SIEMENS

SIMATIC

S7
S7-200 SMART

System Manual

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Preface

Purpose of the manual

The S7-200 SMART series is a line of micro-programmable logic controllers (Micro PLCs) that can control a variety of automation applications. Compact design, low cost, and a powerful instruction set make the S7-200 SMART a perfect solution for controlling small applications. The wide variety of S7-200 SMART models and the Windows-based programming tool give you the flexibility you need to solve your automation problems.

This manual provides information about installing and programming the S7-200 SMART CPUs and is designed for engineers, programmers, installers, and electricians who have a general knowledge of programmable logic controllers.

Required basic knowledge

To understand this manual, it is necessary to have a general knowledge of automation and programmable logic controllers.

Scope of the manual

This manual describes the following products:

- STEP 7-Micro/WIN SMART V2.8
- S7-200 SMART CPU firmware V2.8

For a complete list of the S7-200 SMART products and article numbers described in this manual, see Technical Specifications (Page 839).

Certification, CE, UKCA labels and other standards

Refer to the Technical specifications (Page 839) for more information.

Service and support

In addition to our documentation, we offer our technical expertise on the Internet on the customer support web site (http://www.siemens.com/automation/).

Contact your Siemens distributor or sales office for assistance in answering any technical questions, for training, or for ordering S7 products. Because your sales representatives are technically trained and have the most specific knowledge about your operations, process and industry, as well as about the individual Siemens products that you are using, they can provide the fastest and most efficient answers to any problems you might encounter.

A.4 Analog inputs and outputs expansion modules (EMs)

A.4.1 EM AE04 and EM AE08 analog input specifications

Table A-95 General specifications

Model	EM Analog 4 x inputs (EM AE04)	EM Analog 8 x inputs (EM AE08)
Article number	6ES7288-3AE04-0AA0	6ES7288-3AE08-0AA0
Dimensions W x H x D (mm)	45 x 100 x 81	45 x 100 x 81
Weight	147 grams	186 grams
Power dissipation	1.5 W (no load)	2.0 W (no load)
Current consumption (SM Bus)	80 mA	80 mA
Current consumption (24 V DC)	40 mA (no load)	70 mA (no load)

Table A-96 Analog inputs

Model	EM Analog 4 x inputs (EM AE04)	EM Analog 8 x inputs (EM AE08)
Number of inputs	4	8
Type	Voltage or current (differential), selectable in groups of 2	Voltage or current (differential), selectable in groups of 2
Range	±10 V, ±5 V, ±2.5 V, or 0 to 20 mA	±10 V, ±5 V, ±2.5 V, or 0 to 20 mA
Full scale range (data word)	-27,648 to 27,648	-27,648 to 27,648
Overshoot/undershoot range (data word)	Voltage: 27,649 to 32,511 / -27,649 to -32,512 Current: 27,649 to 32,511 / -4864 to 0	Voltage: 27,649 to 32,511 / -27,649 to -32,512 Current: 27,649 to 32,511 / -4864 to 0 (Refer to Analog input representation for voltage and Analog input representation for current (Page 911).)
Overflow/underflow (data word)	Voltage: 32,512 to 32,767 / -32,513 to -32,768 Current: 32,512 to 32,767 / -4,865 to -32,768	Voltage: 32,512 to 32,767 / -32,513 to -32,768 Current: 32,512 to 32,767 / -4,865 to -32,768 (Refer to Analog input representation for voltage and Analog input representation for current (Page 911).)
Resolution	Voltage mode: 12 bits + sign bit Current mode: 12 bits	Voltage mode: 12 bits + sign bit Current mode: 12 bits
Maximum withstand voltage/ current	±35 V / ±40 mA	±35 V / ±40 mA
Smoothing	None, weak, medium or strong	None, weak, medium or strong (Refer to Analog input response times for step response time.) (Page 910)
Noise rejection	400, 60, 50, or 10 Hz	400, 60, 50, or 10 Hz
Input impedance	≥1 M Ω (voltage) / 290 Ω (current)	≥9 M Ω (voltage) / 250 Ω (current)
Isolation (field side to logic)	None	None

Model	EM Analog 4 x inputs (EM AE04)	EM Analog 8 x inputs (EM AE08)
Accuracy (25 °C / -20 to 60 °C)	Voltage mode: ±0.1% / ±0.2% of full scale Current mode: ±0.2% / ±0.3% of full scale	Voltage mode: ±0.1% / ±0.2% of full scale Current mode: ±0.2% / ±0.3% of full scale
Measuring principle	Actual value conversion	Actual value conversion
Common mode rejection	40 dB, DC to 60 Hz	40 dB, DC to 60 Hz
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V	Signal plus common mode voltage must be less than +12 V and greater than -12 V
Cable length (max.), in meters	100 m twisted and shielded	100 m twisted and shielded

Table A-97 Diagnostics

Model	EM Analog 4 x inputs (EM AE04)	EM Analog 8 x inputs (EM AE08)
Overflow/underflow	Yes	Yes
24 V DC low voltage	Yes	Yes

EM AE04 and EM AE08 wiring current transducers

Wiring current transducers are available as 2-wire transducers and 4-wire transducers as shown below.

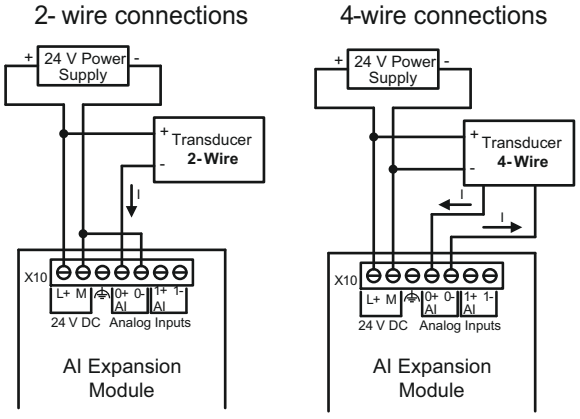


Table A-98 Wiring diagram EM AE04 Analog 4 x Inputs (6ES7288-3AE04-0AA0) and EM AE08 Analog 8 x Inputs (6ES7288-3AE08-0AA0

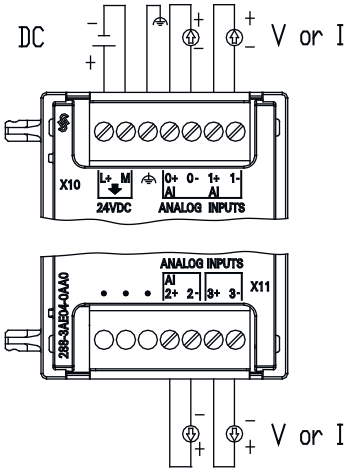
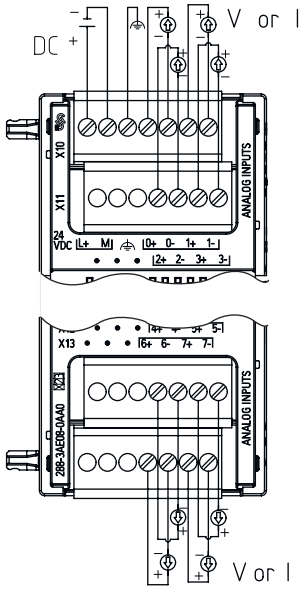
EM AE04 Analog 4 x Inputs (6ES7288-3AE04-0AA0)	**EM AE08 Analog 8 x Inputs (6ES7288-3AE08-0AA0)**
	
Note: Connectors must be gold. See Appendix F, Spare parts and other hardware, for article number.	

Table A-99 Connector pin locations for EM AE04 Analog 4 x Inputs (6ES7288-3AE04-0AA0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24 V DC	No connection
2	M / 24 V DC	No connection
3	Functional Earth	No connection
4	AI 0+	AI 2+
5	AI 0-	AI 2-
6	AI 1+	AI 3+
7	AI 1-	AI 3-

Table A-100 Connector pin locations for EM AE08 Analog 8 x Inputs (6ES7288-3AE08-0AA0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24 V DC	No connection	No connection	No connection
2	M / 24 V DC	No connection	No connection	No connection
3	Functional Earth	No connection	No connection	No connection
4	AI 0+	AI 2+	AI 4+	AI 6+
5	AI 0-	AI 2-	AI 4-	AI 6-

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
6	AI 1+	AI 3+	AI 5+	AI 7+
7	AI 1-	AI 3-	AI 5-	AI 7-

A.4.2 EM AQ02 and EM AQ04 analog output module specifications

Table A-101 General specifications

Technical data	EM Analog 2 x outputs (EM AQ02)	EM Analog 4 x outputs (EM AQ04)
Article number	6ES7288-3AQ02-0AA0	6ES7288-3AQ04-0AA0
Dimensions W x H x D (mm)	45 x 100 x 81	45 x 100 x 81
Weight	147.1 grams	170.5 grams
Power dissipation	1.5 W (no load)	2.1 W (no load)
Current consumption (SM Bus)	60 mA	60 mA
Current consumption (24 V DC)	50 mA (no load)	75 mA (no load)
	90 mA (20 mA load per channel)	155 mA (20 mA load per channel)

Table A-102 Analog outputs

Technical data	EM Analog 2 x outputs (EM AQ02)	EM Analog 4 x outputs (EM AQ04)
Number of outputs	2	4
Type	Voltage or current	Voltage or current
Range	±10 V or 0 to 20 mA	±10 V or 0 to 20 mA
Resolution	Voltage mode: 11 bits + sign bit Current mode: 11 bits	Voltage mode: 11 bits + sign bit Current mode: 11 bits
Full scale range (data word)	Voltage: -27,648 to 27,648 Current: 0 to 27,648	Voltage: -27,648 to 27,648 Current: 0 to 27,648 (Refer to the output ranges for voltage and current (Page 912).)
Accuracy (25 °C / -20 to 60 °C)	±0.5% / ±1.0% of full scale	±0.5% / ±1.0% of full scale
Settling time (95% of new value)	Voltage: 300 µs (R), 750 µs (1 µF) Current: 600 µs (1 mH), 2 ms (10 mH)	Voltage: 300 µs (R), 750 µs (1 µF) Current: 600 µs (1 mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 500 Ω	Voltage: ≥ 1000 Ω Current: ≤ 600 Ω
Output behavior in STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Isolation (field side to logic)	None	None
Cable length (max.), in meters	100 m twisted and shielded	100 m twisted and shielded

Table A-103 Diagnostics

Technical data	EM Analog 2 x outputs (EM AQ02)	EM Analog 4 x outputs (EM AQ04)
Overflow/underflow	Yes	Yes
Short to ground (voltage mode only)	Yes	Yes
Wire break (current mode only)	Yes	Yes
24 V DC low voltage	Yes	Yes

Table A-104 Wiring diagram for the EM AQ02 Analog 2 x Outputs (6ES7288-3AQ02-0AA0) and EM AQ04 Analog 4 x Outputs (6ES7288-3AQ04-0AA0)

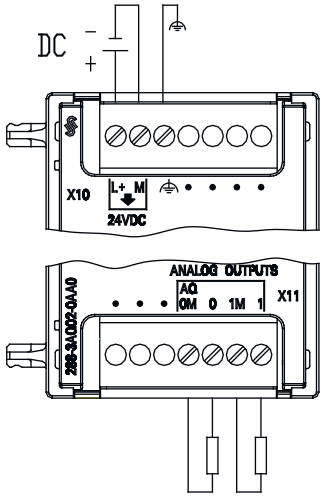
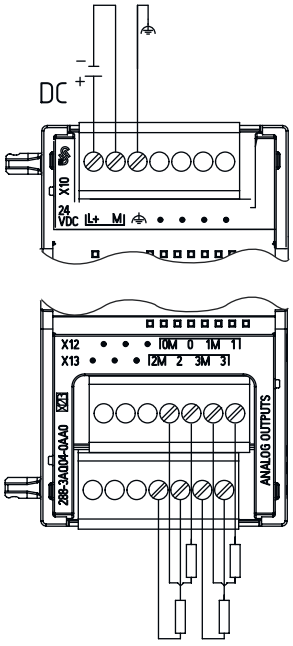
EM AQ02 Analog 2 x Outputs (6ES7288-3AQ02-0AA0)	EM AQ04 Analog 4 x Outputs (6ES7288-3AQ04-0AA0)
	
Note: Connectors must be gold. See Appendix F, Spare parts and other hardware, for article number.	

Table A-105 Connector pin locations for EM AQ02 Analog 2 x Outputs (6ES7288-3AQ02-0AA0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24 V DC	No connection
2	M / 24 V DC	No connection
3	Functional Earth	No connection
4	No connection	AQ 0M
5	No connection	AQ 0

Pin	X10 (gold)	X11 (gold)
6	No connection	AQ 1M
7	No connection	AQ 1

Table A-106 Connector pin locations for EM AQ04 Analog 4 x Outputs (6ES7288-3AQ04-0AA0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24 V DC	No connection	No connection	No connection
2	M / 24 V DC	No connection	No connection	No connection
3	Functional Earth	No connection	No connection	No connection
4	No connection	No connection	AQ 0M	AQ 2M
5	No connection	No connection	AQ 0	AQ 2
6	No connection	No connection	AQ 1M	AQ 3M
7	No connection	No connection	AQ 1	AQ 3

A.4.3 EM AM03 and EM AM06 analog input/output module specifications

Table A-107 General specifications

Technical data	EM 2 x Analog Inputs / 1 x Analog Outputs (AM03)	EM 4 x Analog Inputs / 2 x Analog Outputs (AM06)
Article number	6ES7288-3AM03-0AA0	6ES7288-3AM06-0AA0
Dimensions W x H x D (mm)	45 x 100 x 81	45 x 100 x 81
Weight	172 grams	173.4 grams
Power dissipation	1.1 W (no load)	2.0 W (no load)
Current consumption (SM Bus)	60 mA	80 mA
Current consumption (24 V DC)	30 mA (no load)	60 mA (no load)
	50 mA (20 mA load per channel)	100 mA (20 mA load per channel)

Table A-108 Analog inputs

Model	EM 2 x Analog Inputs / 1 x Analog Outputs (AM03)	EM 4 x Analog Inputs / 2 x Analog Outputs (AM06)
Number of inputs	2	4
Type	Voltage or current (differential): Selectable in groups of 2	Voltage or current (differential): Selectable in groups of 2
Range	±10 V, ±5 V, ±2.5 V, or 0 to 20 mA	±10 V, ±5 V, ±2.5 V, or 0 to 20 mA
Full scale range (data word)	-27,648 to 27,648	-27,648 to 27,648
Overshoot/undershoot range (data word)	Voltage: 27,649 to 32,511 / -27,649 to -32,512 Current: 27,649 to 32,511 / -4,864 to 0	Voltage: 27,649 to 32,511 / -27,649 to -32,512 Current: 27,649 to 32,511 / -4,864 to 0

Model	EM 2 x Analog Inputs / 1 x Analog Outputs (AM03)	EM 4 x Analog Inputs / 2 x Analog Outputs (AM06)
Overflow/underflow (data word)	Voltage: 32,512 to 32,767 / -32,513 to -32,768 Current: 32,512 to 32,767 / -4,865 to -32,768	Voltage: 32,512 to 32,767 / -32,513 to -32,768 Current: 32,512 to 32,767 / -4,865 to -32,768
Resolution	Voltage mode: 12 bits + sign Current mode: 12 bits	Voltage mode: 12 bits + sign Current mode: 12 bits
Maximum withstand voltage/ current	±35 V / ±40 mA	±35 V / ±40 mA
Smoothing	None, weak, medium, or strong	None, weak, medium, or strong
Noise rejection	400, 60, 50, or 10 Hz	400, 60, 50, or 10 Hz
Input impedance	≥1 M Ω (voltage) / 290 Ω (current)	≥1 M Ω (voltage) / 290 Ω (current)
Isolation (field side to logic)	None	None
Accuracy (25 °C / -20 to 60 °C)	Voltage mode: ±0.1% /±0.2% of full scale Current mode: ±0.2% /±0.3% of full scale	Voltage mode: ±0.1% /±0.2% of full scale Current mode: ±0.2% /±0.3% of full scale
Analog to digital conversion time	625 µs (400 Hz rejection)	625 µs (400 Hz rejection)
Common mode rejection	40 dB, DC to 60 Hz	40 dB, DC to 60 Hz
Operational signal range	Signal plus common mode voltage must be less than +12 V and greater than -12 V	Signal plus common mode voltage must be less than +12 V and greater than -12 V
Cable length (max.), in meters	100 m twisted and shielded	100 m twisted and shielded

Table A-109 Analog outputs

Technical data	EM 2 x Analog Inputs / 1 x Analog Outputs (AM03)	EM 4 x Analog Inputs / 2 x Analog Outputs (AM06)
Number of outputs	1	2
Type	Voltage or current	Voltage or current
Range	±10 V or 0 to 20 mA	±10 V or 0 to 20 mA
Resolution	Voltage mode: 11 bits + sign Current mode: 11 bits	Voltage mode: 11 bits + sign Current mode: 11 bits
Full scale range (data word)	Voltage: -27,648 to 27,648 Current: 0 to 27,648	Voltage: -27,648 to 27,648 Current: 0 to 27,648
Accuracy (25 °C / -20 to 60 °C)	±0.5% / ±1.0% of full scale	±0.5% / ±1.0% of full scale
Settling time (95% of new value)	Voltage: 300 µs (R), 750 µs (1 µF) Current: 600 µs (1 mH), 2 ms (10 mH)	Voltage: 300 µs (R), 750 µs (1 µF) Current: 600 µs (1 mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 500 Ω	Voltage: ≥ 1000 Ω Current: ≤ 500 Ω
Output behavior in STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Isolation (field side to logic)	None	None
Cable length (max.), in meters	100 m twisted and shielded	100 m twisted and shielded

Table A-110 Diagnostics

Model	EM 2 x Analog Inputs / 1 x Analog Outputs (AM03)	EM 4 x Analog Inputs / 2 x Analog Outputs (AM06)
Overflow/underflow	Yes	Yes
Short to ground (voltage mode only)	Yes	Yes
Wire break (current mode only)	Yes	Yes
24 V DC low voltage	Yes	Yes

EM AM03 wiring current transducers

Wiring current transducers are available as 2-wire transducers and 4-wire transducers as shown below.

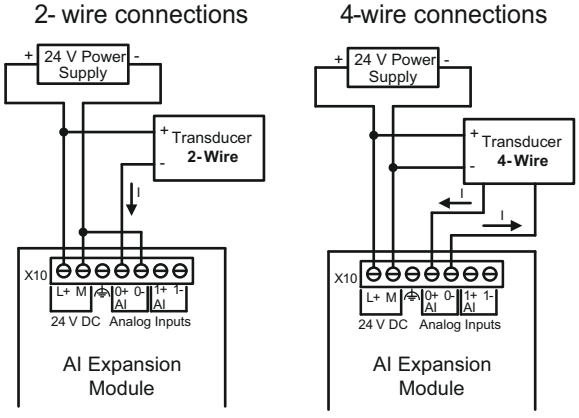


Table A-111 Wiring diagrams for the EM AM03 2 x Analog Inputs / 1 x Analog Outputs (6ES7288-3AM03-0AA and the EM AM06 4 x Analog Inputs / 2 x Analog Outputs (6ES7288-3AM06-0AA0)

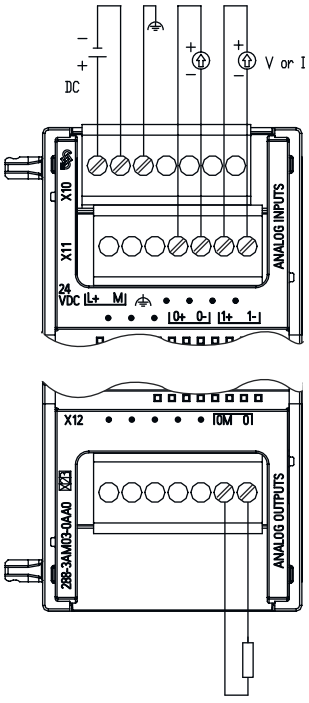
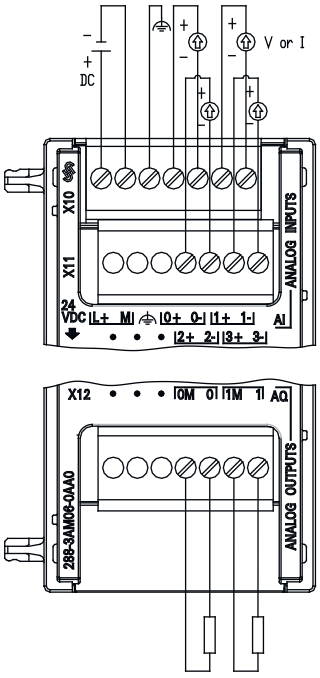
EM AM03 2 x Analog Inputs / 1 x Analog Outputs (6ES7288-3AM03-0AA0)	**EM AM06 4 x Analog Inputs / 2 x Analog Outputs (6ES7288-3AM06-0AA0)**
	
Note: Connectors must be gold. See Appendix F, Spare parts and other hardware, for article number.	

Table A-112 Connector pin locations for AM03 2 x Analog Inputs / 1 x Analog Outputs (6ES7288-3AM03-0AA0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)
1	L+ / 24 V DC	No connection	No connection
2	M / 24 V DC	No connection	No connection
3	Functional Earth	No connection	No connection
4	No connection	AI 0+	No connection
5	No connection	AI 0-	No connection
6	No connection	AI 1+	AQ 0M
7	No connection	AI 1-	AQ 0

Table A-113 Connector pin locations for AM06 4 x Analog Inputs / 2 x Analog Outputs (6ES7288-3AM06-0AA0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)
1	L+ / 24 V DC	No connection	No connection
2	M / 24 V DC	No connection	No connection
3	Functional Earth	No connection	No connection

Pin	X10 (gold)	X11 (gold)	X12 (gold)
4	AI 0+	AI 2+	AQ 0M
5	AI 0-	AI 2-	AQ 0
6	AI 1+	A1 3+	AQ 1M
7	AI 1-	A1 3-	AQ 1

A.4.4 Step response of the analog inputs

Table A-114 Step response (ms), 0 to full-scale measured at 95%

Smoothing selection (sample averaging)	Noise reduction/rejection frequency (Integration time selection)			
	400 Hz (2.5 ms)	60 Hz (16.6 ms)	50 Hz (20 ms)	10 Hz (100 ms)
None (1 cycle): No averaging	4 ms	18 ms	22 ms	100 ms
Weak (4 cycles): 4 samples	9 ms	52 ms	63 ms	320 ms
Medium (16 cycles): 16 samples	32 ms	203 ms	241 ms	1200 ms
Strong (32 cycles): 32 samples	61 ms	400 ms	483 ms	2410 ms
Sample time				
• 4 AI x 13 bits	• 0.625 ms	• 4.17 ms	• 5 ms	• 25 ms
• 8 AI x 13 bits	• 1.25 ms	• 4.17 ms	• 5 ms	• 25 ms

A.4.5 Sample time and update times for the analog inputs

Table A-115 Sample time and update time

Rejection frequency (Integration time)	Sample time	Module update time for all channels	
		4-channel SM	8-channel SM
400 Hz (2.5 ms)	• 4-channel SM: 0.625 ms • 8-channel SM: 1.250 ms	0.625 ms	1.250 ms
60 Hz (16.6 ms)	4.170 ms	4.17 ms	4.17 ms
50 Hz (20 ms)	5.000 ms	5 ms	5 ms
10 Hz (100 ms)	25.000 ms	25 ms	25 ms

A.4.6 Measurement ranges of the analog inputs for voltage and current (SB and EM)

Table A-116 Analog input representation for voltage (SB and EM)

System		Voltage Measuring Range				
Decimal	**Hexadecimal**	**±10 V**	**±5 V**	**±2.5 V**	**±1.25 V**	
32767	7FFF[1]	11.851 V	5.926 V	2.963 V	1.481 V	Overflow
32512	7F00					
32511	7EFF	11.759 V	5.879 V	2.940 V	1.470 V	Overshoot range
27649	6C01					
27648	6C00	10 V	5 V	2.5 V	1.250 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V	0.938 V	
1	1	361.7 µV	180.8 µV	90.4 µV	45.2 µV	
0	0	0 V	0 V	0 V	0 V	
-1	FFFF					
-20736	AF00	-7.5 V	-3.75 V	-1.875 V	-0.938 V	
-27648	9400	-10 V	-5 V	-2.5 V	-1.250 V	
-27649	93FF					Undershoot range
-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.470 V	
-32513	80FF					Underflow
-32768	8000	-11.851 V	-5.926 V	-2.963 V	-1.481 V	

[1] 7FFF can be returned for one of the following reasons: overflow (as noted in this table), before valid values are available (for example immediately upon a power up), or if a wire break is detected.

Table A-117 Analog input representation for current (SB and EM)

System		Current measuring range	
Decimal	**Hexadecimal**	**0 mA to 20 mA**	
32767	7FFF	23.70 mA	Overflow
32512	7F00		
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Nominal range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		Undershoot range
-4864	ED00	-3.52 mA	
-4865	ECFF		Underflow
-32768	8000		

A.4.7 Measurement ranges of the analog outputs for voltage and current (SB and EM)

Table A-118 Analog output representation for voltage (SB and EM)

System		Voltage Output Range	
Decimal	**Hexadecimal**	**± 10 V**	
32767	7FFF	See note 1	Overflow
32512	7F00	See note 1	
32511	7EFF	11.76 V	Overshoot range
27649	6C01		
27648	6C00	10 V	Rated range
20736	5100	7.5 V	
1	1	361.7 µ V	
0	0	0 V	
-1	FFFF	-361.7 µ V	
-20736	AF00	-7.5 V	
-27648	9400	-10 V	
-27649	93FF		Undershoot range
-32512	8100	-11.76 V	
-32513	80FF	See note 1	Underflow
-32768	8000	See note 1	

[1] In an overflow or underflow condition, analog outputs will take on the substitute value of the STOP mode.

Table A-119 Analog output representation for current (SB and EM)

System		Current output range	
Decimal	**Hexadecimal**	**0 mA to 20 mA**	
32767	7FFF	See note 1	Overflow
32512	7F00	See note 1	
32511	7EFF	23.52 mA	Overshoot range
27649	6C01		
27648	6C00	20 mA	Rated range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		Undershoot range
-6912	E500		
-6913	E4FF		Not possible. Output value limited to 0 mA.
-32512	8100		
-32513	80FF	See note 1	Underflow
-32768	8000	See note 1	

[1] In an overflow or underflow condition, analog outputs will take on the substitute value of the STOP mode.

A.5 Thermocouple and RTD expansion modules (EMs)

A.5.1 Thermocouple expansion modules (EMs)

A.5.1.1 EM AT04 thermocouple specifications

Table A-120 General specifications

Model	EM AT04 AI 4 x 16 bit TC
Article number	6ES7288-3AT04-0AA0
Dimensions W x H x D (mm)	45 x 100 x 81
Weight	125 grams
Power dissipation	1.5 W
Current consumption (SM Bus)	80 mA
Current consumption (24 V DC) [1]	40 mA

[1] 20.4 to 28.8 V DC (Class 2, Limited Power, or sensor power from PLC)

Table A-121 Analog inputs

Model		EM AT04 AI 4 x 16 bit TC
Number of inputs		4
Range Nominal range (data word) Overrange/underrange (data word) Overflow/underflow (data word)		See Thermocouple selection table.
Resolution	Temperature	0.1 °C / 0.1 °F
	Voltage	15 bits plus sign
Maximum withstand voltage		± 35
Noise rejection		85 dB for selected filter setting (10 Hz, 50 Hz, 60 Hz or 400 Hz)
Common mode rejection		> 120 dB at 120 V AC
Impedance		≥ 10 MΩ
Isolation	Field to logic	500 V AC
	Field to 24 V DC	500 V AC
	24 V DC to logic	500 V AC
Channel to channel isolation		--
Accuracy		See Thermocouple selection table.
Repeatability		±0.05% FS
Measuring principle		Integrating

Model	EM AT04 AI 4 x 16 bit TC
Module update time	See Filter selection table.
Cold junction error	±1.5 °C
Cable length (meters)	100 m to sensor max.
Wire resistance	100 Ω max.

Table A-122 Diagnostics

Model	EM AT04 AI 4 x 16 bit TC
Overflow/underflow [1]	Yes
Wire break (current mode only) [2]	Yes
24 V DC low voltage [1]	Yes

[1] The overflow, underflow and low voltage diagnostic alarm information will be reported in the analog data values even if the alarms are disabled in the module configuration.

[2] When wire break alarm is disabled and an open wire condition exists in the sensor wiring, the module may report random values.

The EM AT04 Thermocouple (TC) analog expansion module measures the value of voltage connected to the module inputs. The temperature measurement type can be either "Thermocouple" or "Voltage".

- "Thermocouple": The value will be reported in degrees multiplied by ten (for example, 25.3 degrees will be reported as decimal 253).
- "Voltage": The nominal range full scale value will be decimal 27648.

Table A-123 Wiring diagram for the EM AT04 Thermocouple 4 x 16 bit (6ES7288-3AT04-0AA0)

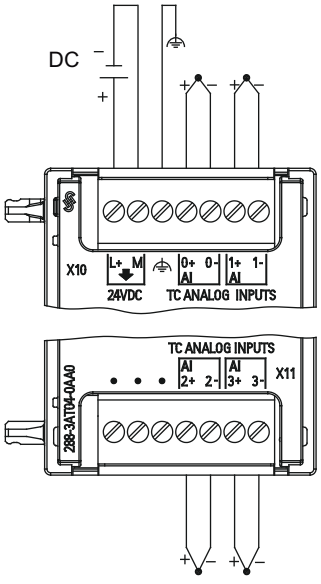
EM AT04 4 x 16 bit (6ES7288-3AT04-0AA0)	
	
Note: Connectors must be gold. See Appendix F, Spare Parts and other hardware for article number.	

Table A-124 Connector pin locations for EM AT04 4 x 16 bit (6ES7288-3AT04-0AA0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24 V DC	No connection
2	M / 24 V DC	No connection
3	Functional Earth	No connection
4	AI 0+ /TC	AI 2+ /TC
5	AI 0- /TC	AI 2- /TC
6	AI 1+ /TC	AI 3+ /TC
7	AI 1- /TC	AI 3- /TC

Note

Unused analog inputs should be shorted.

The thermocouple unused channels can be deactivated. No error will occur if an unused channel is deactivated.

Thermocouples are formed whenever two dissimilar metals are electrically bonded to each other. A voltage is generated that is proportional to the junction temperature. This voltage is small; one microvolt could represent many degrees. Measuring the voltage from a thermocouple, compensating for extra junctions, and then linearizing the result forms the basis of temperature measurement using thermocouples.

When you connect a thermocouple to the EM AT04 Thermocouple module, the two dissimilar metal wires are attached to the module at the module signal connector. The place where the two dissimilar wires are attached to each other forms the sensor thermocouple.

Two more thermocouples are formed where the two dissimilar wires are attached to the signal connector. The connector temperature causes a voltage that adds to the voltage from the sensor thermocouple. If this voltage is not corrected, then the temperature reported will deviate from the sensor temperature.

Cold junction compensation is used to compensate for the connector thermocouple. Thermocouple tables are based on a reference junction temperature, usually zero degrees Celsius. The cold junction compensation compensates the connector to zero degrees Celsius. The cold junction compensation restores the voltage added by the connector thermocouples. The temperature of the module is measured internally, and then converted to a value to be added to the sensor conversion. The corrected sensor conversion is then linearized using the thermocouple tables.

For optimum operation of the cold junction compensation, the thermocouple module must be located in a thermally stable environment. Slow variation (less than 0.1 °C/minute) in ambient module temperature is correctly compensated within the module specifications. Air movement across the module will also cause cold junction compensation errors.

If better cold junction error compensation is needed, an external iso-thermal terminal block may be used. The thermocouple module provides for use of a 0 °C referenced or 50 °C referenced terminal block.

Ordering information

F

F.1 CPU modules

CPU models	Article number
CPU SR20, AC/DC/Relay	6ES7288-1SR20-0AA1
CPU ST20, DC/DC/DC	6ES7288-1ST20-0AA1
CPU CR20s, AC/DC/Relay	6ES7288-1CR20-0AA1
CPU SR30, AC/DC/Relay	6ES7288-1SR30-0AA1
CPU ST30, DC/DC/DC	6ES7288-1ST30-0AA1
CPU CR30s, AC/DC/Relay	6ES7288-1CR30-0AA1
CPU ST40, DC/DC/DC	6ES7288-1ST40-0AA1
CPU SR40, AC/DC/Relay	6ES7288-1SR40-0AA1
CPU CR40s, AC/DC/Relay	6ES7288-1CR40-0AA1
CPU SR60, AC/DC/Relay	6ES7288-1SR60-0AA1
CPU ST60, DC/DC/DC	6ES7288-1ST60-0AA1
CPU CR60s, AC/DC/Relay	6ES7288-1CR60-0AA1
CPU CR40, AC/DC/Relay	6ES7288-1CR40-0AA0[1]
CPU CR60, AC/DC/Relay	6ES7288-1CR60-0AA0[1]

[1] For CPUs using firmware versions prior to V2.3, refer to the S7-200 SMART System Manual for your specific CPU model and version.

F.2 Expansion modules (EMs) and signal boards (SBs)

Expansion modules and signal boards	Article number
EM Digital 8 x Inputs (EM DE08)	6ES7288-2DE08-0AA0
EM Digital 16 x Inputs (EM DE16)	6ES7288-2DE16-0AA0
EM Digital 8 x Outputs Transistor (EM DT08)	6ES7288-2DT08-0AA0
EM Digital 8 x Outputs Relay (EM DR08)	6ES7288-2DR08-0AA0
EM Digital 16 x Outputs Relay (EM QR16)	6ES7288-2QR16-0AA0
EM Digital 16 x Outputs Transistor (EM QT16)	6ES7288-2QT16-0AA0
EM Digital 8 x Inputs / Digital 8 x Outputs Transistor (EM DT16)	6ES7288-2DT16-0AA0
EM Digital 8 x Inputs/ Relay 8 x Outputs (EM DR16)	6ES7288-2DR16-0AA0
EM Digital 16 x Inputs / Digital 16 x Outputs Transistor (EM DT32)	6ES7288-2DT32-0AA0
EM Digital 16 x Inputs / Relay 16 x Outputs (EM DR32)	6ES7288-2DR32-0AA0
EM Analog 4 x Inputs (EM AE04)	6ES7288-3AE04-0AA0
EM Analog 2 x Outputs (EM AQ02)	6ES7288-3AQ02-0AA0

Expansion modules and signal boards	Article number
EM Analog 4 x Outputs (EM AQ04)	6ES7288-3AQ04-0AA0
EM Analog 8 x Inputs (EM AE08)	6ES7288-3AE08-0AA0
EM Analog 2 x Inputs / Analog 1 x Outputs (EM AM03)	6ES7288-3AM03-0AA0
EM Analog 4 x Inputs / Analog 2 x Outputs (EM AM06)	6ES7288-3AM06-0AA0
EM RTD 2 x 16 bit (EM AR02)	6ES 288-3AR02-0AA0
EM RTD 4 x 16 bit (EM AR04)	6ES7288-3AR04-0AA0
EM TC 4 x 16 bit (EM AT04)	6ES7288-3AT04-0AA0
EM DP01 PROFIBUS DP SMART (EM DP01)	6ES7288-7DP01-0AA0
SB Digital 2 x Inputs / Digital 2 x Outputs (SB DT04)	6ES7288-5DT04-0AA0
SB Analog 1 x Output (SB AQ01)	6ES7288-5AQ01-0AA0
SB Analog 1 x Input (SB AE01)	6ES7288-5AE01-0AA0
SB RS485/RS232 (SB CM01)	6ES7288-5CM01-0AA0
SB Battery (SB BA01)	6ES7288-5BA01-0AA0

F.3 Programming software

Programming software	Article number
STEP 7-Micro/WIN SMART Individual License (CD-ROM)	6ES7288-8SW01-0AA0
Drives V90 (PC tools) software	Can be downloaded from the Siemens Services and Support website

F.4 Communication

Communications cards	Article number
CP 5411: Short AT ISA	6GK1541-1AA00
CP 5512: PCMCIA Type II	6GK1551-2AA00
CP 5611: PCI card (version 3.0 or greater)	6GK1561-1AA00

F.5 Spare parts and other hardware

Cables, network connectors, repeaters, and end retainers	Article number
I/O Expansion cable, 1 m	6ES7288-6EC01-0AA0
MPI Cable	6ES7901-0BF00-0AA0
RS-232/PPI Multi-Master cable	6ES7901-3CB30-0XA0
USB/PPI Multi-Master cable	6ES7901-3BD30-0XA0

Cables, network connectors, repeaters, and end retainers	Article number
PROFIBUS Network cable	6XV1830-0EH30
Network Bus Connector with Programming Port Connector, Vertical Cable Outlet	6ES7972-0BB12-0XA0
Network Bus Connector (no programming port connector), Vertical Cable Outlet	6ES7972-0BA12-0XA0
RS485 Bus Connector with 35° Cable Outlet (no programming port connector)	6ES7972-0BA42-0XA0
RS485 Bus Connector with 35° Cable Outlet (with programming port connector)	6ES7972-0BB42-0XA0
RS485 IP 20 Repeater, Isolated	6ES7972-0AA02-0XA0
TD/CPU Connecting cable	6ES7901-3EB10-0XA0
End Retainer Thermoplast, 10 MM	8WA1808
End Retainer, Steel	8WA1805

Table F-1 Terminal block spare kits

If you have	Use this terminal block spare kit (4/pk)	
S7-200 SMART module (article number)	Terminal block article number	Terminal block description
CPU SR20, AC/DC/Relay (6ES7288-1SR20-0AA1)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AH40-0XA0	8 pin, tin-plated, keyed
	6ES7292-1AM30-0XA0	12 pin, tin-plated
CPU ST20, DC/DC/DC (6ES7288-1ST20-0AA1)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AM30-0XA0	12 pin, tin-plated
CPU SR30, AC/DC/Relay (6ES7288-1SR30-0AA1)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AH40-0XA0	8 pin, tin-plated, keyed
	6ES7292-1AP30-0XA0	14 pin, tin-plated
	6ES7292-1AK30-0XA0	10 pin, tin-plated
CPU ST30, DC/DC/DC (6ES7288-1ST30-0AA1)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AP30-0XA0	14 pin, tin-plated
	6ES7292-1AK30-0XA0	10 pin, tin-plated
CPU ST40, DC/DC/DC (6ES7288-1ST40-0AA1)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7 292-1AL30-0XA0	11 pin, tin-plated
CPU SR40, AC/DC/Relay (6ES7288-1SR40-0AA1)	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7292-1AV40-0XA0	20 pin, tin-plated, keyed
	6ES7292-1AM30-0XA0	12 pin, tin-plated
CPU CR40, AC/DC/Relay (6ES7288-1CR40-0AA0)	6ES7292-1AH30-0XA0	8 pin, tin-plated
	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7292-1AL30-0XA0	11 pin, tin-plated
	6ES7292-1AL40-0XA0	11 pin, tin-plated, keyed
CPU ST60, DC/DC/DC (6ES7288-1ST60-0AA1)	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7292-1AM30-0XA0	12 pin, tin-plated
CPU SR60, AC/DC/Relay (6ES7288-1SR60-0AA1)	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7292-1AV40-0XA0	20 pin, tin-plated, keyed
	6ES7292-1AM30-0XA0	12 pin, tin-plated

If you have S7-200 SMART module (article number)	Use this terminal block spare kit (4/pk)	
	Terminal block article number	**Terminal block description**
CPU CR60, AC/DC/Relay (6ES7288-1CR60-0AA0)	6ES7292-1AV30-0XA0	20 pin, tin-plated
	6ES7292-1AV40-0XA0	20 pin, tin-plated, keyed
	6ES7292-1AM30-0XA0	12 pin, tin-plated 0
EM Digital 8 x Inputs (EM DE08) (6ES7288-2DE08-0AA0)	6ES7292-1AG30-0XA0	7 pin, tin-plated
EM Digital 8 x Outputs (EM DT08) (6ES7288-2DT08-0AA0)	6ES7292-1AG30-0XA0	7 pin, tin-plated
EM Digital 8 x Outputs Relay (EM DR08) (6ES7288-2DR08-0AA0)	6ES7292-1AG30-0XA0	7 pin, tin-plated
	6ES7292-1AG40-0XA0	7 pin, tin-plated, keyed-right
EM Digital 8 x Inputs / Digital 8 x Outputs (EM DT16) (6ES7288-2DT16-0AA0)	6ES7292-1AG30-0XA0	7 pin, tin-plated
EM Digital 8 x Inputs/ Relay 8 x Outputs (EM DR16) (6ES7288-2DR16-0AA0)	6ES7292-1AG30-0XA0	7 pin, tin-plated
	6ES7292-1AG40-0XA0	7 pin, tin-plated, keyed-right
EM Digital 16 x Inputs / Digital 16 x Outputs (EM DT32) (6ES7288-2DT32-0AA0)	6ES7292-1AL30-0XA0	11 pin, tin-plated
EM Digital 16 x Inputs / Relay 16 x Outputs (EM DR32) (6ES7288-2DR32-0AA0)	6ES7292-1AL30-0XA0	11 pin, tin-plated
	6ES7292-1AL40-0XA0	11 pin, tin-plated, keyed
EM Analog 4 x Inputs (EM AE04) (6ES7288-3AE04-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Analog 8 x Inputs (EM AE08) (6ES7288-3AE08-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Analog 2 x Outputs (EM AQ02) (6ES7288-3AQ02-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Analog 4 x Outputs (EM AQ04) (6ES7288-3AQ04-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Analog 2 x Inputs / Analog 1 x Outputs (EM AM03) (6ES7288-3AM03-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Analog 4 x Inputs / Analog 2 x Outputs (EM AM06) (6ES7288-3AM06-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM RTD 2 x 16 bit (EM AR02) (6ES7288-3AR02-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM RTD 4 x 16 bit (EM AR04) (6ES7288-3AR04-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM TC 4 x 16 bit (EM AT04) (6ES7288-3AT04-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated
EM Profibus DP SMART (EM DP01) (6ES7288-7DP01-0AA0)	6ES7292-1BG30-0XA0	7 pin, gold-plated

F.6 Human Machine Interface devices

Human Machine Interface device	Article number
SMART LINE HMIs	
SMART LINE 700 IE	6AV6648-0CC11-3AX0
SMART LINE 1000 IE	6AV6648-0CE11-3AX0
Micro HMIs	