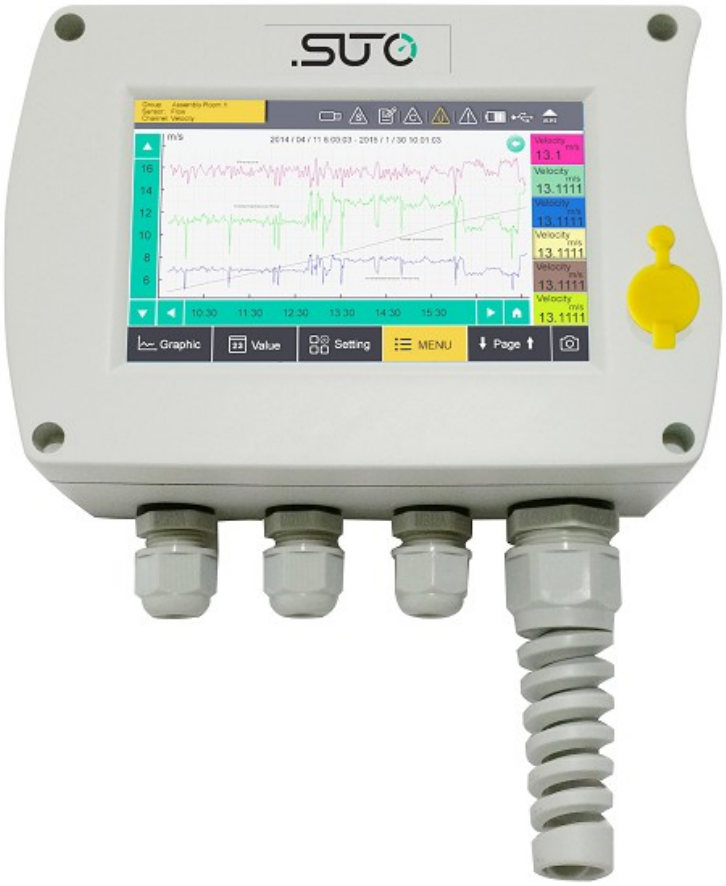
English

Instruction and operation manual

S330/S331

Display and data logger



Dear Customer,

Thank you for choosing our product.

Please read the operating instructions in full and carefully observe them before starting up the device. The manufacturer cannot be held liable for any damage which occurs as a result of non-observance or non-compliance with this manual.

Should the device be tampered with in any manner other than a procedure which is described and specified in the manual, the warranty is void and the manufacturer is exempt from liability.

The device is destined exclusively for the described application.

SUTO offers no guarantee for the suitability for any other purpose. SUTO is also not liable for consequential damage resulting from the delivery, capability or use of this device.

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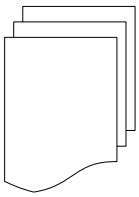
1 Safety instructions



Please check if this instruction manual matches the product type.

Please observe all notes and instructions indicated in this manual. It contains essential information which must be observed before and during installation, operation and maintenance. Therefore this instruction manual must be read carefully by the technician as well as by the responsible user / qualified personnel.

This instruction manual must be available at the operation site of the display and data logger at any time. In case of any obscurities or questions, regarding this manual or the product, please contact the manufacturer.

WARNING!

Voltage used for supply!

Any contact with energized parts of the product, may lead to an electrical shock which can lead to serious injuries or even death!

- Consider all regulations for electrical installations.
- The system must be disconnected from any power supply during maintenance work.
- Any electrical work on the system is only allowed by authorized qualified personal.

WARNING!

Permitted operating parameters!

Observe the permitted operating parameters, any operation exceeding this parameters can lead to malfunctions and may lead to damage on the instrument or the system.

- Do not exceed the permitted operating parameters.
- Make sure the product is operated in its permitted limitations.
- Do not exceed or undercut the permitted storage and operation temperature and pressure.

General safety instructions

- It is not allowed to use the product in explosive areas.
- Please observe the national regulations before/during installation and operation.

Remark

- It is not allowed to disassemble the product.

ATTENTION!

Measurement values can be affected by malfunction!

The product must be installed properly and frequently maintained, otherwise it may lead to wrong measurement values, which can lead to wrong results.

Storage and transportation

- Make sure that the transportation temperature of the display and data logger is between -20 ... +60°C.
- For transportation it is recommended to use the packaging which comes with the display.
- Please make sure that the storage temperature of the display is between -20 ... +70°C.
- Avoid direct UV and solar radiation during storage.
- For the storage the humidity must be <90%, no condensation.

2 Application

The S330/S331 display and data logger provides a universal solution for displaying and recording all kinds of measurement data in a compressed air system, which includes flow, dew point, pressure, temperature, power consumption, compressor status, and so on.
The S330/S331 is mainly used in compressed air systems in the industrial environment. It is not developed to be used in explosive areas. For the use in explosive areas, please contact the manufacturer.

3 Features

- Provides 5” high-resolution colour touch screen.
- Supports connections to all SUTO sensors and third-party sensors.
- Supports 16 Modbus, 2 SDI, 2 analog, and 2 pulse sensors.
- Supports up to 100 measuring channels.
- 2 wall casings available:
  - 4 cable glands
  - 7 cable glands
- Provides the USB interface to enable data transfer to memory stick or PC.
- Provides RS-485 (Modbus / RTU, SUTO-Bus) and Ethernet (Modbus / TCP, SUTO-Bus) interfaces to enable connections to the factory automation system.
- Provides 10 W sensor power supply (24 VDC).
- Provides the optional data logger, which can store 100 million measurement values.
- Alarm monitoring with two relay outputs.
- Integrates Web server for remote monitoring.
- Various options for system extension.
- Supports monitoring of the compressor runtime.

4 Technical data

4.1 General data

CE	
Data logger (only S331)	Internal, 100 million values
Operating temperature	0 ... +50°C
Housing material	PC + ABS
Protection class	IP65
Dimensions	See dimensional drawing on page 11.
Display	5” high-resolution graphic display, 800 x 480 pixels touch screen
Cable entry diameter	4.5 … 8 mm
Cable	Supply: AWG12 ... AWG24, 0.2 ... 2.5 mm²; Signals: AWG16 ... AWG28, 0.14 ... 1.5 mm²
Weight	0.52 kg

4.2 Electrical data

Power supply	100 ... 240 VAC, 20 VA (option, A1663) 18 ... 30 VDC, 20 W (option, A1664)
Sensor supply	24 V, 10 W

4.3 Input-Signals

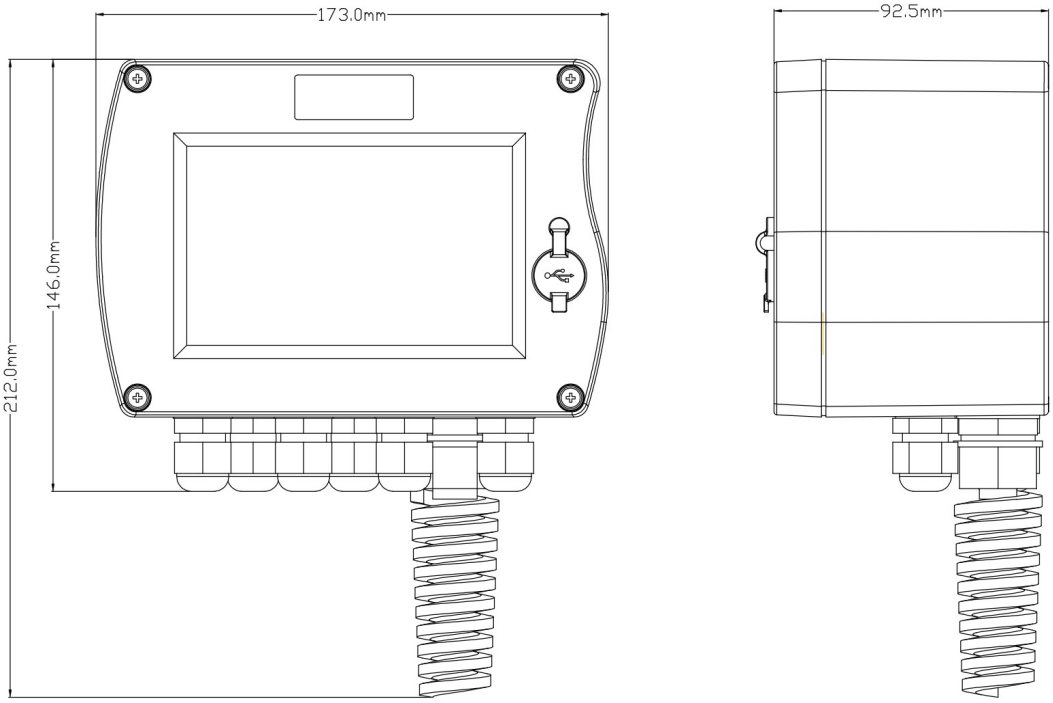
Digital input	2 x SDI sensors 16 x RS-485 Modbus RTU Sensors
Analog input	2 x 0 ... 20 mA / 4 ... 20 mA / 0 ... 10V 2 x pulse
Pulse input	100 Hz maximum; 28 V, 10 mA

4.4 Output-Signals

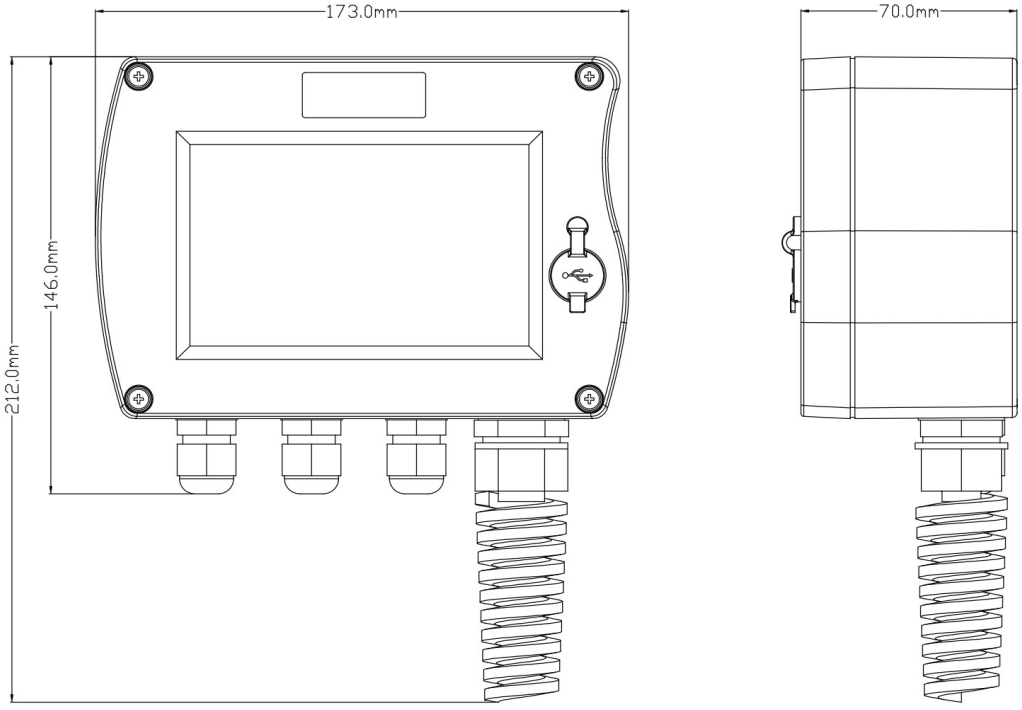
Analog / Pulse output	4 ... 20 mA signal and pulse signal of sensors can be looped through the display by using the connection board
Alarm output	2 relays, 230 VAC, 3 A, NC
Interface	Ethernet / RS-485 Modbus TCP / RTU, USB stick, USB cable

5 Dimensional drawing

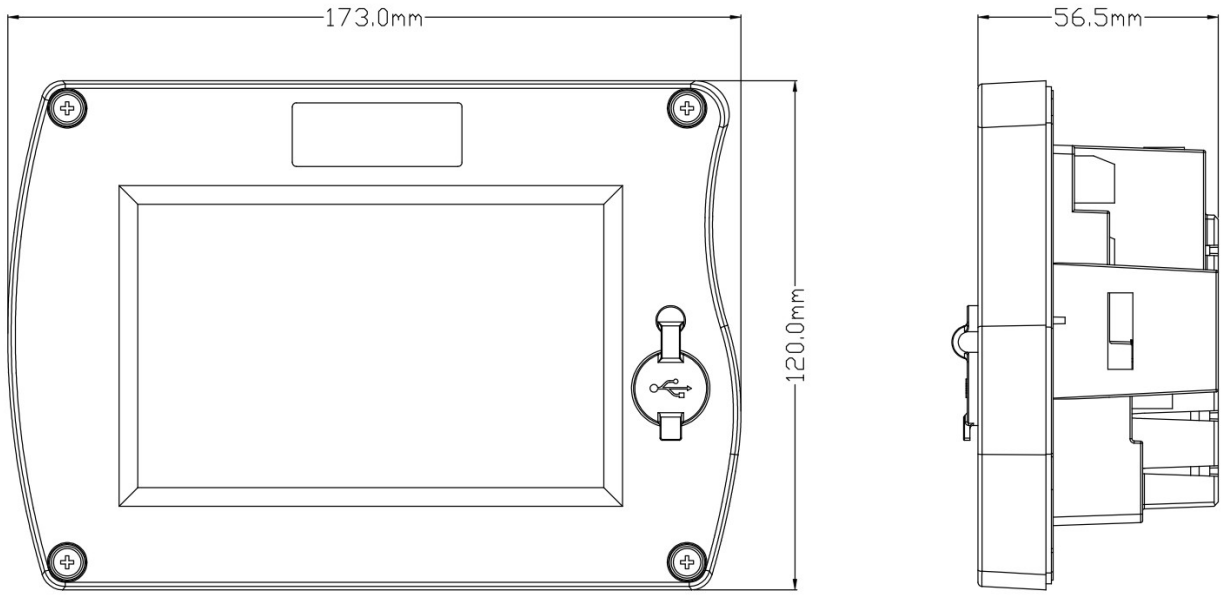
Panel with wall mountable casing (7 glands):



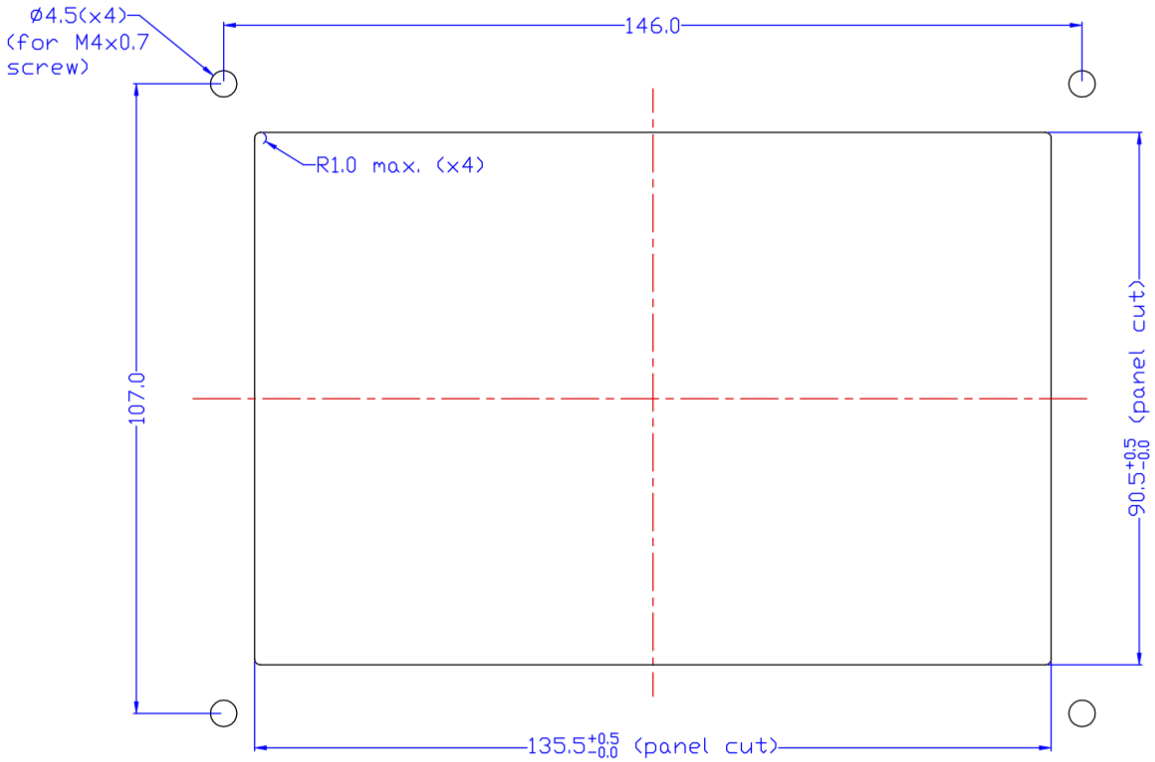
Panel with wall mountable casing (4 glands):



Panel:

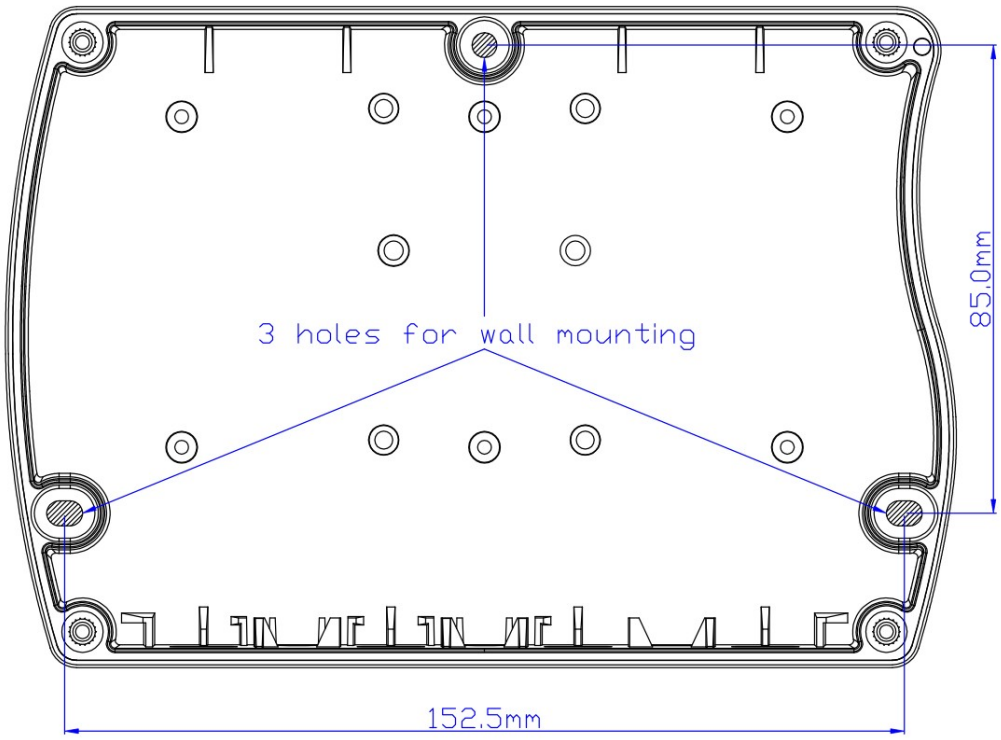


Panel cut size:



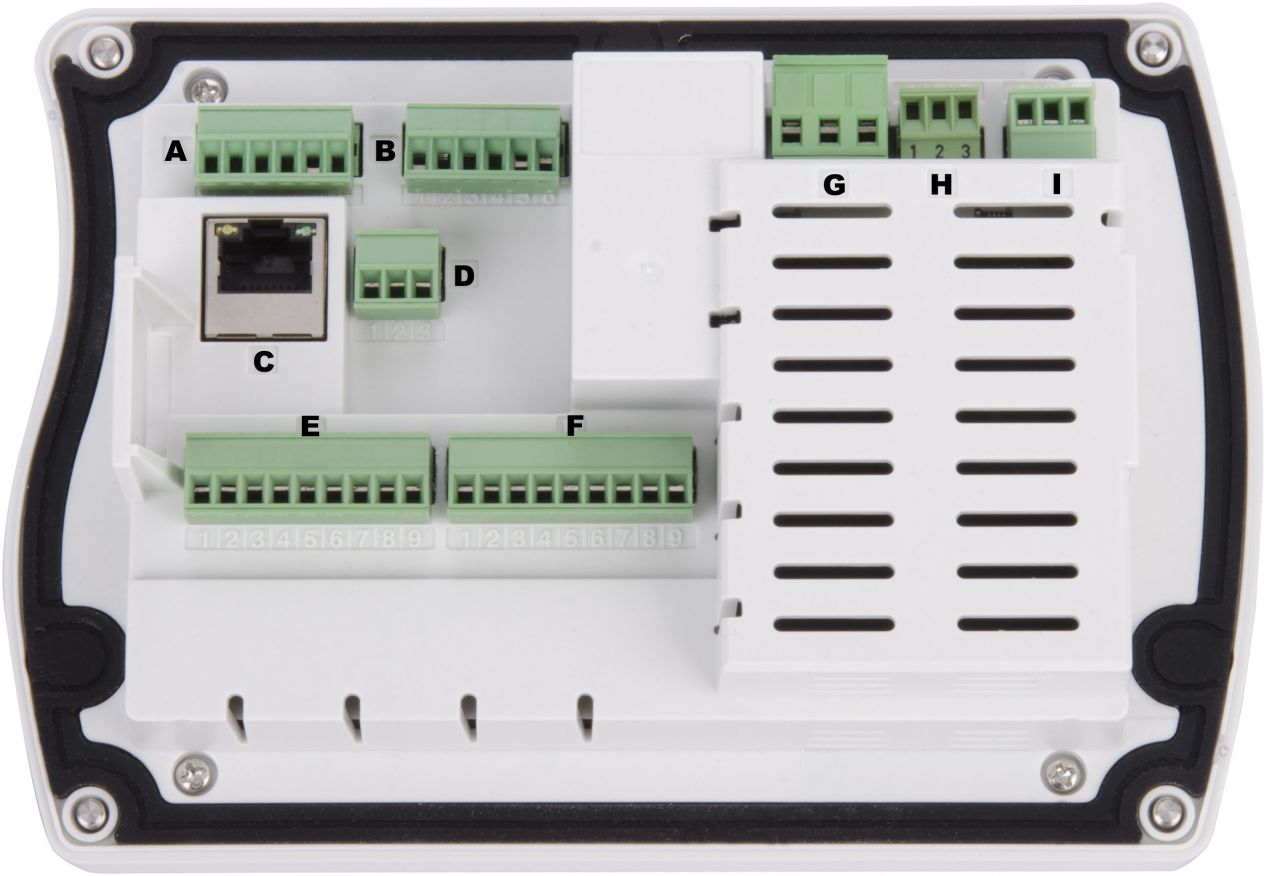
S 330/331 panel cut size

Wall mounting instruction:



6 Signal inputs and outputs

The following diagram shows the terminal block layout in the rear view of the S330/S331.



A : Inputs for digital sensors (1 x SDI + 1 x Modbus)

B : Inputs for digital sensors (1 x SDI + 1 x Modbus)

C : Ethernet

D : RS-485

E : Inputs for analog sensors (1 x analog + 1 x pulse)

F : Inputs for analog sensors (1 x analog + 1 x pulse)

Option A1662

G : Power supply

H : Relay output

I : Relay output

Remark:

Terminals varies depending on the selected options in the order.

6.1 Digital inputs

The display provides two different digital inputs, and can connect:

- 2 x SDI sensors, and
- 16 x Modbus sensors

6.2 Analog inputs

The display provides two optional analog / pulse inputs, and can connect:

- 2 x analog sensors (0 ... 20 mA / 4 ... 20 mA / 0 ... 10 V), and;
- 2 x pulse sensors

6.3 Analog / pulse output

The 4 ... 20 mA signals and pulse signal of sensors can be looped through the display by using the connection board.

6.4 Alarm output

The display has two alarm relay outputs (230 VAC, 3 A).

6.5 Data interface

The data can be transmitted via Ethernet / RS-485 Modbus TCP / RTU to a data collection system or software. Alternatively the data can also be transferred via USB stick or USB cable.

7 Installation

Please make sure that all components listed below are included in your package.

Qty	Description	Item No.
1	S330 or S331 Panel with ordered options	D500 0333 (excluding the data logger) D500 0331 (including the data logger)
1	USB A to USB micro cable	A553 0130
1	Instruction manual	No P/N

7.1 Installation requirements

The instrument can either be mounted into a panel or on a wall if ordered with the optional wall casing. Please observe the drawings in chapter 5 for details. The casing of the S330/S331 must be fixed on the wall using suitable dowels and screws.

ATTENTION!

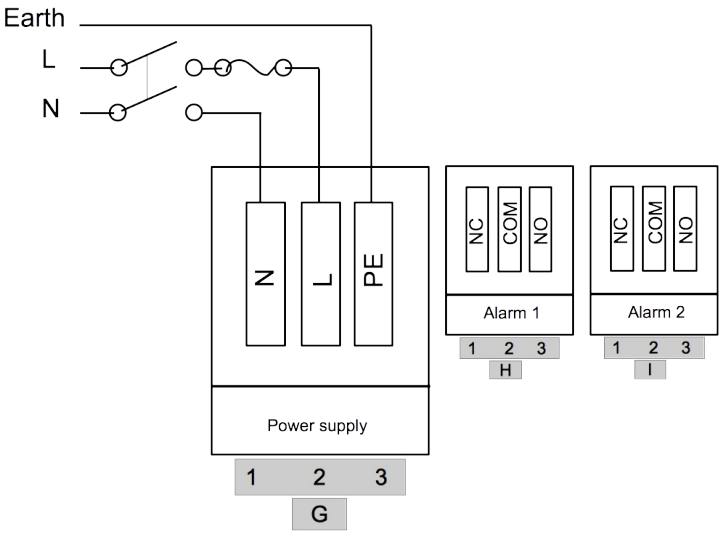
Wrong measurement is possible if the display is not installed correctly.

- The sensor is for indoor use only! At an outdoor installation, the sensor must be protected from solar radiation and rain.
- It is strongly recommend not to install S330/S331 permanently in wet environment which exists right after a compressor outlet.

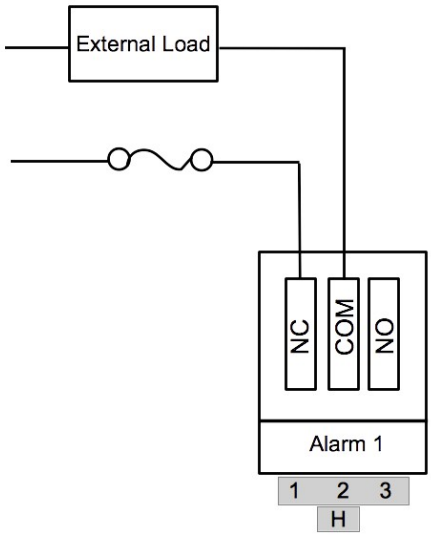
7.2 Electronic connection

7.2.1 Connecting the AC power supply and alarm (A1663)

AC power connection

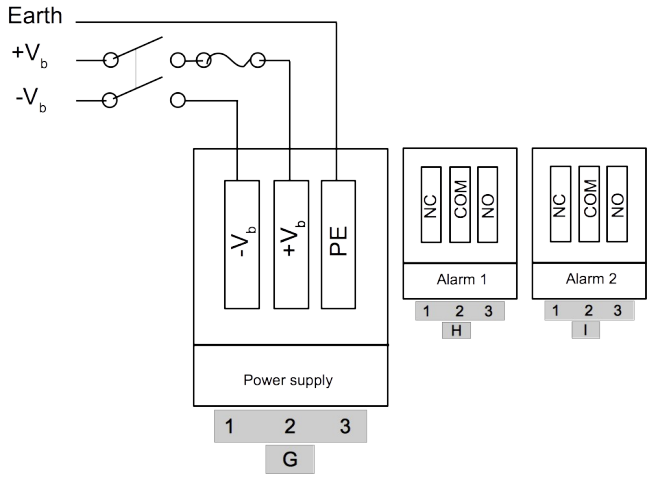


Alarm connection

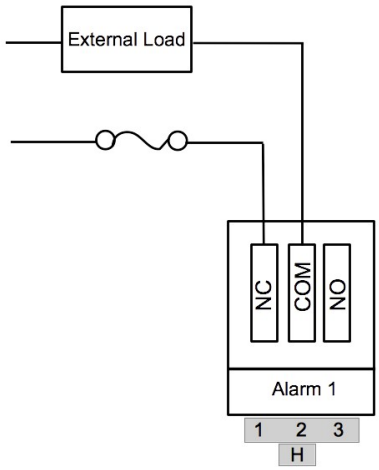


7.2.2 Connecting the DC power supply and alarm (A1664)

DC power connection



Alarm connection



7.2.3 Power consumptions of sensors

The S330 / S331 can provide a maximum 10 W power supply to connected sensors. The following table shows the power consumption of the sensors supported by S330/S331.
If the total power consumption of connected sensors is greater than 10 W, please use an external power source.

Sensor	Power [W]	Sensor	Power [W]
S430	3.0	S201 / S220	1.3
S450 / S452	5.0	S212	1.0
S401 / S421	3.0	S215	0.5
Pressure sensor	0.5	S110	3.5
Rogowski	0.8	S120	10.0
		S130	10.0

7.2.4 Terminal signals of SDI and Modbus sensor input

Terminal	Pin	Signal	Description
A	1	SDI	Digital communication signal from a sensor
	2	$-V_b$	Negative sensor supply
	3	$+V_b$	Positive sensor supply
	4	+D	Modbus sensor input
	5	-D	Modbus sensor input
	6	GND	GND for Modbus sensor communication
B	1	SDI	Digital communication signal from a sensor
	2	$-V_b$	Negative sensor supply
	3	$+V_b$	Positive sensor supply
	4	+D	Modbus sensor input
	5	-D	Modbus sensor input
	6	GND	GND for Modbus sensor communication

The Modbus inputs have pull-up / pull-down resistors permanently connected.

The terminal resistor is software controlled, and can be enabled or disabled through the “communication” menu of S330/S331.
RS-485 requires a termination resistor at both far ends of the network. Please perform the connection correctly. In total, up to 8 slaves can be connected to the 2 Modbus inputs.

ATTENTION!

Always connect to the earth!

When earth connection is missing, conductive components may carry supply voltage. Touching of such parts leads to an electrical shock which can lead to serious injuries or even death!

7.2.5 Terminal signals of Modbus slave

Terminal	Pin	Signal	Description
D	1	+D	Modbus output
	2	-D	Modbus output
	3	GND	GND for Modbus sensor communication

7.2.6 Connecting sensors with terminal A+B (via SDI)

S330/S331			S401 / S421 / S430	S450 / S452	S201	S220 / S212	S215	Colour
Terminal	**Pin**	**Signal**	**Pin**	**Pin**	**Pin**	**Pin**	**Pin**	
A	1	SDI	A.1	4	A.1	1	1	brown
	2	$-V_b$	A.2	3	A.2	2	2	white
	3	$+V_b$	A.3	2	A.3	3	3	blue
B	1	SDI	A.1	4	A.1	1	1	brown
	2	$-V_b$	A.2	3	A.2	2	2	white
	3	$+V_b$	A.3	2	A.3	3	3	blue

7.2.7 Connecting sensors with terminal A+B (via Modbus)

S330/S331			S230 S231	S220	S401 S421 S430	S120	Colour
Terminal	**Pin**	**Signal**	**Pin**	**Pin**	**Pin**	**Pin**	
A	2	$-V_b$	2	A.2	B.2	A.2 / B.2	white
	3	$+V_b$	3	A.3	B.3	A.3 / B.3	blue
	4	+D	4	A.4	B.4	A.4 / C.4	black
	5	-D	5	A.5	B.5	A.5 / C.5	grey
	6	GND	6	N/A	B.1	B.1	brown
B	2	$-V_b$	2	A.2	B.2	A.2 / B.2	white
	3	$+V_b$	3	A.3	B.3	A.3 / B.3	blue
	4	+D	4	A.4	B.4	A.4 / C.4	black
	5	-D	5	A.5	B.5	A.5 / C.5	grey
	6	GND	6	N/A	B.1	B.1	brown

7.2.8 Looping analog signals to a PLC (A554 3313)

If a 4 ... 20 mA or pulse signal of a sensor needs to be connected to a PLC or SCADA system, a separated connection board is needed. With the connection board, two 4 ... 20 mA signals and two pulse signals can be looped to the PLC or SCADA system.

For wiring, please refer to the instruction manual of the connection board.

Remarks:

- S401 / S421 provides isolated pulse output also on connector B. Please refer to instructions manual S401 / S421.

- S450 provides isolated pulse and mA signals directly from the sensor.

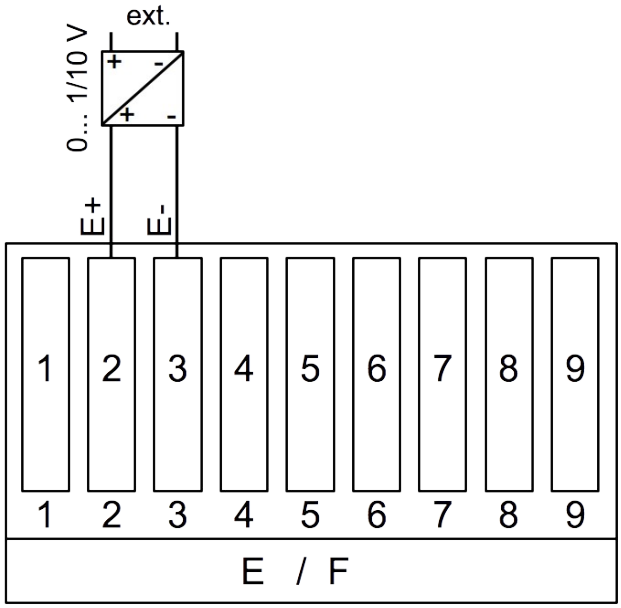
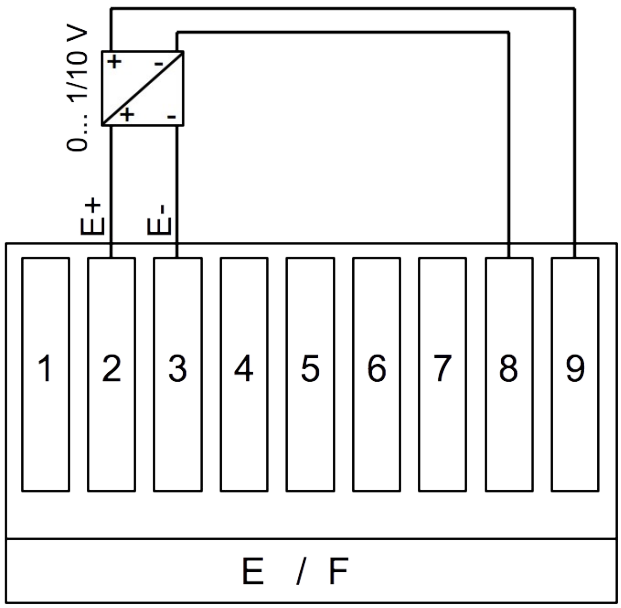
7.2.9 Terminal signals of RS-485 and Ethernet

For the connection of the RS-485 and Ethernet signal, see Chapter 10 .

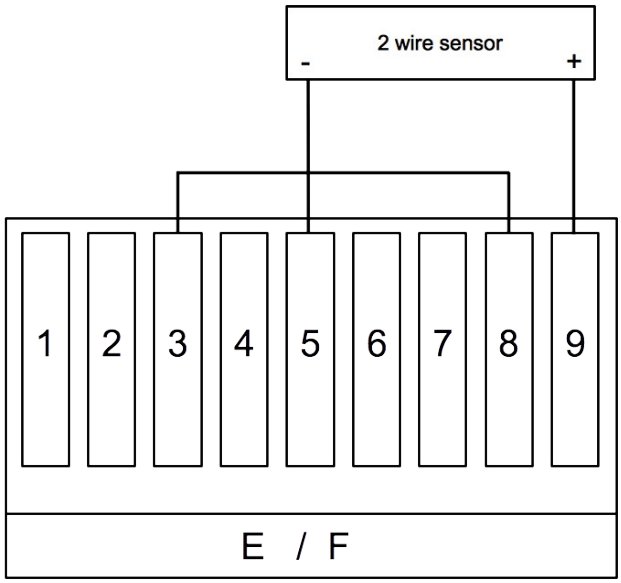
7.2.10 Terminal signals of the optional analog card (A1662)

This optional card offers two more inputs at Terminal E and F, which can be used to receive:

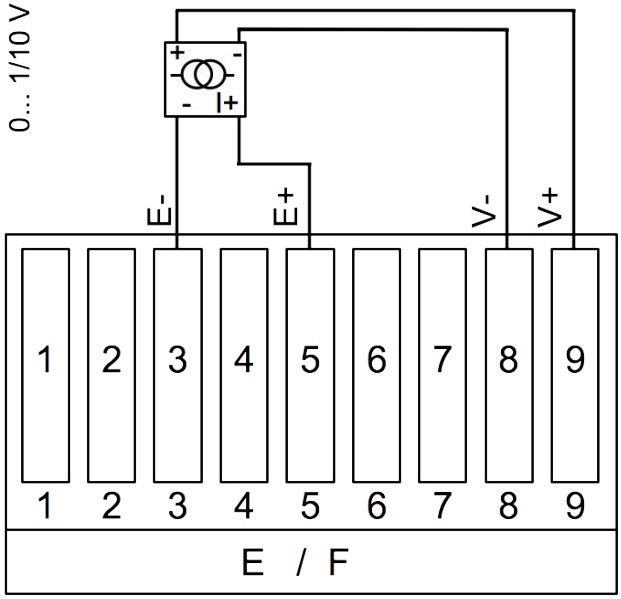
- 4 ... 20 mA, 0 ... 10 V analog signal and pulse signal from third-party flow sensors.
- Relay signals from compressors.

A. Process voltage input 0 ... 1 V or 0 … 10 V	**B.** Process voltage input. The sensor is supplied by S330/S331
	

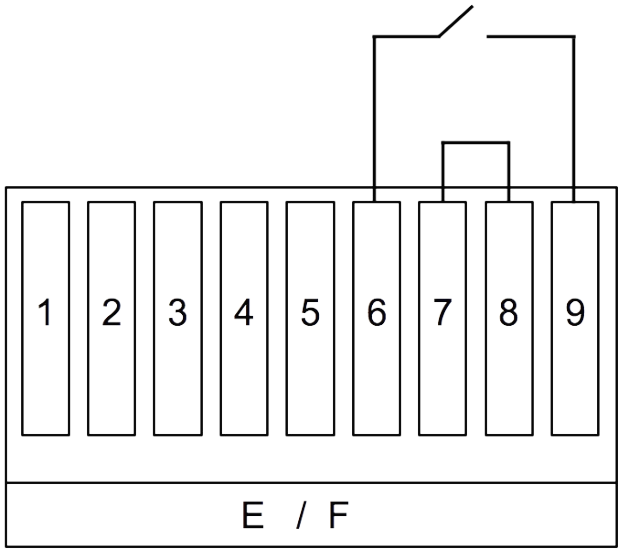
C. Loop current input 0 ... 20 mA / 4 ... 20 mA.



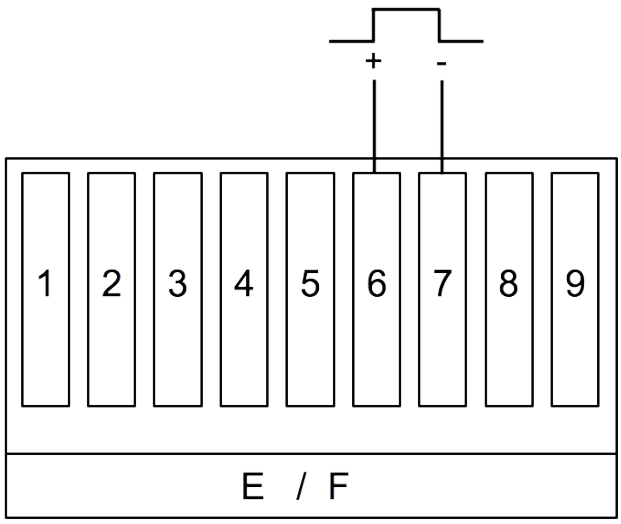
D. Process current input 0 ... 20 mA / 4 ... 20 mA. Sensor is supplied by S330/S331.



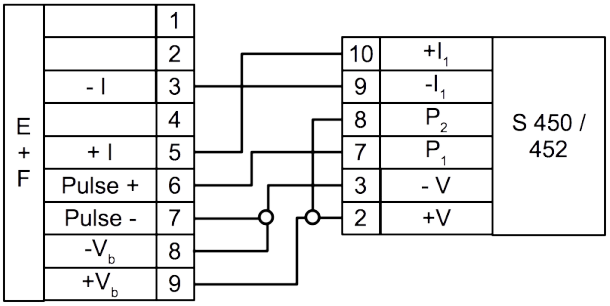
E. Connection of an isolated pulse input from a flow meter or connection of a relay signal from a compressor for monitoring the run time of the compressor (For more details, see section 13.2 .)

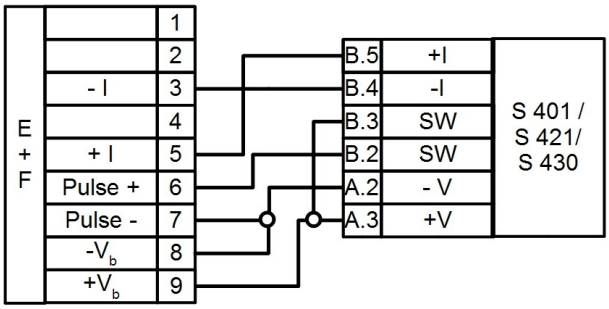


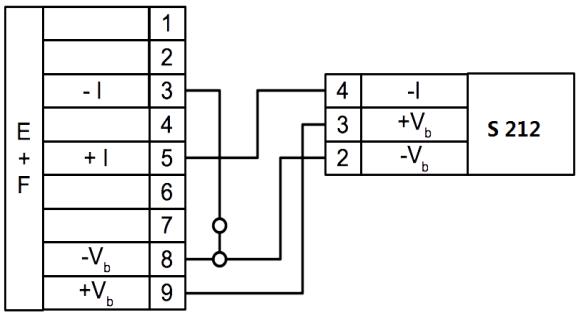
F. Connection of an active pulse signal from a flow meter or connection of a 24 VDC relay signal from a compressor for monitoring the run time of the compressor (For more details, see section 13.2 .)

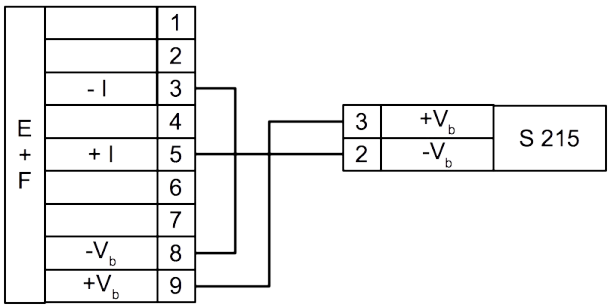


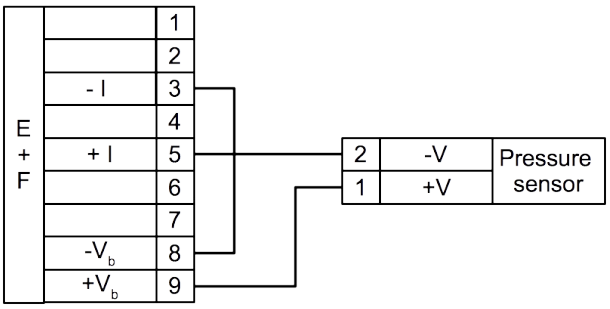
7.2.11 Connecting sensors with terminal E+F (A1662)

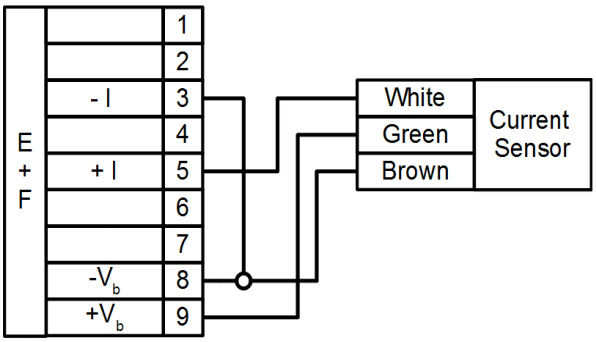












7.3 Software Installation

SS330/S331 has the following supporting software. All software is based on the Windows operating system and is available for free download on the SUTO website (www.SUTO.com).

S/W	Description	HW & SW requirements	How to access
S4C-Display	330/S331 configuration software. Free of charge	PC, OS：Windows XP、Vista 32、Vista 64、Windows 7 32bit、Windows 7 64bit、Windows 10	USB Interface
S4A	Data analysis software for a single data logger. Free of charge	PC, OS：Windows XP、Vista 32、Vista 64、Windows 7 32bit、Windows 7 64bit、Windows 10	* Remote access via Ethernet * USB Interface
S4M	Data monitoring and analysis software for multiple data loggers Free download, and charged according to the numbers of measurement channels.	PC, OS: Windows XP、Vista 32、Vista 64、Windows 7 32bit、Windows 7 64bit	* Remote access via Ethernet

Remarks:

- Download the software according to your needs, and follow the onscreen instructions to install.
- For software instructions, see the software online help.

8 Configuration

The S330 / S331 is shipped with parameter settings specific to orders. For general settings, you can configure them through the S330/331 touch screen. For advanced settings, you need to use S4C-Display software.
The S330 / S331 provides types of sensor inputs (SUTO, analog, Modbus). Each sensor input can contain one or more physical measurement channels.
In addition, S330 / S331 supports virtual measurement channels. These channels are non-physical channels generated by adding, subtracting, multiplying and dividing one or more physical channels. For more information, see Section 13.1 .
S330 / S331 can provide a maximum of 100 total measurement channels. The following table lists the maximum number of channels by input type.

Input type	SDI	Analog& Pulse	Virtual Channel	Modbus
Max. number of channels	12	4	10	58

Remark:

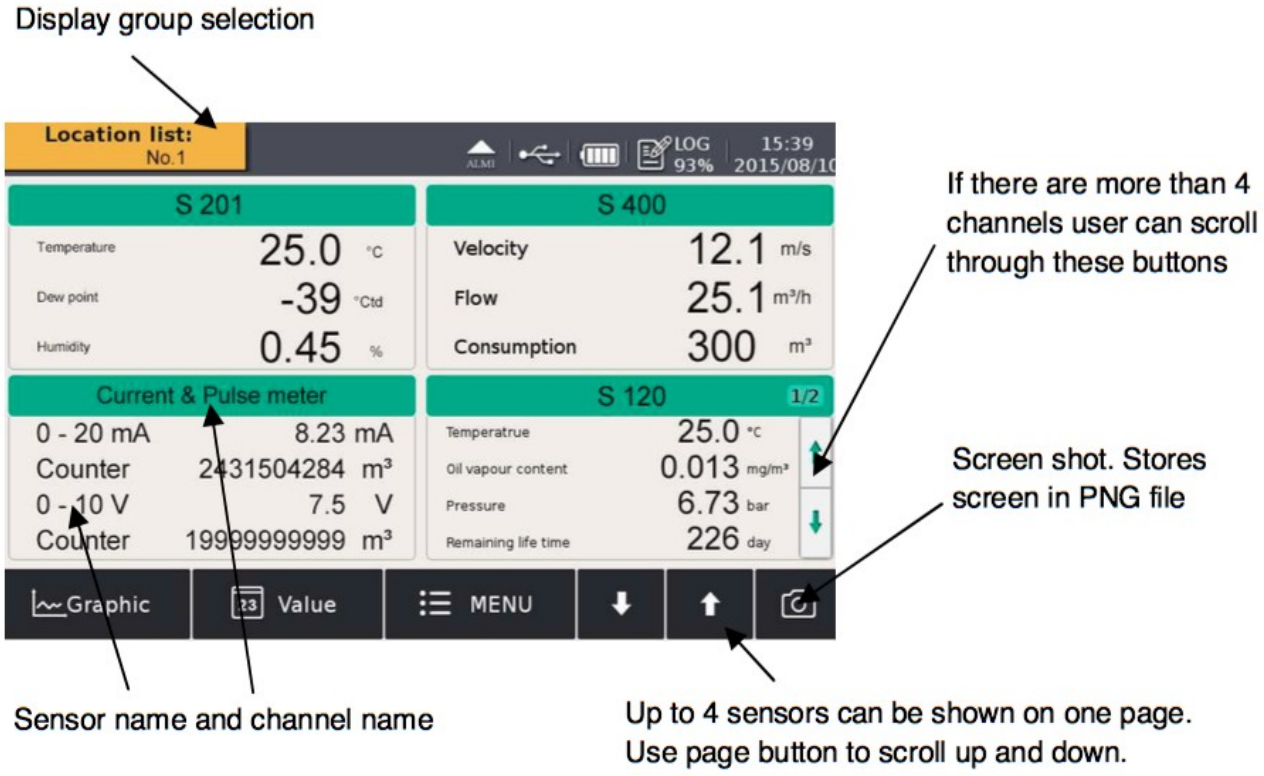
The other 16 channels are reserved.

9 Operation

When the S330/S331 starts up, the launch screen appears for a few seconds. During this period of time, the sensor connections are established and a few other initialization tasks are performed.

9.1 Value screen

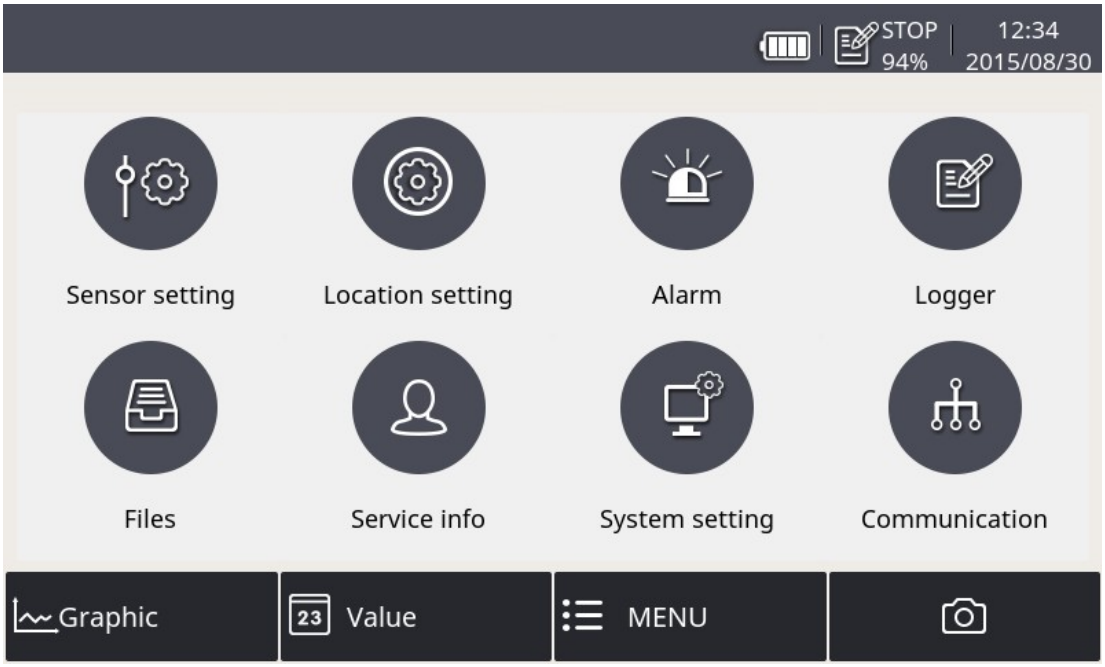
After startup, the S330/S331 displays measurement values by sensors. The display of measurement values may exceed one page. To view the data on the next page, touch the arrow button on the screen.



Remark:

S330 does not support the feature of **Screen shot**.

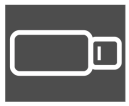
9.2 Main menu



The main menu consists of the following sub-menus:

Sensor settings	Settings related to the connected sensors.
Location setting	To configure where sensors are located. The S330/S331 supports managing sensors based on their locations.
Alarm	Alarm settings and status.
Logger	S331 data logger settings.
Files	All recorded files and screenshots. The memory status can be checked here.
Service info	Contact information for service.
System setting	Other system-level settings.
Communication	Communication settings related to Modbus master, field bus RS-485 or Ethernet, and IIoT.

9.3 Icons in the status bar



USB stick connected

System error

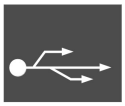
Sensor connection has changed, not matching with configuration

Sensor unit is not matching with configuration

Logger version S331

RTC backup battery status

Sensor calibration is expired



USB to PC connected

Alarm triggered

9.4 Graphic screen

9.5 Sensor setting

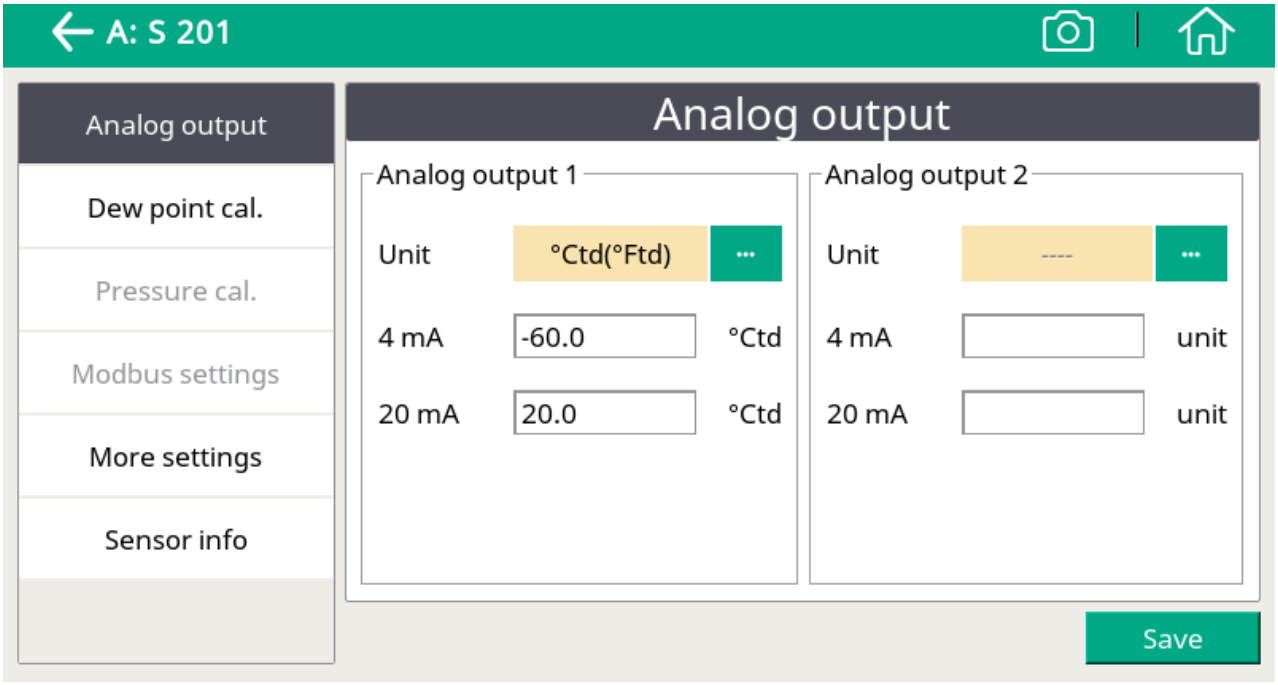
Enables you to configure physical sensors that are connected to the S330/S331 and virtual sensors, which are configured via S4C-Display. This section describes sensor settings by sensor types.

9.5.1 Changing sensor settings

Detailed steps are as follows:

1. In the main screen, select **Sensor setting**.
   The screen shows a list of sensors.
2. Choose a sensor as needed.
3. View and configure the sensor settings through the left navigation menu.
4. Click **Save** to submit the changes to the sensor.

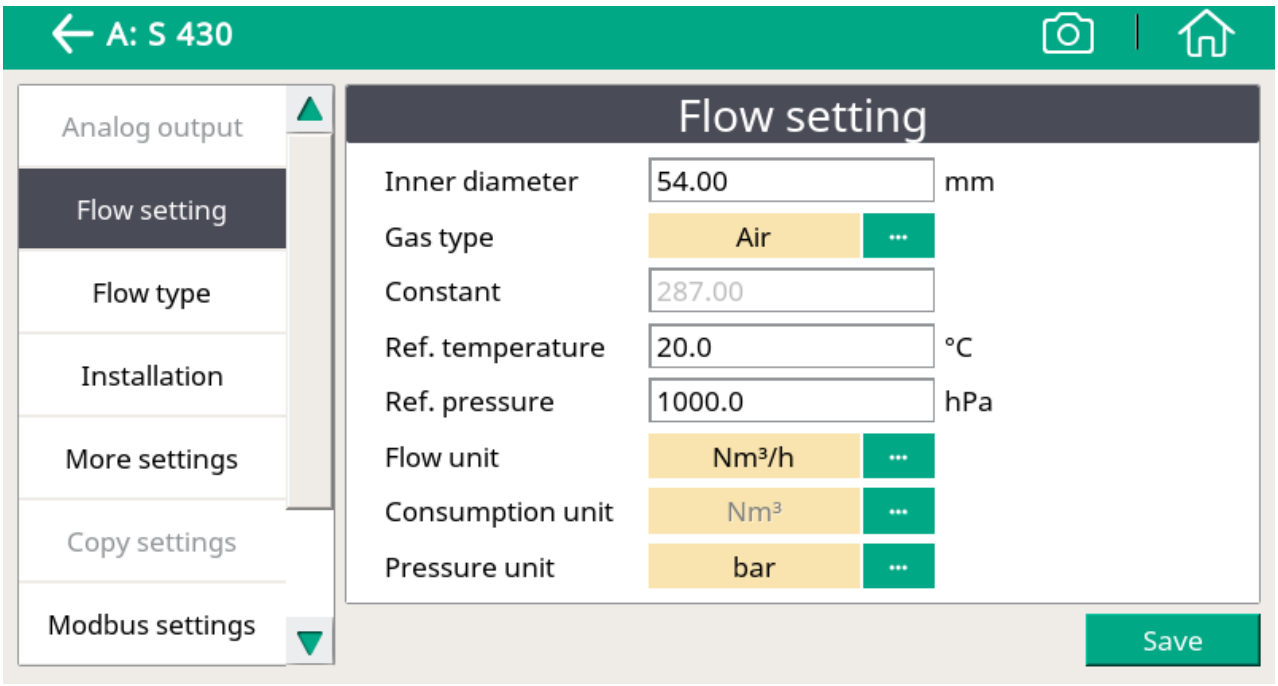
9.5.2 Dew point sensor



Analog output Select the physical moisture unit and set scaling for the analog output:
Whenever you change the moisture unit, it is recommended to adjust the scaling of the analog output. The S330/S331 will recommend a standard scaling.
The scaling is used to express the moisture through a 4 ... 20 mA signal, which then can be transferred to a

	PLC or SCADA system. Set the moisture unit to ppm (V), g/m³, mg/m³. Atmospheric dew point requires to enter a reference pressure.
Dew point cali.	Dew point sensor can be adjusted at one point wit a reference value. We recommend you perform calibration only below -40°C dew point by using a reliable reference.
Pressure calibration	Some dew point sensors have integrated pressure sensors which can be calibrated in this menu.
Modbus setting	Some sensors have Modbus interface. Communication parameters can be set here.
More settings	• Filters can be activated to dampen the output signal. • Auto calibration setting allows the activation of an auto calibration function. • Absolute pressure is required for g/m³, mg/m³, ppm[V] and atmospheric dew point calculation. The pressure must be entered as absolute pressure (not gauge pressure!). For the unit atmospheric dew point and ppm[V], the line pressure (absolute) must be entered. For the unit g/m³, mg/m³, if the calculation should be done under line pressure conditions, reference pressure of 1013 hPa must be entered.
Sensor info	Shows the sensor information for service inquiries.

9.5.3 Flow sensor



Analog output Select the physical flow unit and set scaling of analog output:
Whenever the flow unit is changed, it is recommended you adjust the scaling of the analog output.
The S330/S331 will recommend a standard scaling.
The scaling is used to express the flow through a 4 ... 20 mA signal, which then can be transferred to a PLC or SCADA system.
Some sensors support active and passive analog outputs.

Flow setting **Inner diameter:** To set for flow calculation
Gas type: To select the gas type. (Some gases require the real gas calibration. Please contact the manufacturer.)
Ref. pressure: To set for calculating the standard flow.
Ref. temperature: To set for calculating **the standard flow.**
Constant: Shows the gas constant of selected gas, or enter the gas constant for mixed gas or not-listed gas.
Flow unit: To select a desired flow unit.
Consumption unit: To select a desired consumption

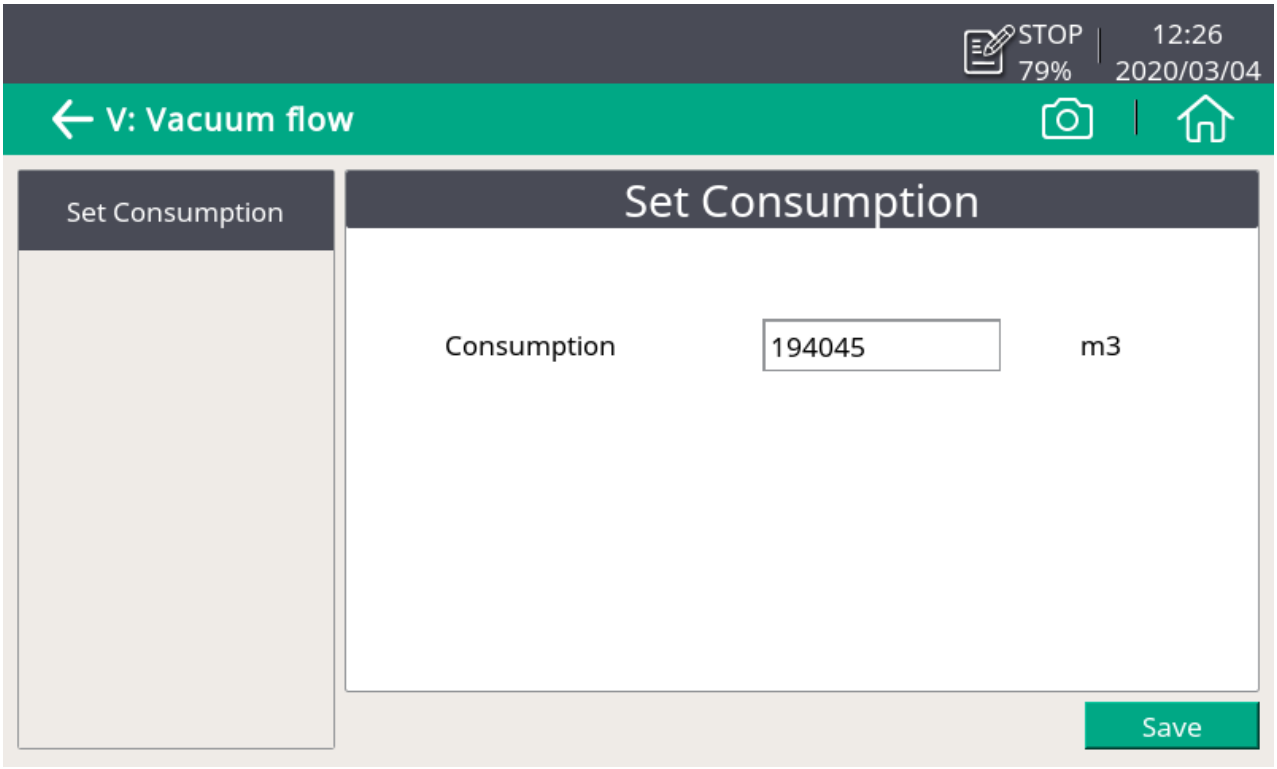
	unit. **Pressure unit**: Only applicable to flow sensors that integrate the pressure sensor such as S430 and S418. To select a desired pressure unit.
Flow type	Only applicable to S430. To select the flow type from Flow, Dry air flow, FAD, and Actual flow.
Installation	Only applicable to an insertion type sensor. To select the installation method from center installation and 100 mm insertion installation.
More settings	**Std. consumption:** To set the internal consumption counter. **Rev. consumption:** Some sensors support bi-directional flow measurement. This is the counter for the reverse direction. **Altitude:** To set the altitude level. The default value is 0. **User slope:** To enable a correction of the flow by a factor. **Temperature coefficient:** by default temperature.
Copy settings	Enabled only for S551-P6.
Modbus settings	Enabled only for sensors with Modbus interface. Communication parameters can be set here.
Sensor info	Shows the sensor information for service inquiries.

Remark:

Reference pressure and reference temperature are used to calculate the standard flow at standard conditions, for example, 1000 hPa, 20°C. They are not related to the actual process pressure and temperature.

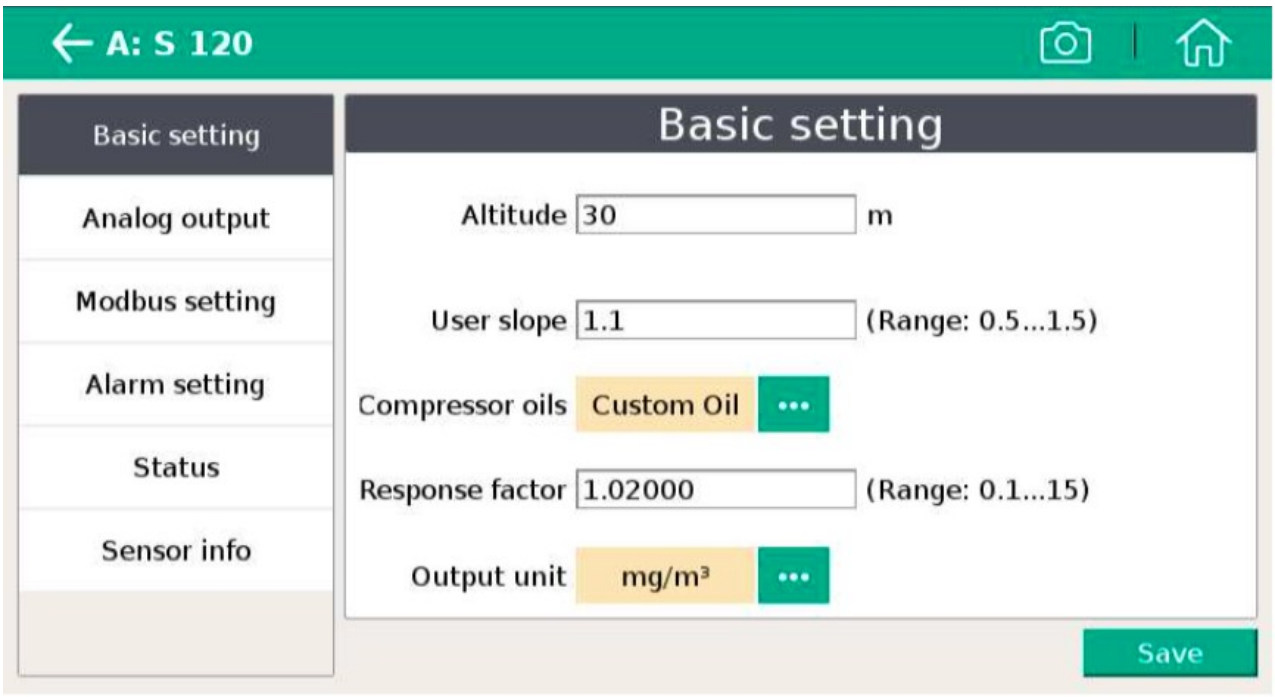
9.5.4 Vacuum flow sensor (virtual sensor)

If a virtual channel (*for example*, vacuum flow channel) is configured in the S330/S331, the corresponding virtual sensor is displayed in the sensor list.



Consumption To configure the initial consumption value for the virtual flow.

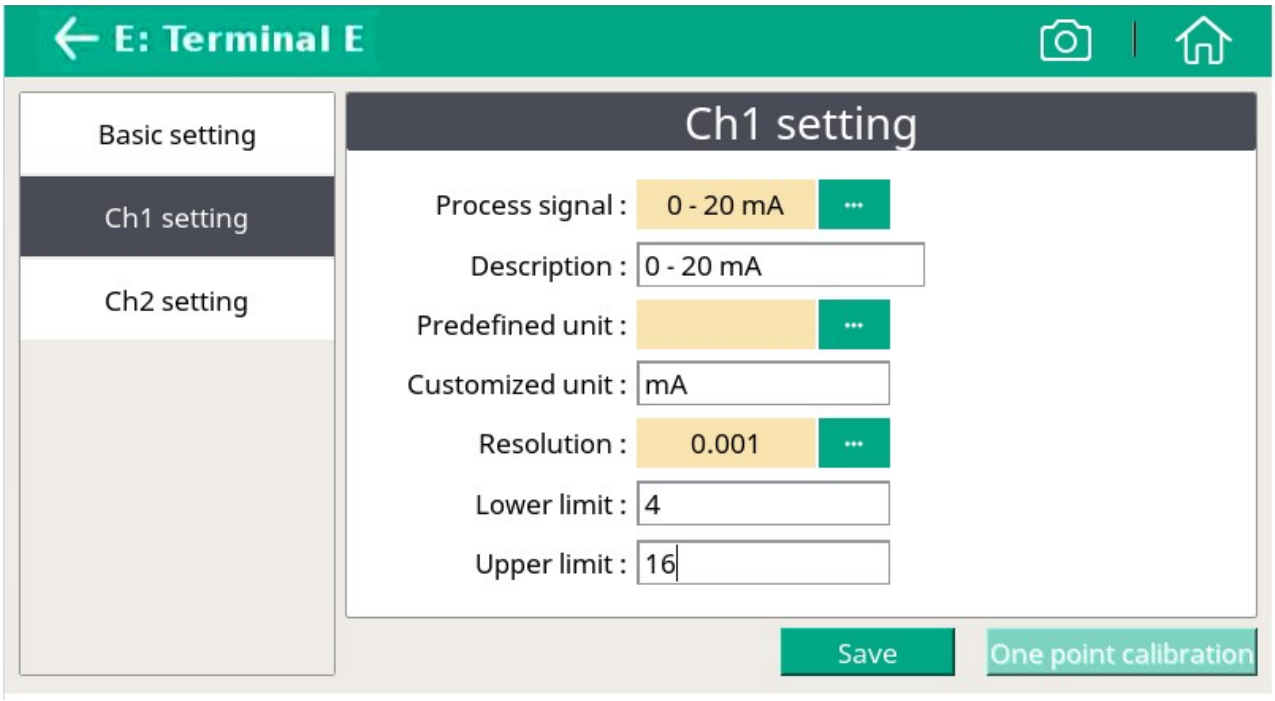
9.5.5 Oil vapor sensor



Basic setting	**Altitude:** To enter the altitude level, and the default value is 0. **User slope:** To enter a correction factor for the oil content. **Compressor oil:** To select an oil type. **Output unit:** Select the unit of the oil content.
Analog output	To set scaling of analog output (4 ... 20 mA).
Modbus setting	To set address, baud-rate and parity for Modbus communication.
Alarm setting	To enable or disable the alarm function and set the alarm threshold.
Status	Shows the PID sensor lifetime, valid calibration time, remaining filter capacity (the filter is consumable component used for the auto zero calibration), gas temperature, and pressure. There is an indication at each line whether the value is normal or not.

9.5.6 Analog input channel

The S330/S331 provides two optional analog input channels for various analog signals (4 ... 20 mA, 0 ... 10 V, etc.). Please note that these channels must be initialized using the S4C-Display software. Only after that, you can configure the channel details on the S330/331.



Basic setting

Sensor description: To enter a sensor name.

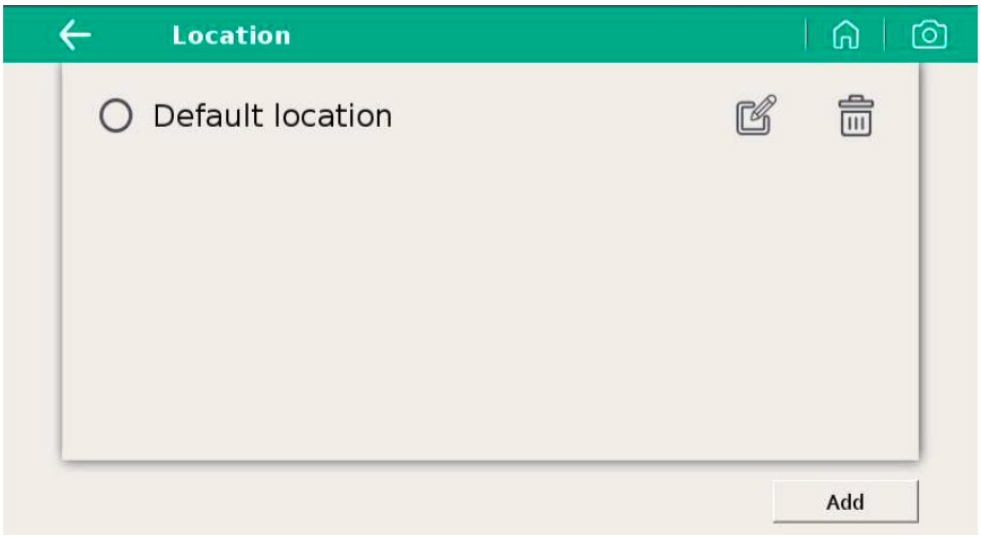
CH 1 setting

Process signal: To select 0 - 20mA or Pulse.
Description: To enter a sensor name.
Predefined unit: to select a physical unit.
Customized unit: Enter a name for the measurement unit as you want.
Resolution: To select a resolution (how many digits behind the decimal point).
Lower limit: To enter the lower limit for the measurement range.
Upper limit: To enter the upper limit for the sensor measurement range.
One point calibration: The instrument provides a one-point system calibration, which can eliminate accuracy failures of instrument and sensor. If an accurate reference is available (e.g. calibration lab), the system can be calibrated at one point to this

	reference. The calibration is stored inside the S330/S331. This calibration offset is applied to every sensor connected to the terminal that is used for calibration.
Ch 2 setting (counter only)	**Measure type:** Only counter is selectable. **Description:** To enter a channel name. **Predefined unit:** To select a physical unit. **Customized unit:** To enter a name for the measurement unit as you want. **Count/pulse:** To specify how many consumption units one pulse is equal to.

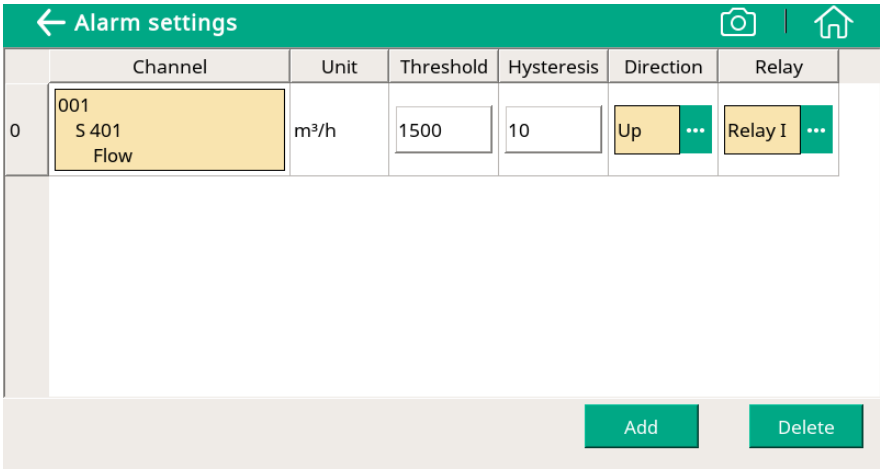
9.6 Location setting

Group the connected sensors and sub-displays (in case S330/S331 is a master device) by locations (room1, room2 etc.)



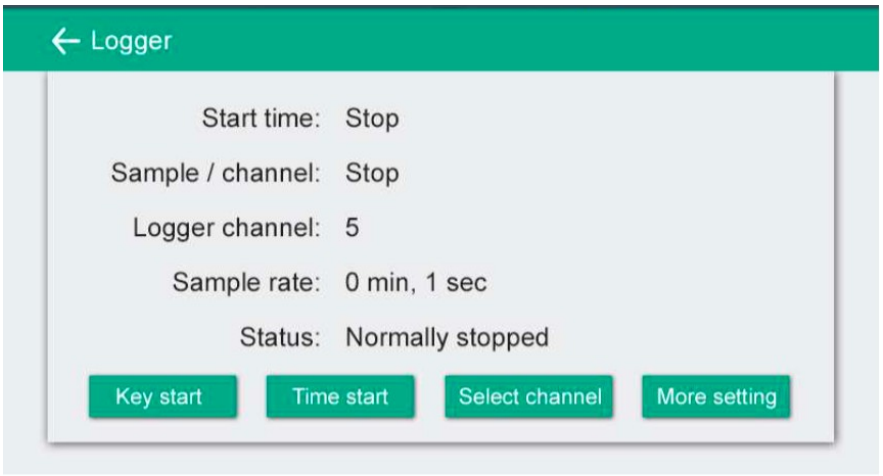
9.7 Alarm settings

Define and view alarm outputs. The S330/S331 comes with two alarm relay outputs and optical alarm indication (flashing value).



9.8 Logger

View the logger status and control the logger.



Start time Logger start time.

Sample / Channel Recorded sample number per logging channel.

Logger channel Total recording channel number.

Sample rate Shows the sampling rate. To change the sampling rate, click More settings.

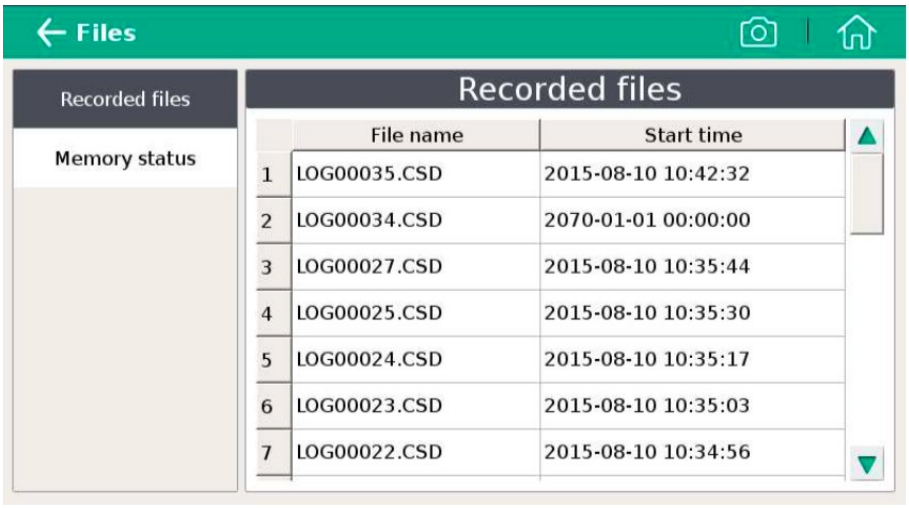
Status Logger status.

Key start button To start logging immediately.

Time start button	To configure a scheduled start for logging.
Select channel button	To select the channel to log for.
More setting button	To configure the logging interval, logging mode, and memory mode. • Average: Turning Average on means to log the average value during an interval; turn the average off means the logged value is an instantaneous one. • Memory mode: Choose a mode as needed. ◦ Full stop: Logging stops if the memory is full. ◦ Wrap around: If the memory is full, new logging data overwrites the oldest data.

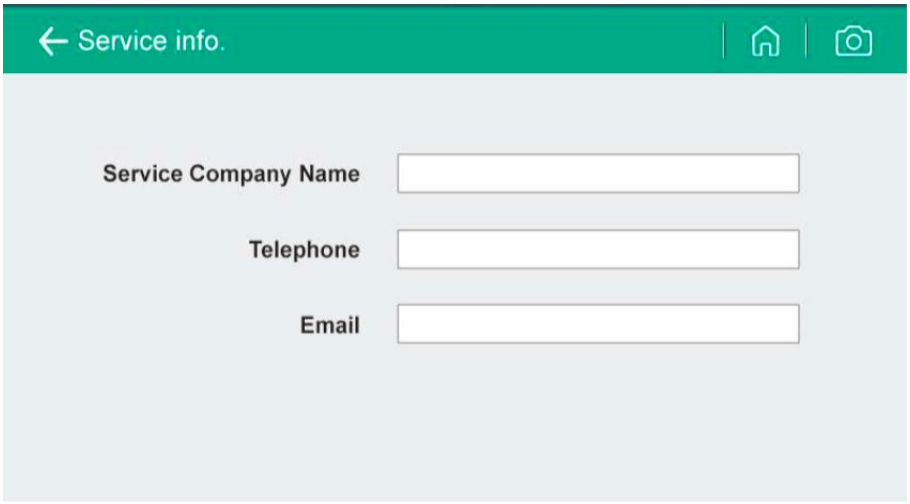
9.9 Files

View and process recorded files and view S330/S331 memory status.



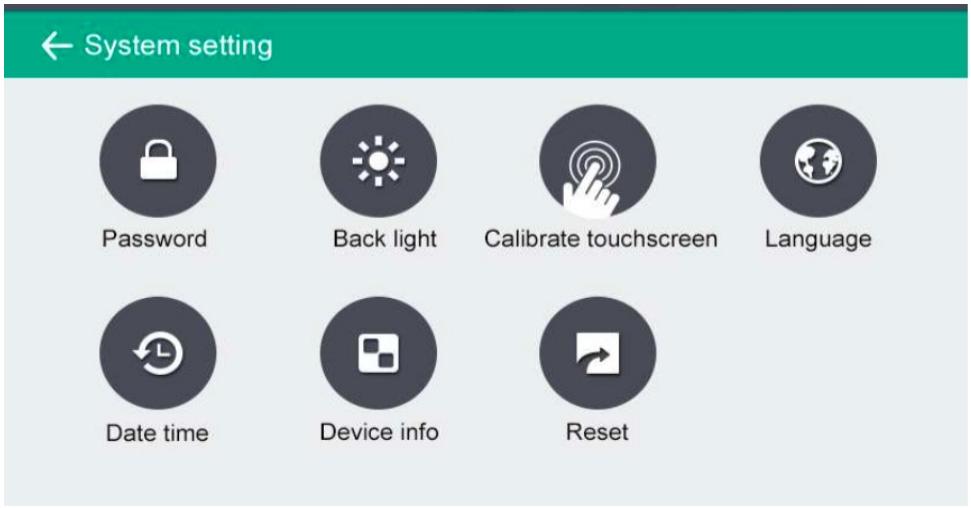
9.10 Service info

Contact information of service company can be set via S4C-Display software.



9.11 System setting

This sub-menu enables you to change various system settings. Click an icon as needed and following the onscreen instructions to proceed.

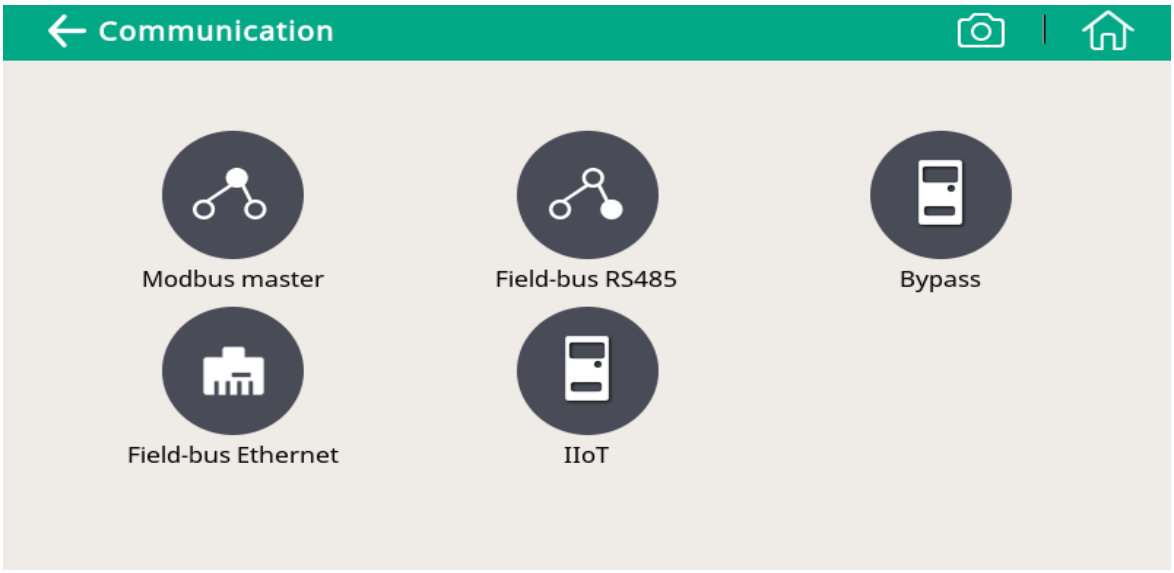


Password	To set password to protect critical operations.
Back light	To adjust brightness and timeout settings for power saving.
Calibrate touch screen	Calibrate touch accuracy.
Language	To select the user interface language.

Date time	To set date and time.
Device info	Shows information for service cases.
Reset	To reboot the display.

9.12 Communication

Configure how S330/331 communicates with other devices and applications. Select a communication mode as needed and follow the onscreen instruction to proceed.



The following table lists the communication modes that S330/S331 supports.

Modbus master	To enter the Modbus communication parameters for S330/331 (as the Modbus master) to communicate with Modbus slaves.
Field-bus RS485	S330/S331 works as the slave. Enter the port (1-247) that S330/S331 uses to communicate with the master.
Field-bus Ethernet	To enter an IP address for the S330/S331 or select DHCP for the S330/S331 to be assigned with a dynamic IP address.
IIoT	Only needed when the S4M is deployed. To enter the IP address or domain name of the S4M server.

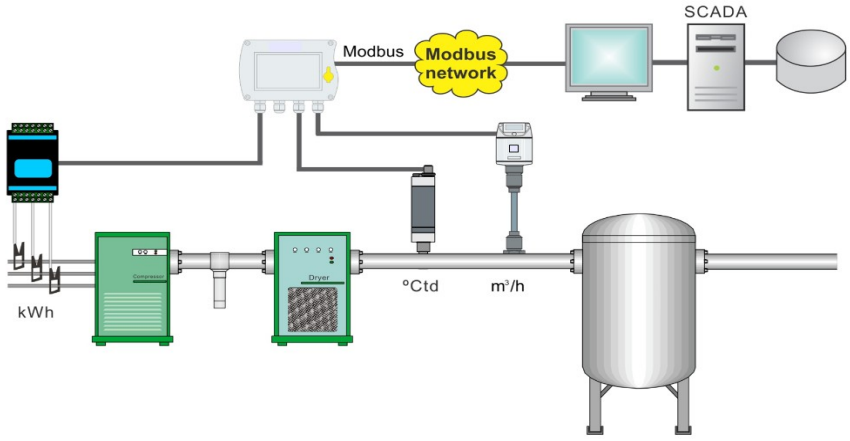
10 Industrial communication

S330/S331 offers various industrial communication options. This chapter briefly describes two solutions.

10.1 Integration with a Factory Automation System

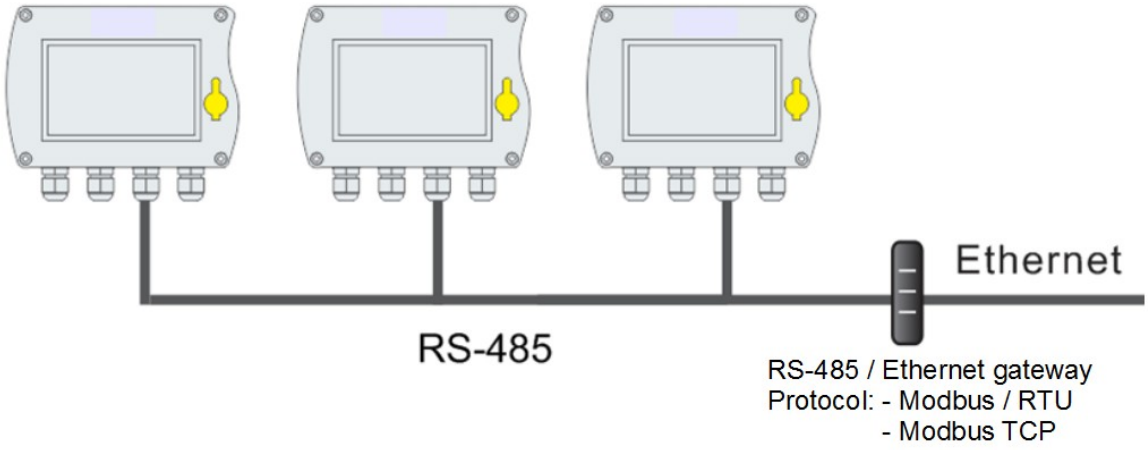
You can use the communication solutions to connect S330/S331 to a factory automation system. In these solutions, S330/S331 enables the factory automation system to retrieve measurement data from sensors, which is sufficient for most of the field applications.

10.1.1 RS-485 through the Modbus-to-RTU gateway



Modbus is a popular industry bus that can be used to connect several S330/S331 to a Modbus master. A PLC, a SCADA system, or a S330/S331 Master can work as the Modbus master.

10.1.2 RS-485 through the RS-485-to-Ethernet gateway



	RS-485 / Ethernet gateway (A554 0013)

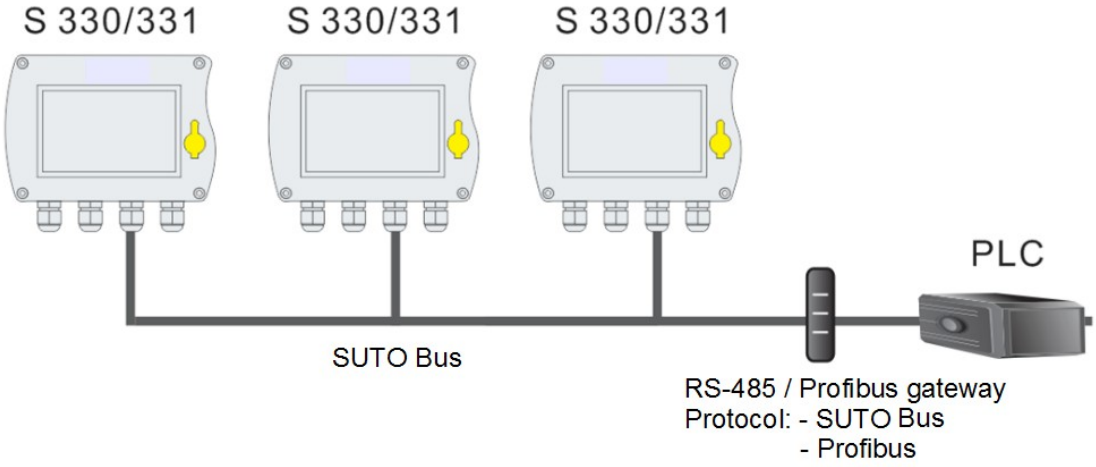
In areas where Ethernet is not accessible, RS-485 can be used to connect the instruments to an access point for Ethernet. Through the RS-485 or Ethernet gateway, the link to Ethernet is established. The gateway can process up to 30 x S330/S331. Please ensure that Modbus protocol is selected on the S330/S331 menu.

Remark:

This gateway works only in a connection to a **Modbus/TCP** Master. (See an alternative solution described in 12.1.4 for Modbus/TCP Ethernet).

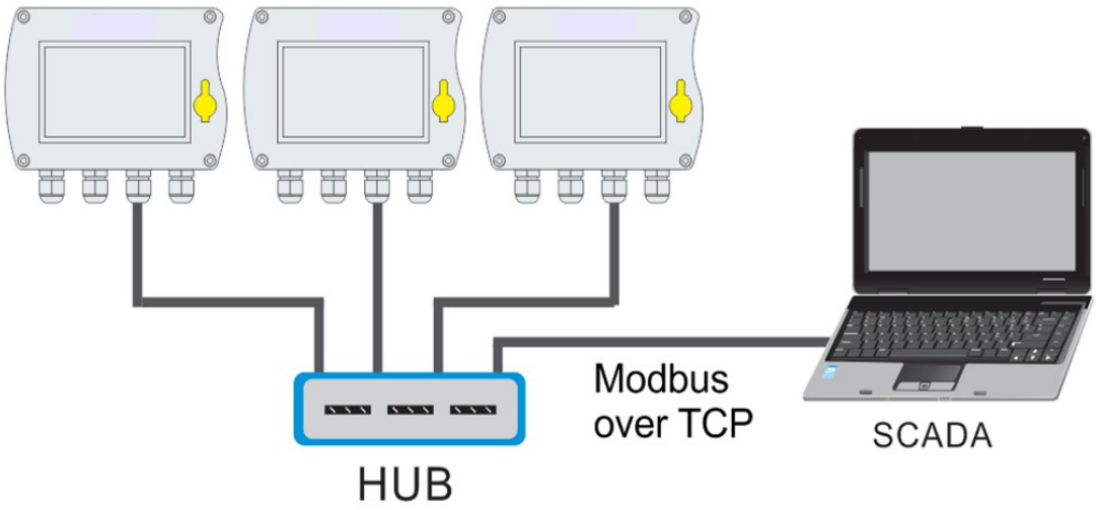
10.1.3 RS-485 through the RS-485-to-Profibus gateway

To connect S330/S331 to a Profibus-master, SUTO offers a gateway to convert signals from SUTO to Profibus. Depending on the number of sensors connected to S330/S331, 4 to 10 S330/S331 products can be routed to the Profibus. Profibus provides functionality to retrieve measurement values.



The SUTO - Profibus gateway (A554 0012) converts signals between RS-485 slaves running the SUTO protocol and a Profibus network on RS-485. Please contact our customer service for detailed information.

10.1.4 Field-bus Ethernet through the Modbus/TCP



S330/S331 comes with an Ethernet interface. By selecting the Field-bus Ethernet protocol from the S330/S331 menu, the communication with a Modbus master can be established. This is a popular way to connect to a Modbus Master through Ethernet. Process visualization systems are using so-called OPC servers to establish the link to Modbus.

10.2 Standalone solution

SUTO provides a standalone total solution for industrial communication, which includes data recording and analysis. If measurement values still need to be fed into a SCADA system or a Factory Automation System, you also have the option to use the analogue signals (4...20 mA or pulse).

10.2.1 Monitoring and Analysis software

S4M and S4A are designed for this solution.

S4M can communicate with almost unlimited devices in a network (Ethernet, RS-485 or RS-485 / Ethernet gateway). The key features include:

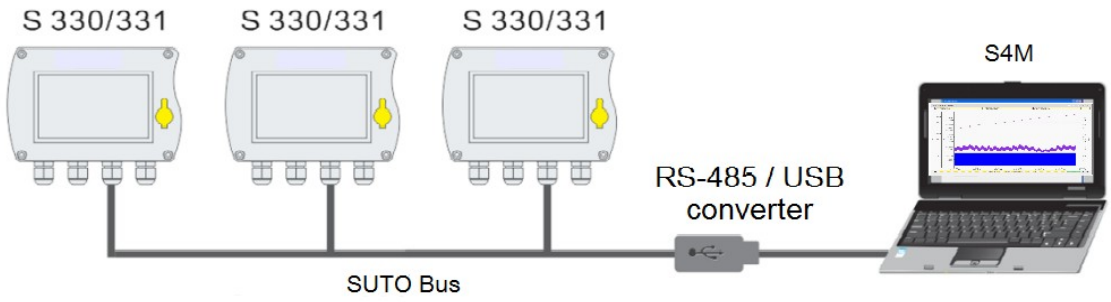
- Online measure values of all instruments and all channels in parallel.
- Change the background picture of the screen as needed, such as using the plant schematics.
- Online records the selected channels over all instruments.
- Backs up data for online recording and recovery after power failure.
- Monitors alarms and records alarm history.
- Starts / stops logger inside S331.
- Reads recorded data from S331 data logger.
- Reports generation and graphical analysis.

10.2.2 Physical networking modes

This standalone solution supports multiple networking modes.

10.2.2.1 RS-485

RS-485 is commonly used in industrial applications. It can reach up to 1000 m distance with a shielded 2-wire cable. If further distance is required, a repeater can be installed to reach another 1000 m. Up to 30 S330/S331 instruments can be connected to the RS-485 network. Please ensure that SUTO protocol is selected on S330/S331 menu and every S330/S331 has a unique device address (1 – 247).



Hardware Requirements:

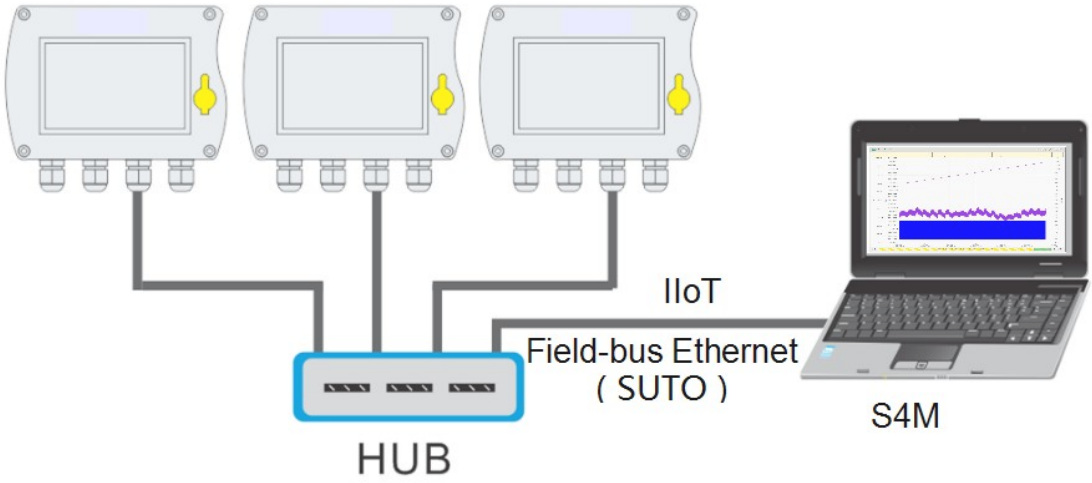
- S330/S331
  - RS-485 / USB converter (order number: A554 0331) and driver installed properly
  - Cables for connecting all the devices and also to the converter
  - PC with operation system of XP, Vista 32, Vista 64, Windows7 32 or Windows7 64

Software Requirements:

- S4A or S4M

10.2.2.2 Ethernet

S330/S331 can be connected to an Ethernet switch or router or sometimes called a hub. Please consider following hardware and software requirements.



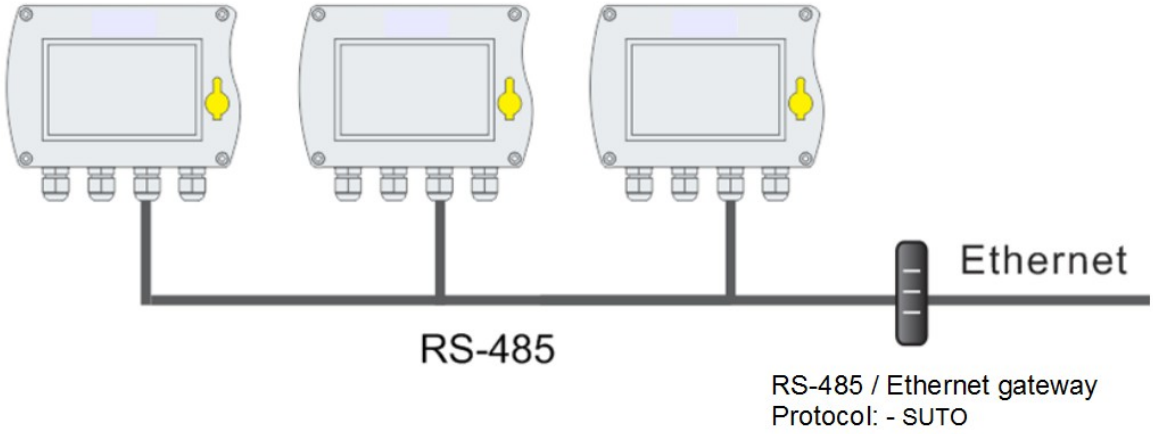
Hardware Requirements:

- S330/S331
- Standard RJ45 Ethernet cable, maximum length 100 meters
- S330/S331 connected into a LAN (Local Area Network)
- PC with Ethernet connection (XP, Vista 32, Vista 64, Windows7 32 or Windows7 64)

Software Requirements:

- S4A or S4M

10.2.2.3 RS-485 / Ethernet gateway



In areas where Ethernet is not accessible, RS-485 can be used to wire the instruments to an access point for Ethernet. Through the RS-485 / Ethernet gateway the link to Ethernet is established. The gateway can handle up to 30 S330/S331. Please ensure that SUTO Bus protocol is selected on S330/S331 menu and every S330RS-485 / Ethernet gatewa

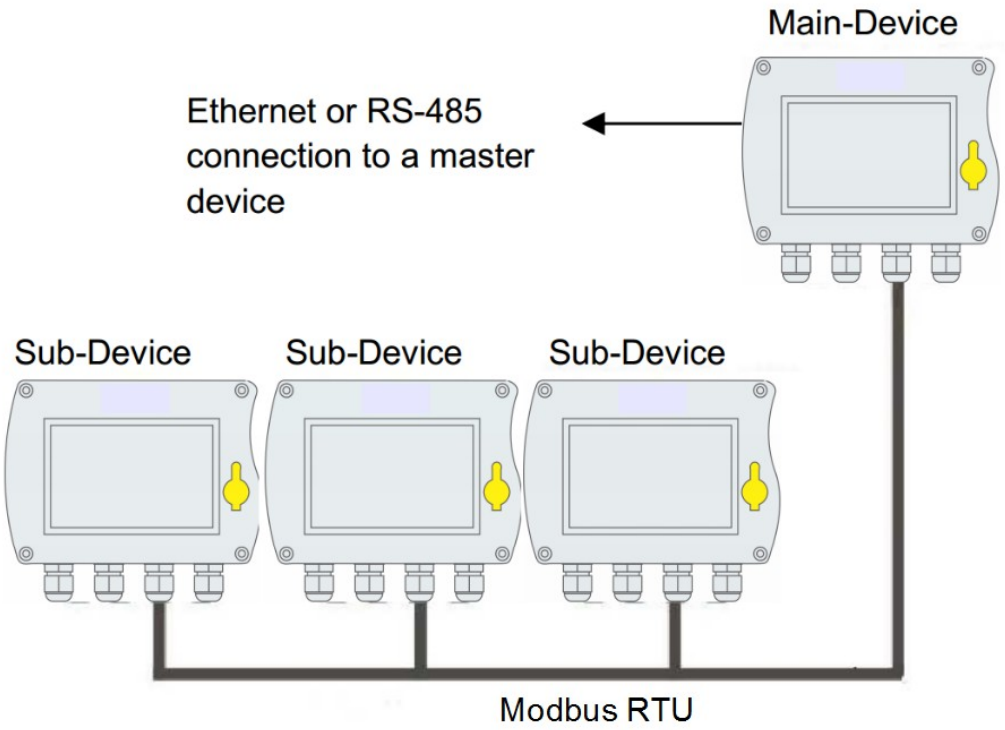
/S331 has a unique device address (1 – 247).
Hardware Requirements:

- S330/S331
- RS-485 / Ethernet gateway (A554 0010)
- Cabling all the devices and also to the gateway
- PC with operation system of XP, Vista 32, Vista 64, Windows7 32 or Windows7 64

Software Requirements:

- S4M

10.2.2.4 More complex networking solutions



The above picture shows that S330/S331 (Sub-Device) - or any other device that has a Modbus/RTU interface can be connected to a Modbus-Master (Main-Device) through Modbus/RTU.

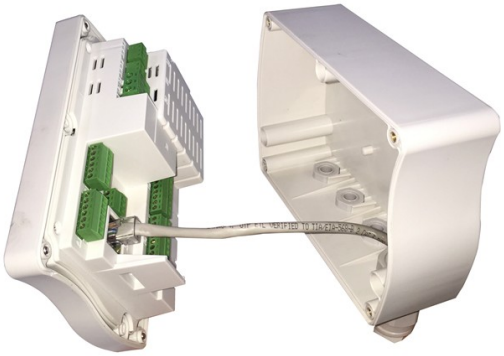
The Main-Device itself then can be connected to a higher level Master Device either through RS-485 or Ethernet.

The Master-Device on top monitors only the main device, which provides all measurement channels from the sub-devices.

10.2.3 Hardware connection

This section introduces the hardware connections for S330/S331.

10.2.3.1 Ethernet hardware



Internal RJ45 connector

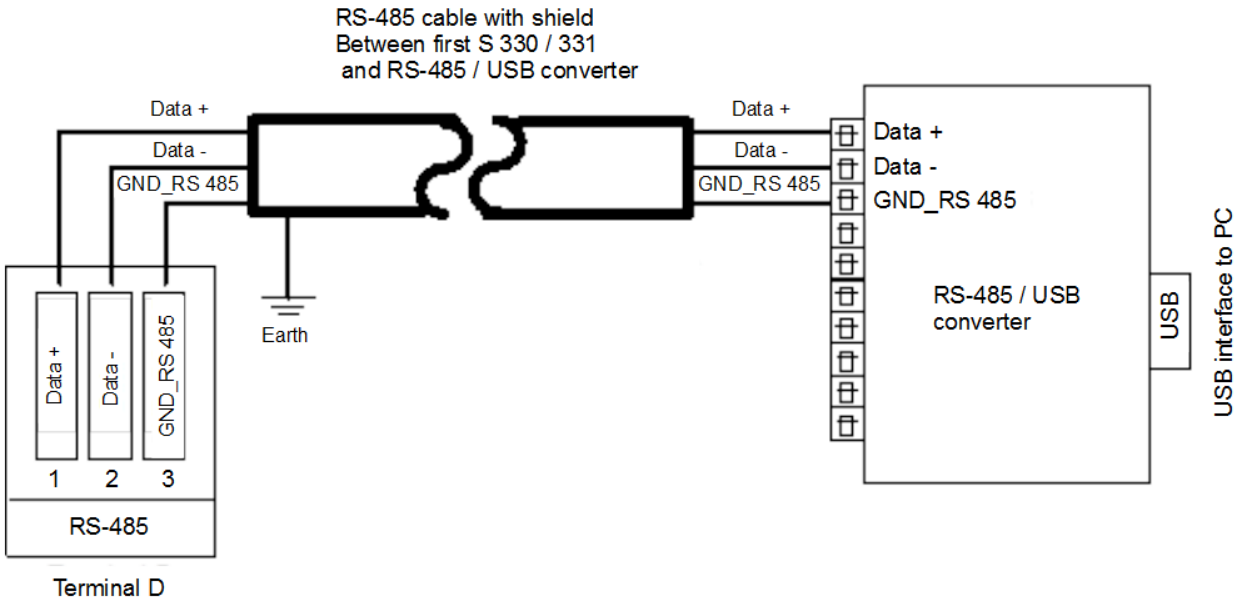
External RJ45 connector (IP65)

Connect Ethernet cable and mount bend protection sleeve

Ethernet cable

An Ethernet cable with category 5 or better is applicable and the maximum cable length is 100 meter between S330/S331 and the connected HUB or computer.

10.2.3.2 RS-485 hardware



Through a RS-485 / USB converter the system is connected to a USB port of the office PC. RS485 network requires a termination resistor network. At both far ends of the devices, termination resistor must be turned on communication menu, all others S330/S331 remain off, Terminal resistor is software control in S330/S331. Please set it up correctly.
There are totally 3 poles on the terminal D for RS 485 network wiring. The pin function description is shown below.

Pin No.	Pin name	Function
1	Data +	Data + signal
2	Data -	Data - signal
3	GND RS-485	Ground of RS-485

RS-485 cable

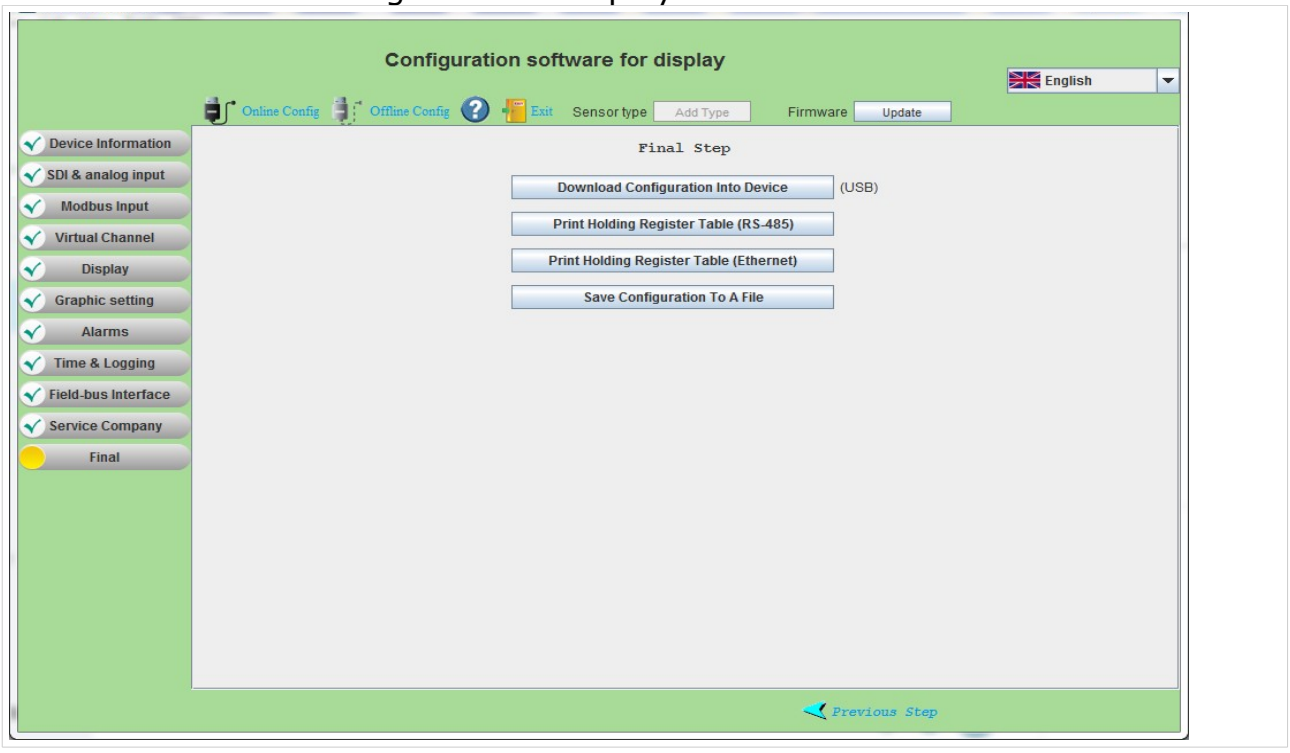
According to the recommendations of EIA 485 standard, only cables should be used. A maximum of 30 devices may be connected to one segment. The bus cable must be laid at a distance of at least 20 cm from other cables. It should be laid in a separate, conductive, and earthed cable trunk. It must be ensured that no potential differences occur between the individual devices on the bus.

RS-485 cable specifications

- Impedance: 135 – 165 Ohm @ 3 to 20 MHz
- Cable capacity: < 30 pF/m
- Cable diameter: > 0.64 mm
- Cross section: > 0.34 mm², conforms to AWG 22
- Loop resistance: < 110 Ohm per km
- Screening: Cu shielding braid or shielding braid and shielding foil
- Outer diameter for power and sensor cable: 4.5 ... 8 mm

10.2.4 Fieldbus Interface Configuration

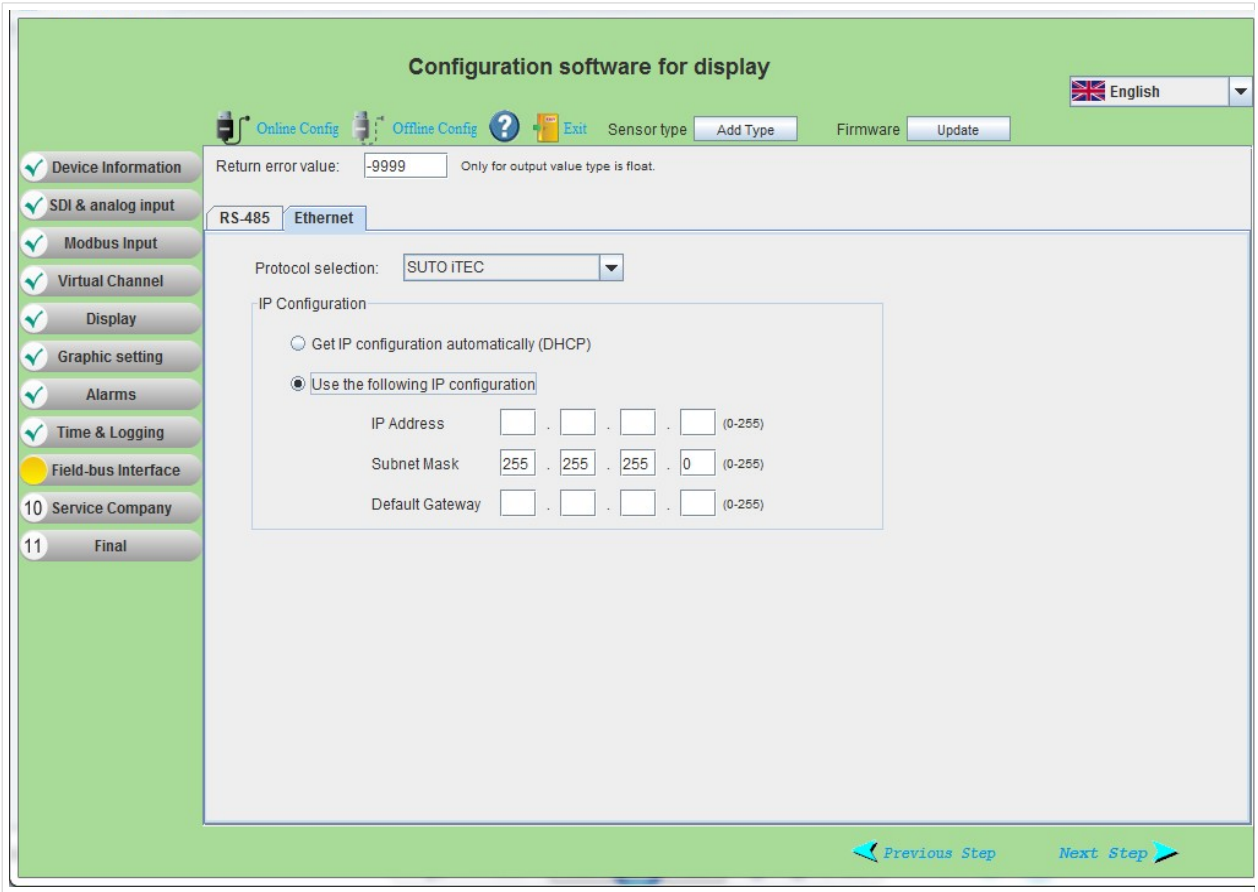
S330/S331This section introduces how to configure the Fieldbus RS-485 and Ethernet interfaces using the S4C-Display software.



10.2.4.1 Field bus RS-485 settings

Setting	Description
Return error value	Enter the value that S330/S331 will return to the master as a measurement value in case of any error condition.
Protocol selection	Select SUTO Protocol if using the SUTO software, and select Modbus if the device is connected to a Modbus network.
Address	Each device on the RS-485 network must have a unique device address. Enter a number that is not assigned to any device in the RS-485 network as the device address of the S330/S331.

10.2.4.2 Field Bus Ethernet settings



Setting	Description
Return error value	Enter the value that the salve device will return as a measurement value in case of any error condition.
Protocol selection	Select SUTO Protocol if using the SUTO software, and select Modbus if the device is connected to a Modbus network.
Get IP config automatically	Select this option to assign the S330/S331 an IP address through the network router. This is convenient but not a recommended choice in industrial networks. We recommend to choose a static IP address.
Use the following IP….	Enter the static IP address.

10.2.4.3 Printing the Modbus slave register table

After the configuration of a S330/S331 is finished, one of the final steps is to print the Modbus register table. This table describes all Modbus register addresses and it’s measurement value contents. The Modbus master device needs to be programmed based on this table .
Example of a Modbus register table

Commnunication: [Ethernet]
Return error value: [-100.0] IP Address: [DHCP enable] Protocol: [Protocol]

Holding register table

Device Description	Sub Device Description	Sensor Description	Channel Type	Channel Description	Holding register	Modbus address	Data type	No. of byte	Unit	Resolu -tion	Read/ Writer	Func Code
Thomas:S 325(I)		S 215	Temperature	Temperature	1	0	FLOAT_L	4	°C	0.1	R	3
Thomas:S 325(I)		S 215	Humidity	Humidity	3	2	FLOAT_L	4	%	0.1	R	3
Thomas:S 325(I)		S 215	Dew point	Dew point	5	4	FLOAT_L	4	°Ctd	0.1	R	3
Thomas S 325(G)		S 400	Flow	Velocity	25	24	FLOAT_L	4	m³/min	0.1	R	3
Thomas S 325(G)		S 400	Consumption	Flow	27	26	UINT32_L	4	m³	1	R	3
Thomas S 325(E)		Pr. 16		Pr. 16 bar	41	40	FLOAT_L	4	bar	0.01	R	3
Thomas S 325(F)		Pt100		Pt100	43	42	FLOAT_L	4	°C	0.1	R	3
Thomas S 325(D)	Device(I)	S 400	Flow	Flow	67	66	FLOAT_L	4	m³/min	0.1	R	3
Thomas S 325(D)	Device(I)	S 400	Consumption	Consumption	69	68	UINT32_L	4	m³	1	R	3
Thomas S 325(D)		TF S 450	Flow	Flow	73	72	FLOAT_L	4	m³/min	0.1	R	3
Thomas S 325(D)		TF S 450	Standard consumption	Standard consumption	75	74	UINT32_L	4	m³	1	R	3
Thomas S 325(D)		Water Meter		Water Flow	83	82	FLOAT_L	4	l/min	0.1	R	3
Thomas S 325(D)				Virtual ch1	85	84	FLOAT_L	4	°C	1	R	3
Thomas S 325(D)				Virtual ch2	87	86	FLOAT_L	4	°C	1	R	3

10.2.5 Trouble shooting

Ethernet

Problem: Cannot find any device or cannot establish communication.

Action:

- Check the device connection. There are two lights at S330/S331 Ethernet connector. When S330/S331 is properly connected, the yellow light is on indicating the power supply works normally, while the green light blinks indicating connectivity is present.
- Check the network cable. Make sure it's a workable RJ-45 Ethernet cable and connected properly.

  Note that the 'Link' light on the switching hub should be on.
- Make sure PC and S330/S331 are on the same subnet.
- Make sure there is a device or PC that has same IP address as the S330/S331.
- Make sure firewall settings on PC do not block the S330/S331 communication which uses port 502.
- Make sure the firewall is closed on the PC.
- Make sure that the PC has installed only one Ethernet card.

Problem: Communication is not stable.

Action:

1. Make sure the speed of switching hub that S330/S331 connects to is 100Mbps.
2. Make sure physical connection (network cable) is well connected.
3. Check and configure the communication option again in the **Configuration > Communication** menu.
4. Try to communicate again.
5. If it still does not work, try to reset S330/S331 by powering it off and on again. Restart the software. Then retry the communication.

RS-485
Problem: Cannot find any device or cannot establish communication **Actions**: • Make sure the RS485-USB converter is correctly cabled to the network. • Make sure each S330/S331 is set with a unique address.
Problem: Communication is not stable or lost during online reading. **Actions**: • Ensure that only the last device on the RS 485 network has the termination resistor switched on. • Ensure the bus cable must be laid at a distance of at least 20 cm from other cables. • Ensure the bus cable is no longer than 1000 m; otherwise consider to install a repeater. • Ensure the length of each T (stub) connection is no more than 1 m.

11 Monitoring data remotely

You can remotely monitor measurement data from the S330/331 using an Internet browser or the S4A software on the same network.

11.1 Enabling remote access

1. Connect the S330/331 to your network.
2. Assign the S330/331 with an IP address by using the **Communicate** > **Field-bus Ethernet** menu on the S330/S331 screen or **Field-bus Interface** > **Ethernet** on the S4C-Display software.

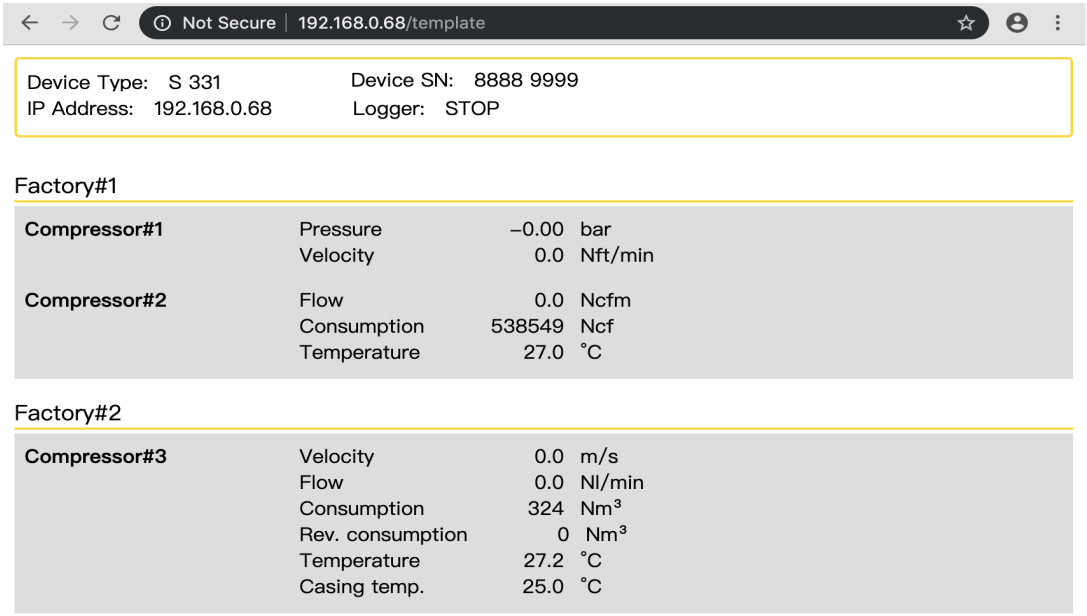
Remarks:

- You can assign a static IP address to S330/S331 or delegate the DHCP server to assign an IP address to S330/S331 dynamically. If the long term access is needed, we recommend you assign S330/331 a static IP address.
- To enable access from Internet, please ask your IT administrator for help on router configuration.

11.2 Monitoring data through an Internet browser

1. On a networked device (*for example*, smart phone, PC, and so on), start a Web browser.
2. View the S330/S331 IP address by accessing the **Communicate** > **Field-bus Ethernet > Status** menu on the S330/S331.
3. Launch an Internet browser, and enter the IP address of the S330/S331 in the address bar.

In the monitoring window that appears as shown below, you can view the information of the S330/S331 and measurement data. The measurement data in alarm is displayed in red.



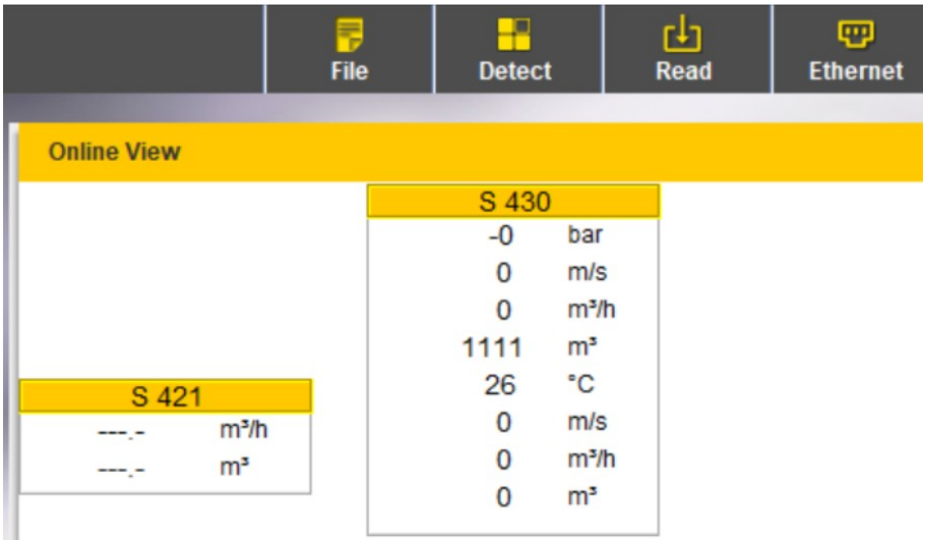
Remark:

Because S330 does not include the data logger, its Logger status always shows N/A.

11.3 Monitoring data through the S4A software

1. Launch the S4A and open its online help.
2. Detect the S330/S331 on the S4A, as described in the "Detect the Connected Device" topic.

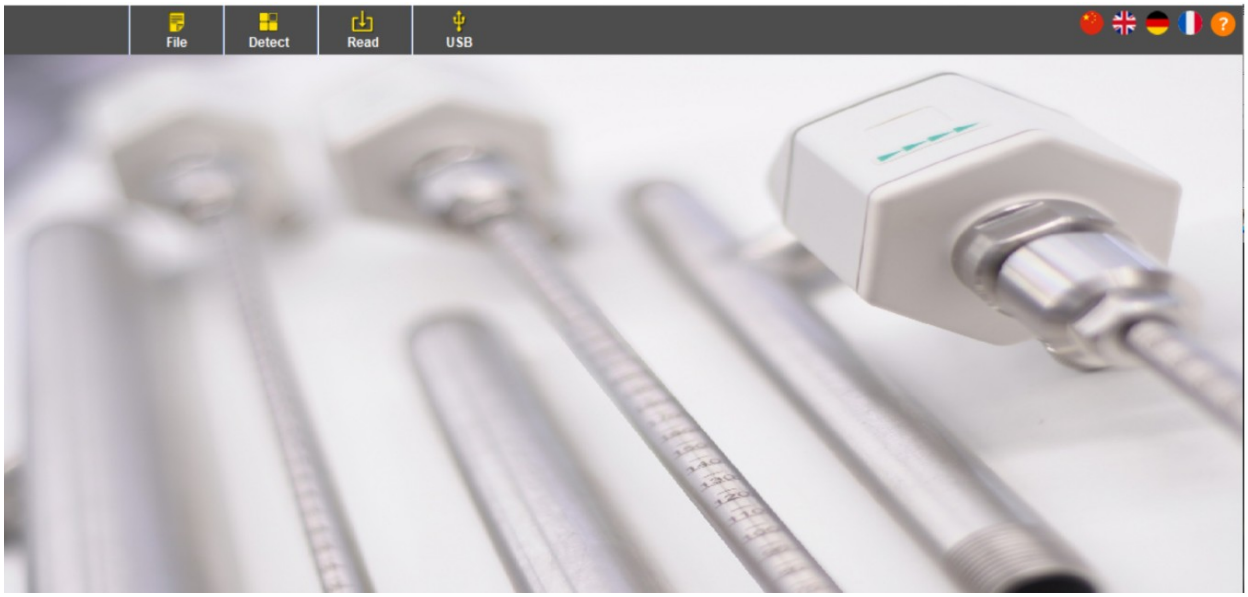
   The online view of the detected S330/S331 appears. In this example, the S331 is configured with an S430 and an S421 sensors, but only the S430 is connected to the S331.



12 Downloading the logger data to local

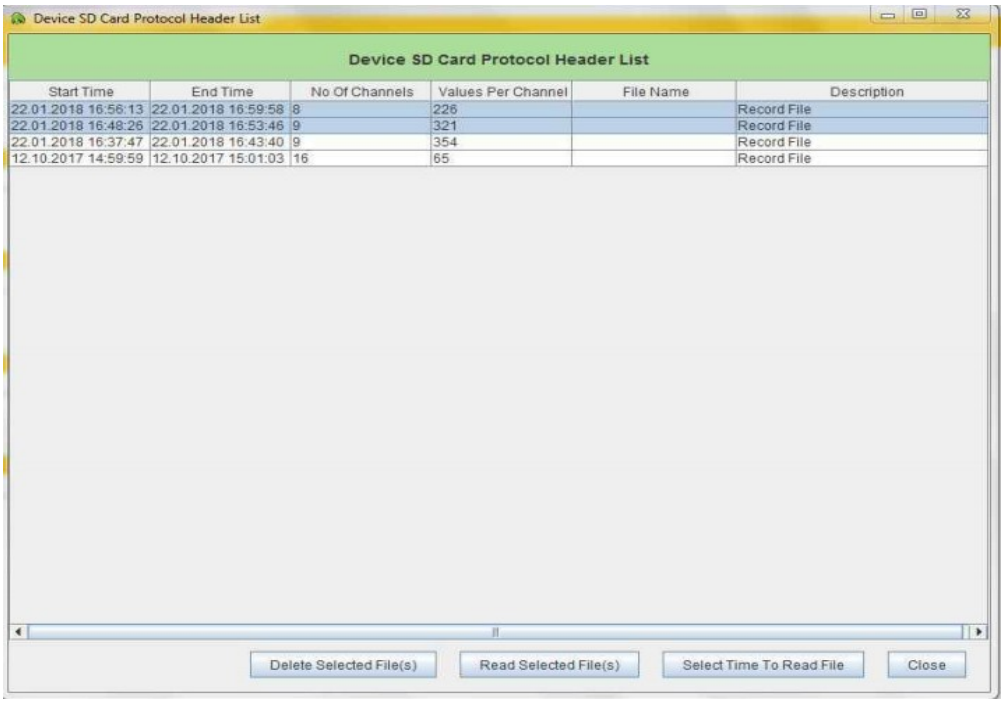
Using the S4A Software, you can download logger data from S331 to your local PC for further analysis. (Joy: Deleted the first section and outdated screenshots)

1. Start the S4A Software and open the online help.

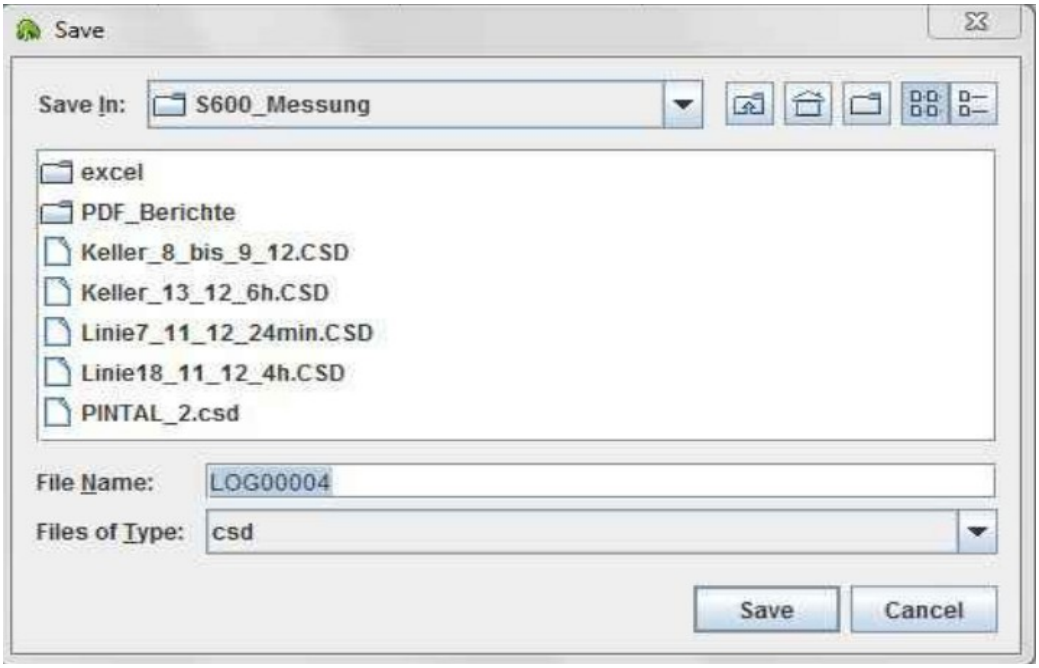


2. Detect the S330/S331 on the S4A, as described in the “Detect the Connected Device” topic.
3. Click on **Read** in the top bar. The Selection window pops up.
4. In the **Selection** window, select you want to download the logger files or the screenshots, and then click **OK**.

   The following window appears showing the log files that are saved on the S331 data logger.

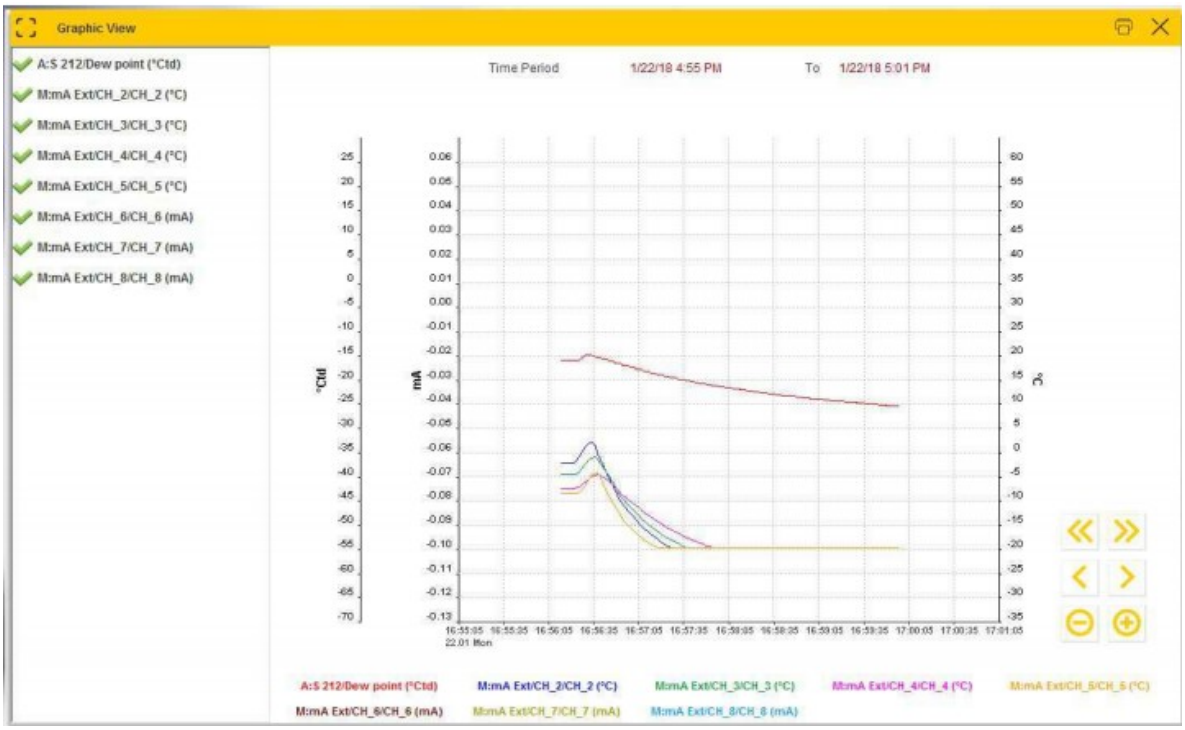


5. Select one or more files and click **Read Selected File(s)**.



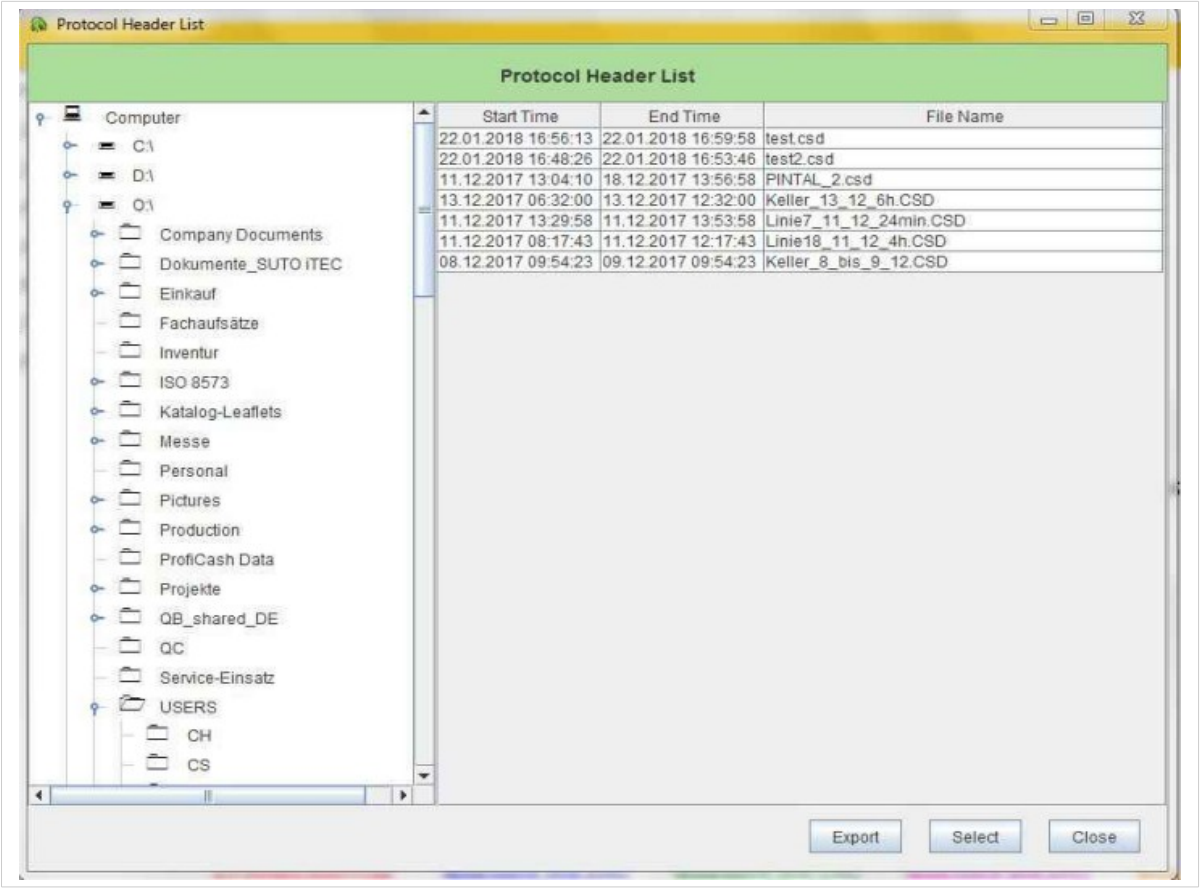
6. In the Save window that appears (shown above), select the path where you want to save the data. And then click **Save**.

   A new window appears showing the downloaded data in a graphic view. Views can be zoomed, modified, and exported.



7. To view graphics of a different file or to export a file into the Excel or CSV format, do the following:

   a. Click **File** in the top bar. The following window appears.



b. To view the graphics of a file, select the file and click **Select**. The graphic view of the file appears.

c. To export a file into the Excel or CSV format, select the file, and click **Export**.

Remark:

The measurement value of -9999 in a logger file denotes an invalid measurement value or a measurement failure. The measurement value of -8888 denotes an out-of-range measurement value.

13 Extended applications

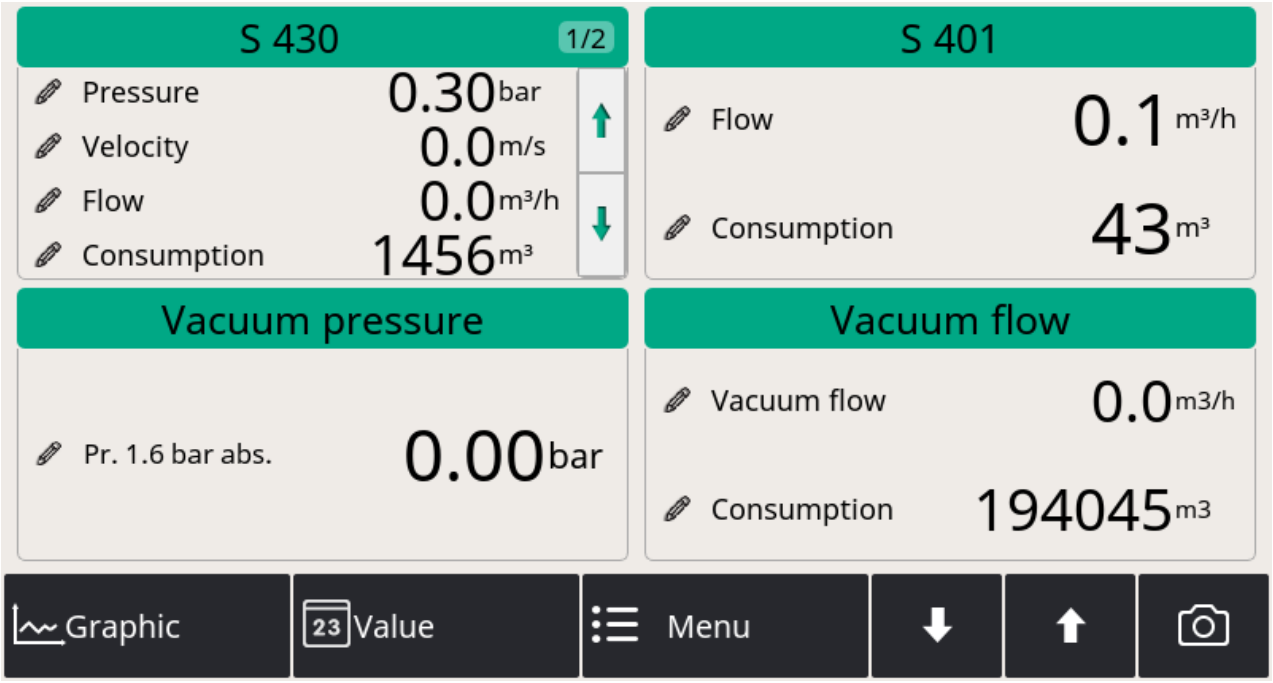
This chapter describes extended applications of S330/S331.

13.1 Applications of virtual channels

The following sections give application examples of virtual channels.

13.1.1 Monitoring vacuum flow and consumption

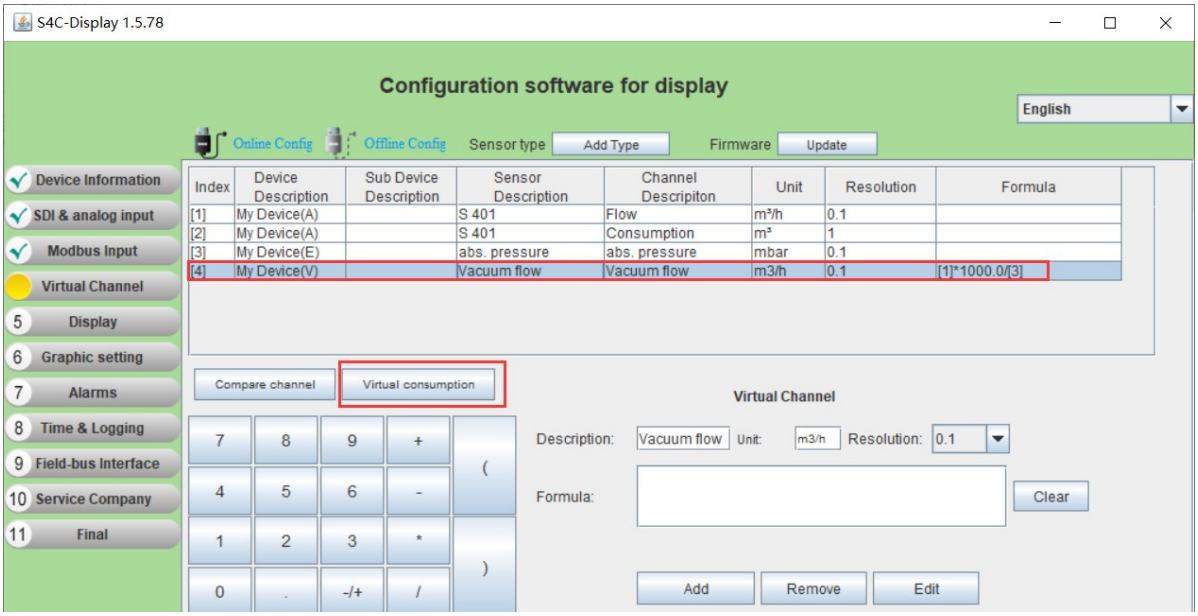
As shown in the following figure, one of the applications is to monitor vacuum flow and consumption that are measured by using the SUTO thermal mass flow sensor S401 and an absolute pressure sensor.



To configure virtual channels for vacuum flow and consumption

1. Launch the S4C-Display.
2. In the left navigation menu, select **Virtual Channel**.

   The physical channels that are connected to the S330/S331 are displayed.
3. Click the **Add** button to add a virtual channel for the vacuum flow, and then configure its attributes following the example below.



4. Select the virtual flow channel that you want to calculate the consumption, and then click the **Virtual consumption** button.

   A virtual consumption channel is automatically created in the list.

   NOTE: You do not need to configure the formula because the calculation formula between the flow and consumption is written in the S330/331.

5. To set the initial consumption, access the Sensor settings menu on the S330/S331 touch screen. For more information, see Section 9.5.4 .

13.1.2 Monitoring flow consumption for several branch lines

Another application of the virtual channel is to measure a total consumption for several branch lines.

To configure virtual channels for the total flow and consumption

1. In the **Virtual Channel** menu of S4C-Display, create a virtual channel for the total flow rate. The formula is configured to add up the flow rates in the desired branch lines.
2. Select this virtual channel for total flow rate, and then click the **Virtual consumption** button.

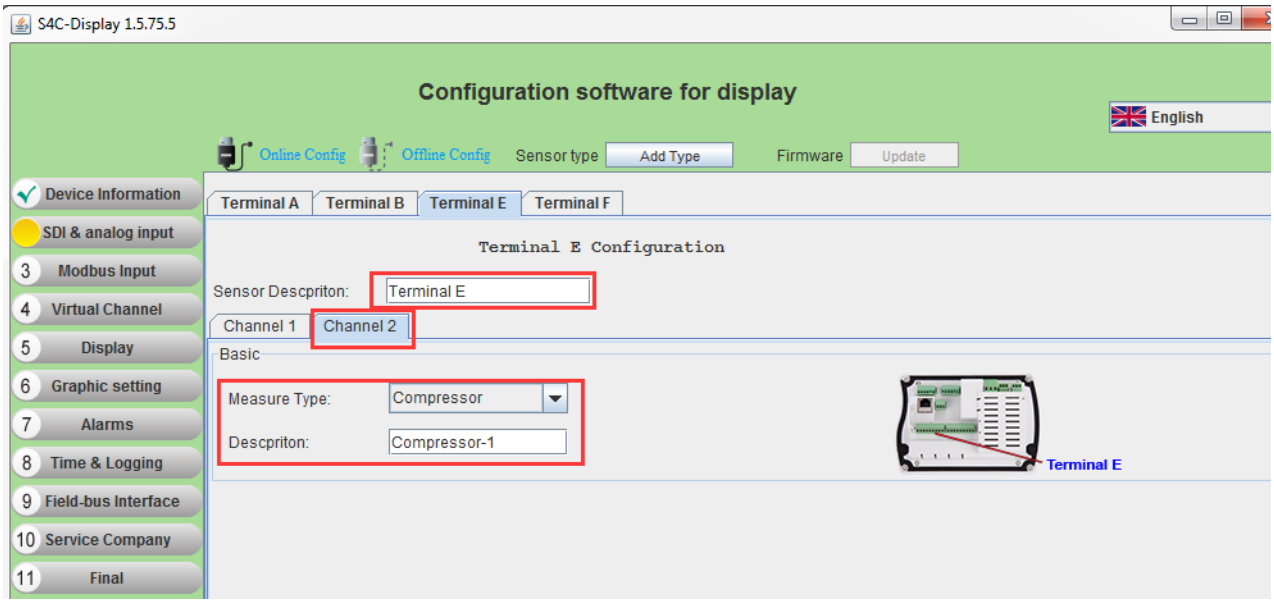
13.2 Monitoring the Compressor Run Time

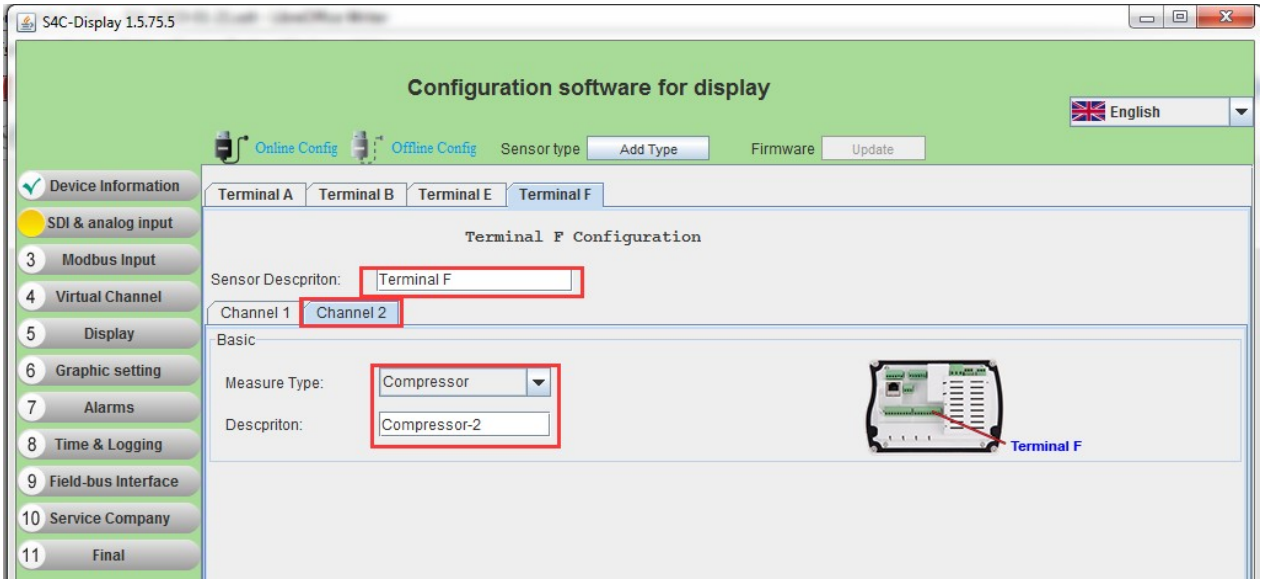
S330/331 enables you to monitor the total run time of a compressor by configuration.

To enable the monitoring by configuration

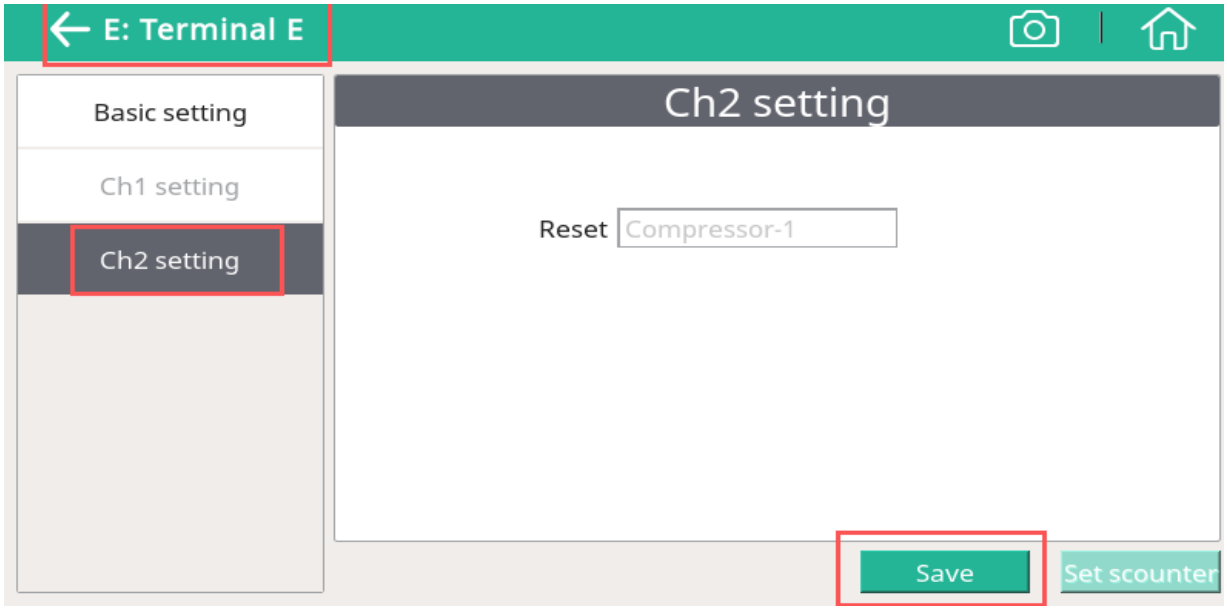
1. Connect a relay signal from a compressor to Terminal E or F on the S330/331. For more information, see case E or F in Section 7.2.10 .
2. Connect the S330/331 with a computer installed with S4C-Display.
3. Launch the **S4C-Display**.
4. In the **SDI&Analog Input** menu, configure the Channel 2 of Terminal E or F as shown in the following figures. Detailed settings are as follows:
   - Measurement type: Select **Compressor**.
   - Description: Enter a display name for the channel.

   NOTE: The configuration is to enable the channel to receive the relay signal from a compressor. By accumulating the time spans during which the relay contact is closed, the S331/S330 can show you the compressor load time, unload time, and the total run time.



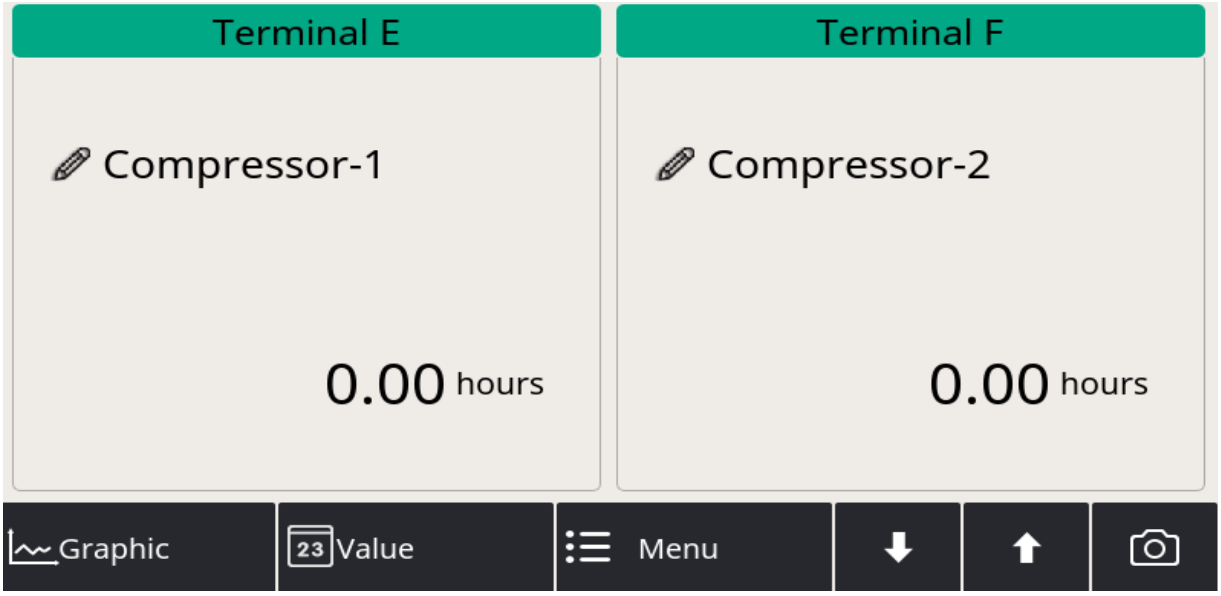


To reset the compressor run time, reset the Channel 2 on Terminal E or F. See the following figure for details.



Please note that if you reset Channel 2 on a Terminal, measurement data on both Channels will be reset.

As shown in the following example, the running hours of the two corresponding compressors are cleared to zero.



14 Optional accessories

Extra accessories may need

- Two analog inputs 0 ... 20 mA with 2 pulse inputs
- Hat rail holder
- Connection board for looping 4 ... 20 mA and pulse signal to PLC, and mountable-in-wall casings A1666 and A1668.

15 Maintenance

To clean the sensor and its accessories it is recommended to use moist cloth only.

ATTENTION!

Do not use isopropyl alcohol to clean the display!

16 Disposal or waste

Electronic devices are recyclable material and do not belong in the household waste.

The device, the accessories and its packings must be disposed according to your local statutory requirements. The dispose can also be carried by the manufacturer of the product, for this please contact the manufacturer.

17 Warranty

SUTO provides a warranty for this product of 24 months covering the material and workmanship under the stated operating conditions from the date of delivery. Please report any findings immediately and within the warranty time. If faults occurring during the warranty time SUTO will repair or replace the defective unit, without charge for labour and material costs but there is a charge for other service such as transport and packing costs.
Excluded from this warranty is:

- Damage caused by:
  - Improper use and non-adherence to the instruction manual.
  - Use of unsuitable accessories.
  - External influences (e.g. damage caused by vibration, damage during transportation, excess heat or moisture).

The warranty is void:

- If a user opens the measurement instrument without a direct request written in this instruction manual.
- If repairs or modifications are undertaken by third parties or unauthorised persons.
- If the serial number has been changed, damaged or removed.

Other claims, especially those for damage occurring outside the instrument are not included unless responsibility is legally binding.

Warranty repairs do not extend the period of warranty.

ATTENTION!

Batteries have a reduced warranty time of 12 months.

18 Appendix A - Modbus communication example

03 (0x03) Read holding register

Request		Response	
Slave address	1 byte	Slave address	1 byte
Function code	1 byte	Function code	1 byte
Starting address Hi	1 byte	Byte count	1 byte
Starting address Lo	1 byte	Register Hi	1 byte
No. of points Hi	1 byte	Register Lo	1 byte
No. of points Lo	1 byte	:	:
CRC	2 bytes	Register Hi	1 byte
		Register Lo	1 byte
		CRC	2 bytes

05 (0x05) Write single coil

Request		Response	
Slave address	1 byte	Slave address	1 byte
Function code	1 byte	Function code	1 byte
Coil address Hi	1 byte	Coil address Hi	1 byte
Coil address Lo	1 byte	Coil address Lo	1 byte
Data Hi	1 byte	Data Hi	1 byte
Data Lo	1 byte	Data L	1 byte
CRC	2 bytes	CRC	2 bytes

16 (0x10) Write multiple registers

Request		Response	
Slave address	1 byte	Slave address	1 byte
Function code	1 byte	Function code	1 byte
Starting address Hi	1 byte	Starting address Hi	1 byte
Starting address Lo	1 byte	Starting address Lo	1 byte
No. of registers Hi	1 byte	No. of registers Hi	1 byte
No. of registers Lo	1 byte	No. of registers Lo	1 byte
Byte count	1 byte	CRC	2 bytes
Data Hi	1 byte		
Data Lo	1 byte		
:	:		
Data Hi	1 byte		
Data Lo	1 byte		
CRC	2 bytes		

17 (0x11) Report slave ID

Request		Response	
Slave address	1 byte	Slave address	1 byte
Function code	1 byte	Function code	1 byte
CRC	2 bytes	Byte count	1 byte
		Slave ID	2 bytes
		Device run indicator	2 bytes
		Product code	2 bytes
		Product name	20 bytes
		CRC	2 bytes

19 Appendix B - LRC CRC calculation

LRC Generation

The Longitudinal Redundancy Checking (LRC) field is one byte, containing an 8–bit binary value. The LRC value is calculated by the transmitting device, which appends the LRC to the message. The device that receives recalculates an LRC during receipt of the message, and compares the calculated value to the actual value it received in the LRC field. If the two values are not equal, an error results.

The LRC is calculated by adding together successive 8–bit bytes in the message, discarding any carries, and then two's complementing the result. The LRC is an 8–bit field, therefore each new addition of a character that would result in a value higher than 255 decimal simply 'rolls over' the field's value through zero. Because there is no ninth bit, the carry is discarded automatically.

A procedure for generating an LRC is:

1. Add all bytes in the message, excluding the starting 'colon' and ending CRLF. Add them into an 8–bit field, so that carries will be discarded.

2. Subtract the final field value from FF hex (all 1's) to produce the ones–complement.
3. Add 1 to produce the twos–complement.

Placing the LRC into the Message

When the 8–bit LRC (2 ASCII characters) is transmitted in the message, the high–order character will be transmitted first, followed by the low–order character. For example, if the LRC value is 61 hex (0110 0001):

Colon	Addr	Func	Data Count	Data	Data	Data	Data	LRC Hi	LRC Lo	CR	LF
								"6" 0x36	"1" 0x31		

Example: an example of a C language function performing LRC generation is shown below.

The function takes two arguments:

```
unsigned char *auchMsg; /* A pointer to the message buffer containing binary data */
                        /* to be used for generating the LRC,                      */
unsigned short usDataLen; /* The quantity of bytes in the message buffer.          */
```

LRC Generation Function

```
Static unsigned char LRC(unsigned char *auchMsg, unsigned short
usDataLen)
{
      unsigned char uchLRC = 0 ;                          /* LRC char initialized */
      while (usDataLen--)                                 /* pass through message buffer */
            uchLRC += *auchMsg++ ;                        /* add buffer byte without carry */
return ((unsigned char)(-((char)uchLRC))) ;   /* return twos
complement */
}
```

CRC Generation

The **C**yclical **R**edundancy **C**hecking (CRC) field is two bytes, containing a 16-bit binary value. The CRC value is first generated by the transmitting device, which appends the CRC to the message. The device that receives recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

There are many ways of calculating a CRC checksum. To ensure correct calculation, please refer to [Reference 1] Modbus over serial line, where detailed descriptions and programming examples are available. Even more information and programming examples in different programming languages can be found on: www.modbus.org searching for CRC.

Below is a short text description of how the CRC is calculated. This description is then followed by a C programming example.

1. Load a 16-bit register with FFFF hex (all 1’s). Call this the CRC register.

2. Exclusive **OR** the first 8-bit byte of the message with the low-order byte of the 16-bit CRC register, putting the result in the CRC register.

3. Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.

4. (If the LSB was 0): Repeat step 3 (another shift). (If the LSB was 1): Exclusive OR the CRC register with the polynomial value 0xA001 (1010 0000 0000 0001).

5. Repeat steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.

6. Repeat steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.

7. The final content of the CRC register is the CRC value.

8. When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

Placing the CRC into the Message

When the 16-bit CRC (two 8-bit bytes) is transmitted in the message, the low-order byte will be transmitted first, followed by the high-order byte.

For example, if the CRC value is 1241 hex (0001 0010 0100 0001):

Addr	Func	Data count	Data	Data	Data	Data	CRC Lo	CRC Hi
							0x41	0x12

High-Order Byte Table

```
/* Table of CRC values for high–order byte */
static unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81,0x40
} ;
```

Low-Order Byte Table

```
/* Table of CRC values for low–order byte */
static char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7,
0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E,
```

```
0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9,
0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32,
0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D,
0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF,
0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1,
0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB,
0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA,
0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97,
0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E,
0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89,
0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83,
0x41, 0x81, 0x80, 0x40
};
unsigned short CRC16(unsigned char *puchMsg, unsigned short usDataLen){
  unsigned char uchCRCHi = 0xFF;                    /* high byte of CRC initialized
*/
  unsigned char uchCRCLo = 0xFF;                    /* low byte of CRC initialized
*/
  unsigned uIndex ;                                 /* will index into CRC lookup
table */
  while(usDataLen—)                                 /* pass through message
buffer */
  {
        uIndex = uchCRCHi ^ *puchMsg++ ;            /* calculate the CRC */
        uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex] ;
        uchCRCLo = auchCRCLo[uIndex] ;
   }
   return (unsigned short int)((uchCRCHi << 8) | uchCRCLo);
}
```

Exception codes

The S330/S331 Modbus module uses the following exception codes, when responding to the master.

Exception code	Exception name
0x01	illegal function
0x02	Illegal data address
0x03	Illegal data value
0x04	Slave device failure
0x05	Acknowledge
0x06	Slave device busy

20 Appendix C - Float definition

32-bit floating-point format

The S330/S331 Modbus module IEEE '**Little-Endian**' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the **Least** significant byte is sent first.

The data type **float** is represented by the 32-bit floating-point format. The representation of a 32-bit floating-point number as an integer is:

bit	31	30 23	22 0
	S	Exponent	Mantissa

The value of the number is:

$$(-1)^{S} * 2^{(Exponent-127)} * Mantissa$$

Value (decimal)	IEEE floating point format MSB LSB	Register N		Register N + 1	
		high	low	high	low
0.0	0x42C80000	0x00	0x00	0x42	0xC8
123.4	0x42F6CCCD	0xCC	0xCD	0x42	0xF6
2.0	0x40000000	0x00	0x00	0x00	0x40
0.0	0xBF800000	0x00	0x00	0xBF	0x80
0.0	0xC2A00000	0x00	0x00	0xC2	0xA0

Read 1st display value (Holding register address 0, 2 register)

Request: 0x01, 0x03, 0x00, 0x00, 0x00, 0x02, 0xC4, 0x0B

Response: 0x01, 0x03, 0x04, 0x99, 0x9A, 0x42, 0x55, 0x04, 0x1F

1st display value = 53.4

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