Legacy (SR30-M2-D1, SR20-D2 & SR15-D1) register map compatibility layer for the latest SR300-D1, SR200-D1 & SR100-D1 industrial-grade instruments

The Modbus interface of SR300-D1, SR200-D1, and SR100-D1 industrial-grade pyranometers differs from that of the SR30-M2-D1, SR20-D2, and SR15-D1 legacy instruments. For customers that are not yet able to adopt the Modbus interface of the latest industrial-grade pyranometers, Hukx offers a compatibility layer that allows the industrial-grade instruments to imitate the Modbus interface of legacy instruments. You can use the Hukx Sensor Manager to change instrument behavior. This application note describes how the compatibility layer can be used and what the limitations of the compatibility layer are.

Introduction

The latest SR300-D1, SR200-D1, and SR100-D1 industrial-grade pyranometers offer many improvements over their legacy counterparts (SR30-M2-D1, SR20-D2, and SR15-D1) in terms of robustness and interfacing, while offering comparable performance as a measurement instrument.

Improvements to the Modbus interface include the organization of registers in topic-based register groups, the increased use of floating point numbers instead of integers, the introduction of statistics registers, and the introduction of dedicated status indicator registers for internal humidity, leak detection, and instrument tilt.

Although the Modbus interface of the industrial-grade instruments offers many advantages over the Modbus interface of the legacy instruments, it is not always easy to update the software of existing SCADA systems, and it is sometimes difficult to adopt the new Modbus interface of the industrial-grade pyranometers.

The two most significant differences in the Modbus interface between the legacy instruments and the industrial-grade instruments are the following:

1. The datatypes are typically different. E.g. in SR30-M2-D1 the irradiance was stored as a 32-bit signed integer. The irradiance was expressed in W/m² divided by a scaling factor stored in another register. In SR300-D1 the irradiance in W/m² is stored as a 32-bit float, removing the need for a scaling factor and corresponding scaling of the data by the SCADA system.

2. The registers are located at different register addresses. E.g. in SR30-M2-D1 the irradiance register was located at 0x0002, whereas in SR300-D1 the irradiance register is located at register 0x0200.

For those customers that are not yet able to adopt the interface, Hukx has implemented a compatibility layer that allows the industrial-grade instruments to be used with the Modbus interface of the legacy instruments. After configuring the industrial-grade instrument, users are able to access a Modbus interface that is to a very large extent compatible with the legacy instruments.

This document describes how the compatibility layer can be used and what the limitations of the compatibility layer are.

Compatibility layer

The compatibility layer allows industrial grade instruments to imitate the Modbus interface of the legacy instruments. The compatibility layer consists of several parts:

- Registers with the same datatype as in the legacy instruments. For example, SR300-D1 offers the irradiance both as a floating point datatype and as a legacy signed 32-bit integer datatype. A list of registers with the register address on legacy instruments and the register address on industrial-grade instruments is shown in Table 2.

- Registers can be mapped to another register address. Internally, the instrument will map an alias register address to a default register address. When configured, this allows registers to be accessed at the same address as in the legacy instruments. For example, in SR30-M2-D1 the irradiance could be read as a 32-bit signed integer at register address 0x0002. On SR300-D1 by default the same register is available at register address 0x0270. However, when the SR30-M2-D1 legacy register map is enabled on SR300-D1, Modbus client can instead read address 0x0002. Internally, the device will map the alias register address 0x0002 to the default register address 0x0270 and the register at 0x0270 is read instead. The Hukx Sensor Manager can be used to program the mapping and to enable or disable the mapping feature.

- For SR300-D1 Modbus coils for controlling the heating and ventilation are available at the same coil address as in SR30-M2-D1.

The compatibility layer is available from a certain firmware version onwards. The firmware version of your instrument can be checked using the Hukx Sensor Manager (HSM). Table 1 lists the minimum firmware version of the industrial-grade pyranometers that support the compatibility features

Table 1 Minimum firmware- and software versions that support the register address mapping feature.

product	minimum version
SR100-D1	firmware version 1.8.0
SR200-D1	firmware version 1.8.0
SR300-D1	firmware version 1.9.0
HSM	version 26.25

Table 2 SR30-M2-D1 legacy registers in SR300-D1. With register address mapping disabled, the registers are available at the default register address, with the legacy register address map programmed and enabled, the registers are accessible at the legacy register address. For the complete register description, please refer to the SR300-D1 register list. The table applies to SR15-D1/SR100-D1 and SR20-D2/SR200-D1 as well, except for registers related to heating, ventilation, internal pressure, and tilt.

legacy register address	default register address	name	datatype
0x0002	0x0270	temperature_compensated_irradiance_int	s32
0x0004	0x0272	uncompensated_irradiance_int	s32
0x0006	0x0274	instrument_temperature_int	s16
0x0007	0x0488	thermopile_resistance_int	u16
0x0008	0x0275	scaling_factor_irradiance	u16
0x0009	0x0276	scaling_factor_temperature	u16
0x000a	0xfa01	raw_sensor_signal	s32
0x0029	0xfa03	sensor_sensitivity	float
0x002e	0xfa0d	sensor_calibration_date	u32
0x003f	0xfa0f	sensor_sensitivity_history_1	float
0x0041	0xfa19	sensor_calibration_date_history_1	u32
0x0043	0xfa11	sensor_sensitivity_history_2	float
0x0045	0xfa1b	sensor_calibration_date_history_2	u32
0x0047	0xfa13	sensor_sensitivity_history_3	float
0x0049	0xfa1d	sensor_calibration_date_history_3	u32
0x004b	0xfa15	sensor_sensitivity_history_4	float
0x004d	0xfa1f	sensor_calibration_date_history_4	u32
0x004f	0xfa17	sensor_sensitivity_history_5	float
0x0051	0xfa21	sensor_calibration_date_history_5	u32
0x0057	0x030c	irradiance_temperature_compensation_a	float
0x0059	0x030e	irradiance_temperature_compensation_b	float
0x005b	0x0310	irradiance_temperature_compensation_c	float
0x0062	0x0686	internal_relative_humidity_int	u16
0x008a	0x0704	internal_pressure_int	u16
0x00c2	0x065f	tilt_int	u16
0x00c4	0x0502	fan_speed	u16
0x00c6	0x0582	heater_current	u16
0x00c7	0x0501	fan_current	u16

Programming, enabling, and disabling register address mapping

The user can program the legacy register map and enable or disable register address mapping using the Hukx Sensor Manager (HSM).

To do so, first connect to an industrial-grade pyranometer using the HSM. Next in the HSM, from the top menu bar, select **Advanced → Register address configuration**. This should open the **Register address configuration** window shown in Figure 1.

To program the legacy register address map, select the register address map from the drop-down menu and press the **Write** button. This will write the selected register address map to the instrument. To remove the register address map, press the **Erase** button.

To enable or disable register address mapping, toggle the **Register address mapping** ON/OFF switch. With the register map disabled the registers are accessible at their default register address as specified in the instrument's register list. With the register map enabled the addresses are translated as defined by the register address map. If the legacy register address map has been programmed onto the instrument and register address mapping is enabled, then the legacy registers will be available at the legacy register address.

E.g. to use the SR30-M2-D1 Modbus interface on an SR300-D1, select the SR30-M2-D1 register address map from the drop-down menu and press the **Write** button. Toggle the **Register address mapping** switch to the ON position to enable register address mapping. After a power cycle or soft reboot the SR30-M2-D1 Modbus interface, with some minor limitations, will be available on the SR300-D1.

Note that the **Register list** window accessed through the **Advanced → Registers** menu always displays the default register list, regardless whether register address mapping is enabled or not on the instrument.

Whenever the instrument does not support register address mapping the message "not supported" will be displayed and the UI elements in the register configuration window will be disabled. In that case, it is recommend to check the firmware version of the firmware currently used by the instrument, and see if it can be updated to a version that does support register address mapping.

For more details, the reader is referred to the HSM manual. Register address mapping is supported from HSM version v26.25 onwards. Always use the latest version of the HSM.

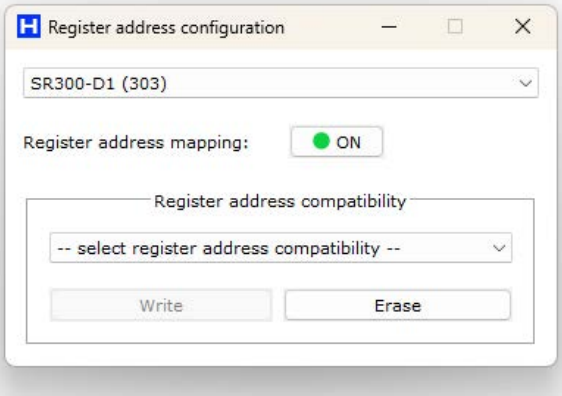

Figure 1 The register address configuration window in the HSM.

Limitations of the compatibility layer

Although the compatibility layer makes the Modbus interface of the industrial-grade instruments largely compatible with that of the legacy instruments, there are some limitations to the compatibility. These limitations are described in this section.

Some legacy registers are not available, or have limitations. These registers are listed in Table 3. Most of these registers are mapped to a registers that always reads zero.

There is some difference in behavior in the Modbus coils that control heating and ventilation in SR300-D1 as compared to the coils that control heating and ventilation in SR30-M2-D1. In SR30-M2-D1, whenever the heating or ventilation is switched on or off through the Modbus coils, that setting is non-persistent. This means that after a power cycle or soft reboot the heating and ventilation return to their value on startup setting, regardless of what was set through the coils. The heater and ventilation settings on startup can only be set through the HSM. For SR300-D1 on the other hand, heating and ventilation settings set on via Modbus coils are persistent. This means that after a power cycle or soft reboot the heating and ventilation settings will return to the value set through the corresponding Modbus coils.

There are some differences in exception handling between the legacy instruments and the industrial-grade instruments. Whenever measurement data is not available in legacy instruments, e.g. immediately after startup or due to an internal communication error, legacy instruments will return a zero. Industrial-grade instruments on the other hand will return an appropriate Modbus exception code.

The register address mapping feature in the industrial-grade instruments translates alias register addresses to default register addresses. If no translation is defined for a given alias register address, then that register address is used directly. This means that for register addresses that are not used by legacy instruments there might still be a register defined at that register address for industrial-grade instruments with the compatibility map enabled.

Table 3 Overview of legacy product registers with limited or no implementation on industrial grade pyranometers.

legacy register address	default register address	register description in legacy product	limitation
0x0001	N/A	serial communication settings	Register is not available on industrial-grade pyranometers. Use the registers in the serial communication settings group to configure serial settings on industrial-grade pyranometers, e.g. using the HSM.
0x0020	0xfa05	sensor model	Mapped to the 16 character sensor_type register, which is a truncated version of the 32 character product_model register. In practice the truncation does not pose any limitation for SR300-D1, SR200-D1, and SR100-D1. Note that the register contains the name of the actual product model, not that of the product model that it is attempting to imitate.
0x0028	0xfa00	truncated serial number	The serial number stripped of non-numeric characters modulo 60000.
0x002b	0xfa00	response time as measured during calibration	Mapped to a dummy register, always reads zero.
0x002c	0xfa00	sensor resistance as measured during calibration	Mapped to a dummy register, always reads zero.
0x002d	0xfa00	reserved, always 0	Mapped to a dummy register, always reads zero.
0x003d	0xfa00	firmware version	Mapped to a dummy register, always reads zero.
0x003e	0xfa00	hardware version	Mapped to a dummy register, always reads zero.

A truncated serial number register is available. Hukx industrial instruments use a 32-character string as a serial number. In the legacy instruments the serial number was available as a 16-bit unsigned integer. It is not possible to uniquely map a 32-character string to a 16-bit unsigned integer. The truncated serial number is obtained by stripping the serial number of non-numeric characters, interpreting the resulting string as an integer and performing a modulo 60000 operation.

Examples are given in Table 4. In most applications the truncated serial number will suffice to uniquely identify the instrument at a specific site, however, users should be aware that the truncated serial number is not guaranteed to be unique. When requesting support from Hukx, users must report the complete serial number, not the truncated version.

Table 4 Examples of truncated serial numbers.

serial number	truncated serial number	explanation
54100	54100	There are no non-numeric characters to remove. 54100 is less than 60000, hence the serial number is unchanged.
59999	59999	There are no non-numeric characters to remove. 59999 is less than 60000, hence the serial number is unchanged.
60000	0	There are no non-numeric characters to remove. The remainder of the integer division of 60000 by 60000, i.e. 60000 modulo 60000, is 0.
60500	500	There are no non-numeric characters to remove. The remainder of the integer division of 60500 by 60000, i.e. 60500 modulo 60000, is 500.
120500	500	There are no non-numeric characters to remove. The remainder of the integer division of 120500, i.e. 120500 modulo 60000 is 500.
AB60500	500	Stripping AB60500 of non-numeric characters gives 60500. 60500 modulo 60000 equals 500.
60AB500	500	Stripping 60AB500 of non-numeric characters gives 60500. 60500 modulo 60000 equals 500.

Hardware limitations

Although the compatibility layer allows industrial-grade pyranometers to imitate the Modbus interface of the legacy instrument, there are still some hardware differences that should be considered.

For example, industrial-grade pyranometers have an isolated RS-485 interface, a dedicated signal ground wire and a dedicated earthing terminal. The power consumption of the industrial-grade instruments differs from that of the legacy instruments. Furthermore, it should be noted that industrial-grade instruments may require a fail-safe biasing or line-polarization circuit to be installed on the RS-485 network. For information on the installation of industrial-grade instruments, we refer to the Industrial Series Class A and Class B user manual.

SR300-D1, SR200-D1 and SR100-D1 use the same 5-pole M12A connectors as SR30-M2-D1 and SR15-D1, thus allowing cables to be reused when replacing a legacy instrument. However, SR20-D2 uses a different 10-pole M16 connector. When replacing an SR20-D2 with an industrial-grade pyranometer the C07-C04E F-M adapter cable may be used.

Conclusion

The compatibility layer allows SR300-D1, SR200-D1, and SR100-D1 with a Modbus interface that is largely identical to that of SR30-M2-D1, SR20-D2, and SR15-D1, respectively. The compatibility layer consists of three parts: Modbus registers with the same data types as in the legacy instruments have been added, a register address mapping feature has been added allowing internal address translation from the legacy register address to the default register address and finally, in the case of SR300-D1, Modbus coils have been added to control the heating and ventilation.

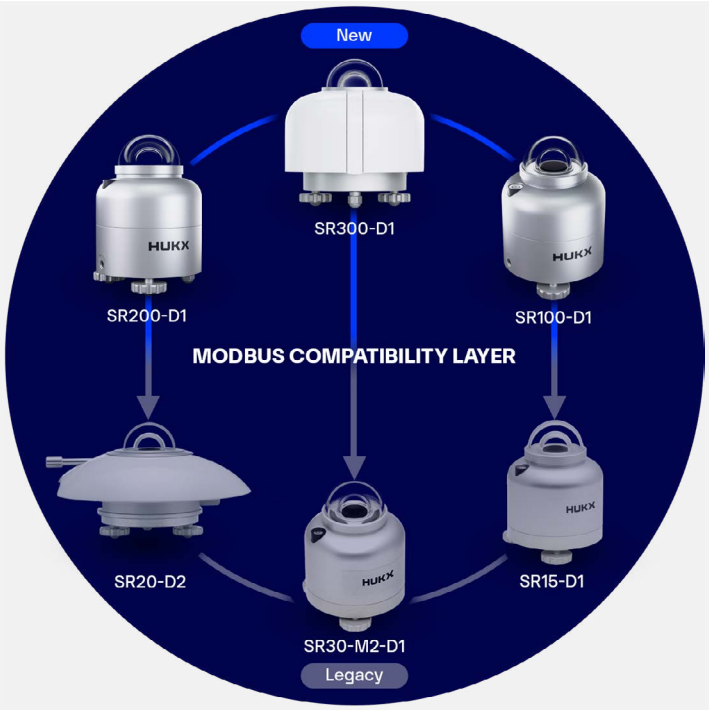

Figure 2 Modbus compatibility layer: compatible with SR30-M2-D1, SR20-D2, and SR15-D1.

About Hukx

Hukx is the leading innovator in solar radiation and heat flux sensor technology. We are proud to set the standard in high-accuracy measurement, and to be working at the heart of the energy transition.

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