Technical Specifications

A

In This Chapter

General Technical Specifications

Standards Compliance

The national and international standards listed below were used to determine appropriate performance specifications and testing for the S7-200 family of products. Table A-1 defines the specific adherence to these standards.

- ❏ European Community (CE) Low Voltage Directive 73/23/EEC
  EN 61131-2: Programmable controllers - Equipment requirements
- ❏ European Community (CE) EMC Directive 89/336/EEC

  Electromagnetic emission standard
  EN 61000-6-3: residential, commercial, and light industry
  EN 61000-6-4: industrial environment

  Electromagnetic immunity standards
  EN 61000-6-2: industrial environment
- ❏ Underwriters Laboratories, Inc.: UL 508 Listed (Industrial Control Equipment), Registration number E75310
- ❏ Canadian Standards Association: CSA C22.2 Number 142 (Process Control Equipment)
- ❏ Factory Mutual Research: Class Number 3600, Class Number 3611, FM Class I, Division 2, Groups A, B, C, & D Hazardous Locations, T4A and Class I, Zone 2, IIC, T4.
- ❏ European Community (ATEX) Atmospheres Explosibles Directive 94/9/EC
  EN 60079-0 General requirements
  EN 50020 Intrinsic safety 'i'
  EN 60079-15 Type of protection 'n'

  ATEX Directive applies to CPUs and expansion modules with a rated voltage of 24 VDC. It does not apply to modules with AC power systems or Relay outputs. Consult your local Siemens representative for a list of ATEX approved modules.

Tip

The SIMATIC S7-200 series meets the CSA standard.

The cULus logo indicates that the S7-200 has been examined and certified by Underwriters Laboratories (UL) to standards UL 508 and CSA 22.2 No. 142.

Maritime Approvals

The S7-200 products are periodically submitted for special agency approvals related to specific markets and applications. This table identifies the agency and certificate number that the S7-200 products have been approved for. Most S7-200 products in this manual have been approved for these special agency approvals. Consult your local Siemens representative if you need additional information related to the latest listing of exact approvals by part number.

Agency	Certificate Number
Lloyds Register of Shipping (LRS)	99 / 20018(E1)
American Bureau of Shipping (ABS)	01-HG20020-PDA
Germanischer Lloyd (GL)	12 045 - 98 HH
Det Norske Veritas (DNV)	A-8862
Bureau Veritas (BV)	09051 / B0BV
Nippon Kaiji Kyokai (NK)	A-534
Polski Rejestr	TE/1246/883241/99

Relay Electrical Service Life

The typical performance data supplied by relay vendors is shown in Figure A-1. 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.

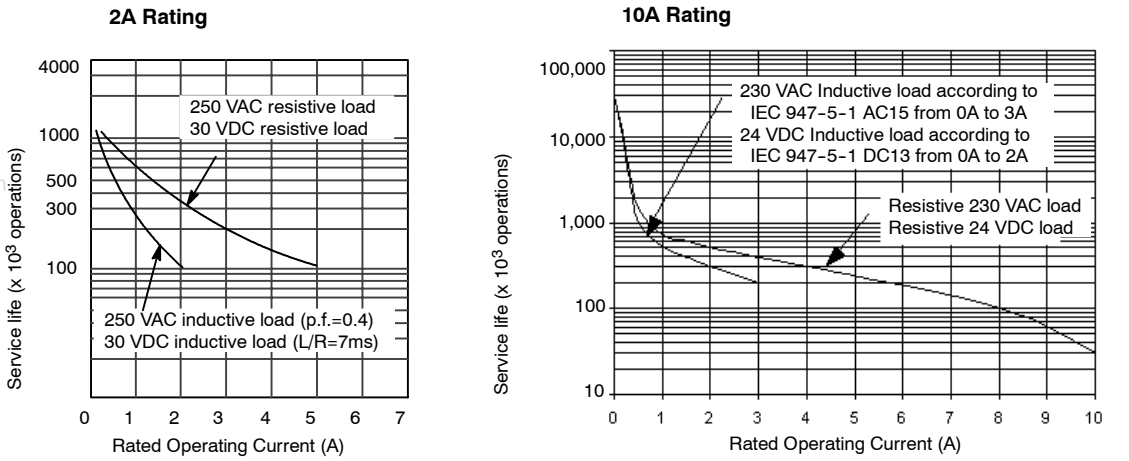


Figure A-1 Relay Electrical Service Life

Technical Specifications

All S7-200 CPUs and expansion modules conform to the technical specifications listed in Table A-1.

Notice

When a mechanical contact turns on output power to the S7-200 CPU, or any digital expansion module, it sends a "1" signal to the digital outputs for approximately 50 microseconds. You must plan for this, especially if you are using devices which respond to short duration pulses.

Table A-1 Technical Specifications

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, 2 cycles
EN 60068-2-32, Free fall	0.3 m, 5 times, product packaging
Environmental Conditions — Operating	
Ambient Temperature Range (Inlet Air 25 mm below unit)	0° C to 55° C horizontal mounting, 0° C to 45° C vertical mounting 95% non-condensing humidity
Atmospheric pressure	1080 to 795 hPa (Corresponding to an altitude of -1000 to 2000 m)
Concentration of contaminants	SO_2: < 0.5 ppm; H_2S: < 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	Panel mount: 0.30 mm from 10 to 57 Hz; 2 G from 57 to 150 Hz DIN rail mount: 0.15 mm from 10 to 57 Hz; 1 G from 57 to 150 Hz 10 sweeps each axis, 1 octave/minute
EN 60529, IP20 Mechanical protection	Protects against finger contact with high voltage as tested by standard probes. External protection is required for dust, dirt, water, and foreign objects of < 12.5 mm in diameter.

Table A-1 Technical Specifications, continued

Electromagnetic Compatibility — Immunity per EN61000-6-2[1]	
EN 61000-4-2 Electrostatic discharge	8 kV air discharge to all surfaces and communications port, 4 kV contact discharge to exposed conductive surfaces
EN 61000-4-3 Radiated electromagnetic field	10 V/m, 80-1000 MHz, 1.4-2.0 GHz and 2.0-2.7 GHz, 80% AM at 1kHz
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 1 kV, 5 kHz with coupling clamp to communications
EN 61000-4-5 Surge immunity	Power supply: 2 kV asymmetrical, 1 kV symmetrical I/O 1 kV symmetrical (24 VDC circuits require external surge protection)
EN 61000-4-6 Conducted disturbances	0.15 to 80 MHz, 10 V RMS, 80% AM at 1kHz
EN 61000-4-11 Voltage dips, short interruptions and voltage variations	>95% reduction for 8.3 ms, 83 ms, 833 ms, and 4167 ms
VDE 0160 Non-periodic overvoltage	At 85 VAC line, 90° phase angle, apply 390 V peak, 1.3 ms pulse At 180 VAC line, 90° phase angle, apply 750 V peak, 1.3 ms pulse
Electromagnetic Compatibility — Conducted and Radiated Emissions per EN 61000-6-3[2] and EN 61000-6-4	
EN 55011, Class A, Group 1, conducted[1] 0.15 MHz to 0.5 MHz 0.5 MHz to 5 MHz 5 MHz to 30 MHz	 < 79 dB (μV) Quasi-peak; < 66 dB (μV) Average < 73 dB (μV) Quasi-peak; < 60 dB (μV) Average < 73 dB (μV) Quasi-peak; < 60 dB (μV) Average
EN 55011, Class A, Group 1, radiated[1] 30 MHz to 230 MHz 230 MHz to 1 GHz	 40 dB (μV/m) Quasi-peak; measured at 10 m 47 dB (μV/m) Quasi-peak; measured at 10 m
EN 55011, Class B, Group 1, conducted[2] 0.15 to 0.5 MHz 0.5 MHz to 5 MHz 5 MHz to 30 MHz	 < 66 dB (μV) Quasi-peak decreasing with log frequency to 56 dB (μV); < 56 dB (μV) Average decreasing with log frequency to 46 dB (μV) < 56 dB (μV) Quasi-peak; < 46 dB (μV) Average < 60 dB (μV) Quasi-peak; < 50 dB (μV) Average
EN 55011, Class B, Group 1, radiated[2] 30 MHz to 230 kHz 230 MHz to 1 GHz	 30 dB (μV/m) Quasi-peak; measured at 10 m 37 dB (μV/m) Quasi-peak; measured at 10 m
High Potential Isolation Test	
24 V/5 V nominal circuits 115/230 V circuits to ground 115/230 V circuits to 115/230 V circuits 230 V circuits to 24 V/5 V circuits 115 V circuits to 24 V/5 V circuits	500 VAC (optical isolation boundaries) 1,500 VAC 1,500 VAC 1,500 VAC 1,500 VAC

1 Unit must be mounted on a grounded metallic frame with the S7-200 ground connection made directly to the mounting metal. Cables are routed along metallic supports.

2 Unit must be mounted in a grounded metal enclosure. AC input power line must be equipped with a EPCOS B84115-E-A30 filter or equivalent, 25 cm max. wire length from filters to the S7-200. The 24 VDC supply and sensor supply wiring must be shielded.

CPU Specifications

Table A-2 CPU Order Numbers

Order Number	CPU Model	Power Supply (Nominal)	Digital Inputs	Digital Outputs	Comm Ports	Analog Inputs	Analog Outputs	Removable Connector
6ES7 211-0AA23-0XB0	CPU 221	24 VDC	6 x 24 VDC	4 x 24 VDC	1	No	No	No
6ES7 211-0BA23-0XB0	CPU 221	120 to 240 VAC	6 x 24 VDC	4 x Relay	1	No	No	No
6ES7 212-1AB23-0XB0	CPU 222	24 VDC	8 x 24 VDC	6 x 24 VDC	1	No	No	No
6ES7 212-1BB23-0XB0	CPU 222	120 to 240 VAC	8 x 24 VDC	6 x Relay	1	No	No	No
6ES7 214-1AD23-0XB0	CPU 224	24 VDC	14 x 24 VDC	10 x 24 VDC	1	No	No	Yes
6ES7 214-1BD23-0XB0	CPU 224	120 to 240 VAC	14 x 24 VDC	10 x Relay	1	No	No	Yes
6ES7 214-2AD23-0XB0	CPU 224XP	24 VDC	14 x 24 VDC	10 x 24 VDC	2	2	1	Yes
6ES7 214-2AS23-0XB0	CPU 224XPsi	24 VDC	14 x 24 VDC	10 x 24 VDC	2	2	1	Yes
6ES7 214-2BD23-0XB0	CPU 224XP	120 to 240 VAC	14 x 24 VDC	10 x Relay	2	2	1	Yes
6ES7 216-2AD23-0XB0	CPU 226	24 VDC	24 x 24 VDC	16 x 24 VDC	2	No	No	Yes
6ES7 216-2BD23-0XB0	CPU 226	120 to 240 VAC	24 x 24 VDC	16 x Relay	2	No	No	Yes

Table A-3 CPU General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Available	
					+5 VDC	+24 VDC[1]
6ES7 211-0AA23-0XB0	CPU 221 DC/DC/DC 6 Inputs/ 4 Outputs	90 x 80 x 62	270 g	3 W	0 mA	180 mA
6ES7 211-0BA23-0XB0	CPU 221 AC/DC/Relay 6 Inputs/ 4 Relays	90 x 80 x 62	310 g	6 W	0 mA	180 mA
6ES7 212-1AB23-0XB0	CPU 222 DC/DC/DC 8 Inputs/ 6 Outputs	90 x 80 x 62	270 g	5 W	340 mA	180 mA
6ES7 212-1BB23-0XB0	CPU 222 AC/DC/Relay 8 Inputs/ 6 Relays	90 x 80 x 62	310 g	7 W	340 mA	180 mA
6ES7 214-1AD23-0XB0	CPU 224 DC/DC/DC 14 Inputs/ 10 Outputs	120.5 x 80 x 62	360 g	7 W	660 mA	280 mA
6ES7 214-1BD23-0XB0	CPU 224 AC/DC/Relay14 Inputs/ 10 Relays	120.5 x 80 x 62	410 g	10 W	660 mA	280 mA
6ES7 214-2AD23-0XB0	CPU 224XP DC/DC/DC 14 Inputs/10 Outputs	140 x 80 x 62	390 g	8 W	660 mA	280 mA
6ES7 214-2AS23-0XB0	CPU 224XPsi DC/DC/DC 14 Inputs/10 Outputs	140 x 80 x 62	390 g	8 W	660 mA	280 mA
6ES7 214-2BD23-0XB0	CPU 224XP AC/DC/Relay 14 Inputs/10 Relays	140 x 80 x 62	440 g	11 W	660 mA	280 mA
6ES7 216-2AD23-0XB0	CPU 226 DC/DC/DC 24 Inputs/16 Outputs	196 x 80 x 62	550 g	11 W	1000 mA	400 mA
6ES7 216-2BD23-0XB0	CPU 226 AC/DC/Relay 24 Inputs/16 Relays	196 x 80 x 62	660 g	17 W	1000 mA	400 mA

1 This is the 24 VDC sensor power that is available after the internal relay coil power and 24 VDC comm port power requirements have been accounted for.

Table A-4 CPU Specifications

	CPU 221	CPU 222	CPU 224	CPU 224XP CPU 224XPsi	CPU 226
Memory					
User program size with run mode edit without run mode edit	4096 bytes 4096 bytes		8192 bytes 12288 bytes	12288 bytes 16384 bytes	16384 bytes 24576 bytes
User data	2048 bytes		8192 bytes	10240 bytes	10240 bytes
Backup (super cap) (optional battery)	50 hours typical (8 hours min. at 40°C) 200 days typical		100 hours typical (70 hours min. at 40°C) 200 days typical	100 hours typical (70 hours min. at 40°C) 200 days typical	
I/O					
Digital I/O	6 inputs/4outputs	8 inputs/6 outputs	14 inputs/10 outputs	14 inputs/10 outputs	24 inputs/16 outputs
Analog I/O	none			2 inputs/1 output	none
Digital I/O image size	256 (128 In/128 Out)				
Analog I/O image size	None	32 (16 In/16 Out)	64 (32 In/32 Out)		
Max. expansion modules allowed	None	2 modules[1]	7 modules[1]		
Max. intelligent modules allowed	None	2 modules[1]	7 modules[1]		
Pulse Catch inputs	6	8	14		24
High-Speed Counters Single phase Two phase	4 counters total 4 at 30 kHz 2 at 20 kHz		6 counters total 6 at 30 kHz 4 at 20 kHz	6 counters total 4 at 30 kHz 2 at 200 kHz 3 at 20 kHz 1 at 100 kHz	6 counters total 6 at 30 kHz 4 at 20 kHz
Pulse outputs	2 at 20 kHz (DC outputs only)			2 at 100 kHz (DC outputs only)	2 at 20 kHz (DC outputs only)
General					
Timers	256 total timers; 4 timers (1 ms); 16 timers (10 ms); 236 timers (100 ms)				
Counters	256 (backed by super capacitor or battery)				
Internal memory bits Stored on power down	256 (backed by super capacitor or battery) 112 (stored to EEPROM)				
Timed interrupts	2 with 1 ms resolution				
Edge interrupts	4 up and/or 4 down				
Analog adjustment	1 with 8 bit resolution		2 with 8 bit resolution		
Boolean execution speed	0.22 μs per instruction				
Real Time Clock	Optional cartridge		Built-in		
Cartridge options	Memory, Battery, and Real Time Clock		Memory and battery		
Communications Built-in					
Ports (Limited Power)	1 RS-485 port			2 RS-485 ports	
PPI, DP/T baud rates	9.6, 19.2, 187.5 kbaud				
Freeport baud rates	1.2 kbaud to 115.2 kbaud				
Max. cable length per segment	With isolated repeater: 1000 m up to 187.5 kbaud, 1200 m up to 38.4 kbaud Without isolated repeater: 50 m				
Max. number of stations	32 per segment, 126 per network				
Max. number of masters	32				
Peer to Peer (PPI Master Mode)	Yes (NETR/NETW)				
MPI connections	4 total, 2 reserved (1 for a PG and 1 for an OP)				

[1] You must calculate your power budget to determine how much power (or current) the S7-200 CPU can provide for your configuration. If the CPU power budget is exceeded, you may not be able to connect the maximum number of modules. See Appendix A for CPU and expansion module power requirements, and Appendix B to calculate your power budget.

Table A-5 CPU Power Specifications

	DC		AC	
Input Power				
Input voltage	20.4 to 28.8 VDC		85 to 264 VAC (47 to 63 Hz)	
Input current CPU 221 CPU 222 CPU 224 CPU 224XP CPU 224XPsi CPU 226	CPU only at 24 VDC 80 mA 85 mA 110 mA 120 mA 120 mA 150 mA	Max. load at 24 VDC 450 mA 500 mA 700 mA 900 mA 900 mA 1050 mA	CPU only 30/15 mA at 120/240 VAC 40/20 mA at 120/240 VAC 60/30 mA at 120/240 VAC 70/35 mA at 120/240 VAC - 80/40 mA at 120/240 VAC	Max. load 120/60 mA at120/240 VAC 140/70 mA at 120/240 VAC 200/100 mA at 120/240VAC 220/100 mA at 120/240 VAC - 320/160 mA at 120/240VAC
Inrush current	12 A at 28.8 VDC		20 A at 264 VAC	
Isolation (field to logic)	Not isolated		1500 VAC	
Hold up time (loss of power)	10 ms at 24 VDC		20/80 ms at 120/240 VAC	
Fuse (non-replaceable)	3 A, 250 V Slow Blow		2 A, 250 V Slow Blow	
24 VDC Sensor Power				
Sensor voltage (Limited Power)	L+ minus 5 V		20.4 to 28.8 VDC	
Current limit	1.5 A peak, thermal limit non-destructive (See Table A-3 for rated load.)			
Ripple noise	Derived from input power		Less than 1 V peak-to-peak	
Isolation (sensor to logic)	Not isolated			

Table A-6 CPU Digital Input Specifications

General	24 VDC Input (CPU 221, CPU 222, CPU 224, CPU 226)		24 VDC Input (CPU 224XP, CPU 224XPsi)	
Type	Sink/Source (IEC Type 1 Sink)		Sink/Source (IEC Type 1 Sink, except I0.3 to I0.5)	
Rated voltage	24 VDC at 4 mA typical		24 VDC at 4 mA typical	
Max. continuous permissible voltage	30 VDC			
Surge voltage	35 VDC for 0.5 s			
Logic 1 (min.)	15 VDC at 2.5 mA		15 VDC at 2.5 mA (I0.0 to I0.2 and I0.6 to I1.5) 4 VDC at 8 mA (I0.3 to I0.5)	
Logic 0 (max.)	5 VDC at 1 mA		5 VDC at 1 mA (I0.0 to I0.2 and I0.6 to I1.5) 1 VDC at 1 mA (I0.3 to I0.5)	
Input delay	Selectable (0.2 to 12.8 ms)			
Connection of 2 wire proximity sensor (Bero) Permissible leakage current (max.)	1 mA			
Isolation (field to logic) Optical (galvanic) Isolation groups	Yes 500 VAC for 1 minute See wiring diagram			
High Speed Counter (HSC) input rate HSC Inputs All HSC All HSC HC4, HC5 on CPU 224XP and CPU 224XPsi only	Logic 1 Level 15 to 30 VDC 15 to 26 VDC > 4 VDC	Single phase 20 kHz 30 kHz 200 kHz	Two phase 10 kHz 20 kHz 100 kHz	
Inputs on simultaneously	All		All CPU 224XP AC/DC/RELAY only: All at 55° C with DC inputs at 26 VDC max. All at 50° C with DC inputs at 30 VDC max.	
Cable length (max.) Shielded Unshielded	500 m normal inputs, 50 m HSC inputs[1] 300 m normal inputs			

1 Shielded twisted pair is recommended for HSC inputs.

Table A-7 CPU Digital Output Specifications

General	24 VDC Output (CPU 221, CPU 222, CPU 224, CPU 226)	24 VDC Output (CPU 224XP)	24 VDC Output (CPU 224XPsi)	Relay Output
Type	Solid State-MOSFET (Sourcing)		Solid State-MOSFET (Sinking)	Dry contact
Rated voltage	24 VDC	24 VDC	24 VDC	24 VDC or 250 VAC
Voltage range	20.4 to 28.8 VDC	5 to 28.8 VDC (Q0.0 to Q0.4) 20.4 to 28.8 VDC (Q0.5 to Q1.1)	5 to 28.8 VDC	5 to 30 VDC or 5 to 250 VAC
Surge current (max.)	8 A for 100 ms			5 A for 4 s @ 10% duty cycle
Logic 1 (min.)	20 VDC at maximum current	L+ minus 0.4 V at max. current	External Voltage Rail minus 0.4V with 10K pullup to External Voltage Rail	-
Logic 0 (max.)	0.1 VDC with 10 K Ω Load		1M + 0.4V at max. load	-
Rated current per point (max.)	0.75 A			2.0 A
Rated current per common (max.)	6 A	3.75 A	7.5 A	10 A
Leakage current (max.)	10 μ A			-
Lamp load (max.)	5 W			30 W DC; 200 W AC[2, 3]
Inductive clamp voltage	L+ minus 48 VDC, 1 W dissipation		1M +48 VDC, 1 W dissipation	-
On State resistance (contact)	0.3 Ω typical (0.6 Ω max.)			0.2 Ω (max. when new)
Isolation Optical (galvanic, field to logic) Logic to contact Resistance (logic to contact) Isolation groups	 500 VAC for 1 minute - - See wiring diagram			 - 1500 VAC for 1 minute 100 M Ω See wiring diagram
Delay (max.) Off to on (μs) On to off (μs) Switching	 2μs (Q0.0, Q0.1), 15μs (all other) 10μs (Q0.0, Q0.1), 130μs (all other) -	 0.5μs (Q0.0, Q0.1), 15μs (all other) 1.5μs (Q0.0, Q0.1), 130μs (all other) -		 - - 10 ms
Pulse frequency (max.)	20 kHz[1] (Q0.0 and Q0.1)	100 kHz[1] (Q0.0 and Q0.1)	100 kHz[1] (Q0.0 and Q0.1)	1 Hz
Lifetime mechanical cycles	-	-	-	10,000,000 (no load)
Lifetime contacts	-	-	-	100,000 (rated load)
Outputs on simultaneously	All at 55° C (horizontal), All at 45° C (vertical)			
Connecting two outputs in parallel	Yes, only outputs in same group			No
Cable length (max.) Shielded Unshielded	 500 m 150 m			

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

2 Relay lifetime with a lamp load will be reduced by 75% unless steps are taken to reduce the turn-on surge below the surge current rating of the output.

3 Lamp load wattage rating is for rated voltage. Reduce the wattage rating proportionally for voltage being switched (for example 120 VAC – 100 W).

Warning

When a mechanical contact turns on output power to the S7-200 CPU, or any digital expansion 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.

Table A-8 CPU 224XP and CPU 224XPsi Analog Input Specifications

General	Analog Input (CPU 224XP, CPU 224XPsi)
Number of inputs	2 points
Analog input type	Single-ended
Voltage range	±10 V
Data word format, full scale range	–32,000 to +32,000
DC Input impedance	>100 KΩ
Maximum input voltage	30 VDC
Resolution	11 bits plus 1 sign bit
LSB value	4.88 mV
Isolation	None
Accuracy Worst case 0° to 55° C Typical 25° C	 ±2.5% of full scale ±1.0% of full scale
Repeatability	±0.05% of full scale
Analog to digital conversion time	125 msec
Conversion type	Sigma Delta
Step response	250 ms max.
Noise rejection	–20 dB @ 50 Hz typical

Table A-9 CPU 224XP and CPU 224XPsi Analog Output Specifications

General	Analog Output (CPU 224XP, CPU 224XPsi)
Number of outputs	1 point
Signal range Voltage Current	 0 to 10 V (Limited Power) 0 to 20 mA (Limited Power)
Data word format, full range	0 to +32767
Date word format, full scale	0 to +32000
Resolution, full range	12 bits
LSB value Voltage Current	 2.44 mV 4.88 μA
Isolation	none
Accuracy Worst case, 0° to 55° C Voltage output Current output Typical 25° C Voltage output Current output	 ± 2% of full-scale ± 3% of full-scale ± 1% of full-scale ± 1% of full-scale
Settling time Voltage output Current output	 < 50 μS < 100 μS
Maximum output drive Voltage output Current output	 ≥ 5000 Ω minimum ≤ 500 Ω maximum

Wiring Diagrams

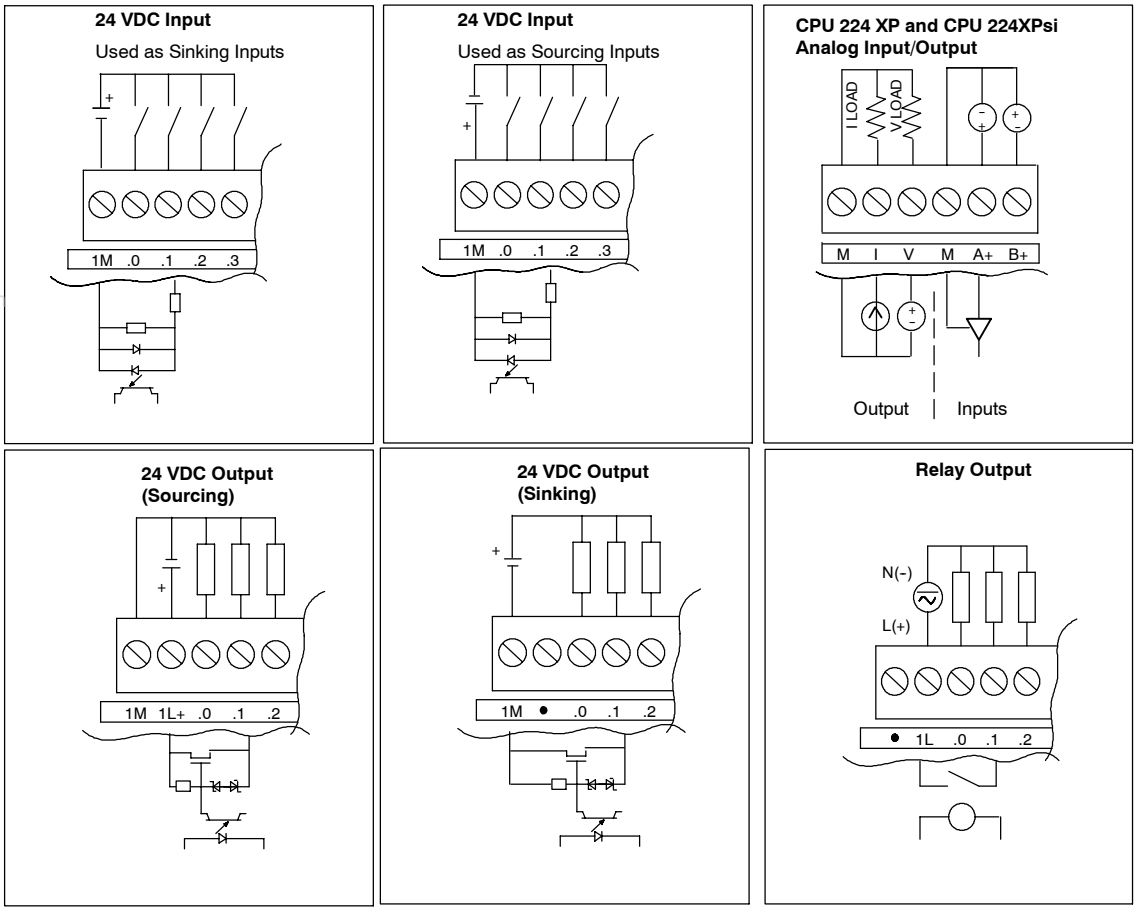


Figure A-2 CPU Inputs and Outputs

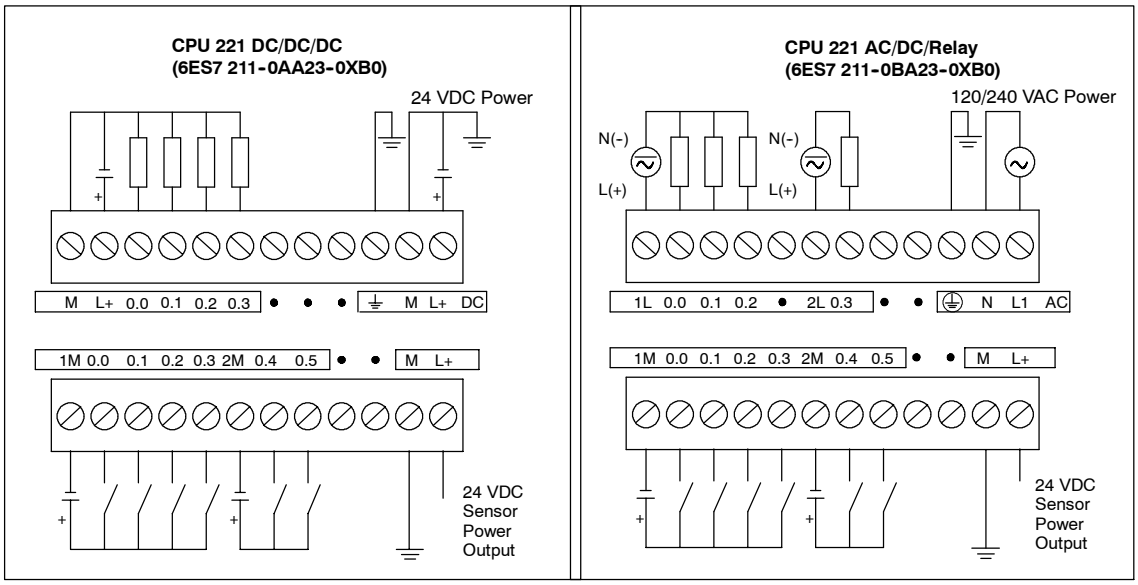


Figure A-3 CPU 221 Wiring Diagrams

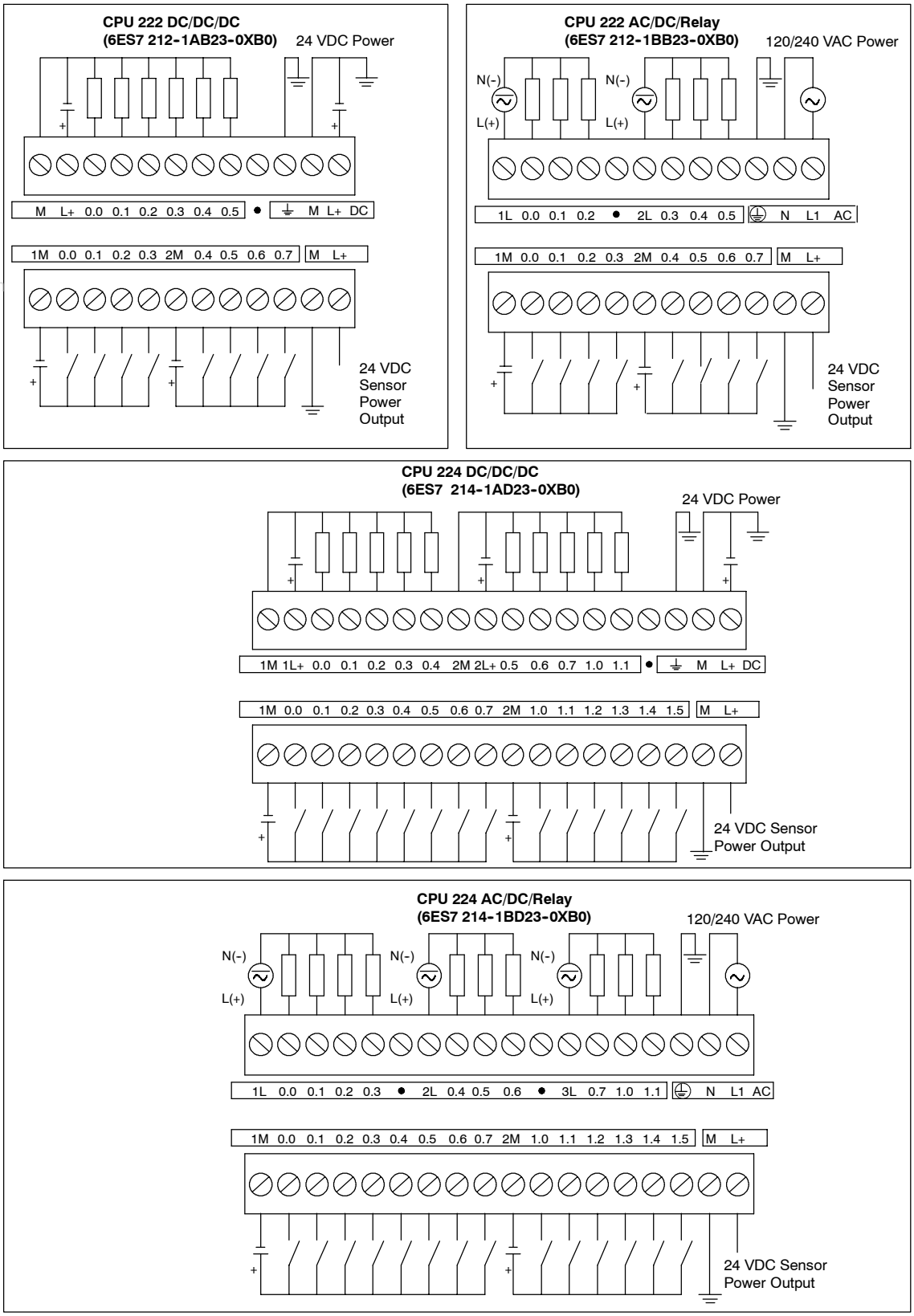


Figure A-4 CPU 222 and CPU 224 Wiring Diagrams

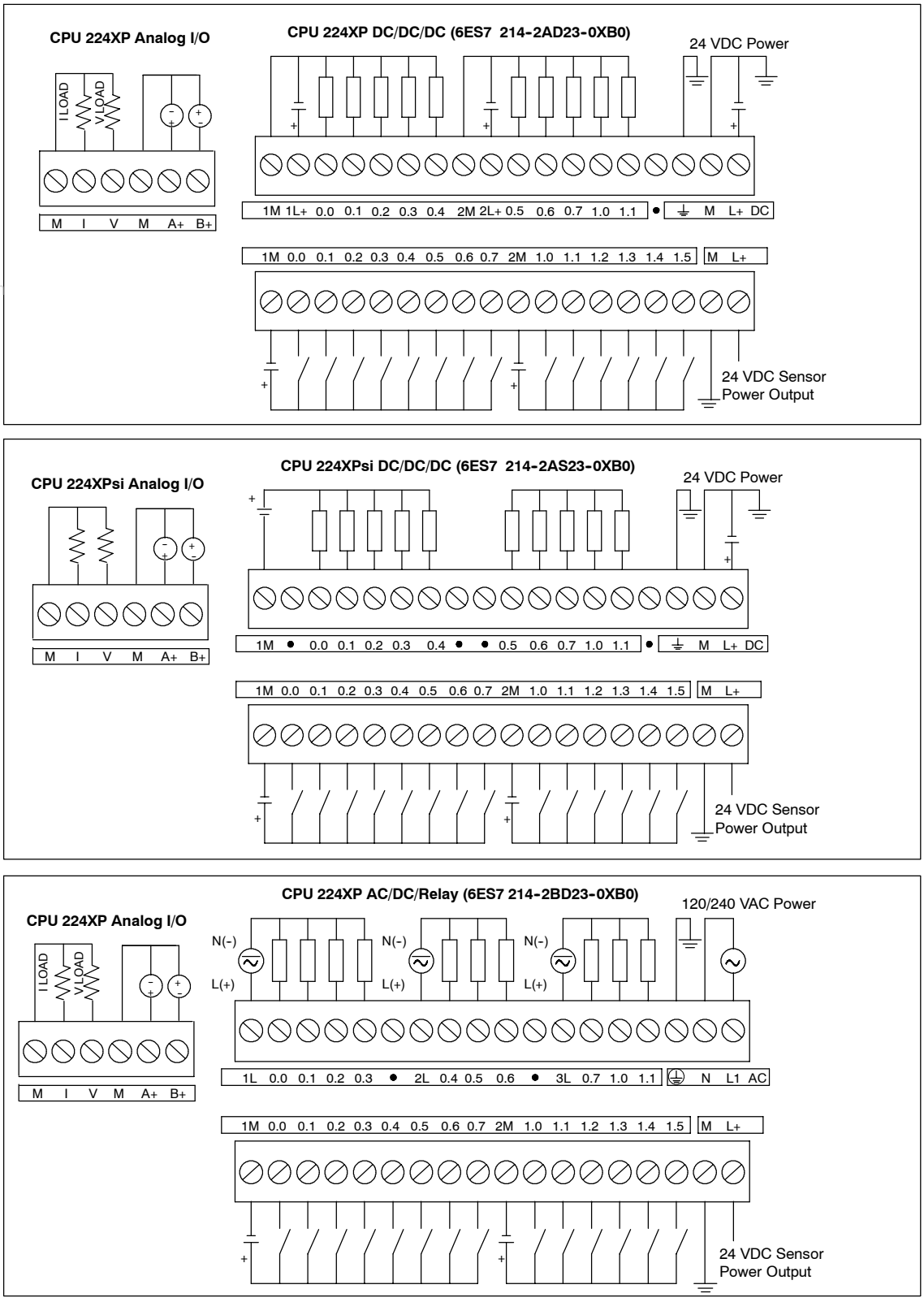


Figure A-5 CPU 224XP Wiring Diagrams

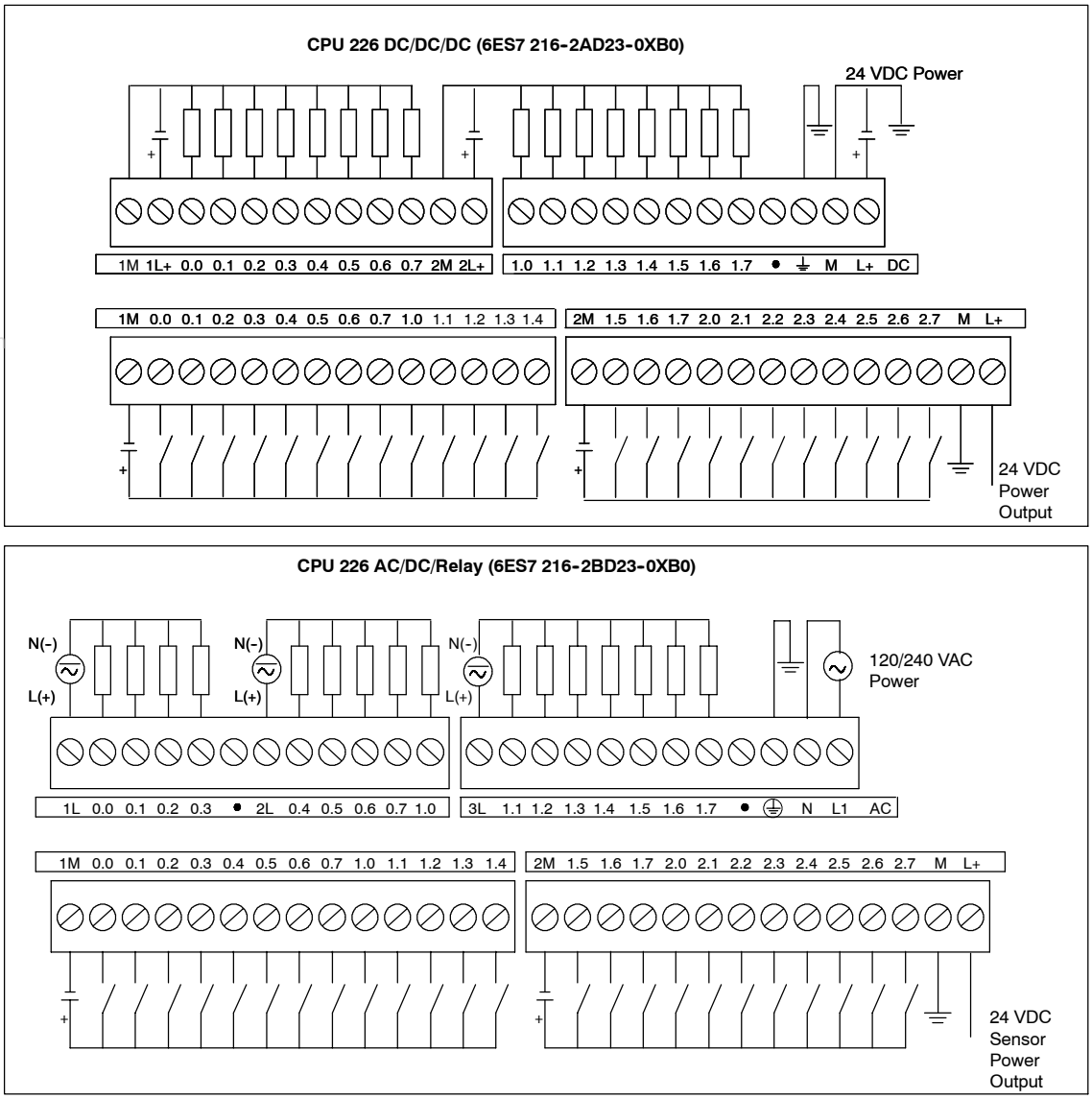
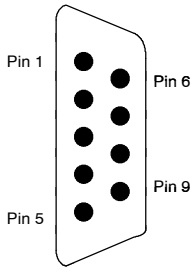


Figure A-6 CPU 226 Wiring Diagrams

Table A-10 Pin Assignments for the S7-200 Communications Port (Limited Power)

Connector	Pin Number	PROFIBUS Signal	Port 0/Port 1
	1	Shield	Chassis ground
	2	24 V Return	Logic common
	3	RS-485 Signal B	RS-485 Signal B
	4	Request-to-Send	RTS (TTL)
	5	5 V Return	Logic common
	6	+5 V	+5 V, 100 Ω series resistor
	7	+24 V	+24 V
	8	RS-485 Signal A	RS-485 Signal A
	9	Not applicable	10-bit protocol select (input)
	Connector shell	Shield	Chassis ground

Digital Expansion Modules Specifications

Table A-11 Digital Expansion Modules Order Numbers

Order Number	Expansion Model	Digital Inputs	Digital Outputs	Removable Connector
6ES7 221-1BF22-0XA0	EM 221 Digital Input 8 x 24 VDC	8 x 24 VDC	-	Yes
6ES7 221-1EF22-0XA0	EM 221 Digital Input 8 x 120/230 VAC	8 x 120/230 VAC	-	Yes
6ES7 221-1BH22-0XA0	EM 221 Digital Input 16 x 24 VDC	16 x 24 VDC	-	Yes
6ES7 222-1BD22-0XA0	EM 222 Digital Output 4 x 24 VDC-5A	-	4 x 24 VDC-5A	Yes
6ES7 222-1HD22-0XA0	EM 222 Digital Output 4 x Relays-10A	-	4 x Relay-10A	Yes
6ES7 222-1BF22-0XA0	EM 222 Digital Output 8 x 24 VDC	-	8 x 24 VDC-0.75A	Yes
6ES7 222-1HF22-0XA0	EM 222 Digital Output 8 x Relays	-	8 x Relay-2A	Yes
6ES7 222-1EF22-0XA0	EM 222 Digital Output 8 x 120/230 VAC	-	8 x 120/230 VAC	Yes
6ES7 223-1BF22-0XA0	EM 223 24 VDC Digital Comb 4 Inputs/4 Outputs	4 x 24 VDC	4 x 24 VDC-0.75A	Yes
6ES7 223-1HF22-0XA0	EM 223 24 VDC Digital Comb 4 Inputs/4 Relay Outputs	4 x 24 VDC	4 x Relay-2A	Yes
6ES7 223-1BH22-0XA0	EM 223 24 VDC Digital Comb 8 Inputs/8 Outputs	8 x 24 VDC	8 x 24 VDC-0.75A	Yes
6ES7 223-1PH22-0XA0	EM 223 24 VDC Digital Comb 8 Inputs/8 Relay Outputs	8 x 24 VDC	8 x Relay-2A	Yes
6ES7 223-1BL22-0XA0	EM 223 24 VDC Digital Comb 16 Inputs/16 Outputs	16 x 24 VDC	16 x 24 VDC-0.75A	Yes
6ES7 223-1PL22-0XA0	EM 223 24 VDC Digital Comb 16 Inputs/16 Relay Outputs	16 x 24 VDC	16 x Relay-2A	Yes
6ES7 223-1BM22-0XA0	EM 223 24 VDC Digital Comb 32 Inputs/32 Outputs	32 x 24 VDC	32 x 24 VDC-0.75 A	Yes
6ES7 223-1PM22-0XA0	EM 223 24 VDC Digital Comb 32 Inputs/32 Relay Outputs	32 x 24 VDC	32 x Relay-2 A	Yes

Table A-12 Digital Expansion Modules General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements	
					+5 VDC	+24 VDC
6ES7 221-1BF22-0XA0	EM 221 DI 8 x 24 VDC	46 x 80 x 62	150 g	2 W	30 mA	ON: 4 mA/input
6ES7 221-1EF22-0XA0	EM 221 DI 8 x 120/230 VAC	71.2 x 80 x 62	160 g	3 W	30 mA	-
6ES7 221-1BH22-0XA0	EM 221 DI 16 x 24 VDC	71.2 x 80 x 62	160 g	3 W	70 mA	ON: 4 mA/input
6ES7 222-1BD22-0XA0	EM 222 DO 4 x 24 VDC-5A	46 x 80 x 62	120 g	3 W	40 mA	-
6ES7 222-1HD22-0XA0	EM 222 DO 4 x Relays-10A	46 x 80 x 62	150 g	4 W	30 mA	ON: 20 mA/output
6ES7 222-1BF22-0XA0	EM 222 DO 8 x 24 VDC	46 x 80 x 62	150 g	2 W	50 mA	-
6ES7 222-1HF22-0XA0	EM 222 DO 8 x Relays	46 x 80 x 62	170 g	2 W	40 mA	ON: 9 mA/output
6ES7 222-1EF22-0XA0	EM 222 DO 8 x 120/230 VAC	71.2 x 80 x 62	165 g	4 W	110 mA	-
6ES7 223-1BF22-0XA0	EM 223 24 VDC 4 In/4 Out	46 x 80 x 62	160 g	2 W	40 mA	ON: 4 mA/input
6ES7 223-1HF22-0XA0	EM 223 24 VDC 4 In/4 Relays	46 x 80 x 62	170 g	2 W	40 mA	ON: 9 mA/output, 4 mA/input
6ES7 223-1BH22-0AX0	EM 223 24 VDC 8 In/8 Out	71.2 x 80 x 62	200 g	3 W	80 mA	ON: 4 mA/input
6ES7 223-1PH22-0XA0	EM 223 24 VDC 8 In/8 Relays	71.2 x 80 x 62	300 g	3 W	80 mA	ON: 9 mA/output, 4 mA/input
6ES7 223-1BL22-0XA0	EM 223 24 VDC 16 In/16 Out	137.3 x 80 x 62	360 g	6 W	160 mA	ON: 4 mA/input
6ES7 223-1PL22-0XA0	EM 223 24 VDC 16 In/16 Relays	137.3 x 80 x 62	400 g	6 W	150 mA	ON: 9 mA/output, 4 mA/input
6ES7 223-1BM22-0XA0	EM 223 24 VDC 32 In/32 Out	196 x 80 x 62	500 g	9 W	240 mA	ON: 4 mA/input
6ES7 223-1PM22-0XA0	EM 223 24 VDC 32 In/32 Relay	196 x 80 x 62	580 g	13 W	205 mA	ON: 9 mA/output 4 mA/input

Table A-13 Digital Expansion Modules Input Specifications

General	24 VDC Input	120/230 VAC Input (47 to 63 HZ)
Type	Sink/Source (IEC Type 1 sink)	IEC Type I
Rated voltage	24 VDC at 4 mA	120 VAC at 6 mA or 230 VAC at 9 mA nominal
Maximum continuous permissible voltage	30 VDC	264 VAC
Surge voltage (max.)	35 VDC for 0.5 s	-
Logic 1 (min.)	15 VDC at 2.5 mA	79 VAC at 2.5 mA
Logic 0 (max.)	5 VDC at 1 mA	20 VAC or 1 mA AC
Input delay (max.)	4.5 ms	15 ms
Connection of 2 wire proximity sensor (Bero) Permissible leakage current (max.)	1 mA	1 mA AC
Isolation Optical (galvanic, field to logic) Isolation groups	500 VAC for 1 minute See wiring diagram	1500 VAC for 1 minute 1 point
Inputs on simultaneously	All at 55° C (horizontal), All on at 45° C (vertical)	
Cable length (max.) Shielded Unshielded	500 m 300 m	500 m 300 m

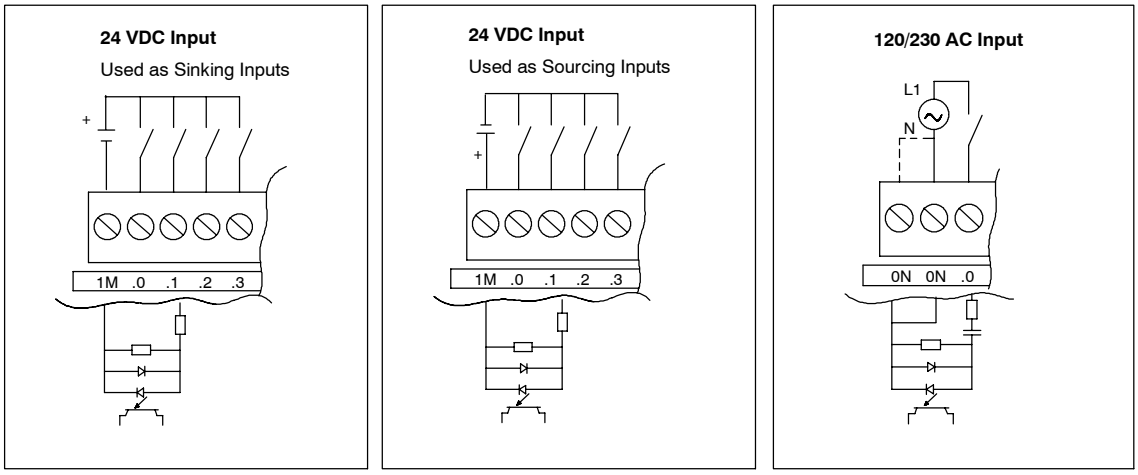


Figure A-7 S7-200 Digital Expansion Modules Inputs

Table A-14 Digital Expansion Modules Output Specifications

General	24 VDC Output		Relay Output		120/230 VAC Output
	0.75 A	5 A	2 A	10 A	
Type	Solid state-MOSFET (Sourcing)		Dry contact		Triac, zero-cross turn-on
Rated voltage	24 VDC		24 VDC or 250 VAC		120/230 VAC
Voltage range	20.4 to 28.8 VDC		5 to 30 VDC or 5 to 250 VAC	12 to 30 VDC or 12 to 250 VAC	40 to 264 VAC (47 to 63 Hz)
24 VDC coil power voltage range	-		20.4 to 28.8 VDC		-
Surge current (max.)	8 A for 100 ms	30 A	5 A for 4 s @ 10% duty cycle	15 A for 4 s @ 10% duty cycle	5 A rms for 2 AC cycles
Logic 1 (min.)	20 VDC		-		L1 (-0.9 V rms)
Logic 0 (max.)	0.1 VDC with 10 K Ω Load	0.2 VDC with 5 K Ω Load	-		-
Rated current per point (max.)	0.75 A	5 A	2.00 A	10 A resistive; 2 A DC inductive; 3 A AC inductive	0.5 A AC[1]
Rated current per common (max.)	10 A	5 A	10 A	10 A	0.5 A AC
Leakage current (max.)	10 μA	30 μA	-		1.1 mA rms at 132 VAC and 1.8 mA rrms at 264 VAC
Lamp load (max.)	5 W	50 W	30 W DC/ 200 W AC[4,5]	100 W DC/ 1000 W AC	60 W
Inductive clamp voltage	L+ minus 48 V	L+ minus 47 V[2]	-		-
On state resistance (contact)	0.3 Ω typical (0.6 Ω max.)	0.05 Ω max.	0.2 Ω max. when new	0.1 Ω max. when new	410 Ω max. when load current is less than 0.05A
Isolation					
Optical (galvanic, field to logic)	500 VAC for 1 minute		-		1500 VAC for 1minute
Coil to logic	-		None		-
Coil to contact	-		1500 VAC for 1 minute		-
Resistance (coil to contact)	-		100 M Ω min. when new		-
Isolation groups	See wiring diagram		See wiring diagram		1 point
Delay Off to On/On to Off (max.)	50 μs / 200 μs	500 μs	-	-	0.2 ms + 1/2 AC cycle
Switching (max.)	-	-	10 ms	15 ms	-
Switching frequency (max.)	-		1 Hz		10 Hz
Lifetime mechanical cycles	-		10,000,000 (no load)	30,000,000 (no load)	-
Lifetime contacts	-		100,000 (rated load)	30,000 (rated load)	-
Output on simultaneously	All at 55° C (horizontal), All at 45° C (vertical)			All at 55 °C (horizontal) with 20A max. module current. All at 45°C (vertical) with 20A max. module current[5]. All at 40 °C (horizontal) with 10A per point	All at 55° C (horizontal), All at 45° C (vertical)
Connecting two outputs in parallel	Yes, only outputs in same group		No		No
Cable length (max.)					
Shielded	500 m		500 m		500 m
Unshielded	150 m		150 m		150 m

1 Load current must be full wave AC and must not be half-wave because of the zero-cross circuitry. Minimum load current is 0.05 A AC. With a load current between 5 mA and 50 mA AC, the current can be controlled, but there is an additional voltage drop due to series resistance of 410 Ohms.

2 If the output overheats due to excessive inductive switching or abnormal conditions, the output point may turn off or be damaged. The output could overheat or be damaged if the output is subjected to more than 0.7 J of energy switching an inductive load off. To eliminate the need for this limitation, a suppression circuit as described in Chapter 3 can be added in parallel with the load. These components need to be sized properly for the given application.

3 The EM 222 DO 4 x Relay has a different FM rating than the rest of the S7-200. This module has a T4 rating, instead of T4A for FM Class I, Division Groups A, B, C, and D Hazardous Locations.

4 Relay lifetime with a lamp load will be reduced by 75% unless steps are taken to reduce the turn-on surge below the surge current rating of the output.

5 Lamp load wattage rating is for rated voltage. Reduce the wattage rating proportionally for voltage being switched (for example 120 VAC - 100 W).

Warning

When a mechanical contact turns on output power to the S7-200 CPU, or any digital expansion 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.

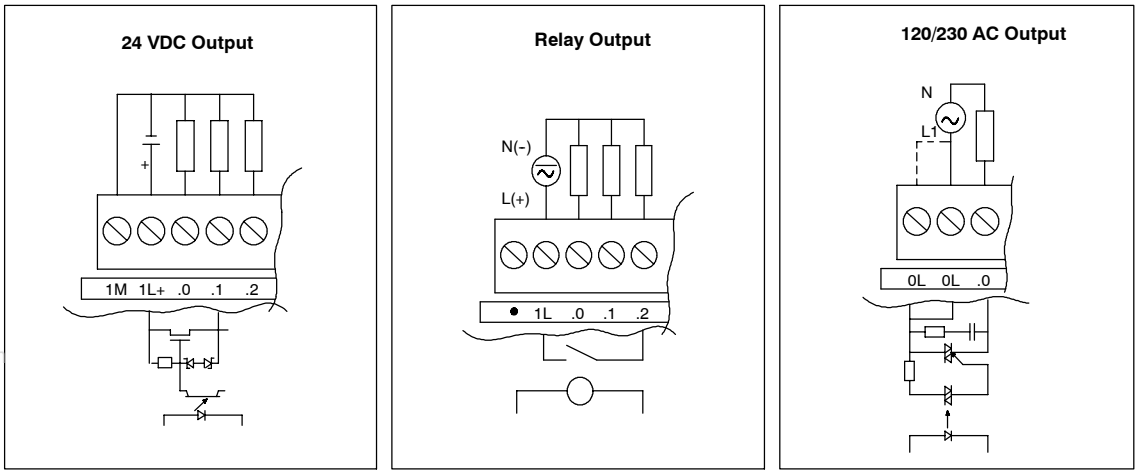


Figure A-8 S7-200 Digital Expansion Modules Outputs

Wiring Diagrams

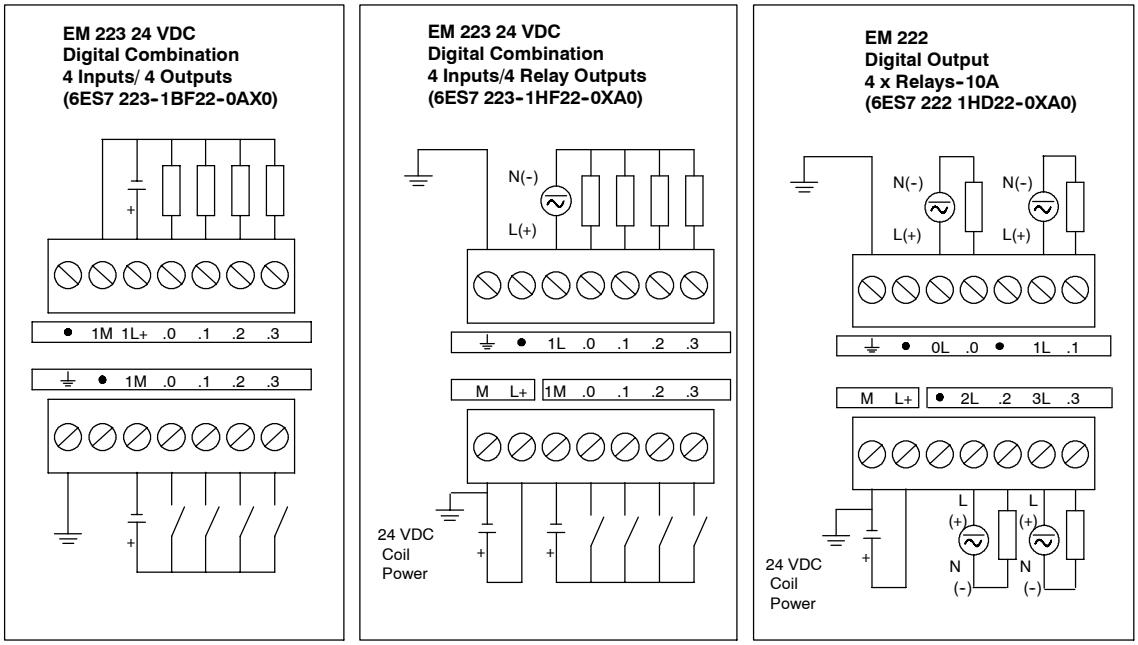


Figure A-9 Wiring Diagrams for EM 222 and EM 223 Expansion Modules

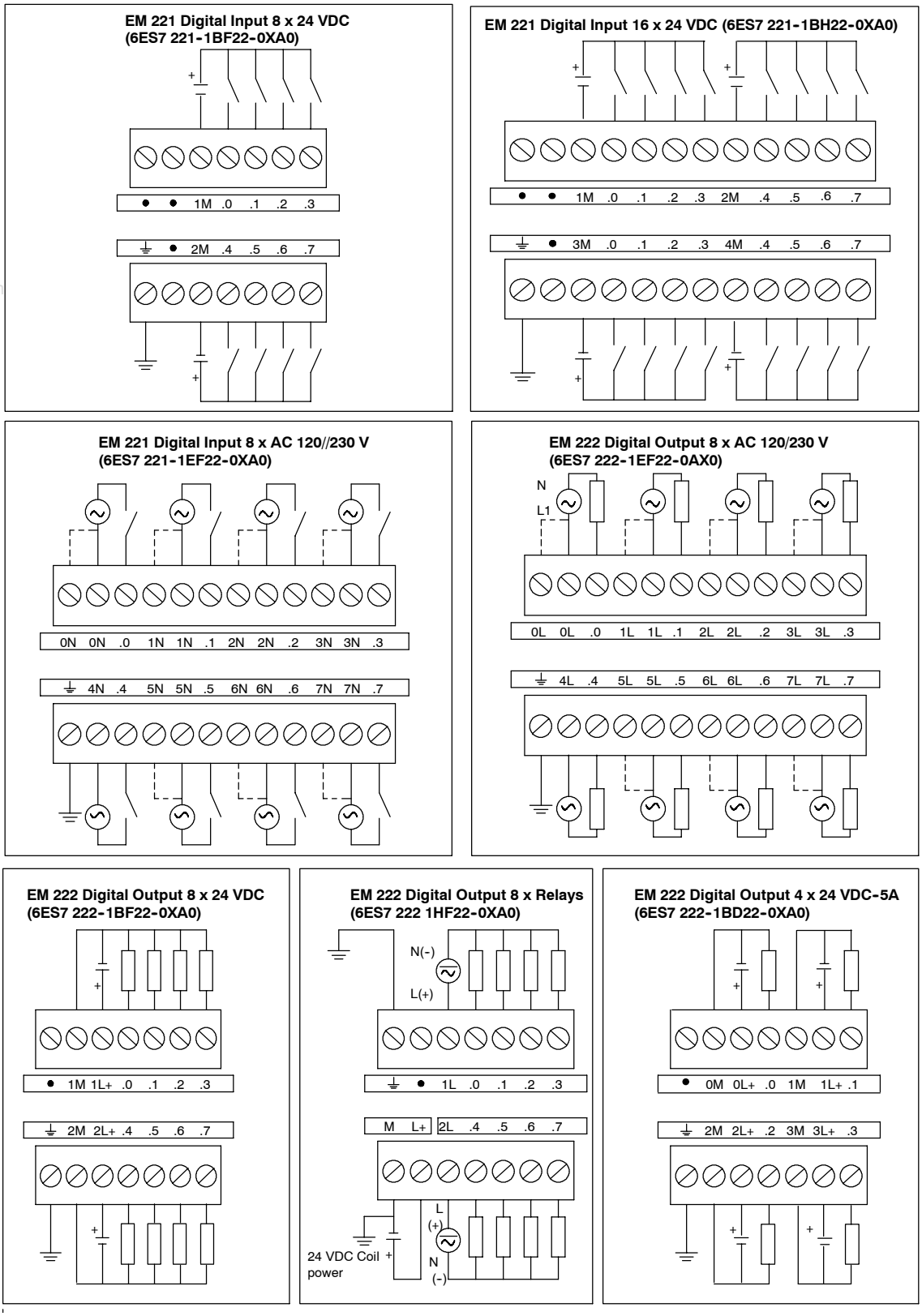


Figure A-10 Wiring Diagrams for EM 221 and EM 222 Expansion Modules

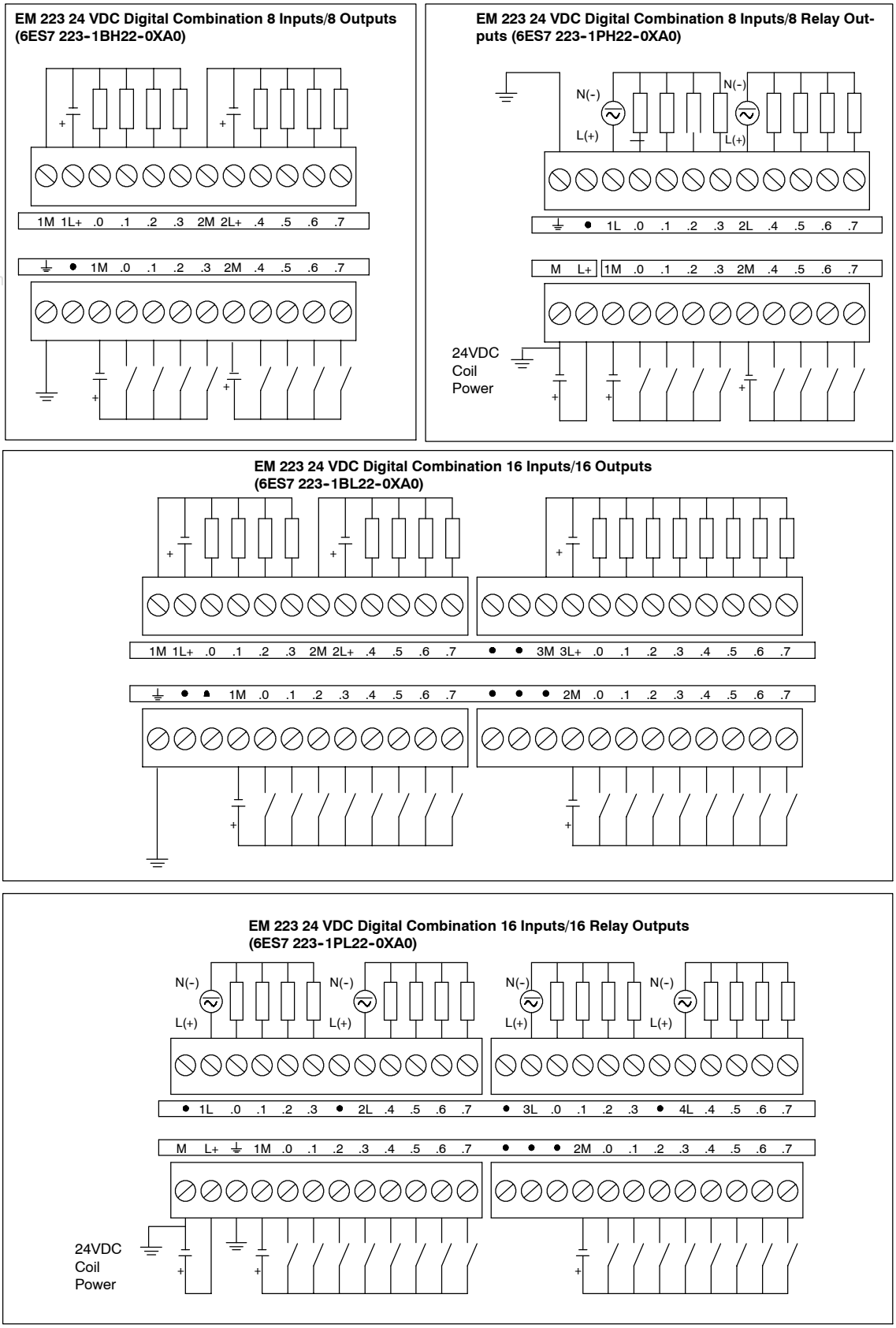


Figure A-11 Wiring Diagrams for EM 223 Expansion Modules

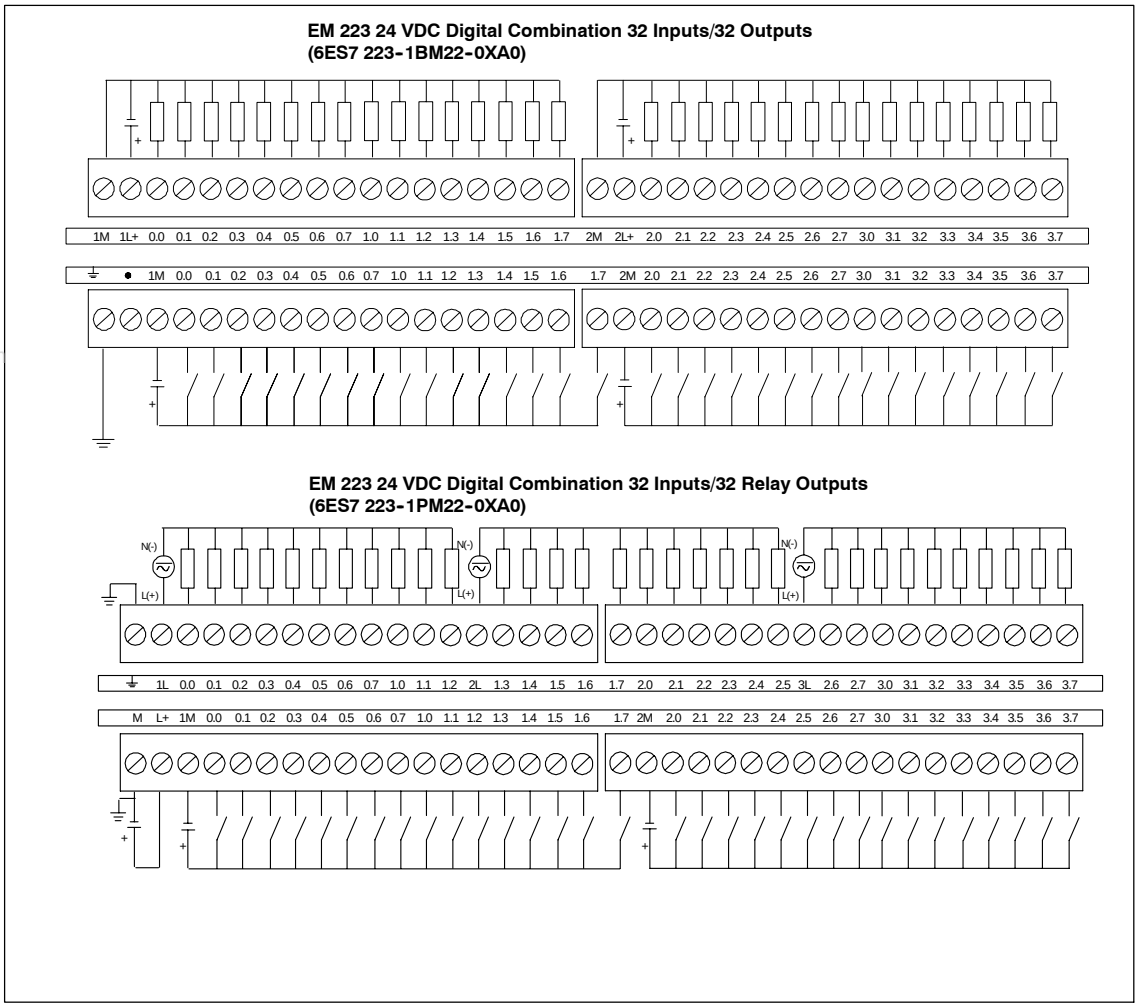


Figure A-12 Wiring Diagrams for EM 223 Expansion Modules

Analog Expansion Modules Specifications

Table A-15 Analog Expansion Modules Order Numbers

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6ES7 231-0HC22-0XA0	EM 231 Analog Input, 4 Inputs	4	-	No
6ES7 231-0HF22-0XA0	EM 231 Analog Input, 8 Inputs	8	-	No
6ES7 232-0HB22-0XA0	EM 232 Analog Output, 2 Outputs	-	2	No
6ES7 232-0HD22-0XA0	EM 232 Analog Output, 4 Outputs	-	4	No
6ES7 235-0KD22-0XA0	EM 235 Analog Combination 4 Inputs/1 Output	4	1[1]	No

[1] The CPU reserves 2 analog output points for this module.

Table A-16 Analog Expansion Modules General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements +24 VDC
6ES7 231-0HC22-0XA0	EM 231 Analog Input, 4 Inputs	71.2 x 80 x 62	183 g	2 W	20 mA	60 mA
6ES7 231-0HF22-0XA0	EM 231 Analog Input, 8 Inputs	71.2 x 80 x 62	190 g	2 W	20 mA	60 mA
6ES7 232-0HB22-0XA0	EM 232 Analog Output, 2 Outputs	46 x 80 x 62	148 g	2 W	20 mA	70 mA (with both outputs at 20 mA)
6327 232-0HD22-0XA0	EM 232 Analog Output, 4 Outputs	71.2 x 80 x 62	190 g	2 W	20 mA	100 MA (with all outputs at 20 mA)
6ES7 235-0KD22-0XA0	EM 235 Analog Combination 4 Inputs/1 Output	71.2 x 80 x 62	186 g	2 W	30 mA	60 mA (with output at 20 mA)

Table A-17 Analog Expansion Modules Input Specifications

General	6ES7 231-0HC22-0XA0 6ES7 235-0KD22-0XA0	6ES7 231-0HF22-0XA0
Data word format Bipolar, full-scale range Unipolar, full-scale range	(See Figure A-16) -32000 to +32000 0 to 32000	
DC Input impedance	≥2 MΩ voltage input 250 Ω current input	> 2 MΩ voltage input 250 Ω current input
Input filter attenuation	-3 db at 3.1 Khz	
Maximum input voltage	30 VDC	
Maximum input current	32 mA	
Resolution Bipolar Unipolar	 11 bits plus 1 sign bit 12 bits	
Isolation (field to logic)	None	
Input type	Differential	Differential voltage, two channels selectable for current
Input ranges	Voltage: Selectable, see Table A-20 for available ranges Current: 0 to 20 mA	Voltage: Channels 0 to 7 0 to +10V, 0 to +5V and +/-2.5 Current: Channels 6 and 7 0 to 20mA
Input resolution	See Table A-20	See Table A-22
Analog to digital conversion time	< 250 μs	< 250 μs
Analog input step response	1.5 ms to 95%	1.5 ms to 95%
Common mode rejection	40 dB, DC to 60 Hz	40 dB, DC to 60 Hz
Common mode voltage	Signal voltage plus common mode voltage must be ≤ ±12 V	Signal voltage plus common mode voltage must be ≤ ±12 V
24 VDC supply voltage range	20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from PLC)	

Table A-18 Analog Expansion Modules Output Specifications

General	6ES7 232-0HB22-0XA0 6ES7 232-0HD22-0XA0 6ES7 235-0KD22-0XA0
Isolation (field to logic)	None
Signal range	
Voltage output	± 10 V
Current output	0 to 20 mA
Resolution, full-scale	
Voltage	11 bits
Current	11 bits
Data word format	
Voltage	-32000 to +32000
Current	0 to +32000
Accuracy	
Worst case, 0° to 55° C	
Voltage output	± 2% of full-scale
Current output	± 2% of full-scale
Typical, 25° C	
Voltage output	± 0.5% of full-scale
Current output	± 0.5% of full-scale
Setting time	
Voltage output	100 μS
Current output	2 mS
Maximum drive	
Voltage output	5000 Ω minimum
Current output	500 Ω maximum
24 VDC supply voltage range	20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from PLC)

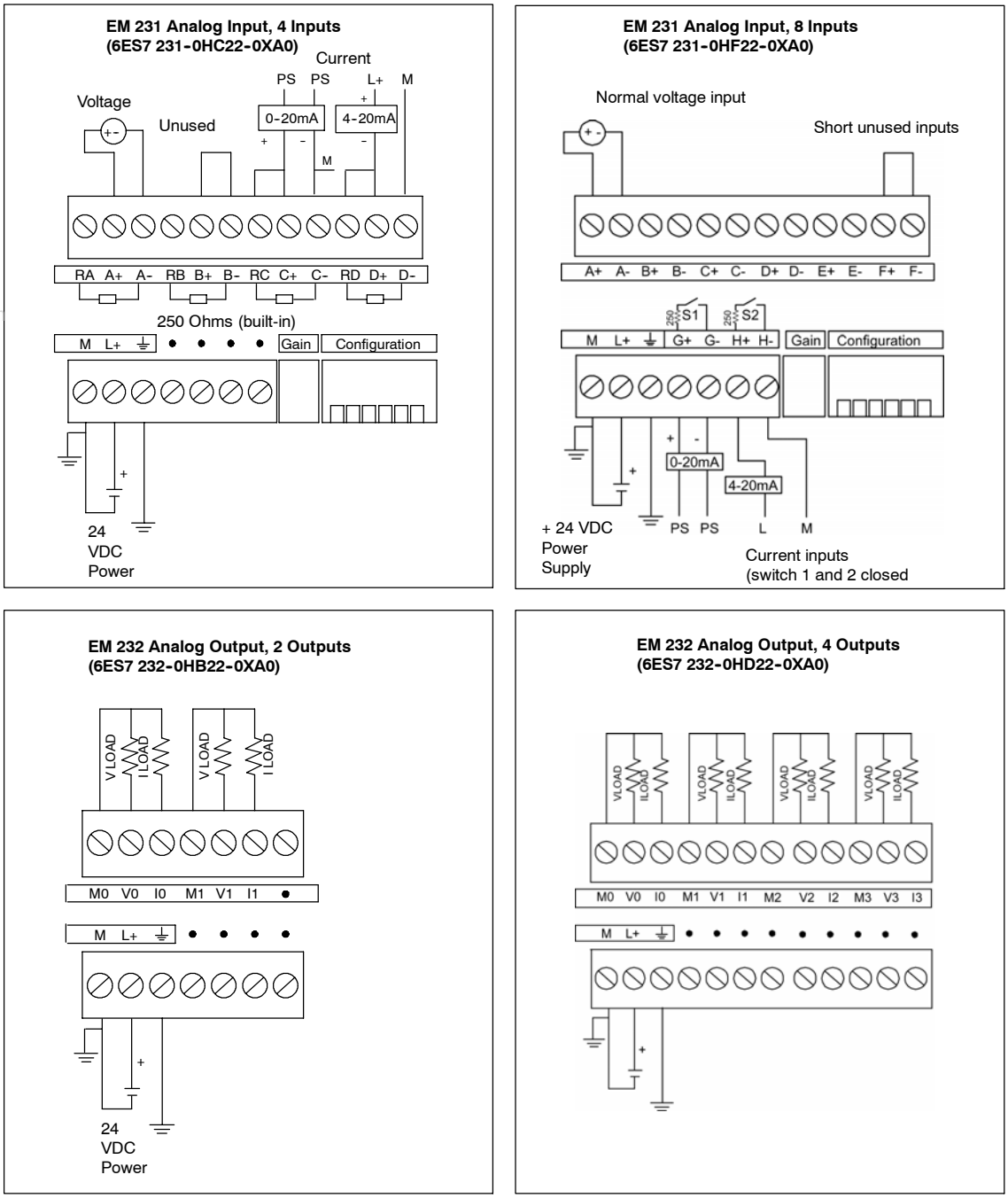


Figure A-13 Wiring Diagrams for Analog Expansion Modules

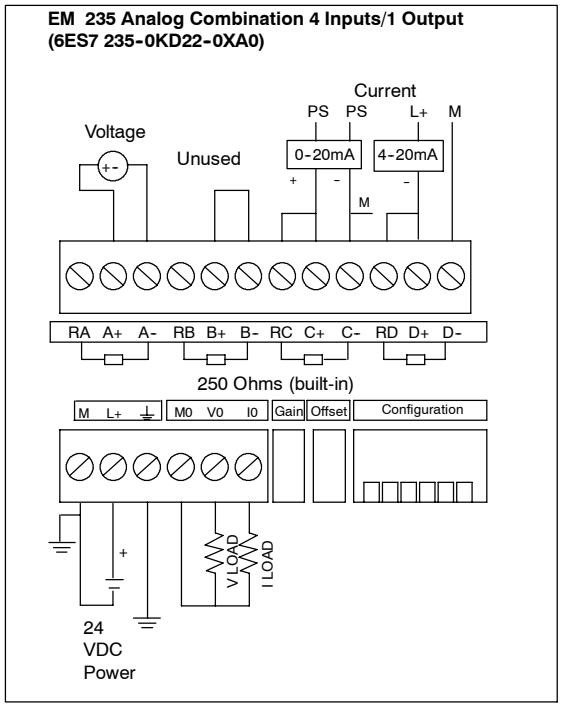


Figure A-14 Wiring Diagrams for Analog Expansion Modules

Analog LED Indicators

The LED indicators for the analog modules are shown in Table A-19.

Table A-19 Analog LED Indicators

LED Indicator	ON	OFF
24 VDC Power Supply Good	No faults	No 24 VDC power

Tip

The state of user power is also reported in Special Memory (SM) bits. For more information, see Appendix D, SMB8 to SMB21 I/O Module ID and Error Registers.

Input Calibration

The calibration adjustments affect the instrumentation amplifier stage that follows the analog multiplexer (see the Input Block Diagram for the EM 231 in Figure A-17 and EM 235 in Figure A-19). Therefore, calibration affects all user input channels. Even after calibration, variations in the component values of each input circuit preceding the analog multiplexer will cause slight differences in the readings between channels connected to the same input signal.

To meet the specifications, you should enable analog input filters for all inputs of the module. Select 64 or more samples to calculate the average value.

To calibrate the input, use the following steps.

1. Turn off the power to the module. Select the desired input range.
2. Turn on the power to the CPU and module. Allow the module to stabilize for 15 minutes.
3. Using a transmitter, a voltage source, or a current source, apply a zero value signal to one of the input terminals.
4. Read the value reported to the CPU by the appropriate input channel.
5. Adjust the OFFSET potentiometer until the reading is zero, or the desired digital data value.
6. Connect a full-scale value signal to one of the input terminals. Read the value reported to the CPU.
7. Adjust the GAIN potentiometer until the reading is 32000, or the desired digital data value.
8. Repeat OFFSET and GAIN calibration as required.

Calibration and Configuration Location for EM 231 and EM 235

Figure A-15 shows the calibration potentiometer and configuration DIP switches located on the right of the bottom terminal block of the module.

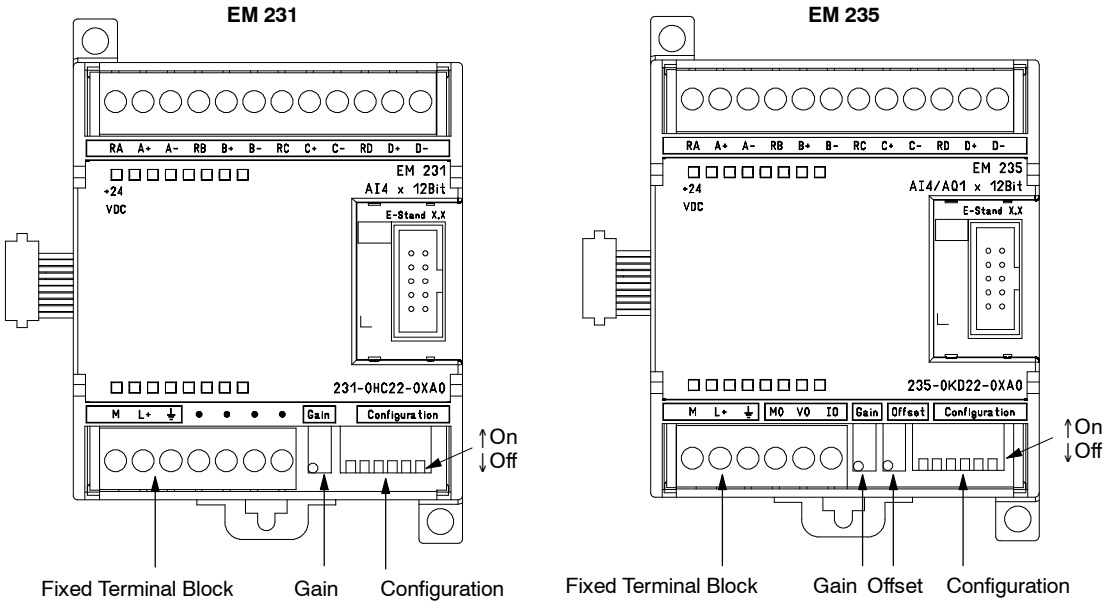


Figure A-15 Calibration Potentiometer and Configuration DIP Switch Location for the EM 231 and EM 235

Configuration for EM 231

Table A-20 and Table A-21show how to configure the the EM 231 modules using the configuration DIP switches. All inputs are set to the same analog input range. In these tables, ON is closed, and OFF is open. The switch settings are read only when the power is turned on.

For the EM 231 Analog Input, 4 Inputs module, switches 1, 2, and 3 select the analog input range (Table A-20).

Table A-20 Configuration Switch Table to Select Analog Input Range for the EM 231 Analog Input, 4 Inputs

Unipolar			Full-Scale Input	Resolution
SW1	**SW2**	**SW3**		
ON	OFF	ON	0 to 10 V	2.5 mV
	ON	OFF	0 to 5 V	1.25 mV
			0 to 20 mA	5 μA
Bipolar			**Full-Scale Input**	**Resolution**
SW1	**SW2**	**SW3**		
OFF	OFF	ON	±5 V	2.5 mV
	ON	OFF	± 2.5 V	1.25 mV

For the EM 231 Analog Input, 8 Inputs module, switches 3, 4, and 5 select the analog input range. Use Switch 1 and 2 to select the current mode input (Table A-21). Switch 1 ON selects current mode input for Channel 6; OFF selects voltage mode. Switch 2 ON selects current mode input for Channel 7; OFF selects voltage mode.

Table A-21 EM 231 Configuration Switch Table to Select Analog Input Range for the EM 231 Analog Input, 8 Inputs

Unipolar			Full-Scale Input	Resolution
SW3	**SW4**	**SW5**		
ON	OFF	ON	0 to 10 V	2.5 mV
	ON	OFF	0 to 5 V	1.25 mV
			0 to 20 mA	5 μA
Bipolar			**Full-Scale Input**	**Resolution**
SW3	**SW4**	**SW5**		
OFF	OFF	ON	±5 V	2.5 mV
	ON	OFF	± 2.5 V	1.25 mV

Configuration for EM 235

Table A-22 shows how to configure the EM 235 module using the configuration DIP switches. Switches 1 through 6 select the analog input range and resolution. All inputs are set to the same analog input range and format. Table A-22 shows how to select for unipolar/bipolar (switch 6), gain (switches 4 and 5), and attenuation (switches 1, 2, and 3). In these tables, ON is closed, and OFF is open. The switch settings are read only when the power is turned on.

Table A-22 EM 235 Configuration Switch Table to Select Analog Range and Resolution

Unipolar						Full-Scale Input	Resolution
SW1	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**		
ON	OFF	OFF	ON	OFF	ON	0 to 50 mV	12.5 μV
OFF	ON	OFF	ON	OFF	ON	0 to 100 mV	25 μV
ON	OFF	OFF	OFF	ON	ON	0 to 500 mV	125 μV
OFF	ON	OFF	OFF	ON	ON	0 to 1 V	250 μV
ON	OFF	OFF	OFF	OFF	ON	0 to 5 V	1.25 mV
ON	OFF	OFF	OFF	OFF	ON	0 to 20 mA	5 μA
OFF	ON	OFF	OFF	OFF	ON	0 to 10 V	2.5 mV
Bipolar						**Full-Scale Input**	**Resolution**
SW1	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**		
ON	OFF	OFF	ON	OFF	OFF	±25 mV	12.5 μV
OFF	ON	OFF	ON	OFF	OFF	±50 mV	25 μV
OFF	OFF	ON	ON	OFF	OFF	±100 mV	50 μV
ON	OFF	OFF	OFF	ON	OFF	±250 mV	125 μV
OFF	ON	OFF	OFF	ON	OFF	±500 mV	250 μV
OFF	OFF	ON	OFF	ON	OFF	±1 V	500 μV
ON	OFF	OFF	OFF	OFF	OFF	±2.5 V	1.25 mV
OFF	ON	OFF	OFF	OFF	OFF	±5 V	2.5 mV
OFF	OFF	ON	OFF	OFF	OFF	±10 V	5 mV

Input Data Word Format for EM 231 and EM 235

Figure A-16 shows where the 12-bit data value is placed within the analog input word of the CPU.

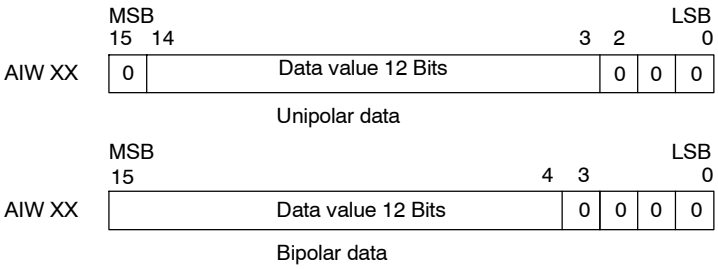


Figure A-16 Input Data Word Format for EM 231 and EM 235

Tip

The 12 bits of the analog-to-digital converter (ADC) readings are left-justified in the data word format. The MSB is the sign bit: zero indicates a positive data word value.

In the unipolar format, the three trailing zeros cause the data word to change by a count of eight for each one-count change in the ADC value.

In the bipolar format, the four trailing zeros cause the data word to change by a count of sixteen for each one count change in the ADC value.

Input Block Diagrams for EM 231 and 235

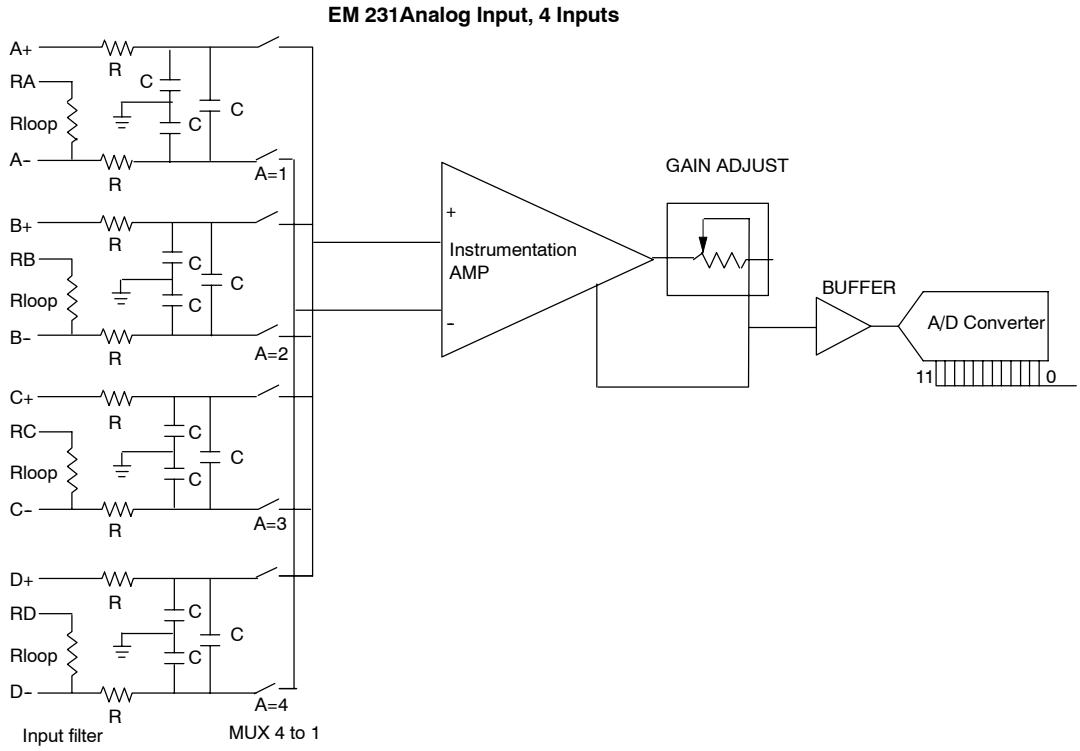


Figure A-17 Input Block Diagram for the EM 231 Analog Input, 4 Inputs

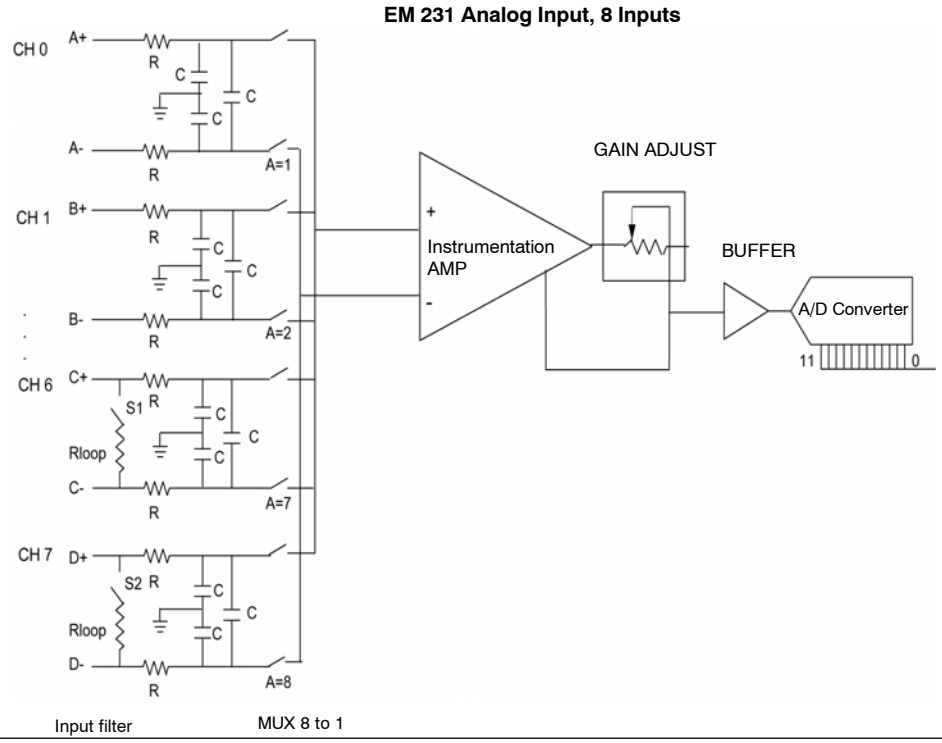


Figure A-18 Input Block Diagram for the EM231 Analog Input, 8 Inputs

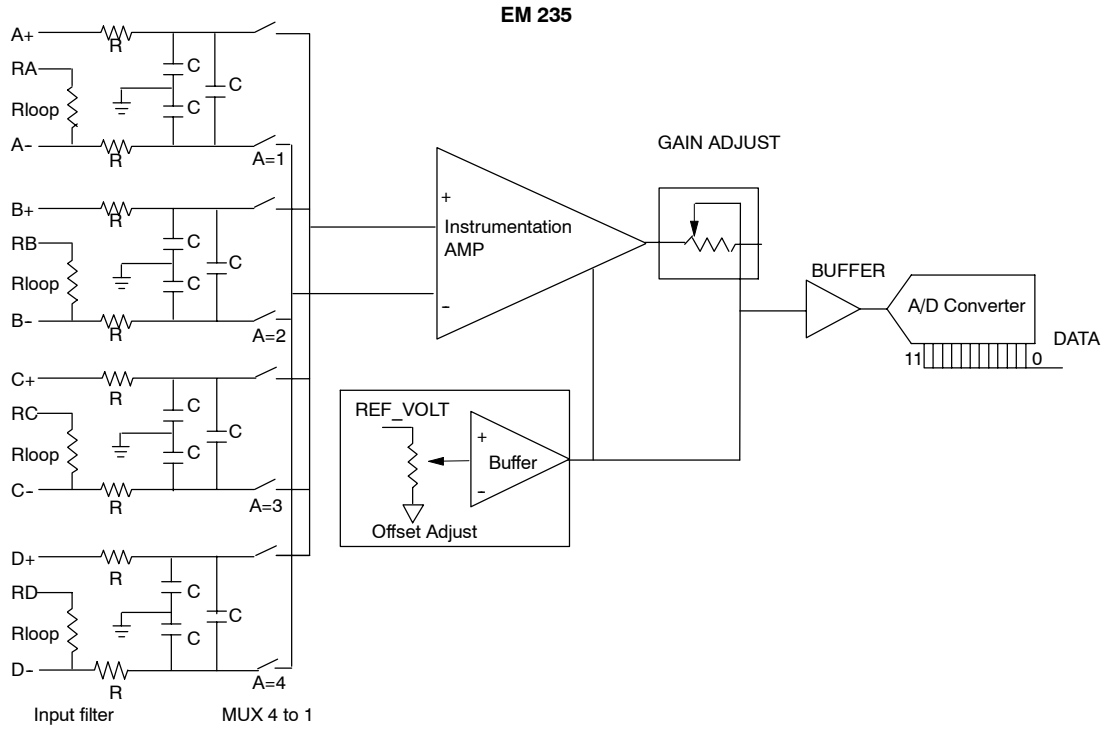


Figure A-19 Input Block Diagram for the EM 235

Output Data Word Format for EM 232 and EM 235

Figure A-20 shows where the 12-bit data value is placed within the analog output word of the CPU.

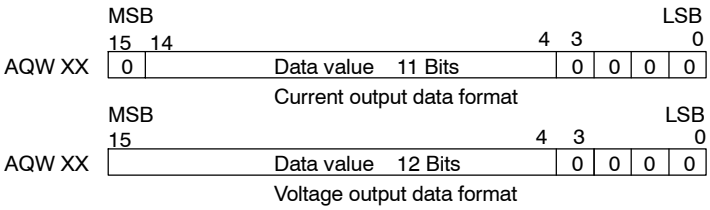


Figure A-20 Output Data Word Format for EM 232 and EM 235

Tip

The 12 bits of the digital-to-analog converter (DAC) readings are left-justified in the output data word format. The MSB is the sign bit: zero indicates a positive data word value. The four trailing zeros are truncated before being loaded into the DAC registers. These bits have no effect on the output signal value.

Output Block Diagram for EM 232 and EM 235

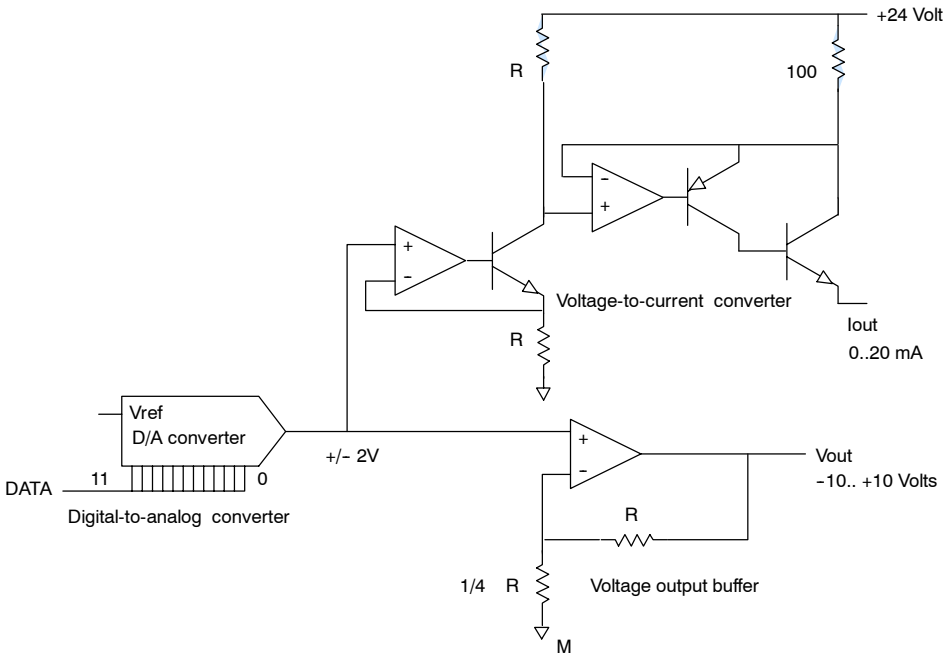


Figure A-21 Output Block Diagram for the EM 232 and EM 235

Installation Guidelines

Use the following guidelines to ensure accuracy and repeatability:

- ❑ Ensure that the 24-VDC Sensor Supply is free of noise and is stable.
- ❑ Use the shortest possible sensor wires.
- ❑ Use shielded twisted pair wiring for sensor wires.
- ❑ Terminate the shield at the Sensor location only.
- ❑ Short the inputs for any unused channels, as shown in Figure A-21.
- ❑ Avoid bending the wires into sharp angles.
- ❑ Use wireways for wire routing.
- ❑ Avoid placing signal wires parallel to high-energy wires. If the two wires must meet, cross them at right angles.
- ❑ Ensure that the input signals are within the common mode voltage specification by isolating the input signals or referencing them to the external 24V common of the analog module.

Tip

The EM 231 and EM 235 expansion modules are not recommended for use with thermocouples.

Understanding the Analog Input Module: Accuracy and Repeatability

The EM 231 and EM 235 analog input modules are low-cost, high-speed 12 bit analog input modules. The modules can convert an analog signal input to its corresponding digital value in 149 μsec. The analog signal input is converted each time your program accesses the analog point. These conversion times must be added to the basic execution time of the instruction used to access the analog input.

The EM 231 and EM 235 provide an unprocessed digital value (no linearization or filtering) that corresponds to the analog voltage or current presented at the module's input terminals. Since the modules are high-speed modules, they can follow rapid changes in the analog input signal (including internal and external noise).

You can minimize reading-to-reading variations caused by noise for a constant or slowly changing analog input signal by averaging a number of readings. Note that increasing the number of readings used in computing the average value results in a correspondingly slower response time to changes in the input signal.

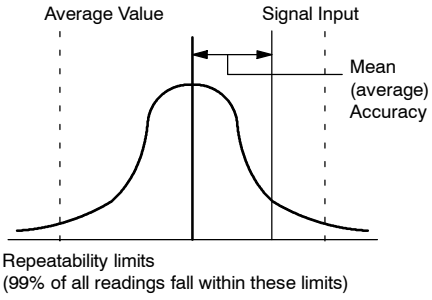


Figure A-22 Accuracy Definitions

Figure A-22 shows the 99% repeatability limits, the mean or average value of the individual readings, and the mean accuracy in a graphical form.

The specifications for repeatability describe the reading-to-reading variations of the module for an input signal that is not changing. The repeatability specification defines the limits within which 99% of the readings will fall. The repeatability is described in this figure by the bell curve.

The mean accuracy specification describes the average value of the error (the difference between the average value of individual readings and the exact value of the actual analog input signal).

Table A-23 gives the repeatability specifications and the mean accuracy as they relate to each of the configurable ranges.

Definitions of the Analog Specifications

- Accuracy: deviation from the expected value on a given point
- Resolution: the effect of an LSB change reflected on the output.

Table A-23 EM 231 and EM 235 Specifications

Full Scale Input Range	Repeatability[1]		Mean (average) Accuracy[1,2,3,4]	
	% of Full Scale	Counts	% of Full Scale	Counts
EM 231 Specifications				
0 to 5 V	± 0.075%	± 24	± 0.1%	± 32
0 to 20 mA				
0 to 10 V				
± 2.5 V		± 48	± 0.05%	
± 5 V				
EM 235 Specifications				
0 to 50 mV	± 0.075%	± 24	± 0.25%	± 80
0 to 100 mV			± 0.2%	± 64
0 to 500 mV			± 0.05%	± 16
0 to 1 V				
0 to 5 V				
0 to 20 mA				
0 to 10 V				
± 25 mV	± 0.075%	± 48	± 0.25%	± 160
± 50 mV			± 0.2%	± 128
± 100 mV			± 0.1%	± 64
± 250 mV			± 0.05%	± 32
± 500 mV				
± 1 V				
± 2.5 V				
± 5 V				
± 10 V				

1 Measurements made after the selected input range has been calibrated.
2 The offset error in the signal near zero analog input is not corrected, and is not included in the accuracy specifications.
3 There is a channel-to-channel carryover conversion error, due to the finite settling time of the analog multiplexer. The maximum carryover error is 0.1% of the difference between channels.
4 Mean accuracy includes effects of non-linearity and drift from 0 to 55 degrees C.

Thermocouple and RTD Expansion Modules Specifications

Table A-24 Thermocouple and RTD Modules Order Numbers

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6ES7 231-7PD22-0XA0	EM 231 Analog Input Thermocouple, 4 Inputs	4 Thermocouple	-	No
6ES7 231-7PB22-0XA0	EM 231 Analog Input RTD, 2 Inputs	2 RTD	-	No

Table A-25 Thermocouple and RTD Modules General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements +24 VDC
6ES7 231-7PD22-0XA0	EM 231 Analog Input Thermocouple, 4 Inputs	71.2 x 80 x 62	210 g	1.8 W	87mA	60 mA
6ES7 231-7PB22-0XA0	EM 231 Analog Input RTD, 2 Inputs	71.2 x 80 x 62	210 g	1.8 W	87 mA	60 mA

Table A-26 Thermocouple and RTD Modules Specifications

General	6ES7 231-7PD22-0XA0 Thermocouple	6ES7 231-7PB22-0XA0 RTD
Isolation		
Field to logic	500 VAC	500 VAC
Field to 24 VDC	500 VAC	500 VAC
24 VDC to logic	500 VAC	500 VAC
Common mode input range (input channel to input channel)	120 VAC	0
Common mode rejection	> 120 dB at 120 VAC	> 120 dB at 120 VAC
Input type	Floating TC	Module ground referenced RTD
Input ranges[1]	TC types (select one per module) S, T, R, E, N, K, J Voltage range : +/- 80 mV	RTD types (select one per module): platinum (Pt), copper (Cu), nickel (Ni), or Resistance See Table A-31 for available RTD types.
Input resolution		
Temperature	0.1° C / 0.1° F	0.1° C / 0.1° F
Voltage	15 bits plus sign	-
Resistance	-	15 bits plus sign
Measuring Principle	Sigma-delta	Sigma-delta
Module update time: All channels	405 ms	405 ms (700 ms for Pt10000)
Wire length	100 meters to sensor max.	100 meters to sensor max.
Wire loop resistance	100Ω max.	20Ω, 2.7Ω for Cu max.
Suppression of interference	85 dB at 50 Hz/60 Hz/ 400 Hz	85 dB at 50 Hz/60 Hz/400 Hz
Data word format	Voltage: -27648 to + 27648	Resistance: 0 to +27648
Maximum sensor dissipation	-	1m W
Input impedance	≥1 MΩ	≥ 10 MΩ
Maximum input voltage	30 VDC	30 VDC (sense), 5 VDC (source)
Input filter attenuation	-3 db at 21 kHz	-3 db at 3.6 kHz
Basic error	0.1% FS (voltage)	0.1% FS (resistance)
Repeatability	0.05% FS	0.05% FS
Cold junction error	±1.5 ° C	-
24 VDC supply voltage range	20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from PLC)	

[1] The input range selection (temperature, voltage on resistance) applies to all channels on the module.

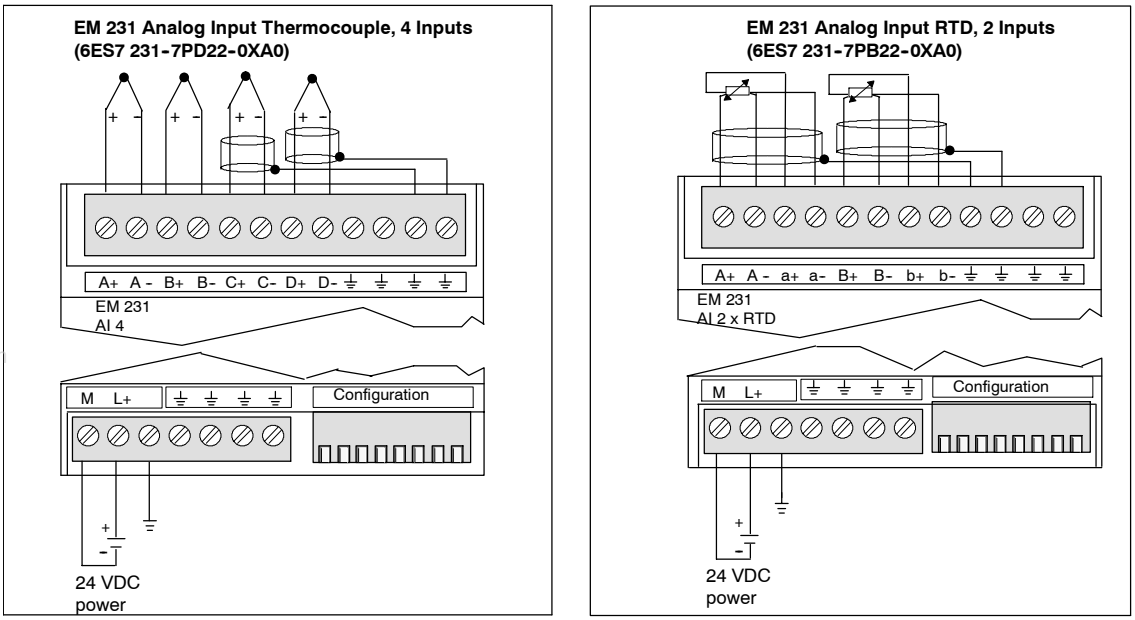


Figure A-23 Connector Terminal Identification for EM 231 Thermocouple and EM 231 RTD Modules

Compatibility

The RTD and Thermocouple modules are designed to work with the CPU 222, CPU 224, CPU 224XP and CPU 226.

Tip

The RTD and Thermocouple modules are designed to give maximum performance when installed in a stable temperature environment.

The EM 231 Thermocouple module, for example, has special cold junction compensation circuitry that measures the temperature at the module connectors and makes necessary changes to the measurement to compensate for temperature differences between the reference temperature and the temperature at the module. If the ambient temperature is changing rapidly in the area where the EM 231 Thermocouple module is installed, additional errors are introduced.

To achieve maximum accuracy and repeatability, Siemens recommends that the S7-200 RTD and Thermocouple modules be mounted in locations that have stable ambient temperature.

Noise Immunity

Use shielded wires for best noise immunity. If a thermocouple input channel is not used, short the unused channel inputs, or connect them in parallel to another channel.

EM 231 Thermocouple Module

The EM 231 Thermocouple module provides a convenient, isolated interface for the S7-200 family to seven thermocouple types: J, K, E, N, S, T, and R. It allows the S7-200 to connect to low level analog signals, ±80mV range. All thermocouples attached to the module must be of the same type.

Thermocouple Basics

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

When you connect a thermocouple to the EM 231 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.

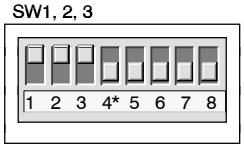
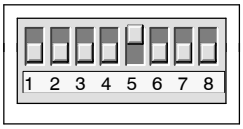
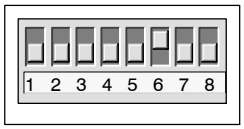
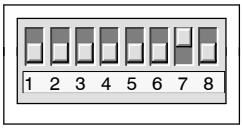
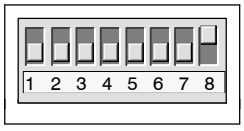
Cold junction compensation is used to compensate for the connector thermocouple. Thermocouple tables are based on a reference junction temperature, usually zero degrees Celsius. The cold junction compensation compensates the connector to zero degrees Celsius. The cold junction compensation restores the 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.

Configuring the EM 231 Thermocouple Module

Configuration DIP switches located on the bottom of the module allow you to select the thermocouple type, open wire detect, temperature scale, and cold junction compensation. For the DIP switch settings to take effect, you need to power cycle the PLC and/or the user 24V power supply.

DIP switch 4 is reserved for future use. Set DIP switch 4 to the 0 (down or off) position. Table A-27 shows other DIP switch settings.

Table A-27 Configuring the Thermocouple Module DIP Switches

Switches 1,2,3	Thermocouple Type	Setting	Description
SW1, 2, 3  Configuration ↑1 – On ↓0 – Off * Set DIP switch 4 to the 0 (down) position.	J (Default)	000	Switches 1 to 3 select the thermocouple type (or mV operation) for all channels on the module. For example, for an E type, thermocouple SW1 = 0, SW2 = 1, SW3 = 1.
	K	001	
	T	010	
	E	011	
	R	100	
	S	101	
	N	110	
	+/–80mV	111	
Switch 5	**Open Wire Detect Direction**	**Setting**	**Description**
SW5  Configuration ↑1 – On ↓0 – Off	Upscale (+3276.7 degrees)	0	0 indicates positive on open wire 1 indicates negative on open wire
	Downscale (–3276.8 degrees)	1	
Switch 6	**Open Wire Detect Enable**	**Setting**	**Description**
SW6  Configuration ↑1 – On ↓0 – Off	Enable	0	Open wire detection is performed by injecting a 25 μA current onto the input terminals. The open wire enable switch enables or disables the current source. The open wire range check is always performed, even when the current source is disabled. The EM 231 Thermocouple module detects open wire if the input signal exceeds approximately ±200mV. When an open wire is detected, the module reading is set to the value selected by the Open Wire Detect.
	Disable	1	
Switch 7	**Temperature Scale**	**Setting**	**Description**
SW7  Configuration ↑1 – On ↓0 – Off	Celsius (°C)	0	The EM 231 Thermocouple module can report temperatures in Celsius or Fahrenheit. The Celsius to Fahrenheit conversion is performed inside the module.
	Fahrenheit (°F)	1	
Switch 8	**Cold Junction**	**Setting**	**Description**
SW8  Configuration ↑1 – On ↓0 – Off	Cold junction compensation enabled	0	Cold junction compensation must be enabled when you are using thermocouples. If cold junction compensation is not enabled, the conversions from the module will be in error because of the voltage that is created when the thermocouple wire is connected to the module connector. Cold junction is automatically disabled when you select the ±80mV range.
	Cold junction compensation disabled	1	

Tip

- The open wire current source could interfere with signals from some low level sources such as thermocouple simulators.
- Input voltages exceeding approximately ±200mV will trigger open wire detection even when the open wire current source is disabled.

Tip

- Module error could exceed specifications while the ambient temperature is changing.
- Exceeding the module ambient temperature range specification could cause the module cold junction to be in error.

Using the Thermocouple: Status Indicators

The EM 231 Thermocouple module provides the PLC with data words that indicate temperatures or error conditions. Status bits indicate range error and user supply/module failure. LEDs indicate the status of the module. Your program should have logic to detect error conditions and respond appropriately for the application. Table A-28 shows the EM 231 Thermocouple status indicators.

Table A-28 EM 231Thermocouple Status Indicators

Error Condition	Channel Data	SF LED Red	24 V LED Green	Range Status Bit[1]	24 VDC User Power Bad[2]
No errors	Conversion data	OFF	ON	0	0
24 V missing	32766	OFF	OFF	0	1
Open wire and current source enabled	-32768/32767	BLINK	ON	1	0
Out of range input	-32768/32767	BLINK	ON	1	0
Diagnostic error[3]	0000	ON	OFF	0	note [3]

1 Range status bit is bit 3 in module error register byte (SMB9 for Module 1, SMB11 for Module 2, etc.)
2 User Power Bad status bit is bit 2 in module error register byte (SMB 9, SMB 11, etc., refer to Appendix D)
3 Diagnostic errors cause a module configuration error. The User Power Bad status bit may or may not be set before the module configuration error.

Tip

The channel data format is two's complement, 16-bit words. Temperature is presented in 0.1 degree units. For example, if the measured temperature is 100.2 degrees, the reported data is 1002. Voltage data are scaled to 27648. For example, -60.0mV is reported as -20736 (=-60mV/80mV * 27648).

All four channels are updated every 405 milliseconds if the PLC has read the data. If the PLC does not read the data within one update time, the module reports old data until the next module update after the PLC read. To keep channel data current, it is recommended that the PLC program read data at least as often as the module update rate.

Tip

When you are using the EM 231 Thermocouple module, you should disable analog filtering in the PLC. Analog filtering can prevent error conditions from being detected in a timely manner.

Table A-29 Temperature Ranges (°C) and Accuracy for Thermocouple Types

Data Word (1 digit = 0.1°C)		Type J	Type K	Type T	Type E	Type R, S	Type N	±80mV	
Dec	Hex								
32767	7FFF	>1200.0 °C	>1372.0 °C	>400.0 °C	>1000.0°C	>1768.0°C	>1300.0°C	>94.071mV	OF
↑	↑							↑	↑
32511	7EFF							94.071mV	OR
:	:								
27649	6C01							80.0029mV	
27648	6C00					↑		80mV	NR
:	:								
17680	4510		↑			1768.0°C			
:	:								
13720	3598		1372.0°C				↑		
:	:		overrange						
13000	32C8	↑	1300.0°C				1300.0°C		
:	:								
12000	2EE0	1200.0°C			↑				
:	:								
10000	2710			↑	1000.0°C				
:	:								
4000	0FA0			400.0°C		400.0°C			
:	:								
1	0001	0.1°C	0.1°C	0.1°C	0.1°C	0.1°C	0.1°C	0.0029mV	
0	0000	0.0°C	0.0°C	0.0°C	0.0°C	0.0°C	0.0°C	0.0mV	
-1	FFFF	-0.1°C	-0.1°C	-0.1°C	-0.1°C	-0.1°C	-0.1°C	-0.0029mV	
:	:					underrange			
-500	FE0C					-50.0°C			
-1500	FA24	-150.0°C				↓			
:	:								
-2000	F830	underrange	-200.0°C						
:	:								
-2100	F7CC	-210.0°C							
:	:								
-2400	F6A0				-240.0°C				
:	:		underrange		underrange				
-2550	F60A			-255.0°C					
:	:			underrange					
-2700	F574	↓	-270.0°C	-270.0°C	-270.0°C		-270.0°C		NR
:	:								
-27648	9400		↓	↓	↓		↓	-80.mV	
-27649	93FF							-80.0029mV	
:	:								
-32512	8100							-94.071mV	UR
↓	↓							↓	↓
-32768	8000	<-210.0°C	<-270.0°C	<-270.0°C	<-270.0°C	<-50.0°C	<-270.0°C	<-94.071mV	UF
Accuracy over full span		±0.1%	±0.3%	±0.6%	±0.3%	±0.6%	±0.4%	±0.1%	
Accuracy (normal range without cold junction)		±1.5°C	±1.7°C	±1.4°C	±1.3°C	±3.7°C	±1.6°C	±0.10%	
Cold junction error		±1.5°C	±1.5°C	±1.5°C	±1.5°C	±1.5°C	±1.5°C	N/A	

*OF = Overflow; OR = Overrange; NR = Normal range; UR = Underrange; UF = Underflow

↑ indicates that all analog values greater than this and below the open wire threshold report the overflow data value, 32767 (0x7FFF).
↓ indicates that all analog values less than this and greater than the open wire threshold report the underflow data value, -32768 (0x8000).

Table A-30 Temperature Ranges (°F) for Thermocouple Types

Data Word (1 digit = 0.1°F) Dec	Hex	Type J	Type K	Type T	Type E	Type R, S	Type N	±80 mV	
32767	7FFF	>2192.0 °F	>2502.0 °F	>752.0 °F	>1832.0°F	>3214.0°F	>2372.0°F	>94.071mV	OF
↑	↑					↑		↑	↑
32511	7EFF							94.071mV	OR
32140	7D90					3214.0°F			
27649	6C01							80.0029mV	
27648	6C00		↑					80mV	NR
:	:					2764.8°F			
25020	61B8		2502.0°F				↑		
:	:		overrange						
23720	5CA8	↑	2372.0°F				2372.0°F		NR
:	:								
21920	55A0	2192.0°F			↑				
:	:								
18320	4790			↑	1832.0°F				
:	:								
7520	1D60			752.0°F		752.0°F			
:	:								
320	0140					underrange	32.0°F		
:	:								
1	0001	0.1°F	0.1°F	0.1°F	0.1°F	0.1°F	0.1°F	0.0029mV	
0	0000	0.0°F	0.0°F	0.0°F	0.0°F	0.0°F	0.0°F	0.0mV	
-1	FFFF	-0.1°F	-0.1°F	-0.1°F	-0.1°F	-0.1°F	-0.1°F	-0.0029mV	
:	:								
-580	FDBC					-58.0°F			
:	:								
-2380	F6B4	-238.0°F							
:	:								
-3280	F330	underrange	-328.0°F				underrange		
:	:								
-3460	F27C	-346.0°F				↓			
:	:		underrange						
-4000	F060				-400.0°F				
:	:				underrange				
-4270	EF52			-427.0°F					
:	:			underrange					
-4540	EE44	↓	-454.0°F	-454.0°F	-454.0°F		-454.0°F		
:	:								NR
-27648	9400		↓	↓	↓		↓	-80mV	
-27649	93FF							-80.0029mV	
:	:								
-32512	8100							-94.071mV	OR
↓	↓							↓	↓
-3268	8000	<-346.0° F	<-454.0° F	<-454.0° F	<-454.0° F	<-58.0° F	<-454.0° F	<-94.07 mV	UF

*OF = Overflow; OR = Overrange; NR = Normal range; UR = Underrange; UF = Underflow
↑ indicates that all analog values greater than this and below the open wire threshold report the overflow data value, 32767 (0x7FFF).
↓ indicates that all analog values less than this and greater than the open wire threshold report the underflow data value, -32768 (0x8000).

EM 231 RTD Module

The EM 231 RTD module provides a convenient interface for the S7-200 family to several different RTDs. It also allows the S7-200 to measure three different resistance ranges. Both RTDs attached to the module must be of the same type.

Configuring the EM 231 RTD Module

DIP switches enable you to select RTD type, wiring configuration, temperature scale, and burnout direction. The DIP switches are located on the bottom of the module as shown in this figure. For the DIP switch settings to take effect, you need to power cycle the PLC and/or the user 24V power supply.

Select RTD type by setting DIP switches 1, 2, 3, 4, and 5 to correspond to the RTD as shown in Table A-31. Refer to Table A-32 for other DIP switch settings.

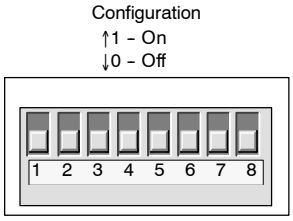


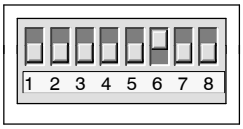
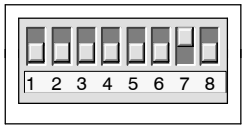
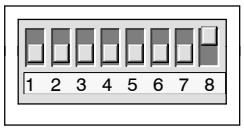
Figure A-24 DIP Switches for the EM 231 RTD Module

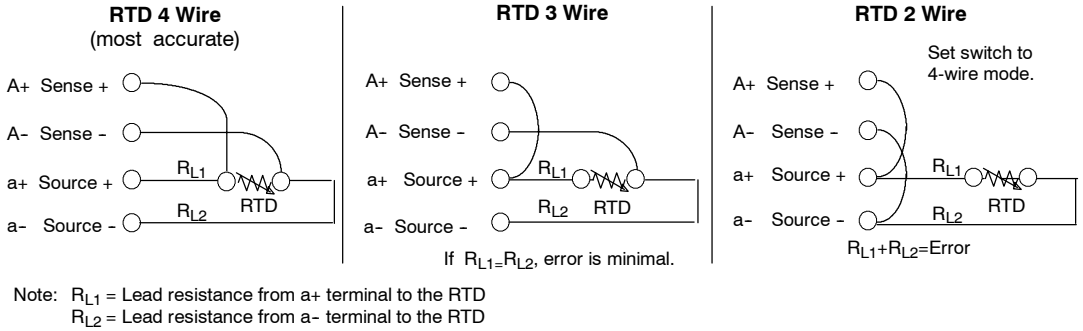
Table A-31 Selecting the RTD Type: DIP Switches 1 to 5

RTD Type and Alpha[1]	SW1	SW2	SW3	SW4	SW5	RTD Type and Alpha[1]	SW1	SW2	SW3	SW4	SW5
100Ω Pt 0.003850 (Default)	0	0	0	0	0	100Ω Pt 0.003902	1	0	0	0	0
200Ω Pt 0.003850	0	0	0	0	1	200Ω Pt 0.003902	1	0	0	0	1
500Ω Pt 0.003850	0	0	0	1	0	500Ω Pt 0.003902	1	0	0	1	0
1000Ω Pt 0.003850	0	0	0	1	1	1000Ω Pt 0.003902	1	0	0	1	1
100Ω Pt 0.003920	0	0	1	0	0	SPARE	1	0	1	0	0
200Ω Pt 0.003920	0	0	1	0	1	100Ω Ni 0.00672	1	0	1	0	1
500Ω Pt 0.003920	0	0	1	1	0	120Ω Ni 0.00672	1	0	1	1	0
1000Ω Pt 0.003920	0	0	1	1	1	1000Ω Ni 0.00672	1	0	1	1	1
100Ω Pt 0.00385055	0	1	0	0	0	100Ω Ni 0.006178	1	1	0	0	0
200Ω Pt 0.00385055	0	1	0	0	1	120Ω Ni 0.006178	1	1	0	0	1
500Ω Pt 0.00385055	0	1	0	1	0	1000Ω Ni 0.006178	1	1	0	1	0
1000Ω Pt 0.00385055	0	1	0	1	1	10000Ω Pt 0.003850	1	1	0	1	1
100Ω Pt 0.003916	0	1	1	0	0	10Ω Cu 0.004270	1	1	1	0	0
200Ω Pt 0.003916	0	1	1	0	1	150Ω FS Resistance	1	1	1	0	1
500Ω Pt 0.003916	0	1	1	1	0	300Ω FS Resistance	1	1	1	1	0
1000Ω Pt 0.003916	0	1	1	1	1	600Ω FS Resistance	1	1	1	1	1

[1] All RTDs represent 0° C. at the listed resistance except for Cu 10 ohm. Cu 10 ohm is 25° C. at 10 ohm and 0° C. at 9.035 ohm.

Table A-32 Setting RTD DIP Switches

Switch 6	Open Wire Detect/ Out of Range	Setting	Description
SW6  Configuration ↑1 – On ↓0 – Off	Upscale (+3276.7 degrees)	0	Indicates positive on open wire or out of range
	Downscale (–3276.8 degrees)	1	Indicates negative on open wire or out of range
Switch 7	**Temperature Scale**	**Setting**	**Description**
SW7  Configuration ↑1 – On ↓0 – Off	Celsius (°C)	0	The RTD module can report temperatures in Celsius or Fahrenheit. The Celsius to Fahrenheit conversion is performed inside the module.
	Fahrenheit (°F)	1	
Switch 8	**Wiring Scheme**	**Setting**	**Description**
SW8  Configuration ↑1 – On ↓0 – Off	3-wire	0	You can wire the RTD module to the sensor in three ways (shown in the figure). The most accurate is 4 wire). The least accurate is 2 wire, which is only recommended if errors due to wiring can be ignored in your application.
	2-wire or 4-wire	1	



Note: R_{L1} = Lead resistance from a+ terminal to the RTD
R_{L2} = Lead resistance from a- terminal to the RTD

Figure A-25 Wiring the RTD to the Sensor by 4, 3, and 2 Wire

EM 231 RTD Status Indicators

The RTD module provides the PLC with data words that indicate temperatures or error conditions. Status bits indicate range error and user supply/module failure. LEDs indicate the status of the module. Your program should have logic to detect error conditions and respond appropriately for the application. Table A-33 shows the status indicators provided by the EM 231 RTD module.

Tip

The channel data format is twos complement, 16-bit words. Temperature is presented in 0.1 degree units. (For example, if the measured temperature is 100.2 degrees, the reported data is 1002.) Resistance data are scaled to 27648. For example, 75% of full scale resistance is reported as 20736.

(225Ω / 300Ω * 27648 = 20736)

Table A-33 EM 231 RTD Status Indicators

Error Condition	Channel Data	SF LED Red	24 V LED Green	Range Status Bit[1]	24 VDC User Power Bad[2]
No errors	Conversion data	OFF	ON	0	0
24 V missing	32766	OFF	OFF	0	1
SW detects open wire	-32768/32767	BLINK	ON	1	0
Out of range input	-32768/32767	BLINK	ON	1	0
Diagnostic error[3]	0000	ON	OFF	0	note[3]

1 Range status bit is bit 3 in module error register byte (SMB9 for Module 1, SMB11 for Module 2, etc.)
2 User Power Bad status bit is bit 2 in module error register byte (such as SMB 9, SMB 11, refer to Appendix D.)
3 Diagnostic errors cause a module configuration error. The User Power Bad status bit may or may not be set before the module configuration error.

Channel data is updated every 405 milliseconds, if the PLC has read the data. If the PLC does not read the data within one update time, the module reports old data until the next module update after the PLC read. To keep channel data current, it is recommended that the PLC program read data at least as often as the module update rate.

Tip

When you are using the RTD module, be sure to disable analog filtering in the PLC. Analog filtering can prevent error conditions from being detected in a timely manner.

Open wire detection is performed by software internal to the RTD module. Out of range inputs and detected open wire conditions are signaled by setting the range status bit in the SMB and by setting the channel data up or down scale per the switch settings. Open wire detection takes a minimum of three module scan cycles and can take longer, depending on which wire(s) are open. Open Source+ and/or Source- wires are detected in the minimum time. Open Sense+ and/or Sense- wires can take 5 seconds or more to detect. Open sense lines can randomly present valid data, with open wire detected intermittently, especially in electrically noisy environments. Electrical noise can also extend the time it takes to detect the open wire condition. It is recommended that open wire/out of range indications be latched in the application program after valid data has been reported.

Tip

If you have an unused channel, you can wire the that channel with a resistor in place of the RTD to prevent open wire detection from causing the SF LED to blink. The resistor must be the nominal value of the RTD. For example, use 100 ohms for PT100 RTD .

EM 231 RTD Module Ranges

EM 231 RTD temperature ranges and accuracy for each type of RTD module are shown in Tables A-34 and A-35.

Table A-34 Temperature Ranges (°C) and Accuracy for RTD Types

System Word (1 digit = 0.1 °C)		Pt10000	Pt100, Pt200, Pt500, Pt1000	Ni100, Ni120, Ni1000[1]	Cu10	0 - 150Ω	0 - 300Ω	0 - 600Ω	
Decimal	Hex								
32767	7FFF								
32766	7FFE					↑	↑	↑	
32511	7EFF					176.383Ω	352.767Ω	705.534Ω	
29649	6C01					150.005Ω	300.011Ω	600.022Ω	
27648	6C00					150.000Ω	300.000Ω	600.000Ω	
25000	61A8								↑
18000	4650								OR
15000	3A98								
13000	32C8	↑	↑						
10000	2710	1000.0°C	1000.0°C						
8500	2134		850.0°C						
6000	1770	600.0°C			↑				
3120	0C30			↑	312.0°C				
2950	0B86			295.0°C					
2600	0A28				260.0°C				
2500	09C4			250.0°C					
1	0001	0.1°C	0.1°C	0.1°C	0.1°C	0.005Ω	0.011Ω	0.022Ω	
0	0000	0.0°C	0.0°C	0.0°C	0.0°C	0.000Ω	0.000Ω	0.000Ω	
-1	FFFF	-0.1°C	-0.1°	-0.1°C	-0.1°C	(negative values are not possible)			
						↓	↓	↓	
-600	FDA8			-60.0°C					N R
-1050	FBE6			-105.0°C					
				↓					
-2000	F830	-200.0°C	-200.0°		-200.0°C				
-2400	F6A0				-240.0°C				
-2430	F682	-243.0°C	-243.0°C		↓				
		↓	↓						
-5000	EC78								
-6000	E890								UR
-10500	D6FC								↓
-12000	D120								
-20000	4E20								
-32767	8001								
-32768	8000								
Accuracy over full span		±0.4%	±0.1%	±0.2%	±0.5%	±0.1%	±0.1%	±0.1%	
Accuracy (normal range)		±4° C	±1° C	±0.6° C	±2.8° C	±0.15Ω	±0.3Ω	±0.6Ω	
*OF = Overflow; OR = Overrange; NR = Normal range; UR= Underrange; UF = Underflow									
↑ or ↓ indicate that all analog values exceeding the limits report the selected out-of-range value, 32767 (0x7FF.) or -32768 (0x8000).									

1 The lower limit for the normal range of 1000 Ω Ni with an alpha of 0.006178 is 0 degrees C. and there is no underrange. The 1000 Ω Ni with an alpha of 0.00672 is shown in this table.

Table A-35 Temperature Ranges (°F) for RTD Types

System Word (1 digit = 0.1 °F)		PT1000	PT100, Pt200, Pt500, Pt1000	Ni100, Ni120, Ni1000[1]	Cu 10	
Decimal	Hexadecimal					
32767	7FFF					
32766	7PHAGE					
						↑
						Overrange
		↑	↑			
18320	4790	1832.0°F	1832.0 °F			
15620	3D04		1562.0°F			
11120	2B70	1112.0°F				
					↑	
5936	1730			↑	593.6°F	
5630	15FE			563.0°F		
5000	1388				500.0°F	
4820	12D4			482.0°F		
						Normal Range
1	0001	0.1°F	0.1°F	0.1°F	0.1°F	
0	0000	0.0°F	0.0°F	0.0°F	0.0°F	
-1	FFFF	-0.1°F	-0.1°F	-0.1°F	-0.1°F	
-760	FD08			-76.0°F		
-1570	F9DE			-157.0°F		
				↓		
-3280	F330	-328.0°F	-328.0°F		-328.0°F	
-4000	F060				-400.0°F	
-4054	F02A	-405.4°F	-405.4°F		↓	
		↓	↓			
-5000	EC78					
-6000	E890					Underrange
-10500	D6FC					↓
-32767	8001					
-32768	8000					

↑ or ↓ indicate that all analog values exceeding the limits report the selected out of range value, 32767 (0x7FFF) or -32768 (0x8000).

1 The lower limit for the normal range of 1000 Ω Ni with an alpha of 0.006178 is 32 degrees F. and there is no underrange. The 1000 Ω Ni with an alpha of 0.00672 is shown in this table.

EM 277 PROFIBUS-DP Module Specifications

Table A-36 EM 277 PROFIBUS-DP Module Order Number

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6ES7 277-0AA22-0XA0	EM 277 PROFIBUS-DP	-	-	No

Table A-37 EM 277 PROFIBUS-DP Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements +24 VDC
6ES7 277-0AA22-0XA0	EM 277 PROFIBUS-DP	71 x 80 x 62	175 g	2.5 W	150mA	See below

Table A-38 EM 277 PROFIBUS-DP Module Specifications

General	6ES7 277-0AA22-0XA0
Number of Ports (Limited Power)	1
Electrical interface	RS-485
PROFIBUS-DP/MPI baud rates (set automatically)	9.6, 19.2, 45.45, 93.75, 187.5, and 500 kbaud; 1, 1.5, 3, 6, and 12 Mbaud
Protocols	PROFIBUS-DP slave and MPI slave
Cable Length	
Up to 93.75 kbaud	1200 m
187.5 kbaud	1000 m
500 kbaud	400 m
1 to 1.5 Mbaud	200 m
3 to 12 Mbaud	100 m
Network Capabilities	
Station address settings	0 to 99 (set by rotary switches)
Maximum stations per segment	32
Maximum stations per network	126, up to 99 EM 277 stations
MPI Connections	6 total, 2 reserved (1 for PG and 1 for OP)
24 VDC Input Power Requirements	
Voltage range	20.4 to 28.8 VDC (Class 2, Limited Power, or sensor power from PLC)
Maximum current Module only with port active Add 90 mA of 5V port load Add 120 mA of 24V port load	 30 mA 60 mA 180 mA
Ripple noise (<10 MHz)	<1 V peak to peak (maximum)
Isolation (field to logic)[1]	500 VAC for 1 minute
5 VDC Power on Communications Port	
Maximum current per port	90 mA
Isolation (24 VDC to logic)	500 VAC for 1 minute
24 VDC Power on Communications Port	
Voltage range	20.4 to 28.8 VDC
Maximum current per port	120 mA
Current limit	0.7 to 2.4 A
Isolation	Not isolated, same circuit as input 24 VDC

[1] No power is supplied to module logic by the 24 VDC supply. 24 VDC supplies power for the communications port.

S7-200 CPUs that Support Intelligent Modules

The EM 277 PROFIBUS-DP slave module is an intelligent expansion module designed to work with the S7-200 CPUs shown in Table A-39.

Table A-39 EM 277 PROFIBUS-DP Module Compatibility with S7-200 CPUs

CPU	Description
CPU 222 Rel. 1.10 or greater	CPU 222 DC/DC/DC and CPU 222 AC/DC/Relay
CPU 224 Rel. 1.10 or greater	CPU 224 DC/DC/DC and CPU 224 AC/DC/Relay
CPU 224XP Rel. 2.0 or greater	CPU 224XP DC/DC/DC and CPU 224XP AC/DC/Relay
CPU 226 Rel. 1.00 or greater	CPU 226 DC/DC/DC and CPU 226 AC/DC/Relay

Address Switches and LEDs

The address switches and status LEDs are located on the front of the module as shown in Figure A-26. The pin-out for the DP slave port connector is also shown. See Table A-43 for a description of the status LEDs.

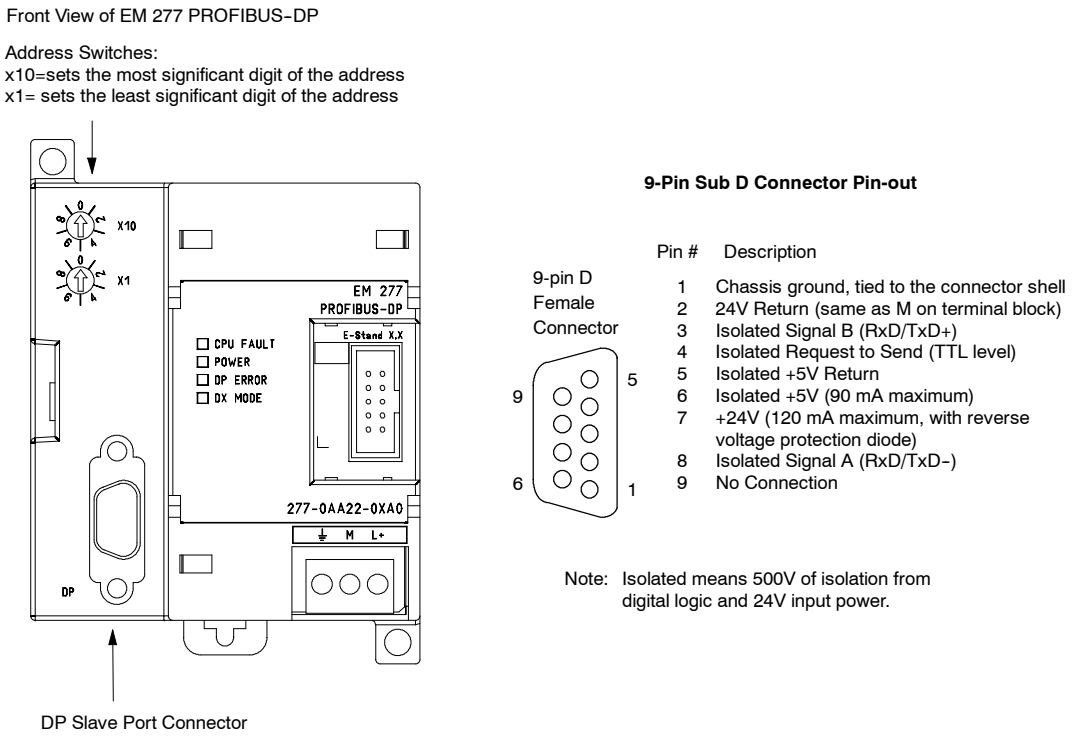


Figure A-26 EM 277 PROFIBUS-DP

Distributed Peripheral (DP) Standard Communications

PROFIBUS-DP (or DP Standard) is a remote I/O communications protocol defined by the European Standard EN 50170. Devices that adhere to this standard are compatible even though they are manufactured by different companies. DP stands for distributed peripherals, that is, remote I/O. PROFIBUS stands for Process Field Bus.

The EM 277 PROFIBUS-DP module has implemented the DP Standard protocol as defined for slave devices in the following communications protocol standards:

- EN 50 170 (PROFIBUS) describes the bus access and transfer protocol and specifies the properties of the data transfer medium.
- EN 50 170 (DP Standard) describes the high-speed cyclic exchange of data between DP masters and DP slaves. This standard defines the procedures for configuration and parameter assignment, explains how cyclic data exchange with distributed I/O functions, and lists the diagnostic options which are supported.

A DP master is configured to know the addresses, slave device types, and any parameter assignment information that the slaves require. The master is also told where to place data that is read from the slaves (inputs) and where to get the data to write to the slaves (outputs). The DP master establishes the network and then initializes its DP slave devices. The master writes the parameter assignment information and I/O configuration to the slave. The master then reads the diagnostics from the slave to verify that the DP slave accepted the parameters and the I/O configuration. The master then begins to exchange I/O data with the slave. Each transaction with the slave writes outputs and reads inputs. The data exchange mode continues indefinitely. The slave devices can notify the master if there is an exception condition and the master then reads the diagnostic information from the slave.

Once a DP master has written the parameters and I/O configuration to a DP slave, and the slave has accepted the parameters and configuration from the master, the master owns that slave. The slave only accepts write requests from the master that owns it. Other masters on the network can read the slave's inputs and outputs, but they cannot write anything to the slave.

Using the EM 277 to Connect an S7-200 as a DP Slave

The S7-200 CPU can be connected to a PROFIBUS-DP network through the EM 277 PROFIBUS-DP expansion slave module. The EM 277 is connected to the S7-200 CPU through the serial I/O bus. The PROFIBUS network is connected to the EM 277 PROFIBUS-DP module through its DP communications port. This port operates at any PROFIBUS baud rate between 9600 baud and 12 Mbaud. See the Specifications for EM 277 PROFIBUS-DP Module for the baud rates supported.

As a DP slave device, the EM 277 module accepts several different I/O configurations from the master, allowing you to tailor the amount of data transferred to meet the requirements of the application. Unlike many DP devices, the EM 277 module does not transfer only I/O data. Inputs, counter values, timer values, or other calculated values can be transferred to the master by first moving the data to the variable memory in the S7-200 CPU. Likewise, data from the master is stored in variable memory in the S7-200 CPU and can be moved to other data areas.

The DP port of the EM 277 PROFIBUS-DP module can be attached to a DP master on the network and still communicate as an MPI slave with other master devices such as SIMATIC programming devices or S7-300/S7-400 CPUs on the same network. Figure A-27 shows a PROFIBUS network with a CPU 224 and an EM 277 PROFIBUS-DP module.

- The CPU 315-2 is the DP master and has been configured by a SIMATIC programming device with STEP 7 programming software.
- The CPU 224 is a DP slave owned by the CPU 315-2. The ET 200 I/O module is also a slave owned by the CPU 315-2.
- The S7-400 CPU is attached to the PROFIBUS network and is reading data from the CPU 224 by means of XGET instructions in the S7-400 CPU user program.

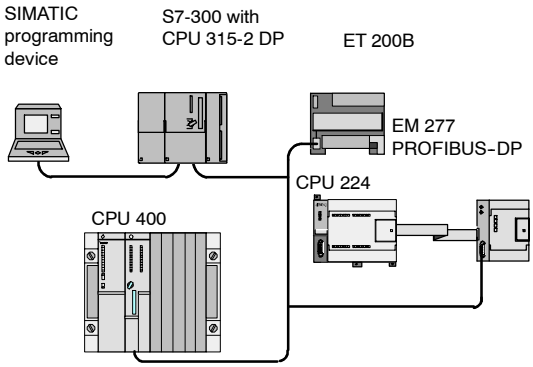


Figure A-27 EM 277 PROFIBUS-DP Module and CPU 224 on a PROFIBUS Network

Configuration

To use the EM 277 PROFIBUS-DP as a DP slave, you must set the station address of the DP port to match the address in the configuration of the master. The station address is set with the rotary switches on the EM 277 module. You must power cycle the CPU after you have made a switch change in order for the new slave address to take effect.

The master device exchanges data with each of its slaves by sending information from its output area to the slave's output buffer (called a "Receive mailbox"). The slave responds to the message from the master by returning an input buffer (called a "Send mailbox") which the master stores in an input area.

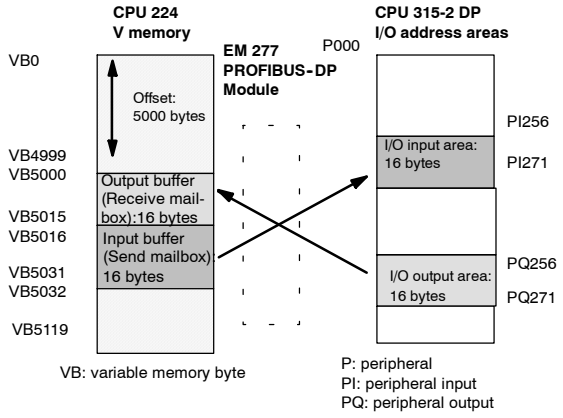


Figure A-28 V Memory and I/O Address Area

Figure A-28 shows an example of the V memory and I/O address area of a PROFIBUS-DP Master.

The EM 277 PROFIBUS-DP can be configured by the DP master to accept output data from the master and return input data to the master. The output and input data buffers reside in the variable memory (V memory) of the S7-200 CPU. When you configure the DP master, you define the byte location in V memory where the output data buffer should start as part of the parameter assignment information for the EM 277. You also define the I/O configuration as the amount of output data to be written to the S7-200 CPU and amount of input data to be returned from the S7-200 CPU. The EM 277 determines the size of the input and output buffers from the I/O configuration. The DP master writes the parameter assignment and I/O configuration information to the EM 277 PROFIBUS DP module. The EM 277 then transfers the V memory address and input and output data lengths to the S7-200 CPU.

Figure A-28 shows a memory model of the V memory in a CPU 224 and the I/O address areas of a DP master CPU. In this example, the DP master has defined an I/O configuration of 16 output bytes and 16 input bytes, and a V memory offset of 5000. The output buffer and input buffer lengths in the CPU 224 (determined from the I/O configuration) are both 16 bytes long. The output data buffer starts at V5000; the input buffer immediately follows the output buffer and begins at V5016. The output data (from the master) is placed in V memory at V5000. The input data (to the master) is taken from the V memory at V5016.

Tip

If you are working with a data unit (consistent data) of three bytes or data units greater than four bytes, you must use SFC14 to read the inputs of the DP slave and SFC15 to address the outputs of the DP slave. For more information, see the S*ystem Software for S7-300 and S7-400 System and Standard Functions Reference Manual*.

Table A-40 lists the configurations that are supported by the EM 277 PROFIBUS–DP module. The default configuration for the EM 277 module is two words of input and two words of output.

Table A-40 EM 277 Configuration Options

Configuration	Inputs to Master	Outputs from Master	Data Consistency
1	1 word	1 word	Word Consistency
2	2 words	2 words	
3	4 words	4 words	
4	8 words	8 words	
5	16 words	16 words	
6	32 words	32 words	
7	8 words	2 words	
8	16 words	4 words	
9	32 words	8 words	
10	2 words	8 words	
11	4 words	16 words	
12	8 words	32 words	
13	2 bytes	2 bytes	Byte Consistency
14	8 bytes	8 bytes	
15	32 bytes	32 bytes	
16	64 bytes	64 bytes	
17	4 bytes	4 bytes	Buffer Consistency
18	8 bytes	8 bytes	
19	12 bytes	12 bytes	
20	16 bytes	16 bytes	

You can configure the location of the input and output buffers to be anywhere in the V memory of the S7-200 CPU. The default address for the input and output buffers is VB0. The location of the input and output buffers is part of the parameter assignment information that the master writes to the S7-200 CPU. You configure the master to recognize its slaves and to write the required parameters and I/O configuration to each of its slaves.

Use the following tools to configure the DP master:

- For SIMATIC S5 masters, use COM PROFIBUS Windows software
- For SIMATIC S7 masters, use STEP 7 programming software
- For SIMATIC 505 masters, use COM PROFIBUS and either TISOFT2 or SoftShop

For detailed information about using these configuration and programming software packages, refer to the manuals for these devices. For detailed information about the PROFIBUS network and its components, refer to the *ET 200 Distributed I/O System Manual*.

Data Consistency

PROFIBUS supports three types of data consistency:

- Byte consistency ensures that bytes are transferred as whole units.
- Word consistency ensures that word transfers cannot be interrupted by other processes in the CPU (the two bytes composing the word are always moved together and cannot be split). Use Word consistency if the data values being transferred are integers.

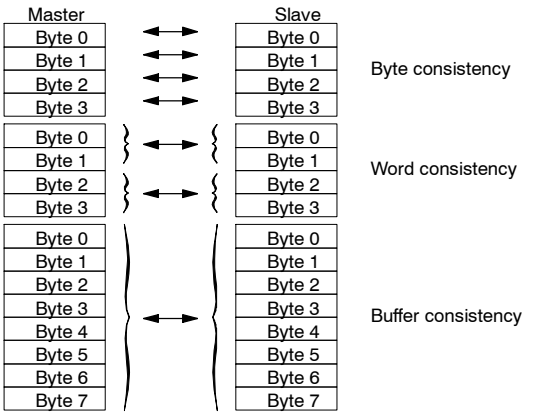


Figure A-29 Byte, Word, and Buffer Data Consistency

- Buffer consistency ensures that the entire buffer of data is transferred as a single unit, uninterrupted by any other process in the CPU. Buffer consistency should be used if the data values are double words or floating point values or when a group of values all relate to one calculation or item.

You set the data consistency as part of the I/O configuration in the master. The data consistency selection is written to the DP slave as part of the initialization of the slave. Both the DP master and the DP slave use the data consistency selection to be sure that data values (bytes, words, or buffers) are transferred uninterrupted within master and slave. The different types of consistency are shown in Figure A-29.

User Program Considerations

Once the EM 277 PROFIBUS–DP module has been successfully configured by a DP master, the EM 277 and the DP master enter data exchange mode. In data exchange mode, the master writes output data to the EM 277 PROFIBUS–DP module, the EM 277 module then responds with most current S7-200 CPU input data. The EM 277 module continuously updates its inputs from the S7-200 CPU in order to provide the most recent input data to the DP Master. The module then transfers the output data to the S7-200 CPU. The output data from the master is placed into V memory (the output buffer) starting at the address that the DP master supplied during initialization. The input data to the master is taken from the V memory locations (the input buffer) immediately following the output data.

The output data from the master must be moved by the user program in the S7-200 CPU from the output buffer to the data areas where it is to be used. Likewise, the input data to the master must be moved from the various data areas to the input buffer for transfer to the master.

Output data from the DP master is placed into V memory immediately after the user program portion of the scan has been executed. Input data (to the master) is copied from V memory to the EM 277 for transfer to the master at the same time.

Output data from the master is only written into V memory when there is new data available from the master.

Input data to the master are transmitted to the master on the next data exchange with the master.

The starting address of the data buffers in V memory and the size of the buffers must be known at the time the user program for the S7-200 CPU is created.

Status Information

There are 50 bytes of special memory (SM) allocated to each intelligent module based on its physical position. The module updates the SM locations corresponding to the modules' relative position to the CPU (with respect to other modules). If it is the first module, it updates SMB200 through SMB249. If it is the second module, it updates SMB250 through SMB299, and so on. See Table A-41.

Table A-41 Special Memory Bytes SMB200 to SMB549

Special Memory Bytes SMB200 to SMB549						
Intelligent Module in Slot 0	**Intelligent Module in Slot 1**	**Intelligent Module in Slot 2**	**Intelligent Module in Slot 3**	**Intelligent Module in Slot 4**	**Intelligent Module in Slot 5**	**Intelligent Module in Slot 6**
SMB200 to SMB249	SMB250 to SMB299	SMB300 to SMB349	SMB350 to SMB399	SMB400 to SMB449	SMB450 to SMB499	SMB500 to SMB549

These SM locations show default values if DP communications have not been established with a master. After a master has written parameters and I/O configuration to the EM 277 PROFIBUS-DP module, these SM locations show the configuration set by the DP master. You should check the protocol status byte (for example SMB224 for slot 0) to be sure that the EM 277 is currently in data exchange mode with the master before using the information in the SM locations shown in Table A-42, or data in the V memory buffer.

Tip

You cannot configure the EM 277 PROFIBUS-DP I/O buffer sizes or buffer location by writing to SM memory locations. Only the DP master can configure the EM 277 PROFIBUS-DP module for DP operation.

Table A-42 Special Memory Bytes for the EM 277 PROFIBUS-DP

Intelligent Module in Slot 0	...	Intelligent Module in Slot 6	Description
SMB200 to SMB215	...	SMB500 to SMB515	Module name (16 ASCII characters) "EM277 ProfibusDP"
SMB216 to SMB219	...	SMB516 to SMB519	S/W revision number (4 ASCII characters) xxxx
SMW220	...	SMW520	Error code 16#0000 No error 16#0001 No user power 16#0002 to 16#FFFF Reserved
SMB222	...	SMB522	DP slave module's station address as set by address switches (0 - 99 decimal)
SMB223	...	SMB523	Reserved
SMB224	...	SMB524	DP standard protocol status byte MSB LSB 0 0 0 0 0 0 S1 S0 S1 S0 DP Standard status byte description 0 0 DP communications not initiated since power on 0 1 Configuration/parameterization error detected 1 0 Currently in data exchange mode 1 1 Dropped out of data exchange mode
SMB225	...	SMB525	DP standard protocol - address of the slave's master (0 to 126)
SMW226	...	SMW526	DP standard protocol - V memory address of the output buffer as an offset from VB0.
SMB228	...	SMB528	DP standard protocol - number of bytes of output data
SMB229	...	SMB529	DP standard protocol - number of bytes of input data
SMB230 to SMB249	...	SMB530 to SMB549	Reserved - cleared on power up

Note: SM locations are updated each time the DP slave module accepts configuration/ parameterization information. These locations are updated even if a configuration/parameterization error is detected. The locations are cleared on each power up.

LED Status Indicators for the EM 277 PROFIBUS-DP

The EM 277 PROFIBUS-DP module has four status LEDs on the front panel to indicate the operational state of the DP port:

- After the S7-200 CPU is turned on, the DX MODE LED remains off as long as DP communications are not attempted.
- Once DP communications have been successfully initiated (the EM 277 PROFIBUS-DP module has entered data exchange mode with the master), the DX MODE LED turns green and remains on until data exchange mode is exited.
- If DP communications are lost, which forces the EM 277 module to exit data exchange mode, the DX MODE LED turns OFF and the DP ERROR LED turns red. This condition persists until the S7-200 CPU is powered off or data exchange is resumed.
- If there is an error in the I/O configuration or parameter information that the DP master is writing to the EM 277 module, the DP ERROR LED flashes red.
- If user 24 VDC is not provided, the POWER LED will be off.

Table A-43 summarizes the status indications signified by the EM 277 status LEDs.

Table A-43 EM 277 PROFIBUS-DP Module Status LEDs

LED	OFF	RED	FLASHING RED	GREEN
CPU FAULT	Module is good	Internal Module Failure	--	--
POWER	No 24 VDC User Power	--	--	24 VDC User Power Good
DP ERROR	No Error	Left Data Exchange Mode	Parameterization/ Configuration Error	--
DX MODE	Not in Data Exchange Mode	--	--	In Data Exchange Mode

Note: When the EM 277 PROFIBUS-DP module is used exclusively as an MPI slave, only the green Power LED is on.

Additional Configuration Features

The EM 277 PROFIBUS-DP module can be used as a communications interface to other MPI masters, whether or not it is being used as a PROFIBUS-DP slave. The module can provide a connection from the S7-300/400 to the S7-200 using the XGET/XPUT functions of the S7-300/400. STEP 7-Micro/WIN and a network card (such as the CP5611) using the MPI or PROFIBUS parameter set, an OP device or the TD 200 (Rel. 2.0 or greater, order number 6ES7 272-0AA20-0YA0) can be used to communicate with the S7-200 through the EM 277 PROFIBUS-DP module.

A maximum of six connections (six devices) in addition to the DP master can be connected to the EM 277 PROFIBUS-DP module. One connection is reserved for a programming device (PG) and one is reserved for an operator panel (OP). The other four connections can be used by any MPI master. In order for the EM 277 PROFIBUS-DP module to communicate with multiple masters, all masters must be operating at the same baud rate. See the Figure A-30 for one possible network configuration.

When the EM 277 PROFIBUS-DP module is used for MPI communications, the MPI master must use the station address of the module for all messages that are sent to the S7-200 to which the module is connected. MPI messages sent to the EM 277 PROFIBUS-DP module are passed on to the S7-200.

The EM 277 PROFIBUS-DP module is a slave module and cannot be used for communications between S7-200 PLCs using the NETR and NETW functions. The EM 277 PROFIBUS-DP module cannot be used for Freeport communications.

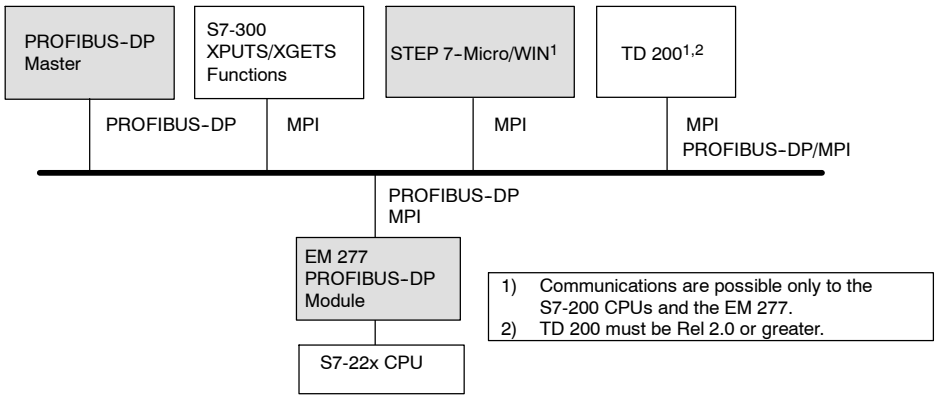


Figure A-30 PROFIBUS-DP/MPI Network

Device Database File: GSD

Different PROFIBUS devices have different performance characteristics. These characteristics differ with respect to functionality (for example, the number of I/O signals and diagnostic messages) or bus parameters, such as transmission speed and time monitoring. These parameters vary for each device type and vendor, and are usually documented in a technical manual. To help you achieve a simple configuration of PROFIBUS, the performance characteristics of a particular device are specified in an electronic data sheet called a device database file, or GSD file. Configuration tools based on GSD files allow simple integration of devices from different vendors in a single network.

The device database file provides a comprehensive description of the characteristics of a device in a precisely defined format. These GSD files are prepared by the vendor for each type of device and made available to the PROFIBUS user. The GSD file allows the configuration system to read in the characteristics of a PROFIBUS device and use this information when configuring the network.

The latest versions of the COM PROFIBUS or STEP 7 software include configuration files for the EM 277 PROFIBUS-DP Module. If your version of software does not include a configuration file for the EM 277, you can access the latest GSD file (SIEM089D.GSD) at website www.profibus.com.

If you are using a non-Siemens master device, refer to the documentation provided by the manufacturer on how to configure the master device by using the GSD file.

```
;================================================
; GSD File for the EM 277 PROFIBUS-DP with a DPC31
; MLFB  : 6ES7 277-0AA2.-0XA0
; DATE  : 26-March-2001
;================================================
#Profibus_DP
;General parameters
GSD_Revision          = 1
Vendor_Name           = "Siemens"
Model_Name            = "EM 277 PROFIBUS-DP"
Revision              = "V1.02"
Ident_Number          = 0x089D
Protocol_Ident        = 0
Station_Type          = 0
FMS_supp              = 0
Hardware_Release      = "1.00"
Software_Release      = "1.02"
9.6_supp              = 1
19.2_supp             = 1
45.45_supp            = 1
93.75_supp            = 1
187.5_supp            = 1
500_supp              = 1
1.5M_supp             = 1
3M_supp               = 1
6M_supp               = 1
12M_supp              = 1
MaxTsdr_9.6           = 60
MaxTsdr_19.2          = 60
MaxTsdr_45.45         = 250
MaxTsdr_93.75         = 60
MaxTsdr_187.5         = 60
MaxTsdr_500           = 100
MaxTsdr_1.5M          = 150
MaxTsdr_3M            = 250
MaxTsdr_6M            = 450
MaxTsdr_12M           = 800
Redundancy            = 0
Repeater_Ctrl_Sig     = 2
24V_Pins              = 2

; Slave-Specification:
OrderNumber="6ES7 277-0AA2.-0XA0"
Periphery="SIMATIC S5"
Slave_Family=10@TdF@SIMATIC

Freeze_Mode_supp      = 1
Sync_Mode_supp        = 1
Set_Slave_Add_Supp    = 0
Auto_Baud_supp        = 1
Min_Slave_Intervall   = 1
Fail_Safe             = 0
Max_Diag_Data_Len     = 6
Modul_Offset          = 0
Modular_Station       = 1
Max_Module            = 1
Max_Input_len         = 128
Max_Output_len        = 128
Max_Data_len          = 256

; UserPrmData-Definition
ExtUserPrmData=1 "I/O Offset in the V-memory"
Unsigned16 0 0-10239
EndExtUserPrmData
; UserPrmData: Length and Preset:
User_Prm_Data_Len=3
User_Prm_Data= 0,0,0
Max_User_Prm_Data_Len=3
Ext_User_Prm_Data_Const(0)=0x00,0x00,0x00
Ext_User_Prm_Data_Ref(1)=1
```

```
;================================================
; Continuation of GSD File
;================================================

; Module Definition List
Module = "2 Bytes Out/ 2 Bytes In      -" 0x31
EndModule
Module = "8 Bytes Out/ 8 Bytes In      -" 0x37
EndModule
Module = "32 Bytes Out/ 32 Bytes In       -"
0xC0,0x1F,0x1F
EndModule
Module = "64 Bytes Out/ 64 Bytes In       -"
0xC0,0x3F,0x3F
EndModule
Module = "1 Word Out/ 1 Word In        -" 0x70
EndModule
Module = "2 Word Out/ 2 Word In        -" 0x71
EndModule
Module = "4 Word Out/ 4 Word In        -" 0x73
EndModule
Module = "8 Word Out/ 8 Word In        -" 0x77
EndModule
Module = "16 Word Out/ 16 Word In      -" 0x7F
EndModule
Module = "32 Word Out/ 32 Word In          -"
0xC0,0x5F,0x5F
EndModule
Module = "2 Word Out/ 8 Word In            -"
0xC0,0x41,0x47
EndModule
Module = "4 Word Out/ 16 Word In           -"
0xC0,0x43,0x4F
EndModule
Module = "8 Word Out/ 32 Word In           -"
0xC0,0x47,0x5F
EndModule
Module = "8 Word Out/ 2 Word In            -"
0xC0,0x47,0x41
EndModule
Module = "16 Word Out/ 4 Word In           -"
0xC0,0x4F,0x43
EndModule
Module = "32 Word Out/ 8 Word In           -"
0xC0,0x5F,0x47
EndModule
Module = "4 Byte buffer I/O            -" 0xB3
EndModule
Module = "8 Byte buffer I/O            -" 0xB7
EndModule
Module = "12 Byte buffer I/O           -" 0xBB
EndModule
Module = "16 Byte buffer I/O           -" 0xBF
EndModule
```

Figure A-31 Listing of the GSD File for the EM 277 PROFIBUS Module

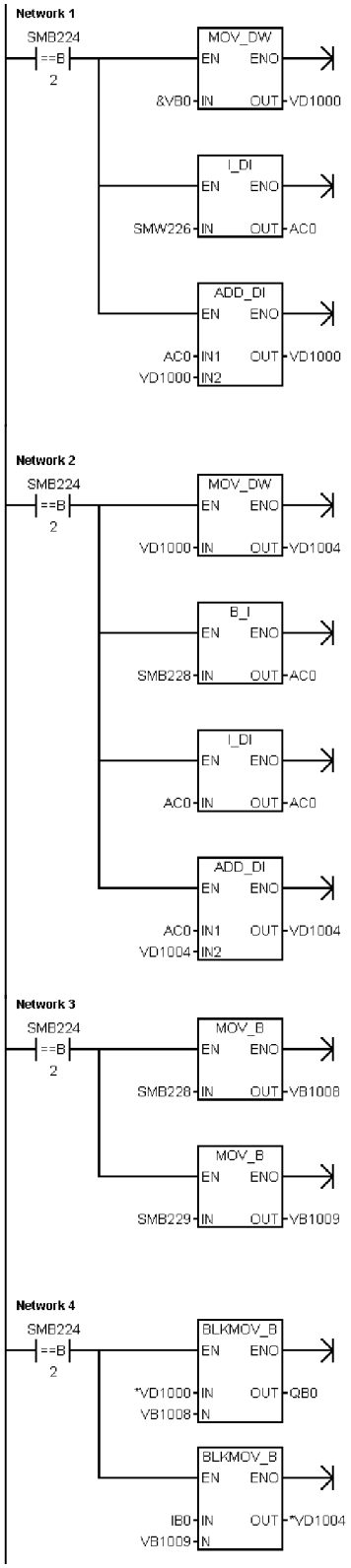
Sample Program for DP Communications to a CPU

A sample program in Statement List for the PROFIBUS-DP module in slot 0 for a CPU that uses the DP port information in SM memory is shown below. The program determines the location of the DP buffers from SMW226 and the sizes of the buffers from SMB228 and SMB229. This information is used to copy the data in the DP output buffer to the process-image output register of the CPU. Similarly, the data in the process-image input register of the CPU are copied into the V memory input buffer.

In the following sample program for a DP module in position 0, the DP configuration data in the SM memory area provides the configuration of the DP slave. The program uses the following data:

SMW220	DP Module Error Status
SMB224	DP Status
SMB225	Master Address
SMW226	V memory offset of outputs
SMB228	Number of bytes of output data
SMB229	Number of bytes of input data
VD1000	Output Data Pointer
VD1004	Input Data Pointer

Example of DP Communications to a CPU




```
Network 1       //Calculate the Output data pointer.
                //If in data exchange mode:
                //1. Output buffer is an offset from VB0
                //2. Convert Vmem offset to double integer
                //3. Add to VB0 address to get output data
                //    pointer.
LDB=    SMB224, 2
MOVD    &VB0, VD1000
ITD     SMW226, AC0
+D      AC0, VD1000

Network 2       //Calculate the Input data pointer.
                //If in data exchange mode:
                //1. Copy the output data pointer
                //2. Get the number of output bytes
                //3. Add to output data pointer to get
                //   starting input data pointer.
LDB=    SMB224, 2
MOVD    VD1000, VD1004
BTI     SMB228, AC0
ITD     AC0, AC0
+D      AC0, VD1004

Network 3       //Set amount of data to be copied.
                //If in data exchange mode:
                //1. Get number of output bytes to copy
                //2. Get number of input bytes to copy
LDB=  SMB224, 2
MOVB  SMB228, VB1008
MOVB  SMB229, VB1009

Network 4       //Transfer Master outputs to CPU
                //outputs. Copy CPU inputs to the
                //Master inputs. If in data exchange mode:
                //1. Copy Master outputs to CPU outputs
                //2. Copy CPU inputs to Master inputs
LDB=    SMB224, 2
BMB     *VD1000, QB0, VB1008
BMB     IB0, *VD1004, VB1009
```

EM 241 Modem Module Specifications

Table A-44 EM 241 Modem Module Order Number

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6ES7 241-1AA22-0XA0	EM 241 Modem Module	-	8[1]	No

1 Eight Q outputs are used as logical controls of the modem function and do not directly control any external signals.

Table A-45 EM 241 Modem Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements +24 VDC
6ES7 241-1AA22-0XA0	EM 241 Modem Module	71.2 x 80 x 62	190 g	2.1 W	80 mA	70 mA

Table A-46 EM 241 Modem Module Specifications

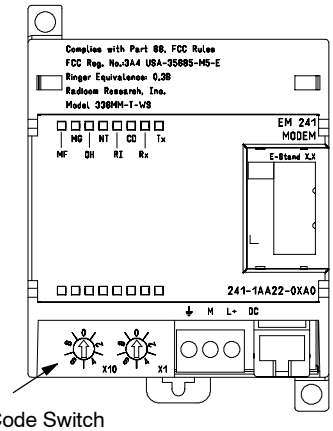
General	6ES7 241-1AA22-0XA0
Telephone Connection	
Isolation (phone line to logic and field power)	1500 VAC (Galvanic)
Physical connection	RJ11 (6 position, 4 wire)
Modem standards	Bell 103, Bell 212, V.21, V.22, V.22 bis, V.23c, V.32, V.32 bis, V.34 (default)
Security features	Password Callback
Dialing	Pulse or Tone
Messaging Protocols	Numeric TAP (alphanumeric) UCP commands 1, 30, 51
Industrial Protocols	Modbus PPI
24 VDC Input Power Requirements	
Voltage range	20.4 to 28.8 VDC
Isolation (field power to logic)	500 VAC for 1 minute

The EM 241 Modem Module replaces the function of an external modem connected to the communications port of the CPU. With an EM 241 installed in your S7-200 system, all you need to communicate with your CPU from a remote location is a personal computer with an external modem and STEP 7-Micro/WIN.

See Chapter 7, Communicating over a Network, for information on configuring. See Chapter 10, Creating a Program for the Modem Module for programming and advanced features of the module.

Modem Expansion

You can use the STEP 7-Micro/WIN Modem Expansion Wizard to configure an EM 241 Modem Module. See Chapter 10 for more information about the Modem Expansion Wizard.



Country Code Switch

Figure A-32 EM 241 Modem Module Terminal Block Diagram

S7-200 CPUs that Support Intelligent Modules

The EM 241 Modem module is an intelligent expansion module designed to work with the S7-200 CPUs shown in Table A-47.

Table A-47 EM 241 Modem Module Compatibility with S7-200 CPUs

CPU	Description
CPU 222 Rel. 1.10 or greater	CPU 222 DC/DC/DC and CPU 222 AC/DC/Relay
CPU 224 Rel. 1.10 or greater	CPU 224 DC/DC/DC and CPU 224 AC/DC/Relay
CPU 224XP Rel 2.0 or greater	CPU 224XP DC/DC/DC and CPU 224XP DC/DC/Relay
CPU 226 Rel. 1.00 or greater	CPU 226 DC/DC/DC and CPU 226 AC/DC/Relay

Installing the EM 241

Follow these steps to install the EM 241:

1. Snap the EM 241 on the DIN rail and plug in the ribbon cable.
2. Connect 24 VDC from the CPU sensor supply or external source, and connect the ground terminal to your system earth ground.
3. Plug the phone line into the RJ11 jack.
4. Set the country code switches according to Table A-48. You must set the switches before power is applied to the CPU for the correct country code to be read.
5. Power the CPU. The green MG (Module Good) light should come on.

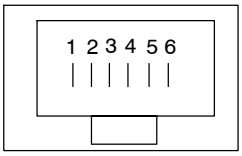
Your EM 241 is now ready to communicate.

Table A-48 Country Codes Supported by EM 241

Code	Country	Telecom Standard
00	Australia	ACA TS-002
01	Austria	CTR21
02	Belgium	CTR21
05	Canada	IC CS03
06	China	GB3482
08	Denmark	CTR21
09	Finland	CTR21
10	France	CTR21
11	Germany	CTR21
12	Greece	CTR21
16	Ireland	CTR21
18	Italy	CTR21
22	Luxembourg	CTR21
25	Netherlands	CTR21
26	New Zealand	PTC 200
27	Norway	CTR21
30	Portugal	CTR21
34	Spain	CTR21
35	Sweden	CTR21
36	Switzerland	CTR21
38	U.K.	CTR21
39	U.S.A.	FCC Part 68

RJ11 Jack

Figure A-33 shows the details of the RJ11 Jack. You can use adaptors to other standard telephone connectors. Refer to your adaptor connector documentation for more information.



Pin	Description
3	Ring
4	Tip

Reverse connection is allowed.

Figure A-33 View of RJ11 Jack

Caution

Lightning surges or other unexpected high voltages on the telephone line can damage your EM 241 Modem Module.

Use a commercially available telephone line surge protector, such as are commonly sold for protection of personal computer modems. Surge protectors can be damaged as they protect your EM 241 Modem Module. Choose a surge protector with a positive indicator that shows it is functional.

Check your surge protector regularly to ensure that your EM 241 Modem Module continues to be protected.

EM 253 Position Module Specifications

Table A-49 EM 253 Position Module Order Number

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6ES7 253-1AA22-0XA0	EM 253 Position Module	-	8[1]	Yes

[1] Eight Q outputs are used as logical controls of the motion function and do not directly control any external signals.

Table A-50 EM 253 Position Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	+24 VDC
6ES7 253-1AA22-0XA0	EM 253 Position Module	71.2 x 80 x 62	0.190 kg	2.5 W	190 mA	See below

Table A-51 EM 253 Position Module Specifications

General	6ES7 253-1AA22-0XA0
Input Features	
Number of inputs	**5 points**
Input type All except ZP ZP	 Sink/Source (IEC Type 1 sink, except ZP) Sink only, current limiting for wide voltage range
Input Voltage Maximum Continuous permissible STP, RPS, LMT+, LMT- ZP Surge (all inputs) Rated Value STP, RPS, LMT+, LMT- ZP Logic “1” signal (minimum) STP, RPS, LMT+, LMT- ZP Logic “0” signal (maximum) STP, RPS, LMT+, LMT- ZP	 30 VDC 30 VDC at 20 mA, maximum 35 VDC for 0.5 sec. 24 VDC at 4 mA, nominal 24 VDC at 15 mA, nominal 15 VDC at 2.5 mA, minimum 3 VDC at 8.0 mA, minimum 5 VDC at 1 mA, maximum 1 VDC at 1 mA, maximum
Isolation (field to logic) Optical Isolation (Galvanic) Isolation groups of	 500 VAC for 1 minute 1 point for STP, RPS, and ZP 2 points for LMT+ and LMT-
Input Delay Times STP, RPS, LMT+, LMT- ZP (countable pulse width)	 0.2 ms to 12.8 ms, user selectable 2 μsec minimum
Connection of 2 Wire Proximity Sensor (Bero) Permissible leakage current	 1 mA, maximum
Cable Length Unshielded STP, RPS, LMT+, LMT- ZP Shielded STP, RPS, LMT+, LMT- ZP	 30 meters Not recommended 100 meters 10 meters
Number of inputs on simultaneously	All at 55° C (horizontal), All at 45° C (vertical)

Table A-51 EM 253 Position Module Specifications, continued

General	6ES7 253-1AA22-0XA0	
Output Features		
Number of integrated outputs	6 points (4 signals)	
Output type		
P0+, P0-, P1+, P1-	RS422/485 driver	
P0, P1, DIS, CLR	Open drain	
Output voltage		
P0, P1, RS-422 drivers, differential output voltage		
Open circuit	3.5 V typical	
Into optocoupler diode with 200Ω series resistance	2.8 V minimum	
100Ω load	1.5 V minimum	
54Ω load	1.0 V minimum	
P0, P1, DIS, CLR open drain		
recommended voltage, open circuit	5 VDC, available from module	
permissible voltage, open circuit	30 VDC[1]	
Sink current	50 mA maximum	
On state resistance	15Ω maximum	
Off state leakage current, 30 VDC	10 μA maximum	
Internal Pull up resistor, output drain to T1	3.3K Ω[2]	
Output current		
Number of output groups	1	
Outputs on simultaneously	All at 55° C (horizontal), All at 45° C (vertical)	
Leakage current per point		
P0, P1, DIS, CLR	10 μA maximum	
Overload Protection	No	
Isolation (field to logic)		
Optical Isolation (Galvanic)	500 VAC for 1 minute	
Output delay		
DIS, CLR: Off to On / On to Off	30 μs, maximum	
Pulse distortion		
P0, P1, outputs, RS-422 drivers, 100 Ω external load	75 ns maximum	
P0, P1 outputs, open drain, 5 V / 470 Ω external load	300 ns maximum	
Switching frequency		
P0+, P0-, P1+, P1-, P0 and P1	200 kHz	
Cable length		
Unshielded	Not recommended	
Shielded	10 meters	
Power Supply		
L+ supply voltage	11 to 30 VDC (Class 2, Limited Power, or sensor power from PLC)	
Logic supply output	+5 VDC +/- 10%, 200 mA maximum	
L+ supply current vs. 5 VDC load		
Load current	12 VDC Input	24 VDC Input
0 mA (no load)	120 mA	70 mA
200 mA (rated load)	300 mA	130 mA
Isolation		
L+ power to logic	500 VAC for 1 minute	
L+ power to inputs	500 VAC for 1 minute	
L+ power to outputs	None	
Reverse Polarity	L+ input and +5V output are diode-protected. Placing a positive voltage on any M terminal with respect to output point connections can result in potentially damaging current flow.	

1 Operation of open drain outputs above 5 VDC may increase radio frequency emissions above permissible limits. Radio frequency containment measures may be required for your system or wiring.

2 Depending on your pulse receiver and cable, an additional external pull up resistor may improve pulse signal quality and noise immunity.

S7-200 CPUs that Support Intelligent Modules

The EM 253 Position module is an intelligent expansion module designed to work with the S7-200 CPUs shown in Table A-52.

Table A-52 EM 253 Position Module Compatibility with S7-200 CPUs

CPU	Description
CPU 222 Rel. 1.10 or greater	CPU 222 DC/DC/DC and CPU 222 AC/DC/Relay
CPU 224 Rel. 1.10 or greater	CPU 224 DC/DC/DC and CPU 224 AC/DC/Relay
CPU 224XP Rel 2.0 or greater	CPU 224XP DC/DC/DC and CPU 224XP DC/DC/Relay
CPU 226 Rel. 1.00 or greater	CPU 226 DC/DC/DC and CPU 226 AC/DC/Relay

EM 253 Position Module Status LEDs

The Status LEDs for the Position Modules are shown in Table A-53.

Table A-53 Position Module Status LEDs

Local I/O	LED	Color	Function Description
-	MF	Red	Illuminated when module detects a fatal error
-	MG	Green	Illuminated when there is no module fault, and flashes at 1 Hz rate when a configuration error is detected
-	PWR	Green	Illuminated when 24 VDC is supplied on the L+ and M terminals of the module
Input	STP	Green	Illuminated when the stop input is on
Input	RPS	Green	Illuminated when the reference point switch input is on
Input	ZP	Green	Illuminated when the zero pulse input is on
Input	LMT-	Green	Illuminated when the negative limit input is on
Input	LMT +	Green	Illuminated when the positive limit input is on
Output	P0	Green	Illuminated when the P0 output is pulsing
Output	P1	Green	Illuminated when the P1 output is pulsing or when this output indicates positive motion
Output	DIS	Green	Illuminated when the DIS output is active
Output	CLR	Green	Illuminated when the clear deviation counter output is active

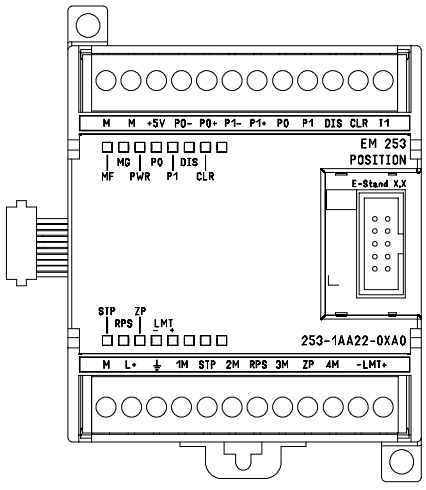


Figure A-34 EM 253 Position Module

Wiring Diagrams

In the following schematic figures, the terminals are not in order. See Figure A-34 for terminal arrangement.

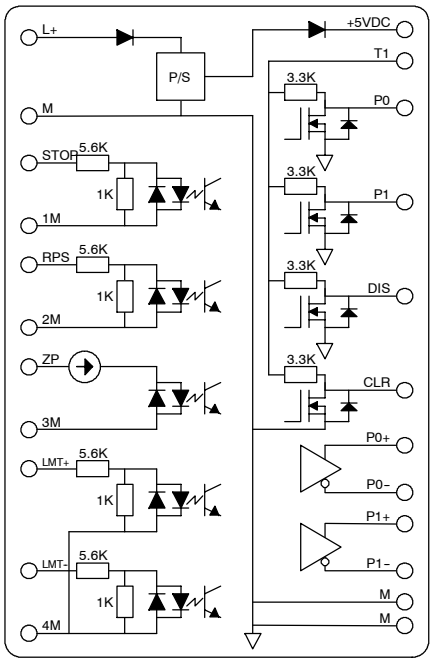
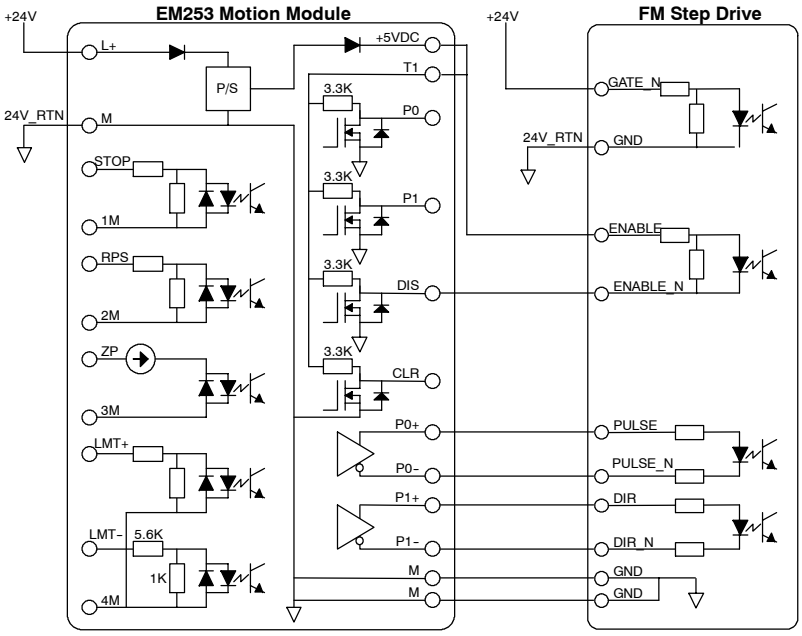
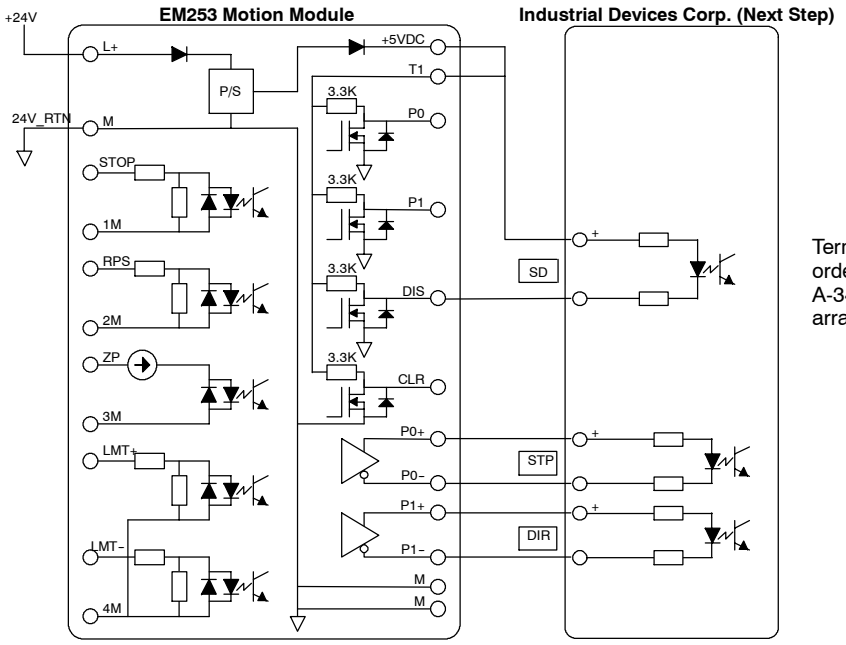


Figure A-35 Internal Schematic for the Inputs and Outputs of the EM 253 Position Module



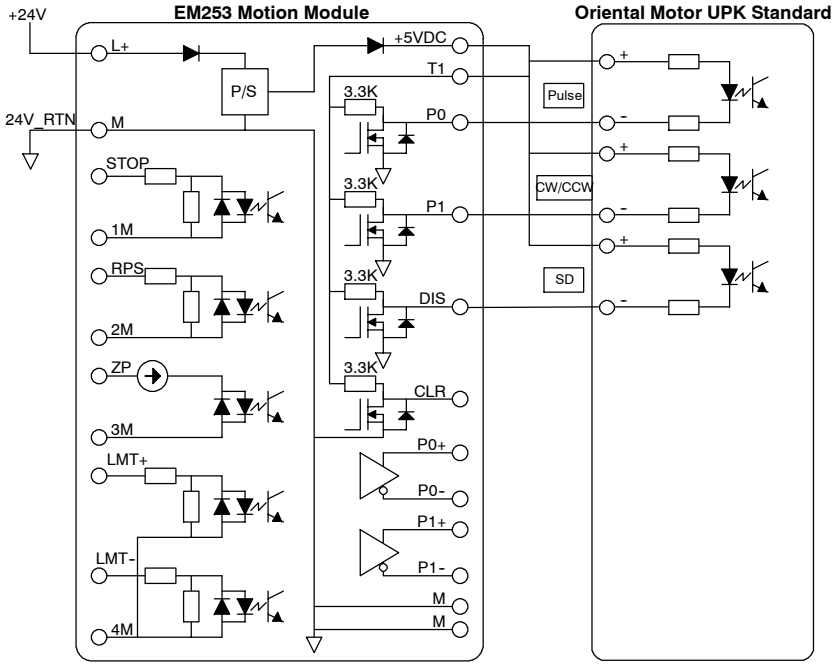
Terminals are not in order. See Figure A-34 for terminal arrangement.

Figure A-36 Connecting an EM 253 Position Module to a SIMATIC FM Step Drive



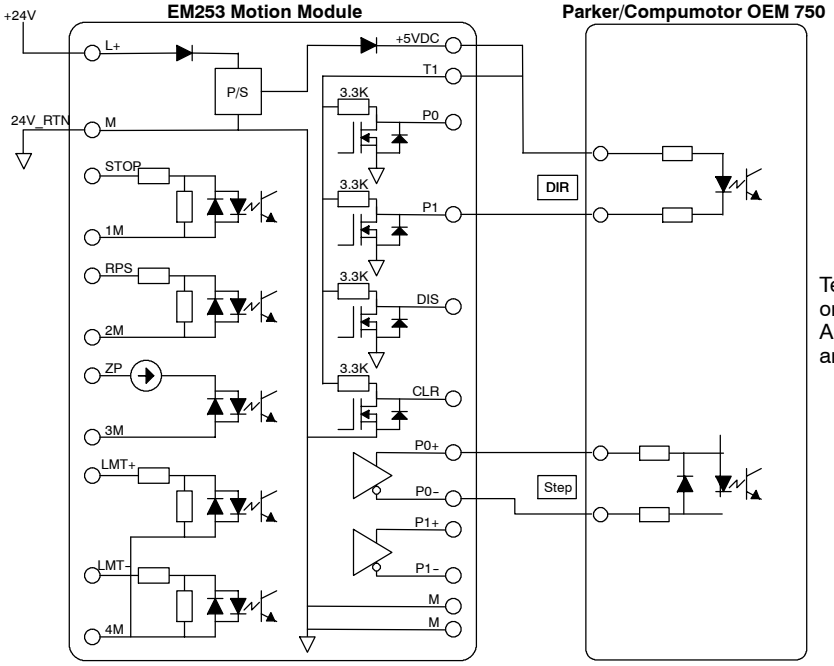
Terminals are not in order. See Figure A-34 for terminal arrangement.

Figure A-37 Connecting an EM 253 Position Module to a Industrial Devices Corp. (Next Step)



Terminals are not in order. See Figure A-34 for terminal arrangement.

Figure A-38 Connecting an EM 253 Position Module to an Oriental Motor UPK Standard



Terminals are not in order. See Figure A-34 for terminal arrangement.

Figure A-39 Connecting an EM 253 Position Module to a Parker/Compumotor OEM 750

(CP 243-1) Ethernet Module Specifications

Table A-54 (CP 243-1) Ethernet Module Order Number

Order Number	Expansion Module	EM Inputs	EM Outputs	Removable Connector
6GK7 243-1EX00-OXE0	(CP 243-1) Ethernet Module	-	8[1]	No

[1] Eight Q outputs are used as logical controls of Ethernet function and do not directly control any external signals.

Table A-55 (CP 243-1) Ethernet Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirement +5 VDC	VDC Requirement +24 VDC
6GK7 243-1EX00-OXE0	(CP 243-1) Ethernet Module	71.2 x 80 x 62	approx. 150 g	1.75 W	55 mA	60 mA

Table A-56 (CP 243-1) Ethernet Module Specifications

General	6GK7 243-1EX00-0XE0
Transmission Rate	**10 Mbits/s and 100 Mbits/s**
Flash memory size	1 Mbyte
SDRAM memory size	8 Mbyte
Interface Connection to Industrial Ethernet (10/100 Mbit/s)	 8-pin RJ45 socket
Input voltage	20.4 to 28.8 VDC
Maximum connections	Maximum of 8 S7 connections (XPUT/XGET and READ/WRITE) plus 1 connection to STEP 7-Micro/WIN per (CP 243-1) Ethernet Module[2]
Starting time or restart time after a reset	Approx. 10 seconds
User data quantities	As client: up to 212 bytes for XPUT/XGET As server: up to 222 bytes for XGET or READ up to 212 bytes for XPUT or WRITE

[2] Only one (CP 243-1) Ethernet module should be connected per S7-200 CPU.

The (CP 243-1) Ethernet module is a communications processor used for connecting the S7-200 system to Industrial Ethernet (IE). The S7-200 can be remotely configured, programmed and diagnosed via Ethernet using STEP 7 Micro/WIN. The S7-200 can communicate with another S7-200, S7-300, or S7-400 controller via Ethernet. It can also communicate with an OPC server.

Industrial Ethernet is designed for industry. It can be used with either noise-free industrial twisted pair (ITP) technology, or the Industry-standard twisted pair (TP) technology. Industrial Ethernet can be implemented to offer a wide range of application specific uses, such as switching, high-speed redundancy, fast connects, and redundant networks. Using the (CP 243-1) Ethernet module, the S7-200 PLC is made compatible with a wide range of existing products that support Ethernet.

S7-200 CPUs that Support Intelligent Modules

The (CP 243-1) Ethernet module is an intelligent expansion module designed to work with the S7-200 CPUs shown in Table A-47.

Table A-57 (CP 243-1) Ethernet Module Compatibility with S7-200 CPUs

CPU	Description
CPU 222 Rel. 1.10 or greater	CPU 222 DC/DC/DC and CPU 222 AC/DC/Relay
CPU 224 Rel. 1.10 or greater	CPU 224 DC/DC/DC and CPU 224 AC/DC/Relay
CPU 224XP Rel. 2.00 or greater	CPU 224XP DC/DC/DC and CPU 224XP AC/DC/Relay
CPU 226 Rel. 1.00 or greater	CPU 226 DC/DC/DC and CPU 226 AC/DC/Relay

The (CP 243-1) Ethernet module is delivered with a preset, unique worldwide MAC address that cannot be changed.

Functions

The (CP 243-1) Ethernet module independently handles data traffic over the Industrial Ethernet.

- Communication is based on TCP/IP
- For communication between S7-200 CPUs and other S7 control systems or PCs via Ethernet, communication services are available as Client and Server. Up to eight connects can be operated.
- The implementation of PC applications is possible by integration of the S7-OPC Server
- The (CP 243-1) Ethernet module allows direct access of the S7-200 programming software, STEP 7-Micro/WIN to S7-200 via Ethernet


Ethernet

Configuration

You can use the STEP 7-Micro/WIN Ethernet Wizard to configure the (CP 243-1) Ethernet module to connect an S7-200 PLC to an Ethernet network. The Ethernet wizard helps you define the parameters for the (CP 243-1) Ethernet module and then places the configuration instructions in your project instruction folder. To start the Ethernet Wizard, select the **Tools > Ethernet Wizard** menu command. The wizard uses the following information: IP Address, Subnet Mask, Gateway Address, and communications connection type.

Connections

The (CP 243-1) Ethernet module has the following connections. The connections are located under the covers of the front doors.

- Terminal block for 24 VDC supply voltage and ground connection
- 8-in RJ45 socket for Ethernet connection
- Plug connector for I/O bus
- Integrated ribbon cable with socket for I/O bus

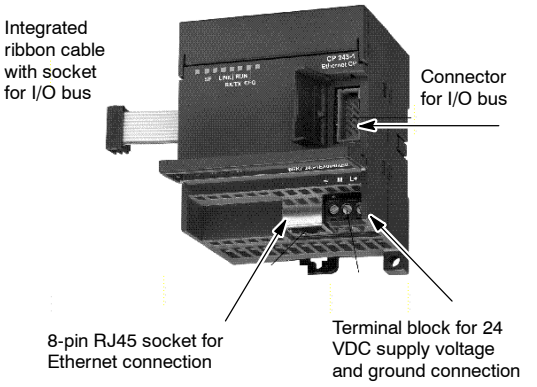


Figure A-40 Connecting the (CP 243-1) Ethernet Module

Additional Information

For more information about the (CP 243-1) Ethernet module, refer to the *SIMATIC NET CP 243-1 Communications Processor for Industrial Ethernet Technical Manual.*

(CP 243-1 IT) Internet Module Specifications

Table A-58 (CP 243-1 IT) Internet Module Order Number

Order Number	Expansion Module	EM Inputs	EM Outputs	Removable Connector
6GK7 243-1GX00-OXE0	(CP 243-1 IT) Internet Module	-	8[1]	No

[1] Eight Q outputs are used as logical controls of the IT function and do not directly control any external signals.

Table A-59 (CP 243-1 IT) Internet Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements +24 VDC
6GK7 243-1GX00-OXE0	(CP 243-1 IT) Internet Module	71.2 x 80 x 62	approx. 150 g	1.75 W	55 mA	60 mA

Table A-60 (CP 243-1 IT) Internet Module Specifications

General	6GK7 243-1GX00-0XE0
Transmission speed	10 Mbit/s and 100 Mbits/s
Flash memory size	8 Mbytes as ROM for firmware of the (CP 243-1 IT) Internet module, 8 Mbytes as RAM for the file system
SDRAM memory size	16 Mbyte
Guaranteed life of flash memory for the file system	1 million write or delete operations
Interface Connection to Industrial Ethernet (10/100 Mbit/s)	 8-pin RJ45 socket
Input voltage	20.4 to 28.8 VDC
Maximum connections	Maximum of 8 S7 connections (XPUT/XGET and READ/WRITE) plus 1 connection to STEP 7-Micro/WIN per (CP 243-1 IT) Internet module[1]
Maximum number of IT connections	1 for FTP server 1 for FTP client 1 for e-mail client 4 for HTTP connections
Starting time or restart time after a reset	Approx. 10 seconds
User data quantities	Client: up to 212 bytes for XPUT/XGET Server: up to 222 bytes for XGET or READ up to 212 bytes for XPUT or WRITE
E-mail size, maximum	1024 characters
File system: Path length including file size and drive names File name length Directory nesting depth	 254 characters maximum 99 characters maximum 49 maximum
Server ports available: HTTP FTP command channel FTP data channels for FTP server S7 connection establishment S7 server	 80 21 3100 to 3199 102 3000 to 3008

[1] Only one (CP 243-1 IT) Internet module should be connected per S7-200 CPU.

The (CP 243-1 IT) Internet module is a communications processor used for connecting the S7-200 system to Industrial Ethernet (IE). The S7-200 can be remotely configured, programmed and diagnosed via Ethernet using STEP 7 Micro/WIN. The S7-200 can communicate with another S7-200, S7-300, or S7-400 controller via Ethernet. It can also communicate with an OPC server.

The IT functions of the (CP 243-1 IT) Internet module form the basis for monitoring and, if necessary, also manipulating automation systems with a WEB browser from a networked PC. Diagnostic messages can be e-mailed from a system. Using the IT functions, it is easy to exchange entire files with other computer and controller systems.

Industrial Ethernet is the network for the process control level and the cell level of the SIMATIC NET open communication system. Physically, Industrial Ethernet is an electrical network based on shielded, coaxial lines, twisted pair cables and an optical network of fiber optic conductors. Industrial Ethernet is defined by the International Standard IEEE 802.3.

S7-200 CPUs that Support Intelligent Modules

The (CP 243-1 IT) Internet module is an intelligent expansion module designed to work with the S7-200 CPUs shown in Table A-61.

Table A-61 (CP 243-1 IT) Internet Module Compatibility with S7-200 CPUs

CPU	Description
CPU 222 Rel. 1.10 or greater	CPU 222 DC/DC/DC and CPU 222 AC/DC/Relay
CPU 224 Rel. 1.10 or greater	CPU 224 DC/DC/DC and CPU 224 AC/DC/Relay
CPU 224XP Rel. 2.00 or greater	CPU 224XP DC/DC/DC and CPU 224XP AC/DC/Relay
CPU 226 Rel. 1.00 or greater	CPU 226 DC/DC/DC and CPU 226 AC/DC/Relay

The (CP 243-1 IT) Internet module has the following features:

- The (CPU 243-1 IT) Internet module is fully compatible with the (CP 243-1) Ethernet module. User programs written for the (CP 243-1) Ethernet module can also be run on the (CP 243-1 IT) Internet module.

The (CP 243-1 1T) Internet module is delivered with a preset, unique worldwide MAC address that cannot be changed.

Tip

Only one (CP 243-1 IT) Internet module should be connected per S7-200 CPU. If more than one (CP 243-1 IT) Internet module is connected, the S7-200 CPU may not operate properly.

Functions

The (CP 243-1 IT) Internet module offers the following functions:

- S7 Communication is based on TCP/IP
- IT communication
- Configuration
- Watchdog timer
- Ability of preset MAC addresses (48-bit value) to be addressed


Internet

Configuration

You can use the STEP 7-Micro/WIN Internet Wizard to configure the (CP 243-1 IT) Internet module to connect an S7-200 PLC to an Ethernet/Internet network. The (CP 243-1 IT) Internet module has additional web server functionality that can be configured with the Internet Wizard. To start the Internet Wizard, select the **Tools > Internet Wizard** menu command.

Connections

The (CP 243-1 IT) Internet module has the following connections. The connections are located under the covers of the front doors.

- ❑ Terminal block for 24 VDC supply voltage and ground connection
- ❑ 8-in RJ45 socket for Ethernet connection
- ❑ Plug connector for I/O bus
- ❑ Integrated ribbon cable with socket for I/O bus

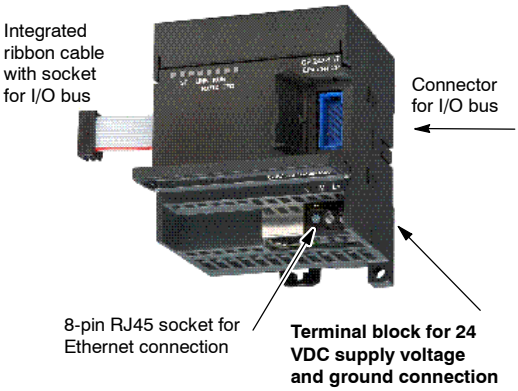


Figure A-41 Connecting the (CP 243-1 IT) Internet Module

Additional Information

For more information about the (CP 243-1 IT) Internet module, refer to the *SIMATIC NET CP 243-1 IT Communications Processor for Industrial Ethernet and Information Technology Technical Manual.*

(CP 243-2) AS-Interface Module Specifications

Table A-62 (CP 243-2) AS-Interface Module Order Number

Order Number	Expansion Model	EM Inputs	EM Outputs	Removable Connector
6GK7 243-2AX01-0XA0	(CP 243-2) AS-Interface Module	8 Digital and 8 Analog	8 Digital and8 Analog	Yes

Table A-63 (CP 243-2) AS-Interface Module General Specifications

Order Number	Module Name and Description	Dimensions (mm) (W x H x D)	Weight	Dissipation	VDC Requirements +5 VDC	VDC Requirements From AS-Interface
6GK7 243-2AX01-0XA0	(CP 243-2) AS-Interface Module	71 x 80 x 62	approx. 250 g	3.7 W	220 mA	100 mA

Table A-64 (CP 243-2) AS-Interface Module Specifications

General	6GK7 243-2AX01-0XA0
Cycle time	5 ms with 31 slaves 10 ms with 62 AS-I slaves using the extended addressing mode
Configuration	Set button on the front panel, or use the total configuration command (refer to the description of the AS-I commands in the *CP 243-2 AS-I Interface Master* manual)
AS-I master profiles supported	M1e
Attachment to the AS-I cable	Via an S7-200 terminal block. Permitted current loading from terminal 1 to 3 or from terminal 2 to 4 maximum 3 A.
Address range	One digital module with 8 digital inputs and 8 digital outputs, and One analog module with 8 analog inputs and 8 analog outputs

Features

You can operate up to two AS-Interface modules on the S7-200 at the same time, significantly increasing the number of available digital and analog inputs/outputs (maximum 124 digital input/124 digital output on AS-Interface per CP). Setup times are reduced because of the ability to configure at the touch of a button. LEDs reduce downtime in the event of an error by displaying status of the CP and of all connected slaves, and by monitoring AS-Interface main voltage.

The AS-Interface Module has the following features:

- ❏ Supports analog modules
- ❏ Supports all master functions and allows connections for up to 62 AS-Interface slaves
- ❏ LEDs in the front plate display operating status and availability of connected slaves.
- ❏ LEDs in the front plate display errors (including AS-Interface voltage error, configuration error)
- ❏ Two terminals allow direct connection of the AS-Interface cable.
- ❏ Two buttons display the status information of the slaves, switch operating mode, and adopt the existing configuration as the SET configuration.


AS-i

You can use the STEP 7-Micro/WIN AS-i Wizard to configure the (CP 243-2) AS-Interface module. The AS-Interface Wizard helps you use the data from an AS-Interface network in your configuration. To start the AS-i Wizard, select the **Tools > AS-i Wizard** menu command.

Operation

In the process image of the S7-200, the AS-Interface Module occupies a digital input byte (status byte), a digital output byte (control byte), 8 analog input and 8 analog output words. The AS-Interface Module uses two logical module positions. You can use the status and the control byte to set the mode of the AS-Interface Module using a user program. Depending on its mode, the AS-Interface stores either the I/O data of the AS-Interface slave, diagnostics values, or enables master calls (for example, changing a slave address) in the analog address area of the S7-200.

All the connected AS-Interface slaves can be configured at the touch of a button. Further configuration of the CP is not necessary.

Caution

When you use the AS-Interface Module, you must disable analog filtering in the CPU.

If analog filtering is not disabled in the CPU, the digital point data will be destroyed, and error conditions will not be returned as bit values in the analog word.

Ensure that analog filtering in the CPU is disabled.

Functions

The CP 243-2 is the AS-Interface master for the M1e master class, which means that it supports all the specified functions. This makes it possible to operate up to 31 digital slaves on the AS-Interface by means of double address assignment (A-B). The CP 243-2 can be set to two different modes:

- Standard mode: access to the I/O data of the AS-Interface slave
- Extended mode: master calls (for example, write parameters) or diagnostic value request

Connections

The AS-Interface Module has the following connections:

- Two connections to the AS-Interface Module cable (bridged internally)
- One connection for functional ground

The terminals are located under the cover of the front panel as shown in Figure A-42.

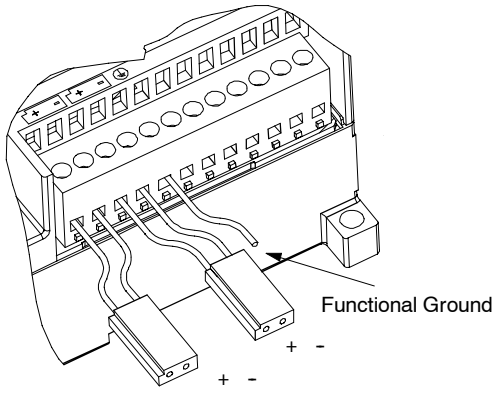


Figure A-42 Connecting the AS-Interface Module Cable

Caution

The load capacity of the AS-Interface Module contacts is a maximum of 3 A. If this value is exceeded on the AS-Interface Module cable, the AS-Interface must not be looped into the AS-I cable, but must be connected by a separate cable (in this case, only one pair of terminals of the AS-Interface Module is used). The AS-Interface must be connected to the grounding conductor via the ground terminal.

Tip

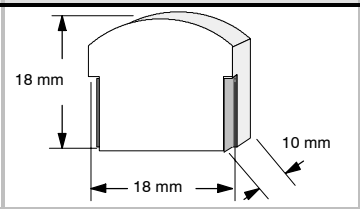
The AS-Interface Module has a connection for functional ground. This connector should be connected to the PE conductor with as little resistance as possible.

Additional Information

For more information about the CP 243-2 AS-Interface Master, refer to the *SIMATIC NET CP 243-2 AS-Interface Master manual.*

Optional Cartridges

Cartridge	Description	Order Number
Memory cartridge	Memory cartridge, 64K (user program, recipe, and data logging)	6ES7 291-8GF23-0XA0
Memory cartridge	Memory cartridge, 256K (user program, recipe, and data logging)	6ES7 291-8GH23-0XA0
Real-Time Clock with battery	Clock cartridge accuracy: 2 minutes/month at 25°C, 7 minutes/month at 0°C to 55°C	6ES7 297-1AA23-0XA0
Battery cartridge	Battery cartridge (data retention time): 200 days typical	6ES7 291-8BA20-0XA0

General Features		Dimensions
Battery	3 V, 30 mA hour, Renata CR 1025	
Size	9.9 mm x 2.5 mm	
Type	Lithium < 0.6 g	

Memory Cartridge

There are restrictions for using memory cartridges between CPUs of a different model. Memory cartridges programmed in a particular model number CPU can be read by CPUs with the same or higher model number as shown in Table A-65:

Table A-65 Memory Cartridge Model Number Read Restrictions

Memory Cartridge programmed in a ...	Can Be Read By A ...
CPU 221	CPU 221, CPU 222, CPU 224, CPU 224XP and CPU 226
CPU 222	CPU 222, CPU 224, CPU 224XP and CPU 226
CPU 224	CPU 224, CPU 224XP and CPU 226
CPU 224XP	CPU 224XP and CPU 226
CPU 226	CPU 226

The 64K and 256K memory cartridges are designed to work only with the new CPUs that have the order number as shown here: 6ES7 21x-xx23-0XB0. Each “x” means that this digit is a don’t care.

You may have user programs stored on 32K memory cartridges originally programmed by older CPUs (version “20”, “21”, or “22”). These cartridges can be read by the new CPUs, subject to the model number restrictions in Table A-65.

Real Time Clock Cartridge

The Real Time Clock cartridge (6ES7 297-1AA23-0XA0) is designed to work only with the “23” CPUs. The earlier version of the Real Time Clock cartridge (6ES7 297-1AA20-0XA0) is not physically or electrically compatible with the “23” CPUs.

I/O Expansion Cable

General Features (6ES7 290-6AA20-0XA0)	
Cable length	0.8 m
Weight	25 g
Connector type	10 pin ribbon

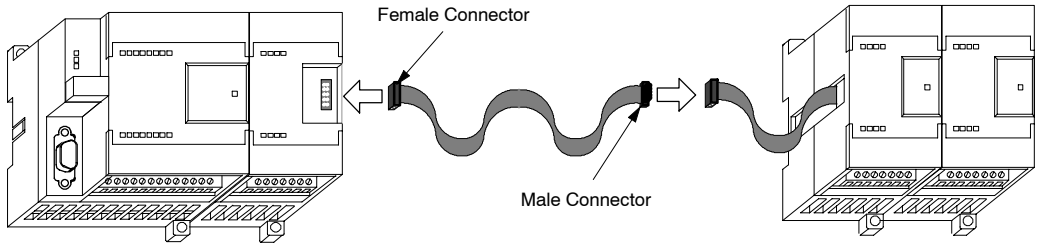


Figure A-43 Typical Installation of the I/O Expansion Cable

Tip
Only one expansion cable is allowed in a CPU/expansion module chain.

RS-232/PPI Multi-Master Cable and USB/PPI Multi-Master Cable

Table A-66 RS-232/PPI Multi-Master Cable and USB/PPI Multi-Master Cable Specifications

Description Order Number	S7-200 RS-232/PPI Multi-Master Cable 6ES7 901-3CB30-0XA0	S7-200 USB/PPI Multi-Master Cable 6ES7-901-3DB30-0XA0
General Characteristics		
Supply voltage	14.4 to 28.8 VDC	14.4 to 28.8 VDC
Supply current at 24 V nominal supply	60 mA RMS max.	50 mA RMS max.
Direction change delay: RS-232 stop bit edge received to RS-485 transmission disabled	-	-
Isolation	RS-485 to RS-232: 500 VDC	RS-485 to USB: 500 VDC
RS-485 Side Electrical Characteristics		
Common mode voltage range	-7 V to +12 V, 1 second, 3 V RMS continuous	-7 V to +12 V, 1 second, 3 V RMS continuous
Receiver input impedance	5.4 K Ω min. including termination	5.4 K Ω min. including termination
Termination/bias	10K Ω to +5 V on B, PROFIBUS pin 3 10K Ω to GND on A, PROFIBUS pin 8	10K Ω to +5 V on B, PROFIBUS pin 3 10K Ω to GND on A, PROFIBUS pin 8
Receiver threshold/sensitivity	+/-0.2 V, 60 mV typical hysteresis	+/-0.2 V, 60 mV typical hysteresis
Transmitter differential output voltage	2 V min. at R_L=100 Ω, 1.5 V min. at R_L=54 Ω	2 V min. at R_L=100 Ω, 1.5 V min. at R_L=54 Ω
RS-232 Side Electrical Characteristics		
Receiver input impedance	3K Ω min.	-
Receiver threshold/sensitivity	0.8 V min. low, 2.4 V max. high 0.5 V typical hysteresis	-
Transmitter output voltage	+/- 5 V min. at R_L=3K Ω	-
USB Side Electrical Characteristics		
Full speed (12 MB/s), Human Interface Device (HID)		
Supply current at 5V	-	50 mA max.
Power down current	-	400 uA max.

Features

The S7-200 RS-232/PPI Multi-Master Cable comes factory set for optimal performance with the STEP 7-Micro/WIN 3.2 Service Pack 4 (or later) programming package. The factory setting for this cable is different than for the PC/PPI cables. Refer to Figure 1 to configure the cable for your application.

You can configure the S7-200 RS-232/PPI Multi-Master Cable to operate the same as the PC/PPI cable and to be compatible with any version of a STEP 7-Micro/WIN programming package by setting Switch 5 to the PPI/Freeport setting and then selecting your required baud rate.

The USB cable requires STEP 7-Micro/WIN 3.2 Service Pack 4 (or later) programming package for operation.

Tip

For more information about using these cables, refer to Chapter 7, Communicating over a Network.

S7-200 RS-232/PPI Multi-Master Cable

Table A-67 S7-200 RS-232/PPI Multi-Master Cable - Pin-outs for RS-485 to RS-232 Local Mode Connector

RS-485 Connector Pin-out		RS-232 Local Connector Pin-out	
Pin Number	**Signal Description**	**Pin Number**	**Signal Description**
1	No connect	1	Data Carrier Detect (DCD) (not used)
2	24 V Return (RS-485 logic ground)	2	Receive Data (RD) (output from PC/PPI cable)
3	Signal B (RxD/TxD+)	3	Transmit Data (TD) (input to PC/PPI cable)
4	RTS (TTL level)	4	Data Terminal Ready (DTR)[1]
5	No connect	5	Ground (RS-232 logic ground)
6	No connect	6	Data Set Ready (DSR)[1]
7	24 V Supply	7	Request To Send (RTS) (not used)
8	Signal A (RxD/TxD-)	8	Clear To Send (CTS) (not used)
9	Protocol select	9	Ring Indicator (RI) (not used)

[1] Pins 4 and 6 are connected internally.

Table A-68 S7-200 RS-232/PPI Multi-Master Cable - Pin-outs for RS-485 to RS-232 Remote Mode Connector

RS-485 Connector Pin-out		RS-232 Remote Connector Pin-out[1]	
Pin Number	**Signal Description**	**Pin Number**	**Signal Description**
1	No connect	1	Data Carrier Detect (DCD) (not used)
2	24 V Return (RS-485 logic ground)	2	Receive Data (RD) (input to PC/PPI cable)
3	Signal B (RxD/TxD+)	3	Transmit Data (TD) (output from PC/PPI cable)
4	RTS (TTL level)	4	Data Terminal Ready (DTR)[2]
5	No connect	5	Ground (RS-232 logic ground)
6	No connect	6	Data Set Ready (DSR)[2]
7	24 V Supply	7	Request To Send (RTS) (output from PC/PPI cable)
8	Signal A (RxD/TxD-)	8	Clear To Send (CTS) (not used)
9	Protocol select	9	Ring Indicator (RI) (not used)

[1] A conversion from female to male, and a conversion from 9-pin to 25-pin is required for modems.
[2] Pins 4 and 6 are connected internally.

Use the S7-200 RS-232/PPI Multi-Master Cable with STEP 7-Micro/WIN as a replacement for the PC/PPI cable or for Freeport operation

For connection directly to your personal computer:

- ❑ Set the PPI/Freeport mode (Switch 5=0)
- ❑ Set the baud rate (Switches 1, 2, and 3)
- ❑ Set Local (Switch 6=0). The Local setting is the same as setting the PC/PPI cable to DCE.
- ❑ Set the 11 Bit (Switch 7=0)

For connection to a modem:

- ❑ Set the PPI/Freeport mode (Switch 5=0)
- ❑ Set the baud rate (Switches 1, 2, and 3)
- ❑ Set Remote (Switch 6=1). The Remote setting is the same as setting the PC/PPI cable to DTE.
- ❑ Set the 10 Bit or 11 Bit (Switch 7) to match the number of bits per character setting of your modem.

Use the S7-200 RS-232/PPI Multi-Master Cable with STEP 7-Micro/WIN 3.2 Service Pack 4 (or later)

For connection directly to your personal computer:

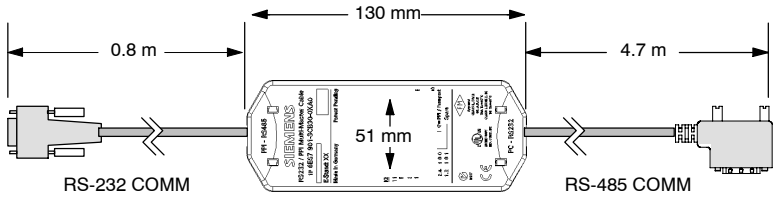
- ❑ Set the PPI mode (Switch 5=1)
- ❑ Set Local (Switch 6=0)
- ❑ Set 11-bit mode (Switch 7=0)

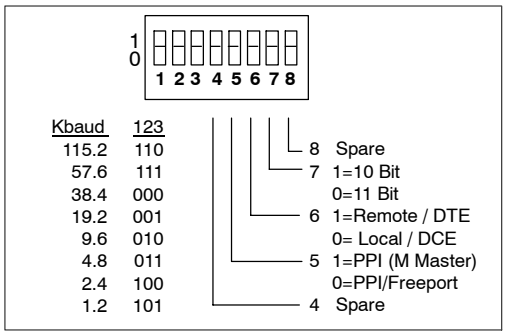
For connection to a modem:

- ❑ Set the PPI mode (Switch 5=1)
- ❑ Set Remote (Switch 6=1)
- ❑ Set 11-bit mode (Switch 7=0)

Tip
All other switches other than those noted above do not matter when using PPI mode.

Figure A-44 shows the S7-200 RS-232/PPI Multi-Master Cable dimensions, label and LEDs.





LED	Color	Description
Tx	Green	RS-232 transmit indicator
Rx	Green	RS-232 receive indicator
PPI	Green	RS-485 transmit indicator

Figure A-44 S7-200 RS-232/PPI Multi-Master Cable Dimensions, Label and LEDs

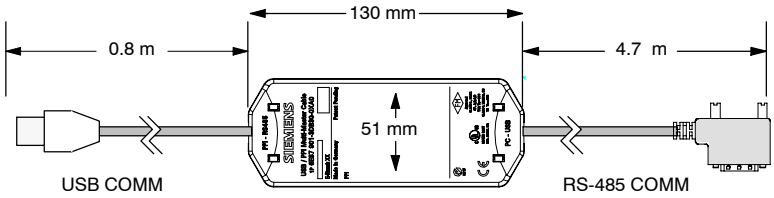
S7-200 USB/PPI Multi-Master Cable

To use the USB cable, you must have STEP 7–Micro/WIN 3.2 Service Pack 4 (or later) installed. It is recommended that you use the USB cable only with an S7-200 CPU22x or later. The USB cable does not support Freeport communications or downloading the TP Designer to the TP070.

Table A-69 S7-200 USB/PPI Multi-Master Cable – Pin-outs for the RS-485 to USB Series "A" Connector

RS-485 Connector Pin-out		USB Connector Pin-out	
Pin Number	**Signal Description**	**Pin Number**	**Signal Description**
1	No connect	1	USB – DataP
2	24 V Return (RS-485 logic ground)	2	USB – DataM
3	Signal B (RxD/TxD+)	3	USB 5V
4	RTS (TTL level)	4	USB logic ground
5	No connect		
6	No connect		
7	24 V Supply		
8	Signal A (RxD/TxD–)		
9	Protocol select (low = 10 bit)		

Figure A-45 shows the S7-200 USB/PPI Multi-Master Cable dimensions and LEDs.



LED	Color	Description
Tx	Green	USB transmit indicator
Rx	Green	USB receive indicator
PPI	Green	RS-485 transmit indicator

Figure A-45 S7-200 USB/PPI Multi-Master Cable Dimensions and LEDs

Input Simulators

Order Number	8 Position Simulator 6ES7 274-1XF00-0XA0	14 Position Simulator 6ES7 274-1XH00-0XA0	24 Position Simulator 6ES7 274-1XK00-0XA0
Size (L x W x D)	61 x 33.5 x 22 mm	91.5 x 35.5 x 22 mm	148.3 x 35.5 x 22 mm
Weight	0.02 Kg	0.03 Kg	0.04 Kg
Points	8	14	24

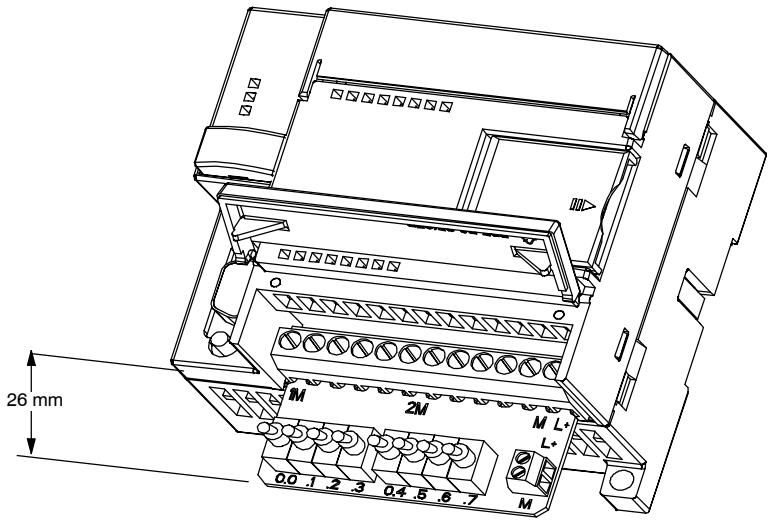


Figure A-46 Installation of the Input Simulator

Warning

These input simulators are not approved for use in Class I DIV 2 or Class I Zone 2 hazardous locations. The switches present a potential spark hazard.

Do not use input simulators in Class I DIV 2 or Class I Zone 2 hazardous locations.