SIEMENS

Equipment for Special Machines
WF 707
Cam Controller

Description

Edition 09.98

WF 707
Cam Controller

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Edition September 1998

Note

Because of clear arrangement, this documentation does not inform about all details of all types of the product. Therefore, it cannot take into account all possible cases of installations, operation and maintenance.

If you require additional information or have special questions, please seek further particulars from your local SIEMENS office.

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Subject to technical changes.

Index

1 Overview

The present description provides information about the properties, characteristic features and capabilities of the WF 707 electronic cam controller.

The WF 707 electronic cam controller is part of the intelligent peripheral equipment of the SIMATIC S5/S7. Its function is to independently control up to 64 cams on a maximum of 16 cam tracks with great precision. On the one hand, this serves to relieve the SIMATIC S5/S7 and gain time for its other functions, and on the other hand, output of the cams is more precise than would be possible with the SIMATIC S5/S7 alone.

The illustration below shows some of the applications which can be implemented with the SIMATIC S5/S7 and with specific modules in addition to the cam controller.

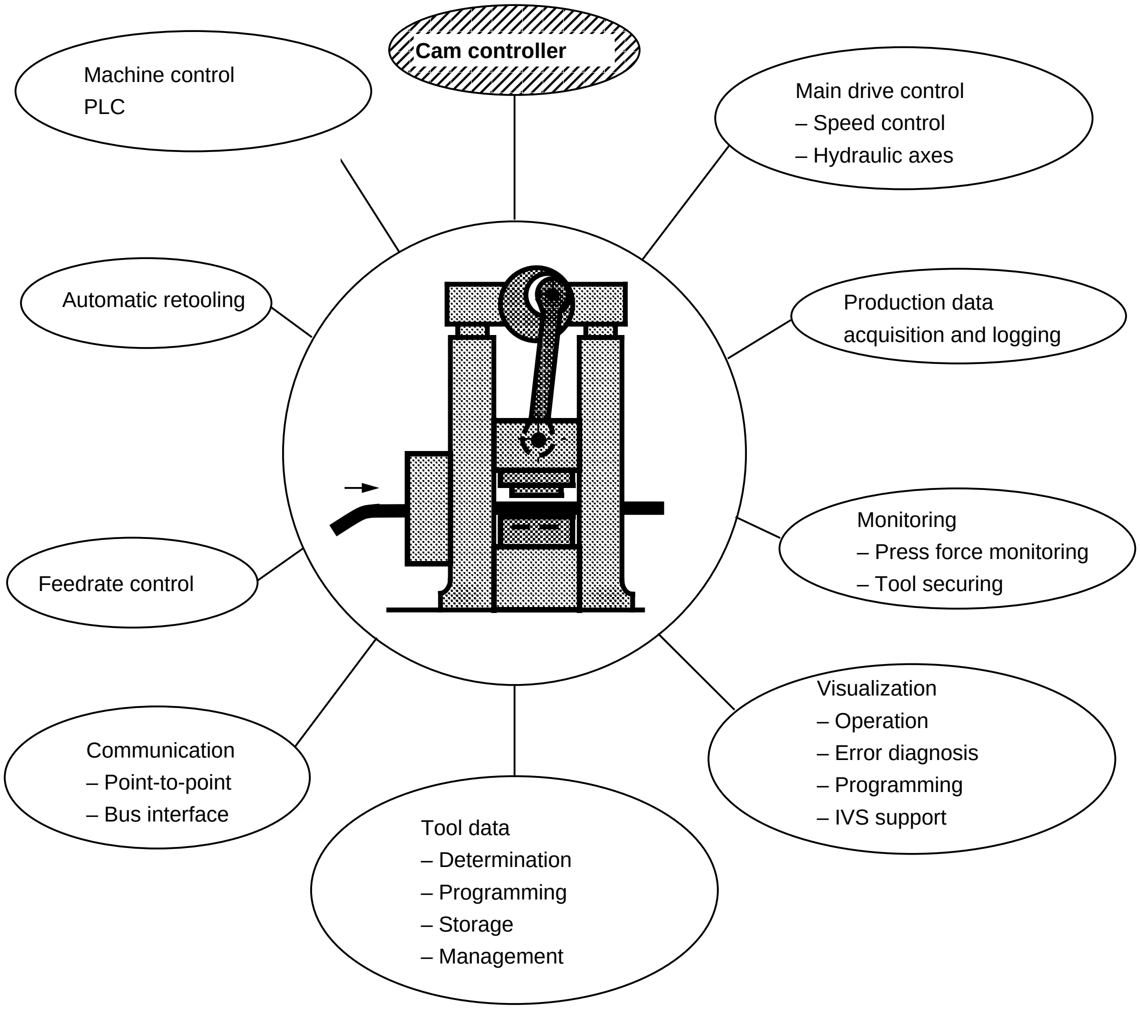


Figure 1.1 Typical applications using the SIMATIC S5/S7 and intelligent peripheral modules

The WF 707 module can be inserted in the programmable controllers for the medium and high performance levels. The following controllers are available:

- SIMATIC S5-115U (as from CPU 941)
- SIMATIC S5-135U (CPU 928)
- SIMATIC S5-155U
- SIMATIC S7-400

1.1 Basic Data of WF 707

1.1.1 Characteristics

- 1 axis per module at a mounting width of 1 SPS
- 8 byte address space in the peripheral area
- Up to 16 WF 707 modules plug into any SIMATIC S5 controller
- Up to 8 WF 707 modules plug into any SIMATIC S7-400 controller (UR1)
- Up to 3 WF 707 modules plug into any SIMATIC S7-400 controller (UR2)
- SSI absolute encoder or incremental encoder can be connected
- Monitoring for cable breaks and short circuits
- 16 digital outputs (cam outputs), loadable with 24 V, 0.5 A
- Reaction time (T_{react}) = 57.6 µs.
- Utilization of actual values for a maximum of 5 modules

1.1.2 Connectable Encoders

SSI absolute encoder:

- Gray or binary code
- Transfer timing: 125 kbit/s, 250 kbit/s, 500 kbit/s or 1 Mbit/s
- 24-VDC-power supply

Incremental encoder:

- 5-V encoder
- Maximum encoder frequency: 500 kHz
- Symmetrical signals: A, $\overline{A}$; B, $\overline{B}$; Z, $\overline{Z}$ to RS 422 A

With incremental encoders, quadruple evaluation is always made in the WF 707 controller.

24-V initiator:

- 24-VDC signal, 5 mA

2 Application

The WF 707 module is an electronic cam controller for a rotary or a linear axis. Following transfer of the switching information from the SIMATIC S5/S7 processor, the module executes the cam program and controls the digital outputs independent of the SIMATIC S5/S7 cycle.

This offers a number of advantages:

- The cycle time for the cam program is very short and constant. Thanks to a special device (ASIC), the cycle time is not more than 57.6 µs with 32 cams (or 115.2 µs with 64 cams, respectively). High grades of precision are thus achieved also with very fast machines.

  At 2400 time cycles per minute and 32 cams, for example, accuracy of operation is higher than 1 degree. This enables also mechanical high-speed cam controllers to be superseded by the WF 707 electronic cam controller.

- All cams are dynamic, each cam has its own dynamic factor. This function is also known as "dead time compensation" as it serves to dynamically offset the reaction times (dead times) of the attachments selected (varying with the number of time cycles).

- All cams can be programmed alternatively as path-path or as path-time cams. 2 special functions (counting cam, braking cam) are available in addition.

- All cams can be assigned at random to any of the 16 cam tracks of the module. Each cam track has a digital output assigned to it. Selection of the attachments connected can thus be made directly and without delay.

- The SIMATIC S5/S7 is relieved and can devote more time to other functions.

For all its independence from the cycle of the SIMATIC S5/S7, the WF 707 controller still is invariably linked with it via the interface, which gives it substantial advantages over a stand-alone cam controller:

- The SIMATIC S5/S7 can at any time interrogate the status of the cam tracks and check and even control the state of the digital outputs, should this ever be necessary (for example, during commissioning or for functional testing for an attachment).

- Cams designed to initiate complex functions can activate an interrupt (alarm) on the SIMATIC S5/S7 bus, which is immediately processed by the SIMATIC S5/S7. This takes place more quickly than would be permitted by polling of the cam states, and without the SIMATIC S5/S7 having to continuously check the cam states.

- The data record of every single cam can be changed on-line by the SIMATIC S5/S7. This allows optimizations to be effected without any problems, for example, during setting-up on the machine in operation.

These functions can all be executed in a matter of microseconds by way of the just 8 byte wide interface in the SIMATIC S5/S7 peripheral area.
With a CPU 944, for example, reading of the cam states takes only about 23 μs, transfer of a complete cam data record only about 97 μs.

- For a rotary or a linear axis, the following encoders can be connected:
  - Incremental encoder
  - SSI absolute encoder
  - 24-V initiator

Moreover, an internal encoder simulator can be activated which allows time-controlled execution of the cam program.

- Typical applications of the WF 707 module include:
  - Power presses
  - Rotary transfer machines
  - Transfer lines
  - Manipulators
  - Packaging machines

Application of the WF 707 offers the following advantages:

- Modular design
  The machine control system can be configured from the wide choice of peripheral and communication modules of the SIMATIC S5/S7 family and can be extended almost at random.

- Economy
  The SIMATIC S5/S7 programmable controller and the WF 707 cam controller constitute a user-oriented control system. This allows functions such as processing, testing, simulation to be performed easily and economically.

- Flexibility
  The WF 707 controller can be adapted to suit the special process technology by input of machine and tool specific parameters.

- Ease of configuration
  The interface between SIMATIC S5/S7 and WF 707 is of simple design to enable the user to address the module by his own function blocks, consistent with his specific requirements. The diskette with sample program supplied with the present documentation may serve as a basis.

- Ease of operation
  Use can be made in addition of the WS 400 operator communication system as a convenient medium of operator communication and monitoring. The features offered by the system include:

  – Extensive adaptation of display format to suit the machine and the process
  – User-configurable masks, e.g., for monitoring/checking of machine and process, and for input of the cam program
  – Menu technique and softkey row for operator guidance
  – Insertion of alarms in text windows (clear text displays)
  – Logging of operator and error messages
  – Fast error location

- Training courses
  Application of the WF 707 controller requires a general knowledge of the SIMATIC S5/S7 and of programming in STEP 5/7. Our training centre offers various courses for you to get to know the systems and learn how to handle them. Along with the theoretical information, you will also be given a chance to work directly with the control systems with specialist assistance.

3 Configuration

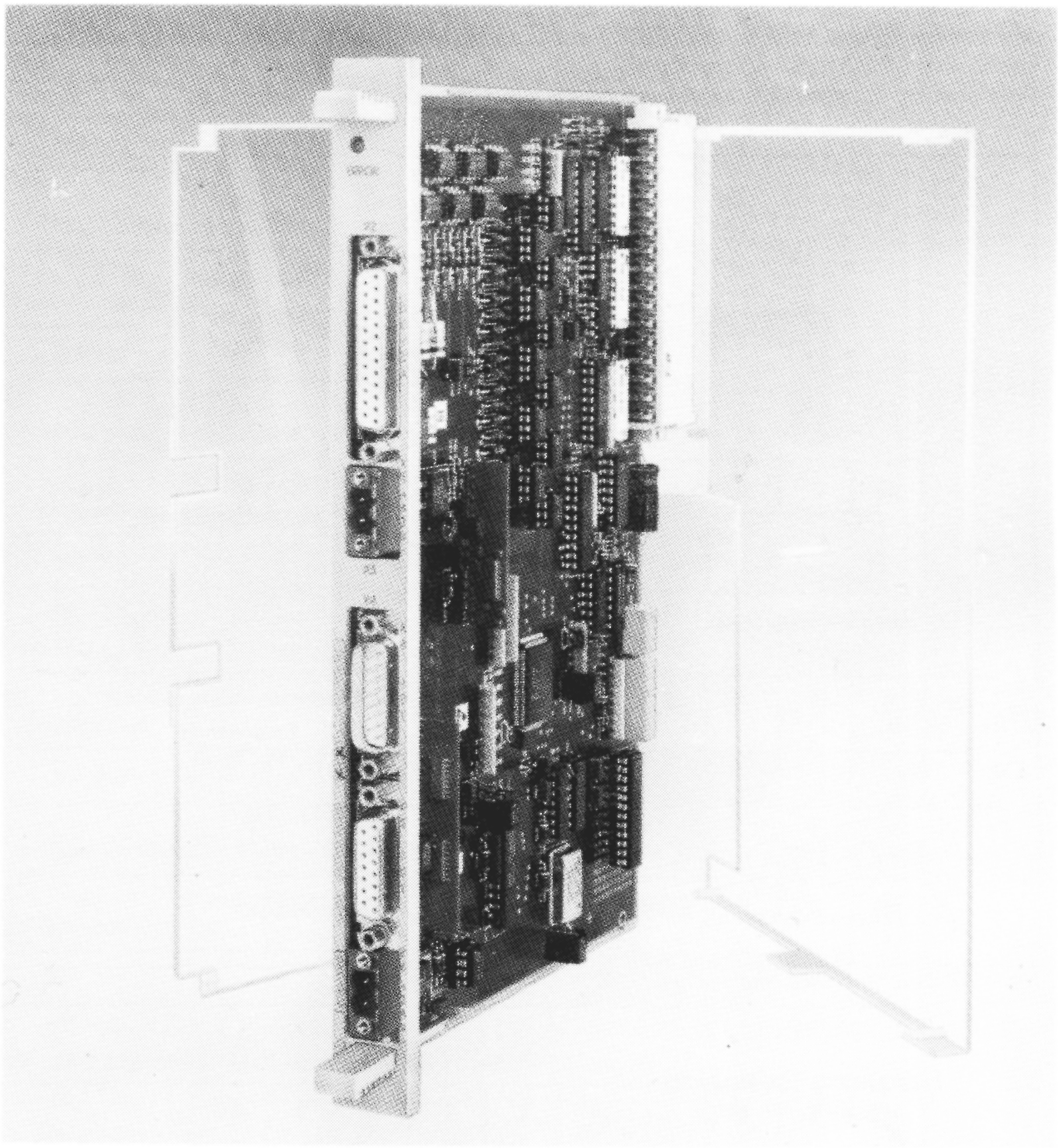


Figure 3.1 WF 707 module

The WF 707 module is a high-speed cam controller for the SIMATIC S5 and SIMATIC S7-400 (with S7 adapter casing) programmable controllers.

On the front are located the connectors of the inputs and outputs to the machine. The back features the connector for the SIMATIC S5 bus or for the S7 adapter casing. All data and control signals of the SIMATIC S5/S7 are routed by way of this bus.

3.1 Basic Hardware Configuration

The basic configuration consists of a SIMATIC S5/S7, the WF 707 module (with SIMATIC S7-400, with S7 adapter casing), and of either a position encoder or a 24-V initiator. Just like any other peripheral module, the WF 707 is inserted in the SIMATIC S5 rack with S7 adapter casing, in a SIMATIC S7-400 rack.
Programming of the module is effected via the SIMATIC S5/S7 (see Figure 3.2).

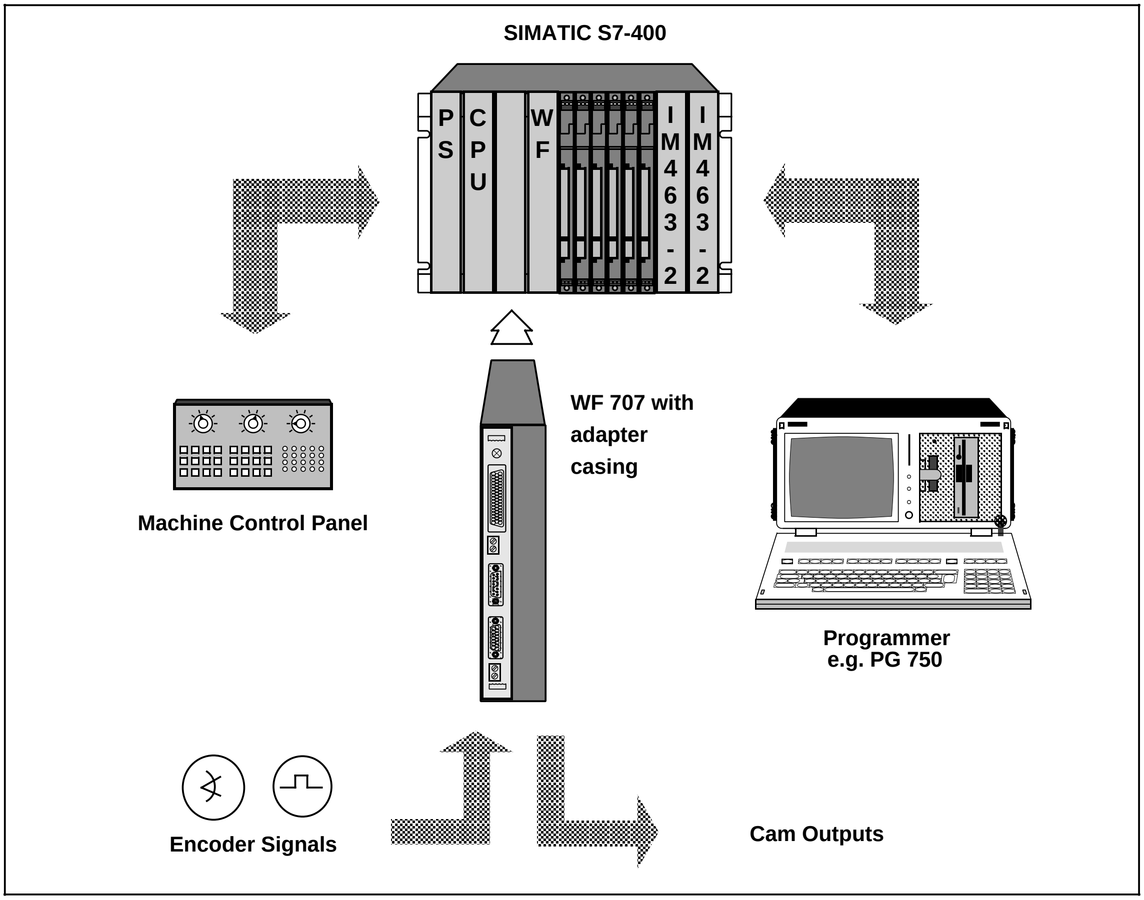


Figure 3.2 Basic hardware configuration with SIMATIC S7-400

3.2 Hardware Extension

The basic configuration as outlined above can be extended on a modular basis. Depending on the requirements of the system, the SIMATIC S5/S7 can be fitted with additional modules.
The small interface width of just 8 bytes allows the operation of 16 WF 707 modules with one programmable controller without cutbacks having to be made on digital inputs and digital outputs.

For information refer to the descriptions of the individual modules, or ask for the catalogue AR 10 or ST 50.
(For order number refer to section 8.2)

3.3 Possible Slots of WF 707 in the SIMATIC S5 Rack

S5-115U central controller - Subrack CR 700-0LA

Slot designation	PS	CPU	0	1	2	3	IM
WF 707			▨				

S5-115U central controller - Subrack CR 700-0LB

Slot designation	PS	CPU	0	1	2	3	IM
WF 707			▨	▨	▨		

S5-115U central controller - Subrack CR 700-1

Slot designation	PS	CPU	0	1	2	3	4	5	6	IM
WF 707			▨							

S5-115U central controller - Subrack CR 700-2

Slot designation	PS	CPU	0	1	2	3	4	5	6	7	IM
WF 707			▨	▨	▨	▨	▨	▨			

S5-115U central controller - Subrack CR 700-3

Slot designation	PS	CPU	0	1	2	3	4	5	6	IM
WF 707			▨	▨	▨	▨	▨	▨		

S5-115U expansion unit - Subrack ER 701-3 1)

Slot designation	PS	0	1	2	3	4	5	6	7	IM
WF 707		▨	▨	▨	▨	▨	▨	▨		

S5-135U central controller (CPU 928 for 700 module range)

Slot designation	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
WF 707			▨	▨ 1)	▨	▨ 1)	▨	▨ 1)	▨	▨	▨	▨	▨	▨	▨	▨	▨				

1) No interrupt processing

S5-155U central controller

Slot designation	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
WF 707			▨ 2)	▨ 2)	▨	▨	▨ 1)	▨ 2)	▨ 2)	▨	▨	▨ 1)	▨ 1)	▨	▨	▨	▨	▨ 3)	▨ 3)		

S5-183U expansion unit 1)

Slot designation	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
WF 707		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	

S5-185U expansion unit 1)

Slot designation	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
WF 707		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	

1) No interrupt processing
2) Restricted interrupt processing
3) Interrupt processing if br 7-13 jumpers inserted on rack bus

Installation of the WF 707 module into remote interfaced expansion units (with IM 308/IM 318) is precluded.

Each WF 707 module occupies 8 address bytes in the peripheral area and is to be addressed preferably in the analog range (address 128). The initial address must therefore be divisible by 8. The current balance has to be taken into account.

3.4 Possible Slots of WF 707 and Authorized CPU Types for SIMATIC S7-400

The WF 707 module can be used in the SIMATIC S7-400 in different ways:

- in SIMATIC S7-400 central units by means of SIMATIC S7 adapter casing
- in SIMATIC S5 extension units by means of interfaces IM463-2 and IM314

For plugging the WF 707 module in the subrack of the SIMATIC S7-400, a WF 707 with S7 adapter casing is supplied. Two slots are required in the SIMATIC S7.

Possible S7-400 central units

Central unit S7-400 - subrack UR1

Slot designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PS	▨	▨	▨															
CPU		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
WF 707 with AC 1)		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
IM 463-2		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

PS:	Power supply may occupy 1, 2 or 3 slots, depending on version
CPU:	May occupy 1 or 2 slots, depending on version
WF 707 with adapter casing:	The S7 adapter casing occupies 2 slots (current consumption: 250 mA)
IM 463-2:	Occupies 1 slot (Up to 3 modules can be plugged)
1)	Up to 8 modules (S7 adapter casings) can be plugged

Central unit S7-400 - subrack UR2

Slot designation	1	2	3	4	5	6	7	8	9
PS	▨	▨	▨						
CPU	▨	▨	▨	▨	▨	▨	▨	▨	▨
WF 707 with AC [1]	▨	▨	▨	▨	▨	▨	▨	▨	▨
IM 463-2	▨	▨	▨	▨	▨	▨	▨	▨	▨

PS:	Power supply may occupy 1, 2 or 3 slots, depending on version
CPU:	May occupy 1 or 2 slots, depending on version
WF 707 with adapter casing:	The S7 adapter casing occupies 2 slots (current consumption: 250 mA)
IM 463-2:	Occupies 1 slot
1)	Up to 3 modules (S7 adapter casings) can be plugged

Possible SIMATIC S5 extension units with receiver IM 314:

- ER 701-3 (SIMATIC S5-115U)
- EG 183U/-185U (SIMATIC S5-135U/-155U)

Extension unit S5-115U - subrack ER 701-3[2]

Slot designation	PS	0	1	2	3	4	5	6	7	IM
Power supply	▨									
IM 306										▨
IM 314									▨	
WF 707		▨	▨	▨	▨	▨	▨	▨		

2) No interrupt processing

Extension units S5-183U/-185U 1)

Slot designation	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163
IM 314	▨																				
WF 707		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	

1) No interrupt processing

Authorized CPU types:

Automation unit	CPU type	Order No.
S7-400	412-1	6ES7 412-1XF00-0AB0
	413-1	6ES7 413-1XG00-0AB0
	413-2DP	6ES7 413-2XG00-0AB0
	414-1	6ES7 414-1XG00-0AB0
	414-2DP	6ES7 414-2XG00-0AB0
	416-1	6ES7 416-1XG00-0AB0
	416-2DP (in prep.) Main memory: • 800 Kbyte • 1600 Kbyte	 6ES7 416-2XK00-0AB0 6ES7 416-2XL00-0AB0

4 Functional Description

For operation of the WF 707 cam controller, the following input signals or input data, respectively, are required:

- Actual values
- Machine data
- Cam program

The actual values are supplied by an encoder at the axis of the machine. The machine data and the cam program are transferred to the WF 707 controller by the SIMATIC S5/S7. Machining and thus output of the cam signals commences once the starting preconditions have been met.

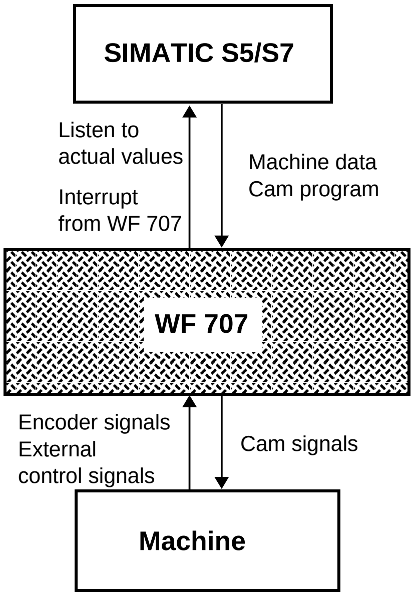


Figure 4.1 Signal flow SIMATIC S5/S7 - WF 707 - machine

4.1 Actual-Value Acquisition

Actual-value acquisition is required for determination of the initial and end positions of the cams.

The use of incremental encoders, or of 24-V-initiators as encoders, respectively, requires the internal WF 707 actual-value counter to be synchronized with the encoder at the machine (see sections 4.1.1, 4.1.2). The actual value in the counter is thus rendered valid.
With SSI absolute encoders, synchronization is not required since the actual value in the counter is valid after the first successful SSI transmission.

4.1.1 24-V-Initiator

A simple type of sensor that can be evaluated is a 24-V-initiator which scans a gear wheel, for example, and in this way supplies positional data. In this case the sensor signal fails to contain any directional information so that this information must be provided by the SIMATIC S5/S7 on the data interface.

**Incorrect presetting of direction
may result in serious faults.**

A separate 24-V digital input is available for connection. A maximum number of 65,536 pulses per time cycle can be processed.

For synchronization of the internal actual-value counter with the initiator input, use can be made of

- an external synchronization signal via a
  fast synchronization input within the indicated number of steps/clock, or
- synchronization bit setting via the software, i.e., by the SIMATIC S5/S7
- a modulo counter (internal)

With an external synchronization signal, the actual-value counter is set to 0 at rising edge and forward direction and to the "steps per time cycle" value at falling edge and backward direction.

If synchronization is to be effected via the software, a function block must be used to load the value of 0 and to set the synchronization bit (refer to sample program).
The actual value is acquired up to the value specified in the "steps per time cycle" register (at forward) (see section 6.2.11), or up to "0" (at backward). If a synchronization signal still fails to come after another 64 steps, an error alarm may be activated.

4.1.2 Incremental Encoder

Use may be made of 5-V incremental encoders with symmetrical, 90° offset rectangular signals A, B, the associated negated tracks $\overline{A}$, $\overline{B}$, and the zero pulse track Z, $\overline{Z}$. Since each edge is evaluated, there is pulse quadruplication. For each machine cycle, a maximum of 65,536 pulses (steps) can be counted. Several encoder rotations per machine cycle are possible. The traversing direction (of interest with translatory movements in particular) and thus the selection of the forward or backward cam program can be effected automatically or via the SIMATIC S5 as under 4.1.1.

Synchronization of the actual-value counter with the incremental encoder can be initiated by means of

- synchronization by zero mark of the encoder
- external synchronization signal within the indicated number of steps/clock, or
- external synchronization signal and zero mark of the encoder
- synchronization bit setting by the SIMATIC S5/S7
- a modulo counter (internal)

At each zero mark, the current actual value is loaded in the zero mark register and is available to the SIMATIC S5 for error evaluation.

4.1.3 SSI Absolute Encoder

The WF 707 controller is capable of processing machine positions also of translatory and rotary absolute measuring systems.
The prerequisites include:

- The absolute measuring system must operate in Gray code or binary code.
- The measuring system signals must be offered to the WF 707 controller in 13-bit or 25-bit SSI format (SSI = synchronous serial interface).

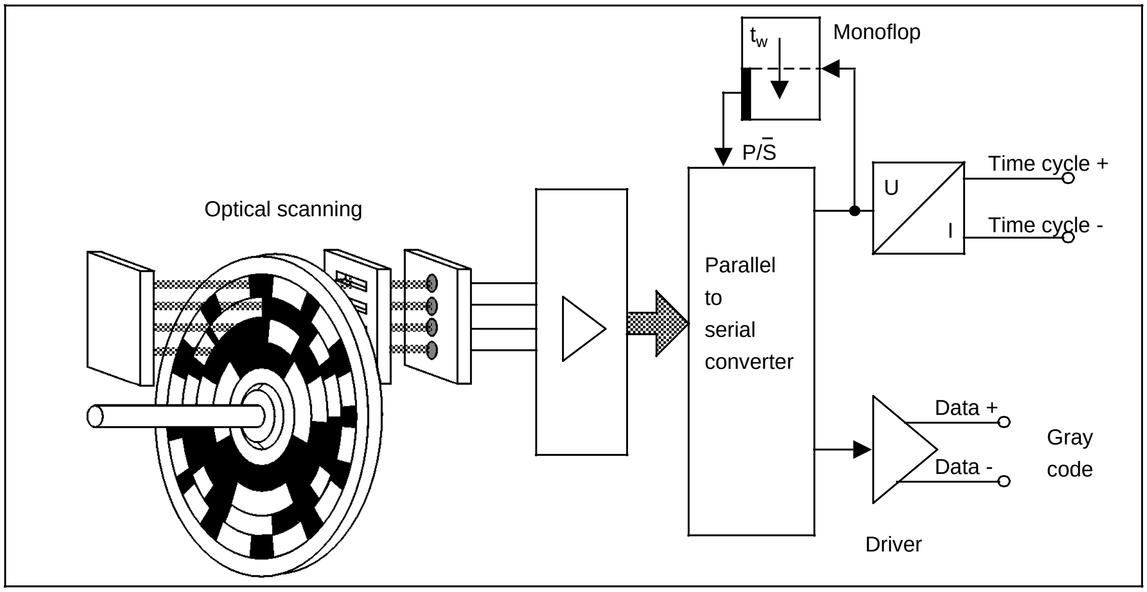


Figure 4.2 Schematic representation of a 4-bit absolute encoder with SSI

The SSI encoder provides for serial communication of the measured absolute position value via a data driver to the WF 707 controller. This offers the advantage that measured-data transfer requires only 4 lines, irrespective of the resolution (13 or 25 bit).
When a SSI absolute encoder is connected, the transfer rate must be specified by a machine datum.
The transfer rate can be selected in the steps of

- 125 kbit/s
- 250 kbit/s
- 500 kbit/s
- 1 Mbit/s

The WF 707 controller features an internal reaction time of less than 60 µs between recognition of actual value = setpoint and output of the cam signals. This reaction time will guarantee maximum switching accuracy of the cam signals only in the event of SSI transfer being accomplished at 1 Mbit/s. If this is not the case, delayed actual-value signalling will affect the accuracy of operation.
The internal actual-value counter features 16 bits. During operation in SSI format with 13 bits, the bits 2^{13} to 2^{15} in the counter are automatically set to 0. In case of the SSI format with 25 bits, a selection can be made during encoder parameter assignment as to which contiguous 16-bit block out of the 25 bits available is to be evaluated (see Figure 4.3). This may possibly have an effect on the maximum traversing distance or on the resolution that can be attained.

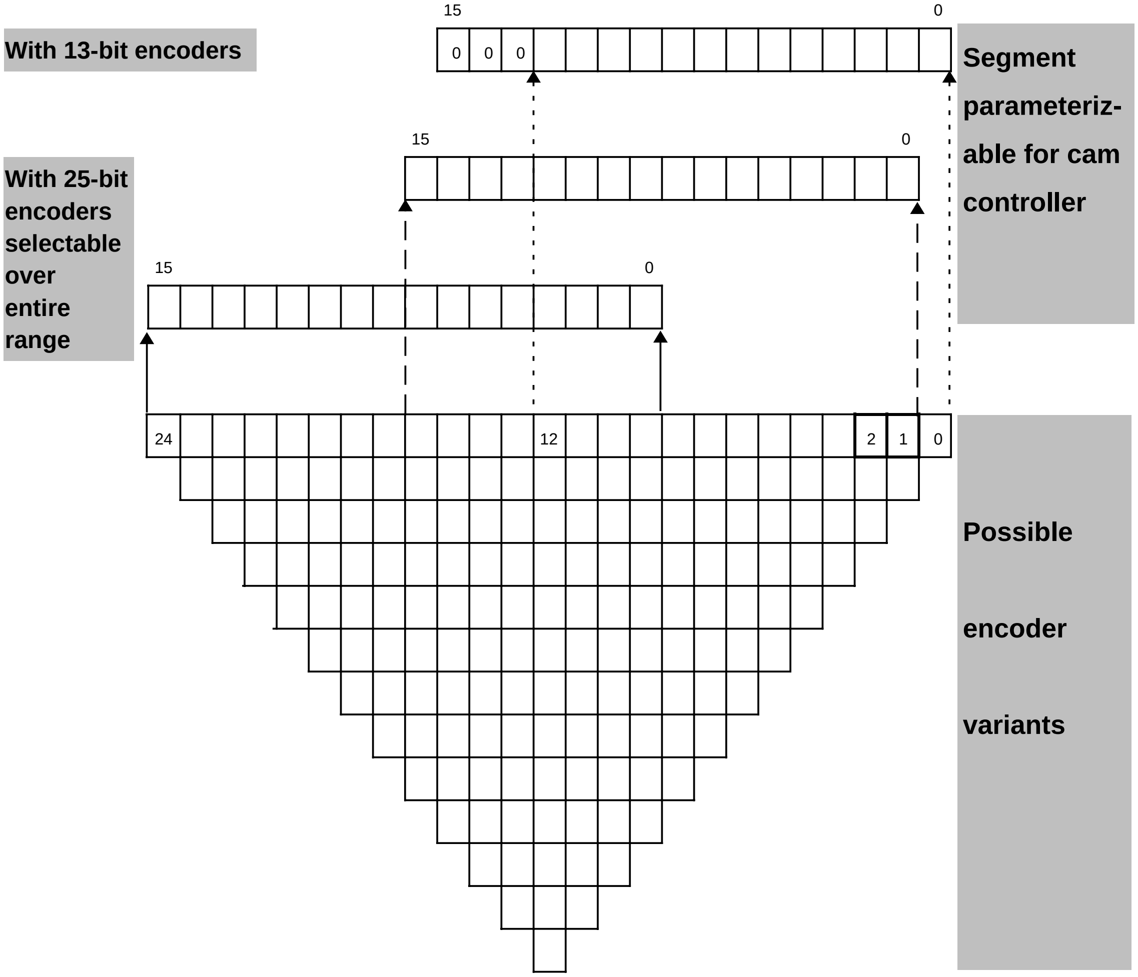


Figure 4.3 Pinetree diagram of the SSI protocol

When single-turn absolute encoders are used, a resolution of 8192 (13 bits) steps/revolution is recommended.

		Data word with 25 Bit																										
Shift sequence		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
Bit significance for WF 707 module		2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}			
Number of rev. 2^Z	Bits Z	Multi-turn bits												Single-turn bits													Bits A/ rev.	Steps/ rev. 2^A	Parameters for chapt 6.2.6.2
4096	12	12	11	10	9	8	7	6	5	4	3	2	1	13	12	11	10	9	8	7	6	5	4	3	2	1	13	8192	0000
2048	11	0	11	10	9	8	7	6	5	4	3	2	1	12	11	10	9	8	7	6	5	4	3	2	1	0	12	4096	0001
1024	10	0	0	10	9	8	7	6	5	4	3	2	1	11	10	9	8	7	6	5	4	3	2	1	0	0	11	2048	0010
512	9	0	0	0	9	8	7	6	5	4	3	2	1	10	9	8	7	6	5	4	3	2	1	0	0	0	10	1024	0011
256	8	0	0	0	0	8	7	6	5	4	3	2	1	9	8	7	6	5	4	3	2	1	0	0	0	0	9	512	0100
128	7	0	0	0	0	0	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	0	0	0	0	0	8	256	0101
64	6	0	0	0	0	0	0	6	5	4	3	2	1	7	6	5	4	3	2	1	0	0	0	0	0	0	7	128	0110
32	5	0	0	0	0	0	0	0	5	4	3	2	1	6	5	4	3	2	1	0	0	0	0	0	0	0	6	64	0111
16	4	0	0	0	0	0	0	0	0	4	3	2	1	5	4	3	2	1	0	0	0	0	0	0	0	0	5	32	1000
8	3	0	0	0	0	0	0	0	0	0	3	2	1	4	3	2	1	0	0	0	0	0	0	0	0	0	4	16	1001
4	2	0	0	0	0	0	0	0	0	0	0	2	1	3	2	1	0	0	0	0	0	0	0	0	0	0	3	8	–
2	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	2	4	–

16-bit window WF 707

((Fig. 4-4 WF 707))

Fig. 4.4 Format table SSI absolute-value encoder with 16-bit window for WF 707

When encoders with a resolution of less than 13 bits are used, note the following:

Example 1: Position encoders with a resolution of 360 steps/revolution correspond to 9 data bits.
In this case, all values

- position values and the value
- ”steps per clock” (e.g. 360),

which have to be transmitted to the module, have to be shifted to the left by 4 digits (13 bits - 9 bits) (SLW 4).

All read position actual values have to be shifted to the right by 4 digits (SRW 4).

Example 2: Position encoders with a resolution of 3600 steps/revolution correspond to 12 data bits.
In that case, the input values have to be shifted to the left by one digit (13 bits - 12 bits), and the read position actual values, to the right by one digit.

Position encoders with ”clipped” Gray code cannot be used.

As in the case of incremental encoders, the traversing direction can be determined automatically. Care must be taken in the process to avoid overriding of zero. This condition is satisfied in the case of linear axes. Otherwise the direction must be preset via the SIMATIC S5/S7.

When SSI absolute encoders are used, there is no need for synchronization of the internal actual-value counter.

SSI transfer is subject to monitoring as follows:

- When the monoflop time of the transfer protocol exceeds 64 µs, "monoflop error" is signalled.
- Should the stop bit fail to be 0, or the start bit fail to be 1, respectively, and should either or both of these errors occur at three successive transfers, "start/stop bit error" is signalled. Until then the old (previous) actual value is used.

4.1.4 Encoder Simulator

For a cam program to be executable with no drive mechanism in operation, the system offers a means of simulating the position encoder. This is effected in "encoder simulator" mode. The only useful synchronization method is modulo.

It is also possible to synchronize the module via an external synchronization signal.

A simulated encoder cycle period has

n · 1 µs   0   **n**   65535

n must be written into the "Encoder simulator time base" register. At n = 0, no encoder signal is generated, i.e. stop of the time-controlled cam controller. Presetting of direction is required.

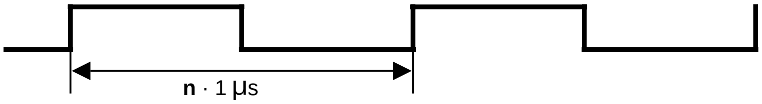


Figure 4.5   Simulated encoder signal

4.1.5 Daisy-Chaining of Actual Position Values

Should the number of cam or cam track outputs of a module prove inadequate, the system offers a means of daisy-chaining the signals of the connected position encoder (not the signals of the encoder simulator) by way of an encoder output. A 24-V initiator must supply at least 30 mA. The incremental encoder signals are refreshed and amplified. Up to 5 modules can thus be connected to one encoder.

For connection of the SSI absolute encoder, parameterize the modules connected at the outlet side for ”monitoring” and set the same baud rate.

When a WF 707 shall be operated together with the positioning module WF 721/WF 723 on one SSI absolute encoder, the WF 721/WF 723 must take over the master functions regarding the SSI clock signals (CLK). Parameterize the WF 707 for ”monitoring” and for the same baudrate as the WF 721/WF 723. Switch over the clock signals with jumpers acc. to section 7.5.3. This operation is only possible with modules as from order No. 6FM1 707-3AA10 (substitution for the module with order No. 6FM1 707-3AA00 as from 7/93).

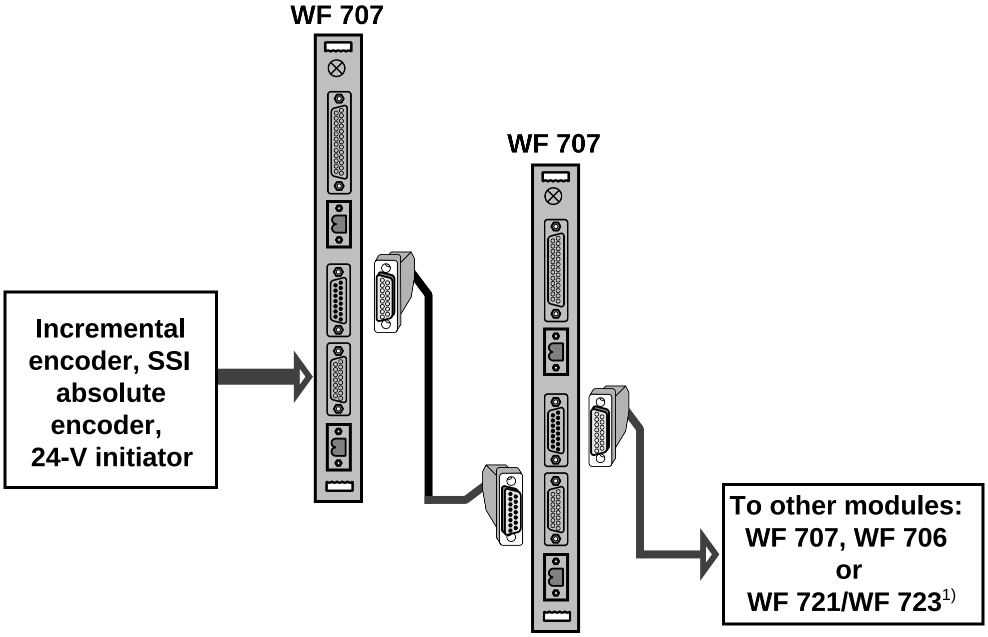


Figure 4.6 Daisy-chaining of actual position values

For further information on daisy-chaining the actual values, please refer to:

- ***Chapter 7.5.1.1 Module Address***
- ***Chapter 7.5.3 Configuration of Jumpers X71/X72***
- ***Chapter 6.2.6.2 SSI Absolute Encoders***

---

1) Prerequisite: An incremental encoder or a 24-V initiator must be connected to the first WF 707 module.
As from order No. 6FM1 707-3AA10 it is possible to connect an SSI absolute encoder.

4.2 Cams

The SIMATIC S5 transfers the cam program to the WF 707 module. If the start conditions are fulfilled, the WF 707 module supplies internal control signals which are turned on and off as a function of displacement and speed, or turned off as a function of time, respectively. These internal control signals are designated as cams. Each cam is assigned to a cam track. ction of several cams upon a common cam track is also possible. Each cam track has a digital output assigned to it.

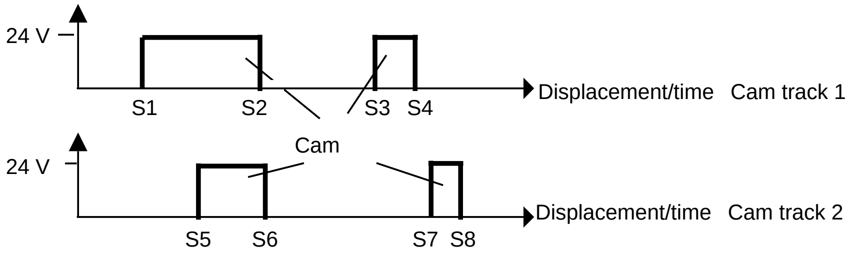


Figure 4.7 Cam signals

If several cams act on the same cam track, the output signal is an OR operation of the individual cams.

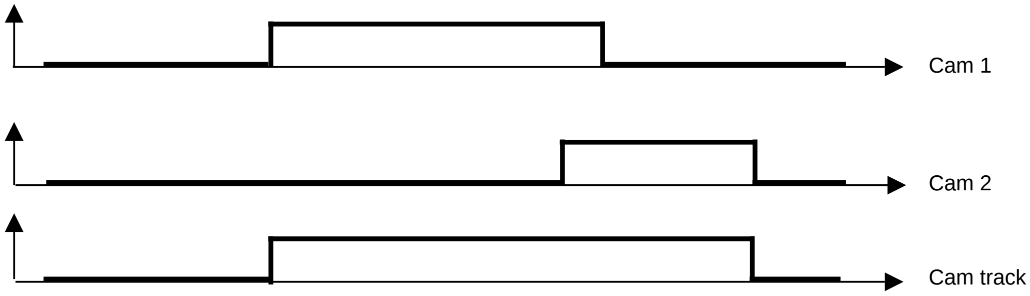


Figure 4.8 Overlapping cams

The length of any programmed cam must invariably be greater than, or at least equal to, the permissible minimum cam length. The minimum permissible cam length is a function of the cycle time, the measuring system with measuring gear, and the machine cycle. The cycle time is 57.6 µs up to 32 cams and 115.2 µs up to 64 cams. The number of steps per time cycle is determined by the measuring system and measuring gear used and also, in case of incremental encoders, by pulse quadruplication.

$$\textbf{Length of progr. cam}\ \text{[incr.]} \qquad \frac{\textbf{Cycle time}^{1)} \times \dfrac{\textbf{Steps}}{\textbf{Time cycle}} \times \dfrac{\textbf{Time cycles}}{\textbf{min}}}{\textbf{60 000 000}}$$

[1)]Cycle time 57.6 µs or 115.2 µs

To avoid "flicker" of the cam track outputs at switching edges with the machine at standstill and an "unsteady actual value", a hysteresis of one or three encoder steps can be selected by means of a jumper (see section 7.5.3).

4.2.1 Path-Path-Cams

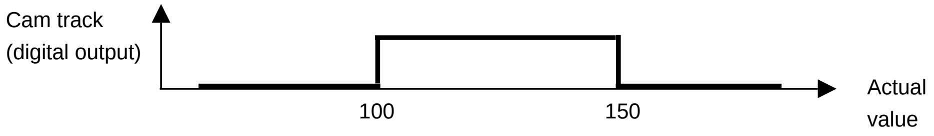


Figure 4.9 Path-Path Cam

Each path-path-cam is defined by a start position and an end position in the cam program. When the actual value reaches the initial position, a cam is set. Upon reaching of the end position, the cam is reset.

4.2.2 Path-Time-Cams

Path-time-cams are defined by a start position and by an "on" time in the cam program. The cam cuts in upon overrunning of the start position and remains on for the specified period of time, regardless of the distance covered.

It is for technical reasons that with the WF 707 module, a time cam is started at the falling edge of an "internal" cam to be programmed. Attention must be paid to the following notes:

1. *In forward motion, the time cam starts at the programmed turn-off point; in backward motion, at the programmed turn-on point.*
2. *The path difference between turn-on point and turn-off point must be large enough for the so programmed "internal" cam to start at least one WF 707 cycle. Failing this, the time cam is not started as no falling edge is detected.*
3. *A time cam can extend at most over close on one time cycle, on no account over several time cycles. If this is the case, the cam turns off in the zone of the programmed "internal" cam, and the time is re-triggered.*

Path-Time-Cam Diagrams

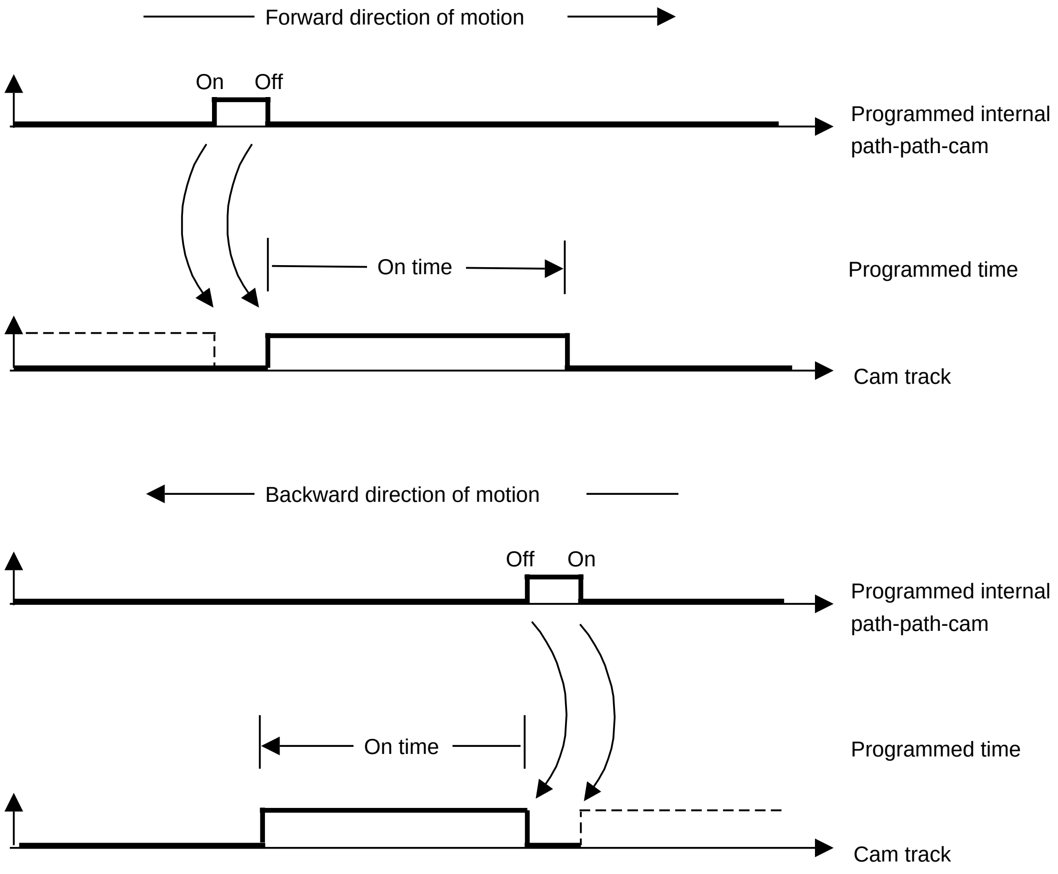


Figure 4.10 Path-time cams

4.2.3 Counting Cam

The cam track 0 can be parameterized as a counting cam (see command register chapt. 6.2). Counting cams are output only at each (n + 1)th time cycle. The value of "n" out of the counting range of 1 to 65,535 is transferred from the SIMATIC S5/S7 to the WF 707 in the "Upper counter value" register.
Each cam (path-path or path-time cam, respectively) programmed for the cam track 0 is counted internally. If just a single cam is programmed, it serves for counting the time cycles. Once the internally counted cams (for track 0) have reached the number of (n + 1),

- the instantaneously active internal cam becomes effective at digital output 0, and
- a maskable interrupt to the SIMATIC S5/S7 is released.

When programming two or more cams, care must be taken to prevent their mutual overlapping (even at maximum machine cycle frequencies). Otherwise the counting operation will not be continued.

4.2.4 Braking Cam

With WF 707 controllers, the cam track 1 can be programmed as a braking cam.
A braking cam is required with power presses in particular. In that application, it serves to control the coupling to the motor and the brake in such a manner that the press upon cutoff will come to a standstill at top dead centre, for example. This is why it is frequently also known as "TDC cam".
These properties call for a special response of the cam:

- The braking cam cuts in with the rising edge of the brake enable and
- cuts out with the falling edge of the programmed internal cam when the brake enable is no longer present.

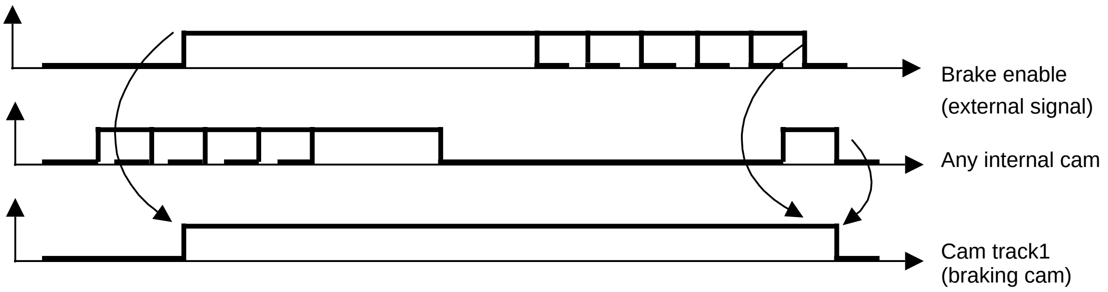


Figure 4.11 Cut-in and cut-out of the braking cam

The braking cam, too, is subject to speed-dependent dynamic relocation (time delay compensation).

Taking into account mass inertia and number of strokes

The square portion of the mass inertia and the velocity (number of strokes) require a correction of the final value of the braking cam. This correction can be realized via the user program with the help of a machine-specific TDC table.

The current number of strokes can be read out from the cam data (chapter 6.2.3.2: byte y + 12/13) of a **free** cam. The current number of strokes will only reside in bytes y + 12/13 provided that this free cam has been dynamized with 2 x WF 707 cycle time.

4.3 Dynamics

Each cam can be dynamically relocated so as to offset the delay times of the attachments connected. To that end, the delay time of the attachment is specified in the cam data record as "Max. delay time factor" to the WF 707 cycle time (57.6 µs or 115.2 µs). The module will then continuously determine the distances required for offset (derivative-action distance) and will relocate the cut-in and cut-out points accordingly.
Updating of the derivative-action distance is accomplished in a module-specific time pattern which results from the "Max. delay time factor" parameter to be input as follows:

Updating time pattern = 0.25 × ”Max. delay time factor”

If the actual value is located in the dynamic area of a cam, no updating of the derivative-action distance is effected for this cam in order to avoid "twitching" due to abrupt speed changes.

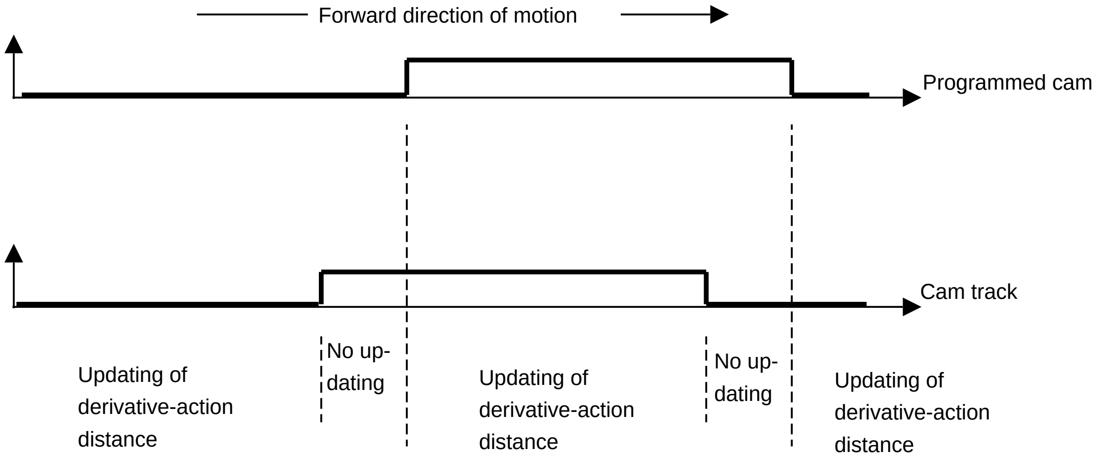


Figure 4.12 Dynamic relocation

4.4 Rotary Axes

Rotary axes as they are found on machines such as power presses or stamping machines as a rule move in a single direction only and require but one cam program for both directions. This results in two cam program options:

1. A cam program with 32 cams:
   2 cams are effective in both directions on 16 cam tracks.
   The WF 707 cycle time in this case is 57.6 µs.

2. A cam program with 64 cams:
   64 cams are effective in both directions on 16 cam tracks.
   The WF 707 cycle time in this case is 115.2 µs.

4.5 Linear Axes

Linear axes as they are found in hydraulic presses, for example, move constantly to and fro within a certain range. The cams output in forward direction must differ from those output in backward direction. For both directions, 32 cams can be programmed altogether. Forward**/**backward allocation of these cams is optional; for example: 30 cams forward, 2 cams backward. The cams are in each case processed in the directional program. Each program has the fixed cycle time of 57.6 µs.

For implementation of the special cases where path and time cams must act beyond the reversal point, both directional cam programs must be linked in accordance with the following programming instruction:

- In the "forward" cam program, the cams of the "backward" cam program are appended in a mirror-inverted manner.
- In the "backward" cam program, the cams of the "forward" cam program are appended in a mirror-inverted manner.

This is to be clarified by means of an example:

- Cams a, b are to act in forward direction,
- cams d, e, f in backward direction;
- cam c starts in forward direction, acts beyond the reversal point and continues in the backward direction.

The cam type is irrelevant. The first step is to fix the switching points of the forward and backward cams and to enter them in an operating diagram.

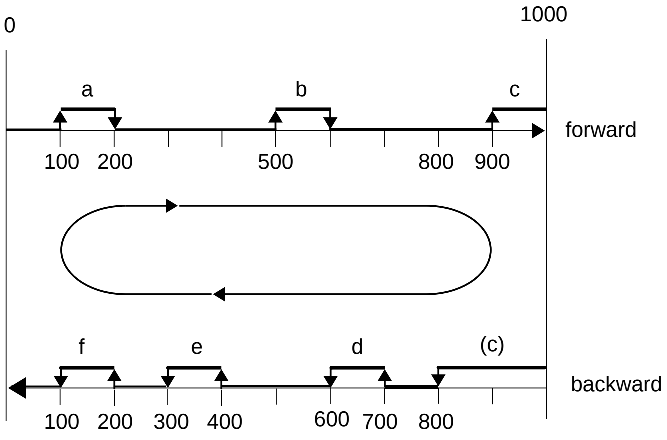


Figure 4.13 Example: Cam switching points

The second step is to

- extend the forward direction (0...1000) to double the fictitious distance (2000).
- In this range (1000...2000), mirror-images (about the 1000 line) of the backward cams d, e, f are to be entered as cams d', e', f'.

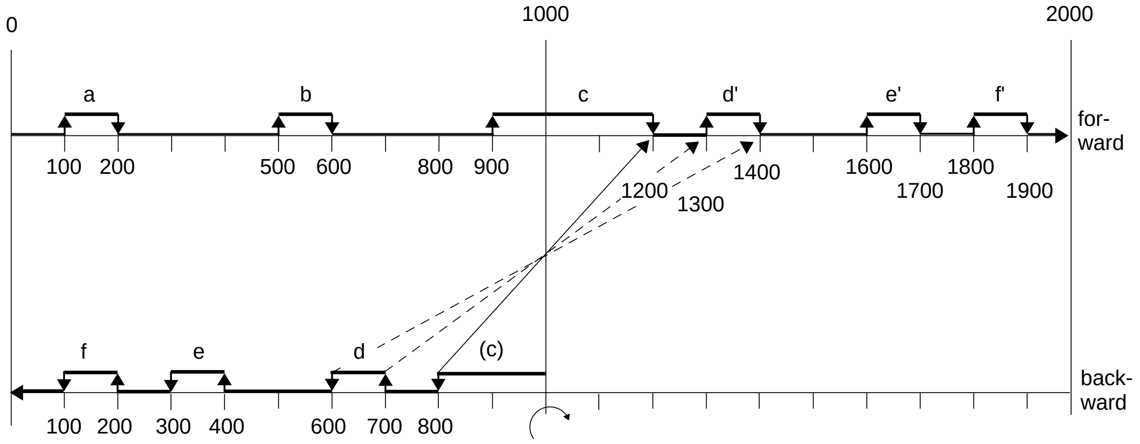


Figure 4.14 Example: Lateral inversion of backward cams

Now the "forward" cam program can be written on the basis of the values of the start and end positions (including the fictitious values) from the operating diagram. On the module, the program is stored in a defined 1 kbyte RAM memory area. It always starts from byte address 0 of the RAM memory area.
In the given example, the cam records are to be written in the specified order of the cams:

Byte:	0	Cam a	1st cam data record
	16	Cam b	2nd cam data record
	32	Cam c	3rd cam data record
	48	Cam d'	4th cam data record
	64	Cam e'	5th cam data record
	80	Cam f'	6th cam data record
	.	.	.
	.	.	.
	.	.	.
Byte:	496	.	32nd cam data record

"Forward"
cam program

Likewise, the forward cams a, b, c are to be laterally inverted into the 1000...2000 range as a', b', c'.

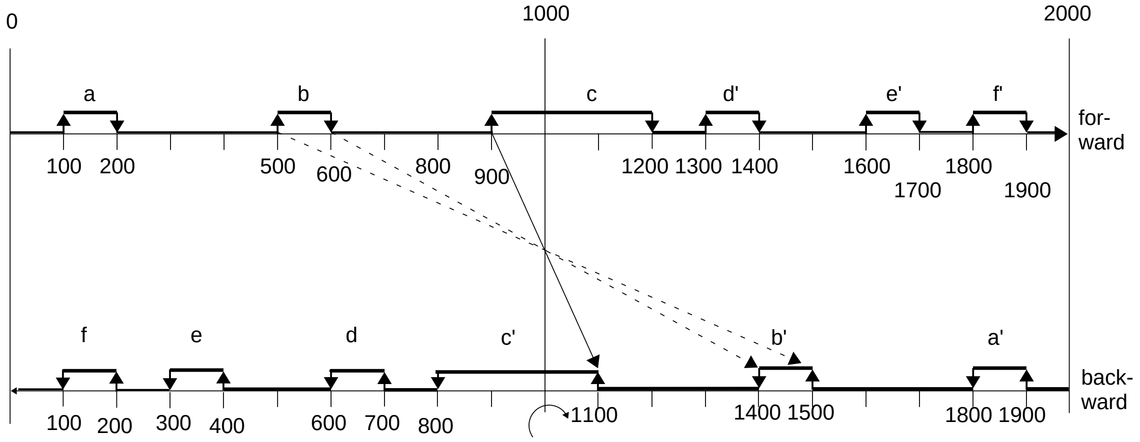


Figure 4.15 Example: Lateral inversion of forward cams

On the analogy of the "forward" cam program, the "backward" cam program can now be written on the basis of the values of the operating diagram. It always starts at byte address 512. In the given example, the cam records are to be written in the following order of the cams:

Byte:	512	Cam a'	33rd cam data record	
	·	Cam b'	34th cam data record	
	·	Cam c'	35th cam data record	
	·	Cam d	36th cam data record	
	·	Cam e	37th cam data record	"Backward"
	·	Cam f	38th cam data record	cam program
	.	.	.	
	.	.	.	
	.	.	.	
Byte:	1008	.	64th cam data record	

5 Sample Programs

5.1 SIMATIC S5 Sample Program

An executable sample program is to be found on the accompanying diskette for greater ease of familiarization with the module.

The sample function blocks used, migth, lend themselves to being used as standard function blocks for many applications. Failing this, the function blocks can be adapted to meet the specific requirements.

The "WF 707" sample program merely requires a SIMATIC S5, a WF 707 controller and a programmer. The WF 707 module must be set to the address specified in the DBWF. When the program has been loaded in the SIMATIC S5, the cam controller will operate with the encoder simulator and will process a number of cams without outputting them via the digital outputs, however. This can be observed in the DBWF and also controlled by means of the programmer.

In the "model" sample program, a small user interface for input of cam data records and the representation of the states on the WS 400 operator communication and monitoring system are shown by way of example. It requires:

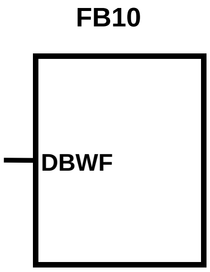
- a SIMATIC S5-115U
- a WF 707 (address: 128)
- a WF 470 (address: 0000) with WF 470 software
- an operator panel for WF 470 (keyboard signals on IB13)

With this program, too, the WF 707 module operates with the encoder simulator so that there is no need for an encoder.

5.1.1 Integration of the Sample Function Blocks into the Application Program

5.1.1.1 Start-Up and Cold Restart

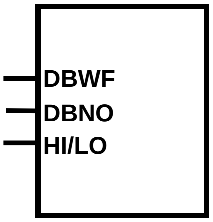
The WF 707 controller does not feature buffering so that in the event of a power failure or cut-off of the controller the data stored on the module will be lost. These data are invariably filed in the data block on the SIMATIC S5, however. They can be re-transferred to the module without any problem during start-up.
To that end, the WF 707 module is first initialized by means of FB10, then FB11 is used to transfer the cam data.



DBWF: DB No. of data block where the module-specific parameters are filed (see section 5.2).

Kind: B Type: - Allowed values: DB1 - DB255

FB11



DBNO: DB No. of data block where 32 cam data records are stored (see section 5.2).

Kind: B Type: - Allowed values: DB1 - DB255

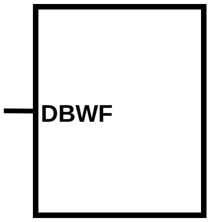
HI/LO: Bit No. indicating whether the information of DBNO is applicable to the cam data records 1 to 32 or 33 to 64:
0=Cam data records 1 to 32
1=Cam data records 33 to 64

Kind: E Type: BI Allowed values: E 0.0 - E127.7
M 0.0 - M200.0

5.1.1.2 Cyclic Program

In the cyclic program, constant access to the module is not absolutely necessary since the WF 707 executes the cam program independently. But as the SIMATIC S5 should exert constant control over the machine, a function block FB12 has been added. In the cyclic program, the FB12 block reads the status and the states from the module and files these data in the module-specific data block. In addition, the FB12 block serves to transfer commands from the data block to the module. The block should be located at the beginning or at the end of the cyclic program.

FB12



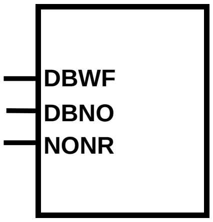
DBWF: DB No. of data block where the module-specific parameters are filed (see section 5.2).

Kind: B Type: - Allowed values: DB1 - DB255

5.1.1.3 Editing a Cam Data Record

This function block can be used to transfer a single cam data record from the DBNO data block to the module. At a number of cams greater than 31 (NONR > 31), a second DBNO (cam data records 32 to 63) must be used to call the FB13 block.

FB13



DBWF: DB No. of data block where the module-specific parameters are filed (see section 5.2.1).

DBNO: DB No. of data block where a cam program is stored (see section 5.2.2).

Kind: B Type: - Allowed values: DB1 - DB255

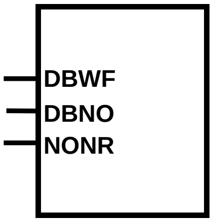
NONR: Number of cam data record (0 to 63) to be transferred to the WF 707.

Kind: E Type: BY Allowed values: EB0 - EB127
MB0 - MB200

5.1.1.4 Reading a Cam Data Record

This function block serves to read the data of a single cam data record back from the module and file them in the DBNO. At a number of cams greater than 31 (NONR > 31), a second DBNO (cam data records 32 to 63) must be used to call the FB14 block.

FB14



DBWF: DB No. of data block where the module-specific parameters are filed (see section 5.2.1).

DBNO: DB No. of data block where a cam data record is to be filed (see section 5.2.2).

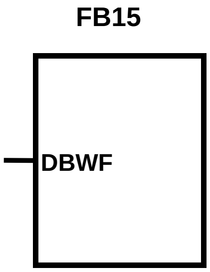
Kind: B Type: - Allowed values: DB1 - DB255

NONR: Number of cam data record (0 to 63) to be read from the WF 707.

Kind: E Type: BY Allowed values: EB0 - EB127
MB0 - MB200

5.1.1.5 Synchronization via Software

Along with the synchronization methods of "External SYNC signal", "Zero mark of encoder" and their combination, there is the possibility of using the SIMATIC S5 software to synchronize the controller with the machine. This requires the machine to be moved to zero position and be stopped. The function block FB15 will then zero the actual-value counter and set the synchronization bit to 1. During synchronization, the cam states are set and reset in accordance with position 0. Interrupts are released in the process if programmed. Any edge error that may occur is irrelevant in this connection and is to be acknowledged.



DBWF: DB No. of data block where the module-specific parameters are filed (see section 5.2).

Kind: B Type: - Allowed values: DB1 - DB255

5.1.1.6 Notes on Interrupt Processing

When an interrupt processing is enabled via the interrupt register, the following must be taken into account:

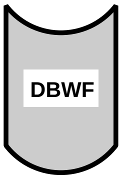
- Cyclic reading of a register of the WF 707 calls for a particular content of the selection register (0, 1, 2, or 3). As the content of the selection register must possibly be modified during interrupt processing, the content must be saved prior to interrupt processing and be reloaded afterwards. This procedure is not required for cyclic reading of the actual value.

- Cyclic reading of the status register and interrupt service are mutually exclusive, as reading of the status register serves to acknowledge the interrupt, and in marginal cases an interrupt may possibly get lost.

5.1.2 Data Blocks

5.1.2.1 DBWF

In the DBWF data block, the module-specific parameters are filed.



	DL (15 14 13 12 11 10 9 8)	DR (7 6 5 4 3 2 1 0)	
DW 0	Module address		(see also sect. 7.5.1)
DW 1	Command register	Interrupt register	(see also sect. 6.2.1/6.2.2)
DW 2	Encoder parameterization		(see also sect. 6.2.6)
DW 3	Steps per time cycle		(see also sect. 6.2.11)
DW 4	Time base for encoder simulator		(see also sect. 6.2.7)
DW 5	Maximum delay time in WF 707 cycles		(see also sect. 6.2.10)
DW 6	Output selection		(see also sect. 6.2.8)
DW 7	Output ports		(see also sect. 6.2.5)
DW 8	Upper counter value		(see also sect. 6.2.4)
DW 9	Reserve		
DW 10	Current actual value		(see also sect. 6.3.1)
DW 11	Current value of counting cam		(see also sect. 6.3.5)
DW 12	Zero mark value		(see also sect. 6.3.3)
DW 13		Status register	(see also sect. 6.3.2)
DW 14	Cam states (cam tracks)		(see also sect. 6.3.7)
DW 15	States of digital outputs		(see also sect. 6.3.6)

5.1.2.2 DBNO

In the DBNO data block, a cam program with a maximum of 32 cam data records is filed. In order to save storage space, the internal cam record data of the WF 707 are not filed here so that each cam data record is reduced to 5 data items (see section 6.2.11). For each cam program, a data block according to DBNO is to be set up and programmed. With FB11, FB13 and FB14, the applicable DB No. must be specified as a parameter of DBNO.

DBNO

	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
	DL	**DR**
DW 0	**Reserve**	**Control byte, cam 1**
DW 1	**Start position, cam 1**	
DW 2	**End position, cam 1**	
DW 3	**Delay time factor, cam 1**	
DW 4	**On time factor, cam 1**	
DW 5	**Reserve**	**Control byte, cam 2**
DW 6	**Start position, cam 2**	
•	•	
•	•	
•	•	
DW 159	**On time factor, cam 32**	

5.2 SIMATIC S7 Sample Program

The WF 707 module in the SIMATIC S7 is addressed in the same way as with the SIMATIC S5. Note, however, the changed scope of commands, e.g. PY is replaced by PEB and PAG (periphery access read/write).

OB 100 (WF 707 with S7 address 512)

```
Network 1
//*****************************************************************************************
//Startup
//*****************************************************************************************
      L      B#16#1                    //Value 1 for selection register
      T      PAB  512                  //Initial address WF 707 selection register = 1

//*****************************************************************************************
//Parameterization of incremental encoder
//*****************************************************************************************
      L      B#16#8                    //Synchronization with encoder zero mark
      T      PAB  518                  //Initial address +6
      L      B#16#0
      T      PAB  519                  //Initial address +7
```

... further transfer of relevant startup data

OB1

```
//*****************************************************************************************
Reading status register and storing in variable "status"
//*****************************************************************************************

      ⋮
      L      B#16#0                    //Value 0 for selection register
      T      PAB  512                  //Initial address WF 707 selection register = 1
//*****************************************************************************************
//Read status register
//*****************************************************************************************
      L      PEB  514                  //Initial address +2
      T      "Status"
      ⋮
```

The following sample sequence shows segments of indirect access by means of the example "Read actual value ".

OB1 / OB 100

```
      ⋮
CALL  FB    10 , DB10
Adress_WF707:=512
Startup_cycle:=0                       //0:Cycle
                                       //1: Pre-assignment pointer/initialization
                                       routine
```

Program parts of FB 100

Adress	Decl.	Variable	Data type	Start value	Comment
0.0	in	Adress_WF707	INT	0	Initial address WF707
2.0	in	Startup_cycle	INT	0	OB100:1 / OB1:0
	out				
	in_out				
⋮					
20.0	stat	w_actual	WORD	W#16#0	Current actual value
32.0	stat	d_z0	DWORD	DW#16#0	Initial address WF707 Pointer
32.0	stat	d_z1	DWORD	DW#16#0	Initial address +1 WF707

Declaration of variables

```
L       #Adress_WF707       //Load address into pointer
SLD     3
T       #d_z0               //Initial address
+       1
SLD     3
T       #d_z1               //Initial address + 1
```

Start-up sequence

```
•
•
•
```

```
L       #d_z0               //(AWR=0)**Read out act. value****
LAR1                        //Load pointer actual value low-byte
L       #d_z1
LAR2                        //Load pointer actual value high-byte
L       PEB [AR1,P#0.0]     //Actual value low
L       PEB [AR2,P#0.0]     //Actual value high
SLW     8
OW
T       #w_actual           //Actual value WF707*************
```

Cycl. processing

6 SIMATIC S5/S7 - WF 707 Communication

6.1 Interface and Control Register

In order to limit the data interface to a mere 8 bytes in the peripheral area, in spite of the large volume of data to be transferred from the SIMATIC S5/S7 to the module, and still achieve high rates of transfer, the interface has been designed for high-speed multiplex operation.

The bytes x of the registers etc. indicated below are addressed in the SIMATIC S5 or S7 via PYx or PABx/PEBx, respectively.

The first byte of the interface is the so-called selection register. Its address matches the initial address x of the module as set via DIL switch. Almost like a pointer register used in indirect addressing, this byte serves to determine the meaning of the following 7 bytes:

Selection register = 0

	Write		Read	
Byte:	7 0		7 0	
x	**0**		**Actual value**	**Low**
x+1	**Command register**			**High**
x+2	**Interrupt register**		**Status register**	
x+3	**Unassigned**		**Unassigned**	
x+4	**Cam address**	**Low**	**Zero mark value**	**Low**
x+5		**High**		**High**
x+6	**Cam data**	**Low**	**Cam data**	**Low**
x+7		**High**		**High**

Selection register = 1

	Write		Read	
Byte:	7 0		7 0	
x	**1**		**Actual value**	**Low**
x+1	**Command register**			**High**
x+2	**Upper counter value**	**Low**	**Current counter value**	**Low**
x+3		**High**		**High**
x+4	**Output ports**	**7 - 0**	**States of digital outputs**	**7 - 0**
x+5		**15 - 8**		**15 - 8**
Y x+6	**Encoder parameterization**		**Unassigned**	
x+7			**Unassigned**	

Selection register = 2

Byte:	Write (7 … 0)	Read (7 … 0)
x	**2**	**Actual value** **Low**
x+1	**Command register**	**High**
x+2	**Time base, encoder simulator** **Low**	––
x+3	**High**	––
x+4	**Output selection** **7-0**	**Cam track states** **7-0**
x+5	**15-8**	**15-8**
x+6	**Encoder programming (iin preparation)**	**Encoder programming (in preparation)**
x+7		

Selection register = 3

Byte:	Write (7 … 0)	Read (7 … 0)
x	**3**	**Actual value** **Low**
x+1	**Command register**	**High**
x+2	––	––
x+3	––	––
x+4	**Factor, max. delay time** **Low**	––
x+5	**High**	––
x+6	**Steps per time cycle** **Low**	––
x+7	**High**	––

Access to a particular register on the module then is obtained as follows:

1. Set selection register.
2. Read (L PY.../PEB...) or write (T PY.../PAB...) desired register.
3. Re-adjust selection register (only if necessary).
4. Read or write next register selected.

For the SIMATIC S5, the corresponding part of the program is as follows:

(WF 707 initial address: 128)

L KH 1 **T PY 128**	Set selection register to 1.
L DR 1 **T PY 130** **L DL 1** **T PY 131**	Transfer "Upper counter value" from DW 1 to module.
L PY 132 **T DR 2** **L PY 133** **T DL 2**	Read states of digital outputs and file in DW 2.
L PY 128 **T DR 3** **L PY 129** **T DL 3**	Read actual value and file in DW 3.
LKH 0 **T PY 128**	Set selection register to 0.
L PY 130 **T MB 1**	Read status register and file in FY 1 (MB 1).

All read and write instructions must be programmed in byte mode and in ascending order (first low, then high byte).

All register contents in KH format are interpreted in binary manner, e.g., Upper counter value 100≙0064 KH

x+2	**6**	**4**	KH
x+3	**0**	**0**	KH

Any access to unassigned addresses during "Write" will be acknowledged by the module without any further reaction whereas during "Read", the states of the digital outputs will be signalled back.

In case of operation with interrupt processing and cyclic reading of a register, the selection register must be saved and be updated again after interrupt processing.

6.2 Write

6.2.1 Command Register

	Write	
x	**0**	KM

	7	6	5	4	3	2	1	0	
Byte x+1	**Direction to be preset (with SSI only)**	**32/64 cam data records**	**Load counting register**	**Enable outputs**	**Cam backward**	**Braking cam**	**Counting cam**	**Enable cam processing**	KM

Enable cam processing: Byte x+1, Bit 0

1=Cam processing enabled
0=Cam processing disabled

Upon enabling of cam processing, the cam data records are processed and the internally available cam states are generated which can be interrogated from the SIMATIC S5. Output to the digital outputs will only be effected upon "Enable outputs".

Counting cam: Bit 1

1=Cam track 0 operates as counting cam
0=Normal operation of cam track 0

With the bit set, the cam track 0 operates as a counting cam showing the response outlined in section 4.2.3.

Braking cam: Bit 2

1=Cam track 1 operates as braking cam
0=Normal operation of cam track 1

With the bit set, the cam track 1 operates as a braking cam showing the response outlined in section 4.2.4.

Cam backward: Bit 3

1=Forward and backward cam output different
0=Forward and backward cam output equal

This bit is of importance only if processing of 32 cam data records has been selected (bit "32/64 cam data records" = 0).
Processing of the 32 cams is effected in forward and in backward direction.
"Cam backward" = 1 means that in forward direction the cam data records 1 to 32 and in backward direction the cam data records 33 to 64 are processed. To maintain coherence of the cams in both directions of movement here, close attention must be paid to the program instructions in section 4.5.

Enable outputs: Byte x+1, Bit 4

1=Digital outputs enabled
0=Digital outputs disabled

This bit is used to enable the digital outputs. With the digital outputs disabled, interrogation of the cam states via the SIMATIC S5/S7 is possible (provided cam processing has been enabled), but no output is made to the digital outputs.

Load counting register: Bit 5

With the bit set, the value of the counting cam is loaded on the "Upper counter value" upon each transfer of the command register. The counting cam can thus be influenced from the SIMATIC S5/S7 at any time.

32/64 cam data records: Bit 6

1=64 cam data records
0=32 cam data records

This bit is used to select the number of cam data records to be processed. This has an effect on the cycle time of the module.

32 cam data records:
32 cam data records are processed in one cycle.
The cycle time of the module is 57.6 µs. Separate control of the cams in forward and in backward direction is possible (see section 4.5).

64 cam data records:
64 cam data records are processed in one cycle. The cycle time of the module is 115.2 µs. Control of the cams is identical in the forward and backward directions.

Direction to be preset: Bit 7

1=Backward
0=Forward

This bit is effective only with an SSI absolute encoder selected and direction recognition disabled. The direction of travel is thus preset from the SIMATIC S5/S7.

6.2.2 Interrupt Register

Write

x	0	KM

	7	6	5	4	3	2	1	0	
Byte x+2	**Cam track 5**	**Cam track 4**	**Cam track 3**	**Cam track 2**	**Cam track 1**	**Cam track 0**	**External synchro-nization**	**Group error interrupt**	KM

1=Interrupts disabled
0=Interrupts enabled

The interrupt register can be used to disable or enable all interrupts. The interrupt is released by the state of the status bits (see section 6.3.2). The state of the status bits is independent of enable. Following RESET, all interrupts are disabled. The interrupt channels A to D are selected via switches on the module (see section 7).

For address setting and interrupt processing when using SIMATIC S7 with S7 adapter casing, refer to chapter 7.5.2.

6.2.3 Cam Program

The cam program is made up of a maximum of 64 cam data records. These records may split up again into a cam program for forward and a cam program for backward (see also sections 4.4 and 4.5).
A separate storage location on the module and a separate transfer mechanism have been provided for the cam program.

For the 64 cam data records available at most, 1024 bytes of storage space are required. This storage area is allocated as follows:

Byte 0...15	**Cam data record 1**	forward	forward and backward
Byte 16	**Cam data record 2**		
⋮	⋮		
Byte 496	**Cam data record 32**		
Byte 512	**Cam data record 33**	backward	
⋮	⋮		
Byte 1008	**Cam data record 64**		

Access to this storage area is obtained via two registers on the interface to the SIMATIC S5/S7. They are "Cam address" and "Cam data" (see section 6.1).

6.2.3.1 Cam Address

Write

x	**0**	KM

Byte:	7	6	5	4	3	2	1	0	
x+4	**2^7**	**2^6**	**2^5**	**2^4**	**2^3**	**2^2**	**2^1**	**2^0**	KM
x+5	**Auto-increment**	––	––	––	––	––	**2^9**	**2^8**	KM

In the "Cam address" register, the desired initial address for the cam data is selected in the bits 2^0 to 2^9. Two bytes are invariably read or written at the same time so that this address must be even-numbered (bit 2^0 must be set to zero). The storage area selected here is subsequently available in the "Cam data" register, or can be written into via the "Cam data" register, respectively. The low byte**/**high byte order is mandatory in the process.

Autoincrement:	1 = Autoincrement on 0 = Autoincrement off

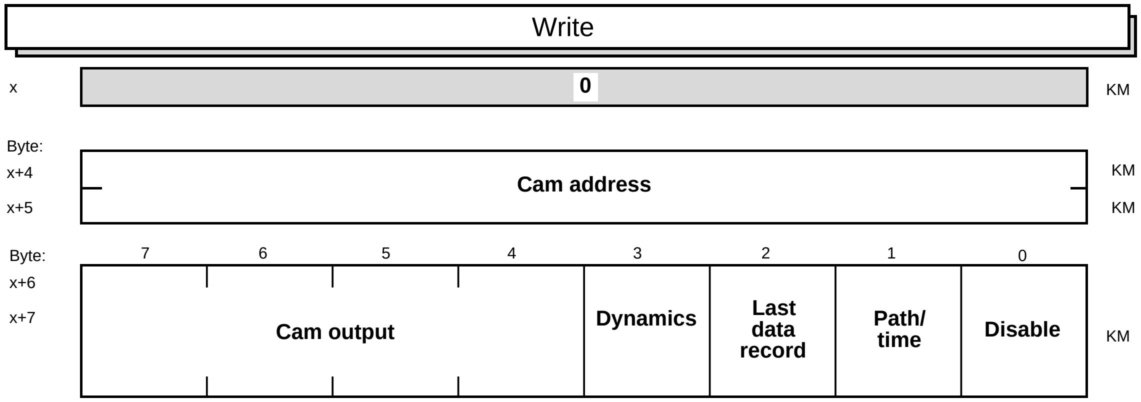
With "autoincrement" on, the module will increase the cam address independently after each access of the SIMATIC S5/S7. Reading or writing is thus possible without a need to constantly change the cam address. A cam data record consists of 16 bytes (see section 6.2.3.2).

6.2.3.2 Cam Data

Byte					
y	**Cam control byte**		KM	Data from SIMATIC S5/S7	Cam data record
y+1	**Reserve**		—		
y+2	**Start position**	**Low**	KH		
y+3		**High**			
y+4	**End position**	**Low**	KH		
y+5		**High**			
y+6	**Delay time factor**	**Low**	KH		
y+7		**High**			
y+8	**On time factor**	**Low**	KH		
y+9		**High**			
y+10	**Current time factor**	**Low**	KH	Internal data of WF 707	
y+11		**High**			
y+12	**1/4×Derivative-action distance**	**Low**	KH		
y+13		**High**			
y+14	**Reserve**	**Low**	KH		
y+15		**High**			

Cam control byte

Each cam data record has a cam control byte of its own.



Disable: Byte y, Bit 0

1 = Disabled
0 = Enable

This bit can be used to disable individual cam data records for processing. This is necessary, for example, to prevent any short-time false reactions during re-parameterization caused by an incomplete cam data record.
(Procedure: disable, change, enable)

Path/time: Bit 1

1 = Time cam
0 = Path-path cam

This bit is used for changeover between path-path cams and time cams.

Last data record: Bit 2

1= Last cam data record for this digital output
0= Further cam data records to follow for this digital output

With this bit set, the cam state so far ascertained is output to the digital output indicated in this cam data record. From this ensue three important rules:

1. *All cam data records of a cam track must be directly successive.*
2. *With all cam data records, the "Last data record" bit = 0.*
   Only with the last cam data record, the bit is =1.
3. *Addressing to the digital output is valid in the last cam data record only.*

Dynamics: Byte y, Bit 3

1=Dynamics off
0=Dynamics on

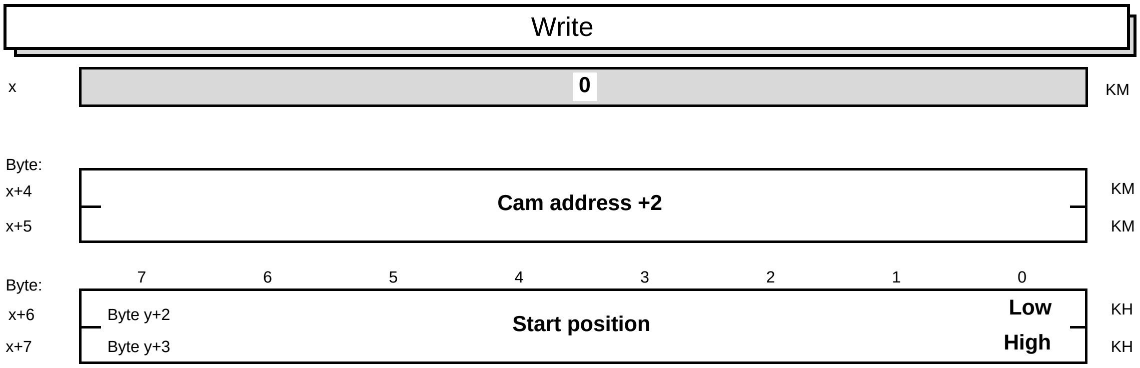
This bit can be used to turn dynamic cam relocation (delay time compensation) on and off (see section 4.3).

Cam output: Bit 4 - 7

In these 4 bits, the digital output associated with the cam track is addressed in binary mode. The address is evaluated only if this is the last cam data record for this digital output ("Last data record" bit = 1).

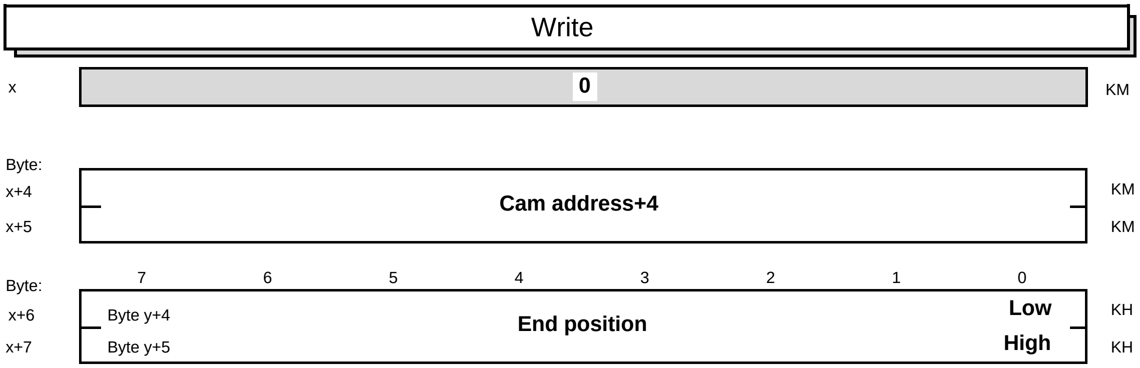
Numbering of the digital outputs from 0 to 15.

Start position



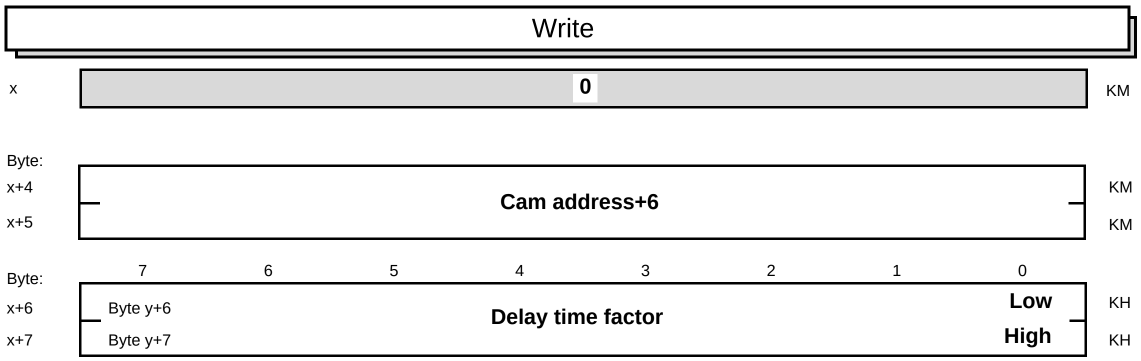
The start position values are to be input in binary mode, described in terms of absolute positions in increments.

End position



The end position values are to be input in binary mode, in terms of absolute positions in increments.

Delay time factor



The delay time is not directly preset for sthe module, but as a weighting factor of the WF 707 cycle time. The factor is determined and input as follows:

$$\text{"Delay time factor"} = \frac{\text{delay time } [\mu s]}{4 \times \text{WF 707 cycle time } [\mu s]}$$

The WF 707 cycle time is: 57.6 µs for max. 32 cams
115.2 µs for max. 64 cams

Example:
- Desired delay time: 8 ms
- WF 707 cycle time: 57.6 µs

$$\text{"Delay time factor"} = \frac{8\,000\ \mu s}{4 \times 57.6\ \mu s} = 35 \mathrel{\hat{=}} \underline{0023\text{ KH}}$$

Ontime factor

Write

x		0		KM
Byte:				
x+4		**Cam address+8**		KM
x+5				KM
Byte:	7	6 5 4 3 2 1	0	
x+6	Byte y+8	**Ontime factor**	**Low**	KH
x+7	Byte y+9		**High**	KH

The Ontime ist not directly preset for the module, but as a weighting factor of the WF 707 cycle time. The factor is determined and input as follows:

$$\text{"Ontime factor"} = \frac{\text{Ontime } [\mu s]}{\text{WF 707 cycle time } [\mu s]}$$

The WF 707 cycle time is:

57.6 µs for max. 32 cams
115.2 µs for max. 64 cams

Example:
- Desired Ontime: 50 ms
- WF 707 cycle time: 115.2 µs

$$\text{"Ontime factor"} = \frac{50\,000\ \mu s}{115.2\ \mu s} = 434 \mathrel{\hat{=}} \underline{\text{01B2 KH}}$$

6.2.4 Upper Counter Value

Write		
x	1	KM

Byte:	7	6	5	4	3	2	1	0	
x+2	**Upper counter value**							**Low**	KH
x+3								**High**	KH

In this register, the "Upper counter value" for the counting cam is passed as 16-bit binary value (see section 4.2.3).

6.2.5 Output Ports

Write		
x	1	KM

Byte:	7	6	5	4	3	2	1	0	
x+4	**Port 7**	**Port 6**	**Port 5**	**Port 4**	**Port 3**	**Port 2**	**Port 1**	**Port 0**	KM
x+5	**Port 15**	**Port 14**	**Port 13**	**Port 12**	**Port 11**	**Port 10**	**Port 9**	**Port 8**	KM

The output ports (and the respective "Output selection", see section 6.2.8) can be used by the SIMATIC S5/S7 for direct control of the digital outputs.

Port z = 1 : Port set
Port z = 0 : Port not set

6.2.6 Encoder Parameterization

In the "Encoder parameterization" register PY x + 6, the bits 0 and 1 serve to select the respective encoder types.

Bit 1	0	
0	0	Incremental encoder
0	1	SSI absolute encoder
1	0	24-V-initiator
1	1	Encoder simulator

6.2.6.1 Incremental Encoder

Write

x	1	KM

Byte:	7	6	5	4	3	2	1	0	
x+6	––	––	––	**Synchronization method**		**Counting direction**	**0**	**0**	KM
x+7	––	**Set synchronization**	––	––	––	––	––	––	KM

Counting direction: Byte x+6, Bit 2

1=Inverted
0=Normal

This bit can be used to adapt the sense of rotation of the encoder to suit the mechanical system.

Synchronization method: Bit 3, 4

Bit 4	3	
0	0	Internal by modulo counter
0	1	Zero mark of encoder
1	0	External SYNC signal
1	1	Zero mark of encoder and ext. SYNC signal

Internal by modulo counter:

With this "Synchronization method", the actual-value counter in forward mode counts up to the value of "Steps per time cycle" (see sections 4.1.2; 6.2.10) and is then set to "0". In backward mode, the counter counts to 0 and is then set to the value of "Steps per time cycle".

Zero mark of encoder:

With this method, each encoder rotation corresponds to one time cycle. At each zero mark of the incremental encoder, the actual-value counter in forward mode is set to 0 with the rising zero mark edge, and in backward mode is set to the "steps per time cycle" value with the falling zero mark edge.

External SYNC signal:

The signal for synchronization comes via the "SYNC" digital input (X2:13). In forward mode, the actual-value counter is set to 0 with the rising edge of this signal, and in backward mode, it is set to the "steps per time cycle" value with the falling edge.

Zero mark of encoder and ext. SYNC signal:

With this synchronization method, the external SYNC signal enables the zero mark for synchronization, i.e., as soon as the SYNC signal is present, the counter is set in accordance with the "Zero mark of encoder" synchronization with the next zero mark.

Set synchronization: Byte x+7, Bit 6

The synchronization bit is set, i.e., the actual value is validated, with the rising edge of this bit.

6.2.6.2 SSI Absolute Encoder

Write

Byte:	7	6	5	4	3	2	1	0	
x	1								KM
x+6	**Baud rate**		**Reserve**	**Reserve**	**Gray-to-binary converter**	**Listening**	**0**	**1**	KM
x+7	––	––	**Direction recognition**	**13/25 Bit**	**Bit selection**				KM

Listening: Byte x+6, Bit 2

1=Module listening
0=Module has encoder of its own

When SSI absolute encoders are used, the "Listening" bit serves to disable the active part in the actual-value channel, and the module receives only the looped-through actual values. Activate this bit on the slave module only. With all other types of encoders, no setting is required for this operational case (see also section 4.1.5).

Gray-to-binary converter: Bit3

1=Conversion from Gray to binary code
0=No conversion

This add-on Gray-to-binary converter enables alternative connection of encoders with binary code or encoders with Gray code. The module itself operates in binary code so that the converter must be turned on in the case of an encoder with Gray code and be turned off in the case of an encoder with binary code.

Reserve Byte x+6, Bit 4

Reserve Bit 5

Baud rate: Bit 6, 7

These bits are used to set the transfer rate. The transfer rate has an effect on the updating time of the actual value of the module. The shorter the updating time, the higher the positioning accuracy. It is therefore recommended to use the highest possible baud rate for the lead length concerned (see section 7.1).

Bit	7	6	
	0	0	125 Kbit/s
	0	1	250 Kbit/s
	1	0	500 Kbit/s
	1	1	1 Mbit/s

Bit selection: Byte x+7, Bit 0-3

When encoders with 25-bit transfer length are used, a choice can be made of the 16 bits to be evaluated.

Bit	3	2	1	0		
	0	0	0	0	Highest bit is	2^{15}
	0	0	0	1	Highest bit is	2^{16}
	0	0	1	0	Highest bit is	2^{17}
	0	0	1	1	Highest bit is	2^{18}
	0	1	0	0	Highest bit is	2^{19}
	0	1	0	1	Highest bit is	2^{20}
	0	1	1	0	Highest bit is	2^{21}
	0	1	1	1	Highest bit is	2^{22}
	1	0	0	0	Highest bit is	2^{23}
	1	0	0	1	Highest bit is	2^{24}

Example: Setting **0101** (highest bit is 2^{20})

2^{24}	2^{23}	2^{22}	2^{21}	**2^{20}**	**2^{19}**	**2^{18}**	**...**	**...**	**...**	**2^{7}**	**2^{6}**	**2^{5}**	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}

These are the 16 bits evaluated

13**/**25 bits: Byte x+7, Bit4

1=25 bits
0=13 bits

This bit is used to set the transfer length in the case of SSI absolute encoders.

Direction recognition: Bit 5

1=Preset by the SIMATIC S5/S7
0=Automatic

With SSI absolute encoders, automatic direction recognition functions only if the encoder zero point is not exceeded. If it is exceeded (e.g., in the case of continuously rotating machines with single-turn encoder), the direction information must be preset in the command register from the SIMATIC S5/S7.

6.2.6.3 24-V Initiator (BERO)

Write

x	**1**								KM
	7	6	5	4	3	2	1	0	
Byte x+6	––	––	––	**Synchronization method**		**Counting direction**	**1**	**0**	KM
x+7	––	**Set synchronization**	––	––	––	––	––	––	KM

With this setting, simple initiators can be used as encoders for the cam controller. As direction information cannot be derived from these signals, it must be preset by the SIMATIC S5/S7.

Counting direction: Byte x+6, Bit 2

1=Backward
0=Forward

Synchronization method: Bit 3, 4
(see section 6.2.6.1)

Set synchronization: Byte x+7, Bit 6
(see section 6.2.6.1)

6.2.6.4 Encoder Simulator

Write

x	1								KM
	7	6	5	4	3	2	1	0	
Byte x+6	––	––	––	**Synchronization method**		**Counting direction**	1	1	KM
x+7	––	**Set synchronization**	––	––	––	––	––	––	KM

The encoder simulator can be used to simulate a lacking incremental encoder. Here again, as in the case of the 24-V initiator, presetting of the counting direction is required.
The "speed" of the encoder simulator is set in the "Encoder simulator time base" register (see section 6.2.7).

Counting direction: Byte x+6, Bit 2

1=Backward
0=Forward

Set synchronization: Byte x+7, Bit 6
(see section 6.2.6.1)

6.2.7 Encoder Simulator Time Base

Write

x	**2**	KM

Byte:	7	6	5	4	3	2	1	0	
x+2	**Encoder simulator time base**							**Low**	KH
x+3								**High**	KH

In this byte, the value "n" is given as the period of an encoder time cycle in 1-µs increments (see section 4.1.4).

6.2.8 Output Selection

Write

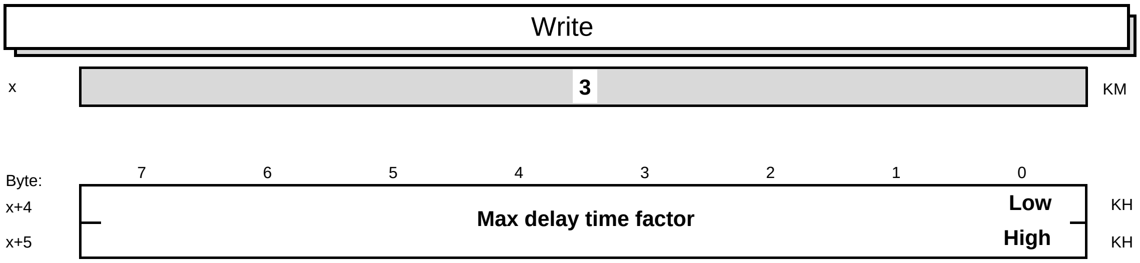
x	**2**	KM

Byte:	7	6	5	4	3	2	1	0	
x+4	**DA 7**	**DA 6**	**DA 5**	**DA 4**	**DA 3**	**DA 2**	**DA 1**	**DA 0**	KM
x+5	**DA 15**	**DA 14**	**DA 13**	**DA 12**	**DA 11**	**DA 10**	**DA 9**	**DA 8**	KM

DAz = 1 : At the DAz digital output is output the state of the output port.
DAz = 0 : At the DAz digital output is output the state of the cam track.

Each bit of this register serves to determine individually the function of the associated output. At "0", the cam state as ascertained is output, at "1" the state of the output port. This enables individual control of each digital output, either from the cam controller or from the SIMATIC S5/S7.

6.2.9 Max. Delay Time Factor



To determine the dynamic shift of cams, the module requires a time basis for updating the shifting values. This basis is the maximum delay time, which appears in the cam data blocks. It has been fixed that the updating time pattern has to be preset as ”max. delay time factor”. This value is not checked, but has a decisive influence on the cam dynamics.

The maximum delay time therefore should be selected as short as possible, still it must in any case be greater than the maximum delay time of the cams occurring. Failing this, cam relocation is incorrectly performed.

The ”max. delay time factor” is calculated as follows:

$$\text{”Max. delay time factor”} = \frac{\text{max. delay time [µs]}}{4 \times \text{WF 707 cycle time [µs]}}$$

The WF 707 cycle time is:
– 57.6 µs for max. 32 cams
– 115.2 µs for max. 64 cams

Example:	Max. existing delay time:	10 ms
	WF 707 cycle time:	57.6 µs

$$\text{”Max. delay time factor”} > \frac{10\,000\ \text{µs}}{4 \times 57.6\ \text{µs}} = 43$$

$$\text{”Max. delay time factor”} = 45 \mathrel{\hat{=}} \underline{\text{002D KH}}$$

6.2.10 Steps per Time Cycle

Write

Byte:	7	6	5	4	3	2	1	0	
x					3				KM
x+6	Steps per time cycle							Low	KH
x+7								High	KH

Contained in this register are the "Steps per time cycle" as a 16-bit binary value. It serves to specify the number of increments of a stroke or of one direction with a translatory movement.

With incremental encoders, the signals are quadrupled internally, i.e., the factor 4 must be taken into consideration upon input.

6.3 Read

6.3.1 Actual Value

In these registers, the current values can be read as binary values.

Write

x	**0 or 1 oder 2 or 3**	KM

Read

Byte:	7	6	5	4	3	2	1	0	
x	**Actual value**							**Low**	KH
x+1								**High**	KH

Current actual position of the cam controller.

6.3.2 Status Register

Cyclic reading of the status register and interrupt processing are mutually exclusive as reading of the status register serves to acknowledge the interrupt.

To acknowledge any undesired interrupts which might have occured during start-up (OB20, 21, 22), the status register must be read once more at the end oft the WF 707 start-up FB's.

The significance of the status register varies with the type of encoder:

With incremental encoders, 24-V signal generators and encoder simulator (not all messages) **there applies:**

Write

x	**0**	KM

Read

	7	6	5	4	3	2	1	0	
Byte x+2	**Cam alarm**	**Edge on ext. SYNC**	**Sense of rotation**	**SYNC signal missing**	**Line interruption**	**Short circuit**	**Edge error**	**SYNC**	KM

SYNC: Byte x+2, Bit 0

1 = Module is synchronized
0 = Module is not synchronized

With this bit set, the module is synchronized. With an unsynchronized module, the error LED is on.
The message may release a group error interrupt.

Edge error: Bit 1

1 = Edge error of encoder tracks A, B
0 = No edge error

Two edges of the tracks A and B were too close together for the evaluating electronics to be able to recognize the sense of rotation. Presumably the actual value is no longer correct. The message may release a group error interrupt.

Short circuit: Byte x+2, Bit 2

1 = Overload of digital output
0 = No overload

At least one of the digital outputs is overloaded. The error LED is on. With this message, all digital outputs are disabled and a group error interrupt may be released. Program execution continues and the cam track states in the register (see section 6.3.7) are updated. If interrupts are enabled, they will be released.

Line interruption: Bit 3

1 = Encoder line interruption
0 = No line interruption

A line interruption has been detected in the encoder line. The cause may also be a defective or misconnected encoder. The error LED is on.
The message may release a group error interrupt.
Cam output is disabled.

SYNC signal missing: Bit 4

1 = Synchronization signal missing
0 = Synchronization signal identified

The synchronization signal selected has not been set during 64 successive steps. Either the "Steps per time cycle" value as specified is not correct, or the synchronization signal has not been generated due to a fault in the machine. The message may release a group error interrupt.

Sense of rotation: Bit 5

1=Backward
0=Forward

This bit signals the current sense of rotation.

Edge on ext. SYNC: Bit 6

1 = External synchronization edge received
0 = External synchronization edge missing

At the external synchronization input, there was a rising synchronization edge (see also section 6.2.6.1). This message is independent of the synchronization method selected. The message is retained until it is read. This serves to acknowledge it. The message may release an individually maskable interrupt (see section 6.2.2).

Cam alarm: Bit 7

1 = Signal change on cam track
0 = No signal change

One of the cam tracks with interrupt capability and interrupt enable (see section 6.2.2) had a change in signal state. The message is retained until it is read and thus acknowledged.

With SSI absolute encoders, there applies:

Write

x	**0**	KM

Read

	7	6	5	4	3	2	1	0	
Byte x+2	**Cam alarm**	**Edge on ext. SYNC**	**Sense of rotation**	**Monoflop error**	**Cable interruption**	**Short circuit**	**Start/ stop error**	**SYNC**	KM

With the exception of bit 1 and bit 4, the significance of the messages is the same as with incremental encoders. Those differing are:

Start/stop error: Byte x+2, Bit 1

1 = Start/stop bit error
0 = No start/stop bit error

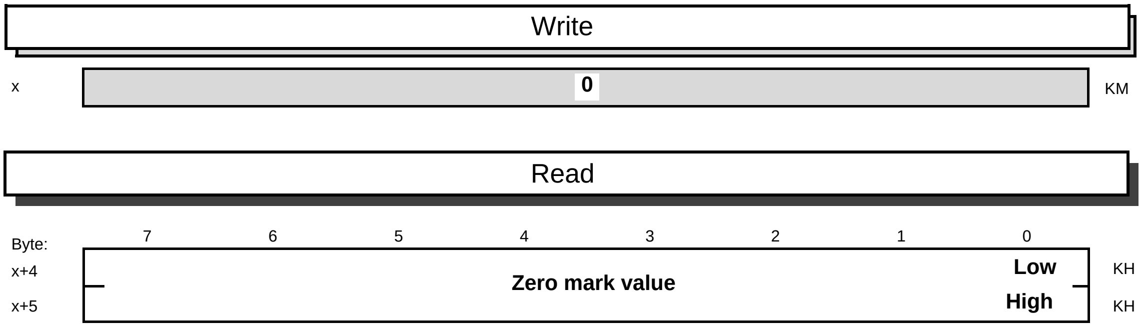
The start bit or the stop bit of the SSI signal was faulty several times in a row. Presumably the actual value received is faulty as well. The error LED is on. The message may release a group error interrupt. Cam output is disabled.

Monoflop error: Bit 4

1 = Monoflop time > 64 µs
0 = Monoflop time   64 µs

The monoflop time of the SSI encoder as a rule is 10 to 30 µs. Monitoring of the WF 707 module responds once the monoflop time of the SSI encoder has exceeded 64 µs. The error LED is on. The message may release a group error interrupt. Cam output is disabled.

6.3.3 Zero Mark Value

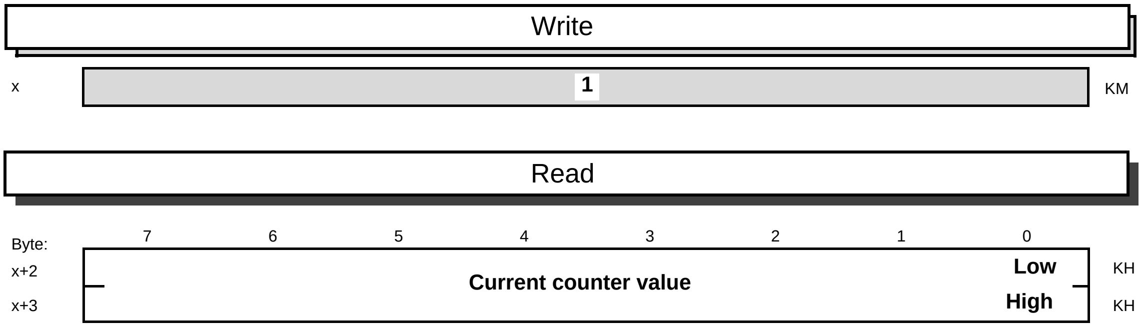


At each zero mark signal, the current actual value is stored in this register. This value can then be evaluated by the SIMATIC S5/S7 for encoder monitoring purposes.

6.3.4 Cam Data

All cam data can be re-read. The procedure is the same as in the case of writing (see section 6.2.3).

6.3.5 Current Counter Value



Current counter value of the counting cam (see also section 4.2.3).

6.3.6 States of Digital Outputs

Write

x	**1**	KM

Read

Byte:	7	6	5	4	3	2	1	0	
x+4	**DA 7**	**DA 6**	**DA 5**	**DA 4**	**DA 3**	**DA 2**	**DA 1**	**DA 0**	KM
x+5	**DA 15**	**DA 14**	**DA 13**	**DA 12**	**DA 11**	**DA 10**	**DA 9**	**DA 8**	KM

In this register are represented the current states of the digital outputs. They correspond either to the states of the cam tracks or to those of the output ports (see also section 6.2.5).

6.3.7 Cam Track States

Write

x	**2**	KM

Read

Byte:	7	6	5	4	3	2	1	0	
x+4	**Track 7**	**Track 6**	**Track 5**	**Track 4**	**Track 3**	**Track 2**	**Track 1**	**Track 0**	KM
x+5	**Track 15**	**Track 14**	**Track 13**	**Track 12**	**Track 11**	**Track 10**	**Track 9**	**Track 8**	KM

In this register are represented the current states of the cam tracks.

6.4 Hardware Interface (X2 Connector)

Cam outputs (NA):

Consistent with output selection (see section 6.2.8), the cam outputs are set either from the cam program or from the SIMATIC S5/S7 program.

OK message (A):

The output is set when the following conditions are fulfilled:

- Module is synchronized (see section 6.3.2)
- No short circuit of outputs (see section 6.3.2)
- Cam processing enable (see section 6.2.1)
- Output enable (see section 6.2.1)

External synchronization (E):

Input for connection of the external synchronization signal (see sections 6.2.6.1 and 6.2.6.3).

Braking enable (E):

Input for connection of an external signal for activation of the braking cam (cam track 1; see section 4.2.4).

The input signals must be bounce-free.

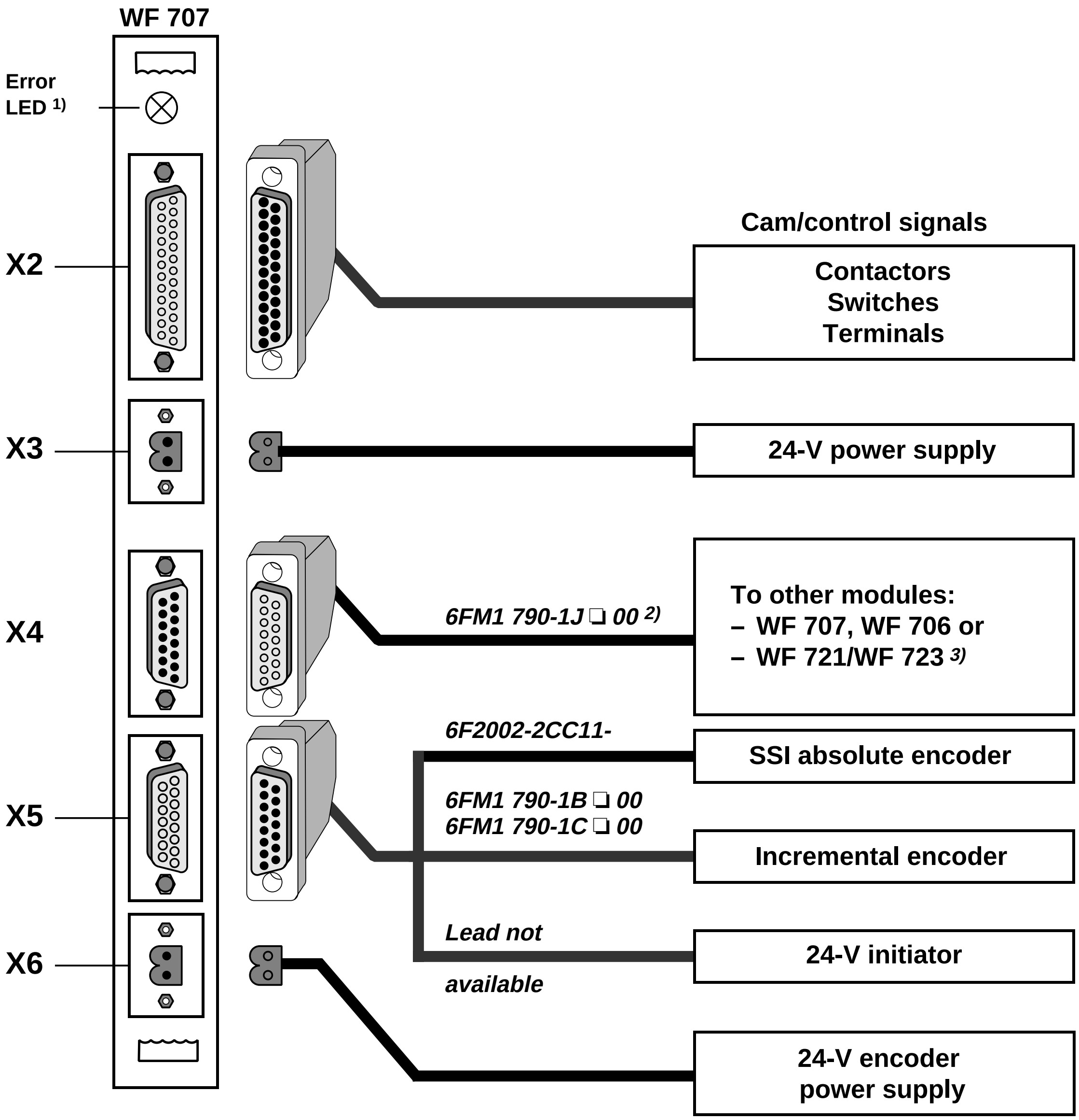
7 Technical Data

7.1 Characteristics of the Module

Electrical and Mechanical Characteristics	WF 707
Voltage level 5 V	Supplied by the SIMATIC
Power input at 5 V (without encoder)	250 mA
Voltage level 24 V	Supplied via X3 and X6 connectors
24-V digital inputs, non-floating	3 inputs
Input current required	5 mA
Maximum frequency on 24-V digital inputs	100 kHz
24-V, 0.5-A digital outputs, non-floating	17 outputs
Maximum encoder frequency (incremental encoder)	200 kHz
Admissible encoder power input	300 mA
Required input current of encoder signals	10 mA
SSI absolute encoder: Transfer rate up to 35 m distance up to 120 m distance	 1 Mbit/s 125 Kbit/s
Space required in SIMATIC S5 rack	$1\,^{1}/_{3}$ SEP (Standard Peripheral Slot)
Space required in SIMATIC S7 rack (with S7 adapter casing)	$2\,^{2}/_{3}$ SEP (Standard Peripheral Slot)

Table 7.1 Characteristics of the Module

7.2 Overview of Plug-In Leads and Devices



6FM1 790-1B ❑ 00
↑
Dummy for length code

For front connector pin assignment refer to section 7.3
For details refer to section 7.4
Observe shielding precautions as per section 7.6 !

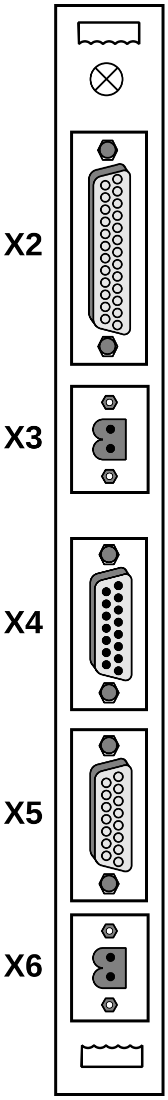
---

[1] The error LED lights up when the module is not synchronized or when one or more errors are pending in the status register (see section 6.3.2 "Status Register".

[2] Looping of position encoder signals without 24-V initiator signals.

[3] see section 4.1.5

7.3 Front Connector Pin Assignment



X2 connector, cam and control signals

PIN	Significance
1	Cam output 0
2	Cam output 1
3	Cam output 2
4	Cam output 3
5	Cam output 4
6	Cam output 5
7	Cam output 6
8	Cam output 7
9	Cam output 8
10	Cam output 9
11	–
12	–
13	Ext. synchronization (E)
14	Cam output 10
15	Cam output 11
16	Cam output 12
17	Cam output 13
18	Cam output 14
19	Cam output 15
20	OK message (A)
21	–
22	–
23	–
24	–
25	Braking enable (E)

X4 connector to next slaveWF (e.g., WF 707)

PIN	Incremental encoder	SSI encoder	24 V initiator
1	–	–	BERO-OUT
2	–	CLK +	–
3	–	CLK –	–
4	–	–	–
5	–	–	–
6	–	–	–
7	GND	GND	–
8	–	–	–
9	–	–	–
10	Z zero mark	–	–
11	$\overline{Z}$ zero mark	–	–
12	$\overline{B}$ track	CLK –	–
13	B track	CLK +	–
14	$\overline{A}$ track	SDAT –	–
15	A track	SDAT+	–

BEERO-OUT is the looped-through signal with 24-V-level from initiator.

X5 connector for position encoder, or from preceding WF

PIN	Incremental encoder	SSI encoder	24 V initiator
1	–	–	BERO-IN
2	–	CLK +	–
3	–	CLK –	–
4	–	–	–
5	(24 V supply)	24-V-supply	–
6	5 V supply	–	–
7	E-GND	E-GND	–
8	–	–	–
9	–	–	–
10	Z zero mark	–	–
11	$\overline{Z}$ zero mark	–	–
12	$\overline{B}$ track	–	–
13	B track	–	–
14	$\overline{A}$ track	SDAT –	–
15	A track	SDAT +	–

A, B, Z are the tracks of an incremental encoder.

CLK and SDAT are the signals of the absolute encoder with SSI protocol.

BERO-IN is the counting input with 24-V level for the 24-V-initiator.

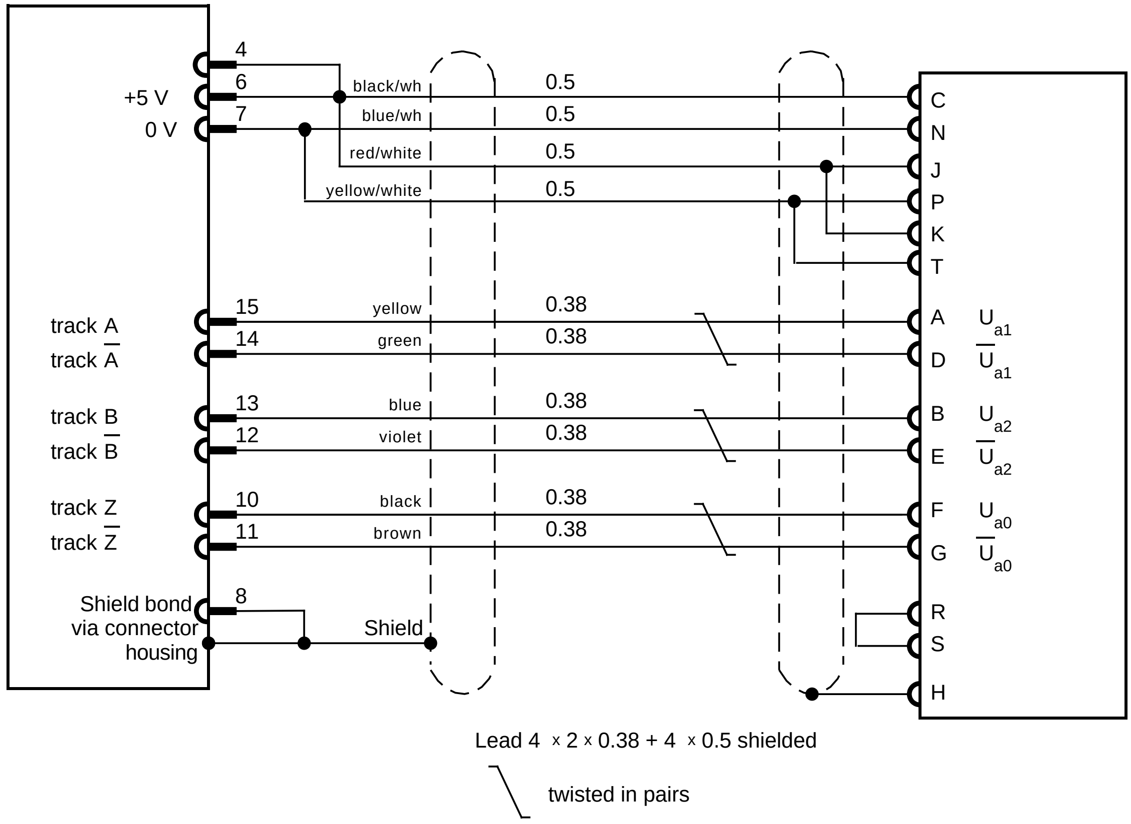
7.4 Plug-In Leads

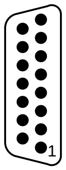
Plug-in lead from WF 707 actual-value connector to ROD 320 rotary position encoder

Order No.: 6FM1 790-1B ❑ 00

WF 707
X5 front connector

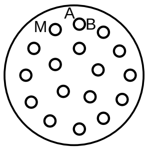
ROD 320 position encoder





Connector
D Sub, Cannon
15-pin, male
6FM1 790-8DA00
Solder side

Circular connector
17-pin, female
Amphenol Tuchel
6FC9 341-1AC
Solder side



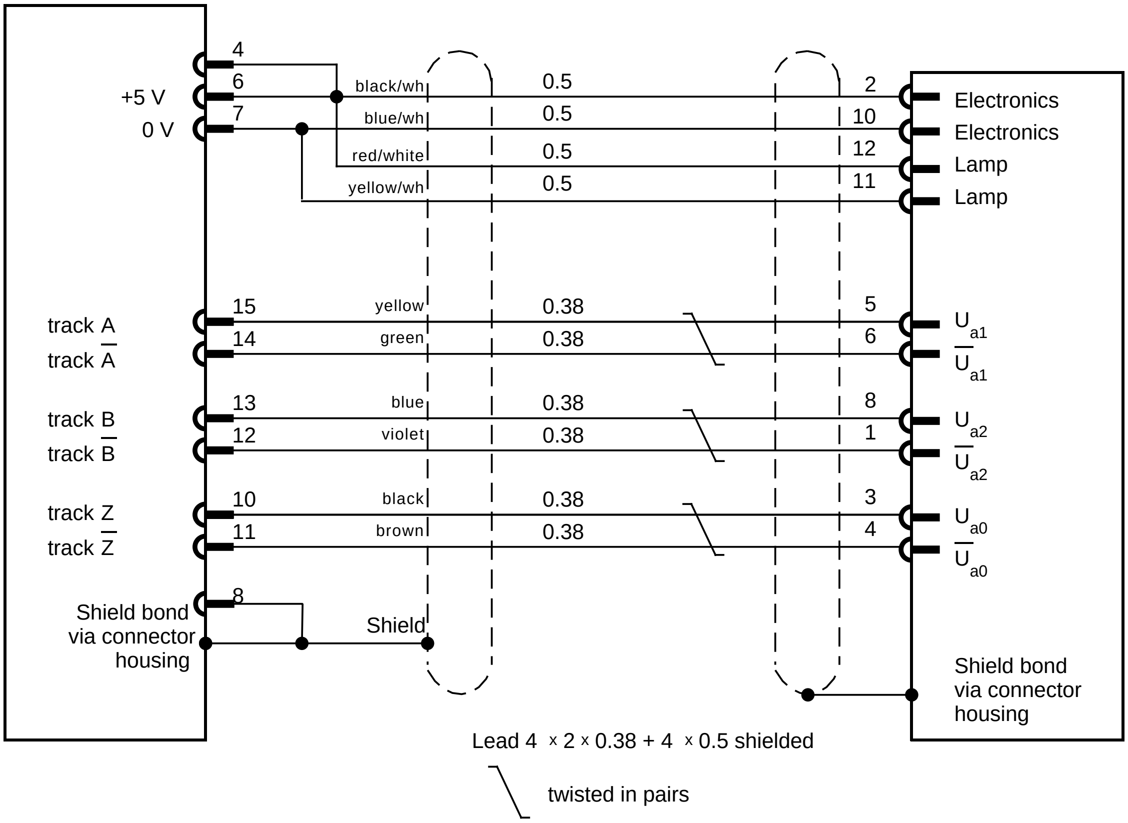
The shield of the actual-value lead must have large-area earthing on the module side. Pins 4 and 8 are not analyzed.

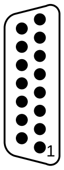
Plug-in lead from WF 707 actual-value connector to digital rotary Siemens position encoder

Order No.: 6 FM1 790-1C ❑ 00

WF 707
X5 front connector

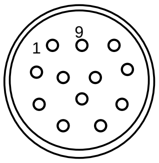
SIMODRIVE Sensor - position encoder
6FX2 001 - 2 ❑❑❑





Connector
D Sub, Cannon
15-pin, male
6FM1 790-8DA00
Solder side

Circular connector
12-pin, female
SIEMENS
6FX2 003 - 0CE12
Solder side



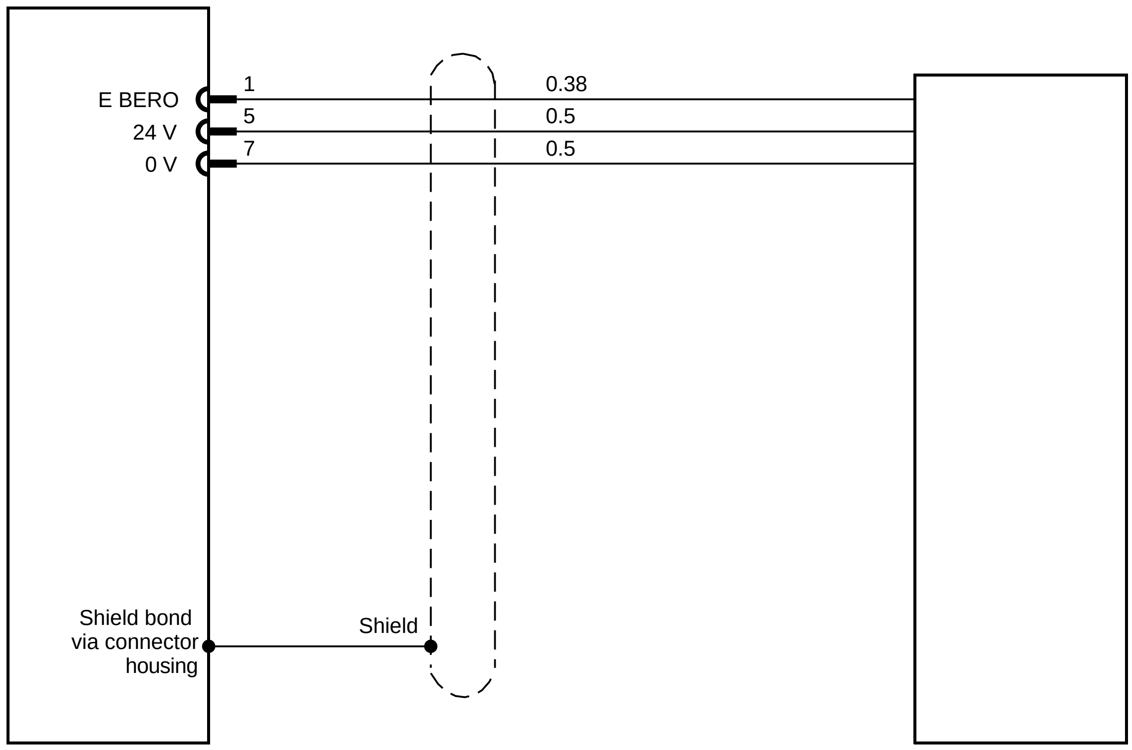
The shield of the actual-value lead must have large-area earthing on the module side. Pins 4 and 8 are not analyzed.

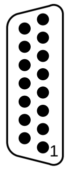
Plug-in lead from WF 707 actual-value connector to 24-V initiator
Order No.: (Lead to be provided by customer)

WF 707

X5X5 front connector

24-V initiator





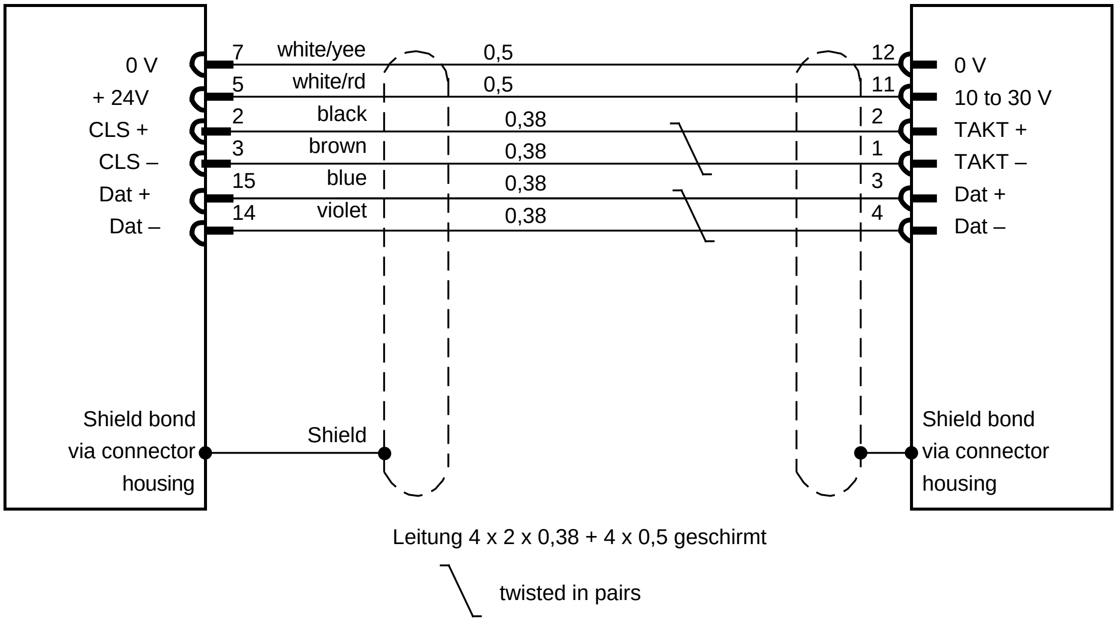
Connector
D Sub, Cannon
15-pin, male
6FM1 790-8DA00
Solder side

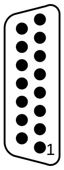
The shield of the actual-value lead must have large-area earthing on the module side.

Plug-in lead from serial interface to SSI absolute encoder
Order No.: 6FX2002-2CC11-❑❑❑❑

WF 707 **SIMODRIVE Sensor - SSI - encoder**

X5 front connector **6FX2001-5❑S❑❑**

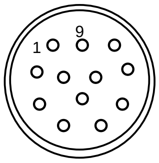




Connector
D Sub,
15-pin, male
6FC9 341-1HC
Solder side

Circular connector
12-pin, female

6FX2 003 - 0CE12
Solder side

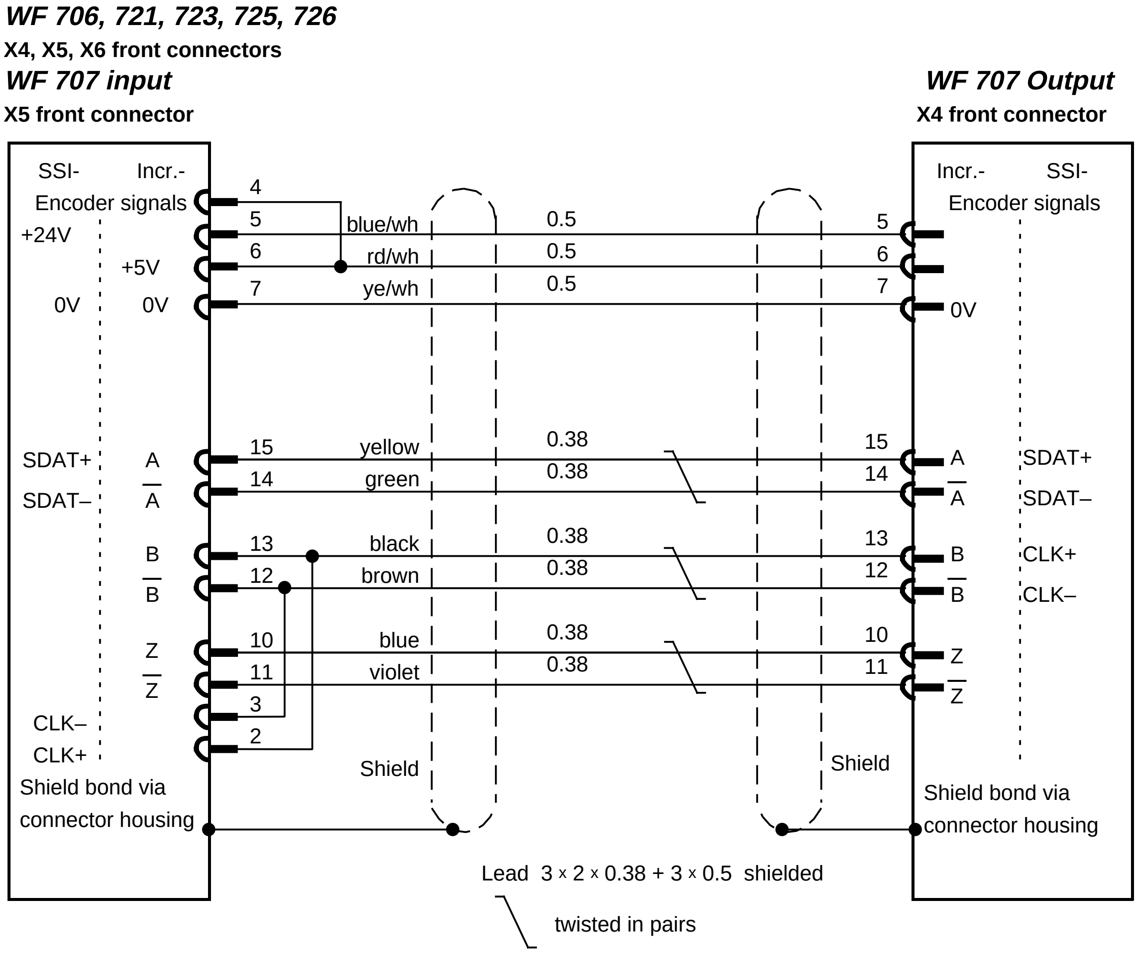


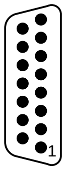
The shield of the actual-value lead must have large-area earthing on the module side.

Connection of the encoder must be in accordance with the manufacturer's instructions.

Plug-in lead from WF 707 to WF 706, WF 707, WF 721/WF 723 or from WF 706, 707, 721, 723, 725, 726 to WF 794

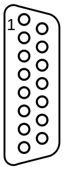
Order No.: 6 FM1 790-1J ☐00





Connector
D Sub, Cannon
15-pin, male
6FM1 790-8DA00
Solder side

Connector
D Sub
15-pin, female
6FM1 790-8CA00
Solder side

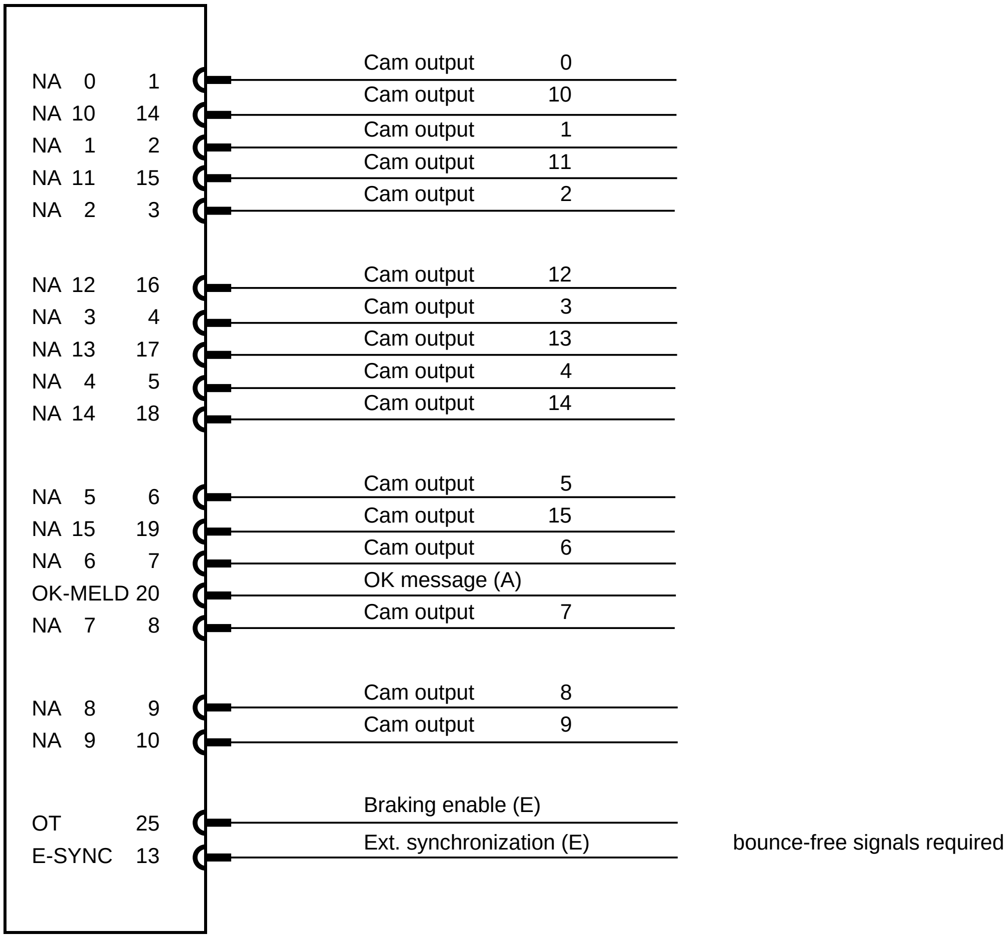


This plug-in lead does not permit looping-on of the 24-V-initiator signal. This connection is to be effected by the customer.

Lead to the digital inputs/outputs (to be provided by customer)

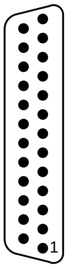
WF 707

X2 front connector



NA 0	1	Cam output 0
NA 10	14	Cam output 10
NA 1	2	Cam output 1
NA 11	15	Cam output 11
NA 2	3	Cam output 2
NA 12	16	Cam output 12
NA 3	4	Cam output 3
NA 13	17	Cam output 13
NA 4	5	Cam output 4
NA 14	18	Cam output 14
NA 5	6	Cam output 5
NA 15	19	Cam output 15
NA 6	7	Cam output 6
OK-MELD	20	OK message (A)
NA 7	8	Cam output 7
NA 8	9	Cam output 8
NA 9	10	Cam output 9
OT	25	Braking enable (E)
E-SYNC	13	Ext. synchronization (E)

bounce-free signals required



Connector

D Sub, Cannon
25-pin, male
6FM1 790-8GA0

Solder side

7.5 Addressing

7.5.1 Addressing the WF 707 - SIMATIC S5

7.5.1.1 Module Address (DPR Address)

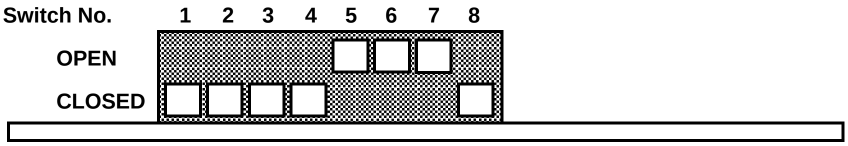
The exchange of data between the WF 707 module and the SIMATIC S5 is effected **via** the **periphery address space** of the SIMATIC S5. The module occupies **eight bytes** on the peripheral bus and is to be addressed preferably in the analog range (address   128).
The initial address can be set via the DIL switch S1.

When the WF 707 module is applied in the central controller of the SIMATIC S5-135U/155U, the address switch can be used to set not only the P range but also the Q range.

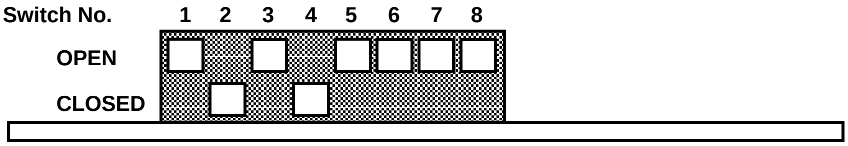
Switch S 1

Switch No.	1	2	3	4	5	6	7	8	Significance
OPEN	2^3	2^4	2^5	2^6	2^7				Address
CLOSED	0	0	0	0	0				
OPEN	2^3	2^4	2^5	2^6	2^7		☐		Central controller: P range
CLOSED	0	0	0	0	0			☐	
OPEN	2^3	2^4	2^5	2^6	2^7				Central controller: Q range
CLOSED	0	0	0	0	0		☐	☐	
OPEN	2^3	2^4	2^5	2^6	2^7		☐	☐	Expansion unit: P/Q range selection via interface module
CLOSED	0	0	0	0	0				
OPEN	2^3	2^4	2^5	2^6	2^7				Encoder interface for looping-through of actual values active
CLOSED	0	0	0	0	0	☐			
OPEN	2^3	2^4	2^5	2^6	2^7	☐			Encoder interface for looping-through of actual values non-active
CLOSED	0	0	0	0	0				

Example 1: **Module in central controller, P range, address 128**
Looping-through of actual values non-active



Example 2: **Module in expansion unit, address 168**
Looping-through of actual values non-active

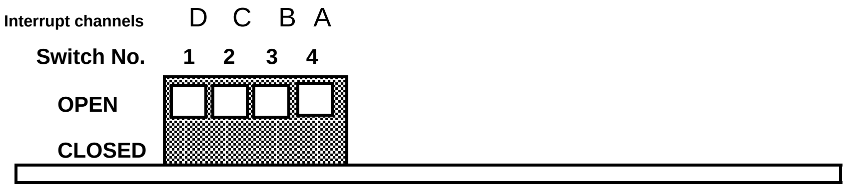


7.5.1.2 Interrupt Channel

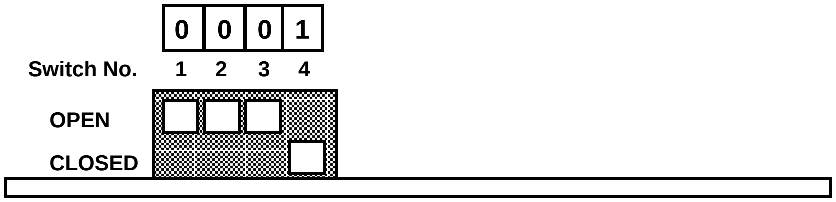
The interrupts are signalled to the SIMATIC S5 as a group interrupt.

The group interrupt can be routed to the interrupt lines (channels) A to D of the SIMATIC S5 rack bus via the DIL switch S2.

Switch S2



Example: Interrupt channel A



If interrupt setting with SIMATIC S5-135U/-155U is level-triggered, the limitations of chapter 7.5.2.2 apply, taking into account the S5-specific alarm blocks.

7.5.2 Addressing / Interrupt WF 707 - SIMATIC S7-400

The WF 707 module can be used in the SIMATIC S7-400 in different ways:

- in a SIMATIC S7-400 central unit by means of SIMATIC S7 adapter casing
- in a SIMATIC S5 extension unit linked with the central unit of the SIMATIC S7-400 via interfaces IM463-2 (S7) and IM314 (S5)

In the SIMATIC S7-400 central unit, you can plug:

- up to 8 S7 adapter casings, i.e. up to 8 WF modules
- up to 4 IM463-2; each IM463-2 can be linked with up to 8 SIMATIC S5 extension units

In a SIMATIC S7-400 system, you can address:

- up to 64 WF 707 modules

STEP7-Tool HWKonfig (hardware configuration) is needed for:

- configuration of the S7 adapter casing
- configuration of the IM463-2 interface

7.5.2.1 Settings

The following settings have to be made in HWKonfig:

- Entry:
  - Only one WF module can be operated in one S7 adapter casing. Therefore, only one entry per casing is admissible.
  - For the IM463-2 interface, one entry must be generated for each WF module. As several S5 extension units can be linked via one IM463-2, the entries refer to the total number of modules.

- S7 address:
  - Address under which the WF 707 is to be addressed in the S7 program (initial address). S7 addresses start at 512.

- Address of the S7 adapter casing:
  - Input address and output address of the S7 adapter casing must be identical.

- S5 address:
  - Address which is set by the addressing switch S1 on the WF 707. The range is set separately.

- Length (dual-port RAM)
  - The WF 707 has a fixed length of 8 bytes.

If the WF 707 has the address n, the next S7 address must be n+8.

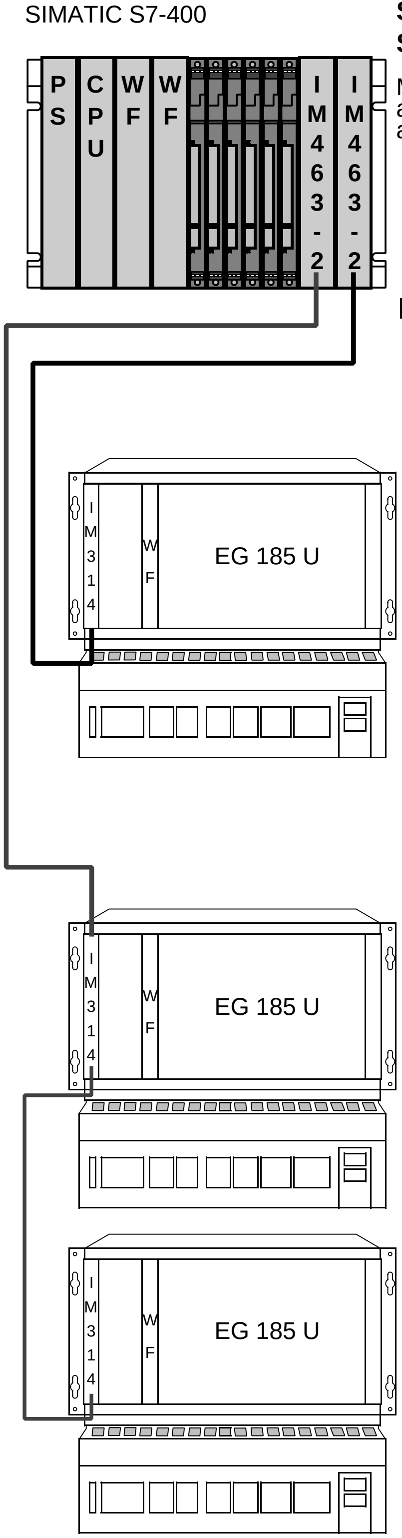
- Part PA:
  - For WF modules, 0 must be set.

- Range:
  - In the S7 adapter casing, only range P is allowed. Via the IM463-2 interface, ranges P and Q can be selected.

The corresponding ranges must also be set on the IM314.

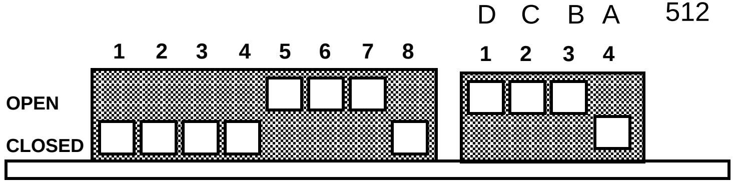
Make sure that neither S7 addresses nor S5 addresses overlap.

Addressing example



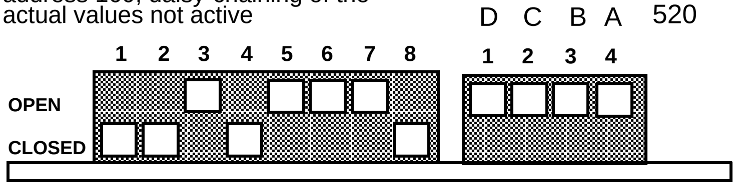
Settings:

S1 (S5 address)	**S2**	**S7 addr.**
Module in central unit, range P, address 128, daisy-chaining of the actual values not active	Interrupt channel A enabled	512



Settings:

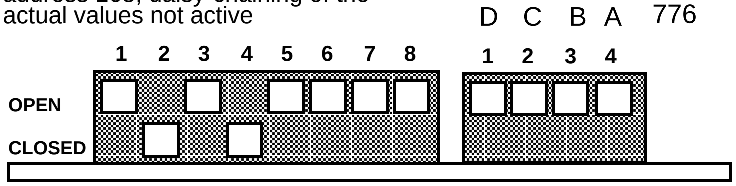
S1 (S5 address)	**S2**	**S7 addr.**
Module in extension unit, range P, (addressed via IM 314), address 160, daisy-chaining of the actual values not active	Interrupt channel A disabled	520



Im EG ist keine Interruptverarbeitung möglich.

Settings:

S1 (S5 address)	**S2**	**S7 addr.**
Module in extension unit, range Q, (addressed via IM 314), address 168, daisy-chaining of the actual values not active	Interrupt channel A disabled	776



The S7 addresses per WF module must differ within one range (P, Q) by 8 bytes.

On the last IM314, plug in a terminating connector (see catalogue ST50, chapter 3/S5-135U/155U under ordering data of interfaces).

7.5.2.2 Interrupt Processing

In the S7 adapter casing in the central unit, you can use interrupt line A (for CPU 1).

Note the following points:

1. Pre-condition for first commissioning of WF 707 or new start of SIMATIC S7 without parameterizing software for WF 707 in the startup branch (OB 100):
   - Alternatively block interrupt processing:
     - deactivate S2 (Off/OPEN)
     - in startup by writing "1" in the interrupt register (see chapter 6.2.2)
   - Reason for deactivation of S2:
     The interrupt register of the WF 707 was not written, i.e. the bits are "0", so that a group interrupt is triggered.

     This leads to the following chain reaction:
     - SIMATIC S7 receives low level via the INTA alarm line (switch S2.4 = ON (CLOSED)),
     - through this "permanent" reason of fault, the cycle time is exceeded,
     - the cyclic programm part is interrupted.

2. Interrupt acknowledgement
   - Interrupt was triggered and is acknowledged by:
     - reading the status register (see chapter 6.3.2) in the alarm block (e.g. OB 40).
   - Interrupt was triggered and is not acknowledged.

     This leads to the following chain reaction:
     - INTA alarm line remains at low level,
     - the cyclic programm execution is blocked (after execution of the alarm program, immediate branching into the alarm OB),
     - the cycle time is exceeded (OB 80).

3. Group fault (interrupt register bit 0, chapter 6.2.2)

   A group fault interrupt is only triggered on INTA via the following "AND" condition:
   - A fault triggering a group fault is pending from the status register (see chapter 6.3.2),
   - interrupt enable with bit 0 = 0 in the interrupt register (see chapter 6.2.2).

   After this interrupt has occurred, it must be disabled in the alarm OB (OB 40) via interrupt register and after elimination of the fault, it must be enabled in cyclic operation.

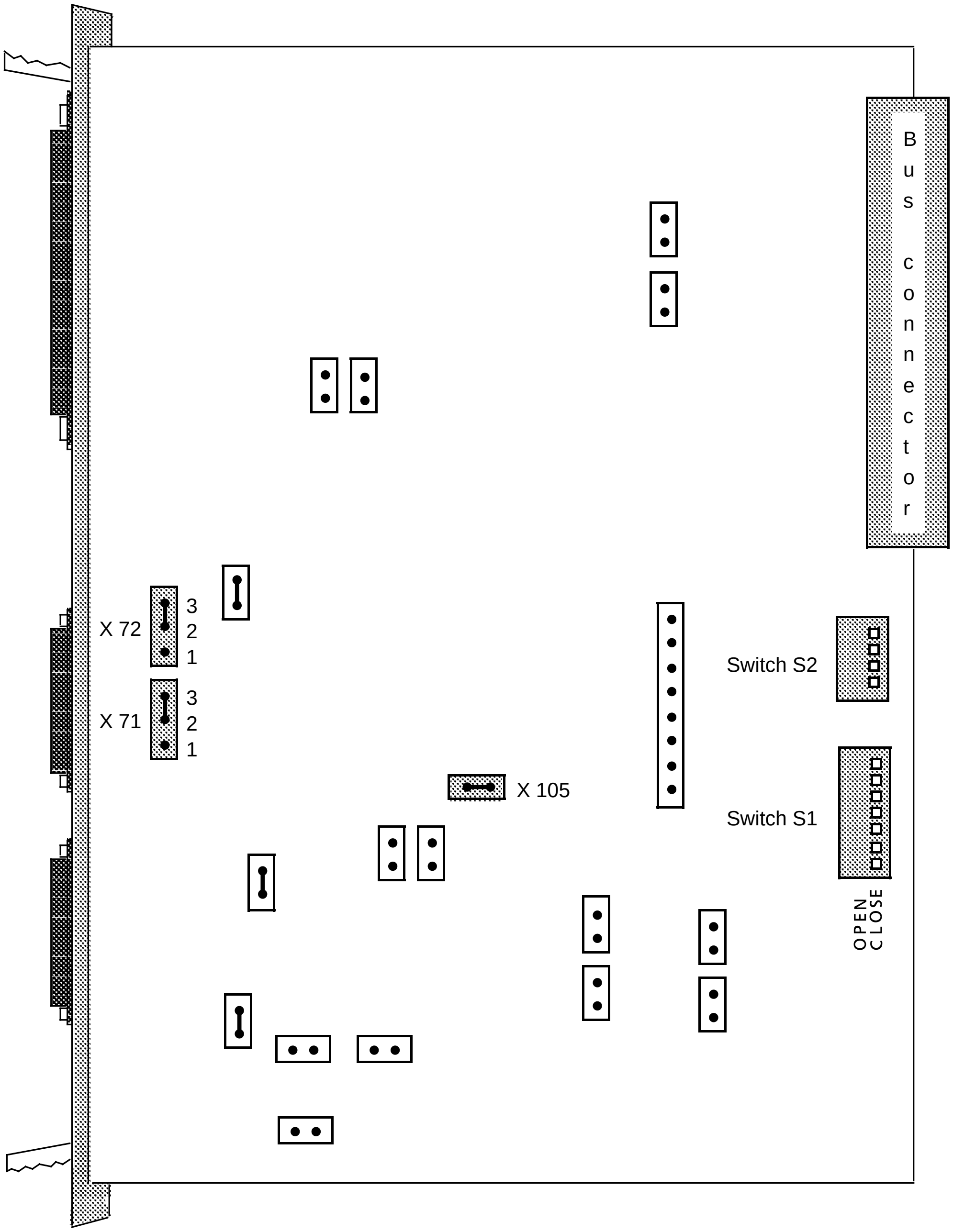
4. Interrupt in case of external synchronization (interrupt register bit 1, chapter 6.2.2)

   Refer to point 5.

5. Interrupt at turn-on or turn-off point of the cam track (interrupt register bit 2 ... 7, chapter 6.2.2)

   With alarm processing being set (S2.4 = ON/CLOSED, INTA), a triggered interrupt must be acknowledged by reading the status byte in the alarm OB (OB 40).
   This prevents that the cyclic program processing is disabled and the cycle time is exceeded.

7.5.3 Configuration of Jumpers and Switches on the WF 707 Module



Selection of hysteresis for actual-value acquisition (see section 4.2):

X 105 close:	Hysteresis 1 encoder step (as-delivered condition)
X 105 open:	Hysteresis 3 encoder steps

As from 6FM1 77-3AA10, it is possible to switch over the SSI clock signals for WF 721/WF 723 master operation, WF 707 slave operation (see section 4.1.5):

X71/2-3 and X72/2-3 mounted:	Clock signals from WF 707 (as-delivered condition)
X71/1-2 and X72/1-2 mounted:	Clock signals from WF 721/WF 723 master

7.6 Instructions Regarding Electromagnetic Compatibility (EMC)

It is an essential prerequisite of troublefree operation of the controller that the entire installation is earthed.

The instructions regarding electromagnetic compatibility provide recommendations on how to enhance immunity to interference from different earth potentials and electromagnetic fields.

Be sure to follow the instructions in the accompanying publication
"EMC Recommendation".
Order-Number: 6ZB5 440-0QX02-0BA4

The following subjects are being dealt with:

- Connection principle for equipotential bonding leads
- Simplification of the connection principle to save equipotential bonding leads
- Potential connection of power and non-power units
- Grouping of equipotential bonding leads on the equipotential bonding strip
- Connection of shield lines

In addition to these instructions, DIN VDE 0113, part 1,
must be observed in any case.

8 Ordering Data and Documentation

8.1 Ordering Data

Modules	**Order No.**
WF 707 cam controller for SIMATIC S5	6FM1 707-3AA10
WF 707 cam controller for SIMATIC S7-400	6FM1 707-3AA70

Connecting leads - preferred lengths (see also catalogue NC Z)	**Order No.**	**Max. length**
For ROD 320 digital rotary position encoder 5 m 10 m 18 m	6FM1 790-1BB00 6FM1 790-1BC00 6FM1 790-1BD00	35 m
For SIMODRIVE-Sensor digital rotary position encoder (6FX2 001-2 . . .) 2 m 5 m 10 m 18 m	6FM1 790-1CA00 6FM1 790-1CB00 6FM1 790-1CC00 6FM1 790-1CD00	35 m
For SIMODRIVE-Sensor SSI absolute encoder 2 m 5 m 10 m 18 m	6FX2002-2CC11-1AC0 6FX2002-2CC11-1AF0 6FX2002-2CC11-1BA0 6FX2002-2CC11-1BJ0	dependent on baud rate: 125 kbit/s 120m 1 Mbit/s 25m
For daisy-chaining of actual position values from WF 707 to WF 707 0.5m 2.0m	6FM1 790-1JS00 6FM1 790-1JA00	

Connectors	Order No.
Connectors to WF 707 module:	
D Sub connector, 15-pin, female	**6FM1 790-8CA00**
D Sub connector, 15-pin, male	**6FM1 790-8DA00**
D Sub connector, 25-pin, male	**6FM1 790-8GA00**
Connector to ROD 320 encoder:	
Amphenol Tuchel connector, 17-pin, female	**6FC9 341-1AC**
Counter-connector for SIMODRIVE-Sensor position encoder (6FX2 001-2 . . .) :	
Siemens circular connector, 12-pin, female	**6FX2 003-0CE12**

8.2 Documentation

Designation	Order No.
WF 707 description with sample program diskette	**6ZB5 440 - 0ST02 - 0BA5**
WF 707 product brief	**6ZB5 440 - 0SS02 - 0BA1**
EMC guide	**6ZB5 440 - 0QX02 - 0BA4**
Catalogue AR 10: WS/WF Technology-Systems and Components	**E86060 - K6310 - A101 - A5 - 7600**
Catalogue ST 50 Automation Systems SIMATIC S5/PC/TI505	**E86060 - K4650 - A110 - A7 - 7600**
Catalogue ST 70 Automation Systems SIMATIC S7 / M7 / C7	**E86060 - K4670 - A101 - A3 - 7600**
Catalogue NC Z Connection Systems	**E86060 - K4490 - A001 - A5 - 7600**

Siemens AG

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Fed. Rep. of Germany

Suggestions/Corrections

For Publication/Manual:

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Cam Controller

Description

Order No.:	6ZB5 440-0ST02-0BA5
Edition:	September 1998

From:

Name

Company/Dept.

Address

Telephone /

Should you come across any printing errors when reading this publication, please notify us on this sheet. Suggestions for improvement are also welcome.

Suggestions and/or corrections:

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