW 1	Beginning block	Program 1
DW 2	End block	
DW 3	Nr. of program cycles	
		Part Program (data word 1-245)
DW 242	Absolute or incremental dimension or dwell time	Block 63
DW 243		
DW 244	Feed rate	
DW 245	M-function, S-function	
DW 246 DW 247	Tool length compensation	
DW 248 DW 249	Actual value register preset	
DW 250	Feed rate for MDI mode	Operation data (data word 246-254)
DW 251	Feed rate 1, for set-up mode	
DW 252	Feed rate 2, for set-up mode	
DW 253 DW 254	Absolute and incremental dimension for MDI mode	

Fig. 2.8: Structure of data blocks (101 through 255) for part programs and operation data

DW 0	Standard software operating data	
DW 130		
DW 113	Maximum block No.	
DW 121	Data block No. for transfer from auto Pr.	
DW 129	Axis No. for transfer from auto Pr.	maximum axis No.
DW 131	Axis 1	
DW 132	Axis 2	
	Signals from S5 to WF 625	
DW 145	Axis 15	
DW 146	Axis 16	
DW 147	Operating mode	
DW 148	Selected axis for WS 600 G operator panel	
DW 151	Axis 1	
DW 152	Axis 2	
	Signals from WF 625 to S5	
DW 165	Axis 15	
DW 166	Axis 16	
DW 167	Initializing DB transfer	
DW 170	For start-up routines from standard software	
DW 171	Overstoring of	
DW 172	traversing speed	
DW 173	(feed compensation)	
DW 176	Machine data transfer	

Fig. 2.9: Data block 100

2.1.4 Used with several operator panels WS 600 G

Hardware structure

Up to four AS 310 can be connected at one 301 interface module. Depending on the SIMATIC PC concerned, a maximum of four (130 W, 150 K) or eight WS 600 G operator panels can be connected.

Software structure

The STEP 5 standard software is so designed that the axes are freely assignable to the operator panels. It is also possible to operate each axis in its own mode.

2.2 WS 620

The positioning module and the operator panel of the WS 620 single-axis control are both accommodated in a compact self-contained unit (Fig. 2.11). 24 V inputs and outputs are used for signal exchange with the machine control (Fig. 2.12).

Memory of the S5-130 W/150 K/150 S

Siemens standard program
Includes: 8 K of instructions, irrespective of the number of axes,
for storage either in RAM or EPROM.

Variable data (data blocks)
Requirements:
0.25 K for control signals
0.25 K for 56 program blocks (part programs)
The assignment of axes to data blocks for part programs in freely selectable.
These data must be stored in RAM.

Fig. 2.10: Memory requirements of the S5-130 W/150 K

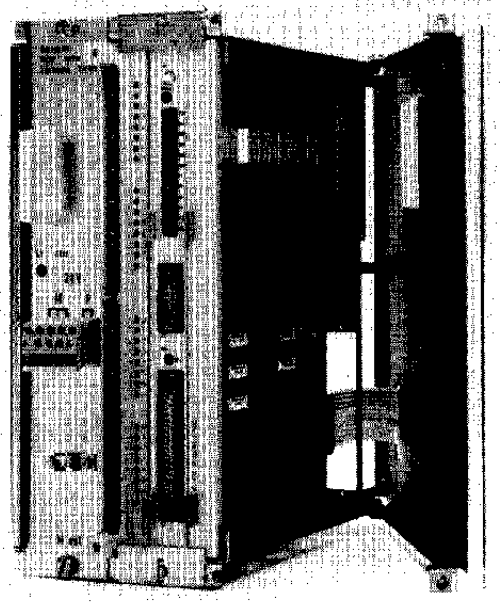


Fig. 2.11: WS 620 single-axis control

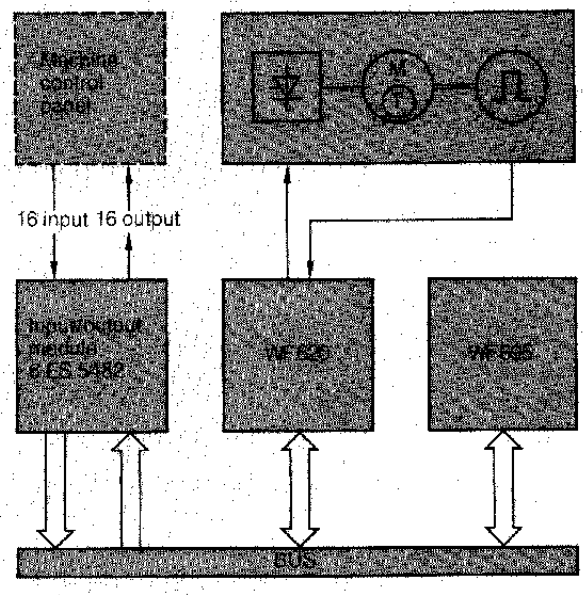


Fig. 2.12: WS 620 structure

3 Programming

3.1 Part program

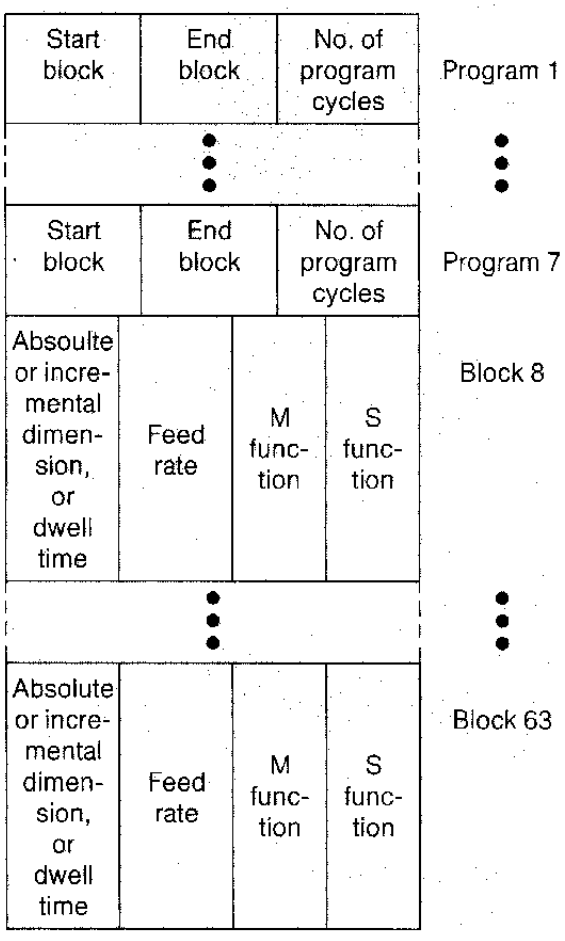
3.1.1 Program structure

The part program memory is subdivided into two blocks:

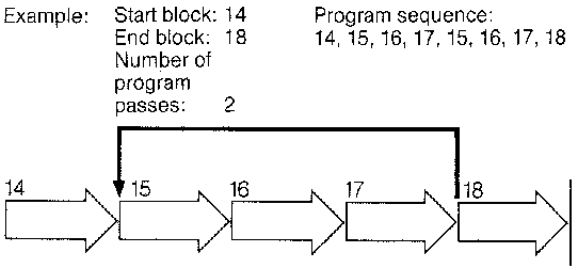
- Maximum of 7 program calls:
  - Start block No.
  - End block No.
  - Number of program cycles
- Maximum of 56 program blocks with fixed input sequence:
  - Absolute or incremental dimension or dwell time
  - Feed rate (does not apply to dwell time)
  - M function (3 BCD decades)
  - S function (3 BCD decades)

Note concerning automatic mode
A program consists of at least three blocks in the 8-63 range, the beginning and end blocks being processed only once (N8 and N11 in the example).

Program format



Example of program cycle



3.1.2 Program key

The **absolute dimension** is the distance of each point to the zero point of the coordinate system.

The **incremental dimension** is the path difference to the previous position.

Dwell time
The dwell time can be programmed for a predetermined feed drive standstill period (e.g. for cutting to free the tool). A dwell time is programmed in increments of 100 ms (maximum value 999.9 s) instead of a position.

M function, S function
Theses functions are programmed in two of three decades and output in two-decade BCD code (including strobe signal):

- WF 625: Output to software interface (data block 100)
- WS 620: Output to 24 V outputs.

Program key

Key	Function	Value ranges
N	Block selection	8...63
	Absolute dimension	± 9999999 µm*)
	Incremental dimension	± 9999999 µm*)
	Dwell time	1...9999 (x 0.1 s*)
	Feed rate	1...15000 mm/min*)
M	M function	0...199, 254, 255
	S function	0...199, 254, 255 (WF 625) 0...99, 255 (WS 620)

*) At 1 µm resolution

Input and output of M and S functions, Calculation of tool offset, Stop at block end:

Input	Output
M.., S..	M.., S.. functions
M1..	M.. Calculation of tool offset; the tool offset acts blockwise (like the M function)
S1..	S.., Stop at block end for WF 625 (irrespective of start signal)
M 254 S 254	No output of M function No output of S function for WF 625
M 255	No output of M function, but calculation of tool offset
S 255	No output of S function, but stop at block end for WF 625

Note: The tool offset is described in Chapter 3.2

3.1.3 Decimal point programming

Decimal point programming permits abbreviated input of:

- **Program data**
  - Absolute dimension
  - Incremental dimension
  - Feed rate
  - Actual value register preset
  - Tool length compensation
- **Machine data**
  - Acceleration
  - Deceleration
  - Max. feed rate
  - Max. following error
  - Backlash compensation
  - Standstill tolerance
  - Reference point coordinates

Decimal point programming skips the trailing zeros. Data, with or without decimal point, can be input at the operator panel at all times.

The stored data are always displayed without decimal point.

3.2 Compensation values

Overview of compensations

Compensation for	Designation	Description Page
Feed rate	Feed rate override	14
Tool	Tool offset	14
Tool fixture	Actual value register preset	18
Part program	Program edit	18
Measuring system	Machine reference point	18
Machine	Backlash compensation	14

Backlash compensation

The control can take into account a correction value of up to 65 mm in order to compensate for the mechanical reversing error of the feed screw with indirect position measurement.
This correction value is added to the command position each time the direction is reversed.

Tool offset

The tool offset value of ± 9999.999 mm allows the total tool length to be entered either as geometry value or wear value. Tool compensation is called up together with the M functions (see 3.1). Tool compensation takes effect block by block. In the program block in which the corresponding M function is programmed, the tool offset value is activated after power up in the single-block and automatic modes and is taken into account in the actual value display.

Feed rate override of the WF 625

The feed rate can be corrected by means of a switch on the machine control panel. The user can select the number of overrides and the numerical values. These are fixed by the STEP 5 application program. The selection value takes immediate effect even while a feed movement is in progress. This override can be used in the set-up, MDI, single-block and automatic modes.

Reference points

After power-up, the control has to be synchronized with the machine or workpiece to retain the starting point laid down by the programmer (Fig. 3.1).
Reference to the machine zero point (M)
If the program is referenced to the machine's zero point (M) the control must first be synchronized by reference point (R) approach. The absolute distance from the reference point to the machine zero point (MR) is fixed for each machine. It is entered on start-up of the machine with machine datum No. 9. The control stores the values.

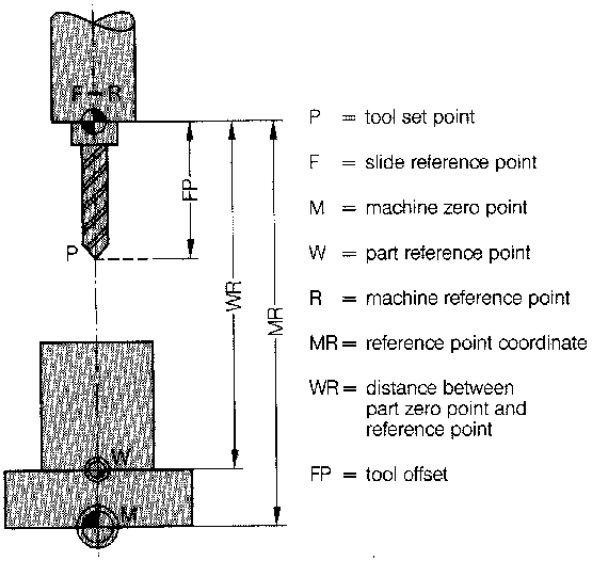


Fig. 3.1 Reference points

The tool length offset is entered with 

The program:

N	31	⊢	−180	⋀⋀	8	M	255	254
N	32	⊢	− 70	⋀⋀	.3	M	254	254
N	33	◷	10			M	20	254
N	34	⊢	250	⋀⋀	8	M	255	254
N	35	◷	10			M	02	254

The program call:

with | I | 1 | ⇨ | 31 | ⇨ | 35 | ⇨ | 1 |

This program will be executed if:
- Operation mode "automatic" is selected,
- Program No. 1 is selected through the interface
- NC Start is issued.

Reference to the workpiece zero point (W)
If the program is referenced to the workpiece zero point, the control must first be synchronized by reference point (R) approach. This workpiece zero point is distinct from the machine zero point. The distance from the reference point to the workpiece zero point (WR) is entered with machine datum No. 9.

Actual value register preset
This function allows the control's zero point to be shifted to any desired point within the machine's coordinate system.

3.3 Program example

This example (Fig. 3.2) is programmed in the program input mode.

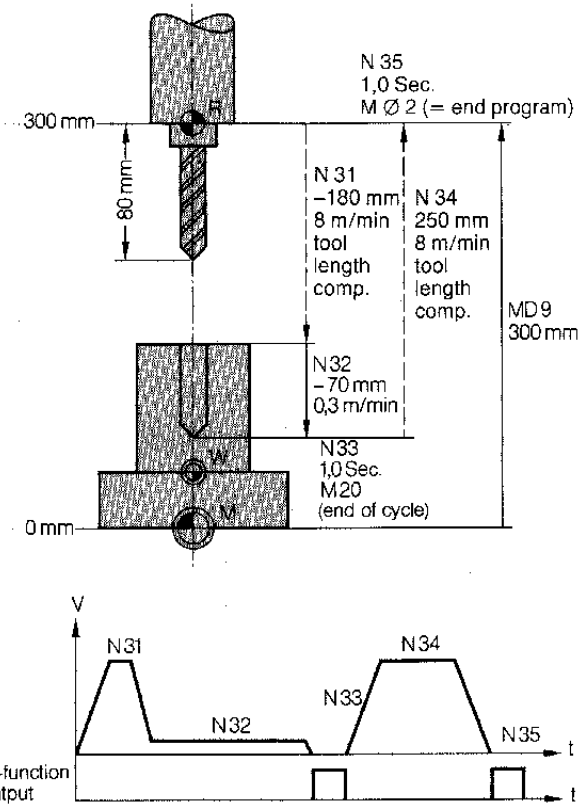


Fig. 3.2 Program example (drilling with dwell time)

3.4 Machine data

No.	Function	Value range and units	Remarks
1	Acceleration value	1...9980 mm/s^2 .001...9.98 m/s^2	The given range for machine data 1, 2 applies to WF 625; for WS 620, the smallest settable value is 60 mm/s^2.
2	Deceleration value	1...9980 mm/s^2 .001...9.98 m/s^2	
3	Max. feed rate	1...15,000 mm/min .001...15 m/min	
4	Max. following error	1...65,000 µm .001...65 mm	
5	Backlash compensation	1...65,000 µm .001...65 mm	
6	Scaling factor f (position loop gain)	−9...+9	A typical value would be −3, corresponding to $K_V \approx 1$
7	Standstill monitoring	1...65,000 µm .001...65 mm	
8	Output time for M, S, PE signals	1...99 (x 0.1 sec)	
9	Reference point coordinates	0...± 9999.999 mm	

Additional machina data for WF 625

10	Pulses per (table) revolution	1	Linear
		2...9999999	Rotary
11	Feed direction for reference point approach mode	1: Positive feed direction	
		2: Negative feed direction	
21	Max. axis No.	1...16	21 + 22 apply to all axes
22	Max. block No.	8...63	

Note: The feed rates for set-up and reference point approach are entered as operation data in these two modes of operation.

4 Operation

4.1 Operator panel

The operator panel (Fig. 4.1) of the WF 625 is a WS 600 G selfcontained unit. The well-organized keyboard with integrated LEDs for the display of the active function keys serves to simplify operation.

Operator prompting
During program input, the operator is prompted by the colour-coded keyboard, the LEDs and the display, and the necessary input time is considerably shortened in this way.
Display of the sequence:
- Symbol key
- Numerical value
- Memory key

largely prevents operating errors.

While machining is in progress, the operator can use the display field to check the actual position value of the block being processed.

1 Display field "block No."
Displays figures for – block No.
– program No.
– machine data No.
Displays of special characters used as operating aids:

– for data block (WF 625)

– program selection

2 Display field "value"
Displays – block information
– position actual value
– following error
– machine data
– alarm numbers
– data for program selection
– compensation values

3 LEDs show the active function key(s)

4 Function keys (compare with program keys, Chapter 3.1)

Position actual value display.

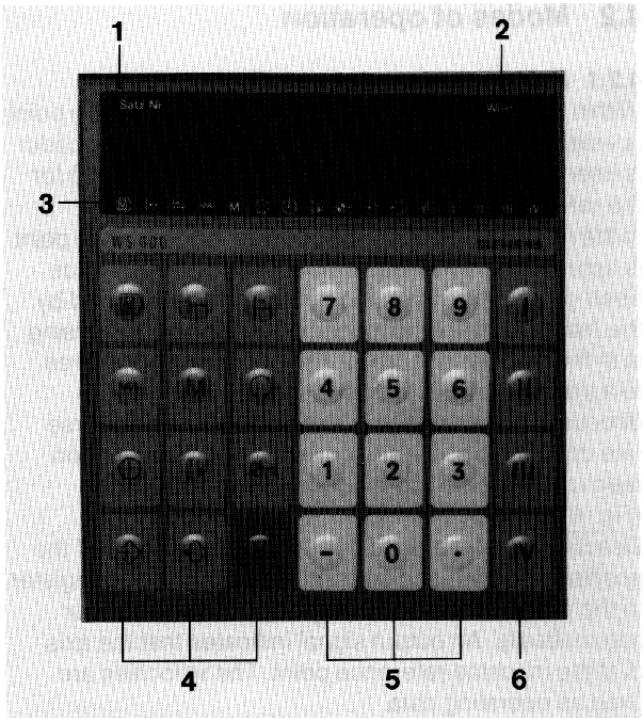


Fig. 4.1: Operator panel

Tool offset

Set actual value

Data transfer/ set key

Clear display

5 Numerical keys

6 Special keys

I Program number selection

II Data block selection (WF 625)

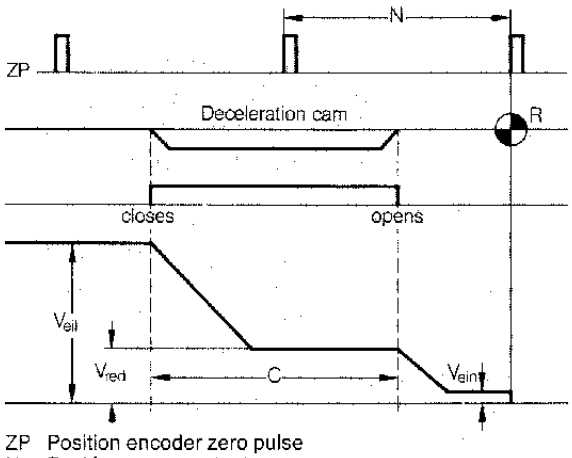
III Following error display

IV Machine data (input)

4.2 Modes of operation

4.2.1 Reference point approach

Within the traversing range, one machine reference point is established for each axis. If a digital position encoder is used, the zero pulse of the encoder is evaluated for the reference point.
In the reference point approach mode, the reference point is approached automatically after the start signal has been given. The traversing direction is determined by the machine data (exception: WS 620; here traversing is in the positive direction). First, the machine moves to a travel limit switch, then it stops and reverses direction. The approach is executed at rapid traverse rate up to the deceleration cam, then at deceleration feed rate and finally at reduced approach velocity (Fig. 4.2).
Deactivation of the drive through the zero pulse of the position encoder, and setting of the actual value register to the value of the reference point coordinate occur automatically. An output signal indicates that the axis is at the machine reference point. The velocities are fixed as operating data.



ZP Position encoder zero pulse
N Position per encoder turn
R Machine reference point
C Length of deceleration cam
V_{eil} Rapid traverse rate
V_{red} Deceleration feed rate
V_{ein} Approach velocity

Fig. 4.2: Machine reference point approach with the incremental rotary measuring system

4.2.2 Set-up

In the set-up mode the travel movements are controlled manually by means of the direction keys on the machine control panel. Two different speeds can also be selected at the machine control panel. The numerical values are entered from the operator panel.

The position control loop is active in controlling the drive. The traversing movements can be checked with the actual value display on the operator panel.

The programmed feed rates (block No. 8-63) are not active during set-up.

Teach-in

In the set-up mode, the positions reached by means of the direction keys can be transferred to the part program as command values. Feed rate and auxiliary functions can then be added in the program input mode.

4.2.3 Actual value register preset

In this operating mode, the control's zero point can be shifted to any desired point within the machine's coordinate system.

The value entered at the keyboard is transmitted to the actual value register of the corresponding axis.
The setting of the actual value register does not cause the machine to move.

4.2.4 Manual data input (MDI)

A position and the associated traversing speed are entered and processed. The programmed blocks (8-63) are not active. The position and traversing speed are not transferred to the part program memory for automatic and single loop operation.

4.2.5 Program input (manual)

In this mode, part programs can be transferred manually from the keyboard direct into the memory of the S5 programmable controller (WF 625) or into the memory of the appropriate positioning modules (WS 620).
All input data are displayed.

Program edit

The stored data are edited in the PC memory (WF 625) or in the part memory of the positioning modules (WS 620). The previous block information is overwritten.
The corrections are entered at the operator panel keyboard and are displayed on the display field.

4.2.6 Single-block operation

The control calls up and executes the program block selected via the machine control panel. This block can be repeated by reissuing the start signal. In the case of the WS 620, single block operation can be carried out up to block 39.

Cancel distance to go

A programmed sequence can be interrupted by activating the stop signal.
If another block number is selected at the machine control panel, the remaining path information (distance to go) of the interrupted block is cleared in the active memory. The part program memory remains unaffected. By presetting the actual value register, the position reached at the moment of interruption can be established as the new reference point for the following blocks.

4.2.7 Automatic mode

The following functions can be selected and activated from the machine control panel or the PC:

- Automatic mode
- Axis No. (WF 625, WS 628)
- Program No.
- Start signal

The appropriate part program is now executed. The distance to go can also be cancelled in automation mode.

4.2.8 Open-loop mode

The position control is inactive in this mode. Constant voltages are selected at the machine control panel by entering block numbers which are transferred as velocity command values to the servo drive. The travel movements are displayed on the operator field.

4.2.9 Machine data input

Machine data are entered at the keyboard. The stored data can be checked on the display of the operator panel.

4.2.10 Follow-up mode

This mode of operation allows generation of command values for controlling the servo drives from external devices. The control remains synchronized with the machine. The travel movements can be checked on the actual value display.

4.2.11 Data input/output

In this mode, data input and output is carried out via the WF 683 application programs (compare Chapter 4.3).

4.2.12 Changing the mode of operation

Changing the operation mode during machining causes an interruption of the programmed sequence. The drive comes to a controlled stop. After renewed selection of the operating mode and activation of the start signal, the distance to go of the preceding program is cancelled, and machining starts from the beginning again.

4.2.13 Design suggestion

A design suggestion for the external machine control panel (Fig. 4.3).

4.3 Data traffic over the standard data interface

(with SIMATIC S5-130 W/150 K)

The possibilities are – RS 232 C; V24 to DIN 66 020
– 20 mA–current loop (TTY)
each with different transmission speeds adjustable in steps from 110 to 9600 baud; the SIMATIC S5 is coupled to the I/O devices through the WF 683 module (see Figs. 2.2 and 2.3).

Types of input

- Read-in from cassette recorder
- Programming and read-in from paper tape unit on printer

Checking mechanisms

1. Block parity (S5 to WF 683 and vice versa)
2. Character parity (external memory to WF 683)
3. Trial run of the entire part program:
   All programs stored by the WF 683 on external memory are read into the WF 683 again and checked for block parity.

Types of output

- Output to cassette recorder
- Output through paper tape punch
- Output through printer in plaintext

When a cassette recorder is used, the entire part program must be read-in or read-out.

4.4 Monitoring and data protection

The controls are equipped with monitoring functions for error recognition to prevent damage to the machine and workpiece. The individual alarm signals are transmitted to the interface.

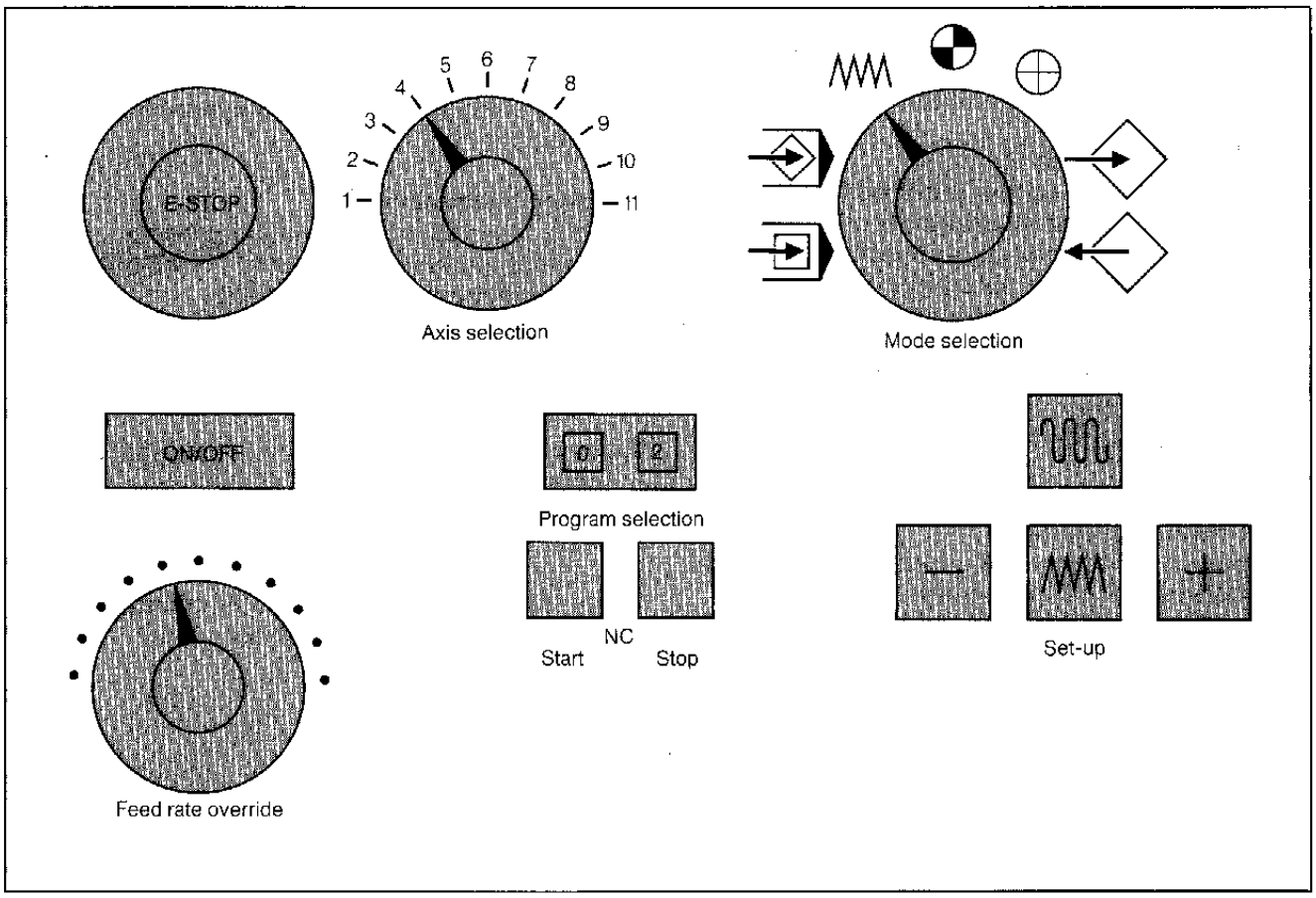
Standstill monitoring
To guard against uncontrolled motions of the axes during standstill.

Following-error monitoring
If the maximum following-error value set by means of the machine datum is exceeded, the machining sequence is interrupted and an alarm signal is given. With the WS 620 this signal is acknowledged by a strobe pulse, while in the case of the WF 625 acknowledgement is by standard program call-up.

Voltage
If the voltage falls below the permissible value, the "ready" signal is cancelled.

Data protection
In the absence of external voltage, memory of the part programs and machine data are buffered with a rechargeable battery.
At an average ambient temperature of 95 °C, and when the battery is fully charged, this data protection system keeps the control operational for one month.

Fig. 4.3: Machine control panel (suggestion for the WF 625)



5 Position control loop

Overview
All part programs are stored in the individual WF modules during machining. The position control and positioning are executed without the participation of the S5 programmable controller (Fig. 5.1). The main components of the positioning module (WF 620, 625) are

- the 8085 processor,
- the EPROM for the executive program,
- the data store (RAM) for part programs and machine-specific data,
- the digital-analog converter for converting the calculated velocity command value into a proportinal voltage,
- the high-speed counter for sampling the position encoder pulses and
- the timer for generating the internal clock.

Position command value generation
The position per time increment is calculated in the control independently of the acceleration and deceleration values a_1 and a_2 determined by the machine data. This calculated position is input as command value to the position controller. The deceleration starting point is established according to the magnitude of deceleration value a_2 and of the feed rate (Fig. 5.2).

Position control
The digital position controller, which operates with very high resolutions of time and velocity, has a proportional characteristic, i.e. it reacts instantaneously to changes of actual value input. The proportional characteristic of the controller is taken into account in the proportional control factor. This factor, the so-called velocity gain K_V, also know as the K_V factor, is defined as the ratio of programmed traversing velocity V to the position deviation ΔS:

$$K_V = \frac{V}{\Delta S}$$

This factor is laid down via machine datum 6. In the case of a movement at constant speed, the position deviation, the so-called following error, can be expressed on the basis of this equation as:

$$\Delta S = \frac{V}{K_V}$$

The position deviation states the amount by which the position actual value is behind the position setpoint (Fig. 5.3).

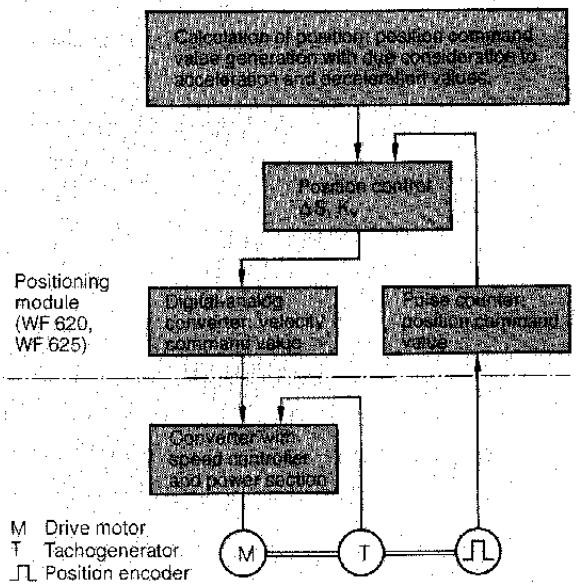


Fig. 5.1: Block diagram of the position control loop

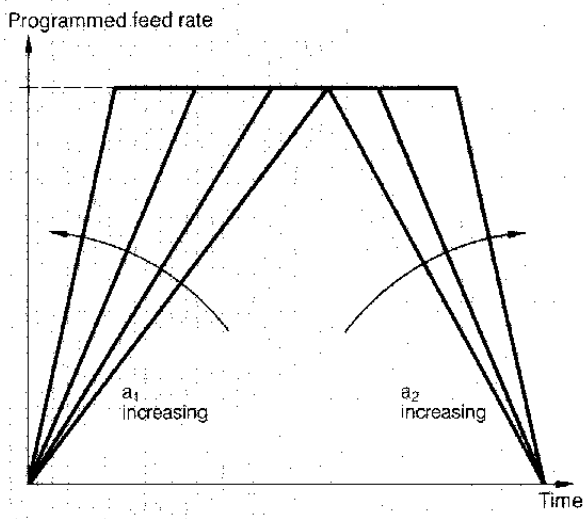


Fig. 5.2: Acceleration value a_1 and deceleration value a_2

The position control loop is designed to operate continuous control elements. A DC signal of max. ± 10 V, 2 mA is output for the operation of these control elements.

Control element
As control element, use can be made either of a converter in combination with a DC servo motor, or an electrohydraulic servo valve.

Selection table for number of pulses of the position encoder

Lead screw pitch mm/rev	Pulse/rev of position encoder
2	2000
3	1500
4	2000
5	2500
6	1500
8	2000
10	2500
20	5000

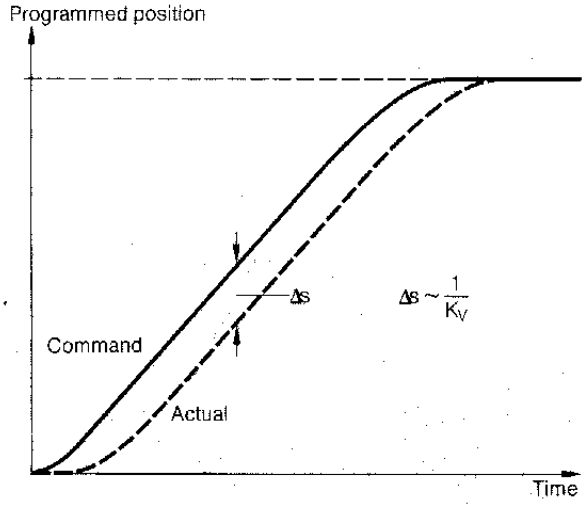


Fig. 5.3: Following error ΔS and position loop gain K_V

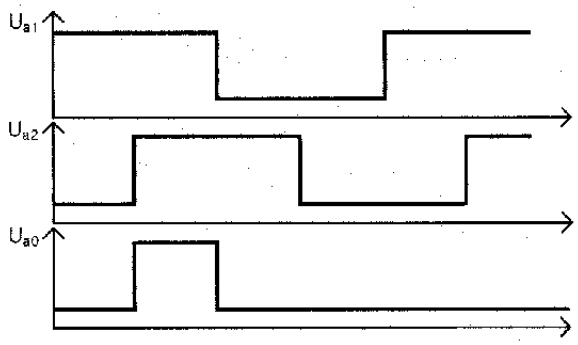


Fig. 5.4: Output signals of the incremental position encoder

Because of the non-linearities in the continuous regulator and the control system, the position control loop must be backed up in either case by a subordinated control loop with PI controller. In the case of the converter, this is accomplished with the speed control loop.

Position measurement
Position measurement can be performed with incremental rotary position encoders or with digital linear scales. An encoder is necessary for each axis.

Function principle: A (glass) disk with suitable divisions is scanned photoelectrically. The scanning elements generate sine-wave signals, which are converted into square-wave signals by an electronic device in the encoder.

Recognition of direction of rotation: This requires two output signals U_{a1} and U_{a2} offset with respect to time.
The direction discriminator of the WF modules recognizes the direction of rotation therefrom.

Reference point: Is roughly given by limit switch (deceleration cam). The precise reference point is given by a reference pulse (zero mark) U_{a0} from the encoder. One pulse is output per revolution of the encoder.

Interference signal suppression: The inverted signals are also generated for each square-wave output signal and are used to suppress stray interference signals.

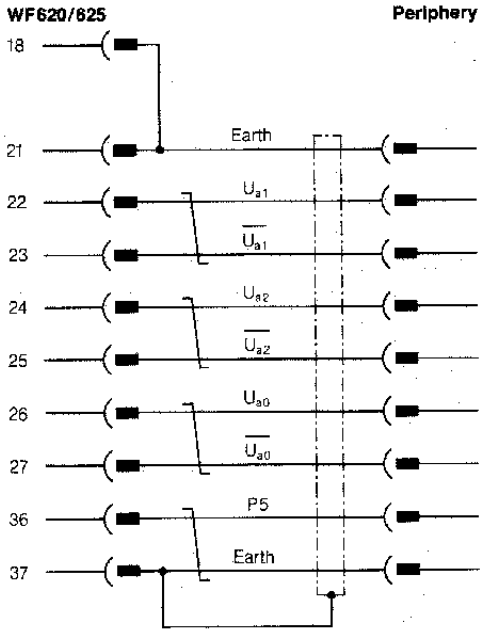
The table can be used for selection of the position encoder in accordance with the lead screw pitch. In the event of pitches not listed or the addition of gears, we recommend consultation with our technical department.

Linear or rotary axes (WF 625)
Machine datum 10 is used to establish whether the WF modules are to operate with linear or rotary axes. If rotary axes are selected, the number programmed contains information concerning the number of pulses that will cause the WF module's actual value counter to be reset to zero. Machine datum 10 can be flexibly arranged and is not tied to the pulse number of the position encoder.

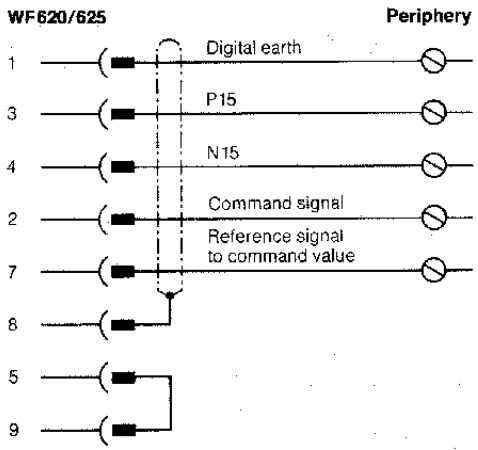
6 Interface

6.1 WF 620/625

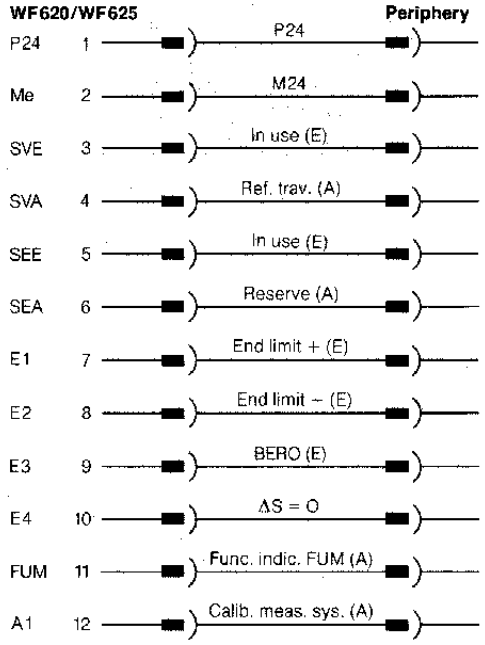
6.1.1 Position encoder



6.1.2 Static converter (command value)

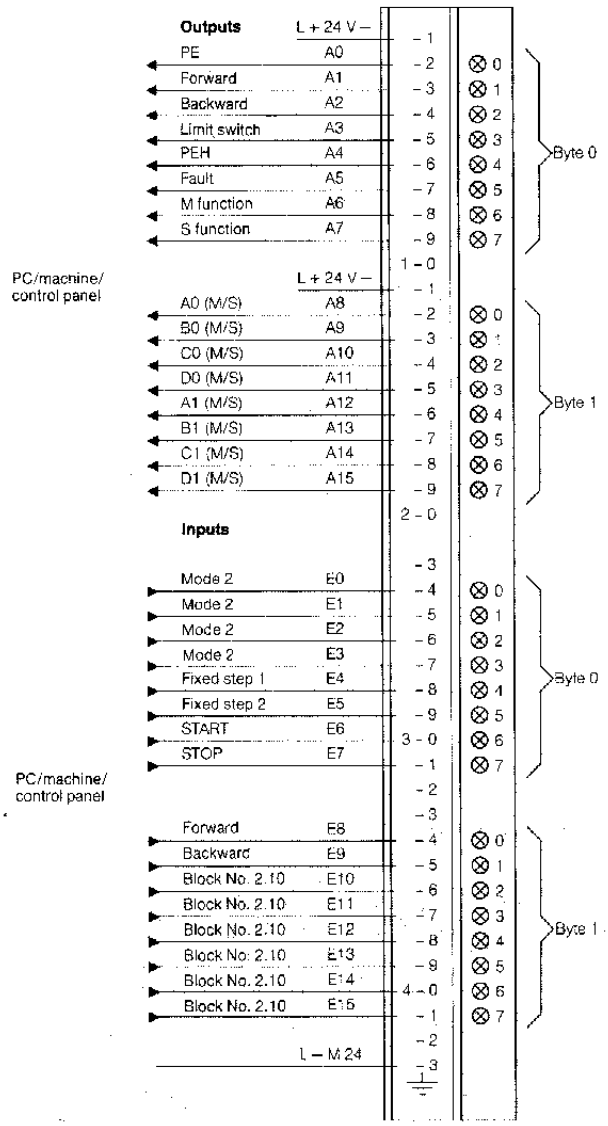


6.1.3 Faston pins



7 Connection data

Connections on the front connector of module 6 ES 5482



* Ripple ≤ 5 %. In the case of uncontrolled mains units in three-phase bridge connection, smoothing to 200 µF per amp is required.

WS 620 single-axis control

Ambient temperature • Operation • Storage	 0 °C ... 55 °C −40 °C ... 60 °C
Humidity	Designation F
Type of protection, housing Type of protection, operator panel	IP 10 IP 54
Power supply	24 V DC; 0.6 A*)
Line voltage of inputs and outputs	24 V DC; 100 mA

WF 625 positioning module

Power supply through bus connector	5 V ± 5 %
Power consumption on 5 V side	1.3 A without position encoder 1.55 A with position encoder
Part program memory	1 K RAM buffered, at least 4 weeks at 25 °C
Power supply for measuring circuit, external	± 15 V ± 5 %, 20 mA
Command value voltage	± 10 V; 2 mA
Power supply for Faston pins, external	24 V DC; 0.2 A

WF 683 interface module

Power supply through bus connector	5 V ± 5 %
Power consumption on 5 V side	1.0 A

8 Selection and order data

Devices and modules	Order No.
WS 620 single-axis position control WS 620 single-axis compact version comprising: Operator panel with power supply and display, WS 620 central module, I/O module 482	6FM1600-2BB00

Devices and modules	Order No.
SIMATIC S5 with WF 625 WF 625 positioning module in the SIMATIC S5 system	6FM1610-2CB00
WF 683 module for linking SIMATIC S5 with external memories	6FM1680-1EA00
Expansion unit interface 301	6ES5301-3AB11
Central unit/expansion unit interface 310	6ES5310-3AB11
Connector 760	6ES5760-0A.11
Connection cable 721 to operator panel	6ES5721-0...0
WS 600 G operator panel with power supply and display (without interface 310)	6FM1680-3AA00

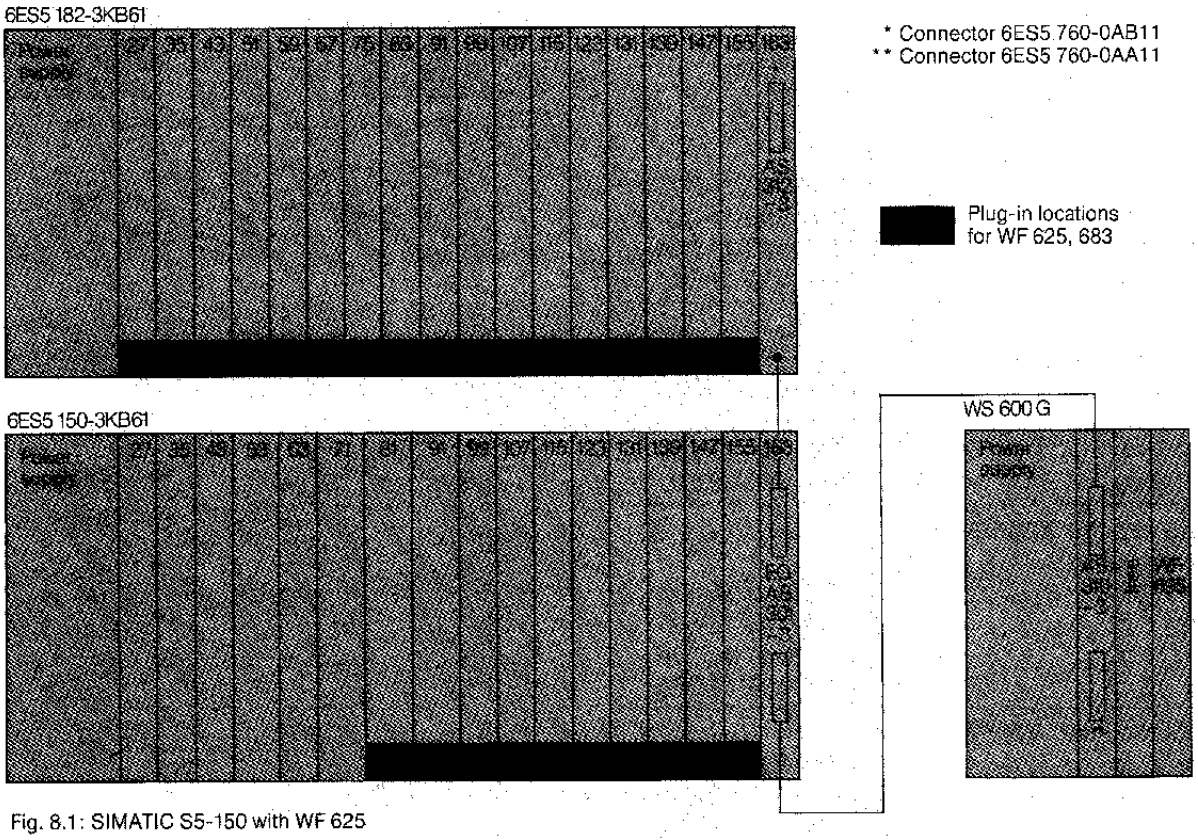


Fig. 8.1: SIMATIC S5-150 with WF 625

Software packages	Order No.
For WF 625	
Without manual input BT WS 600 G	
a) S5-130 W (B), WF 625 (FB 160)	6FM1 673-2CA 10
b) S5-150 K, WF 625 (FB 86)	6FM1 674-2CA 10
c) S5-150 S, WF 625 (FB 86)	6FM1 672-2CA 10
One manual input BT WS 600 G	
a) S5-130 W (B), WF 625, 1 × WS 600 G	6FM1 671-2CA 30
b) S5-150 K, WF 625, 1 × WS 600 G	6FM1 670-2CA 30
c) S5-150 S, WF 625, 1 × 600 G	6FM1 672-2CA 30
Several manual inputs BTn WS 600 G	
a) S5-130 W (B), WF 625, several WS 600 G	6FM1 671-2CX 30
b) S5-150 K, WF 625, several WS 600 G	6FM1 670-2CX 30
c) S5-150 S, WF 625, several WS 600 G	6FM1 672-2CX 30
For WF 683	
S5-130 W(B)/150 K/150 S without WS 600 G	6FM1 670-5CH00
S5-130 W(B)/150 K/150 S with WS 600 G	6FM1 670-5CA00

Accessories	Order No.
Connectors	
Set of connectors for WS 620 comprising: 1 × 9-way Cannon, pin (X 2) 1 × 37-way Cannon, pin (X 3) 1 × 48-way Harting, socket (X 4) 12 Faston connectors (X 1) 2 Connections to the power supply	6FM1690-9AA00
Set of connectors for WF 625 comprising: 1 × 9-way Cannon, pin (X 2) 1 × 37-way Cannon, pin (X 3) 12 Faston connectors (X 1)	6FM1690-9AC00

Accessories	Order No.
Position encoder	
Incremental position encoder for mounting ROD 426	
500 pulses/rev	6FC9320-3CD
1000 pulses/rev	6FC9320-3CE
2000 pulses/rev	6FC9320-3CA
2500 pulses/rev	6FC9320-3CB
ROD 320 built into the 1 HU motors is available.	
Connector cables	
Position encoder ROD 426–WF 620/625 (actual value)	
Length: 5 m	6FM1690-1AB00
Length: 10 m	6FM1690-1AC00
Length: 18 m	6FM1690-1AD00
Length: 25 m	6FM1690-1AE00
Position encoder ROD 320–WF 620/625 (actual value)	
Length: 5 m	6FM1690-1BB00
Length: 10 m	6FM1690-1BC00
Length: 18 m	6FM1690-1BD00
Length: 25 m	6FM1690-1BE00
Thyristor unit–WF 620/625 (command value)	
Length: 2 m	6FM1690-1EA00
Length: 5 m	6FM1690-1EB00
Length: 10 m	6FM1690-1EC00
Lenght: 18 m	6FM1690-1ED00
Cassette recorder–WF 683	
Length: 2 m	6FM1690-1GA00
Length: 5 m	6FM1690-1GB00
Length: 10 m	6FM1690-1GC00

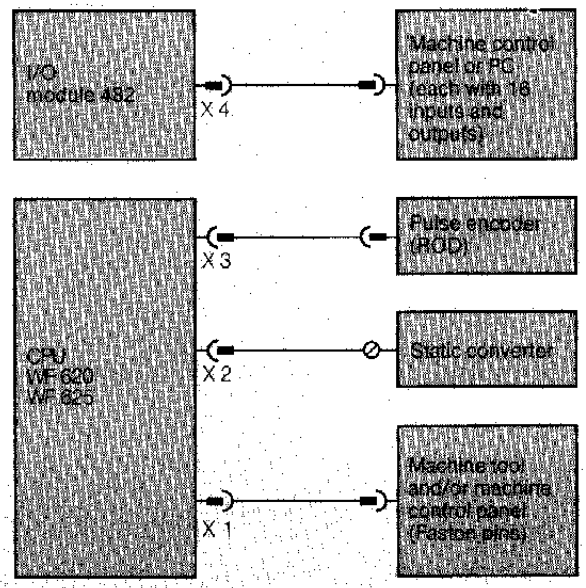
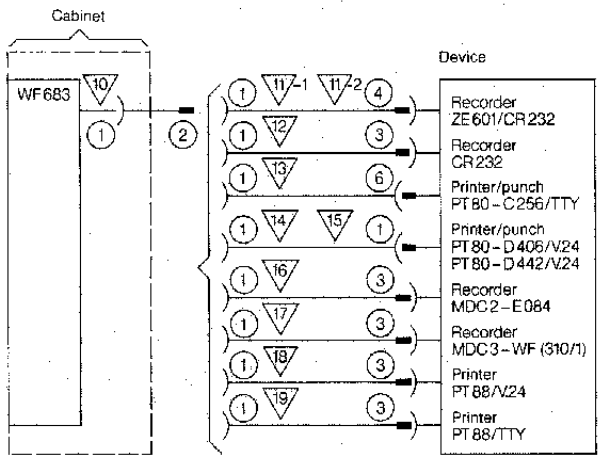


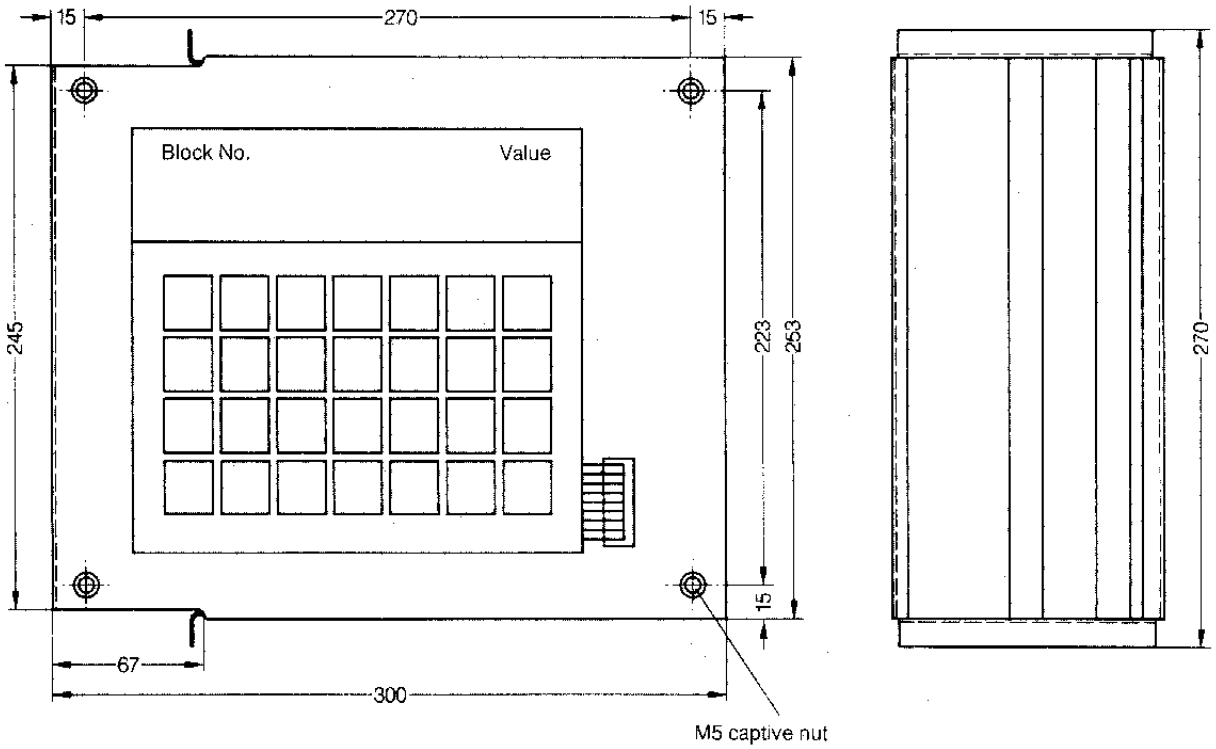
Fig. 8.2: Block diagram of cables and external devices

Connectors: X2 9-way Cannon (socket)
X3 37-way Cannon (socket)
X4 48-way Harting (pin)
1 12 flat connectors (Minifaston)

WF 683 cable and device overview (Fig. 8.3)



9 Dimension drawings



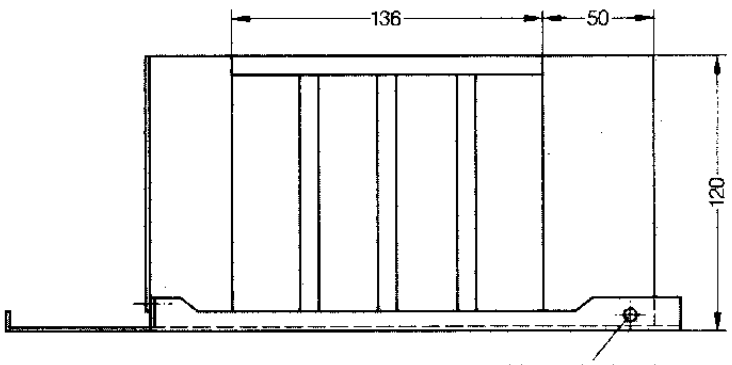


Fig. 9.1: WS 620, WS 600

All dimensions in mm

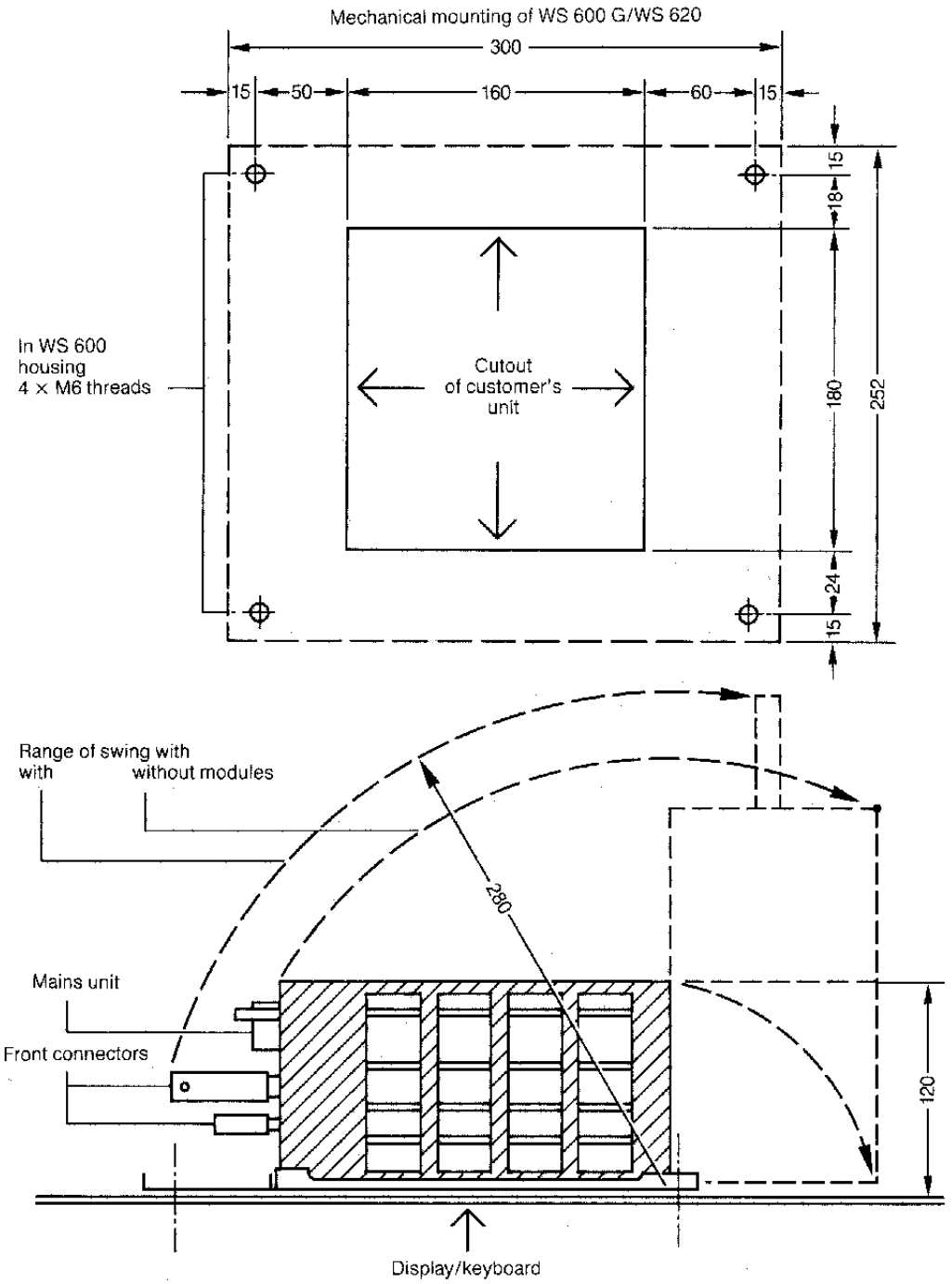


Fig. 9.2: Dimensions for fitting WS 600 G/WS 620 in switchgear cabinet

Siemens AG

AUT V261
Postfach 4848
W-8500 Nürnberg 1
Fed. Rep.of Germany

Suggestions

Corrections

For Publication/Manual:

Equipment for Machine Tools

WS 627, WF 625

Description

Order-No.: 6ZB5 440-0HM02-0BA0

Edition: July 1987

From:

Name

Company/Dept.

Address

Telephone /

If you find any printing errors when reading this publication, please let us know, using this form. We also welcome any suggestions to improve the manual.

Suggestions and/or corrections

Equipment for Machine Tools

WS 600

Manual

Siemens AG
Automation Systems
for Machine Tools and Robots
Postfach 48 48, D-8500 Nuernberg 1
Federal Republic of Germany

Siemens Aktiengesellschaft

Order No.: 6ZB5 440-0HM02-0BA0
Printed in the Fed. Rep. of Germany
(720) 232/216180 BS 01910.1 (800)

progress in automation: Siemens