SIEMENS

SIMATIC C7

Supplement to

C79000-Z7076-C631-01

Manual Package C7-623/624 (MLFB 6ES7 623-1AE00-8BA0) and
Manual Package C7-626/626 DP (MLFB 6ES7 626-1AG00-8BA0)

Control Systems	**C7-623/P**	**(MLFB 6ES7 623-1DE01-0AE3)**
	C7-624/P	**(MLFB 6ES7 624-1DE01-0AE3)**
	C7-626/P	**(MLFB 6ES7 626-1DG02-0AE3)**
	C7-626/P DP	**(MLFB 6ES7 626-2DG02-0AE3)**

The control systems listed above have new functions and technical properties which are described in this supplement.

This supplement contains **additional information** about the products. If uncertainties arise, this information should be considered more up-to-date than the information in the manuals and catalogs.

Disclaimer of Liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Technical data subject to change.

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Contents

1 Properties of the I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Overview

The chapters of this addendum describe the differences between the two control systems C7-623/P, C7-624/P, C7-626/P and C7-626/P DP and the control systems C7-623, C7-624, C7-626 and C7-626 DP. With the exception of the properties of the I/Os, the properties of the control systems described in the manuals of the C7-623 and C7-626 are as described in the manuals.

The following table contains an overview of the I/Os of the control systems.

	C7-623, C7-624, C7-626, C7-626 DP	**C7-623/P, C7-624/P C7-626/P, C7-626/P DP**
Digital I/Os	16 digital inputs, 16 digital outputs	16 digital inputs, 16 digital outputs
Analog I/Os	4 analog inputs, 1 analog output	4 analog inputs, 4 analog outputs
Universal inputs	4 digital universal inputs	4 digital universal inputs

2 Digital I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Pinout of the Digital Inputs and Digital Outputs

The pinout of the digital inputs and digital outputs is identical to the pinout of the C7-623, C7-623/A, C7-624, C7-626, C7-626/A and C7-626 DP.

Technical Data of the Digital Inputs

The following table lists the technical data of the digital inputs.

Specific Data of the Digital Input	
Number of inputs	16
Cable length	
• Unshielded	600 m
• Shielded	1000 m
Voltages, Currents, Potentials	
Nominal load voltage L +	24 VDC
Number of simultaneously energizable inputs	16
Galvanic isolation	Yes (optocoupler)
• In groups of	16
Permissible potential difference	
• Between the M terminals of the groups	-
• Insulation resistance	U_{ISO} = 500 VDC
Status, Interrupts, Diagnostics	
Interrupts	No
Diagnostic functions	No

Data for Selecting a Sensor	
Input voltage	
• Nominal voltage	24 VDC
• For “1” signal	from 11 to 30 V
• For “0” signal	from -3 to 5 V
Input current	
• For “1” signal	from 6 to 11.5 mA
Input delay time	
• Programmable	No
• At “0” to “1”	from 1.2 to 4.8 ms
• At “1” to “0”	from 1.2 to 4.8 ms
Input characteristic	In accordance with EN 61131-2 (IEC 1131, Part 2)
Type of input in accordance with IEC 1131	Type 2
Connection of 2-wire BEROs	Possible
• Permissible quiescent current	≤ 2 mA

Technical Data of the Digital Outputs

The following table lists the technical data of the digital outputs.

Specific Data of the Digital Output Function	
Number of outputs	16
Cable length	
• Unshielded	600 m
• Shielded	1000 m
Voltages, Currents, Potentials	
Nominal load voltage L +	24 VDC/0.5A
Total current of the outputs (per group)	
• Up to 20 °C	4 A
• Up to 45 °C	2 A
Galvanic isolation	Yes (optocoupler)
• In groups of	8
Insulation resistance	U_{ISO} = 500 VDC
Status, Interrupts, Diagnostics	
Interrupts	No
Diagnostic functions	No

Data for Selecting an Actuator	
Output voltage	
• At “1” signal	L + (- 0.8 V)
Output current	
• At “1” signal	
nominal value	0.5 A
Permissible range	5 mA to 0.5 mA
• At “0” signal (quiescent current)	max. 0.5 mA
Lamp load	max. 5 W
Parallel switching of 2 outputs	
• For logic operations	Possible (outputs of the same group only)
• For enhancing performance	Not possible
Activating a digital input	Yes
Max. switching frequency	
• With resistive load/lamp load	100 Hz
• With inductive load	0.5 Hz
Inductive cutoff voltage limited (internally) to	L + (- 48 V)
Short-circuit protection of the outputs	Yes, electronically timed
• Operating point	1 A

2.1 Addressing the analog I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Addressing the C7 I/O

Figure 1 shows the diagram for addressing the individual channels of the digital I/O.

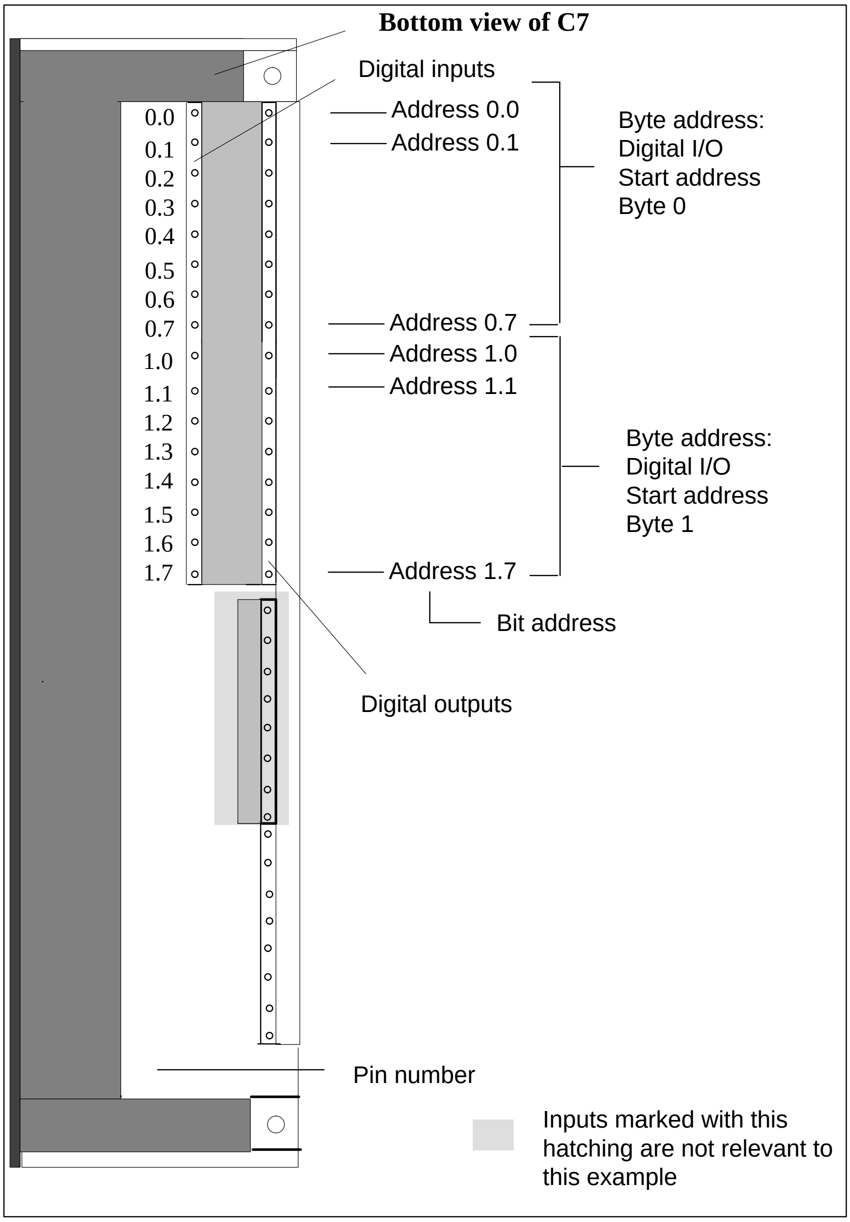

Figure 1 Digital I/O Addresses

3 Analog I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Pinout and Connection Diagram of the Analog Inputs

The following diagram shows the pinouts and the connection diagram of the analog inputs.

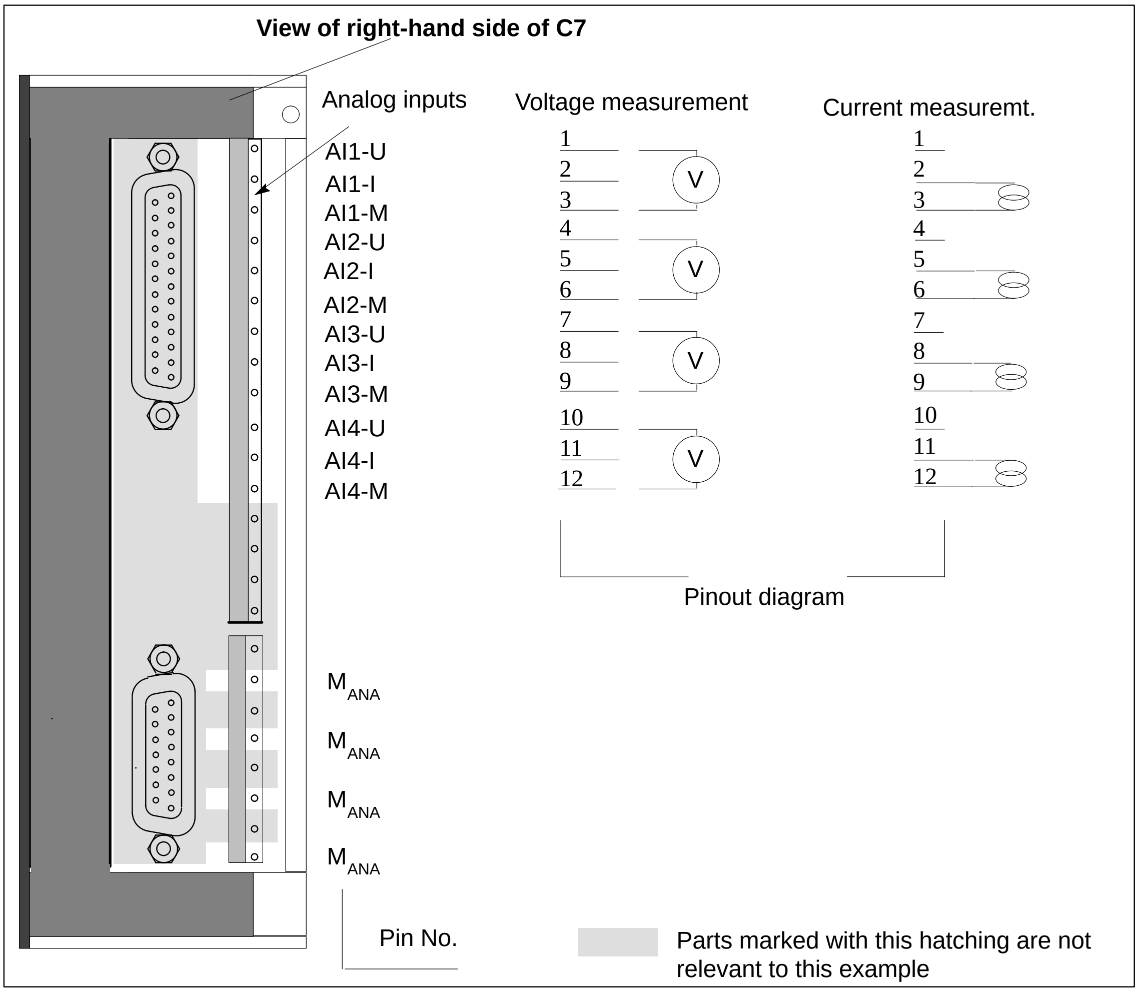

Figure 2 Terminal Connection Diagram of the Analog Inputs

Connecting a Power/Voltage Sensor

You can connect either a power sensor or a voltage sensor to an analog input, but never both at the same time.

Unused Analog Inputs

To prevent interference from occurring, all unused analog inputs should be short-circuited.

Channels

Three pins are combined to form a channel.

Table 1-1 Channels of the Analog Input Module

Pin No.	Value	Channel
AI1-U	Voltage input	Channel 1 (AI1)
AI1-I	Current input	
AI1-M	Reference potential	
AI2-U	Voltage input	Channel 2 (AI2)
AI2-I	Current input	
AI2-M	Reference potential	
AI3-U	Voltage input	Channel 3 (AI3)
AI3-I	Current input	
AI3-M	Reference potential	
AI4-U	Voltage input	Channel 4 (AI4)
AI4-I	Current input	
AI4-M	Reference potential	

Block Diagram

Figure 3 shows the block diagram of the analog input module.

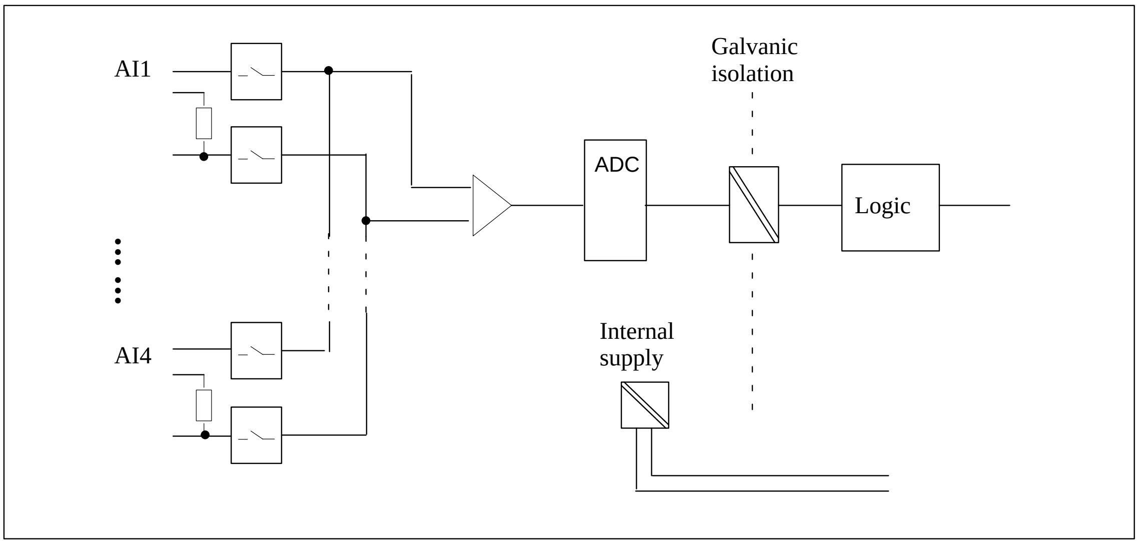

Figure 3 Block Diagram of the Analog Input Module

Technical Specifications

Data Specific to Analog Inputs	
Number of inputs	4
Cable length, shielded	200 m
Voltages, Currents, Potentials	
Isolation (analog I/Os to electronics)	yes
Isolation resistance	U_{ISO} = 500 V DC
Permitted potential difference	
• Between reference potential of the inputs AIx-M and M_{ANA} for signal = 0V	U_{CM} = 2.5 V DC
Analog Value Formation	
Measurement principle	Instantaneous value
• Cycle time (all channels)	2 ms
Processing time (per channel)	0.5 ms
• Resolution in bits incl. sign (incl. overflow range)	12
Measurement ranges:	Measurement range selected by connection to different pins
Voltage	± 10V
Current	± 20mA, 4 to 20mA
Noise Suppression, Error Limits	
Noise voltage suppression	
• Common mode noise (U_{CM} < 1.0 V)	> 40 dB
Crosstalk between the inputs	> 60 dB
Error limit (in entire temperature range, relative to input range)	
• Voltage	± 0.8 %
• Current	± 0.8 %
Basic error limit (error limit at 25 °C, relative to the input range)	
• Voltage	± 0.6 %
• Current	± 0.6 %
Reproducibility in settled state at 25 °C related to range	0.05 %

Data for Selecting a Sensor		
Input ranges (rated values)/input resistance		
• Voltage	± 10 V;	/50 kΩ
• Current	± 20 mA;	/105.5Ω
	4 - 20 mA;	/105.5Ω
Permitted input voltage for voltage input (destruction limit)	Max. 30 V permanent, 38 V for max. 1 s (pulse duty ratio 1:20)	
Permitted input current for current input (destruction limit)	30 mA	
Connection of signal sensors		
• For voltage measurement	Possible	
• For current measurement		
as 4-wire transducer	Possible	
as 2-wire transducer	Not directly possible	
Status, Interrupts, Diagnostics		
Interrupts		
• Hardware interrupt		
as cyclic interrupt	yes, selectable	
as cycle end interrupt	yes, selectable	
• Diagnostic interrupt	yes, selectable	
Diagnostic functions	yes, selectable	
• Diagnostic information can be read out	yes	
Time intervals	yes, selectable	
Wire break detection	In measurement range 4 to 20mA, selectable	

Terminal Connection Diagram

Figure 4 shows the terminal connection diagram of the analog output module.

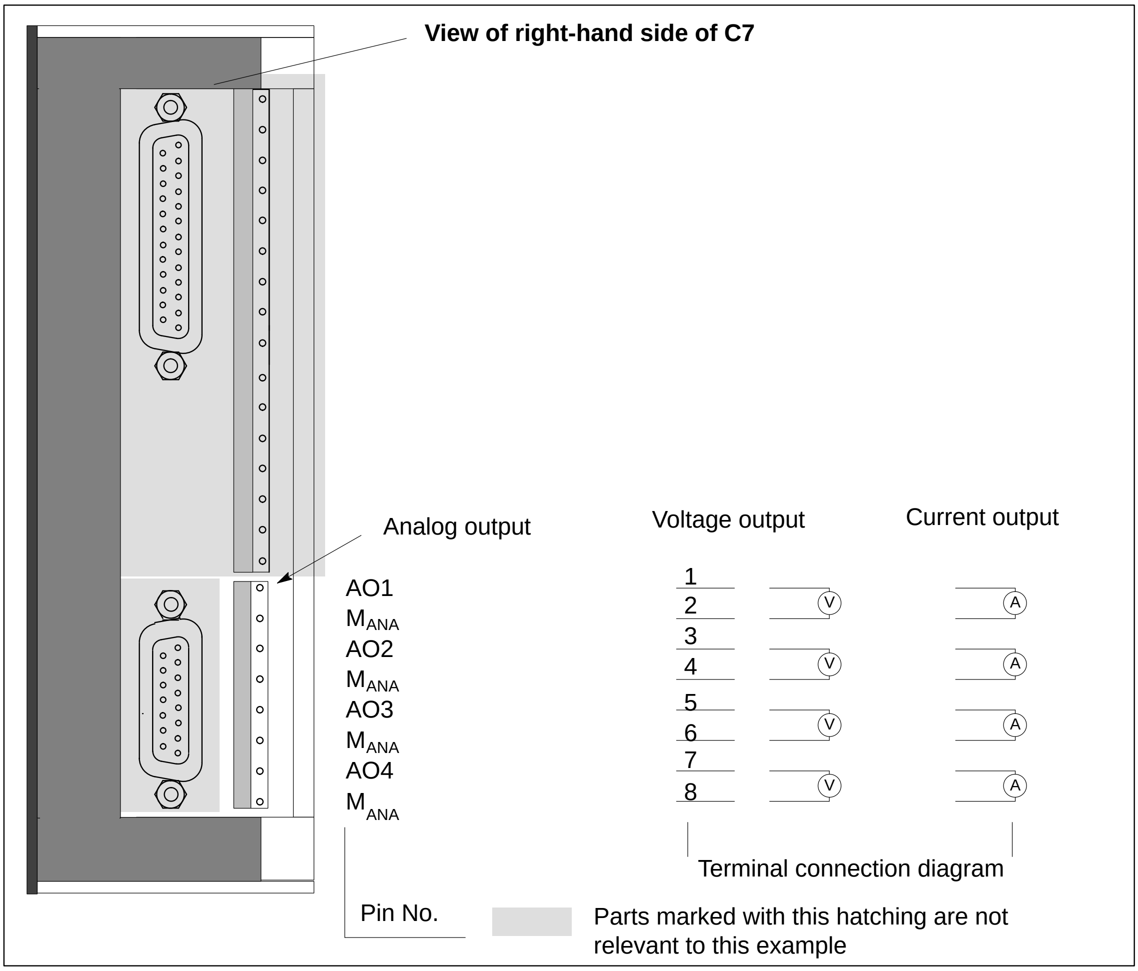

Figure 4 Terminal Connection Diagram of the Analog Output Module

Block Diagram

Figure 5 shows the block diagram of the analog output module.

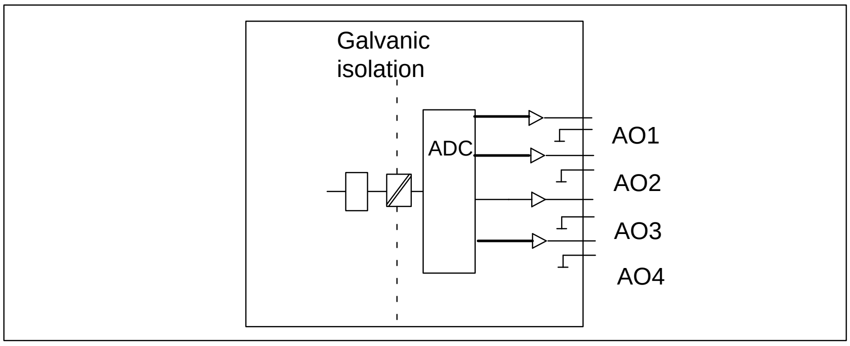

Figure 5 Block Diagram of the Analog Output Module

Technical Specifications

Data Specific to Analog Outputs	
Number of outputs	4
Cable length, shielded	200 m
Voltages, Currents, Potentials	
Isolation	yes
Dielectric strength	U_{ISO} = 500 V DC
Measurement ranges:	Voltage or current selectable
Voltage	± 10V
Current	± 20mA, 4 to 20mA
Analog Value Formation	
Resolution (incl. overflow range)	
• ± 10 V; ≥ 20 mA; 4 to 20 mA	12 bits incl. sign
Conversion time (all active channels)	max. 4 ms typ. 2 ms
Settling time	
• For resistive load	0.1 ms
• For capacitive load	3.3 ms
• For inductive load	0.5 ms
Substitute value	
Idle power and voltage	yes, selectable
Global value can be substituted (one value for all channels)	yes, selectable
Retain last value	yes, selectable
Noise Suppression, Limit Values	
Crosstalk attenuation between outputs	> 40 dB
Error limit (in the entire temperature range, relative to the output range)	
• Voltage	± 0.8 %
• Current	± 1 %
Basic error limit (error limit at 25 °C relative to the output range)	
• Voltage	± 0.5 %
• Current	± 0.6 %
Output ripple (relative to the output range)	± 0.05 %
Reproducibility (in settled state at 25 °C relative to the output range)	± 0.06 %

Status, Interrupts, Diagnostics	
Interrupts	
• Diagnostic interrupt	yes, selectable
Diagnostic functions	yes, selectable
• Diagnostic information can be read out	yes, group error
Data for Selecting an Actuator	
Output ranges (rated values)	± 10 V ± 20 mA From 4 to 20 mA
Load resistance	
• For voltage outputs	min. 2 k Ω
• For current outputs	max. 500 Ω
• Capacitive load	max. 1 µF
• Inductive load	max. 1 mH
Voltage output	
• Short-circuit protection	Short-circuit proof yes
• Short-circuit current	approx. 25 mA
Current output	
• Idle voltage	max. ± 16V
Connecting actuators	
• For voltage output 2-wire connection	possible
• For current output 2-wire connection	possible
Destruction limits for voltages/currents applied externally	
• Voltage at the outputs against M_{ANA}	max. 20 V DC
• Current	max. 40 mA DC

3.1 Addressing the I/Os of the C7-623/P, C7-624P, C7-626/P and C7-626/P DP Control Systems

Analog I/O Addresses

The address of an analog channel is always a word address.

An analog input/output has the same start address for the analog input and output channels (see Figure 6).

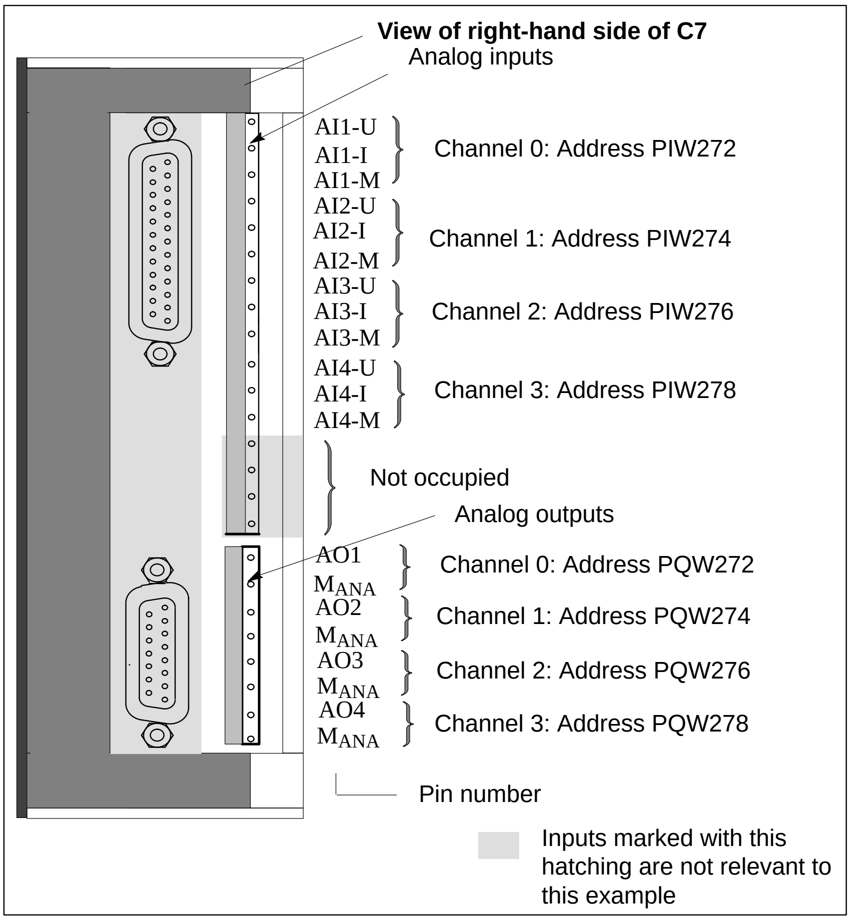

Figure 6 Analog Input/Output Addresses

3.2 Timing of the Analog I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Analog Inputs

The timing of the analog inputs depends on the current parameter assignment of the analog I/Os (see Section 1.4). The duration of the measuring cycle depends on the number of activated analog input channels. Deactivated channels reduce the length of the measuring cycle.
The measuring cycle is the sum of the conversion times of the activated analog inputs.

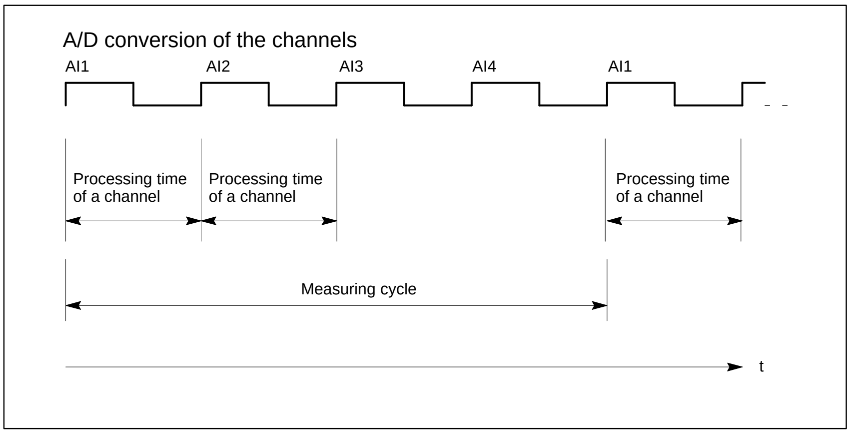

Figure 7 Measuring Cycle when All Analog Input Channels are Activated

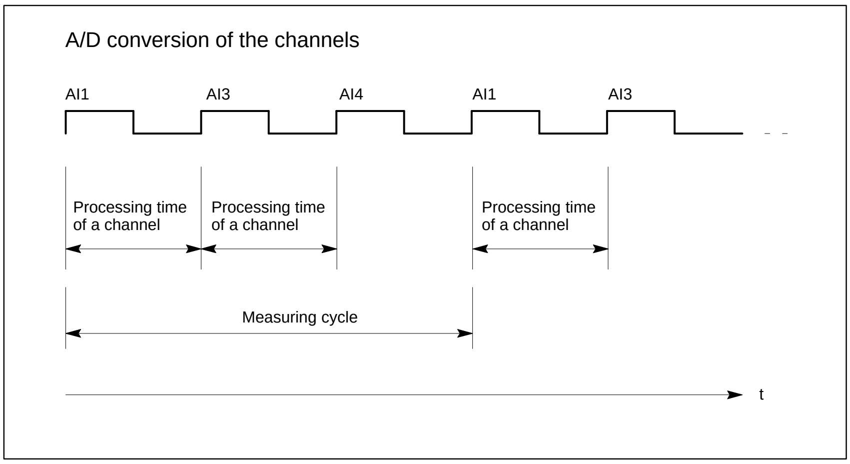

Figure 8 Measuring Cycle when Analog Input Channel 2 is Deactivated

Analog Outputs

The duration of the output cycle does **not** depend on the number of activated analog output channels. This is always constant and deactivated channels do not reduce the output cycle.

$t_{output\ cycle} = 4 \times t_{conversion\ time\ of\ a\ channel} = const.$

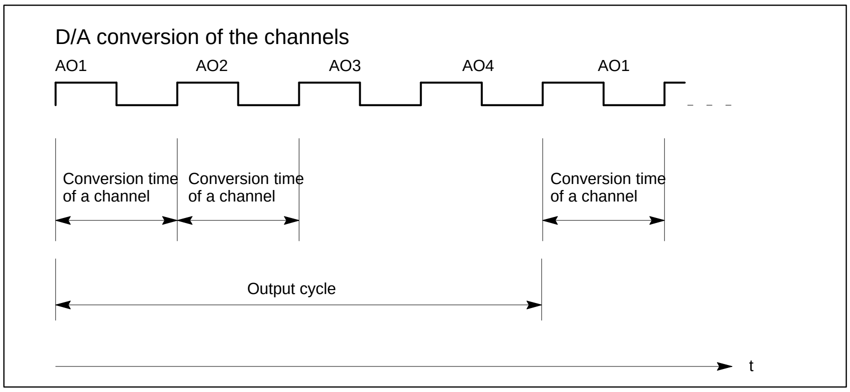

Figure 9 Output Cycle when All Analog Output Channels are Activated

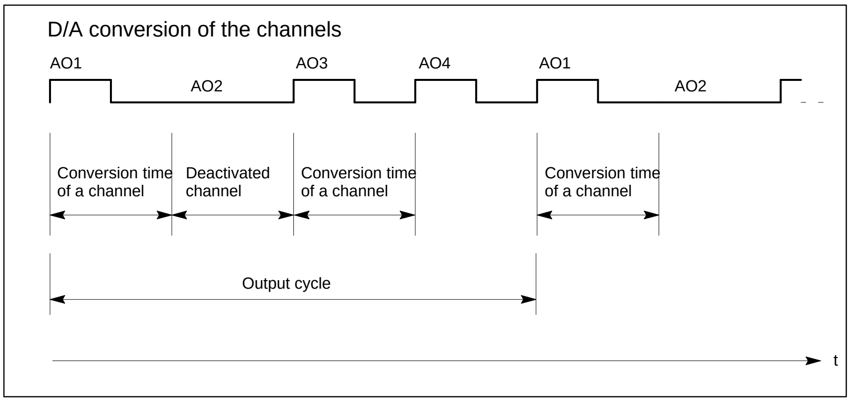

Figure 10 Output Cycle when Analog Output Channel 2 is Deactivated

3.3 Assigning Parameters to the Analog I/Os of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

Configuration

You configure your setup with STEP 7 V4.02.
You can extend the hardware catalog by reinstalling with an expansion diskette. Later versions of STEP 7 already contain these device types.

Parameter Assignment

You set the parameters for the analog I/O using the S7 application *Configuring Hardware*. A parameter block is generated that contains all the currently selected I/O parameters. After loading this parameter block, the parameters are not immediately transferred to the analog I/O. The C7 CPU then transfers the parameters to the analog I/O after every operating mode change from STOP→RUN.

Alternatively, you can also change some parameters in the user program with SFCs 55 to 57 (see Reference Manual **/235/**).

We subdivide the parameters for the two configuration alternatives into:

- Static parameters and
- Dynamic parameters

The following table explains when the static and dynamic parameters are adopted.

Table 1-2 Time of Transfer of the Parameters from the C7 CPU to the Analog I/O

Parameter	Set with	Time of Parameter Transfer
Static	*Configuring Hardware*	STOP -> RUN
Dynamic	*Configuring Hardware*	STOP -> RUN
	SFCs 55 to 57	for SFC call

Assignment of Parameters for Characteristics

The following parameter blocks permit the assignment of parameters in *Configuring Hardware* to define the following characteristics of the analog I/O:

- For inputs
  - Basic settings
  - Diagnostics
  - Measurement
  - Interrupt cycle
- For outputs
  - Basic settings
  - Diagnostics
  - Substitute values
  - Output range

Analog Input Parameters

Table 1-3 provides an overview of the analog input parameters.

Table 1-3 Analog Input Parameters

Parameter	Analog Inputs	
	Value Range	**Preset Value**
Basic settings • Enable diagnostic interrupt	Yes/No	No
Diagnostics • Enable – Configuration/parameter assignment error – Wire break (only 4 to 20 mA) – Range undershoot – Range overshoot • Wire break test (only for measurement range 4 to 20 mA)	Yes/No Yes/No	No No
Measurement • Type of measurement • Measurement range	Deactivated Voltage Current ± 10 V ± 20 mA 4 to 20 mA	Voltage ± 10 V
Interrupt cycle • Interrupt • Interrupt time	Yes/No Unsolicited, 3ms, 3.5 ms, 4 ms, 4.5 ms to 16 ms	No Unsolicited

Hardware Interrupt

You can operate the inputs of the analog I/Os in three ways:

- Without hardware interrupt

  A free measuring cycle of all activated channels without generating hardware interrupts.

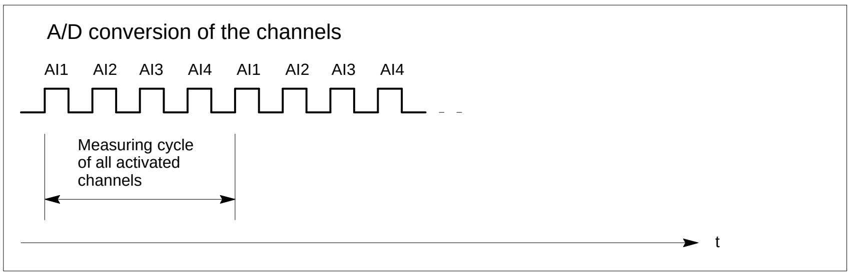

Figure 11 Sequence of the Measurement with Four Analog Input Channels without Generating Hardware Interrupts

- Hardware interrupt as a cyclic interrupt

  Free measuring cycle of all activated channels with generation of a non measuring cycle-dependent hardware interrupt as a time interrupt with a selectable interrupt time.

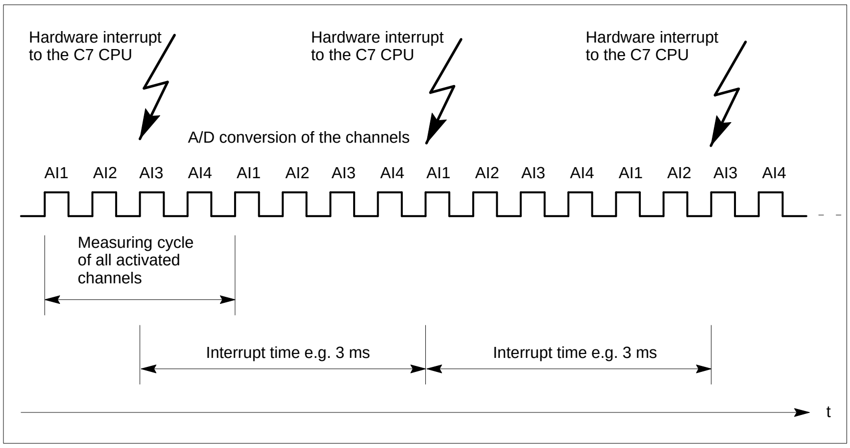

Figure 12 Sequence of the Measurement with Four Analog Input Channels and Generation of Hardware Interrupts as Cyclic Interrupts

- Hardware interrupt as cycle end interrupt

  A measuring cycle with a selectable cycle time and generation of a hardware interrupt as a cycle end interrupt.

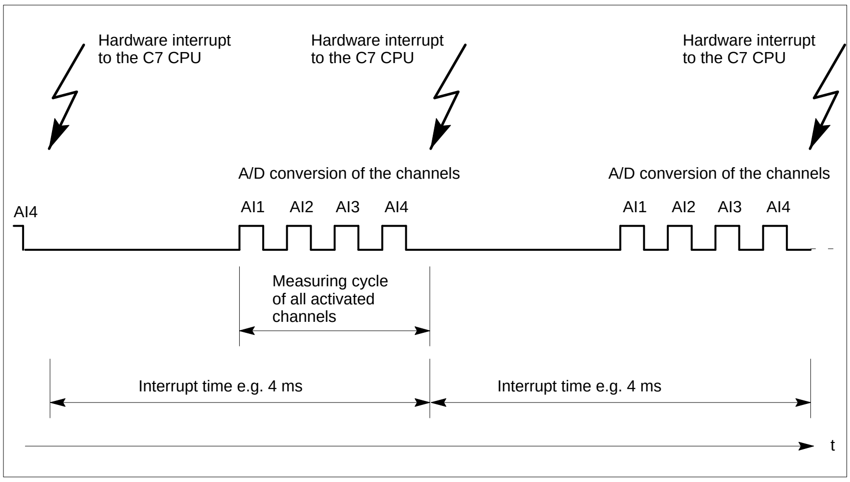

Figure 13 Sequence of the Measurement with Four Analog Input Channels with Generation of Hardware Interrupts as Cycle End Interrupts

A hardware interrupt from the I/Os triggers the start of OB40 (hardware interrupt OB) on the C7 CPU. In this case, the process variable OB40_POINT_ADDR supplies the value DW#16#FFFFFFFF.

Analog Output Parameters

Table 1-4 provides an overview of the analog output parameters.

Table 1-4 Analog Output Parameters

Parameter	Analog Output	
	Value Range	**Preset Value**
Basic setting		
• Enable diagnostic interrupt	Yes/No	No
Diagnostics		
• Enable	Yes/No	No
– Configuration/parameter assignment error		
– Substitute value switched on		
Substitute value		
• Idle power and voltage (value 0)	Yes/No	Yes
• Retain last value	Yes/No	No
• Global substitute value	9400_H...$6C00_H$	0
Output range		
• Type of output	Deactivated Voltage Current	Voltage
• Output range	± 10 V ± 20 mA 4 to 20 mA	± 10 V

Parameter Characteristics of Analog Outputs

Table 1-5 shows which parameters

- Are static or dynamic
- Can be set.

Table 1-5 Parameter Characteristics of Analog Outputs

Parameter	Static/Dynamic	Effective Range
Enable diagnostic interrupt	Static	Analog inputs / Analog outputs/ Universal inputs
Enable diagnostics	Static	Outputs
Substitute value		
• Idle power and voltage (value 0)	Dynamic	Outputs
• Retain last value	Dynamic	Outputs
• Global substitute value	Dynamic	Outputs
Type of output	Dynamic	Outputs
Output range	Dynamic	Outputs

4 Universal Inputs of C7-623/P, C7-624/P, C7-626/P and C7-626/P DP

Overview

The C7 has 4 digital universal inputs that provide the following functionality:

- Digital input
- Interrupt input
- Counter input
- Frequency/period duration counter input
- External gate counter input

These input functions can be set by assigning them parameters; this determines how the inputs are used.

Assigning Parameters to the Inputs

The universal inputs are set using software. This is done using the *Configuring Hardware* application. You use this application to determine which function the individual input is to execute (see Table 1-6).

Interrupt Input

If this function is set, the input responds like a normal interrupt input, that is, a hardware interrupt is triggered in the C7 CPU as a response to the assigned edge.

Digital Input

If this function is set, the input responds like a normal digital input. The only difference here is that the current process signal is not automatically given to the control program but must first be read in from the I/O.

Counter Input

These universal inputs enable you to capture counter pulses up to a frequency of 10 kHz. The counter can count either up or down. You can also assign parameters to the count edge.

Frequency Counter

This enables you to count pulses within a programmed length of time. From this you can calculate a frequency $\leq$ 10 kHz.

Period Duration Counter

This function enables you to count fixed timer ticks between two positive edges. From this you can calculate the duration of an interval period.

External Gate Counter

This function enables you to count pulses within a gate time that starts with a rising edge on the external gate pin and ends with a falling edge.

Terminal Connection Diagram

Figure 1 shows the pin assignments of the universal inputs

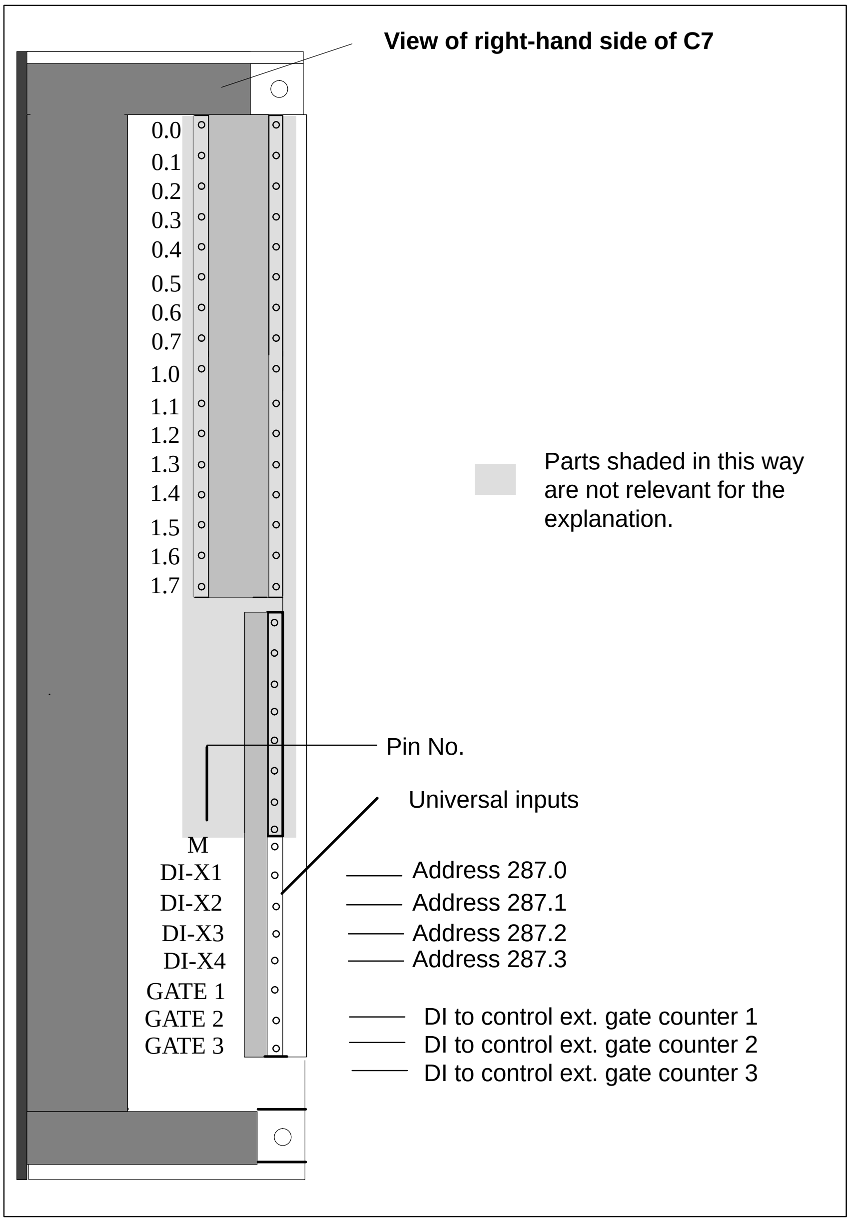

Figure 14 Pin Assignments of the Universal Inputs

Pin Assignments of the Universal Inputs

The pin assignments of the universal inputs are as follows:

Table 1-6 Assignments of the Universal Inputs

Pin No.	Function
M	Ground for all DI–Xx
DI-X1	Universal input 1 (interrupt, digital and counter input, external gate counter 16 bit)
DI-X2	Universal input 2 (interrupt, digital and counter input, external gate counter 16 bit)
DI-X3	Universal input 3 (interrupt, digital, counter, frequency counter and period duration counter input, external gate counter 24 bit)
DI-X4	Universal input 4 (interrupt or digital input)
GATE 1	External gate pin for DI-X1
GATE 2	External gate pin for DI-X2
GATE 3	External gate pin for DI-X3

Technical Specifications of the Universal Inputs

Specific Data of the Universal Inputs	
Number of inputs	4 + 3 (gate pins)
Cable length, shielded	1000 m
Voltages, Currents, Potentials	
Nominal load voltage L +	24 VDC
Number of simultaneously energizable inputs	4 + 3 (gate pins)
Galvanic isolation	No
Function, Interrupts, Diagnostics	
Interrupts Counter functions	Can be assigned parameters
Max. counter frequency	10 kHz
Diagnostic function	Module standard diagnostics in conjunction with analog I/O. No channel-specific diagnostics
Counters	Max. 3
• Principle	Edge counting
• Counter range C1/C2	up 0 to 2^{16}-1 down 2^{16}-1 to 0
• Counter range C3	up 0 to 2^{24}-1 down 2^{24}-1 to 0
• Limit value (setpoint) specification	1 value per counter
• Counter interrupt of up counter	When limit value is reached
• Counter interrupt of down counter	When “0” is reached
• Enable	In the program
Period Duration Counter	Max. 1
• Principle	Counting fixed time units between two positive edges
• Counter range	0 to 2^{24}-1
• Max. period duration	8.395 s or 0.119 Hz
Frequency Counter	Max. 1
• Principle	Counting of pulses within a time period
• Counter range	0 to 2^{24}-1
• Gate width	0, 1 s, 10 s (can be set)
• Max. frequency	10 kHz; limited by input filter

External Gate Counter	Max. 3
• Principle	Edge counting via external pin
• Counter range C1/C2	0 to 2^{16}-1
• Counter range C3	0 to 2^{24}-1
Data for Selecting a Sensor	
Input voltage	
• Nominal voltage	24 VDC
• For “1” signal	from 11 to 30 V
• For “0” signal	from -3 to 5 V
Input current	
• At “1” signal	from 2 to 8 mA
Input delay time	
• Configurable	No
• From “0” to “1”	approx. 0.01 ms
• From “1” to “0”	approx. 0.01 ms
Input characteristic	In accordance with IEC 1131, Part 2
Type of input in accordance with IEC 1131	Type 2
Input current	
• At “1” signal	From 6 to 11.5 mA

4.1 Addressing Universal Inputs

Universal Input Addresses

The addresses for the universal inputs are default addresses which cannot be changed. According to the application of the universal inputs, the results occupy differing addresses.

For the address allocation, a distinction is made between:

- The input range PIW280 to PIB287 for count values or signal state of the digital inputs, and
- The output/control range PQW 280 to PQB287 for counters

Input Range

The 4 universal inputs of the input range (see Figure 1) have the following addresses and weightings:

Table 1-7 Input Address of the Universal Inputs

Address		Designation
PIB280 PIB281		**CI1**: Counter input
PIB282 PIB283		**CI2**: Counter input
PIB284 PIB285 PIB286		**CI3**: Counter input Frequency/period time counter
PIB287	Bit 7	—
	Bit 6	1 = Counter 3 enabled 0 = Counter 3 disabled
	Bit 5	1 = Counter 2 enabled 0 = Counter 2 disabled
	Bit 4	1 = Counter 1 enabled 0 = Counter 1 disabled
	Bit 3	1 = universal input 4 set, 0= universal input 1 reset.
	Bit 2	1 = universal input 3 set, 0= universal input 1 reset.
	Bit 1	1 = universal input 2 set, 0= universal input 1 reset.
	Bit 0	1 = universal input 1 set, 0= universal input 1 reset.

Output Range

If the universal inputs are used as counters, then the behavior of the counters is controlled via the output range.

Table 1-8 Addresses and Weighting of the Output Range of the Count Inputs

Address	Control of Counters 1 to 3
PQW280	Start/comparison value counter 1 Initial value for down counter, comparison value for up counter
PQB287: Bit 0 Bit 1	0 = Counter 1 disabled 1 = Counter 1 enabled 0 = Do not accenitial value for down counter, comparison value for up counterpt new start/comparison value 1 = Set new start/comparison value
PQW282	Start/comparison value counter 2 Initial value for down counter, comparison value for up counter
PQB287: Bit 0 Bit 1	0 = Counter 2 disabled 1 = Counter 2 enabled 0 = Do not accept new start/comparison value 1 = Set new start/comparison value
PQB284 PQB285 PQB285	Start/comparison value counter 3 Initial value for down counter, comparison value for up counter
PQB287 Bit 4 Bit 5	0 = Counter 3 disabled 1 = Counter 3 enabled 0 = Do not accept new start/comparison value 1 = Set new start/comparison value

Hinweis

Please note that no direct read-in function is available for reading in the complete counter status of counter 3.

When counting in the 0 to 65535 value range (2 bytes), the counter values are stored in PQW285.

4.2 Parametrieren der Universaleingänge

Assigning Parameters

You set the parameters for the universal inputs using the STEP 7 application *Configuring Hardware*. A parameter block is generated which contains all currently selected parameters of the universal inputs. After loading this parameter block, the C7 CPU then transfers the parameters to the appropriate universal inputs at every operating mode change from STOP → RUN.

Interrupt Inputs

If the universal inputs are used as interrupt inputs, a hardware interrupt will be triggered on the C7 CPU for the assigned rising or falling edge at the input. The default is the rising edge.

Counter Inputs

The universal inputs 1 to 3 can be assigned as:

- Counter input, 16 bit (counters 1 and 2)
- Counter input, 24 bit (counter 3)
- Frequency counter (input 3 only)
- Period time counter (input 3 only)
- External gate counter, 16 bit (inputs 1 and 2 only)
- External gate counter, 24 bit (input 3 only)

The counter values are made available to the user program as 16-bit or 24-bit values and the frequency and period time counter values as 24-bit values. The counter values of the external gate counter are either 16-bit or 24-bit values, depending on the input.

Table 1-9 lists the parameters for the above-mentioned functions:

Table 1-9 Parameter Block of the Count Inputs

Parameter	Explanation	Value Range	Default Setting
Count input 1	Activate the count input and define the type of counting	Standard Interrupt Counter HW gate counter	Standard
	Define the count direction	Up Down	Up
	Set edge to be used for counting	Rising edge Falling edge	Rising edge
	Counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	No further parameters for external gate counter (16 bit)	–	–

Table 1-9 Parameter Block of the Count Inputs

Parameter	Explanation	Value Range	Default Setting
Count input 2	Activate the count input and define the type of counting	Standard Interrupt Counter HW gate counter	Standard
	Define the count direction	Up Down	Up
	Set edge to be used for counting	Rising edge Falling edge	Rising edge
	Counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	No further parameters for external gate counter (16 bit)	–	–
Count input 3	Activate the count input and define the type of counting	Standard Interrupt Counter Frequency counter Period duration counter HW gate counter	Standard
	If counter activated then define the count direction	Up Down	Up
	If counter activated then define the edge to be used for counting	Rising edge Falling edge	Rising edge
	If counter activated, then the counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	If frequency counter selected, then select the gate time for the frequency counting	0.1 s 1 s 10 s	1 s
	No further parameters for period time counter	–	–
	No further parameters for external gate counter (24 bit)	–	–

Digital Inputs

If the universal inputs are deactivated in the parameter block (default setting), then the inputs react as digital inputs. However, no automatically updated process image will be made available to the user program for these inputs. The current state of the universal input can only be read by means of a direct I/O access. (See Table 1-7 for address).

4.3 External Gate Counter

Gate Time Measurement

You can count pulses within a gate time with an external gate counter. The counting direction is forwards. The counting process starts at zero with a rising edge on the external gate pin and ends with a falling edge.

After the falling edge, a hardware interrupt can be generated and the new count value is written to the output area.

Figure 15 illustrates gate time measurement with an external gate counter.

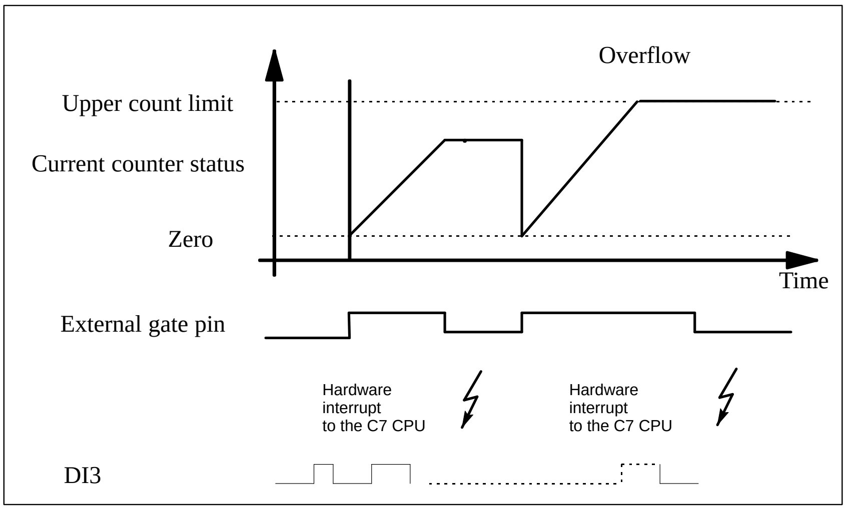

Figure 15 Gate Time Measurement with an External Gate Counter

Start Bit

The gate time measurement is only activated if the start bit is set in the input area at the same time as the external gate pin.

16-Bit and 24-Bit Counters

Counters 1 and 2 operate as 16-bit counters, while counter 3 is a 24-bit counter.

Default Value

The default value is 0xFFFF for counters 1 and 2 and 0xFFFFFF for counter 3. If no valid value is available, for example, during the first measuring cycle, this default value is output.

Counter Overflow

If the count value exceeds the upper count limit and an overflow occurs, the corresponding bit is set in byte 15.7 and value $0FFFF_H$ (for counters 1 and counter 2) or $0FFFFFF_H$ (for counter 3) is output.

4.4 Example for Programming the Counters

Overview

The following programming example for the universal inputs, parameterized as inputs, is intended to familiarize you with programming the I/O.

Function of Block

The program is intended to implement a simple function which shows the principle of addressing the counter inputs by the STEP 7 program.

The counters are implemented to count up until the comparison value is reached. They are reset when the comparison value is reached and counting is restarted, beginning with zero. Due to the immediate reset, the specified comparison value never can be read out.

In the following program example, the universal inputs are assigned parameters as follows:

UI1	counter C1
UI2	counter C2
UI3	counter C3
UI4	standard digital input; not used in the example

The three counters are assigned parameters as follows:

Interrupt:	yes
Counting direction:	up
Edge:	rising

Execution of block:

OB100

1. First, all three counters are stopped on startup.
   This is necessary so that the counter will start counting from zero after a complete restart. If this is not required, that is if the counter must continue after a restart with its “old” value, the counters must not be stopped.
2. After a waiting time of about 10 ms, a comparison value is written for each counter.
   This waiting time is required so that the STOP command for the counters can become effective on the C7 module. In the complete restart OB (OB100), the times are not critical since the cycles are not monitored.
3. Immediately after the comparison value has been written, the comparison values are declared valid and the counters are started.
4. **OB1**
   The counter values can be read cyclically in OB1. The counter status bits are evaluated to ensure that the counters are active. OB1 is ended if not all counters are activated.

   If all counters are active, the read counter values are reassigned. This is an optional feature which can be useful for specific applications. If the same value must always be used within an OB1 cycle, re-assignment is recommended (for example in the case of high counting frequency and relatively long cycles > accessing OB1 more than once might supply different values).

5. **OB40**
   This block is used for interrupt evaluation. A jump is executed by evaluating the information of the interrupt vector register from the start information of OB40 (LB 8). A memory byte is incremented as a function of the counter which has triggered the interrupt. OB40 is programmed to recognize even several interrupts occurring almost simultaneously.
6. **OB35**
   OB35 is used to generate the count pulses. The following wiring is required to execute the example:

Connect	digital output 1.2	with	DI-X1
Connect	digital output 1.3	with	DI-X2
Connect	digital output 1.4	with	DI-X3

   In OB35, the output bits of the C7 digital outputs are toggled (alternately enabled/disabled), and the effect is a period time of 200 ms at each output, correponding to a frequency of 5 Hz. This value results from the 100 ms default cyclic interrupt time of OB35. This means that each output is set to a logical “1” for 100 ms and then, also for 100 ms, reset to a logical “0”.

S7 Status

With the *Monitoring and Modifying Variables* application in STEP 7, the following can be monitored:

PIW280	current counter value C1
MW20	counter image C1
PIW282	current counter value C2
MW22	counter image C2
PIW285	current counter value C3
MW25	counter image C3 (C3: direct monitoring only possible with a counter status between 0 and 65535, otherwise only indirect monitoring possible in *Monitoring and Modifying Variables*)
MB40	number of interrupts triggered by C1
MB41	number of interrupts triggered by C2
MB42	number of interrupts triggered by C3
PIB287	status of counters

OB100 Statement Sequence

The OB100 complete restart block contains the following statements:

```
ORGANIZATION_BLOCK OB100
var_temp
                start_info : array(0..19) of byte;
end_var
BEGIN

//***Resetting the counters***
T PQB287;       // C1, C2, C3
```

```
CALL SFC 47     // wait so that STOP becomes effective
(WT:=10000)     // 10000 ms = 10 ms

//***Setting comparison values***
L 10;           // set comparison value C1
T PQW280;
L 20;           // set comparison value C2
T PQW282;
L 40;           // set comparison value C3
T PQW285;

//***Declaring comparison values valid and starting counter***
L 3F;           // declare comparison value valid and start
T PQB287;       // C1, C2, C3

END_ORGANIZATION_BLOCK
```

OB1 Statement Sequence

OB1 contains the following statements:

```
ORGANIZATION_BLOCK OB1
var_temp
                start_info : array(0..19] of byte;
                status : BYTE;
end_var
BEGIN

//***Check whether all counters are active***
L PIB287;       // scanning status bits
T status;

A L20.4;        // C1 signalled active
A L20.5;        // C2 signalled active
A L20.6;        // C3 signalled active
JC run;
BEU;

//***Waiting time of 1 ms***
CALL SFC47      // “Wait function”
(WT:=1000);     // 1000 ms = 1 ms

//***Determining counter image (optional)***
run: NOP 0;
L PIW280;       // C1
T MW20;
L PIW282;       // C2
T MW22;
```

either

```
//*** Determining counter image for 16-bit counter ***
L PIW285;       // C3
T MW25;
```

or

```
//*** Determining counter image for 24-bit counter ***
L PID284;       // read in C3 (PIB284-286) and status byte (PIB287)
S RD8;          // transfer PIB287 bits from ACCU
T MD24;         // transfer ACCU or C3 to memory double word

END_ORGANIZATION_BLOCK
```

OB35 Statement Sequence

OB35 contains the following statements:

```
ORGANIZATION_BLOCK OB35
var_temp
                start_info : array(0..19) of byte;
end_var
BEGIN

AN Q1.2;        // assigned to C1
=Q1.2;

AN Q1.3;        // assigned to C2
=Q1.3;

AN Q1.4;        // assigned to C3
=Q1.4;

L QW0;          // transfer QW0 immediately
T PQW0;

END_ORGANIZATION_BLOCK
```

OB40 Statement Sequence

OB40 contains the following statements:

```
ORGANIZATION_BLOCK OB40
var_temp
                start_info : array[0..19] of byte;
end_var
BEGIN

//***Determining which input has triggered interrupt***

AN L8.0;        // interrupt from C1?
JC c2;

L MB40;         // counts number of interrupts from C1 (up to 255)
INC 1;
T MB40;

c2:NOP 0;
AN L8.1;        // interrupt from C2?
JC c3;

L MB41;         // counts number of interrupts from C2 (up to 255)
INC 1;
T MB41;

c3:NOP 0;
AN L8.2;        // interrupt from C3?
BEB;

L MB42;         // counts number of interrupts from C3 (up to 255)
INC 1;
T MB42;

END_ORGANIZATION_BLOCK
```

5 Structure of the Parameter Data Records

If you want to reassign parameters during operation, you must check the validity and interdependency of the individual parameters in your program.

Incorrect value ranges for the parameters can lead to incorrect responses from the I/Os. The following table shows the structure of the parameter data records.

Table 1-10 Table with Data Set Descriptions Parameter Block

DS	Byte	Bit	Default-Value	Contents	Meaning of the Respective Bits
0	00	7	0	Enable diagnostics AO4	0=No 1=Yes
		6	0	Enable diagnostics AO3	0=No 1=Yes
		5	0	Enable diagnostics AO2	0=No 1=Yes
		4	0	Enable diagnostics AO1	0=No 1=Yes
		3	0	Enable diagnostics AI4	0=No 1=Yes
		2	0	Enable diagnostics AI3	0=No 1=Yes
		1	0	Enable diagnostics AI2	0=No 1=Yes
		0	0	Enable diagnostics AI1	0=No 1=Yes
	01	7..5	000	–	
		4	0	Enable diagn. interrupt module	
		3	0	Enable diagn. wire break AI4	0=No, 1=Yes (only if measurement range 4 to 20mA)
		2	0	Enable diagn. wire break AI3	0=No, 1=Yes (only if measurement range 4 to 20mA)
		1	0	Enable diagn. wire break AI2	0=No, 1=Yes (only if measurement range 4 to 20mA)
		0	0	Enable diagn. wire break AI1	0=No, 1=Yes (only if measurement range 4 to 20mA)
	02	0..7	00000000	Reserved	Must always be zero, otherwise parameter assignment error
	03		00000000	Reserved	Must always be zero, otherwise parameter assignment error
1	04	7..6	00	AI2 –	
		5..4	01	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
		3..2	00	AI1 –	
		1..0	01	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	05	7..6	01	AI4 –	
		5..4	00	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
		3..2	01	AI3 –	
		1..0	00	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	06	7..2	000000	–	
		1..0	00	Enable cyclic interrupt	00=No cyclic interrupt 01=Time cyclic interrupt (only if byte 7 <> 1) 10=Cycle end interrupt (only if all AIx are not deactivated)
	07	7..4	0000	–	
		3..0	0001	Cycle time	0=16 ms, 1=Free-running, 6=3 ms, 7=3.5 ms, 8=4 ms etc. (increment 0.5 ms up to 15.5 ms)

Table 1-10 Table with Data Set Descriptions Parameter Block (Continued)

DS	Byte	Bit	Default-Value	Contents	Meaning of the Respective Bits
1	08	7..6	00	Univ. DI1 –	
		5	0	Direction	0=Up, 1=Down (only if mode=010)
		4	0	Edge	0=Rising edge, 1=Falling edge
		3	0	Hardware interrupt	0=No, 1=Yes
		2..0	000	Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 101=External gate counter
	09	7..6	00	Univ. DI2 –	
		5	0	Direction	0=Up, 1=Down (only if mode=010)
		4	0	Edge	0=Rising edge, 1=Falling edge
		3	0	Hardware interrupt	0=No, 1=Yes
		2..0	000	Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 101=External gate counter
	10	7..6	00	Univ. DI3 gate time	00=0.1 s, 01=1 s, 10=10 s (only if mode=010)
		5	0	Direction	0=Up, 1=Down (only if mode =010)
		4	0	Edge	0=Rising edge, 1=Falling edge
		3	0	Hardware interrupt	0=No, 1=Yes
		2..0	000	Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 011=Frequency counter (FC) 100=Period duration counter (PC), 101=External gate counter
	11	7..5	00000	Univ. DI4 –	
		4	0	Edge	0=Rising edge, 1=Falling edge
		3	0	Hardware interrupt	0=No, 1=Yes
		2..0	0	Mode	000=General DI, 001=Interrupt DI
	12	7..6	00	AO2 STOP Reaction to CPU	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		5..4	01	Output area	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
		3..2	00	AO1 STOP Reaction to CPU	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		1..0	01	Output area	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	13	7..6	00	AO4 STOP Reaction to CPU	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		5..4	01	Output area	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
		3..2	00	AO3 STOP Reaction to CPU	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		1..0	01	Output area	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	14		$oooo_H$	Global substitute value for AO1 to AO4	(only if “global substitute value” active on at least one of the AO)
	15				

6 Diagnostic Data of the Analog I/Os and the Universal Inputs of the C7-623/P, C7-624/P, C7-626/P and C7-626/P DP Control Systems

6.1 Diagnostic Messages

Overview

The C7 CPU possesses a diagnostic buffer in which detailed information is provided for all diagnostic events in the order of their occurrence. The contents of the diagnostic buffer is preserved even after a memory reset on the C7 CPU. The diagnostic entries in the diagnostic buffer can be read and interpreted by the user program.

Advantages

Errors in the system can be evaluated after a long time delay using the diagnostic buffer in order be able to identify the cause of a STOP, for example, or to trace and assign the occurrence of individual diagnostic events.

Diagnostic Events

Diagnostic events can be:

- Errors in an I/O (module)
- System errors in the C7 CPU
- Change in operating modes (for example, from RUN to STOP)
- Program errors in the CPU program

C7 CPU I/O Diagnostics

The I/O diagnostics are divided into two groups:

- Standard diagnostics (general malfunction of the C7 analog I/O and universal inputs)
- Module-specific diagnostics

The standard diagnostics are always entered into the diagnostic buffers of the C7 CPU after the occurrence of a diagnostic interrupt. The requirement is that the module is able to diagnose.

The module-specific diagnostics provide detailed information regarding the type and possible cause of the error. This information can be called up by the user program by means of special system calls. The requirement is that diagnostics have been enabled (default setting is always “no” in this case).

Assigning I/O Diagnostic Parameters

You can set whether the analog I/O diagnostic messages should be generated using STEP 7.

Using the STEP 7 application *Configuring Hardware*, you can also assign parameters to the diagnostic behavior of the analog I/O, i.e. you set whether the analog I/O diagnostic messages should be sent to the C7 CPU on request. Furthermore, you can assign parameters to define whether the module should trigger a diagnostic interrupt in the C7 CPU after the occurrence of an error.

Diagnostic Information (I/O)

In the diagnostic information, we differentiate between permanent and temporary diagnostic errors.

- Permanent diagnostic errors cannot be influenced by the user program and can only be removed by resetting the C7 CPU (memory reset and complete restart) or equipment exchange (after a fault).
- Temporary diagnostic errors disappear automatically after a renewed measurement (ADC error, overrange or underrange error), can be removed by the user program (if necessary, by assigning parameters via SFC55 during operation) or by hand at the connections (correcting the wiring).

Read Diagnostic Messages

Diagnostic messages will be entered into the diagnostic buffer only if the diagnostic interrupt OB (OB82) occurs. The requirement is that the parameter “diagnostic interrupt enable = yes” was assigned. Then you can read out the detailed diagnostic messages in addition to the standard diagnostic information using the STEP 7 application *Module Information* (see *Manual* **/231/**). No entry is made in the diagnostic buffer of the C7 CPU in all other cases. Therefore the diagnostic message cannot be read out.

Analog Input Diagnostics

Table 1-11 provides an overview of the channel-specific diagnostic messages of the analog input.

The diagnostic information is allocated to the individual channels.

Table 1-11 Diagnostic Message of the Analog Input

Diagnostic message	are supported?
Parameter assignment error	Yes
Common mode error	No
P short circuit	No
M short circuit	No
Wire break (only for 4 to 20mA by software)	Yes
Reference error	No
Underrange (underflow)	Yes
Overrange (overflow)	Yes

Analog Output Diagnostics

Only one group error exists for the analog output.
Possible causes of the group error could be:

- Parameter error
- Substitute value is connected

6.2 Layout of Diagnostic Area of the Module

The diagnostic area consists of:

- Data set 0: the standard diagnostic bytes (0 to 3)
- Data set 1: the channel-specific diagnostic bytes (for enabled diagnostics).
  - Bytes 4 to 7 and bytes 8 to 11 - channel and individual information analog input (AI) diagnostics
  - Bytes 12 to 15 - channel information- analog output (AO) diagnostics

Table 1-12 illustrates the structure of the diagnostic area and the meaning of the individual entries.

Table 1-12 Structure of the Diagnostic Area

Byte	Bit	Meaning	Explanation	Value Range
00	0	Module fault	1 = error occurred, 0 = everything OK	0 | 1
	1	Internal error	1 = watchdog, EPROM, ADC error	0 | 1
	2	External error	1 = error at AI or AO	0 | 1
	3	Channel error	1 = with byte 0/bit 2 and channel-specific diagnostic byte byte 4 ...	0 | 1
	4	External auxiliary voltage missing	(Cannot be checked)	0
	5	Front plug missing	(Cannot be checked)	0
	6	Module not assigned parameters	Normal state (standard parameters set) byte 0/bit 0=0 [3)]	0 | 1
	7	Incorrect parameters	1 with bit 0 of bytes 8/9/10/11 or bit 0 ... 3 of byte 15 (Standard parameters set for channel	0 | 1
01	0	Module class	SM type class	
	1	Module class	SM type class	5
	2	Module class	SM type class	
	3	Module class	SM type class	
	4	System-oriented channel-specific diagnostic info.	Yes	1
	5	User-defined diagnostic info. (diag. info. not configured by sy-stem)	No	0
	6	—	—	0
	7	—	—	0
02	0	Coding connector incorrect/ missing	—	0
	1	Communications failure	Error during transfer of parameters/input data	0
	2	Operating mode RUN/STOP		0
	3	Watchdog activated	with bit 1 of byte 0 [1)] [2)]	0 | 1
	4	Internal voltage failed	—	0
	5	Battery 1 empty	—	0
	6	Entire backup battery failed	—	0
	7	—	—	0
03	0	Rack failure	—	0
	1	Processor failure	—	0
	2	EEPROM error	Serial calibration EEPROM for analog mea-sured value calibration, set with bit 1 of byte 0 [1)] [2)]	0 | 1
	3	RAM error	—	0
	4	ADC error	with bit 1 of byte 0 [1)]	0
	5	Fuse failure	—	0
	6	Hardware interrupt lost	—	0
	7		—	0

Table 1-12 Structure of the Diagnostic Area (Continued)

Byte	Bit	Meaning	Explanation	Value Range
		Channel-Specific Diagnostic Entries		
04	0..7	Channel type AI of the following channel-specific diagnostic information		71_H
05	0..7	Number of analog input channels		4
06	0..7	Number of diagnostic bits per channel		8
07		Channel Vector Channel Group AI		
	0	Error assigning parameters to DI1	0 = no, 1 = yes	0 | 1
	1	Error assigning parameters to DI2	0 = no, 1 = yes	0 | 1
	2	Error assigning parameters to DI3	0 = no, 1 = yes	0 | 1
	3	Error assigning parameters to DI4	0 = no, 1 = yes	0 | 1
	4	Error in channel AI1	0 = no, 1 = yes	0 | 1
	5	Error in channel AI2	0 = no, 1 = yes	0 | 1
	6	Error in channel AI3	0 = no, 1 = yes	0 | 1
	7	Error in channel AI4	0 = no, 1 = yes	0 | 1
08		Channel-Specific Diagnostic Byte AI1		
	0	Parameter error in parameters for channel	0 = no, 1 = yes [1)]	0 | 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 | 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 | 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 | 1
09		Channel-Specific Diagnostic Byte AI2		
	0	Parameter error in parameters for channel	0 = no, 1 = yes [1)]	0 | 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 | 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 | 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 | 1
10		Channel-Specific Diagnostic Byte AI3		
	0	Parameter error in parameters for channel	0 = no, 1 = yes [1)]	0 | 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 | 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 | 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 | 1
11		Channel-Specific Diagnostic Byte AI4		
	0	Parameter error in parameters for channel	0 = no, 1 = yes [1)]	0 | 1
	1..3	—		0
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 | 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 | 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 | 1

Table 1-12 Structure of the Diagnostic Area (Continued)

Byte	Bit	Meaning	Explanation	Value Range
12	0..7	Channel type AO of the following channel-specific diagnostic information		73_H
13	0..7	Number of analog output channels on module		4
14	0..7	Number of diagnostic bits per channel		1
15		Channel Vector for Channel Group AO		
	0	Collective error in AO1	0 = no, 1 = yes	0 | 1
	1	Collective error in AO2	0 = no, 1 = yes	0 | 1
	2	Collective error in AO3	0 = no, 1 = yes	0 | 1
	3	Collective error in AO4	0 = no, 1 = yes	0 | 1
	4..7	—		0000

1) Analog inputs will be reset until the channel functions again. (Exception: parameter assignment for wire-break check for setting <>4...20 mA) AI=$7FFF_H$

2) Analog output will be reset until channel functions again AO=0V 0 mA

3) No hardware interrupt, no diagnostic interrupt, no disturbance on the bit 0 of byte 0 =0