

Provisions should be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40%.

#### C-Tick approval



The S7-1200 automation system satisfies requirements of standards to AS/NZS 2064 (Class A).

#### Korea Certification



The S7-1200 automation system satisfies the requirements of the Korean Certification (KC Mark). It has been defined as Class A Equipment and is intended for industrial applications and has not been considered for home use.

#### Maritime approval

The S7-1200 products are periodically submitted for special agency approvals related to specific markets and applications. Consult your local Siemens representative if you need additional information related to the latest listing of exact approvals by part number.

Classification societies:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)
- GL (Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)

#### Industrial environments

The S7-1200 automation system is designed for use in industrial environments.

Table A- 1 Industrial environments

Application field	Noise emission requirements	Noise immunity requirements
Industrial	EN 61000-6-4:2007	EN 61000-6-2:2005

## Electromagnetic compatibility

Electromagnetic Compatibility (EMC) is the ability of an electrical device to operate as intended in an electromagnetic environment and to operate without emitting levels of electromagnetic interference (EMI) that may disturb other electrical devices in the vicinity.

Table A- 2 Immunity per EN 61000-6-2

Electromagnetic compatibility - Immunity per EN 61000-6-2	
EN 61000-4-2 Electrostatic discharge	8 kV air discharge to all surfaces 6 kV contact discharge to exposed conductive surfaces
EN 61000-4-3 Radiated, radio-frequency, electromagnetic field immunity test	80 to 1000 MHz, 10 V/m, 80% AM at 1 kHz 1.4 to 2.0 GHz, 3 V/m, 80% AM at 1 kHz 2.0 to 2.7 GHz, 1 V/m, 80% AM at 1 kHz
EN 61000-4-4 Fast transient bursts	2 kV, 5 kHz with coupling network to AC and DC system power 2 kV, 5 kHz with coupling clamp to I/O
EN 61000-4-5 Surge immunity	AC systems - 2 kV common mode, 1kV differential mode DC systems - 2 kV common mode, 1kV differential mode For DC systems (I/O signals, DC power systems) external protection is required.
EN 61000-4-6 Conducted disturbances	150 kHz to 80 MHz, 10 V RMS, 80% AM at 1kHz
EN 61000-4-11 Voltage dips	AC systems 0% for 1 cycle, 40% for 12 cycles and 70% for 30 cycles at 60 Hz

Table A- 3 Conducted and radiated emissions per EN 61000-6-4

Electromagnetic compatibility - Conducted and radiated emissions per EN 61000-6-4		
Conducted Emissions EN 55011, Class A, Group 1	0.15 MHz to 0.5 MHz	<79dB (µV) quasi-peak; <66 dB (µV) average
	0.5 MHz to 5 MHz	<73dB (µV) quasi-peak; <60 dB (µV) average
	5 MHz to 30 MHz	<73dB (µV) quasi-peak; <60 dB (µV) average
Radiated Emissions EN 55011, Class A, Group 1	30 MHz to 230 MHz	<40dB (µV/m) quasi-peak; measured at 10m
	230 MHz to 1 GHz	<47dB (µV/m) quasi-peak; measured at 10m

## Environmental conditions

Table A- 4 Transport and storage

Environmental conditions - Transport and storage	
EN 60068-2-2, Test Bb, Dry heat and EN 60068-2-1, Test Ab, Cold	-40° C to +70° C
EN 60068-2-30, Test Db, Damp heat	25° C to 55° C, 95% humidity
EN 60068-2-14, Test Na, temperature shock	-40° C to +70° C, dwell time 3 hours, 5 cycles
EN 60068-2-32, Free fall	0.3 m, 5 times, product packaging
Atmospheric pressure	1080 to 660h Pa (corresponding to an altitude of -1000 to 3500m)

Table A- 5 Operating conditions

Environmental conditions - Operating	
Ambient temperature range (Inlet Air 25 mm below unit)	-20° C to 60° C horizontal mounting -20° C to 50° C vertical mounting 95% non-condensing humidity Unless otherwise specified
Atmospheric pressure	1080 to 795 hPa (corresponding to an altitude of -1000 to 2000m)
Concentration of contaminants	SO <sub>2</sub> : < 0.5 ppm; H <sub>2</sub> S: < 0.1 ppm; RH < 60% non-condensing
EN 60068-2-14, Test Nb, temperature change	5° C to 55° C, 3° C/minute
EN 60068-2-27 Mechanical shock	15 G, 11 ms pulse, 6 shocks in each of 3 axis
EN 60068-2-6 Sinusoidal vibration	DIN rail mount: 3.5 mm from 5-9 Hz, 1G from 9 - 150 Hz Panel Mount: 7.0 mm from 5-9 Hz, 2G from 9 to 150 Hz 10 sweeps each axis, 1 octave per minute

**NOTICE**

For systems that must start up in the range of -20° C to 0° C, the user program should delay energizing outputs for 10 seconds following startup.

Table A- 6 High potential isolation test

High potential isolation test	
24 V/5 V nominal circuits	520 VDC (type test of optical isolation boundaries)
115/230 V circuits to ground	1500 VAC
115/230 V circuits to 115/230 V circuits	1500 VAC
115 V/230V circuits to 24 V/5 V circuits	1500 VAC (3000 VAC / 4242 VDC type test)
Ethernet port to 24V/5V circuits and ground <sup>1</sup>	1500 VAC (type test only)

<sup>1</sup> Ethernet port isolation is designed to limit hazard during short term network faults to hazardous voltages. It does not conform to safety requirements for routine AC line voltage isolation.

**Protection class**

- Protection Class II according to EN 61131-2 (Protective conductor not required)

**Degree of protection**

- IP20 Mechanical Protection, EN 60529
- Protects against finger contact with high voltage as tested by standard probe. External protection required for dust, dirt, water and foreign objects of < 12.5mm in diameter.

## Rated voltages

Table A- 7 Rated voltages

Rated voltage	Tolerance
24 VDC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° C to 0° C
120/230 VAC	85 VAC to 264 VAC, 47 to 63 Hz

### NOTICE

When a mechanical contact turns on output power to the S7-1200 CPU, or any digital signal module, it sends a "1" signal to the digital outputs for approximately 50 microseconds. This could cause unexpected machine or process operation which could result in death or serious injury to personnel and/or damage to equipment. You must plan for this, especially if you are using devices which respond to short duration pulses.

## Reverse voltage protection

Reverse voltage protection circuitry is provided on each terminal pair of +24 VDC power or user input power for CPUs, signal modules (SMs), and signal boards (SBs). It is still possible to damage the system by wiring different terminal pairs in opposite polarities.

Some of the 24 VDC power input ports in the S7-1200 system are interconnected, with a common logic circuit connecting multiple M terminals. For example, the following circuits are interconnected when designated as "not isolated" in the data sheets: the 24 VDC power supply of the CPU, the power input for the relay coil of an SM, or the power supply for a non-isolated analog input. All non-isolated M terminals must connect to the same external reference potential.



### WARNING

Connecting non-isolated M terminals to different reference potentials will cause unintended current flows that may cause damage or unpredictable operation in the PLC and any connected equipment.

Failure to comply with these guidelines could cause damage or unpredictable operation which could result in death or serve personal injury and/or property damage.

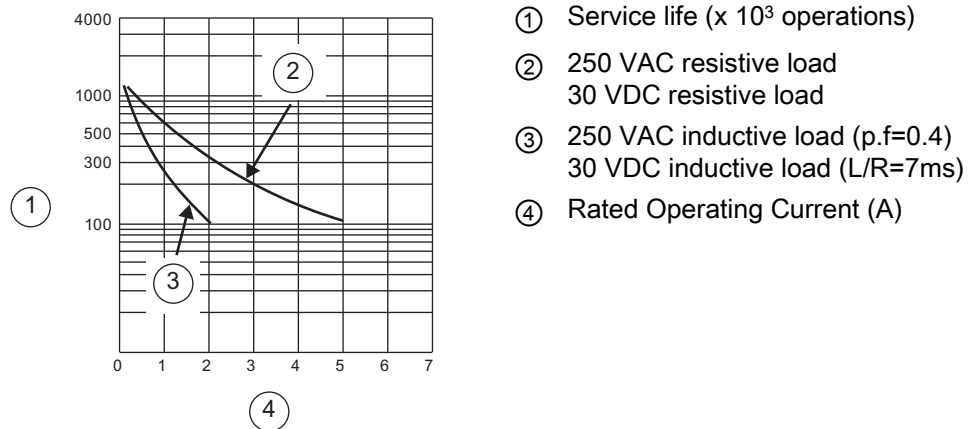
Always ensure that all non-isolated M terminals in an S7-1200 system are connected to the same reference potential.

## DC Outputs

Short circuit protection circuitry is not provided for DC outputs on CPUs, signal modules (SMs) and signal boards (SBs).

## Relay electrical service life

The typical performance data supplied by relay vendors is shown below. Actual performance may vary depending upon your specific application. An external protection circuit that is adapted to the load will enhance the service life of the contacts.



## A.2 CPU 1211C

### A.2.1 General specifications and features

Table A- 8 General specifications

Technical data	CPU 1211C AC/DC/Relay	CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Order number	6ES7 211-1BE31-0XB0	6ES7 211-1HE31-0XB0	6ES7 211-1AE31-0XB0
Dimensions W x H x D (mm)	90 x 100 x 75	90 x 100 x 75	90 x 100 x 75
Shipping weight	420 grams	380 grams	370 grams
Power dissipation	10 W	8 W	8 W
Current available (CM bus)	750 mA max. (5 VDC)	750 mA max. (5 VDC)	750 mA max. (5 VDC)
Current available (24 VDC)	300 mA max. (sensor power)	300 mA max. (sensor power)	300 mA max. (sensor power)
Digital input current consumption (24VDC)	4 mA/input used	4 mA/input used	4 mA/input used

## A.2 CPU 1211C

Table A- 9 CPU features

Technical data		Description
User memory <sup>1</sup>	Work	30 Kbytes
	Load	1 Mbyte internal, expandable up to SD card size
	Retentive	10 Kbytes
On-board digital I/O		6 inputs/4 outputs
On-board analog I/O		2 inputs
Process image size		1024 bytes of inputs (I) /1024 bytes of outputs (Q)
Bit memory (M)		4096 bytes
Temporary (local) memory		<ul style="list-style-type: none"> <li>• 16 Kbytes for startup and program cycle (including associated FBs and FCs)</li> <li>• 4 Kbytes for standard interrupt events including FBs and FCs</li> <li>• 4 Kbytes for error interrupt events including FBs and FCs</li> </ul>
Signal modules expansion		none
SB, CB, BB expansion		1 max.
Communication module expansion		3 CMs max.
High-speed counters		3 built-in I/O, 5 with signal board, refer to table, HSC input assignments for CPU 1211C (Page 339) <ul style="list-style-type: none"> <li>• Single phase: 3 at 100 kHz, SB: 2 at 30 kHz</li> <li>• Quadrature phase: 3 at 80 kHz, SB: 2 at 20 kHz</li> </ul>
Pulse outputs <sup>2</sup>		4
Pulse catch inputs		6
Time delay / cyclic interrupts		4 total with 1 ms resolution
Edge interrupts		6 rising and 6 falling (10 and 10 with optional signal board)
Memory card		SIMATIC Memory Card (optional)
Real time clock accuracy		+/- 60 seconds/month
Real time clock retention time		20 days typ./12 days min. at 40°C (maintenance-free Super Capacitor)

<sup>1</sup> The size of the user program, data, and configuration is limited by the available load memory and work memory in the CPU. There is no specific limit to the number of OB, FC, FB and DB blocks supported or to the size of a particular block; the only limit is due to overall memory size.

<sup>2</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

Table A- 10 Performance

Type of instruction	Execution speed
Boolean	0.08 µs/instruction
Move Word	1.7 µs/instruction
Real math	2.3 µs/instruction

## A.2.2 Timers, counters and code blocks supported by CPU 1211C

Table A- 11 Blocks, timers and counters supported by CPU 1211C

Element		Description
Blocks	Type	OB, FB, FC, DB
	Size	30 Kbytes
	Quantity	Up to 1024 blocks total (OBs + FBs + FCs + DBs)
	Address range for FBs, FCs, and DBs	1 to 65535 (such as FB 1 to FB 65535)
	Nesting depth	16 from the program cycle or start up OB; 4 from the time delay interrupt, time-of-day interrupt, cyclic interrupt, hardware interrupt, time error interrupt, or diagnostic error interrupt OB
	Monitoring	Status of 2 code blocks can be monitored simultaneously
OBs	Program cycle	Multiple: OB 1, OB 200 to OB 65535
	Startup	Multiple: OB 100, OB 200 to OB 65535
	Time-delay interrupts and cyclic interrupts	4 <sup>1</sup> (1 per event): OB 200 to OB 65535
	Hardware interrupts (edges and HSC)	50 (1 per event): OB 200 to OB 65535
	Time error interrupts	1: OB 80
	Diagnostic error interrupts	1: OB 82
Timers	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, 16 bytes per timer
Counters	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, size dependent upon count type <ul style="list-style-type: none"> <li>• SInt, USInt: 3 bytes</li> <li>• Int, UInt: 6 bytes</li> <li>• DInt, UDInt: 12 bytes</li> </ul>

<sup>1</sup> Time-delay and cyclic interrupts use the same resources in the CPU. You can have only a total of 4 of these interrupts (time-delay plus cyclic interrupts). You cannot have 4 time-delay interrupts and 4 cyclic interrupts.

Table A- 12 Communication

Technical data	Description
Number of ports	1
Type	Ethernet
HMI device <sup>1</sup>	3
Programming device (PG)	1

## A.2 CPU 1211C

Technical data	Description
Connections	<ul style="list-style-type: none"> <li>8 for Open User Communication (active or passive): TSEND_C, TRCV_C, TCON, TDISCON, TSEND, and TRCV</li> <li>3 for server GET/PUT (CPU-to-CPU) S7 communication</li> <li>8 for client GET/PUT (CPU-to-CPU) S7 communication</li> </ul>
Data rates	10/100 Mb/s
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VAC, for short term event safety only
Cable type	CAT5e shielded

- <sup>1</sup> The CPU provides dedicated HMI connections to support up to 3 HMI devices. (You can have up to 2 SIMATIC Comfort panels.) The total number of HMI is affected by the types of HMI panels in your configuration. For example, you could have up to three SIMATIC Basic panels connected to your CPU, or you could have up to two SIMATIC Comfort panels with one additional Basic panel.

Table A- 13 Power supply

Technical data	CPU 1211C AC/DC/Relay	CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Voltage range	85 to 264 VAC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° C to 0° C	
Line frequency	47 to 63 Hz	--	--
Input current	CPU only at max. load 60 mA at 120 VAC 30 mA at 240 VAC	300 mA at 24 VDC	300 mA at 24 VDC
	CPU with all expansion accessories at max. load 180 mA at 120 VAC 90 mA at 240 VAC	900 mA at 24 VDC	900 mA at 24 VDC
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	12 A at 28.8 VDC
Isolation (input power to logic)	1500 VAC	Not isolated	Not isolated
Ground leakage, AC line to functional earth	0.5 mA max.	--	--
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	10 ms at 24 VDC
Internal fuse, not user replaceable	3 A, 250 V, slow blow	3 A, 250 V, slow blow	3 A, 250 V, slow blow

Table A- 14 Sensor power

Technical data	CPU 1211C AC/DC/Relay	CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min. L+ minus 5 VDC min. for ambient temperature -20° C to 0° C	
Output current rating (max.)	300 mA (short circuit protected)	300 mA (short circuit protected)	300 mA (short circuit protected)
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	Same as input line
Isolation (CPU logic to sensor power)	Not isolated	Not isolated	Not isolated



### A.2.3 Digital inputs and outputs

Table A- 15 Digital inputs

Technical data	CPU 1211C AC/DC/Relay, CPU 1211C DC/DC/Relay, and CPU 1211C DC/DC/DC
Number of inputs	6
Type	Sink/Source (IEC Type 1 sink)
Rated voltage	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz Quadrature phase: 80 KHz
Number of inputs on simultaneously	6 at 60° C horizontal, 50° C vertical
Cable length (meters)	500 m shielded, 300 m unshielded, 50 m shielded for HSC inputs

Table A- 16 Digital outputs

Technical data	CPU 1211C AC/DC/Relay and CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Number of outputs	4	4
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	20 VDC min.
Logic 0 signal with 10 K $\Omega$ load	--	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC / 200 W AC	5 W
ON state resistance	0.2 $\Omega$ max. when new	0.6 $\Omega$ max.
Leakage current per point	--	10 $\mu$ A max.
Surge current	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	500 VAC for 1 minute
Isolation resistance	100 M $\Omega$ min. when new	--
Isolation between open contacts	750 VAC for 1 minute	--
Isolation groups	1	1
Inductive clamp voltage	--	L+ minus 48 VDC, 1 W dissipation

## A.2 CPU 1211C

Technical data	CPU 1211C AC/DC/Relay and CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Maximum relay switching frequency	1 Hz	--
Switching delay (Qa.0 to Qa.3)	10 ms max.	1.0 µs max., off to on 3.0 µs max., on to off
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended <sup>1</sup>	100 KHz max., 2 Hz min. <sup>2</sup>
Lifetime mechanical (no load)	10,000,000 open/close cycles	--
Lifetime contacts at rated load	100,000 open/close cycles	--
Behavior on RUN to STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Number of outputs on simultaneously	4 at 60° C horizontal, 50° C vertical	
Cable length (meters)	500 m shielded, 150 m unshielded	500 m shielded, 150 m unshielded

<sup>1</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

<sup>2</sup> Depending on your pulse receiver and cable, an additional load resistor (at least 10% of rated current) may improve pulse signal quality and noise immunity.

### A.2.4 Analog inputs

Table A- 17 Analog inputs

Technical data	Description
Number of inputs	2
Type	Voltage (single-ended)
Full-scale range	0 to 10 V
Full-scale range (data word)	0 to 27648
Overshoot range	10.001 to 11.759 V
Overshoot range (data word)	27,649 to 32,511
Overflow range	11.760 to 11.852 V
Overflow range (data word)	32,512 to 32,767
Resolution	10 bits
Maximum withstand voltage	35 VDC
Smoothing	None, Weak, Medium, or Strong See the table for step response (ms) for the analog inputs of the CPU (Page 711).
Noise rejection	10, 50, or 60 Hz
Impedance	≥100 KΩ
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale
Cable length (meters)	100 m, shielded twisted pair

### A.2.4.1 Step response of the built-in analog inputs of the CPU

Table A- 18 Step Response (ms), 0V to 10V measured at 95%

Smoothing selection (sample averaging)	Rejection frequency (Integration time)		
	60 Hz	50 Hz	10 Hz
None (1 cycle): No averaging	50 ms	50 ms	100 ms
Weak (4 cycles): 4 samples	60ms	70 ms	200 ms
Medium (16 cycles): 16 samples	200 ms	240 ms	1150 ms
Strong (32 cycles): 32 samples	400 ms	480 ms	2300 ms
<b>Sample time</b>	<b>4.17 ms</b>	<b>5 ms</b>	<b>25 ms</b>

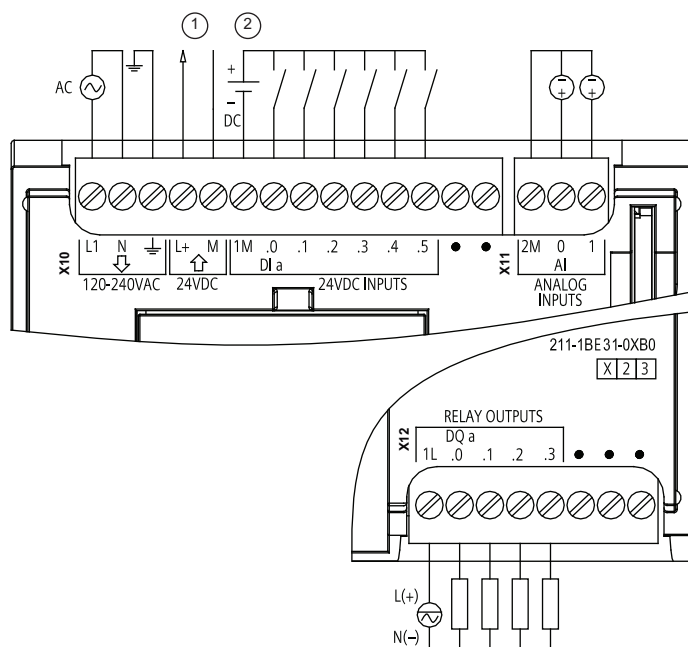
### A.2.4.2 Sample time for the built-in analog ports of the CPU

Table A- 19 Sample time for built-in analog inputs of the CPU

Rejection frequency (Integration time selection)	Sample time
60 Hz (16.6 ms)	4.17 ms
50 Hz (20 ms)	5 ms
10 Hz (100 ms)	25 ms

## A.2.5 CPU 1211C Wiring diagrams

Table A- 20 CPU 1211C AC/DC/Relay (6ES7 211-1BE31-0XB0)



① 24 VDC Sensor Power Out  
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

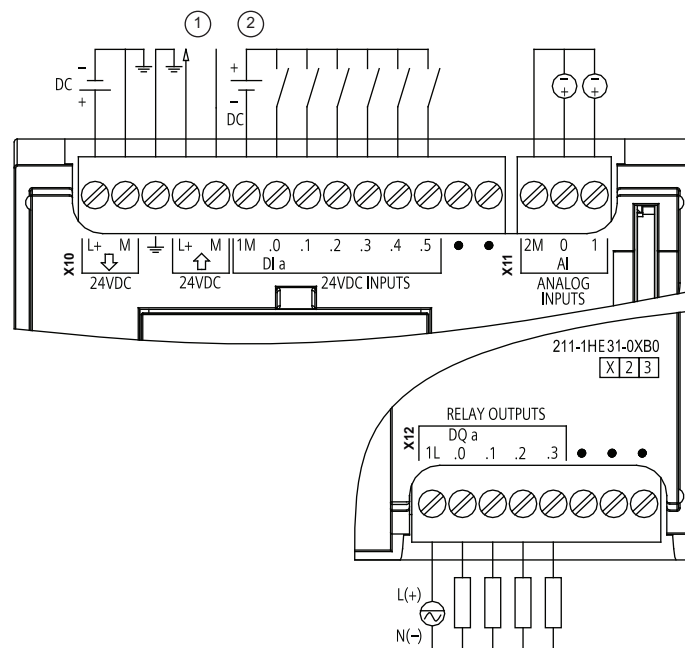
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 21 Connector pin locations for CPU 1211C AC/DC/Relay (6ES7 211-1BE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 / 120-240 VAC	2 M	1L
2	N / 120-240 VAC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	No connection
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

Table A- 22 CPU 1211C DC/DC/Relay (6ES7 211-1HE31-0XB0)



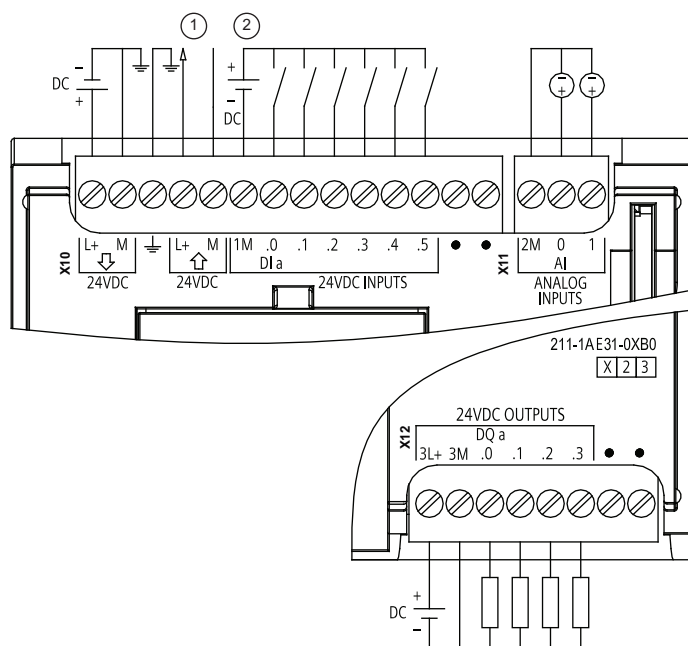
- ① 24 VDC Sensor Power Out  
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.
- ② For sinking inputs, connect "-" to "M" (shown).  
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 23 Connector pin locations for CPU 1211C DC/DC/Relay (6ES7 211-1HE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	1L
2	M / 24VDC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	No connection
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

Table A- 24 CPU 1211C DC/DC/DC (6ES7 211-1AE31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 25 Connector pin locations for CPU 1211C DC/DC/DC (6ES7 211-1AE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	3L+
2	M / 24VDC	AI 0	3M
3	Functional Earth	AI 1	DQ a.0
4	L+ / 24VDC Sensor Out	--	DQ a.1
5	M / 24VDC Sensor Out	--	DQ a.2
6	1M	--	DQ a.3
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

#### Note

Unused analog inputs should be shorted.

## A.3 CPU 1212C

### A.3.1 General specifications and features

Table A- 26 General

Technical data	CPU 1212C AC/DC/Relay	CPU 1212C DC/DC/Relay	CPU 1212C DC/DC/DC
Order number	6ES7 212-1BE31-0XB0	6ES7 212-1HE31-0XB0	6ES7 212-1AE31-0XB0
Dimensions W x H x D (mm)	90 x 100 x 75	90 x 100 x 75	90 x 100 x 75
Shipping weight	425 grams	385 grams	370 grams
Power dissipation	11 W	9 W	9 W
Current available (SM and CM bus)	1000 mA max. (5 VDC)	1000 mA max. (5 VDC)	1000 mA max. (5 VDC)
Current available (24 VDC)	300 mA max. (sensor power)	300 mA max. (sensor power)	300 mA max. (sensor power)
Digital input current consumption (24 VDC)	4 mA/input used	4 mA/input used	4 mA/input used

Table A- 27 CPU features

Technical data	Description
User memory <sup>1</sup>	Work 50 Kbytes
	Load 1 Mbyte internal, expandable up to SD card size
	Retentive 10 Kbytes
On-board digital I/O	8 inputs/6 outputs
On-board analog I/O	2 inputs
Process image size	1024 bytes of inputs (I)/1024 bytes of outputs (Q)
Bit memory (M)	4096 bytes
Temporary (local) memory	<ul style="list-style-type: none"> <li>16 Kbytes for startup and program cycle (including associated FBs and FCs)</li> <li>4 Kbytes for standard interrupt events including FBs and FCs</li> <li>4 Kbytes for error interrupt events including FBs and FCs</li> </ul>
Signal modules expansion	2 SMs max.
SB, CB, BB expansion	1 max.
Communication module expansion	3 CMs max.
High-speed counters	5 built in I/O, 6 with signal board, see table, HSC input assignments for CPU 1212C (Page 339) <ul style="list-style-type: none"> <li>Single phase: 3 at 100 kHz and 1 at 30 kHz clock rate, SB: 2 at 30 kHz</li> <li>Quadrature phase: 3 at 80 kHz and 1 at 20 kHz clock rate, SB: 2 at 20 kHz</li> </ul>
Pulse outputs <sup>2</sup>	4
Pulse catch inputs	8

### A.3 CPU 1212C

Technical data	Description
Time delay / cyclic interrupts	4 total with 1 ms resolution
Edge interrupts	8 rising and 8 falling (12 and 12 with optional signal board)
Memory card	SIMATIC Memory Card (optional)
Real time clock accuracy	+/- 60 seconds/month
Real time clock retention time	20 days typ./12 days min. at 40°C (maintenance-free Super Capacitor)

- <sup>1</sup> The size of the user program, data, and configuration is limited by the available load memory and work memory in the CPU. There is no specific limit to the number of OB, FC, FB and DB blocks supported or to the size of a particular block; the only limit is due to overall memory size.
- <sup>2</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

Table A- 28 Performance

Type of instruction	Execution speed
Boolean	0.08 µs/instruction
Move Word	1.7 µs/instruction
Real math	2.3 µs/instruction

### A.3.2 Timers, counters and code blocks supported by CPU 1212C

Table A- 29 Blocks, timers and counters supported by CPU 1212C

Element	Description
Blocks	Type
	OB, FB, FC, DB
	Size
	50 Kbytes
	Quantity
	Up to 1024 blocks total (OBs + FBs + FCs + DBs)
OBs	Address range for FBs, FCs, and DBs
	1 to 65535 (such as FB 1 to FB 65535)
	Nesting depth
	16 from the program cycle or start up OB; 4 from the time delay interrupt, time-of-day interrupt, cyclic interrupt, hardware interrupt, time error interrupt, or diagnostic error interrupt OB
	Monitoring
	Status of 2 code blocks can be monitored simultaneously
OBs	Program cycle
	Multiple: OB 1, OB 200 to OB 65535
	Startup
	Multiple: OB 100, OB 200 to OB 65535
	Time-delay interrupts and cyclic interrupts
	4 <sup>1</sup> (1 per event): OB 200 to OB 65535
OBs	Hardware interrupts (edges and HSC)
	50 (1 per event): OB 200 to OB 65535
	Time error interrupts
	1: OB 80
	Diagnostic error interrupts
	1: OB 82
Timers	Type
	IEC
	Quantity
Timers	Limited only by memory size
	Storage
	Structure in DB, 16 bytes per timer



Element	Description	
Counters	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, size dependent upon count type <ul style="list-style-type: none"> <li>• SInt, USInt: 3 bytes</li> <li>• Int, UInt: 6 bytes</li> <li>• DInt, UDInt: 12 bytes</li> </ul>

<sup>1</sup> Time-delay and cyclic interrupts use the same resources in the CPU. You can have only a total of 4 of these interrupts (time-delay plus cyclic interrupts). You cannot have 4 time-delay interrupts and 4 cyclic interrupts.

Table A- 30 Communication

Technical data	Description
Number of ports	1
Type	Ethernet
HMI device <sup>1</sup>	3
Programming device (PG)	1
Connections	<ul style="list-style-type: none"> <li>• 8 for Open User Communication (active or passive): TSEND_C, TRCV_C, TCON, TDISCON, TSEND, and TRCV</li> <li>• 3 for server GET/PUT (CPU-to-CPU) S7 communication</li> <li>• 8 for client GET/PUT (CPU-to-CPU) S7 communication</li> </ul>
Data rates	10/100 Mb/s
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VAC, for short term event safety only
Cable type	CAT5e shielded

<sup>1</sup> The CPU provides dedicated HMI connections to support up to 3 HMI devices. (You can have up to 2 SIMATIC Comfort panels.) The total number of HMI is affected by the types of HMI panels in your configuration. For example, you could have up to three SIMATIC Basic panels connected to your CPU, or you could have up to two SIMATIC Comfort panels with one additional Basic panel.

Table A- 31 Power supply

Technical data		CPU 1212C AC/DC/Relay	CPU 1212C DC/DC/Relay	CPU 1212C DC/DC/DC
Voltage range		85 to 264 VAC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° to 0° C	
Line frequency		47 to 63 Hz	--	--
Input current (max. load)	CPU only	80 mA at 120 VAC 40 mA at 240 VAC	400 mA at 24 VDC	400 mA at 24 VDC
	CPU with all expansion accessories	240 mA at 120 VAC 120 mA at 240 VAC	1200 mA at 24 VDC	1200 mA at 24 VDC
Inrush current (max.)		20 A at 264 VAC	12 A at 28.8 VDC	12 A at 28.8 VDC
Isolation (input power to logic)		1500 VAC	Not isolated	Not isolated
Ground leakage, AC line to functional earth		0.5 mA max.	--	--

### A.3 CPU 1212C

Technical data	CPU 1212C AC/DC/Relay	CPU 1212C DC/DC/Relay	CPU 1212C DC/DC/DC
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	10 ms at 24 VDC
Internal fuse, not user replaceable	3 A, 250 V, slow blow	3 A, 250 V, slow blow	3 A, 250 V, slow blow

Table A- 32 Sensor power

Technical data	CPU 1212C AC/DC/Relay	CPU 1212C DC/DC/Relay	CPU 1212C DC/DC/DC
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min. L+ minus 5 VDC min. for ambient temperature -20° C to 0° C	
Output current rating (max.)	300 mA (short circuit protected)	300 mA (short circuit protected)	300 mA (short circuit protected)
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	Same as input line
Isolation (CPU logic to sensor power)	Not isolated	Not isolated	Not isolated

### A.3.3 Digital inputs and outputs

Table A- 33 Digital inputs

Technical data	CPU 1212C AC/DC/Relay, DC/DC/Relay, and DC/DC/DC
Number of inputs	8
Type	Sink/Source (IEC Type 1 sink)
Rated voltage	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz (Ia.0 to Ia.5) and 30 KHz (Ia.6 to Ia.7) Quadrature phase: 80 KHz (Ia.0 to Ia.5) and 20 KHz (Ia.6 to Ia.7)
Number of inputs on simultaneously	8 at 60°C horizontal, 50°C vertical
Cable length (meters)	500 m shielded, 300 m unshielded, 50 m shielded for HSC inputs

Table A- 34 Digital outputs

Technical data	CPU 1212C AC/DC/Relay and DC/DC/Relay	CPU 1212C DC/DC/DC
Number of outputs	6	6
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	20 VDC min.
Logic 0 signal with 10 K $\Omega$ load	--	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC / 200 W AC	5 W
ON state resistance	0.2 $\Omega$ max. when new	0.6 $\Omega$ max.
Leakage current per point	--	10 $\mu$ A max.
Surge current	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	500 VAC for 1 minute
Isolation resistance	100 M $\Omega$ min. when new	--
Isolation between open contacts	750 VAC for 1 minute	--
Isolation groups	2	1
Inductive clamp voltage	--	L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.	1.0 $\mu$ s max., off to on 3.0 $\mu$ s max., on to off
Switching delay (Qa.4 to Qa.5)	10 ms max.	50 $\mu$ s max., off to on 200 $\mu$ s max., on to off
Maximum relay switching frequency	1 Hz	--
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended <sup>1</sup>	100 KHz max., 2 Hz min. <sup>2</sup>
Lifetime mechanical (no load)	10,000,000 open/close cycles	--
Lifetime contacts at rated load	100,000 open/close cycles	--
Behavior on RUN to STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Number of outputs on simultaneously	6 up to 60°C horizontal, 50°C vertical	
Cable length (meters)	500 m shielded, 150 m unshielded	500 m shielded, 150 m unshielded

<sup>1</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

<sup>2</sup> Depending on your pulse receiver and cable, an additional load resistor (at least 10% of rated current) may improve pulse signal quality and noise immunity.

## A.3.4 Analog inputs

Table A- 35 Analog inputs

Technical data	Description
Number of inputs	2
Type	Voltage (single-ended)
Full-scale range	0 to 10 V
Full-scale range (data word)	0 to 27648
Overshoot range	10.001 to 11.759 V
Overshoot range (data word)	27,649 to 32,511
Overflow range	11.760 to 11.852 V
Overflow range (data word)	32,512 to 32,767
Resolution	10 bits
Maximum withstand voltage	35 VDC
Smoothing	None, Weak, Medium, or Strong See the table for step response (ms) for the analog inputs of the CPU (Page 720).
Noise rejection	10, 50, or 60 Hz
Impedance	≥100 KΩ
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale
Cable length (meters)	100 m, shielded twisted pair

### A.3.4.1 Step response of the built-in analog inputs of the CPU

Table A- 36 Step Response (ms), 0V to 10V measured at 95%

Smoothing selection (sample averaging)	Rejection frequency (Integration time)		
	60 Hz	50 Hz	10 Hz
None (1 cycle): No averaging	50 ms	50 ms	100 ms
Weak (4 cycles): 4 samples	60ms	70 ms	200 ms
Medium (16 cycles): 16 samples	200 ms	240 ms	1150 ms
Strong (32 cycles): 32 samples	400 ms	480 ms	2300 ms
<b>Sample time</b>	<b>4.17 ms</b>	<b>5 ms</b>	<b>25 ms</b>

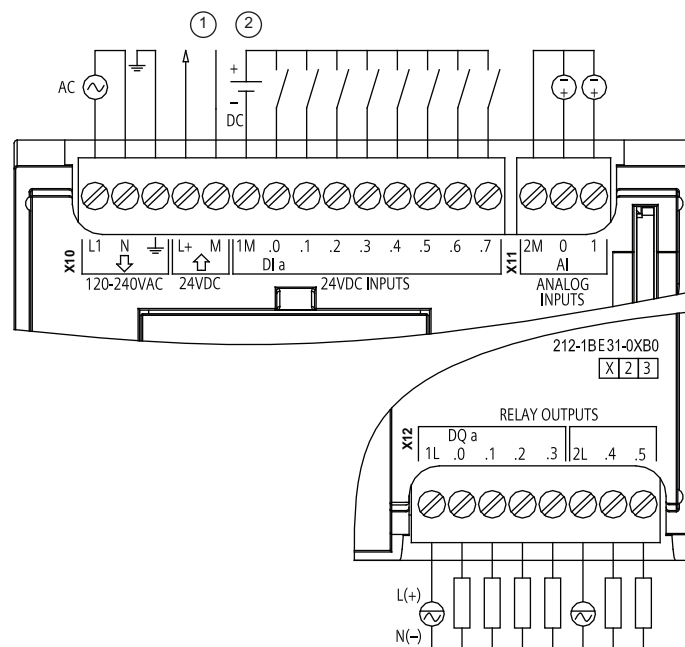
### A.3.4.2 Sample time for the built-in analog ports of the CPU

Table A- 37 Sample time for built-in analog inputs of the CPU

Rejection frequency (Integration time selection)	Sample time
60 Hz (16.6 ms)	4.17 ms
50 Hz (20 ms)	5 ms
10 Hz (100 ms)	25 ms

### A.3.5 CPU 1212C Wiring diagrams

Table A- 38 CPU 1212C AC/DC/Relay (6ES7 212-1BE31-0XB0)



① 24 VDC Sensor Power Out  
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

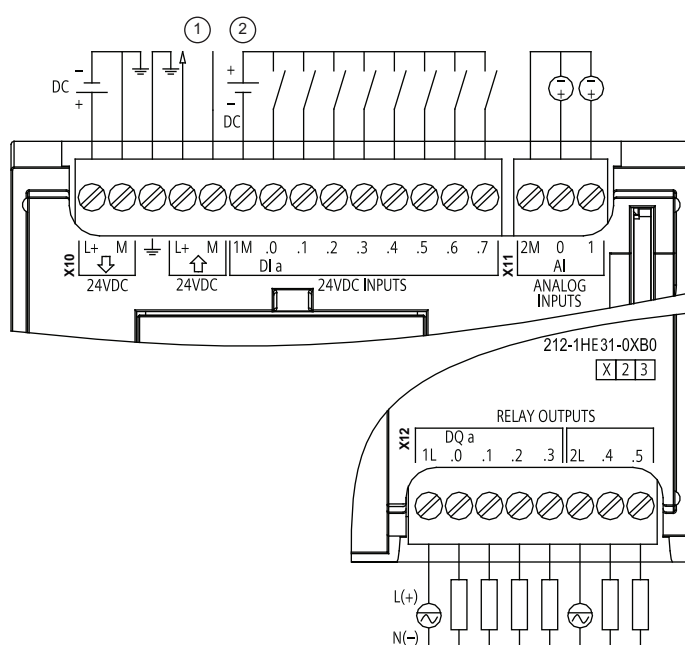
Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 39 Connector pin locations for CPU 1212C AC/DC/Relay (6ES7 212-1BE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 / 120-240 VAC	2 M	1L
2	N / 120-240 VAC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	2L
7	DI a.0	--	DQ a.4
8	DI a.1	--	DQ a.5

Pin	X10	X11 (gold)	X12
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	DI a.6	--	--
14	DI a.7	--	--

Table A- 40 CPU 1212C DC/DC/Relay (6ES7 212-1HE31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

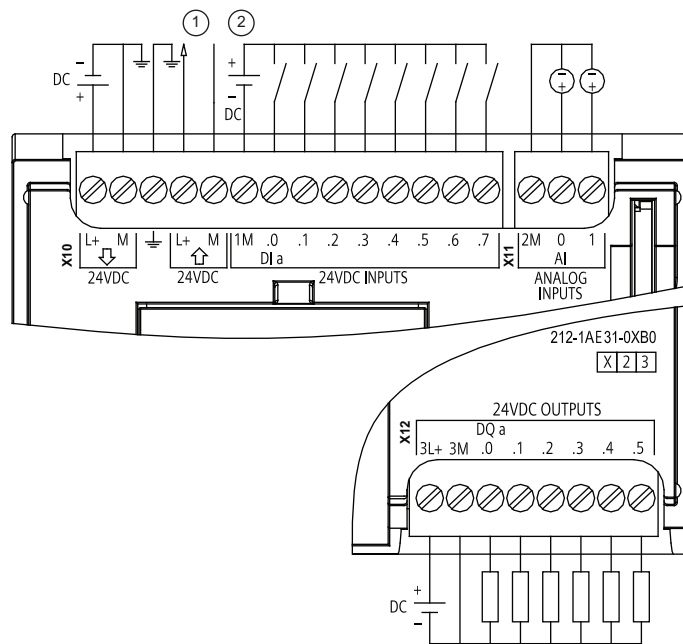
Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 41 Connector pin locations for CPU 1212C DC/DC/Relay (6ES7 212-1HE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	1L
2	M / 24VDC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	2L
7	DI a.0	--	DQ a.4
8	DI a.1	--	DQ a.5
9	DI a.2	--	--
10	DI a.3	--	--

Pin	X10	X11 (gold)	X12
11	DI a.4	--	--
12	DI a.5	--	--
13	DI a.6	--	--
14	DI a.7	--	--

Table A- 42 CPU 1212C DC/DC/DC (6ES7-212-1AE31-0XB0)



- ① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

- ② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 43 Connector pin locations for CPU 1212C DC/DC/DC (6ES7 212-1AE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	3L+
2	M / 24VDC	AI 0	3M
3	Functional Earth	AI 1	DQ a.0
4	L+ / 24VDC Sensor Out	--	DQ a.1
5	M / 24VDC Sensor Out	--	DQ a.2
6	1M	--	DQ a.3
7	DI a.0	--	DQ a.4
8	DI a.1	--	DQ a.5
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--

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Pin	X10	X11 (gold)	X12
13	DI a.6	--	--
14	DI a.7	--	--

### Note

Unused analog inputs should be shorted.

## A.4 CPU 1214C

### A.4.1 General specifications and features

Table A- 44 General

Technical data	CPU 1214C AC/DC/Relay	CPU 1214C DC/DC/Relay	CPU 1214C DC/DC/DC
Order number	6ES7 214-1BG31-0XB0	6ES7 214-1HG31-0XB0	6ES7 214-1AG31-0XB0
Dimensions W x H x D (mm)	110 x 100 x 75	110 x 100 x 75	110 x 100 x 75
Shipping weight	475 grams	435 grams	415 grams
Power dissipation	14 W	12 W	12 W
Current available (SM and CM bus)	1600 mA max. (5 VDC)	1600 mA max. (5 VDC)	1600 mA max. (5 VDC)
Current available (24 VDC)	400 mA max. (sensor power)	400 mA max. (sensor power)	400 mA max. (sensor power)
Digital input current consumption (24VDC)	4 mA/input used	4 mA/input used	4 mA/input used

Table A- 45 CPU features

Technical data	Description
User memory <sup>1</sup>	Work
	75 Kbytes
	Load
	4 Mbytes internal, expandable up to SD card size
	Retentive
	10 Kbytes
On-board digital I/O	14 inputs/10 outputs
On-board analog I/O	2 inputs
Process image size	1024 bytes of inputs (I)/1024 bytes of outputs (Q)
Bit memory (M)	8192 bytes



Technical data	Description
Temporary (local) memory	<ul style="list-style-type: none"> <li>16 Kbytes for startup and program cycle (including associated FBs and FCs)</li> <li>4 Kbytes for standard interrupt events including FBs and FCs</li> <li>4 Kbytes for error interrupt events including FBs and FCs</li> </ul>
Signal modules expansion	8 SMs max.
SB, CB, BB expansion	1 max.
Communication module expansion	3 CMs max.
High-speed counters	6 total, see table Operation of the high-speed counter (Page 339) <ul style="list-style-type: none"> <li>Single phase: 3 at 100 kHz and 3 at 30 kHz clock rate,</li> <li>Quadrature phase: 3 at 80 kHz and 3 at 20 kHz clock rate</li> </ul>
Pulse outputs <sup>2</sup>	4
Pulse catch inputs	14
Time delay / cyclic interrupts	4 total with 1 ms resolution
Edge interrupts	12 rising and 12 falling (14 and 14 with optional signal board)
Memory card	SIMATIC Memory Card (optional)
Real time clock accuracy	+/- 60 seconds/month
Real time clock retention time	20 days typ./12 days min. at 40°C (maintenance-free Super Capacitor)

<sup>1</sup> The size of the user program, data, and configuration is limited by the available load memory and work memory in the CPU. There is no specific limit to the number of OB, FC, FB and DB blocks supported or to the size of a particular block; the only limit is due to overall memory size.

<sup>2</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

Table A- 46 Performance

Type of instruction	Execution speed
Boolean	0.08 µs/instruction
Move Word	1.7 µs/instruction
Real math	2.3 µs/instruction

## A.4.2 Timers, counters and code blocks supported by CPU 1214C

Table A- 47 Blocks, timers and counters supported by CPU 1214C

Element	Description
Blocks	Type
	OB, FB, FC, DB
	Size
	64 Kbytes
	Quantity
	Up to 1024 blocks total (OBs + FBs + FCs + DBs)
	Address range for FBs, FCs, and DBs
	1 to 65535 (such as FB 1 to FB 65535)
	Nesting depth
	16 from the program cycle or start up OB; 4 from the time delay interrupt, time-of-day interrupt, cyclic interrupt, hardware interrupt, time error interrupt, or diagnostic error interrupt OB

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Element		Description
OBs	Monitoring	Status of 2 code blocks can be monitored simultaneously
	Program cycle	Multiple: OB 1, OB 200 to OB 65535
	Startup	Multiple: OB 100, OB 200 to OB 65535
	Time-delay interrupts and cyclic interrupts	4 <sup>1</sup> (1 per event): OB 200 to OB 65535
	Hardware interrupts (edges and HSC)	50 (1 per event): OB 200 to OB 65535
	Time error interrupts	1: OB 80
	Diagnostic error interrupts	1: OB 82
Timers	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, 16 bytes per timer
Counters	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, size dependent upon count type <ul style="list-style-type: none"> <li>• SInt, USInt: 3 bytes</li> <li>• Int, UInt: 6 bytes</li> <li>• DInt, UDInt: 12 bytes</li> </ul>

<sup>1</sup> Time-delay and cyclic interrupts use the same resources in the CPU. You can have only a total of 4 of these interrupts (time-delay plus cyclic interrupts). You cannot have 4 time-delay interrupts and 4 cyclic interrupts.

Table A- 48 Communication

Technical data	Description
Number of ports	1
Type	Ethernet
HMI device <sup>1</sup>	3
Programming device (PG)	1
Connections	<ul style="list-style-type: none"> <li>• 8 for Open User Communication (active or passive): TSEND_C, TRCV_C, TCON, TDISCON, TSEND, and TRCV</li> <li>• 3 for server GET/PUT (CPU-to-CPU) S7 communication</li> <li>• 8 for client GET/PUT (CPU-to-CPU) S7 communication</li> </ul>
Data rates	10/100 Mb/s
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VAC, for short term event safety only
Cable type	CAT5e shielded

<sup>1</sup> The CPU provides dedicated HMI connections to support up to 3 HMI devices. (You can have up to 2 SIMATIC Comfort panels.) The total number of HMI is affected by the types of HMI panels in your configuration. For example, you could have up to three SIMATIC Basic panels connected to your CPU, or you could have up to two SIMATIC Comfort panels with one additional Basic panel.

Table A- 49 Power supply

Technical data	CPU 1214C AC/DC/Relay	CPU 1214C DC/DC/Relay	CPU 1214C DC/DC/DC
Voltage range	85 to 264 VAC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° C to 0° C	
Line frequency	47 to 63 Hz	--	
Input current (max. load)	CPU only 100 mA at 120 VAC 50 mA at 240 VAC	500 mA at 24 VDC	
	CPU with all expansion accessories 300 mA at 120 VAC 150 mA at 240 VAC	1500 mA at 24 VDC	
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	
Isolation (input power to logic)	1500 VAC	Not isolated	
Ground leakage, AC line to functional earth	0.5 mA max.	-	
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	
Internal fuse, not user replaceable	3 A, 250 V, slow blow		

Table A- 50 Sensor power

Technical data	CPU 1214C AC/DC/Relay	CPU 1214C DC/DC/Relay	CPU 1214C DC/DC/DC
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min. L+ minus 5 VDC min. for ambient temperature -20° C to 0° C	
Output current rating (max.)	400 mA (short circuit protected)		
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	
Isolation (CPU logic to sensor power)	Not isolated		

### A.4.3 Digital inputs and outputs

Table A- 51 Digital inputs

Technical data	CPU 1214C AC/DC/Relay	CPU 1214C DC/DC/Relay	CPU 1214C DC/DC/DC
Number of inputs	14		
Type	Sink/Source (IEC Type 1 sink)		
Rated voltage	24 VDC at 4 mA, nominal		
Continuous permissible voltage	30 VDC, max.		
Surge voltage	35 VDC for 0.5 sec.		
Logic 1 signal (min.)	15 VDC at 2.5 mA		
Logic 0 signal (max.)	5 VDC at 1 mA		

A.4 CPU 1214C

Technical data	CPU 1214C AC/DC/Relay	CPU 1214C DC/DC/Relay	CPU 1214C DC/DC/DC
Isolation (field side to logic)	500 VAC for 1 minute		
Isolation groups	1		
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)		
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz (Ia.0 to Ia.5) and 30 KHz (Ia.6 to Ib.5) Quadrature phase: 80 KHz (Ia.0 to Ia.5) and 20 KHz (Ia.6 to Ib.5)		
Number of inputs on simultaneously	<ul style="list-style-type: none"> <li>7 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>14 at 55° C horizontal or 45° C vertical</li> </ul>		
Cable length (meters)	500 m shielded, 300 m unshielded, 50 m shielded for HSC inputs		

Table A- 52 Digital outputs

Technical data	CPU 1214C AC/DC/Relay and DC/DC/Relay	CPU 1214C DC/DC/DC
Number of outputs	10	10
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	20 VDC min.
Logic 0 signal with 10 KΩ load	--	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC / 200 W AC	5 W
ON state resistance	0.2 Ω max. when new	0.6 Ω max.
Leakage current per point	--	10 μA max.
Surge current	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	500 VAC for 1 minute
Isolation resistance	100 MΩ min. when new	--
Isolation between open contacts	750 VAC for 1 minute	--
Isolation groups	2	1
Inductive clamp voltage	--	L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.	1.0 μs max., off to on 3.0 μs max., on to off
Switching delay (Qa.4 to Qb.1)	10 ms max.	50 μs max., off to on 200 μs max., on to off
Maximum relay switching frequency	1 Hz	--
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended <sup>1</sup>	100 KHz max., 2 Hz min. <sup>2</sup>
Lifetime mechanical (no load)	10,000,000 open/close cycles	--
Lifetime contacts at rated load	100,000 open/close cycles	--
Behavior on RUN to STOP	Last value or substitute value (default value 0)	

Technical data	CPU 1214C AC/DC/Relay and DC/DC/Relay	CPU 1214C DC/DC/DC
Number of outputs on simultaneously	<ul style="list-style-type: none"> <li>• 5 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>• 10 at 55° C horizontal or 45° C vertical</li> </ul>	
Cable length (meters)	500 m shielded, 150 m unshielded	

- <sup>1</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.
- <sup>2</sup> Depending on your pulse receiver and cable, an additional load resistor (at least 10% of rated current) may improve pulse signal quality and noise immunity.

## A.4.4 Analog inputs

Table A- 53 Analog inputs

Technical data	Description
Number of inputs	2
Type	Voltage (single-ended)
Full-scale range	0 to 10 V
Full-scale range (data word)	0 to 27648
Overshoot range	10.001 to 11.759 V
Overshoot range (data word)	27,649 to 32,511
Overflow range	11.760 to 11.852 V
Overflow range (data word)	32,512 to 32,767
Resolution	10 bits
Maximum withstand voltage	35 VDC
Smoothing	None, Weak, Medium, or Strong See the table for step response (ms) for the analog inputs of the CPU (Page 730).
Noise rejection	10, 50, or 60 Hz
Impedance	≥100 KΩ
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale
Cable length (meters)	100 m, shielded twisted pair

#### A.4.4.1 Step response of the built-in analog inputs of the CPU

Table A- 54 Step Response (ms), 0V to 10V measured at 95%

Smoothing selection (sample averaging)	Rejection frequency (Integration time)		
	60 Hz	50 Hz	10 Hz
None (1 cycle): No averaging	50 ms	50 ms	100 ms
Weak (4 cycles): 4 samples	60ms	70 ms	200 ms
Medium (16 cycles): 16 samples	200 ms	240 ms	1150 ms
Strong (32 cycles): 32 samples	400 ms	480 ms	2300 ms
<b>Sample time</b>	<b>4.17 ms</b>	<b>5 ms</b>	<b>25 ms</b>

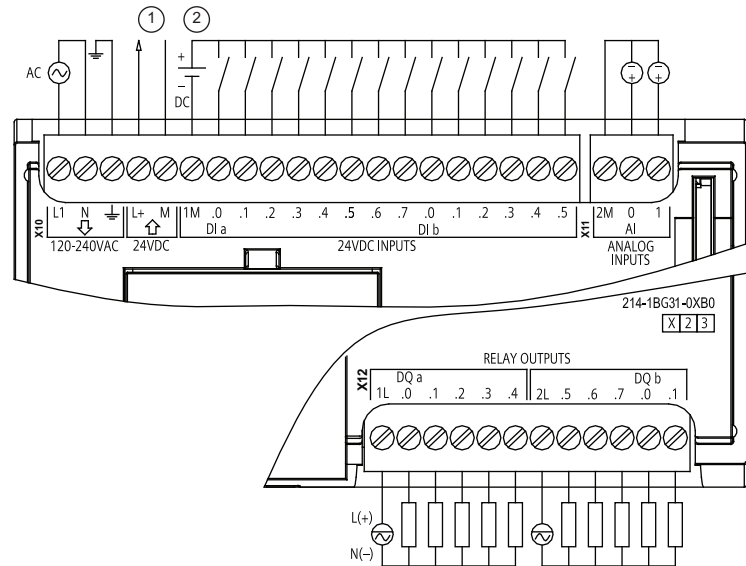
#### A.4.4.2 Sample time for the built-in analog ports of the CPU

Table A- 55 Sample time for built-in analog inputs of the CPU

Rejection frequency (Integration time selection)	Sample time
60 Hz (16.6 ms)	4.17 ms
50 Hz (20 ms)	5 ms
10 Hz (100 ms)	25 ms

## A.4.5 CPU 1214C Wiring Diagrams

Table A- 56 CPU 1214C AC/DC/Relay (6ES7 214-1BG31-0XB0)



- ① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

- ② For sinking inputs, connect "-" to "M" (shown).

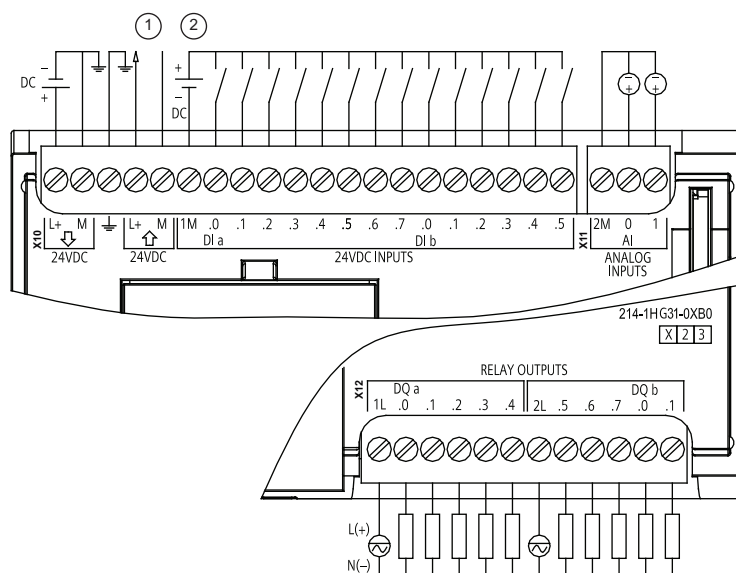
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 57 Connector pin locations for CPU 1214C AC/DC/Relay (6ES7 214-1BG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 / 120-240 VAC	2 M	1L
2	N / 120-240 VAC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	DQ a.4
7	DI a.0	--	2L
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	--
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--
19	DI b.4	--	--
20	DI b.5	--	--

Table A- 58 CPU 1214C DC/DC/Relay (6ES7 214-1HG31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

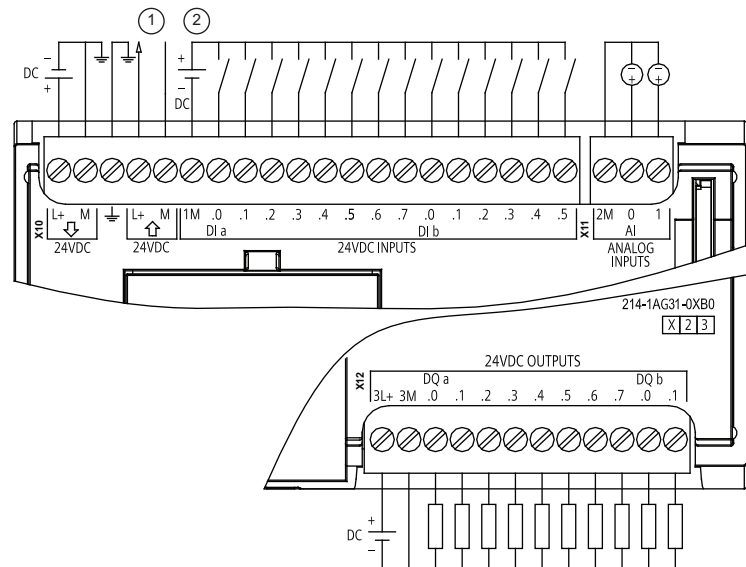
Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 59 Connector pin locations for CPU 1214C DC/DC/Relay (6ES7 214-1HG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	1L
2	M / 24VDC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	DQ a.4
7	DI a.0	--	2L
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	--
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--
19	DI b.4	--	--
20	DI b.5	--	--



Table A- 60 CPU 1214C DC/DC/DC (6ES7 214-1AG31-0XB0)



- ① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

- ② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 61 Connector pin locations for CPU 1214C DC/DC/DC (6ES7 214-1AG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	3L+
2	M / 24VDC	AI 0	3M
3	Functional Earth	AI 1	DQ a.0
4	L+ / 24VDC Sensor Out	--	DQ a.1
5	M / 24VDC Sensor Out	--	DQ a.2
6	1M	--	DQ a.3
7	DI a.0	--	DQ a.4
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	-
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--

## A.5 CPU 1215C

Pin	X10	X11 (gold)	X12
19	DI b.4	--	--
20	DI b.5	--	--

### Note

Unused analog inputs should be shorted.

## A.5 CPU 1215C

### A.5.1 General specifications and features

Table A- 62 General

Technical data	CPU 1215C AC/DC/Relay	CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Order number	6ES7 215-1BG31-0XB0	6ES7 215-1HG31-0XB0	6ES7 215-1AG31-0XB0
Dimensions W x H x D (mm)	130 x 100 x 75	130 x 100 x 75	130 x 100 x 75
Shipping weight	550 grams	585 grams	520 grams
Power dissipation	14 W	12 W	12 W
Current available (SM and CM bus)	1600 mA max. (5 VDC)	1600 mA max. (5 VDC)	1600 mA max. (5 VDC)
Current available (24 VDC)	400 mA max. (sensor power)	400 mA max. (sensor power)	400 mA max. (sensor power)
Digital input current consumption (24VDC)	4 mA/input used	4 mA/input used	4 mA/input used

Table A- 63 CPU features

Technical data	Description
User memory <sup>1</sup>	Work
	Load
	Retentive
On-board digital I/O	14 inputs/10 outputs
On-board analog I/O	2 inputs/2 outputs
Process image size	1024 bytes of inputs (I)/1024 bytes of outputs (Q)
Bit memory (M)	8192 bytes

Technical data	Description
Temporary (local) memory	<ul style="list-style-type: none"> <li>16 Kbytes for startup and program cycle (including associated FBs and FCs)</li> <li>4 Kbytes for standard interrupt events including FBs and FCs</li> <li>4 Kbytes for error interrupt events including FBs and FCs</li> </ul>
Signal modules expansion	8 SMs max.
SB, CB, BB expansion	1 max.
Communication module expansion	3 CMs max.
High-speed counters	6 total, see table HSC input assignments for CPU 1215C <ul style="list-style-type: none"> <li>Single phase: 3 at 100 kHz and 3 at 30 kHz clock rate</li> <li>Quadrature phase: 3 at 80 kHz and 3 at 20 kHz clock rate</li> </ul>
Pulse outputs <sup>2</sup>	4
Pulse catch inputs	14
Time delay / cyclic interrupts	4 total with 1 ms resolution
Edge interrupts	12 rising and 12 falling (14 and 14 with optional signal board)
Memory card	SIMATIC Memory Card (optional)
Real time clock accuracy	+/- 60 seconds/month
Real time clock retention time	20 days typ./12 days min. at 40°C (maintenance-free Super Capacitor)

<sup>1</sup> The size of the user program, data, and configuration is limited by the available load memory and work memory in the CPU. There is no specific limit to the number of OB, FC, FB and DB blocks supported or to the size of a particular block; the only limit is due to overall memory size.

<sup>2</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

Table A- 64 Performance

Type of instruction	Execution speed
Boolean	0.08 µs/instruction
Move Word	1.7 µs/instruction
Real math	2.3 µs/instruction

## A.5.2 Timers, counters and code blocks supported by CPU 1215C

Table A- 65 Blocks, timers and counters supported by CPU 1215C

Element	Description
Blocks	Type
	OB, FB, FC, DB
	Size
	64 Kbytes
	Quantity
	Up to 1024 blocks total (OBs + FBs + FCs + DBs)
	Address range for FBs, FCs, and DBs
	1 to 65535 (such as FB 1 to FB 65535)
	Nesting depth
	16 from the program cycle or start up OB; 4 from the time delay interrupt, time-of-day interrupt, cyclic interrupt, hardware interrupt, time error interrupt, or diagnostic error interrupt OB

## A.5 CPU 1215C

Element		Description
OBs	Monitoring	Status of 2 code blocks can be monitored simultaneously
	Program cycle	Multiple: OB 1, OB 200 to OB 65535
	Startup	Multiple: OB 100, OB 200 to OB 65535
	Time-delay interrupts and cyclic interrupts	4 <sup>1</sup> (1 per event): OB 200 to OB 65535
	Hardware interrupts (edges and HSC)	50 (1 per event): OB 200 to OB 65535
	Time error interrupts	1: OB 80
	Diagnostic error interrupts	1: OB 82
Timers	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, 16 bytes per timer
Counters	Type	IEC
	Quantity	Limited only by memory size
	Storage	Structure in DB, size dependent upon count type <ul style="list-style-type: none"> <li>• SInt, USInt: 3 bytes</li> <li>• Int, UInt: 6 bytes</li> <li>• DInt, UDInt: 12 bytes</li> </ul>

<sup>1</sup> Time-delay and cyclic interrupts use the same resources in the CPU. You can have only a total of 4 of these interrupts (time-delay plus cyclic interrupts). You cannot have 4 time-delay interrupts and 4 cyclic interrupts.

Table A- 66 Communication

Technical data	Description
Number of ports	2
Type	Ethernet
HMI device <sup>1</sup>	3
Programming device (PG)	1
Connections	<ul style="list-style-type: none"> <li>• 8 for Open User Communication (active or passive): TSEND_C, TRCV_C, TCON, TDISCON, TSEND, and TRCV</li> <li>• 3 for server GET/PUT (CPU-to-CPU) S7 communication</li> <li>• 8 for client GET/PUT (CPU-to-CPU) S7 communication</li> </ul>
Data rates	10/100 Mb/s
Isolation (external signal to PLC logic)	Transformer isolated, 1500 VAC, for short term event safety only
Cable type	CAT5e shielded

<sup>1</sup> The CPU provides dedicated HMI connections to support up to 3 HMI devices. (You can have up to 2 SIMATIC Comfort panels.) The total number of HMI is affected by the types of HMI panels in your configuration. For example, you could have up to three SIMATIC Basic panels connected to your CPU, or you could have up to two SIMATIC Comfort panels with one additional Basic panel.

Table A- 67 Power supply

Technical data	CPU 1215C AC/DC/Relay	CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Voltage range	85 to 264 VAC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° C to 0° C	
Line frequency	47 to 63 Hz	--	
Input current (max. load)	CPU only 100 mA at 120 VAC 50 mA at 240 VAC	500 mA at 24 VDC	
	CPU with all expansion accessories 300 mA at 120 VAC 150 mA at 240 VAC	1500 mA at 24 VDC	
Inrush current (max.)	20 A at 264 VAC	12 A at 28.8 VDC	
Isolation (input power to logic)	1500 VAC	Not isolated	
Ground leakage, AC line to functional earth	0.5 mA max.	-	
Hold up time (loss of power)	20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	
Internal fuse, not user replaceable	3 A, 250 V, slow blow		

Table A- 68 Sensor power

Technical data	CPU 1215C AC/DC/Relay	CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Voltage range	20.4 to 28.8 VDC	L+ minus 4 VDC min. L+ minus 5 VDC min. for ambient temperature -20° C to 0° C	
Output current rating (max.)	400 mA (short circuit protected)		
Maximum ripple noise (<10 MHz)	< 1 V peak to peak	Same as input line	
Isolation (CPU logic to sensor power)	Not isolated		

### A.5.3 Digital inputs and outputs

Table A- 69 Digital inputs

Technical data	CPU 1215C AC/DC/Relay	CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Number of inputs	14		
Type	Sink/Source (IEC Type 1 sink)		
Rated voltage	24 VDC at 4 mA, nominal		
Continuous permissible voltage	30 VDC, max.		
Surge voltage	35 VDC for 0.5 sec.		
Logic 1 signal (min.)	15 VDC at 2.5 mA		
Logic 0 signal (max.)	5 VDC at 1 mA		

A.5 CPU 1215C

Technical data	CPU 1215C AC/DC/Relay	CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Isolation (field side to logic)	500 VAC for 1 minute		
Isolation groups	1		
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)		
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz (Ia.0 to Ia.5) and 30 KHz (Ia.6 to Ib.5) Quadrature phase: 80 KHz (Ia.0 to Ia.5) and 20 KHz (Ia.6 to Ib.5)		
Number of inputs on simultaneously	<ul style="list-style-type: none"> <li>7 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>14 at 55° C horizontal or 45° C vertical</li> </ul>		
Cable length (meters)	500 m shielded, 300 m unshielded, 50 m shielded for HSC inputs		

Table A- 70 Digital outputs

Technical data	CPU 1215C AC/DC/Relay and CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Number of outputs	10	10
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	20 VDC min.
Logic 0 signal with 10 KΩ load	--	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC / 200 W AC	5 W
ON state resistance	0.2 Ω max. when new	0.6 Ω max.
Leakage current per point	--	10 μA max.
Surge current	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	500 VAC for 1 minute
Isolation resistance	100 MΩ min. when new	--
Isolation between open contacts	750 VAC for 1 minute	--
Isolation groups	2	1
Inductive clamp voltage	--	L+ minus 48 VDC, 1 W dissipation
Switching delay (Qa.0 to Qa.3)	10 ms max.	1.0 μs max., off to on 3.0 μs max., on to off
Switching delay (Qa.4 to Qb.1)	10 ms max.	50 μs max., off to on 200 μs max., on to off
Maximum relay switching frequency	1 Hz	--
Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended <sup>1</sup>	100 KHz max., 2 Hz min. <sup>2</sup>
Lifetime mechanical (no load)	10,000,000 open/close cycles	--
Lifetime contacts at rated load	100,000 open/close cycles	--
Behavior on RUN to STOP	Last value or substitute value (default value 0)	

Technical data	CPU 1215C AC/DC/Relay and CPU 1215C DC/DC/Relay	CPU 1215C DC/DC/DC
Number of outputs on simultaneously	<ul style="list-style-type: none"> <li>• 5 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>• 10 at 55° C horizontal or 45° C vertical</li> </ul>	
Cable length (meters)	500 m shielded, 150 m unshielded	

<sup>1</sup> For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

<sup>2</sup> Depending on your pulse receiver and cable, an additional load resistor (at least 10% of rated current) may improve pulse signal quality and noise immunity.

## A.5.4 Analog inputs and outputs

### A.5.4.1 Analog input specifications

Table A- 71 Analog inputs

Technical data	Description
Number of inputs	2
Type	Voltage (single-ended)
Full-scale range	0 to 10 V
Full-scale range (data word)	0 to 27648
Overshoot range	10.001 to 11.759 V
Overshoot range (data word)	27,649 to 32,511
Overflow range	11.760 to 11.852 V
Overflow range (data word)	32,512 to 32,767
Resolution	10 bits
Maximum withstand voltage	35 VDC
Smoothing	None, Weak, Medium, or Strong See the table for step response (ms) for the analog inputs of the CPU.
Noise rejection	10, 50, or 60 Hz
Impedance	≥100 KΩ
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale
Cable length (meters)	100 m, shielded twisted pair

### A.5.4.2 Step response of built-in analog inputs of the CPU

Table A- 72 Step Response (ms), 0V to 10V measured at 95%

Smoothing selection (sample averaging)	Rejection frequency (Integration time)		
	60 Hz	50 Hz	10 Hz
None (1 cycle): No averaging	50 ms	50 ms	100 ms
Weak (4 cycles): 4 samples	60ms	70 ms	200 ms
Medium (16 cycles): 16 samples	200 ms	240 ms	1150 ms
Strong (32 cycles): 32 samples	400 ms	480 ms	2300 ms
<b>Sample time</b>	<b>4.17 ms</b>	<b>5 ms</b>	<b>25 ms</b>

### A.5.4.3 Sample time for the built-in analog ports of the CPU

Table A- 73 Sample time for built-in analog inputs of the CPU

Rejection frequency (Integration time selection)	Sample time
60 Hz (16.6 ms)	4.17 ms
50 Hz (20 ms)	5 ms
10 Hz (100 ms)	25 ms

### A.5.4.4 Analog output specifications

#### Analog outputs

Table A- 74 Analog outputs

Technical data	Description
Number of outputs	2
Type	Current
Full-scale range	0 to 20 mA
Full-scale range (data word)	0 to 27648
Overshoot range	20.01 to 23.52 mA <sup>1</sup>
Overshoot range (data word)	27,649 to 32,511
Overflow range	see footnote <sup>2</sup>
Overflow range data word	32,512 to 32,767
Resolution	10 bits
Output drive impedance	≤500 Ω max.
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale

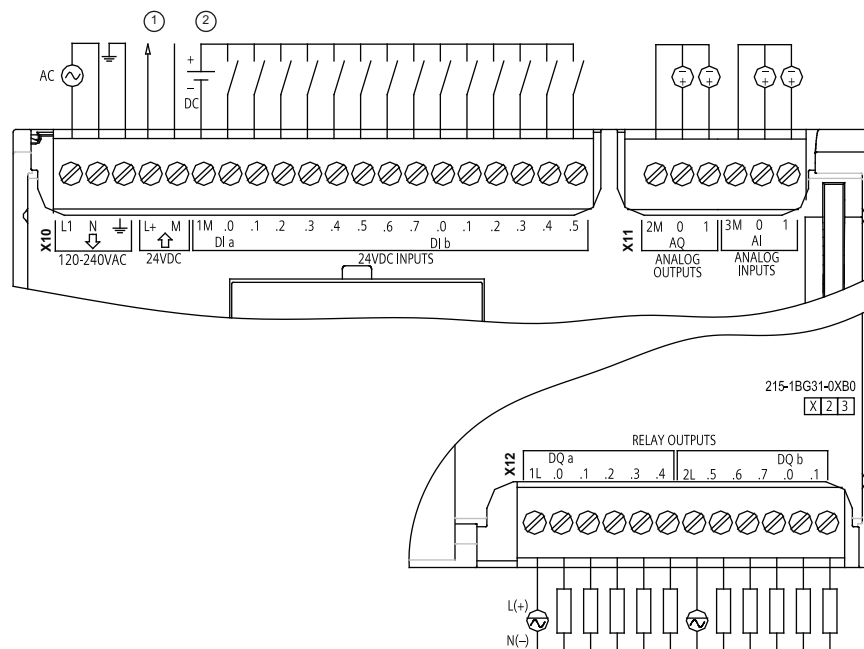


Technical data	Description
Settling time	2 ms
Cable length (meters)	100 m, shielded twisted pair

- For the CPU 1215C with DC power supply: at supply voltage 20.4 VDC, up to 400  $\Omega$  output drive impedance is supported in overshoot range.
- In an overflow condition, analog outputs will behave according to the device configuration properties settings. In the "Reaction to CPU STOP" parameter, select either: Use substitute value or Keep last value.

## A.5.5 CPU 1215C Wiring Diagrams

Table A- 75 CPU 1215C AC/DC/Relay (6ES7 215-1BG31-0XB0)



- 24 VDC Sensor Power Out**  
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.
- For sinking inputs, connect "-" to "M" (shown).  
For sourcing inputs, connect "+" to "M".

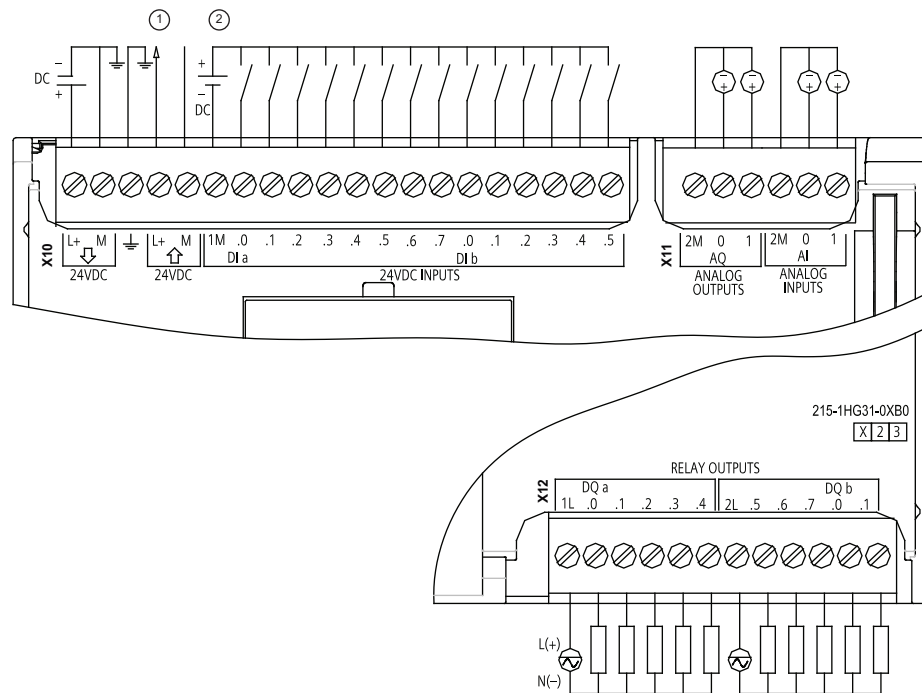
Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 76 Connector pin locations for CPU 1215C AC/DC/Relay (6ES7 215-1BG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 /120-240 VAC	2 M	1L
2	N / 120 - 240 VAC	AQ 0	DQ a.0

Pin	X10	X11 (gold)	X12
3	Functional Earth	AQ 1	DQ a.1
4	L+ / 24VDC Sensor Out	3M	DQ a.2
5	M / 24VDC Sensor Out	AI 0	DQ a.3
6	1M	AI 1	DQ a.4
7	DI a.0	--	2L
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	--
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--
19	DI b.4	--	--
20	DI b.5	--	--

Table A- 77 CPU 1215C DC/DC/Relay (6ES7 215-1HG31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown). For sourcing inputs, connect "+" to "M".

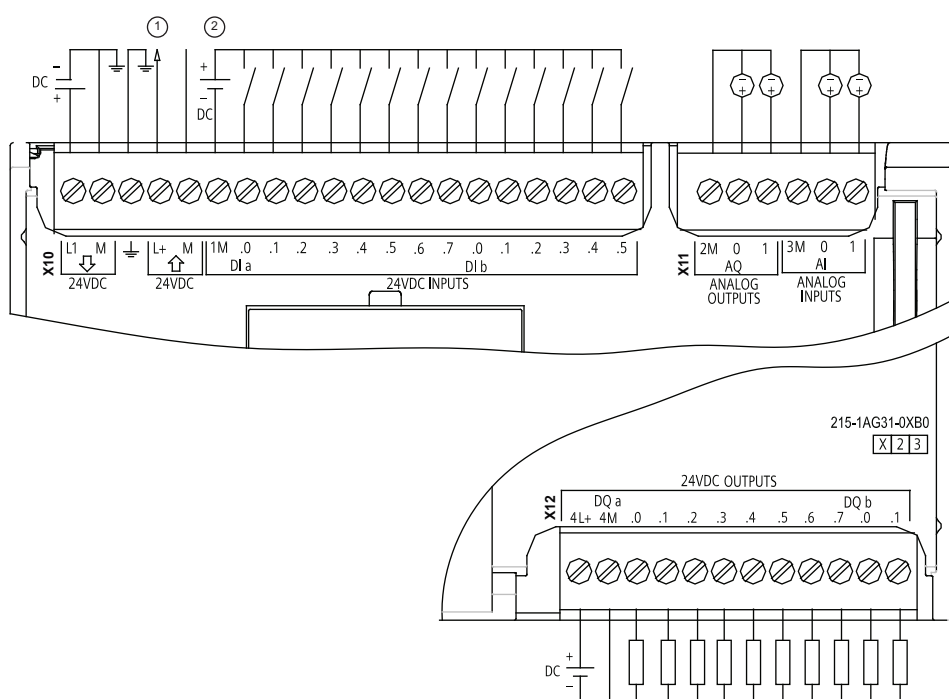
Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 78 Connector pin locations for CPU 1215C DC/DC/Relay (6ES7 215-1HG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	1L
2	M / 24VDC	AQ 0	DQ a.0
3	Functional Earth	AQ 1	DQ a.1
4	L+ / 24VDC Sensor Out	2M	DQ a.2
5	M / 24VDC Sensor Out	AI 0	DQ a.3
6	1M	AI 1	DQ a.4
7	DI a.0	--	2L
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	--

Pin	X10	X11 (gold)	X12
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--
19	DI b.4	--	--
20	DI b.5	--	--

Table A- 79 CPU 1215C DC/DC/DC (6ES7 215-1AG31-0XB0)



- ① 24 VDC Sensor Power Out  
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.
- ② For sinking inputs, connect "-" to "M" (shown). For sourcing inputs, connect "+" to "M".
- Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 80 Connector pin locations for CPU 1215C DC/DC/DC (6ES7 215-1AG31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 / 24VDC	2 M	4L+
2	M / 24VDC	AQ 0	4M
3	Functional Earth	AQ 1	DQ a.0
4	L+ / 24VDC Sensor Out	3M	DQ a.1

Pin	X10	X11 (gold)	X12
5	M / 24VDC Sensor Out	AI 0	DQ a.2
6	1M	AI 1	DQ a.3
7	DI a.0	--	DQ a.4
8	DI a.1	--	DQ a.5
9	DI a.2	--	DQ a.6
10	DI a.3	--	DQ a.7
11	DI a.4	--	DQ b.0
12	DI a.5	--	DQ b.1
13	DI a.6	--	--
14	DI a.7	--	--
15	DI b.0	--	--
16	DI b.1	--	--
17	DI b.2	--	--
18	DI b.3	--	--
19	DI b.4	--	--
20	DI b.5	--	--

#### Note

Unused analog inputs should be shorted.

## A.6 Digital signal modules (SMs)

### A.6.1 SM 1221 digital input specifications

Table A- 81 General specifications

Model	SM 1221 DI 8 x 24 VDC	SM 1221 DI 16 x 24 VDC
Order number	6ES7 221-1BF30-0XB0	6ES7 221-1BH30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75
Weight	170 grams	210 grams
Power dissipation	1.5 W	2.5 W
Current consumption (SM Bus)	105 mA	130 mA
Current consumption (24 VDC)	4 mA / input used	4 mA / input used

A.6 Digital signal modules (SMs)

Table A- 82 Digital inputs

Model	SM 1221 DI 8 x 24 VDC	SM 1221 DI 16 x 24 VDC
Number of inputs	8	16
Type	Sink/Source (IEC Type 1 sink)	Sink/Source (IEC Type 1 sink)
Rated voltage	24 VDC at 4 mA, nominal	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA	5 VDC at 1 mA
Isolation (field side to logic)	500 VAC for 1 minute	500 VAC for 1 minute
Isolation groups	2	4
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)
Number of inputs on simultaneously	8	16
Cable length (meters)	500 m shielded, 300 unshielded	500 m shielded, 300 unshielded

Table A- 83 Wiring diagrams for the digital input SMs

SM 1221 DI 8 x 24 VDC (6ES7 221-1BF30-0XB0)	SM 1221 DI 16 x 24 VDC (6ES7 221-1BH30-0XB0)

① For sinking inputs, connect "-" to "M" (shown). For sourcing inputs, connect "+" to "M".

Table A- 84 Connector pin locations for SM 1221 DI 8 x 24 VDC (6ES7 221-1BF30-0XB0)

Pin	X10	X11
1	GND	No connection
2	No connection	No connection
3	1M	2M
4	DI a.0	DI a.4
5	DI a.1	DI a.5
6	DI a.2	DI a.6
7	DI a.3	DI a.7

Table A- 85 Connector pin locations for SM 1221 DI 16 x 24 VDC (6ES7 221-1BH30-0XB0)

Pin	X10	X11	X12	X13
1	GND	No connection	No connection	No connection
2	No connection	No connection	No connection	No connection
3	1M	2M	3 M	4 M
4	DI a.0	DI a.4	DI b.0	DI b.4
5	DI a.1	DI a.5	DI b.1	DI b.5
6	DI a.2	DI a.6	DI b.2	DI b.6
7	DI a.3	DI a.7	DI b.3	DI b.7

## A.6.2 SM 1222 8-Point Digital Output Specifications

Table A- 86 General specifications

Model	SM 1222 DQ 8 x Relay	SM 1222 DQ8 RLY Changeover	SM 1222 DQ 8 x 24 VDC
Order number	6ES7 222-1HF30-0XB0	6ES7 222-1XF30-0XB0	6ES7 222-1BF30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	70 x 100 x 75	45 x 100 x 75
Weight	190 grams	310 grams	180 grams
Power dissipation	4.5 W	5 W	1.5 W
Current consumption (SM Bus)	120 mA	140 mA	120 mA
Current consumption (24 VDC)	11 mA / Relay coil used	16.7 mA/Relay coil used	11 mA / Relay coil used

Table A- 87 Digital outputs

Model	SM 1222 DQ 8 x Relay	SM 1222 DQ8 RLY Changeover	SM 1222 DQ 8 x 24 VDC
Number of outputs	8	8	8
Type	Relay, dry contact	Relay change over contact	Solid state - MOSFET (sourcing)

A.6 Digital signal modules (SMs)

Model	SM 1222 DQ 8 x Relay	SM 1222 DQ8 RLY Changeover	SM 1222 DQ 8 x 24 VDC
Voltage range	5 to 30 VDC or 5 to 250 VAC	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	--	20 VDC min.
Logic 0 signal with 10K $\Omega$ load	--	--	0.1 VDC max
Current (max.)	2.0 A	2.0 A	0.5 A
Lamp load	30 W DC/200 W AC	30 W DC/200 W AC	5W
ON state contact resistance	0.2 $\Omega$ max. when new	0.2 $\Omega$ max. when new	0.6 $\Omega$ max.
Leakage current per point	--	--	10 $\mu$ A max.
Surge current	7 A with contacts closed	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	1500 VAC for 1 minute (coil to contact)	500 VAC for 1 minute
Isolation resistance	100 M $\Omega$ min. when new	100 M $\Omega$ min. when new	--
Isolation between open contacts	750 VAC for 1 minute	750 VAC for 1 minute	--
Isolation groups	2	8	1
Current per common (max.)	10 A	2 A	4 A
Inductive clamp voltage	--	--	L+ minus 48 V, 1 W dissipation
Switching delay	10 ms max.	10 ms max	50 $\mu$ s max. off to on 200 $\mu$ s max. on to off
Maximum relay switching frequency	1 Hz	1 Hz	--
Lifetime mechanical (no load)	10,000,000 open/close cycles	10,000,000 open/close cycles	--
Lifetime contacts at rated load	100,000 open/close cycles	100,000 open/close cycles	--
Behavior on RUN to STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Number of outputs on simultaneously	8	<ul style="list-style-type: none"> <li>4 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>8 at 55° C horizontal or 45° C vertical</li> </ul>	8
Cable length (meters)	500 m shielded, 150 m unshielded	500 m shielded, 150 m unshielded	500 m shielded, 150 m unshielded



### A.6.3 SM 1222 16-Point Digital Output Specifications

Table A- 88 General specifications

Model	SM 1222 DQ 16 x Relay	SM 1222 DQ 16 x 24 VDC
Order number	6ES7 222-1HH30-0XB0	6ES7 222-1BH30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75
Weight	260 grams	220 grams
Power dissipation	8.5 W	2.5 W
Current consumption (SM Bus)	135 mA	140 mA
Current consumption (24 VDC)	11 mA / Relay coil used	-

Table A- 89 Digital outputs

Model	SM1222 DQ 16 x Relay	SM1222 DQ 16 x 24 VDC
Number of outputs	16	16
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	-	20 VDC min.
Logic 0 signal with 10K $\Omega$ load	-	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC/200 W AC	5W
ON state contact resistance	0.2 $\Omega$ max. when new	0.6 $\Omega$ max.
Leakage current per point	--	10 $\mu$ A max.
Surge current	7 A with contacts closed	8 A for 100 ms max.
Overload protection	No	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)	500 VAC for 1 minute
Isolation resistance	100 M $\Omega$ min. when new	-
Isolation between open contacts	750 VAC for 1 minute	-
Isolation groups	4	1
Current per common (max.)	10 A	8 A
Inductive clamp voltage	-	L+ minus 48 V, 1 W dissipation
Switching delay	10 ms max.	50 $\mu$ s max. off to on 200 $\mu$ s max. on to off
Maximum relay switching frequency	1 Hz	-
Lifetime mechanical (no load)	10,000,000 open/close cycles	-
Lifetime contacts at rated load	100,000 open/close cycles	-
Behavior on RUN to STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)

Model	SM1222 DQ 16 x Relay	SM1222 DQ 16 x 24 VDC
Number of outputs on simultaneously	<ul style="list-style-type: none"> <li>8 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>16 at 55° C horizontal or 45° C vertical</li> </ul>	16
Cable length (meters)	500 m shielded, 150 m unshielded	500 m shielded, 150 m unshielded

Table A- 90 Wiring diagrams for the 8-point digital output SMs

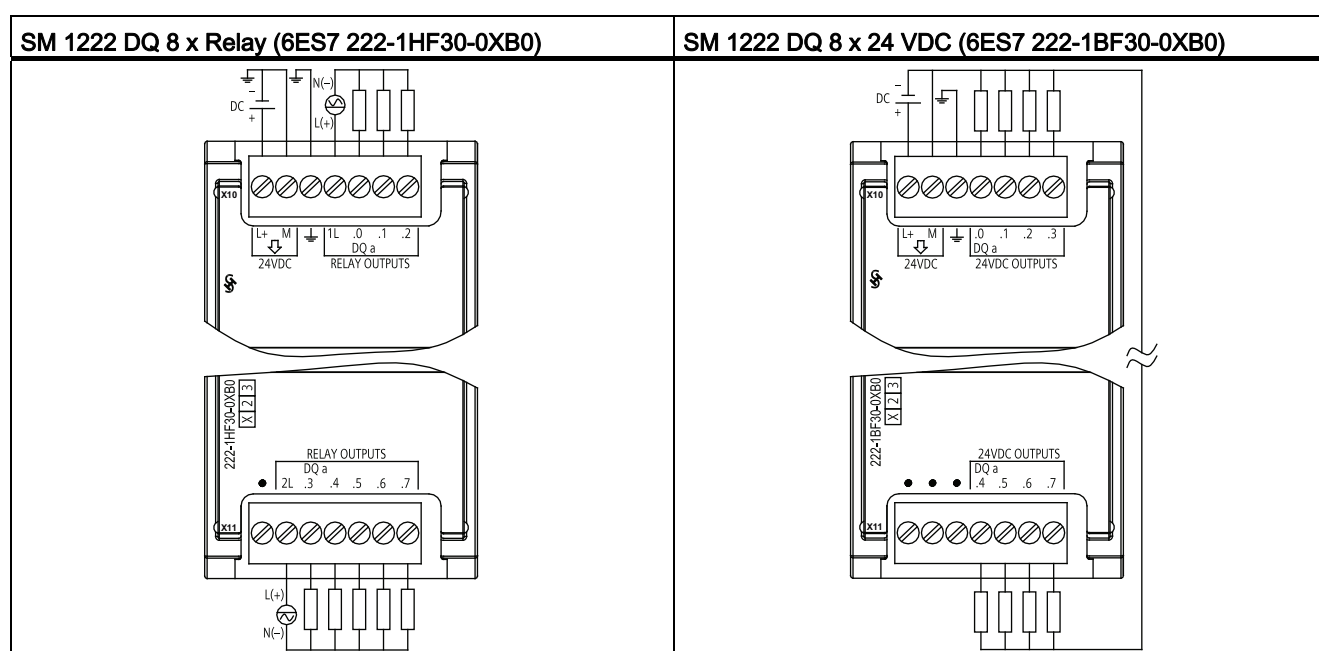


Table A- 91 Connector pin locations for SM 1222 DQ 8 x Relay (6ES7 222-1HF30-0XB0)

Pin	X10	X11
1	L+ / 24VDC	No connection
2	M / 24VDC	2L
3	Functional Earth	DQ a.3
4	1L	DQ a.4
5	DQ a.0	DQ a.5
6	DQ a.1	DQ a.6
7	DQ a.2	DQ a.7

Table A- 92 Connector pin locations for SM 1222 DQ 8 x 24 VDC (6ES7 222-1BF30-0XB0)

Pin	X10	X11
1	L+ / 24VDC	No connection
2	M / 24VDC	No connection
3	Functional Earth	No connection
4	DQ a.0	DQ a.4
5	DQ a.1	DQ a.5
6	DQ a.2	DQ a.6
7	DQ a.2	DQ a.7

Table A- 93 Wiring diagram for the 8-point digital output relay changeover SM

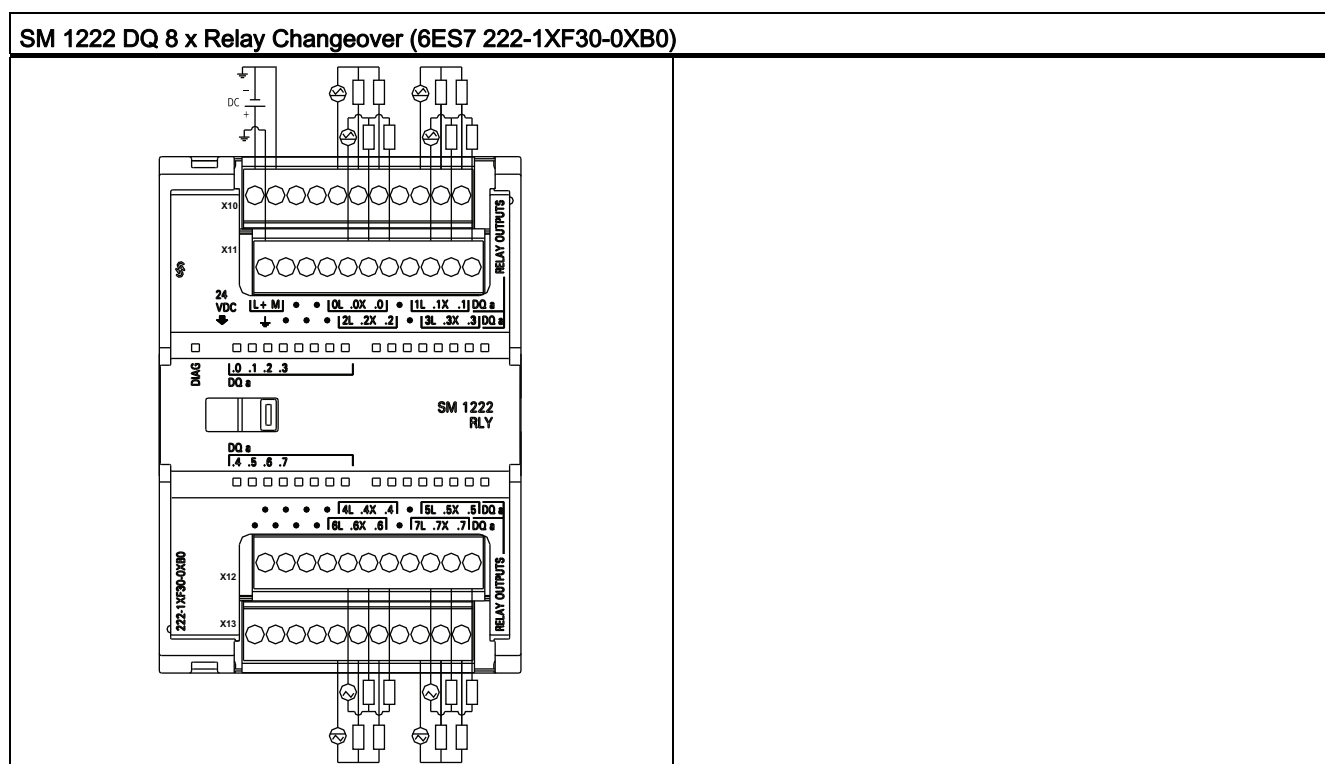


Table A- 94 Connector pin locations for SM 1222 DQ 8 x Relay Changeover (6ES7 222-1XF30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	Functional Earth	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	No connection	No connection	No connection	No connection
4	No connection	No connection	No connection	No connection
5	0L	2L	4L	6L

Pin	X10	X11	X12	X13
6	DQ a.0X	DQ a.2X	DQ a.4X	DQ a.6X
7	DQ a.0	DQ a.2	DQ a.4	DQ a.6
8	No connection	No connection	No connection	No connection
9	1L	3L	5L	7L
10	DQ a.1X	DQ a.3X	DQ a.5X	DQ a.7X
11	DQ a.1	DQ a.3	DQ a.5	DQ a.7

Table A- 95 Wiring diagrams for the 16-point digital output SMs

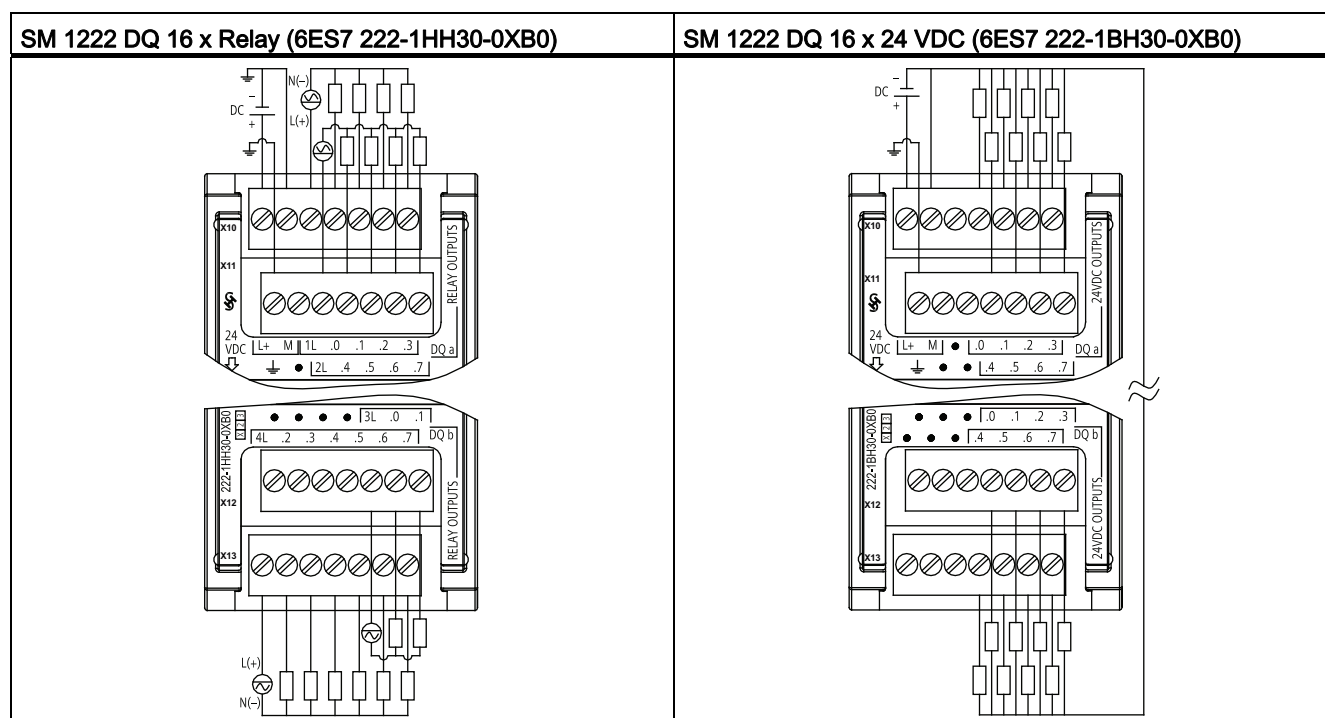


Table A- 96 Connector pin locations for SM 1222 DQ 16 x Relay (6ES7 222-1HH30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	Functional Earth	No connection	4L
2	M / 24VDC	No connection	No connection	DQ b.2
3	1L	2L	No connection	DQ b.3
4	DQ a.0	DQ a.4	No connection	DQ b.4
5	DQ a.1	DQ a.5	3L	DQ b.5
6	DQ a.2	DQ a.6	DQ b.0	DQ b.6
7	DQ a.3	DQ a.7	DQ b.1	DQ b.7

Table A- 97 Connector pin locations for SM 1222 DQ 16 x 24 VDC (6ES7 222-1BH30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	Functional Earth	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	No connection	No connection	No connection	No connection
4	DQ a.0	DQ a.4	DQ b.0	DQ b.4
5	DQ a.1	DQ a.5	DQ b.1	DQ b.5
6	DQ a.2	DQ a.6	DQ b.2	DQ b.6
7	DQ a.3	DQ a.7	DQ b.3	DQ b.7

## A.6.4 SM 1223 Digital Input/Output VDC Specifications

Table A- 98 General specifications

Model	SM 1223 DI 8 x 24 VDC, DQ 8 x Relay	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay	SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC
Order number	6ES7 223-1PH30-0XB0	6ES7 223-1PL30-0XB0	6ES7 223-1BH30-0XB0	6ES7 223-1BL30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	70 x 100 x 75	45 x 100 x 75	70 x 100 x 75
Weight	230 grams	350 grams	210 grams	310 grams
Power dissipation	5.5 W	10 W	2.5 W	4.5 W
Current consumption (SM Bus)	145 mA	180 mA	145 mA	185 mA
Current consumption (24 VDC)	4 mA / Input used 11 mA / Relay coil used		4 mA / Input used	

Table A- 99 Digital inputs

Model	SM 1223 DI 8 x 24 VDC, DQ 8 x Relay	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay	SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC
Number of inputs	8	16	8	16
Type	Sink/Source (IEC Type 1 sink)			
Rated voltage	24 VDC at 4 mA, nominal			
Continuous permissible voltage	30 VDC max.			
Surge voltage	35 VDC for 0.5 sec.			
Logic 1 signal (min.)	15 VDC at 2.5 mA			
Logic 0 signal (max.)	5 VDC at 1 mA			
Isolation (field side to logic)	500 VAC for 1 minute			
Isolation groups	2	2	2	2
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms, selectable in groups of 4			

A.6 Digital signal modules (SMs)

Model	SM 1223 DI 8 x 24 VDC, DQ 8 x Relay	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay	SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC
Number of inputs on simultaneously	8	<ul style="list-style-type: none"> <li>8 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>16 at 55° C horizontal or 45° C vertical</li> </ul>	8	16
Cable length (meters)	500 m shielded, 300 m unshielded			

Table A- 100 Digital outputs

Model	SM 1223 DI 8 x 24 VDC, DQ 8 x Relay	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay	SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC
Number of outputs	8	16	8	16
Type	Relay, dry contact		Solid state - MOSFET (sourcing)	
Voltage range	5 to 30 VDC or 5 to 250 VAC		20.4 to 28.8 VDC	
Logic 1 signal at max. current	--		20 VDC, min.	
Logic 0 signal with 10 KΩ load	--		0.1 VDC, max.	
Current (max.)	2.0 A		0.5 A	
Lamp load	30 W DC / 200 W AC		5 W	
ON state contact resistance	0.2 Ω max. when new		0.6 Ω max.	
Leakage current per point	--		10 μA max.	
Surge current	7 A with contacts closed		8 A for 100 ms max.	
Overload protection	No			
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)		500 VAC for 1 minute	
Isolation resistance	100 MΩ min. when new		--	
Isolation between open contacts	750 VAC for 1 minute		--	
Isolation groups	2	4	1	1
Current per common	10A	8 A	4 A	8 A
Inductive clamp voltage	--		L+ minus 48 V, 1 W dissipation	
Switching delay	10 ms max.		50 μs max. off to on 200 μs max. on to off	
Maximum relay switching frequency	1 Hz		--	
Lifetime mechanical (no load)	10,000,000 open/close cycles		--	
Lifetime contacts at rated load	100,000 open/close cycles		--	
Behavior on RUN to STOP	Last value or substitute value (default value 0)			

Model	SM 1223 DI 8 x 24 VDC, DQ 8 x Relay	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay	SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC
Number of outputs on simultaneously	8	<ul style="list-style-type: none"> <li>8 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>16 at 55° C horizontal or 45° C vertical</li> </ul>	8	16
Cable length (meters)	500 m shielded, 150 m unshielded			

Table A- 101 Wiring diagrams for the digital input VDC/output relay SMs

SM 1223 DI 8 x 24 VDC, DQ 8 x Relay (6ES7 223-1PH30-0XB0)	SM 1223 DI 16 x 24 VDC, DQ 16 x Relay (6ES7 223-1PL30-0XB0)	Notes
		<p>① For sinking inputs, connect "-" to "M" (shown). For sourcing inputs, connect "+" to "M".</p>

Table A- 102 Connector Pin Locations for SM 1223 DI 8 x 24 VDC, DQ 8 x Relay (6ES7 223-1PH30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	GND	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	1M	2M	1L	2L
4	DI a.0	DI a.4	DQ a.0	DQ a.4

Pin	X10	X11	X12	X13
5	DI a.1	DI a.5	DQ a.1	DQ a.5
6	DI a.2	DI a.6	DQ a.2	DQ a.6
7	DI a.3	DI a.7	DQ a.3	DQ a.7

Table A- 103 Connector Pin Locations for SM 1223 DI 16 x 24 VDC, DQ 16 x Relay (6ES7 223-1PL30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	GND	1L	3L
2	M / 24VDC	No connection	DQ a.0	DQ b.0
3	1M	2M	DQ a.1	DQ b.1
4	DI a.0	DI b.0	DQ a.2	DQ b.2
5	DI a.1	DI b.1	DQ a.3	DQ b.3
6	DI a.2	DI b.2	No connection	No connection
7	DI a.3	DI b.3	2L	4L
8	DI a.4	DI b.4	DQ a.4	DQ b.4
9	DI a.5	DI b.5	DQ a.5	DQ b.5
10	DI a.6	DI b.6	DQ a.6	DQ b.6
11	DI a.7	DI b.7	DQ a.7	DQ b.7

Table A- 104 Wiring diagrams for the digital input VDC/output SMs

SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC (6ES7 223-1BH30-0XB0)	SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC (6ES7 223-1BL30-0XB0)	Notes
		<p>① For sinking inputs, connect "-" to "M" (shown). For sourcing inputs, connect "+" to "M".</p>



Table A- 105 Connector Pin Locations for SM 1223 DI 8 x 24 VDC, DQ 8 x 24 VDC (6ES7 223-1BH30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	GND	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	1M	2M	No connection	No connection
4	DI a.0	DI a.4	DQ a.0	DQ a.4
5	DI a.1	DI a.5	DQ a.1	DQ a.5
6	DI a.2	DI a.6	DQ a.2	DQ a.6
7	DI a.3	DI a.7	DQ a.3	DQ a.7

Table A- 106 Connector Pin Locations for SM 1223 DI 16 x 24 VDC, DQ 16 x 24 VDC (6ES7 223-1BL30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	GND	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	1M	2M	No connection	No connection
4	DI a.0	DI b.0	DQ a.0	DQ b.0
5	DI a.1	DI b.1	DQ a.1	DQ b.1
6	DI a.2	DI b.2	DQ a.2	DQ b.2
7	DI a.3	DI b.3	DQ a.3	DQ b.3
8	DI a.4	DI b.4	DQ a.4	DQ b.4
9	DI a.5	DI b.5	DQ a.5	DQ b.5
10	DI a.6	DI b.6	DQ a.6	DQ b.6
11	DI a.7	DI b.7	DQ a.7	DQ b.7

## A.6.5 SM 1223 Digital Input/Output AC Specifications

Table A- 107 General specifications

Model	SM 1223 DI 8 x120/230 VAC / DQ 8 x Relay
Order number	6ES7 223-1QH30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75 mm
Weight	190 grams
Power dissipation	7.5 W
Current consumption (SM Bus)	120 mA
Current consumption (24 VDC)	11 mA per output when on

A.6 Digital signal modules (SMs)

Table A- 108 Digital inputs

Model	SM 1223 DI 8 x 120/230 VAC / DQ 8 x Relay
Number of inputs	8
Type	IEC Type 1
Rated voltage	120 VAC at 6 mA, 230 VAC at 9 mA
Continuous permissible voltage	264 VAC
Surge voltage	--
Logic 1 signal (min.)	79 VAC at 2.5 mA
Logic 0 signal (max.)	20 VAC at 1 mA
Leakage current (max.)	1 mA
Isolation (field side to logic)	1500 VAC for 1 minute
Isolation groups <sup>1</sup>	4
Input delay times	Typical: 0.2 to 12.8 ms, user selectable Maximum: -
Connection of 2 wire proximity sensor (Bero) (max.)	1 mA
Cable length	Unshielded: 300 meters Shielded: 500 meters
Number of inputs on simultaneously	8

<sup>1</sup> Channels within a group must be of the same phase.

Table A- 109 Digital outputs

Model	SM 1223 DI 8 x 120/230 VAC / DQ 8 x Relay
Number of outputs	8
Type	Relay, dry contact
Voltage range	5 to 30 VDC or 5 to 250 VAC
Logic 1 signal at max. current	--
Logic 0 signal with 10K $\Omega$ load	--
Current (max.)	2.0 A
Lamp load	30 W DC / 200 W AC
ON state contact resistance	0.2 $\Omega$ max. when new
Leakage current per point	--
Surge current	7 A with contacts closed
Overload protection	No
Isolation (field side to logic)	1500 VAC for 1 minute (coil to contact) None (coil to logic)
Isolation resistance	100 M $\Omega$ min. when new
Isolation between open contacts	750 VAC for 1 minute
Isolation groups	2
Current per common (max.)	10 A
Inductive clamp voltage	--

Model	SM 1223 DI 8 x 120/230 VAC / DQ 8 x Relay
Switching delay (max.)	10 ms
Maximum relay switching frequency	1 Hz
Lifetime mechanical (no load)	10,000,000 open/close cycles
Lifetime contacts at rated load	1000,000 open/close cycles
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Number of outputs on simultaneously	<ul style="list-style-type: none"> <li>4 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>8 at 55° C horizontal or 45° C vertical</li> </ul>
Cable length (meters)	500 m shielded, 150 m unshielded

Table A- 110 SM 1223 DI 8 x 120/230 VAC, DQ 8 x Relay (6ES7 223-1QH30-0XB0)

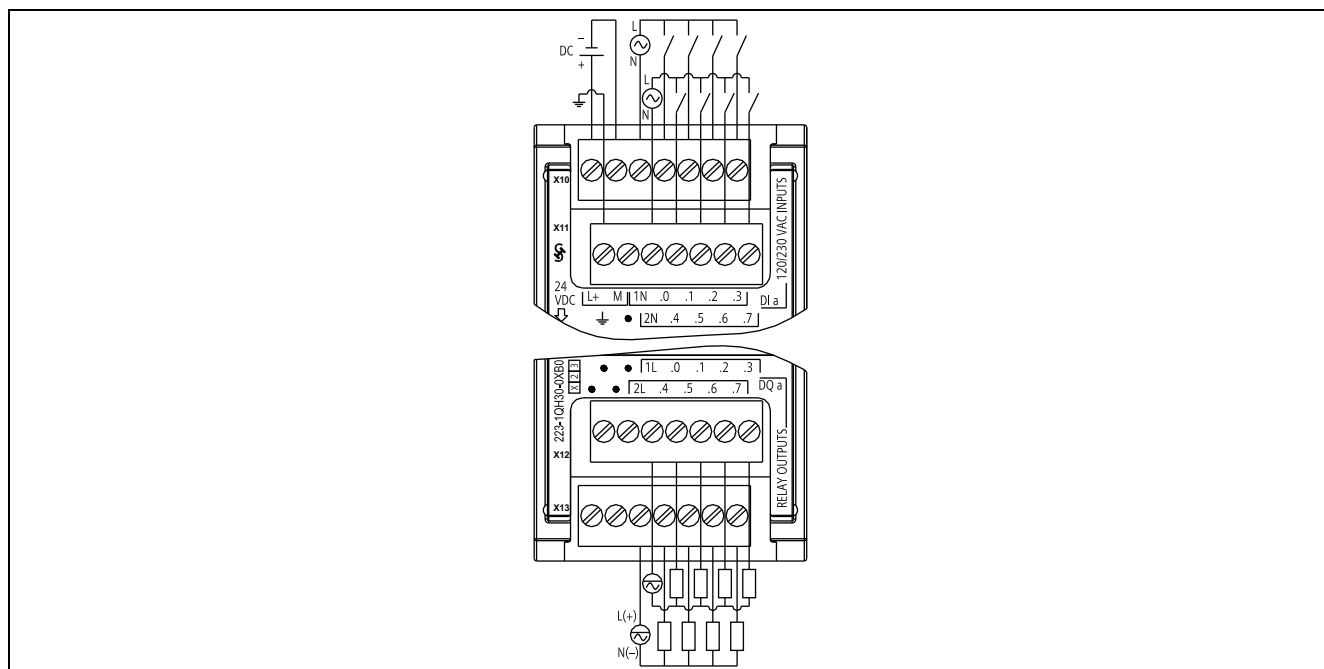


Table A- 111 Connector Pin Locations for SM 1223 DI 8 x 120/240 VAC, DQ 8 x Relay (6ES7 223-1QH30-0XB0)

Pin	X10	X11	X12	X13
1	L+ / 24VDC	GND	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	1N	2N	1L	2L
4	DI a.0	DI a.4	DQ a.0	DQ a.4
5	DI a.1	DI a.5	DQ a.1	DQ a.5
6	DI a.2	DI a.6	DQ a.2	DQ a.6
7	DI a.3	DI a.7	DQ a.3	DQ a.7

## A.7 Analog signal modules (SMs)

### A.7.1 SM 1231 analog input module specifications

Table A- 112 General specifications

Model	SM 1231 AI 4 x 13 bit	SM 1231 AI 8 x 13 bit	SM 1231 AI 4 x 16 bit
Order number	6ES7 231-4HD30-0XB0	6ES7 231-4HF30-0XB0	6ES7 231-5ND30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75	45 x 100 x 75
Weight	180 grams	180 grams	180 grams
Power dissipation	2.2 W	2.3 W	2.0 W
Current consumption (SM Bus)	80 mA	90 mA	80 mA
Current consumption (24 VDC)	45 mA	45 mA	65 mA

Table A- 113 Analog inputs

Model	SM 1231 AI 4 x 13 bit	SM 1231 AI 8 x 13 bit	SM 1231 AI 4 x 16 bit
Number of inputs	4	8	4
Type	Voltage or current (differential): Selectable in groups of 2		Voltage or current (differential)
Range	$\pm 10$ V, $\pm 5$ V, $\pm 2.5$ V, or 0 to 20 mA		$\pm 10$ V, $\pm 5$ V, $\pm 2.5$ V, $\pm 1.25$ V, 0 to 20 mA or 4 mA to 20 mA
Full scale range (data word)	-27,648 to 27,648 voltage / 0 to 27,648 current		
Overshoot/undershoot range (data word) Refer to the section on analog input ranges for voltage and current (Page 770).	Voltage: 32,511 to 27,649 / -27,649 to -32,512 Current: 32,511 to 27,649 / 0 to -4864		Voltage: 32,511 to 27,649 / -27,649 to -32,512 Current: (0-20 mA): to 32,511 to 27,649 / 0 to -4864; 4-20 mA: 32,511 to 27,649 / -1 to -4,864
Overflow/underflow (data word) Refer to the section on input ranges for voltage and current (Page 770).	Voltage: 32,767 to 32,512 / -32,513 to -32,768 Current: 32,767 to 32,512 / -4865 to -32,768		Voltage: 32,767 to 32,512 / -32,513 to -32,768 Current: 0 to 20 mA 32,767 to 32,512 / -4865 to -32,768 4-20 mA 32,767 to 32,512 / -4,865 to -32,768
Resolution <sup>1</sup>	12 bits + sign bit		15 bits + sign bit
Maximum withstand voltage/current	$\pm 35$ V / $\pm 40$ mA		
Smoothing	None, weak, medium, or strong Refer to the section on step response times (Page 769).		
Noise rejection	400, 60, 50, or 10 Hz Refer to the section on sample rates (Page 769).		

Model	SM 1231 AI 4 x 13 bit	SM 1231 AI 8 x 13 bit	SM 1231 AI 4 x 16 bit
Input impedance	$\geq 9 \text{ M}\Omega$ (voltage) / $280 \text{ }\Omega$ (current)		$\geq 1 \text{ M}\Omega$ (voltage) / $<315 \text{ }\Omega$ , $>280 \text{ }\Omega$ (current)
Isolation	None		
Field side to logic			500 VAC
Logic to 24 VDC			500 VAC
Field side to 24 VDC			500 VAC
Channel to channel			None
Accuracy (25°C / -20 to 60°C)	$\pm 0.1\%$ / $\pm 0.2\%$ of full scale		$\pm 0.1\%$ / $\pm 0.3\%$ of full scale
Measuring principle	Actual value conversion		
Common mode rejection	40 dB, DC to 60 Hz		
Operational signal range <sup>1</sup>	Signal plus common mode voltage must be less than +12 V and greater than -12 V		
Cable length (meters)	100 m, twisted and shielded		

<sup>1</sup> Voltages outside the operational range applied to one channel may cause interference on other channels.

Table A- 114 Diagnostics

Model	SM 1231 AI 4 x 13 bit	SM 1231 AI 8 x 13 bit	SM 1231 AI 4 x 16 bit
Overflow/underflow	Yes <sup>1</sup>	Yes	Yes
24 VDC low voltage	Yes	Yes	Yes
Open wire	--	--	4 to 20 mA range only (if input is below -4,164; 1.0 mA)

<sup>1</sup> For SM 1231 AI 4 x 13 bit: If a voltage greater than +30 VDC or less than -15 VDC is applied to the input, the resulting value will be unknown and the corresponding overflow or underflow may not be active.

Table A- 115 Wiring diagrams for the analog input SMs

SM 1231 AI 4 x 13 bit (6ES7 231-4HD30-0XB0)	SM 1231 AI 8 x 13 bit (6ES7 231-4HF30-0XB0)
Note: Connectors must be gold. See Appendix C, Spare Parts for order number.	

Table A- 116 Connector pin locations for SM 1231 AI 4 x 13 bit (6ES7 231-4HD30-0XB0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24VDC	No connection
2	M / 24VDC	No connection
3	GND	No connection
4	AI 0+	AI 2+
5	AI 0-	AI 2-
6	AI 1+	AI 3+
7	AI 1-	AI 3-

Table A- 117 Connector pin locations for SM 1231 AI 8 x 13 bit (6ES7 231-4HF30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	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-

Table A- 118 Wiring diagram for the analog input SM

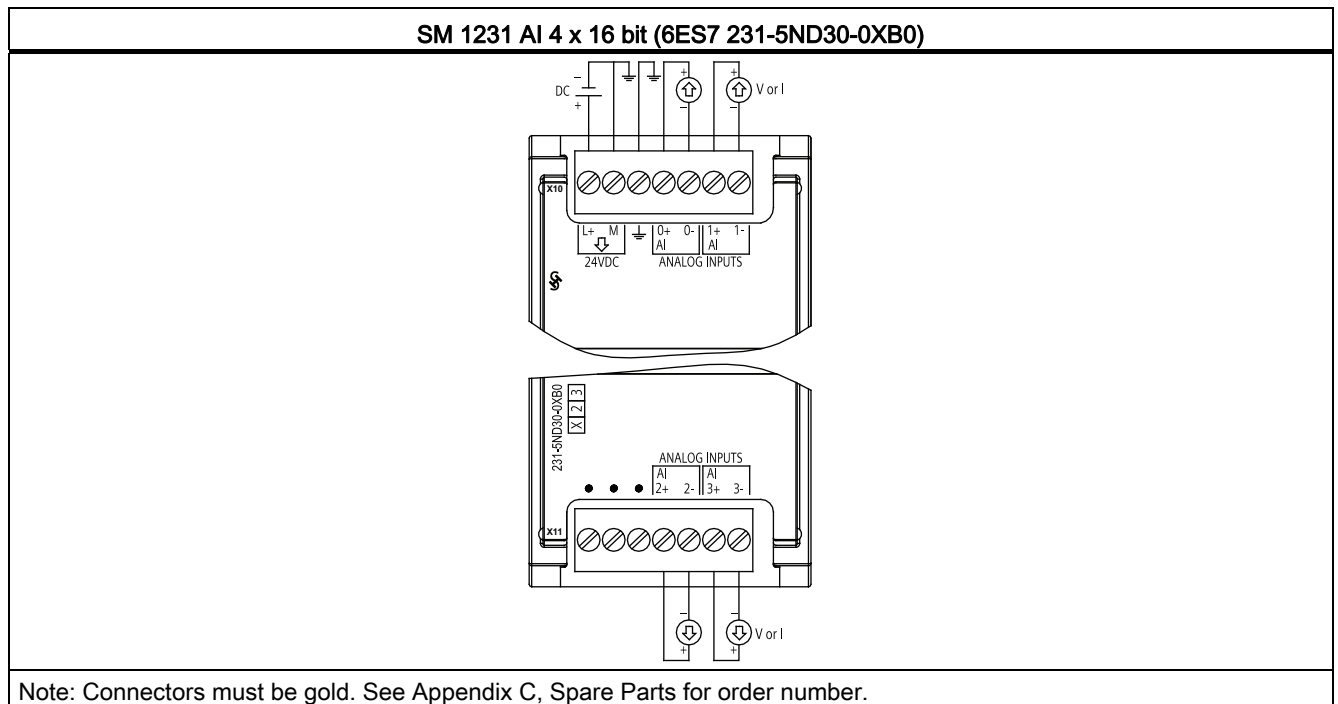


Table A- 119 Connector pin locations for SM 1231 AI 4 x 16 bit (6ES7 231-5ND30-0XB0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24VDC	No connection
2	M / 24VDC	No connection
3	GND	No connection
4	AI 0+	AI 2+
5	AI 0-	AI 2-
6	AI 1+	AI 3+
7	AI 1-	AI 3-

**Note**

Unused analog inputs should be shorted.

When the inputs are configured for "current" mode, no current will flow through the input unless you supply external power to the module.

## A.7.2 SM 1232 analog output module specifications

Table A- 120 General specifications

Technical data	SM 1232 AQ 2 x 14 bit	SM 1232 AQ 4 x 14 bit
Order number	6ES7 232-4HB30-0XB0	6ES7 232-4HD30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75
Weight	180 grams	180 grams
Power dissipation	1.8 W	2.0 W
Current consumption (SM Bus)	80 mA	80 mA
Current consumption (24 VDC)	45 mA (no load)	45 mA (no load)

Table A- 121 Analog outputs

Technical data	SM 1232 AQ 2 x 14 bit	SM 1232 AQ 4 x 14 bit
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: 14 bits Current: 13 bits	Voltage: 14 bits Current: 13 bits
Full scale range (data word)	Voltage: -27,648 to 27,648 ; Current: 0 to 27,648 Refer to the output ranges for voltage and current (Page 771).	
Accuracy (25°C / -20 to 60°C)	±0.3% / ±0.6% 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)	
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 600 Ω	
Behavior on RUN to STOP	Last value or substitute value (default value 0)	
Isolation (field side to logic)	none	
Cable length (meters)	100 m twisted and shielded	



Table A- 122 Diagnostics

Technical data	SM 1232 AQ 2 x 14 bit	SM 1232 AQ 4 x 14 bit
Overflow/underflow	Yes	Yes
Short to ground (voltage mode only)	Yes	Yes
Wire break (current mode only)	Yes	Yes
24 VDC low voltage	Yes	Yes

Table A- 123 Wiring diagrams for the analog output SMs

SM 1232 AQ 2 x 14 bit (6ES7 232-4HB30-0XB0)	SM 1232 AQ 4 x 14 bit (6ES7 232-4HD30-0XB0)
Note: Connectors must be gold. See Appendix C, Spare Parts for order number.	

Table A- 124 Connector pin locations for SM 1232 AQ 2 x 14 bit (6ES7 232-4HB30-0XB0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24VDC	No connection
2	M / 24VDC	No connection
3	GND	No connection
4	No connection	AQ 0M
5	No connection	AQ 0
6	No connection	AQ 1M
7	No connection	AQ 1

Table A- 125 Connector pin locations for SM 1232 AQ 4 x 14 bit (6ES7 232-4HD30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	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	AIQ 3

### A.7.3 SM 1234 analog input/output module specifications

Table A- 126 General specifications

Technical data	SM 1234 AI 4 x 13 bit / AQ 2 x 14 bit
Order number	6ES7 234-4HE30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75
Weight	220 grams
Power dissipation	2.4 W
Current consumption (SM Bus)	80 mA
Current consumption (24 VDC)	60 mA (no load)

Table A- 127 Analog inputs

Model	SM 1234 AI 4 x 13 bit / AQ 2 x 14 bit
Number of inputs	4
Type	Voltage or Current (differential): Selectable in groups of 2
Range	$\pm 10$ V, $\pm 5$ V, $\pm 2.5$ V, or 0 to 20 mA
Full scale range (data word)	-27,648 to 27,648
Overshoot/undershoot range (data word)	Voltage: 32,511 to 27,649 / -27,649 to -32,512 Current: 32,511 to 27,649 / 0 to -4864 Refer to the section on input ranges for voltage and current (Page 770).
Overflow/underflow (data word)	Voltage: 32,767 to 32,512 / -32,513 to -32,768 Current: 32,767 to 32,512 / -4865 to -32,768 Refer to the section on input ranges for voltage and current (Page 770).
Resolution	12 bits + sign bit
Maximum withstand voltage/current	$\pm 35$ V / $\pm 40$ mA
Smoothing	None, weak, medium, or strong Refer to the section on step response times (Page 769).
Noise rejection	400, 60, 50, or 10 Hz Refer to the section on sample rates (Page 769).

Model	SM 1234 AI 4 x 13 bit / AQ 2 x 14 bit
Input impedance	≥ 9 MΩ (voltage) / 280 Ω (current)
Isolation (field side to logic)	None
Accuracy (25 °C / -20 to 60°C)	±0.1% / ±0.2% of full scale
Analog to digital conversion time	625 μs (400 Hz rejection)
Common mode rejection	40 dB, DC to 60 Hz
Operational signal range <sup>1</sup>	Signal plus common mode voltage must be less than +12 V and greater than -12 V
Cable length (meters)	100 m, twisted and shielded

<sup>1</sup> Voltages outside the operational range applied to one channel may cause interference on other channels.

Table A- 128 Analog outputs

Technical data	SM 1234 AI 4 x 13 bit / AQ 2 x 14 bit
Number of outputs	2
Type	Voltage or current
Range	±10 V or 0 to 20 mA
Resolution	Voltage: 14 bits ; Current: 13 bits
Full scale range (data word)	Voltage: -27,648 to 27,648; Current: 0 to 27,648 Refer to the section on output ranges for voltage and current (Page 771).
Accuracy (25°C / -20 to 60°C)	±0.3% / ±0.6% of full scale
Settling time (95% of new value)	Voltage: 300 μs (R), 750 μs (1 uF) Current: 600 μs (1 mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 600 Ω
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Isolation (field side to logic)	none
Cable length (meters)	100 m twisted and shielded

Table A- 129 Diagnostics

Model	SM 1234 AI 4 x 13 bit / AQ 2 x 14 bit
Overflow/underflow	Yes <sup>1</sup>
Short to ground (voltage mode only)	Yes on outputs
Wire break (current mode only)	Yes on outputs
24 VDC low voltage	Yes

<sup>1</sup> If a voltage greater than +30 VDC or less than -15 VDC is applied to the input, the resulting value will be unknown and the corresponding overflow or underflow may not be active.

Table A- 130 Wiring diagrams for the analog input/output SM

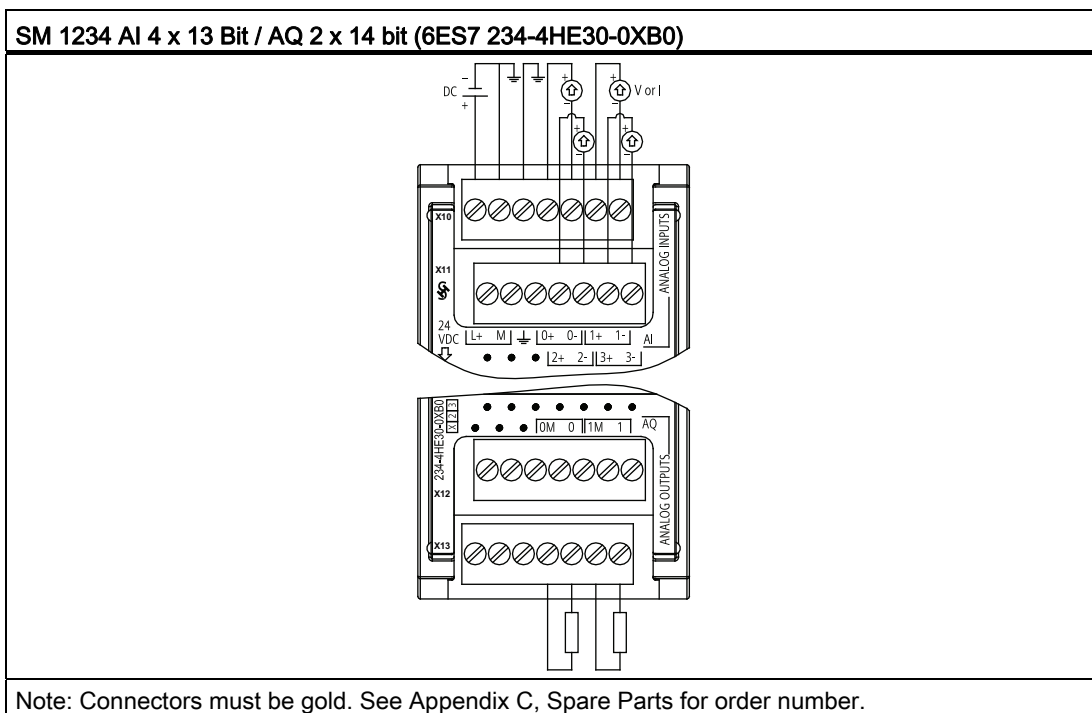


Table A- 131 Connector pin locations for SM 1234 AI 4 x 13 Bit / AQ 2 x 14 bit (6ES7 234-4HE30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	No connection	No connection	No connection
4	AI 0+	AI 2+	No connection	AQ 0M
5	AI 0-	AI 2-	No connection	AQ 0
6	AI 1+	AI 3+	No connection	AQ 1M
7	AI 1-	AI 3-	No connection	AQ 1

#### Note

Unused analog inputs should be shorted.

When the inputs are configured for "current" mode, no current will flow through the input unless you supply external power to the module.

## A.7.4 Step response of the analog inputs

Table A- 132 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
<b>Sample time</b>				
• 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
• 4 AI4 x 16 bits	• 0.417 ms	• 0.397 ms	• 0.400 ms	• 0.400 ms

## A.7.5 Sample time and update times for the analog inputs

Table A- 133 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)	<ul style="list-style-type: none"> <li>4-channel SM: 0.625 ms</li> <li>8-channel SM: 1.250 ms</li> </ul>	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.7.6 Measurement ranges of the analog inputs for voltage

Table A- 134 Analog input representation for voltage

System		Voltage Measuring Range						
Decimal	Hexadecimal	±10 V	±5 V	±2.5 V	±1.25V		0 to 10 V	
32767	7FFF	11.851 V	5.926 V	2.963 V	1.481 V	Overflow	11.851 V	Overflow
32512	7F00							
32511	7EFF	11.759 V	5.879 V	2.940 V	1.470 V	Overshoot range	11.759 V	Overshoot range
27649	6C01							
27648	6C00	10 V	5 V	2.5 V	1.250 V	Rated range	10 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V	0.938 V		7.5 V	
1	1	361.7 µV	180.8 µV	90.4 µV	45.2 µV		361.7 µV	
0	0	0 V	0 V	0 V	0 V		0 V	
-1	FFFF					Undershoot range	Negative values are not supported	
-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							
-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.470 V	Underflow		
-32513	80FF							
-32768	8000	-11.851 V	-5.926 V	-2.963 V	-1.481 V			

## A.7.7 Measurement ranges of the analog inputs for current

Table A- 135 Analog input representation for current

System		Current measuring range		
Decimal	Hexidecimal	0 mA to 20 mA	4 mA to 20 mA	
32767	7FFF	23.70 mA	22.96 mA	Overflow
32512	7F00			
32511	7EFF	23.52 mA	22.81 mA	Overshoot range
27649	6C01			
27648	6C00	20 mA	20 mA	Nominal range
20736	5100	15 mA	16 mA	
1	1	723.4 nA	4 mA + 578.7 nA	
0	0	0 mA	4 mA	
-1	FFFF			Undershoot range
-4864	ED00	-3.52 mA	1.185 mA	
-4865	ECFF			Underflow
-32768	8000			

## A.7.8 Output (AQ) measurement ranges for voltage and current (SB and SM)

Table A- 136 Analog output representation for voltage

System		Voltage Output Range	
Decimal	Hexadecimal	$\pm 10$ 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 $\mu$ V	
0	0	0 V	
-1	FFFF	-361.7 $\mu$ 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	

<sup>1</sup> In an overflow or underflow condition, analog outputs will behave according to the device configuration properties set for the analog signal module. In the "Reaction to CPU STOP" parameter, select either: Use substitute value or Keep last value.

Table A- 137 Analog output representation for current

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	

<sup>1</sup> In an overflow or underflow condition, analog outputs will behave according to the device configuration properties set for the analog signal module. In the "Reaction to CPU STOP" parameter, select either: Use substitute value or Keep last value.

## A.8 Thermocouple and RTD signal modules (SMs)

### A.8.1 SM 1231 Thermocouple

Table A- 138 General specifications

Model	SM 1231 AI 4 x 16 bit TC	SM 1231 AI 8 x 16 bit TC
Order number	6ES7 231-5QD30-0XB0	6ES7 231-5QF30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	45 x 100 x 75
Weight	180 grams	190 grams
Power dissipation	1.5 W	1.5 W
Current consumption (SM Bus)	80 mA	80 mA
Current consumption (24 VDC) <sup>1</sup>	40 mA	40 mA

<sup>1</sup> 20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from PLC)

Table A- 139 Analog inputs

Model	SM 1231 AI 4 x 16 bit TC	SM 1231 AI 8 x 16 bit TC
Number of inputs	4	8
Range	See Thermocouple selection table	See Thermocouple selection table
Nominal range (data word)	(Page 776).	(Page 776).
Overrange/underrange (data word)		
Overflow/underflow (data word)		
Resolution	0.1° C/0.1° F	0.1° C/0.1° F
Temperature		
Voltage	15 bits plus sign	15 bits plus sign
Maximum withstand voltage	± 35 V	± 35 V
Noise rejection	85 dB for selected filter setting (10 Hz, 50 Hz, 60 Hz or 400 Hz)	85 dB for selected filter setting (10 Hz, 50 Hz, 60 Hz or 400 Hz)
Common mode rejection	> 120 dB at 120 VAC	> 120 dB at 120 VAC
Impedance	≥ 10 MΩ	≥ 10 MΩ
Isolation		
Field to logic	500 VAC	500 VAC
Field to 24 VDC	500 VAC	500 VAC
24 VDC to logic	500 VAC	500 VAC
Channel to channel	120 VAC	120 VAC
Accuracy	See Thermocouple selection table (Page 776).	See Thermocouple selection table (Page 776).
Repeatability	±0.05% FS	±0.05% FS
Measuring principle	Integrating	Integrating
Module update time	See Noise reduction selection table (Page 776).	See Noise reduction selection table (Page 776).
Cold junction error	±1.5°C	±1.5°C



A.8 Thermocouple and RTD signal modules (SMs)

Model	SM 1231 AI 4 x 16 bit TC	SM 1231 AI 8 x 16 bit TC
Cable length (meters)	100 meters to sensor max.	100 meters to sensor max.
Wire resistance	100 $\Omega$ max.	100 $\Omega$ max.

Table A- 140 Diagnostics

Model	SM 1231 AI 4 x 16 bit TC	SM 1231 AI 8 x 16 bit TC
Overflow/underflow <sup>1</sup>	Yes	Yes
Wire break (current mode only) <sup>2</sup>	Yes	Yes
24 VDC low voltage <sup>1</sup>	Yes	Yes

<sup>1</sup> 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.

<sup>2</sup> When wire break alarm is disabled and an open wire condition exists in the sensor wiring, the module may report random values.

The SM 1231 Thermocouple (TC) analog signal 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.

A.8 Thermocouple and RTD signal modules (SMs)

Table A- 141 Wiring diagrams for the thermocouple SMs

SM 1231 AI 4 x TC 16 bit (6ES7 231-5QD30-0XB0)	SM 1231 AI 8 x TC bit (6ES7 231-5QF30-0XB0)
Note: Connectors must be gold. See Appendix C, Spare Parts for order number.	

① TC 2, 3, 4, and 5 not shown connected for clarity.

Table A- 142 Connector pin locations for SM 1231 AI 4 x TC 16 bit (6ES7 231-5QD30-0XB0)

Pin	X10 (gold)	X11 (gold)
1	L+ / 24VDC	No connection
2	M / 24VDC	No connection
3	GND	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

Table A- 143 Connector Pin Locations for SM 1231 AI 8 x TC bit (6ES7 231-5QF30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	No connection	No connection	No connection
4	AI 0+ /TC	AI 2+ /TC	AI 4 I- /TC	AI 6 I- /TC
5	AI 0- /TC	AI 2- /TC	AI 4 I+ /TC	AI 6 I+ /TC

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

### A.8.1.1 Basic operation for a thermocouple

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 SM 1231 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, 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.

A.8 Thermocouple and RTD signal modules (SMs)

A.8.1.2 Selection tables for the SM 1231 thermocouple

The ranges and accuracy for the different thermocouple types supported by the SM 1231 Thermocouple signal module are shown in the table below.

Table A- 144 SM 1231 Thermocouple selection table

Type	Under-range minimum <sup>1</sup>	Nominal range low limit	Nominal range high limit	Over-range maximum <sup>2</sup>	Normal range <sup>3, 4</sup> accuracy @ 25°C	Normal range <sup>1, 2</sup> accuracy -20°C to 60°C
J	-210.0°C	-150.0°C	1200.0°C	1450.0°C	±0.3°C	±0.6°C
K	-270.0°C	-200.0°C	1372.0°C	1622.0°C	±0.4°C	±1.0°C
T	-270.0°C	-200.0°C	400.0°C	540.0°C	±0.5°C	±1.0°C
E	-270.0°C	-200.0°C	1000.0°C	1200.0°C	±0.3°C	±0.6°C
R & S	-50.0°C	100.0°C	1768.0°C	2019.0°C	±1.0°C	±2.5°C
N	-270.0°C	-200.0°C	1300.0°C	1550.0°C	±1.0°C	±1.6°C
C	0.0°C	100.0°C	2315.0°C	2500.0°C	±0.7°C	±2.7°C
TXK/XK(L)	-200.0°C	-150.0°C	800.0°C	1050.0°C	±0.6°C	±1.2°C
Voltage	-32512	-27648 -80mV	27648 80mV	32511	±0.05%	±0.1%

<sup>1</sup> Thermocouple values below the under-range minimum value are reported as -32768.

<sup>2</sup> Thermocouple values above the over-range minimum value are reported as 32767.

<sup>3</sup> Internal cold junction error is ±1.5°C for all ranges. This adds to the error in this table. The module requires at least 30 minutes of warmup time to meet this specification.

<sup>4</sup> In the presence of radiated radio frequency of 970 MHz to 990 MHz, the accuracy of the SM 1231 AI 4 x 16 bit TC may be degraded.

Table A- 145 Noise reduction and update times for the SM 1231 Thermocouple

Rejection frequency selection	Integration time	4 Channel module update time (seconds)	8 Channel module update time (seconds)
400 Hz (2.5 ms)	10 ms <sup>1</sup>	0.143	0.285
60 Hz (16.6 ms)	16.67 ms	0.223	0.445
50 Hz (20 ms)	20 ms	0.263	0.525
10 Hz (100 ms)	100 ms	1.225	2.450

<sup>1</sup> To maintain module resolution and accuracy when 400 Hz rejection is selected, the integration time is 10 ms. This selection also rejects 100 Hz and 200 Hz noise.

It is recommended for measuring thermocouples that a 100 ms integration time be used. The use of smaller integration times will increase the repeatability error of the temperature readings.

#### Note

After power is applied, the module performs internal calibration for the analog-to-digital converter. During this time the module reports a value of 32767 on each channel until valid data is available on that channel. Your user program may need to allow for this initialization time. Because the configuration of the module can vary the length of the initialization time, you should verify the behavior of the module in your configuration. If required, you can include logic in your user program to accommodate the initialization time of the module.

### Representation of analog values for Thermocouple Type J

A representation of the analog values of thermocouples type J is shown in the table below.

Table A- 146 Representation of analog values of thermocouples type J

Type J in °C	Units		Type J in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1450.0	32767	7FFF	> 2642.0	32767	7FFF	Overflow
1450.0	14500	38A4	2642.0	26420	6734	Overrange
:	:	:	:	:	:	
1200.1	12001	2EE1	2192.2	21922	55A2	
1200.0	12000	2EE0	2192.0	21920	55A0	Rated range
:	:	:	:	:	:	
-150.0	-1500	FA24	-238.0	-2380	F6B4	
< -150.0	-32768	8000	< -238.0	-32768	8000	Underflow <sup>1</sup>

<sup>1</sup> Faulty wiring (for example, polarity reversal, or open inputs) or sensor error in the negative range (for example, wrong type of thermocouple) may cause the thermocouple module to signal underflow.

## A.8.2 SM 1231 RTD

### SM 1231 RTD specifications

Table A- 147 General specifications

Technical data	SM 1231 AI 4 x RTD x 16 bit	SM 1231 AI 8 x RTD x 16 bit
Order number	6ES7 231-5PD30-0XB0	6ES7 231-5PF30-0XB0
Dimensions W x H x D (mm)	45 x 100 x 75	70 x 100 x 75
Weight	220 grams	270 grams
Power dissipation	1.5 W	1.5 W
Current consumption (SM Bus)	80 mA	90 mA
Current consumption (24 VDC) <sup>1</sup>	40 mA	40 mA

<sup>1</sup> 20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from CPU)

Table A- 148 Analog inputs

Technical data	SM 1231 AI 4 x RTD x 16 bit	SM 1231 AI 8 x RTD x16 bit
Number of inputs	4	8
Type	Module referenced RTD and $\Omega$	Module referenced RTD and $\Omega$
Range	See RTD Sensor selection table	See RTD Sensor selection table
Nominal range (data word)	(Page 781).	(Page 781).
Overshoot/undershoot range (data word)		
Overflow/underflow (data word)		
Resolution		
Temperature	0.1° C/0.1° F	0.1° C/0.1° F
Resistance	15 bits plus sign	15 bits plus sign
Maximum withstand voltage	± 35 V	± 35 V
Noise rejection	85 dB for the selected noise reduction (10 Hz, 50 Hz, 60 Hz or 400 Hz)	85 dB for the selected noise reduction (10 Hz, 50 Hz, 60 Hz or 400 Hz)
Common mode rejection	> 120dB	> 120dB
Impedance	≥ 10 M $\Omega$	≥ 10 M $\Omega$
Isolation		
Field side to logic	500 VAC	500 VAC
Field to 24 VDC	500 VAC	500 VAC
24 VDC to logic	500 VAC	500 VAC
Channel to channel isolation	none	none
Accuracy	See RTD Sensor selection table (Page 781).	See RTD Sensor selection table (Page 781).
Repeatability	±0.05% FS	±0.05% FS
Maximum sensor dissipation	0.5m W	0.5m W
Measuring principle	Integrating	Integrating
Module update time	See Noise reduction selection table (Page 781).	See Noise reduction selection table (Page 781).

Technical data	SM 1231 AI 4 x RTD x 16 bit	SM 1231 AI 8 x RTD x16 bit
Cable length (meters)	100 meters to sensor max.	100 meters to sensor max.
Wire resistance	20 $\Omega$ , 2.7 $\Omega$ for 10 $\Omega$ RTD max.	20 $\Omega$ , 2.7 $\Omega$ for 10 $\Omega$ RTD max.

Table A- 149 Diagnostics

Technical data	SM 1231 AI 4 x RTD x 16 bit	SM 1231 AI 8 x RTD x16 bit
Overflow/underflow <sup>1,2</sup>	Yes	Yes
Wire break <sup>3</sup>	Yes	Yes
24 VDC low voltage <sup>1</sup>	Yes	Yes

<sup>1</sup> 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.

<sup>2</sup> For resistance ranges underflow detection is never enabled.

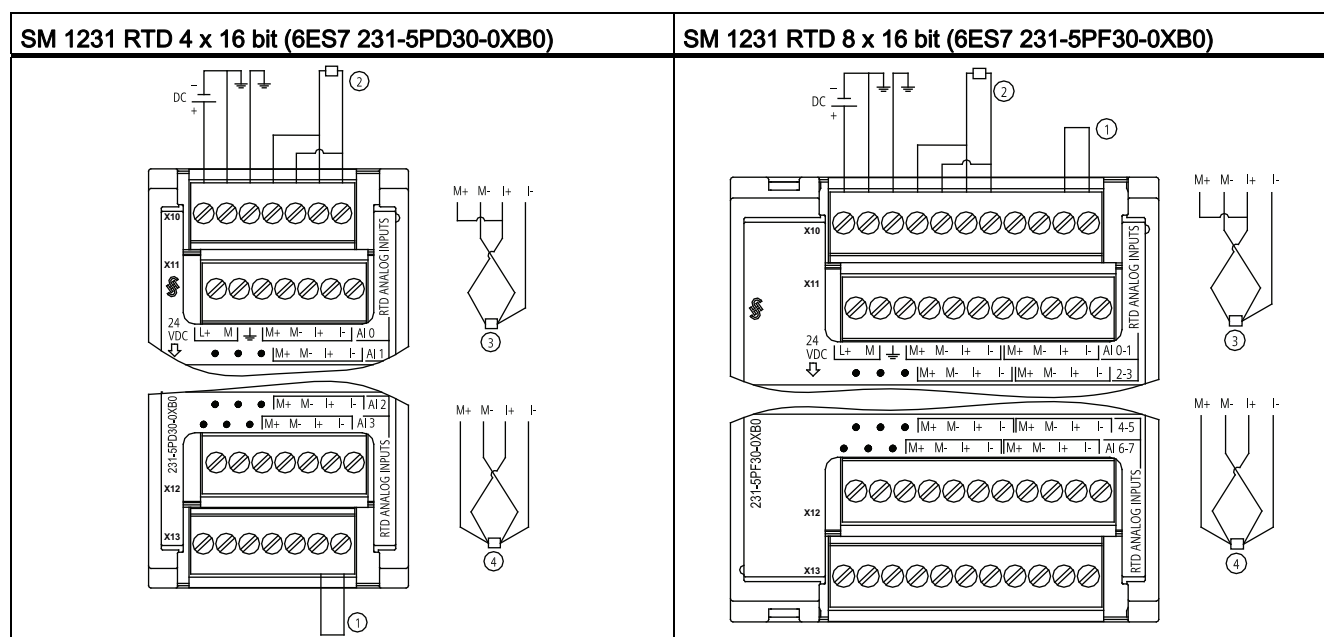
<sup>3</sup> When wire break alarm is disabled and an open wire condition exists in the sensor wiring, the module may report random values.

The SM 1231 RTD analog signal module measures the value of resistance connected to the module inputs. The measurement type can be selected as either "Resistor" or "Thermal resistor".

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

The SM 1231 RTD module supports measurements with 2-wire, 3-wire and 4-wire connections to the sensor resistor.

Table A- 150 Wiring diagrams for the RTD SMs



① Loop-back unused RTD inputs

② 2-wire RTD ③ 3-wire RTD ④ 4-wire RTD

NOTE: Note: Connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 151 Connector Pin Locations for SM 1231 RTD 4 x 16 bit (6ES7 231-5PD30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	No connection	No connection	No connection
4	AI 0 M+ /RTD	AI 1 M+ /RTD	AI 2 M+ /RTD	AI 3 M+ /RTD
5	AI 0 M- /RTD	AI 1 M- /RTD	AI 2 M- /RTD	AI 3 M- /RTD
6	AI 0 I+ /RTD	AI 1 I+ /RTD	AI 2 I+ /RTD	AI 3 I+ /RTD
7	AI 0 I- /RTD	AI 1 I- /RTD	AI 2 I- /RTD	AI 3 I- /RTD

Table A- 152 Connector Pin Locations for SM 1231 RTD 8 x 16 bit (6ES7 231-5PF30-0XB0)

Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
1	L+ / 24VDC	No connection	No connection	No connection
2	M / 24VDC	No connection	No connection	No connection
3	GND	No connection	No connection	No connection
4	AI 0 M+ /RTD	AI 2 M+ /RTD	AI 4 M+ /RTD	AI 6 M+ /RTD
5	AI 0 M- /RTD	AI 2 M- /RTD	AI 4 M- /RTD	AI 6 M- /RTD
6	AI 0 I+ /RTD	AI 2 I+ /RTD	AI 4 I+ /RTD	AI 6 I+ /RTD



Pin	X10 (gold)	X11 (gold)	X12 (gold)	X13 (gold)
7	AI 0 I- /RTD	AI 2 I- /RTD	AI 4 I- /RTD	AI 6 I- /RTD
8	AI 1 M+ /RTD	AI 3 M+ /RTD	AI 5 M+ /RTD	AI 7 M+ /RTD
9	AI 1 M- /RTD	AI 3 M- /RTD	AI 5 M- /RTD	AI 7 M- /RTD
10	AI 1 I+ /RTD	AI 3 I+ /RTD	AI 5 I+ /RTD	AI 7 I+ /RTD
11	AI 1 I- /RTD	AI 3 I- /RTD	AI 5 I- /RTD	AI 7 I- /RTD

#### Note

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

The RTD module needs to have the current loop continuous to eliminate extra stabilization time which is automatically added to an unused channel that is not deactivated. For consistency the RTD module should have a resistor connected (like the 2-wire RTD connection).

### A.8.2.1 Selection tables for the SM 1231 RTD

Table A- 153 Ranges and accuracy for the different sensors supported by the RTD modules

Temperature coefficient	RTD type	Under range minimum <sup>1</sup>	Nominal range low limit	Nominal range high limit	Over range maximum <sup>2</sup>	Normal range accuracy @ 25°C	Normal range accuracy -20°C to 60°C
Pt 0.003850 ITS90 DIN EN 60751	Pt 10	-243.0°C	-200.0°C	850.0°C	1000.0°C	±1.0°C	±2.0°C
	Pt 50	-243.0°C	-200.0°C	850.0°C	1000.0°C	±0.5°C	±1.0°C
	Pt 100						
	Pt 200						
	Pt 500						
	Pt 1000						
Pt 0.003902 Pt 0.003916 Pt 0.003920	Pt 100	-243.0°C	-200.0°C	850.0°C	1000.0°C	± 0.5°C	±1.0°C
	Pt 200	-243.0°C	-200.0°C	850.0°C	1000.0°C	± 0.5°C	±1.0°C
	Pt 500						
	Pt 1000						
Pt 0.003910	Pt 10	-273.2°C	-240.0°C	1100.0°C	1295°C	±1.0°C	±2.0°C
	Pt 50	-273.2°C	-240.0°C	1100.0°C	1295°C	±0.8°C	±1.6°C
	Pt 100						
	Pt 500						
Ni 0.006720 Ni 0.006180	Ni 100	-105.0°C	-60.0°C	250.0°C	295.0°C	±0.5°C	±1.0°C
	Ni 120						
	Ni 200						
	Ni 500						

A.8 Thermocouple and RTD signal modules (SMs)

Temperature coefficient	RTD type	Under range minimum <sup>1</sup>	Nominal range low limit	Nominal range high limit	Over range maximum <sup>2</sup>	Normal range accuracy @ 25°C	Normal range accuracy -20°C to 60°C
	Ni 1000						
LG-Ni 0.005000	LG-Ni 1000	-105.0°C	-60.0°C	250.0°C	295.0°C	±0.5°C	±1.0°C
Ni 0.006170	Ni 100	-105.0°C	-60.0°C	180.0°C	212.4°C	±0.5°C	±1.0°C
Cu 0.004270	Cu 10	-240.0°C	-200.0°C	260.0°C	312.0°C	±1.0°C	±2.0°C
Cu 0.004260	Cu 10	-60.0°C	-50.0°C	200.0°C	240.0°C	±1.0°C	±2.0°C
	Cu 50	-60.0°C	-50.0°C	200.0°C	240.0°C	±0.6°C	±1.2°C
	Cu 100						
Cu 0.004280	Cu 10	-240.0°C	-200.0°C	200.0°C	240.0°C	±1.0°C	±2.0°C
	Cu 50	-240.0°C	-200.0°C	200.0°C	240.0°C	±0.7°C	±1.4°C
	Cu 100						

<sup>1</sup> RTD values below the under-range minimum value report -32768.

<sup>2</sup> RTD values above the over-range maximum value report +32767.

Table A- 154 Resistance

Range	Under range minimum	Nominal range low limit	Nominal range high limit	Over range maximum <sup>1</sup>	Normal range accuracy @ 25°C	Normal range accuracy -20°C to 60°C
150 Ω	n/a	0 (0 Ω)	27648 (150 Ω)	176.383 Ω	±0.05%	±0.1%
300 Ω	n/a	0 (0 Ω)	27648 (300 Ω)	352.767 Ω	±0.05%	±0.1%
600 Ω	n/a	0 (0 Ω)	27648 (600 Ω)	705.534 Ω	±0.05%	±0.1%

<sup>1</sup> Resistance values above the over-range minimum value are reported as +32767.

**Note**

The module reports 32767 on any activated channel with no sensor connected. If open wire detection is also enabled, the module flashes the appropriate red LEDs.

When 500 Ω and 1000 Ω RTD ranges are used with other lower value resistors, the error may increase to two times the specified error.

Best accuracy will be achieved for the 10 Ω RTD ranges if 4 wire connections are used.

The resistance of the connection wires in 2 wire mode will cause an error in the sensor reading and therefore accuracy is not guaranteed.

Table A- 155 Noise reduction and update times for the RTD modules

Rejection frequency selection	Integration time	Update time (seconds)	
		4-channel module	8-channel module
400 Hz (2.5 ms)	10 ms <sup>1</sup>	4-/2-wire: 0.142 3-wire: 0.285	4-/2-wire: 0.285 3-wire: 0.525
60 Hz (16.6 ms)	16.67 ms	4-/2-wire: 0.222 3-wire: 0.445	4-/2-wire: 0.445 3-wire: 0.845
50 Hz (20 ms)	20 ms	4-/2-wire: 0.262 3-wire: .505	4-/2-wire: 0.524 3-wire: 1.015
10 Hz (100 ms)	100 ms	4-/2-wire: 1.222 3-wire: 2.445	4-/2-wire: 2.425 3-wire: 4.845

<sup>1</sup> To maintain module resolution and accuracy when the 400 Hz filter is selected, the integration time is 10 ms. This selection also rejects 100 Hz and 200 Hz noise.

**NOTICE**

After power is applied, the module performs internal calibration for the analog-to-digital converter. During this time the module reports a value of 32767 on each channel until valid data is available on that channel. Your user program may need to allow for this initialization time. Because the configuration of the module can vary the length of the initialization time, you should verify the behavior of the module in your configuration. If required, you can include logic in your user program to accommodate the initialization time of the module.

**Representation of Analog values for RTDs**

A representation of the digitized measured value for the RTD standard temperature range sensors are shown in the tables below.

Table A- 156 Representation of analog values for resistance thermometers PT 100, 200, 500, 1000 and PT 10, 50, 100, 500 GOST (0.003850) standard

Pt x00 standard in °C (1 digit = 0.1° C)	Units		Pt x00 standard in °F (1 digit = 0.1 F)	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1000.0	32767	7FFF	> 1832.0	32767	7FFF	Overflow
1000.0	10000	2710	1832.0	18320	4790	Overrange
:	:	:	:	:	:	
850.1	8501	2135	1562.1	15621	3D05	Rated range
850.0	8500	2134	1562.0	15620	3D04	
:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	

Pt x00 standard in °C (1 digit = 0.1° C)	Units		Pt x00 standard in °F (1 digit = 0.1 F)	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
-200.1 : -243.0	-2001 : -2430	F82F : F682	-328.1 : -405.4	-3281 : -4054	F32F : F02A	Underrange
< -243.0	-32768	8000	< -405.4	-32768	8000	Underflow

## A.9 Digital signal boards (SBs)

### A.9.1 SB 1221 200 kHz digital input specifications

Table A- 157 General specifications

Technical data	SB 1221 DI 4 x 24 VDC, 200 kHz	SB 1221 DI 4 x 5 VDC, 200 kHz
Order number	6ES7 221-3BD30-0XB0	6ES7 221-3AD30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21	38 x 62 x 21
Weight	35 grams	35 grams
Power dissipation	1.5 W	1.0 W
Current consumption (SM Bus)	40 mA	40 mA
Current consumption (24 VDC)	7 mA / input + 20 mA	15 mA / input + 15 mA

Table A- 158 Digital inputs

Technical data	SB 1221 DI 4 x 24 VDC, 200 kHz	SB 1221 DI 4 x 5 VDC, 200 kHz
Number of inputs	4	4
Type	Source	Source
Rated voltage	24 VDC at 7 mA, nominal	5 VDC at 15 mA, nominal
Continuous permissible voltage	28.8 VDC	6 VDC
Surge voltage	35 VDC for 0.5 sec.	6 V
Logic 1 signal (min.)	L+ minus 10 VDC at 2.9 mA	L+ minus 2.0 VDC at 5.1 mA
Logic 0 signal (max.)	L+ minus 5 VDC at 1.4 mA	L+ minus 1.0 VDC at 2.2 mA
HSC clock input rates (max.)	Single phase: 200 kHz Quadrature phase: 160 kHz	Single phase: 200 kHz Quadrature phase: 160 kHz
Isolation (field side to logic)	500 VAC for 1 minute	500 VAC for 1 minute
Isolation groups	1	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms; Selectable in groups of 4	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms; Selectable in groups of 4

Technical data	SB 1221 DI 4 x 24 VDC, 200 kHz	SB 1221 DI 4 x 5 VDC, 200 kHz
Number of inputs on simultaneously	<ul style="list-style-type: none"> <li>2 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>4 at 55° C horizontal or 45° C vertical</li> </ul>	4
Cable length (meters)	50 shielded twisted pair	50 shielded twisted pair

#### NOTICE

When switching frequencies above 20 kHz, it is important that the digital inputs receive a square wave. Consider the following options to improve the signal quality to the inputs:

- Minimize the cable length
- Change a driver from a sink only driver to a sinking and sourcing driver
- Change to a higher quality cable
- Reduce the circuit/components from 24 V to 5 V
- Add an external load at the input

Table A- 159 Wiring diagrams for the 200 kHz digital input SBs

SB 1221 DI 4 x 24 VDC, 200 kHz (6ES7 221-3BD30-0XB0)	SB 1221 DI 4 x 5 VDC, 200 kHz (6ES7 221-3AD30-0XB0)

① Supports sourcing inputs only

Table A- 160 Connector pin locations for SB 1221 DI 4 x 24 VDC, 200 kHz (6ES7 221-3BD30-0XB0)

Pin	X19
1	L+ / 24VDC
2	M / 24VDC
3	DI e.0
4	DI e.1
5	DI e.2
6	DI e.3

Table A- 161 Connector pin locations for SB 1221 DI 4 x 5 VDC, 200 kHz (6ES7 221-3AD30-0XB0)

Pin	X19
1	L+ / 5VDC
2	M / 5VDC
3	DI e.0
4	DI e.1
5	DI e.2
6	DI e.3

## A.9.2 SB 1222 200 kHz digital output specifications

Table A- 162 General specifications

Technical data	SB 1222 DQ 4 x 24 VDC, 200 kHz	SB 1222 DQ 4 x 5 VDC, 200 kHz
Order number	6ES7 222-1BD30-0XB0	6ES7 222-1AD30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21	38 x 62 x 21
Weight	35 grams	35 grams
Power dissipation	0.5 W	0.5 W
Current consumption (SM Bus)	35 mA	35 mA
Current consumption (24 VDC)	15 mA	15 mA

Table A- 163 Digital outputs

Technical data	SB 1222 DQ 4 x 24 VDC, 200 kHz	SB 1222 DQ 4 x 5 VDC, 200 kHz
Number of outputs	4	4
Output type	Solid state - MOSFET sink and source <sup>1</sup>	Solid state - MOSFET sink and source <sup>1</sup>
Voltage range	20.4 to 28.8 VDC	4.25 to 6.0 VDC
Logic 1 signal at max. current	L+ minus 1.5 V	L+ minus 0.7 V
Logic 0 signal at max. current	1.0 VDC, max.	0.2 VDC, max.
Current (max.)	0.1 A	0.1 A

Technical data	SB 1222 DQ 4 x 24 VDC, 200 kHz	SB 1222 DQ 4 x 5 VDC, 200 kHz
Lamp load	--	--
On state contact resistance	11 $\Omega$ max.	7 $\Omega$ max.
Off state resistance	6 $\Omega$ max.	0.2 $\Omega$ max.
Leakage current per point	--	--
Pulse Train Output rate	200 kHz max., 2 Hz min.	200 kHz max., 2 Hz min.
Surge current	0.11 A	0.11 A
Overload protection	No	No
Isolation (field side to logic)	500 VAC for 1 minute	500 VAC for 1 minute
Isolation groups	1	1
Currents per common	0.4 A	0.4 A
Inductive clamp voltage	None	None
Switching delay	1.5 $\mu$ s + 300 ns rise 1.5 $\mu$ s + 300 ns fall	200 ns + 300 ns rise 200 ns + 300 ns fall
Behavior on RUN to STOP	Last value or substitute value (default value 0)	Last value or substitute value (default value 0)
Number of outputs on simultaneously	<ul style="list-style-type: none"> <li>2 (no adjacent points) at 60° C horizontal or 50° C vertical</li> <li>4 at 55° C horizontal or 45° C vertical</li> </ul>	4
Cable length (meters)	50 shielded twisted pair	50 shielded twisted pair

- <sup>1</sup> Because both sinking and sourcing configurations are supported by the same circuitry, the active state of a sourcing load is opposite that of a sinking load. A source output exhibits positive logic (Q bit and LED are ON when the load has current flow), while a sink output exhibits negative logic (Q bit and LED are OFF when the load has current flow). If the module is plugged in with no user program, the default for this module is 0 V, which means that a sinking load will be turned ON.

#### NOTICE

When switching frequencies above 20 kHz, it is important that the digital inputs receive a square wave. Consider the following options to improve the signal quality to the inputs:

- Minimize the cable length
- Change a driver from a sink only driver to a sinking and sourcing driver
- Change to a higher quality cable
- Reduce the circuit/components from 24 V to 5 V
- Add an external load at the input

Table A- 164 Wiring diagrams for the 200 kHz digital output SBs

SB 1222 DQ 4 x 24 VDC, 200 kHz (6ES7 222-1BD30-0XB0)	SB 1222 DQ 4 x 5 VDC, 200 kHz (6ES7 222-1AD30-0XB0)

① For sourcing outputs, connect "Load" to "-" (shown). For sinking outputs, connect "Load" to "+". Because both sinking and sourcing configurations are supported by the same circuitry, the active state of a sourcing load is opposite that of a sinking load. A source output exhibits positive logic (Q bit and LED are ON when the load has current flow), while a sink output exhibits negative logic (Q bit and LED are OFF when the load has current flow). If the module is plugged in with no user program, the default for this module is 0 V, which means that a sinking load will be turned ON.

Table A- 165 Connector pin locations for SB 1222 DQ 4 x 24 VDC, 200 kHz (6ES7 222-1BD30-0XB0)

Pin	X19
1	L+ / 24VDC
2	M / 24VDC
3	DQ e.0
4	DQ e.1
5	DQ e.2
6	DQ e.3

Table A- 166 Connector pin locations for SB 1222 DQ 4 x 5 VDC, 200 kHz (6ES7 222-1AD30-0XB0)

Pin	X19
1	L+ / 5VDC
2	M / 5VDC
3	DQ e.0
4	DQ e.1
5	DQ e.2
6	DQ e.3



### A.9.3 SB 1223 200 kHz digital input / output specifications

Table A- 167 General specifications

Technical data	SB 1223 DI 2 x 24 VDC / DQ 2 x 24 VDC, 200 kHz	SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz
Order number	6ES7 223-3BD30-0XB0	6ES7 223-3AD30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21	38 x 62 x 21
Weight	35 grams	35 grams
Power dissipation	1.0 W	0.5 W
Current consumption (SM Bus)	35 mA	35 mA
Current consumption (24 VDC)	7 mA / Input + 30 mA	15 mA / input + 15 mA

Table A- 168 Digital inputs

Technical data	SB 1223 DI 2 x 24 VDC / DQ 2 x 24 VDC, 200 kHz	SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz
Number of inputs	2	2
Type	Source	Source
Rated voltage	24 VDC at 7 mA, nominal	5 VDC at 15 mA, nominal
Continuous permissible voltage	28.8 VDC	6 VDC
Surge voltage	35 VDC for 0.5 sec.	6 V
Logic 1 signal (min.)	L+ minus 10 VDC at 2.9 mA	L+ minus 2.0 VDC at 5.1 mA
Logic 0 signal (max.)	L+ minus 5 VDC at 1.4 mA	L+ minus 1.0 VDC at 2.2 mA
HSC clock input rates (max.)	Single phase: 200 kHz Quadrature phase: 160 kHz	Single phase: 200 kHz Quadrature phase: 160 kHz
Isolation (field side to logic)	500 VAC for 1 minute	500 VAC for 1 minute
Isolation groups	1 (no isolation to outputs)	1 (no isolation to outputs)
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms; Selectable in groups of 4	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms; Selectable in groups of 4
Number of inputs on simultaneously	2	2
Cable length (meters)	50 shielded twisted pair	50 shielded twisted pair

Table A- 169 Digital outputs

Technical data	SB 1223 DI 2 x 24 VDC / DQ 2 x 24 VDC, 200 kHz	SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz
Number of outputs	2	2
Output type	Solid state - MOSFET sink and source <sup>1</sup>	Solid state - MOSFET sink and source <sup>1</sup>
Voltage range	20.4 to 28.8 VDC	4.25 to 6.0 VDC
Rated value	24 VDC	5 VDC
Logic 1 signal at max. current	L+ minus 1.5 V	L+ minus 0.7 V
Logic 0 signal at max. current	1.0 VDC, max.	0.2 VDC, max.

Technical data	SB 1223 DI 2 x 24 VDC / DQ 2 x 24 VDC, 200 kHz	SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz
Current (max.)	0.1 A	0.1 A
Lamp load	--	--
On state contact resistance	11 $\Omega$ max.	7 $\Omega$ max.
Off state resistance	6 $\Omega$ max.	0.2 $\Omega$ max.
Leakage current per point	--	--
Pulse Train Output rate	200 kHz max., 2 Hz min.	200 kHz max., 2 Hz min.
Surge current	0.11 A	0.11 A
Overload protection	No	No
Isolation (field side to logic)	500 VAC for 1 minute	500 VAC for 1 minute
Isolation groups	1 (no isolation to inputs)	1 (no isolation to inputs)
Currents per common	0.2 A	0.2 A
Inductive clamp voltage	None	None
Switching delay	1.5 $\mu$ s + 300 ns rise 1.5 $\mu$ s + 300 ns fall	200 ns + 300 ns rise 200 ns + 300 ns fall
Behavior on RUN to STOP	Last value or substitute (default value 0)	Last value or substitute (default value 0)
Number of outputs on simultaneously	2	2
Cable length (meters)	50 shielded twisted pair	50 shielded twisted pair

- <sup>1</sup> Because both sinking and sourcing configurations are supported by the same circuitry, the active state of a sourcing load is opposite that of a sinking load. A source output exhibits positive logic (Q bit and LED are ON when the load has current flow), while a sink output exhibits negative logic (Q bit and LED are OFF when the load has current flow). If the module is plugged in with no user program, the default for this module is 0 V, which means that a sinking load will be turned ON.

#### NOTICE

When switching frequencies above 20 kHz, it is important that the digital inputs receive a square wave. Consider the following options to improve the signal quality to the inputs:

- Minimize the cable length
- Change a driver from a sink only driver to a sinking and sourcing driver
- Change to a higher quality cable
- Reduce the circuit/components from 24 V to 5 V
- Add an external load at the input

Table A- 170 Wiring diagrams for the 200 kHz digital input/output SBs

SB 1223 DI 2 x 24 VDC/DQ 2 x 24 VDC, 200 kHz (6ES7 223-3BD30-0XB0)	SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz (6ES7 223-3AD30-0XB0)

① Supports sourcing inputs only

② For sourcing outputs, connect "Load" to "-" (shown). For sinking outputs, connect "Load" to "+".<sup>1</sup> Because both sinking and sourcing configurations are supported by the same circuitry, the active state of a sourcing load is opposite that of a sinking load. A source output exhibits positive logic (Q bit and LED are ON when the load has current flow), while a sink output exhibits negative logic (Q bit and LED are OFF when the load has current flow). If the module is plugged in with no user program, the default for this module is 0 V, which means that a sinking load will be turned ON.

Table A- 171 Connector pin locations for SB 1223 DI 2 x 24 VDC/DQ 2 x 24 VDC, 200 kHz (6ES7 223-3BD30-0XB0)

Pin	X19
1	L+ / 24VDC
2	M / 24VDC
3	DI e.0
4	DI e.1
5	DQ e.0
6	DQ e.1

Table A- 172 Connector pin locations for SB 1223 DI 2 x 5 VDC / DQ 2 x 5 VDC, 200 kHz (6ES7 223-3AD30-0XB0)

Pin	X19
1	L+ / 5VDC
2	M / 5VDC
3	DI e.0
4	DI e.1

Pin	X19
5	DQ e.0
6	DQ e.1

#### A.9.4 SB 1223 2 X 24 VDC input / 2 X 24 VDC output specifications

Table A- 173 General specifications

Technical Data	SB 1223 DI 2 x 24 VDC, DQ 2 x 24 VDC
Order number	6ES7 223-0BD30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21
Weight	40 grams
Power dissipation	1.0 W
Current consumption (SM Bus)	50 mA
Current consumption (24 VDC)	4 mA / Input used

Table A- 174 Digital inputs

Technical Data	SB 1223 DI 2 x 24 VDC, DQ 2 x 24 VDC
Number of inputs	2
Type	IEC Type 1 sink
Rated voltage	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA
HSC clock input rates (max.)	20 kHz (15 to 30 VDC) 30 kHz (15 to 26 VDC)
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms Selectable in groups of 2
Number of inputs on simultaneously	2
Cable length (meters)	500 shielded, 300 unshielded

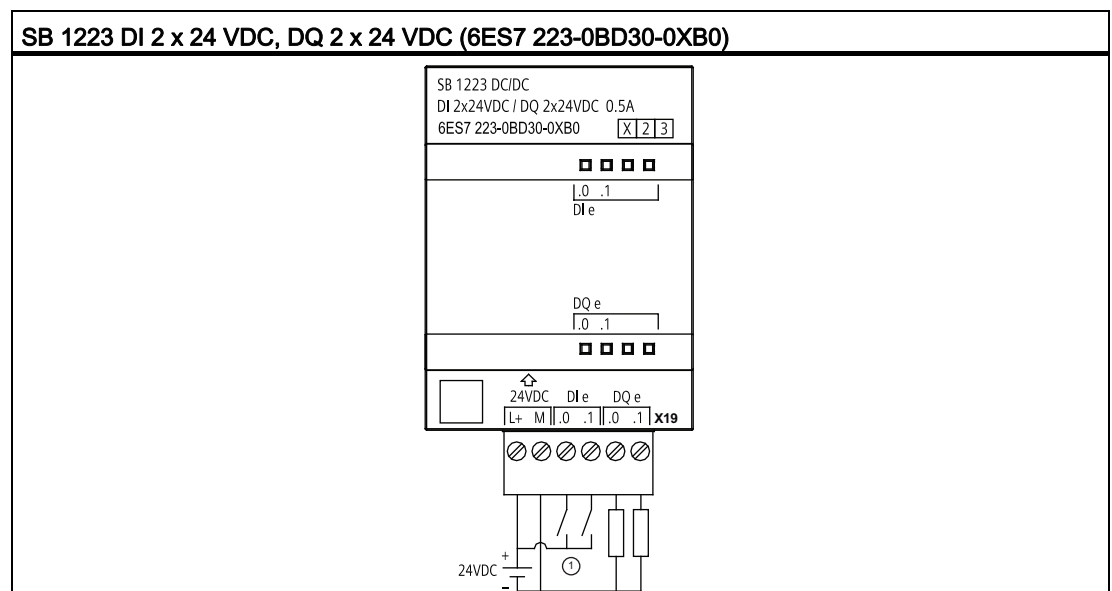
Table A- 175 Digital outputs

Technical Data	SB 1223 DI 2 x 24 VDC, DQ 2 x 24 VDC
Number of outputs	2
Output type	Solid state - MOSFET (sourcing)

Technical Data	SB 1223 DI 2 x 24 VDC, DQ 2 x 24 VDC
Voltage range	20.4 to 28.8 VDC
Logic 1 signal at max. current	20 VDC min.
Logic 0 signal with 10K $\Omega$ load	0.1 VDC max.
Current (max.)	0.5 A
Lamp load	5 W
On state contact resistance	0.6 $\Omega$ max.
Leakage current per point	10 $\mu$ A max.
Pulse Train Output (PTO) rate	20 KHz max., 2 Hz min. <sup>1</sup>
Surge current	5 A for 100 ms max.
Overload protection	No
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Currents per common	1 A
Inductive clamp voltage	L+ minus 48 V, 1 W dissipation
Switching delay	2 $\mu$ s max. off to on 10 $\mu$ s max. on to off
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Number of outputs on simultaneously	2
Cable length (meters)	500 m shielded, 150 m unshielded

<sup>1</sup> Depending on your pulse receiver and cable, an additional load resistor (at least 10% of rated current) may improve pulse signal quality and noise immunity.

Table A- 176 Wiring diagram for the digital input/output SB



① Supports sinking inputs only

## A.10 Analog signal boards (SBs)

Table A- 177 Connector pin locations for SB 1223 DI 2 x 24 VDC, DQ 2 x 24 VDC (6ES7 223-0BD30-0XB0)

Pin	X19
1	L+ / 24VDC
2	M / 24VDC
3	DI e.0
4	DI e.1
5	DQ e.0
6	DQ e.1

## A.10 Analog signal boards (SBs)

### A.10.1 SB 1231 1 analog input specifications

#### Note

To use this SB, your CPU firmware must be V2.0 or higher.

Table A- 178 General specifications

Technical data	SB 1231 AI 1 x 12 bit
Order number	6ES7 231-4HA30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21
Weight	35 grams
Power dissipation	0.4 W
Current consumption (SM Bus)	55 mA
Current consumption (24 VDC)	none

Table A- 179 Analog inputs

Technical data	SB 1231 AI 1x12 bit
Number of inputs	1
Type	Voltage or current (differential)
Range	±10V, ±5V, ±2.5 or 0 to 20 mA
Resolution	11 bits + sign bit
Full scale range (data word)	-27,648 to 27,648

Technical data	SB 1231 AI 1x12 bit
Over/Under range (data word)	Voltage: 32,511 to 27,649 / -27,649 to -32,512 Current: 32,511 to 27,649 / 0 to -4,864 (Refer to Analog input representation for voltage and Analog input representation for current.)
Overflow/Underflow (data word)	Voltage: 32,767 to 32,512 / -32,513 to -32,768 Current: 32,767 to 32,512 / -4,865 to -32,768 (Refer to Analog input representation for voltage and Analog input representation for current.)
Maximum withstand voltage / current	±35V / ±40 mA
Smoothing	None, weak, medium, or strong (refer to Analog input response times for step response time.)
Noise rejection	400, 60, 50, or 10 Hz (refer to Analog input response times for sample rates.)
Accuracy (25°C / -20 to 60°C)	±0.3% / ±0.6% of full scale
Input impedance	
Differential	Voltage: 220 kΩ; Current: 250 Ω
Common mode	Voltage: 55 kΩ; Current: 55 kΩ
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Measuring principle	Actual value conversion
Common mode rejection	400 dB, DC to 60 Hz
Operational signal range	Signal plus common mode voltage must be less than +35 V and greater than -35 V
Isolation (field side to logic)	None
Cable length (meters)	100 m, twisted and shielded

Table A- 180 Diagnostics

Technical data	SB 1231 AI 1 x 12 bit
Overflow/underflow	Yes
24 VDC low voltage	no

Table A- 181 Wiring diagram for the analog input SB

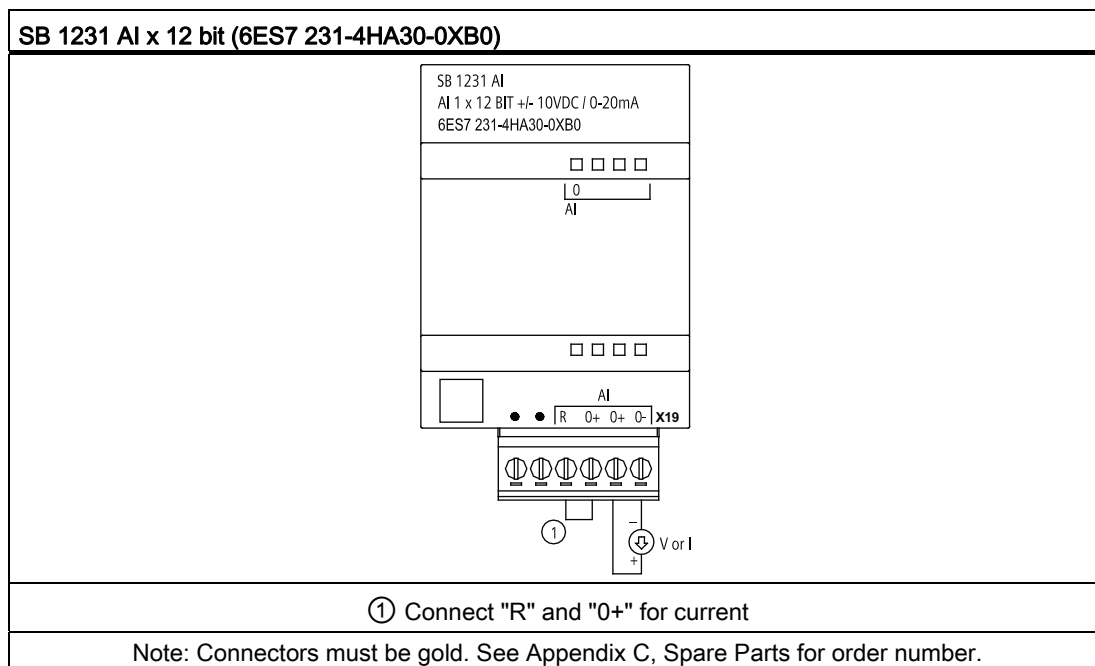


Table A- 182 Connector pin locations for SB 1231 AI x 12 bit (6ES7 231-4HA30-0XB0)

Pin	X19 (gold)
1	No connection
2	No connection
3	AI R
4	AI 0+
5	AI 0+
6	AI 0-

## A.10.2 SB 1232 1 analog output specifications

Table A- 183 General specifications

Technical data	SB 1232 AQ 1 x 12 bit
Order number	6ES7 232-4HA30-0XB0
Dimensions W x H x D (mm)	38 x 62 x 21
Weight	40 grams
Power dissipation	1.5 W
Current consumption (SM Bus)	15 mA
Current consumption (24 VDC)	40 mA (no load)



Table A- 184 Analog outputs

Technical data	SB 1232 AQ 1 x 12 bit
Number of outputs	1
Type	Voltage or current
Range	±10 V or 0 to 20 mA
Resolution	Voltage: 12 bits Current: 11 bits
Full scale range (data word)	Voltage: -27,648 to 27,648
Refer to the output ranges for voltage and current (Page 800).	Current: 0 to 27,648
Accuracy (25°C / -20 to 60°C)	±0.5% / ±1% of full scale
Settling time (95% of new value)	Voltage: 300 µS (R), 750 µS (1 uF) Current: 600 µS (1 mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 Ω Current: ≤ 600 Ω
Behavior on RUN to STOP	Last value or substitute value (default value 0)
Isolation (field side to logic)	None
Cable length (meters)	100 m, twisted and shielded

Table A- 185 Diagnostics

Technical data	SB 1232 AQ 1 x 12 bit
Overflow/underflow	Yes
Short to ground (voltage mode only)	Yes
Wire break (current mode only)	Yes

Table A- 186 Wiring diagram for the SB 1232 AQ 1 x 12 bit

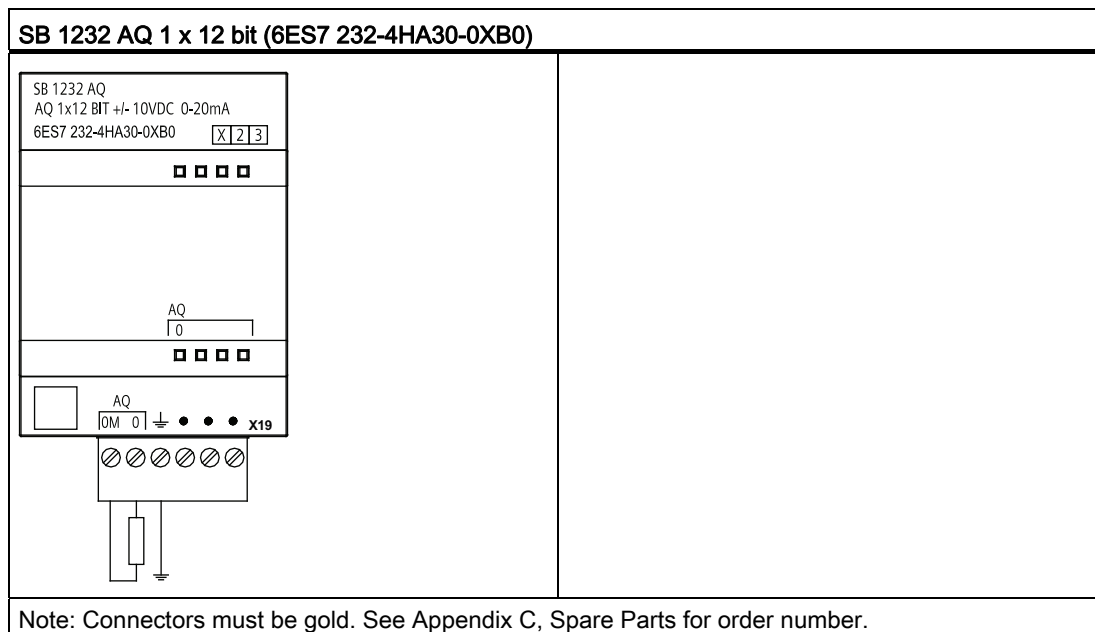


Table A- 187 Connector pin locations for SB 1232 AQ 1 x 12 bit (6ES7 232-4HA30-0XB0)

Pin	X19 (gold)
1	AQ 0M
2	AQ 0
3	GND
4	No connection
5	No connection
6	No connection

## A.10.3 Measurement ranges for analog inputs and outputs

### A.10.3.1 Step response of the analog inputs

Table A- 188 Step response (ms), 0V to 10V measured at 95%

Smoothing selection (sample averaging)	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	4.5 ms	18.7 ms	22.0 ms	102 ms
Weak (4 cycles): 4 samples	10.6 ms	59.3 ms	70.8 ms	346 ms

Smoothing selection (sample averaging)	Integration time selection			
	400 Hz (2.5 ms)	60 Hz (16.6 ms)	50 Hz (20 ms)	10 Hz (100 ms)
Medium (16 cycles): 16 samples	33.0 ms	208 ms	250 ms	1240 ms
Strong (32 cycles): 32 samples	63.0 ms	408 ms	490 ms	2440 ms
<b>Sample time</b>	<b>0.156 ms</b>	<b>1.042 ms</b>	<b>1.250 ms</b>	<b>6.250 ms</b>

### A.10.3.2 Sample time and update times for the analog inputs

Table A- 189 Sample time and update time

Selection	Sample time	SB update time
400 Hz (2.5 ms)	0.156 ms	0.156 ms
60 Hz (16.6 ms)	1.042 ms	1.042 ms
50 Hz (20 ms)	1.250 ms	1.25 ms
10 Hz (100 ms)	6.250 ms	6.25 ms

### A.10.3.3 Measurement ranges of the analog inputs for voltage

Table A- 190 Analog input representation for voltage

System		Voltage Measuring Range						
Decimal	Hexadecimal	±10 V	±5 V	±2.5 V	±1.25V	0 to 10 V		
32767	7FFF	11.851 V	5.926 V	2.963 V	1.481 V	Overflow	11.851 V	Overflow
32512	7F00							
32511	7EFF	11.759 V	5.879 V	2.940 V	1.470 V	Overshoot range	11.759 V	Overshoot range
27649	6C01							
27648	6C00	10 V	5 V	2.5 V	1.250 V	Rated range	10 V	Rated range
20736	5100	7.5 V	3.75 V	1.875 V	0.938 V		7.5 V	
1	1	361.7 μV	180.8 μV	90.4 μV	45.2 μV		361.7 μV	
0	0	0 V	0 V	0 V	0 V		0 V	
-1	FFFF					Undershoot range	Negative values are not supported	
-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							
-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.470 V	Underflow		
-32513	80FF							
-32768	8000	-11.851 V	-5.926 V	-2.963 V	-1.481 V			

### A.10.3.4 Measurement ranges of the analog inputs for current

Table A- 191 Analog input representation for current

System		Current measuring range		
Decimal	Hexidecimal	0 mA to 20 mA	4 mA to 20 mA	
32767	7FFF	23.70 mA	22.96 mA	Overflow
32512	7F00			
32511	7EFF	23.52 mA	22.81 mA	Overshoot range
27649	6C01			
27648	6C00	20 mA	20 mA	Nominal range
20736	5100	15 mA	16 mA	
1	1	723.4 nA	4 mA + 578.7 nA	
0	0	0 mA	4 mA	
-1	FFFF			
-4864	ED00	-3.52 mA	1.185 mA	Undershoot range
-4865	ECFF			
-32768	8000			Underflow

### A.10.3.5 Output (AQ) measurement ranges for voltage and current (SB and SM)

Table A- 192 Analog output representation for voltage

System		Voltage Output Range	
Decimal	Hexadecimal	$\pm 10$ 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 $\mu$ V	
0	0	0 V	
-1	FFFF	-361.7 $\mu$ V	
-20736	AF00	-7.5 V	
-27648	9400	-10 V	