OFFICIAL DOCUMENT PACKAGE

Manufacturer's Manual

Amikon cover with selected official Siemens technical pages

SIEMENS S7-200 SMART

6ES7288-5AQ01-0AA0

SB AQ01 ANALOG OUTPUT BOARD

Selected official pages retain the original technical tables, ratings, notes and pagination.

OFFICIAL SOURCE

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Original pages59-60,67,73-75,353-354,362,928-929

This technical extract does not replace the complete equipment and system manuals. Check the installed hardware and project before use.

Installation

4

4.1 Guidelines for installing S7-200 SMART devices

The S7-200 SMART equipment is designed to be easy to install. You can install the S7-200 SMART either on a panel or on a standard DIN rail, and you can orient the S7-200 SMART either horizontally or vertically. The small size of the S7-200 SMART allows you to make efficient use of space.

⚠ WARNING

Safety requirements for installing S7-200 SMART PLCs

S7-200 SMART PLCs are Open Type Controllers. You must install the PLC in a housing, cabinet, or electric control room. Open Type Controllers must be installed within an enclosure which protects you from hazards, including mechanical hazards, electrical shock and spread of fire. Limit entry to the housing, cabinet, or electric control room to authorized personnel.

Failure to follow these installation requirements could result in death or serious injury to personnel, and/or damage to equipment.

Always follow these requirements when installing the PLC.

The installation should provide a dry environment for the S7-200 SMART. SELV/PELV circuits are considered to provide protection against electric shock in dry locations.

The installation should provide the appropriate mechanical strength, flammability protection, and stability protection that is approved for open equipment in your particular location category according to applicable electrical and building codes.

Conductive contamination due to dust, moisture, and airborne pollution can cause operational and electrical faults in the PLC.

If you locate the PLC in an area where conductive contamination may be present, the PLC must be protected by an enclosure with appropriate protection rating. IP54 is one rating that is generally used for electronic equipment enclosures in dirty environments and may be appropriate for your application.

⚠ WARNING

Improper installation of the S7-200 SMART can result in electrical faults or unexpected operation of machinery.

Electrical faults or unexpected machine operation can result in death, severe personal injury, and/or property damage.

All instructions for installation and maintenance of a proper operating environment must be followed to ensure the equipment operates safely.

Separate the devices from heat, high voltage, and electrical noise

As a general rule for laying out the devices of your system, always separate the devices that generate high voltage and high electrical noise from the low-voltage, logic-type devices such as the PLC.

When configuring the layout of the PLC inside your panel, consider the heat-generating devices and locate the electronic-type devices in the cooler areas of your cabinet. Reducing the exposure to a high-temperature environment will extend the operating life of any electronic device.

Consider also the routing of the wiring for the devices in the panel. Avoid placing low-voltage signal wires and communications cables in the same tray with AC power wiring and high-energy, rapidly-switched DC wiring.

Provide adequate clearance for cooling and wiring

S7-200 SMART devices are designed for natural convection cooling. For proper cooling, you must provide a clearance of at least 25 mm above and below the devices. Also, allow at least 25 mm of depth between the front of the modules and the inside of the enclosure.

⚠ CAUTION

Temperature considerations

Vertical mounting reduces the maximum allowable ambient temperature by 10 degrees C. Operating outside the maximum temperature range could result in erratic process operation and could result in minor personal injury.

If your installation includes expansion modules, mount the CPU below them as shown in the following figure. Follow the prescribed guidelines for mounting modules to ensure proper cooling.

4.3.3 Installing and removing a signal board or battery board

The CPU models CPU CR20s, CPU CR30s, CPU CR40s, and CPU CR60s do not support the use of expansion modules, signal boards or battery boards.

Table 4-3 Installing a signal board on a CPU

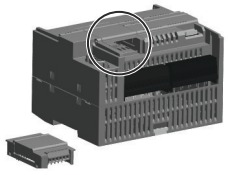
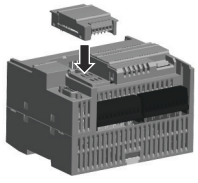
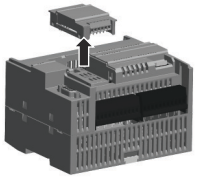
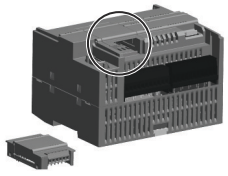
Task	Procedure
 	Follow the steps below to install a signal board or battery board 1. Ensure that the CPU and all S7-200 SMART equipment are disconnected from electrical power. 2. Remove the top and bottom terminal block covers from the CPU. 3. Place a screwdriver into the slot on top of the CPU at the rear of the cover. 4. Gently pry the cover up and remove it from the CPU. 5. Place the signal board or battery board straight down into its mounting position in the top of the CPU. 6. Firmly press the module into position until it snaps into place. 7. Replace the terminal block covers.

Table 4-4 Removing a signal board or battery board on a CPU

Task	Procedure
 	Follow the steps below to remove a signal board or battery board 1. Ensure that the CPU and all S7-200 SMART equipment are disconnected from electrical power. 2. Remove the top and bottom terminal block covers from the CPU. 3. Place a screwdriver into the slot on top of the module. 4. Gently pry the module up to disengage it from the CPU. 5. Remove the module straight up from its mounting position in the top of the CPU. 6. Replace the cover onto the CPU. 7. Replace the terminal block covers.

Prerequisites

Before you ground or install wiring to any electrical device, ensure that the power to that equipment has been turned off. Also, ensure that the power to any related equipment has been turned off.

Ensure that you follow all applicable electrical codes when wiring the PLC and related equipment. Install and operate all equipment according to all applicable national and local standards. Contact your local authorities to determine which codes and standards apply to your specific case.

⚠ WARNING

Attempts to install or wire the PLC or related equipment with power applied could cause electric shock or faulty operation of equipment. Failure to disable all power to the PLC and related equipment during installation or removal procedures could result in death or serious injury to personnel, and/or damage to equipment.

Always follow appropriate safety precautions and ensure that power to the PLC is disabled before attempting to install or remove the PLC or related equipment.

Always take safety into consideration as you design the grounding and wiring of your PLC system. Electronic control devices, such as the PLC, can fail and can cause unexpected operation of the equipment that is being controlled or monitored. For this reason, you should implement safeguards that are independent of the PLC to protect against possible personal injury or equipment damage.

⚠ WARNING

Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment. Such unexpected operations could result in death or serious injury to personnel, and/or damage to equipment.

Use an emergency stop function, electromechanical overrides, or other redundant safeguards that are independent of the PLC.

Isolation guidelines

The AC power supply boundaries and I/O boundaries to AC circuits have been designed and approved to provide safe separation between AC line voltages and low voltage circuits. These boundaries include double or reinforced insulation, or basic plus supplementary insulation, according to various standards. Components which cross these boundaries such as optical couplers, capacitors, transformers, and relays have been approved as providing safe separation. Only circuits rated for AC line voltage include safety isolation to other circuits. Isolation boundaries between 24 V DC circuits are functional only, and you should not depend on these boundaries for safety.

The sensor supply output, communications circuits, and internal logic circuits of an S7-200 SMART with included AC power supply are sourced as SELV (safety extra-low voltage) according to EN 61131-2.

To maintain the safe character of the S7-200 SMART low voltage circuits, external connections to communications ports, analog circuits, and all 24 V DC nominal power supply

and I/O circuits must be powered from approved sources that meet the requirements of SELV, PELV, Class 2, Limited Voltage, or Limited Power according to various standards.

⚠ WARNING

Safe use of power converters

Use of non-isolated or single insulation supplies to supply low voltage circuits from an AC line can result in hazardous voltages appearing on circuits that are expected to be touch safe, such as communications circuits and low voltage sensor wiring.

Such unexpected high voltages could result in death or serious injury to personnel, and/or damage to equipment.

Use only high-voltage-to-low-voltage power converters that are approved as sources of touch-safe, limited-voltage circuits.

Grounding guidelines

The best way to ground your application is to ensure that all the common and ground connections of your PLC and related equipment are grounded to a single point. This single point should be connected directly to the earth ground for your system.

All ground wires should be as short as possible and should use a large wire size, such as 2 mm^2 (14 AWG).

When locating grounds, remember to consider safety grounding requirements and the proper operation of protective interrupting devices.

Wiring guidelines

When designing the wiring for your S7-200 SMART CPU, provide a single disconnect switch that simultaneously removes power from the CPU power supply, from all input circuits, and from all output circuits. Provide over-current protection, such as a fuse or circuit breaker, to limit fault currents on supply wiring. Consider providing additional protection by placing a fuse or other current limit in each output circuit.

Install appropriate surge suppression devices for any wiring that could be subject to lightning surges.

Avoid placing low-voltage signal wires and communications cables in the same wire tray with AC wires and high-energy, rapidly switched DC wires. Always route wires in pairs, with the neutral or common wire paired with the hot or signal-carrying wire.

Use the shortest wire possible and ensure that the wire is sized properly to carry the required current.

Use wire and cable with a temperature rating 30 °C higher than the ambient temperature around the S7-200 SMART CPU (for example, a minimum of 85 °C-rated conductors for 55 °C ambient temperature). You should determine other wiring type and material requirements from the specific electrical circuit ratings and your installation environment.

Use shielded wires for optimum protection against electrical noise. Typically, grounding the shield at the S7-200 SMART CPU gives the best results. You should ground communication cable shields to S7-200 SMART CPU communication connector shells using connectors that

engage the cable shield, or by bonding the communication cable shields to a separate ground. You should ground other cable shields using clamps or copper tape around the shield to provide a high surface area connection to the grounding point.

When wiring input circuits that are powered by an external power supply, include an overcurrent protection device in that circuit. External protection is not necessary for circuits that are powered by the 24 V DC sensor supply from the S7-200 SMART CPU because the sensor supply is already current-limited.

All S7-200 SMART CPU modules have removable connectors for user wiring. To prevent loose connections, ensure that the connector is seated securely and that the wire is installed securely into the connector.

To help prevent unwanted current flows in your installation, the S7-200 SMART CPU provides isolation boundaries at certain points. When you plan the wiring for your system, you should consider these isolation boundaries. Refer to the technical specifications (Page 839) for the amount of isolation provided and the location of the isolation boundaries. Circuits rated for AC line voltage include safety isolation to other circuits. Isolation boundaries between 24 V DC circuits are functional only, and you should not depend on these boundaries for safety.

A summary of wiring rules for the S7-200 SMART CPUs, EMs, and SBs is shown below:

Table 4-11 Wiring rules for S7-200 SMART CPUs, EMs, and SBs

Wiring rules for...	CPU and EM connector	SB connector
Connectible conductor cross-sections for standard wires	2 mm^2 to 0.3 mm^2 (14 AWG to 22 AWG)	1.3 mm^2 to 0.3 mm^2 (16 AWG to 22 AWG)
Number of wires per connection	1 or combination of 2 wires up to 2 mm^2 (total)	1 or combination of 2 wires up to 1.3 mm^2 (total)
Wire strip length	6.4 mm	6.3 to 7 mm
Tightening torque* (maximum)	0.56 N-m (5 inch-pounds)	0.33 N-m (3 inch-pounds)
Tool	2.5 to 3.0 mm flathead screwdriver	2.0 to 2.5 mm flathead screwdriver

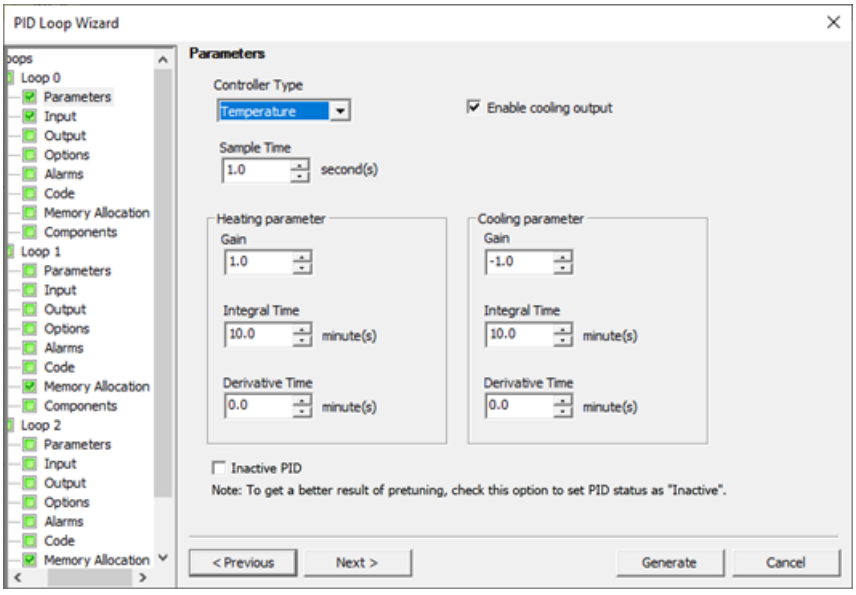
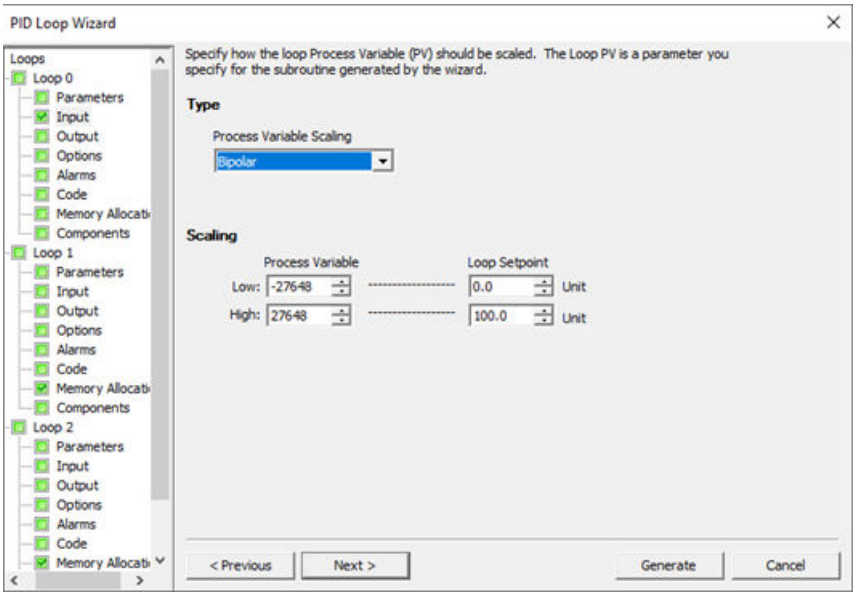
* To avoid damaging the connector, be careful that you do not over-tighten the screws.

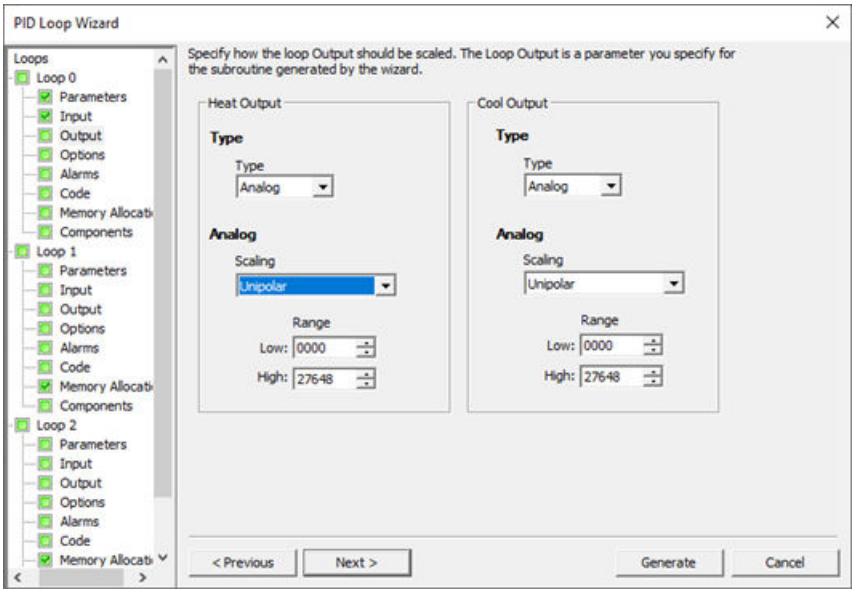
Note

Ferrules or end sleeves on stranded conductors reduce the risk of stray strands causing short circuits. Ferrules longer than the recommended strip length should include an insulating collar to prevent shorts due to side movement of conductors. Cross-sectional area limits for bare conductors also apply to ferrules.

Guidelines for lamp loads

Lamp loads are damaging to relay contacts because of the high turn-on surge current. This surge current will nominally be 10 to 15 times the steady state current for a tungsten lamp. A replaceable interposing relay or surge limiter is recommended for lamp loads that will be switched a large number of times during the lifetime of the application.

Screen	Description
	Set the following loop parameters: **Bidirectional Output disabled** • Gain (Default value = 1.00) • Sample Time (Default value = 1.00) • Integral Time (Default value = 10.00) • Derivative Time (Default value = 0.00) **Bidirectional Output enabled** Forward/Heating parameter • Gain (default value = 1.00) • Sample Time (default value = 1.00) • Integral Time (default value = 10.00) • Derivative Time (default value = 0.00) Reverse/Cooling parameter • Gain (default value = -1.00) • Sample Time (default value = 1.00) • Integral Time (default value = 10.00) • Derivative Time (default value = 0.00)
	You assign how the loop Process Variable (PV) is to be scaled. You can choose from the following options: • Unipolar (default: 0 to 27648) • Bipolar (default: -27648 to 27648) • Unipolar 20% offset (range: 5530 to 27648) • Temperature x 10 °C • Temperature x 10 °F In the Scaling parameter, you assign how the loop setpoint (SP) is to be scaled. Default is a real number between 0.0 and 100.0.

Screen	Description
	You enter the loop output options: • How the loop output is to be scaled: – Analog – Digital • Analog scaling parameter: – Unipolar (default: 0 to 27648) – Bipolar (default: -27648 to 27648) – Unipolar 20% offset (range: 5530 to 27648) • Analog range parameter: Assign the loop output range. The possible range is -27648 to +27648, depending on your scaling selection.

The following instruction sequence shows how to normalize the bipolar value in AC0 (whose span is 55,296) as a continuation of the previous instruction sequence:

```
/R      55296.0, AC0  //Normalize the value in the accumulator
+R      0.5, AC0      //Offset the value to the range from 0.0 to 1.0
MOVR    AC0, VD100    //Store the normalized value in the loop TABLE
```

9.9.4 Converting the loop output to a scaled integer value

The loop output is the control variable, such as the throttle setting of the cruise control on an automobile. The loop output is a normalized, real number value between 0.0 and 1.0. Before the loop output can be used to drive an analog output, the loop output must be converted to a 16-bit, scaled integer value. This process is the reverse of converting the PV and SP to a normalized value. The first step is to convert the loop output to a scaled, real number value using the formula given below:

$$R_{Scal} = (M_n - Offset) * Span$$

R_{Scal}	is the scaled, real number value of the loop output
M_n	is the normalized, real number value of the loop output
Offset	is 0.0 for unipolar values is 0.5 for bipolar values
Span	is the maximum possible value minus the minimum possible value = 27,648 for unipolar values (typical) = 55,296 for bipolar values (typical)

The following instruction sequence shows how to scale the loop output:

```
MOVR    VD108, AC0    //Moves the loop output to the accumulator
-R      0.5, AC0      //Include this statement only if the value is bipolar
*R      55296.0, AC0  //Scales the value in the accumulator
```

Next, the scaled, real number value representing the loop output must be converted to a 16-bit integer. The following instruction sequence shows how to do this conversion:

```
ROUND   AC0, AC0      //Converts the real number to a 32-bit integer
DTI     AC0, LW0      //Converts the value to a 16-bit integer
MOVW    LW0, AQW0     //Writes the value to the analog output
```

A.7.2 SB AQ01 analog output specifications

Table A-146 General specifications

Technical data	SB Analog 1 x Output (SB AQ01)
Article number	6ES7288-5AQ01-0AA0
Dimensions W x H x D (mm)	35 x 52.2 x 16
Weight	17.4 grams
Power dissipation	1.5 W
Current consumption (5 V DC)	15 mA
Current consumption (24 V DC)	40 mA (no load)

Table A-147 Analog outputs

Technical data	SB Analog 1 x Output (SB AQ01)
Number of outputs	1
Type	Voltage or current
Range	±10 V, 0 to 20 mA
Resolution	Voltage: 11 bits + sign Current: 11 bits
Full scale range (data word) Refer to the output ranges for voltage and current.	-27,648 to 27,648 (-10 V to 10 V) 0 to 27,648 (0 to 20 mA)
Accuracy (25 °C / -20 to 60 °C)	±0.5% / ±1%
Settling time (95% of new value)	Voltage: 300 µs (R), 750 µs (1 µF) Current: 600 µs (1mH), 2 ms (10 mH)
Load impedance	Voltage: ≥ 1000 ohms Current: ≤ 600 ohms
Output behavior in STOP	Last value, substitute value (default value 0)
Isolation (field side to logic)	None
Cable length (max.), in meters	10 m twisted and shielded

Table A-148 Diagnostics

Technical data	SB Analog 1 x Output (SB AQ01)
Overflow/underflow	Yes
Short to ground (voltage mode only)	Yes
Wire break (current mode only)	Yes

Table A-149 Wiring diagram for the SB AQ01 Analog 1 x Output (6ES7288-5AQ01-0AA0)

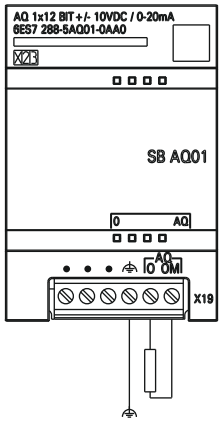
SB AQ01 Analog 1 x Output (6ES7288-5AQ01-0AA0)	
	

Table A-150 Connector pin locations for SB AQ01 Analog 1 x Output (6ES7288-5AQ01-0AA0)

Pin	X19
1	No connection
2	No connection
3	No connection
4	Functional Earth
5	AQ 0
6	AQ 0M

A.8 RS485/RS232 signal boards

A.8.1 SB RS485/RS232 specifications

Table A-151 General specifications

Technical data	SB RS485/RS232
Article number	6ES7288-5CM01-0AA0
Dimensions W x H x D (mm)	35 x 52.2 x 16
Weight	18.2 grams
Power dissipation	0.5 W
Current consumption (5 V DC)	50 mA
Current consumption (24 V DC)	N/A