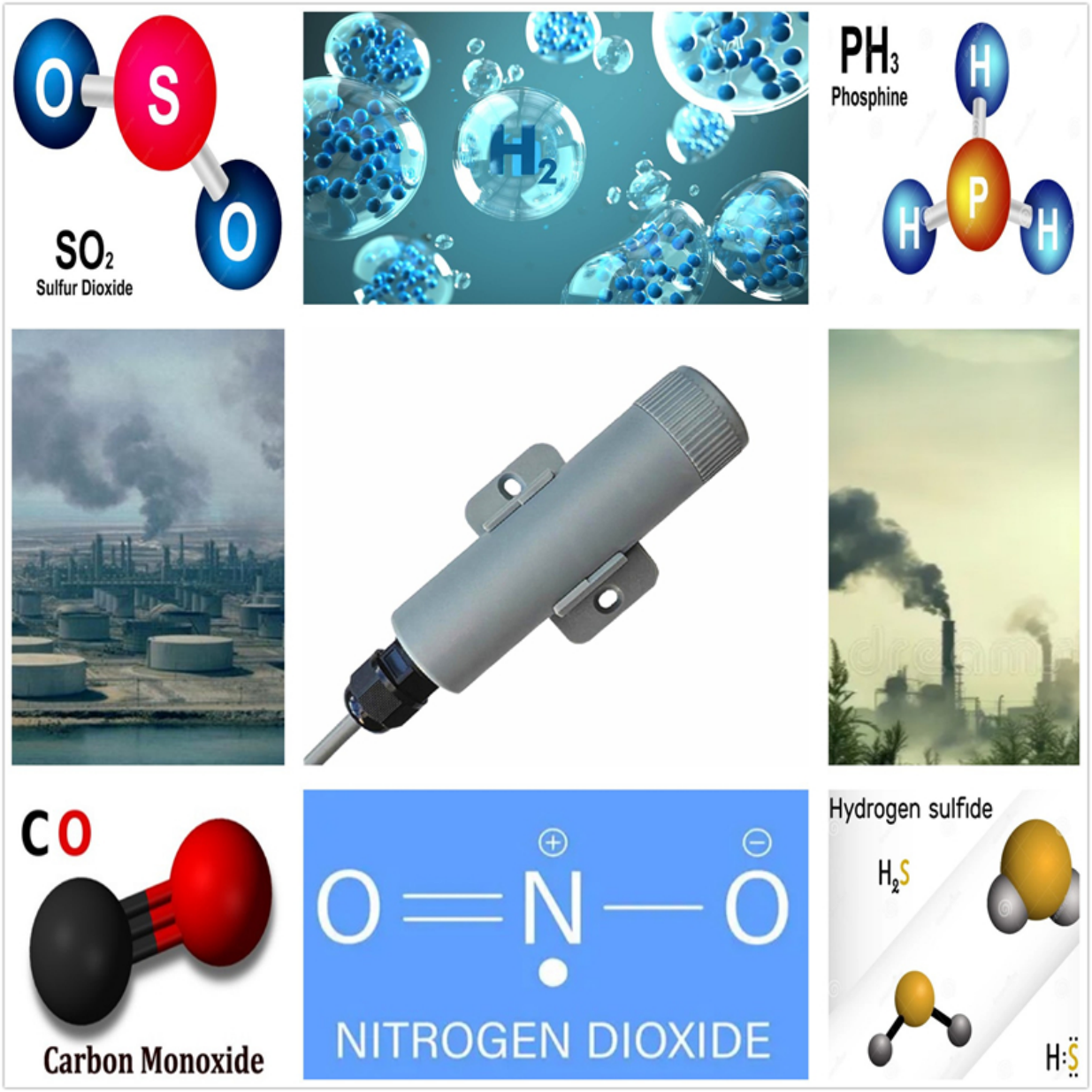
DigiGas-TOXIC

Hazardous Gas Concentration Sensor (SDI-12 Interface)

Hazardous Gas Concentration Sensor (RS485 Interface)

User Manual



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2 Introduction

2.1 Brief

The DigiGas-TOXIC hazardous gas concentration sensor is based on electrochemical gas sensor technology and can detect the concentration value of a single gas (including but not limited to: ammonia, hydrogen sulfide, carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide, phosphine, hydrogen, ethylene oxide, hydrogen cyanide, methyl mercaptan, tetrafluorothiophene, hydrogen chloride, chlorine, oxygen). The sensor is equipped with built-in temperature compensation and features low baseline drift, high sensitivity, high precision and long service life.

The sensor supports SDI-12 interface or RS485 interface (Modbus-RTU protocol), and is compatible with various data collectors that support SDI-12 and RS485 communication for long-distance multi-point monitoring and recording.

Features

- Single hazardous gas concentration detection, with the option of multiple different harmful gas sensors
- Low baseline drift, high precision, long service life, and good interchangeability
- Integrated gas concentration and temperature compensation
- SDI-12 or RS485 communication interface with surge protection
- Wall-mounted installation, small size, easy integration
- Low-power devices can be used in battery-powered systems
- Reverse power protection and Built-in TVS/ESD protection
- Excellent price-performance ratio

Applications

- Concentration monitoring of harmful gases
- Environmental Monitoring
- Laboratory

Special Note

This sensor is only suitable for monitoring and data collection in non-safety-related scenarios. It is strictly prohibited to use it in personnel safety protection (such as life support-related monitoring, etc.), production safety control (such as equipment safety interlock, dangerous working condition warning, safety production compliance monitoring, etc.), and other critical safety fields involving personal safety and property safety.

Specifications	
Output Interface	Optional: SDI-12, V1.3 Optional: RS485, Modbus-RTU
Power Supply	5-28V DC
Power Consumption	SDI-12 Interface: Quiescent current: <500uA @12V DC (The specific value depends on the type of gas) Max. current during measurement: <5mA@12VDC RS485 Interface: Quiescent current: <2mA @12V DC Max. current during measurement: <7mA@12VDC
Gas Type	**Optional:** Ammonia, hydrogen sulfide, carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide, phosphine, hydrogen, ethylene oxide, hydrogen cyanide, methyl mercaptan, tetrafluorothiophene, hydrogen chloride, chlorine, oxygen; **Other gas types:** Customizable
Gas Concentration	Range: Refer to chapter “Gas Quick Reference” or separate sensor data sheet. Resolution: Refer to chapter “Gas Quick Reference” or separate sensor data sheet. Accuracy: Refer to separate sensor data sheet. Response time: Refer to chapter “Gas Quick Reference” or separate sensor data sheet.
Temperature	Range: -40 to 80℃, resolution: 0.01℃, typical accuracy: +/-0.3℃
Operating	Refer to chapter “Gas Quick Reference” or separate sensor data sheet
IP Ratings	IP50
Installation	Wall mounting
Cable Length	2 meters or customization
Dimension	Sensor body: 111*25.5mm (Length*Diameter)

2.2 Measurement Parameters Quick Reference

2.2.1 Gas Quick Reference

Gas Type ID	Gas Name	Full Range	Resolution	Decimal Point Number
xxxx	Customization	TBD	TBD	TBD
0001	Ammonia NH3	0-100 ppm	0.5 ppm	1
0002	Ammonia NH3	0-500 ppm	3 ppm	1
0003	Hydrogen Sulfide H2S	0-100 ppm	0.1 ppm	1
0004	Hydrogen Sulfide H2S	0-1000 ppm	1 ppm	1
0005	Carbon Monoxide CO	0-500 ppm	1 ppm	1
0006	Carbon Monoxide CO	0-2000 ppm	10 ppm	1
0007	Nitrogen Dioxide NO2	0-20 ppm	0.1 ppm	1
0008	Nitrogen Dioxide NO2	0-2000 ppm	5 ppm	1
0009	Nitric Oxide NO	0-250 ppm	0.5 ppm	1
0010	Nitric Oxide NO	0-2000 ppm	1 ppm	1
0011	Sulphur Dioxide SO2	0-20 ppm	0.1 ppm	1
0012	Sulphur Dioxide SO2	0-2000 ppm	5 ppm	1
0013	Phosphine PH3	0-20 ppm	0.1 ppm	1
0014	Phosphine PH3	0-1000 ppm	1 ppm	1
0015	Hydrogen H2	0-1000 ppm	10 ppm	1
0016	Hydrogen H2	0-40000 ppm	80 ppm	0
0017	Ethylene Oxide ETO	0-10 ppm	0.1 ppm	1
0018	Ethylene Oxide ETO	0-100 ppm	1 ppm	1
0019	Ethylene Oxide ETO	0-500 ppm	10 ppm	1
0020	Hydrogen Cyanide HCN	0-50 ppm	0.2 ppm	1
0021	Methyl Mercaptan CH3SH	0-10 ppm	0.1 ppm	1
0022	Tetrahydrothiophene THT	0-50 mg/m3	0.3 mg/m3	1
0023	Hydrogen Chloride HCl	0-30 ppm	1 ppm	1
0024	Chlorine Dioxide ClO2	0-1 ppm	0.03 ppm	2
0025	Chlorine Dioxide ClO2	0-50 ppm	0.05 ppm	2
0026	Chlorine Cl2	0-10 ppm	0.1 ppm	1
0027	Chlorine Cl2	0-50 ppm	0.1 ppm	1
0028	Chlorine Cl2	0-200 ppm	0.1 ppm	1
0029	Oxygen O2 (Non Liquid Electrolyte)	0-30 %	0.1% O2	1
0030	Oxygen O2	0-30 %	0.1% O2	1

Gas Type ID	Gas Name	Sensitivity (nA)	Operating (non-condensing)
xxxx	Customization	TBD	TBD
0001	Ammonia NH3	135±35 nA/ppm	-20~40℃, 15~90%RH, 90~110 kPa
0002	Ammonia NH3	35±15 nA/ppm	-20~40℃, 15~90%RH, 90~110 kPa
0003	Hydrogen Sulfide H2S	800±200 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0004	Hydrogen Sulfide H2S	105±55 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0005	Carbon Monoxide CO	70±15 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0006	Carbon Monoxide CO	28±10 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0007	Nitrogen Dioxide NO2	600±150 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0008	Nitrogen Dioxide NO2	20±10 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0009	Nitric Oxide NO	400±80 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0010	Nitric Oxide NO	130±60 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0011	Sulphur Dioxide SO2	500±100 nA/ppm	-20~40℃, 10~90%RH, 90~110 kPa
0012	Sulphur Dioxide SO2	20±8 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0013	Phosphine PH3	1400±600 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0014	Phosphine PH3	70±40 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0015	Hydrogen H2	20±10 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0016	Hydrogen H2	7±2 nA/ppm	-20~50℃, 10~90%RH, 91~110 kPa
0017	Ethylene Oxide ETO	1900±800 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0018	Ethylene Oxide ETO	250±0.125 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0019	Ethylene Oxide ETO	58±33 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0020	Hydrogen Cyanide HCN	100±20 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0021	Methyl Mercaptan CH3SH	700±150 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0022	Tetrahydrothiophene THT	150±50 nA/(mg/m3)	-20~50℃, 10~90%RH, 90~110 kPa
0023	Hydrogen Chloride HCl	300±100 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0024	Chlorine Dioxide ClO2	-650±300 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0025	Chlorine Dioxide ClO2	-400±180 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0026	Chlorine Cl2	750±150 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0027	Chlorine Cl2	-450±200 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0028	Chlorine Cl2	180±50 nA/ppm	-20~50℃, 10~90%RH, 90~110 kPa
0029	Oxygen O2 (Non Liquid Electrolyte)	-16670±2381 nA/1%	-20~50℃, 10~90%RH, 90~110 kPa
0030	Oxygen O2	-16670±2381 nA/1%	-20~50℃, 10~90%RH, 90~110 kPa

Gas Type ID	Gas Name	Warm up time since power on	Response Time (T90)
xxxx	Customization	TBD	TBD
0001	Ammonia NH3	10 minutes at least	<90 s
0002	Ammonia NH3	10 minutes at least	<90 s
0003	Hydrogen Sulfide H2S	10 minutes at least	<35 s
0004	Hydrogen Sulfide H2S	10 minutes at least	<45 s
0005	Carbon Monoxide CO	10 minutes at least	<30 s
0006	Carbon Monoxide CO	10 minutes at least	<35 s
0007	Nitrogen Dioxide NO2	10 minutes at least	<30 s
0008	Nitrogen Dioxide NO2	10 minutes at least	<60 s
0009	Nitric Oxide NO	6 hours at least	<45 s
0010	Nitric Oxide NO	6 hours at least	<60 s
0011	Sulphur Dioxide SO2	10 minutes at least	<45 s
0012	Sulphur Dioxide SO2	10 minutes at least	<60 s
0013	Phosphine PH3	10 minutes at least	<60 s
0014	Phosphine PH3	10 minutes at least	<60 s
0015	Hydrogen H2	10 minutes at least	<70 s
0016	Hydrogen H2	10 minutes at least	<60 s
0017	Ethylene Oxide ETO	6 hours at least	<120 s
0018	Ethylene Oxide ETO	6 hours at least	<120 s
0019	Ethylene Oxide ETO	6 hours at least	<120 s
0020	Hydrogen Cyanide HCN	10 minutes at least	<120 s
0021	Methyl Mercaptan CH3SH	10 minutes at least	<40 s
0022	Tetrahydrothiophene THT	6 hours at least	<60 s
0023	Hydrogen Chloride HCl	6 hours at least	<70 s
0024	Chlorine Dioxide ClO2	10 minutes at least	<60 s
0025	Chlorine Dioxide ClO2	10 minutes at least	<60 s
0026	Chlorine Cl2	10 minutes at least	<30 s
0027	Chlorine Cl2	10 minutes at least	<30 s
0028	Chlorine Cl2	10 minutes at least	<30 s
0029	Oxygen O2 (Non Liquid Electrolyte)	6 hours at least	<30 s
0030	Oxygen O2	6 hours at least	<30 s

Note: Please Refer to separate sensor data sheet for more information.

2.2.2 Gas Concentration

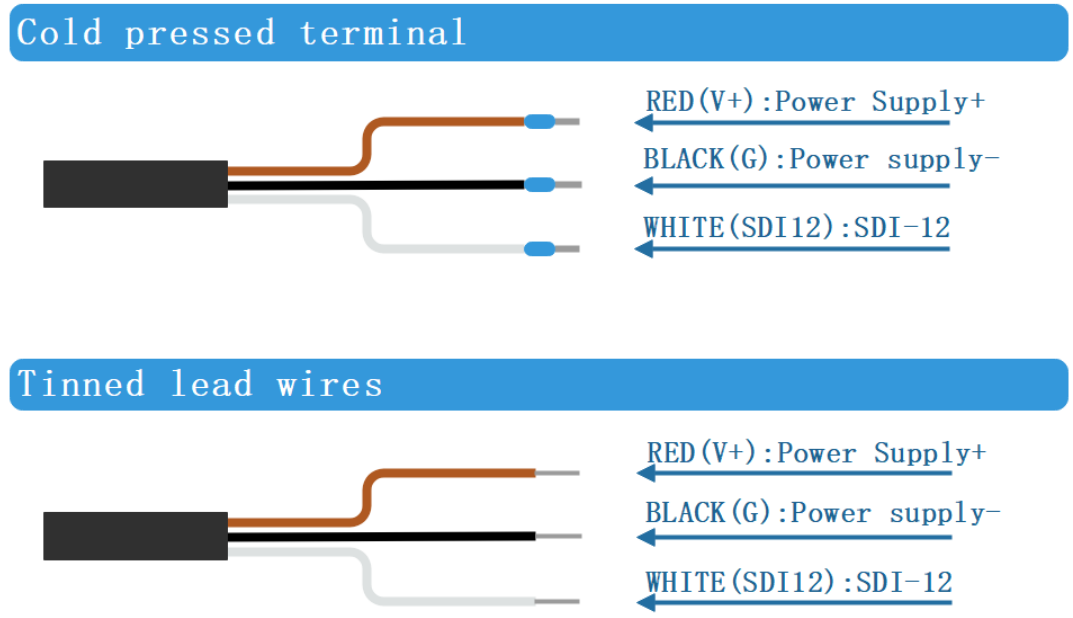
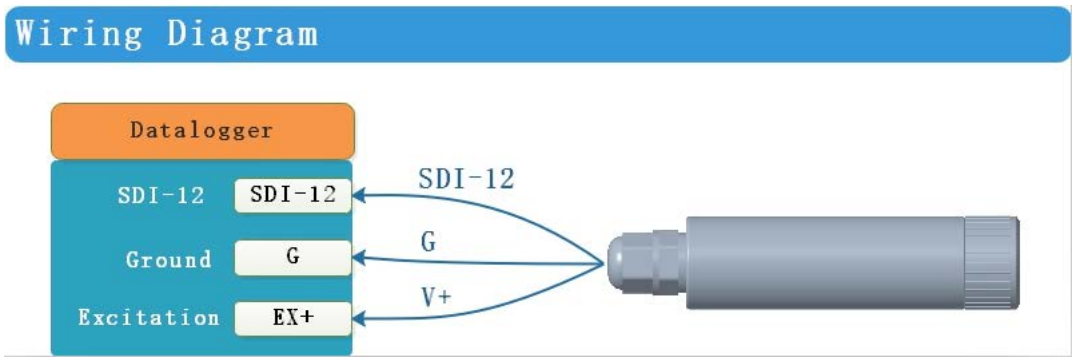
Parameter	Conditions	Value
Range	-	Refer to chapter “Gas Quick Reference” or separate sensor data sheet
Resolution	-	Refer to chapter “Gas Quick Reference” or separate sensor data sheet
Accuracy	-	Refer to chapter “Gas Quick Reference” or separate sensor data sheet
Response Time	-	Refer to chapter “Gas Quick Reference” or separate sensor data sheet

2.2.3 Temperature Sensing Performance

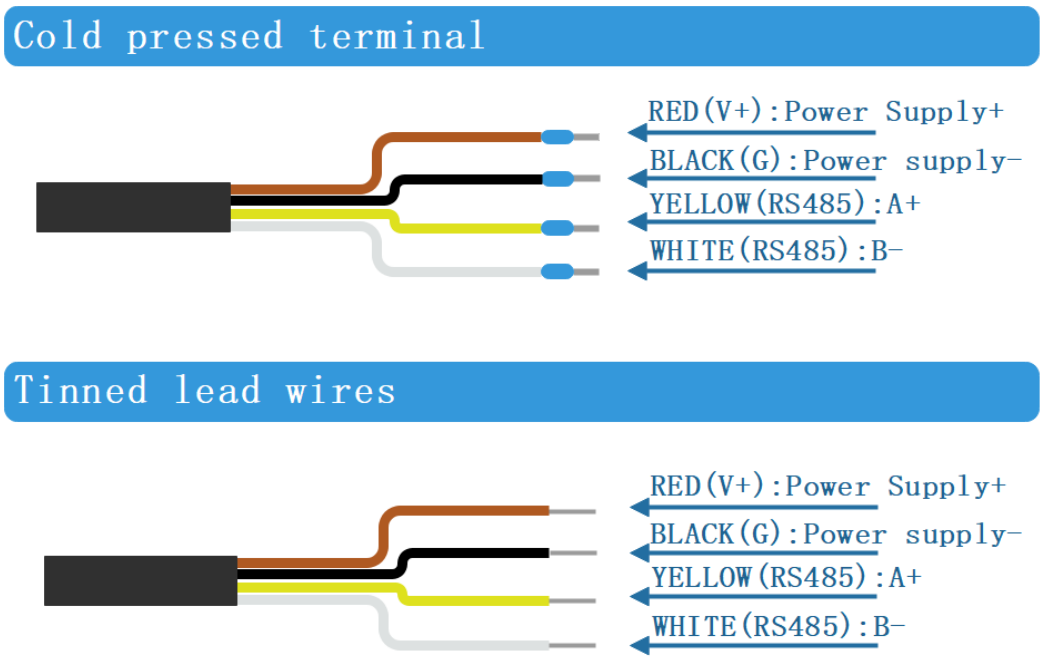
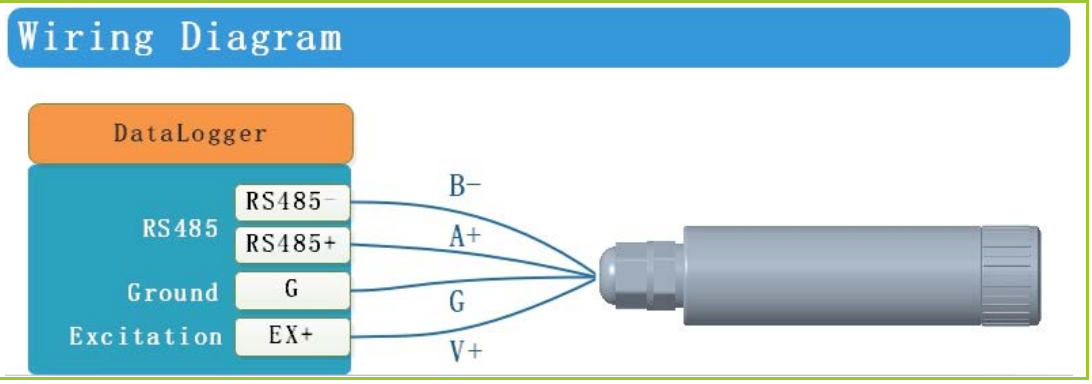
Parameter	Conditions	Value
Temperature measurement range	-	- 40～80 ℃
Resolution	-	0.01℃
Accuracy	typical	± 0.3 ℃
Response time	τ63%	90 s

3 Wiring diagrams

3.1 SDI-12 Interface

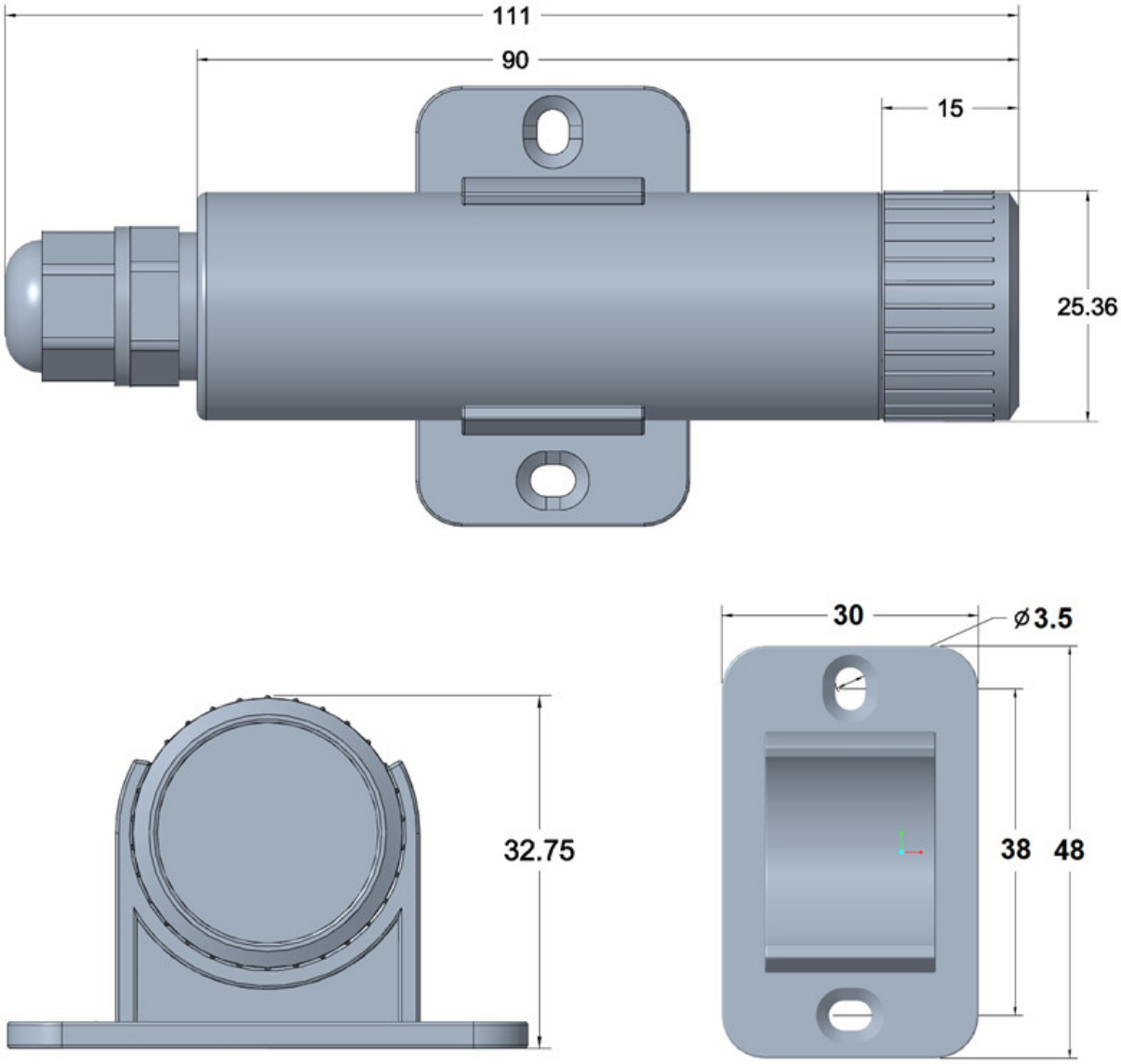
Type	Wiring diagram
SDI-12 Interface	
Connections	

3.2 RS485 Interface

Type	Wiring diagram
RS485 Interface	
Connections	

4 Dimension and Ordering Infomation

4.1 Dimension



Unit: mm

4.2 Ordering Information

Ordering Information		
Parameters	**Code**	**Comments**
Code 1:Product Series	DigiGas-TOXIC	DigiGas-TOXIC, Hazardous Gas Concentration Sensor
Code 2: Gas Type ID	xxxx	Customization
	0001	Ammonia (-100 ppm) [Honeywell Part No.：CLE-1012-401]
	0002	Ammonia (0-500 ppm) [Honeywell Part No.：CLE-1052-400]
	0003	Hydrogen Sulfide (0-100 ppm) [Honeywell Part No.：CLE-0112-400]
	0004	Hydrogen Sulfide (0-1000 ppm) [Honeywell Part No.：CLE-0113-400]
	0005	Carbon Monoxide (0-500 ppm) [Honeywell Part No.：CLE-0052-400]
	0006	Carbon Monoxide (0-2000 ppm) [Honeywell Part No.：CLE-0023-400]
	0007	Nitrogen Dioxide (0-20 ppm) [Honeywell Part No.：CLE-0321-400]
	0008	Nitrogen Dioxide (0-2000 ppm) [Honeywell Part No.：CLE-0323-400]
	0009	Nitric Oxide (0-250 ppm) [Honeywell Part No.：CLE-0522-400]
	0010	Nitric Oxide (0-2000 ppm) [Honeywell Part No.：CLE-0523-400]
	0011	Sulphur Dioxide (0-20 ppm) [Honeywell Part No.：CLE-0421-400]
	0012	Sulphur Dioxide (0-2000 ppm) [Honeywell Part No.：CLE-0423-400]
	0013	Phosphine (0-20 ppm) [Honeywell Part No.：CLE-1121-400]
	0014	Phosphine (0-1000 ppm) [Honeywell Part No.：CLE-1113-400]
	0015	Hydrogen (0-1000 ppm) [Honeywell Part No.：CLE-0613-400]
	0016	Hydrogen (0-40000 ppm) [Honeywell Part No.：CLE-0644-400]
	0017	Ethylene Oxide (0-10 ppm) [Honeywell Part No.：CLE-1212-400]
	0018	Ethylene Oxide (0-100 ppm) [Honeywell Part No.：CLE-1222-400]
	0019	Ethylene Oxide (0-500 ppm) [Honeywell Part No.：CLE-1213-400]
	0020	Hydrogen Cyanide (0-50 ppm) [Honeywell Part No.：CLE-0731-400]
	0021	Methyl Mercaptan (0-10 ppm) [Honeywell Part No.：CLE-3611-400]
	0022	Tetrahydrothiophene (0-50 ppm) [Honeywell Part No.：CLE-3501-400]
	0023	Hydrogen Chloride (0-30 ppm) [Honeywell Part No.：CLE-1431-400]
	0024	Chlorine Dioxide (0-1 ppm) [Honeywell Part No.：CLE-0810-400]
	0025	Chlorine Dioxide (0-50 ppm) [Honeywell Part No.：CLE-0851-400]
	0026	Chlorine (0-10 ppm) [Honeywell Part No.：CLE-0911-400]
	0027	Chlorine (0-50 ppm) [Honeywell Part No.：CLE-0951-400]
	0028	Chlorine (0-200 ppm) [Honeywell Part No.：CLE-0922-400]
	0029	Oxygen (0-30%Non Liquid Electrolyte) [Honeywell Part No.：CLE-0231-40S]
	0030	Oxygen (0-30%) [Honeywell Part No.：CLE-0231-400]
Code 3: Power Supply	A	5-28V DC
	X	Customize
Code 4: Output Interface	A	RS485(Modbus-RTU)
	B	SDI-12

Code 5: Connector	B C	Cold pressed terminal Stripped & tinned lead wires
Code 6: Cable Length	002 XXX	2 Meters Customize, XXX is required cable length (Unit: meter)
Ordering Code Example: DigiGas-TOXIC-0001 A A B 002 Product Series: DigiGas-TOXIC, Hazardous Gas Concentration Sensor; Gas Type ID: Ammonia (0-100 ppm) [Honeywell Part No.: CLE-1012-401]; Power Supply: 5-28V DC Output Interface: RS485(Modbus-RTU); Connector: Cold pressed terminal; Cable Length: 2 Meters		

5 SDI-12 Communication

The sensor has SDI-12 interface and protocol. The description and terms used within this chapter are listed in table below:

Parameters	Unit	Description
±	-	Sign of the value
a	-	SDI-12 address
n	-	Number of measurements (fixed width of 1)
nn	-	Number of measurements with leading zero if necessary (fixed width of 2)
ttt	Seconds	Maximum measurement time (fixed width of 3)
tttt	Seconds	Maximum measurement time (fixed width of 4)
<TAB>	-	Tab character
<SAPCE>	-	Space character
<CR>	-	Carriage return character
<LF>	-	Line feed character
<Checksum>	-	SUM Checksum
<CRC_ADI>		ADI protocol CRC Checksum
<CRC>	-	SDI-12 protocol CRC Checksum
<VERIFY_STATUS>	-	Sensor Verification status
<+Gas>	ppm or % or mg/m3	Gas concentration
<±Temperature>	℃ ℉	Temperature(Original), The value is output based on the temperature unit setting
<±TemperatureCalibed>	℃ ℉	Temperature(Calibrated), The value is output based on the temperature unit setting
<±TOffset>	℃ ℉	Temperature offset, The value is output based on the temperature unit setting Range: -10.00~10.00 Default: 0.00 <±TemperatureCalibed> = <±Temperature> + <±TOffset>
<TemperatureUnit>	℃ ℉	Temperature unit C: Degree Celsius (Default) F: Degree Fahrenheit
<GasType>	-	Gas type ID. Refer to chapter “Gas Quick Reference” or separate sensor data sheet.
<FullRange>	ppm or % or mg/m3	Full range of gas concentration. Refer to chapter “Gas Quick Reference” or separate sensor data sheet.
<DecimalPointNum>	-	The decimal point of the gas concentration value. Refer to chapter “Gas Quick Reference” or separate

		sensor data sheet.
<CalibMethod>	N/A	Gas concentration calibration method 0: Calibrate with sensor sensitivity 1: Calibrate with standard gas
<±Sensitivity>	nA/ppm or nA/1% or nA/mg/m3	The sensitivity of the gas sensor, when the gas concentration calibration method is "Calibrate with sensor sensitivity". Refer to chapter “Gas Quick Reference” or separate sensor data sheet.
<GasCalibZeroValue>	ppm or % or mg/m3	The concentration value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas"
<GasCalibSpanValue>	ppm or % or mg/m3	The concentration value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas"
<GasCalibZeroValueInternalRef>	-	The internal reference value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas"
<GasCalibSpanValueInternalRef>	-	The internal reference value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas"
<TemperatureCompensateEn>	-	Temperature compensation enable for gas concentration 0: Enable 1: Disable
<TCCoef0> ~ <TCCoef12>	%	Temperature compensation coefficient for gas concentration. From -40℃ to 80℃, there is a compensation coefficient every 10℃, totaling 13. Among them: The coefficient @ -40℃ is <TCCoef0>. The coefficient @ -30℃ is <TCCoef1>. ... The coefficient @ +70℃ is <TCCoef11>. The coefficient @ +80℃ is <TCCoef12>. Note: The unit of the values <TCCoef0> to <TCCoef12> is "%". Note: The temperature compensation coefficient can be found in the data sheet of the specific gas sensor.

The following error value will be responded as measurement value when there is error:

Error Value	Description
-9999	Sensor Broken

5.1 SDI-12 Interface and Protocol

5.1.1 SDI-12 Interface

Please refer to SDI-12 standard user manual V1.3.

5.1.2 Protocol

Request	Response	Comment
a!	a<CR><LF> a: Sensor address	**Acknowledge Active** **Example:** Request: 0! Response: 0<CR><LF>
aI!	allccccccccmmmmmmvvvxxxxxxxxxxxxx<CR><LF> a: Sensor address ll:SDI-12 Version Number cccccccc: 8 characters vendor identification mmmmmm: 6 characters specifying the sensor model number vvv: 3 characters specifying the sensor version xxxxxxxxxxxxx: 13 characters serial number <CR><LF>: terminates the response	**Send Identification** **Example:** Request: 0I! Response: 013INFWIN DGGTXC3.2000026012100 0<CR><LF>
?!	a<CR><LF> a: Sensor address	**Sensor Address Query** **Example:** Request: ?! Response: 0<CR><LF>
aAb!	b<CR><LF> a:Current Sensor address b:New Sensor address	**Change Sensor address** **Example:** Request: 0A1! Response: 1<CR><LF>
aM!, aMC!	a0012<CR><LF> a: Sensor address 001: Measurement data will be ready	**Gas concentration, Temperature calibrated Measurement** **Example:**

	in 001 seconds, 2: Number of measurement data returned by aD0! <CR><LF>: terminates the response aD0! Response data format: a<+Gas><±TemperatureCalibed>[<CRC>]<CR><LF>	Request: 0M! Response: 00012<CR><LF> Response: 0<CR><LF> Request: 0D0! Response: 0+6.7+23.33<CR><LF>
aM1!, aMC1!	a0015<CR><LF> a: Sensor address 001: Measurement data will be ready in 001 seconds 5: Number of measurement data returned by aD0! <CR><LF>: terminates the response aD0! Response data format: a<GasType><FullRange><DecimalPointNum><+Gas><±TemperatureCalibed>[<CRC>]<CR><LF>	**Gas Type ID, Full Range, Decimal Point Number, Gas concentration, Temperature calibrated Measurement** **Example:** Request: 0M1! Response: 00015<CR><LF> Response: 0<CR><LF> Request: 0D0! Response: 0+1+100+1+6.7+23.33<CR><LF>
aM2!, aMC2!	a0012<CR><LF> a: Sensor address 001: Measurement data will be ready in 001 seconds 2: Number of measurement data returned by aD0! <CR><LF>: terminates the response aD0! Response data format: a<±TemperatureCalibed><±Temperature>[<CRC>]<CR><LF>	**Temperature Calibed and Temperature Original Measurement** **Example (<±TOffset>=0.00):** Request: 0M2! Response: 00012<CR><LF> Response: 0<CR><LF> Request: 0D0! Response: 0+23.53+23.53<CR><LF>
aC!,aCC! aC1!,aCC1! aC2!,aCC2! aC3!,aCC3! aC4!,aCC4! aC5!,aCC5! aC6!,aCC6! aC7!,aCC7! aC8!,aCC8!	This command set has the same data format as aM!, aMC!, aMx!, aMCx! (x=1-9), refer to the corresponding command.	This command set has the same data format as aM!, aMC!, aMx!, aMCx! (x=1-9), refer to the corresponding command. The only difference is that data response has no SDI-12 service request output compared to aM!, aMC!, aMx!, aMCx! Command.

aC9!,aCC9!		
aV!	a0011<CR><LF> a: Sensor address 001: Measurement data will be ready in 001 seconds 1: Number of measurement data <CR><LF>: terminates the response aD0! Response data format: a<VERIFY_STATUS><CR><LF>	**Sensor Verification Command** **Example:** Request: 0V! Response: 00011<CR><LF> Response: 0<CR><LF> Request: 0D0! Response: 0+0<CR><LF>, “+0” indicate sensor normal, “+1” means sensor error.
aD0! aD1! aD2!	[<svvvv><svvvv><svvvv>…][<CRC>]<CR><LF> [<svvvv>]: data value [<CRC>]: Optional 3 characters CRC checksum, <CR><LF>:terminates the response	Send Data since the last aM, aMC, aC, aCC, aV command, The data returned depends on the command sent most recently.
aR0!, aRC0!	Response data format: a<+Gas><±TemperatureCalibed>[<CRC>]<CR><LF>	**Gas concentration, Temperature calibrated Measurement** **Example:** Request: 0R0! Response: 0+6.7+23.33<CR><LF>
aR1!, aRC1!	Response data format: a<GasType><FullRange><DecimalPointNum><+Gas><±TemperatureCalibed>[<CRC>]<CR><LF>	**Gas Type ID, Full Range, Decimal Point Number, Gas concentration, Temperature calibrated Measurement** **Example:** Request: 0R1! Response: 0+1+100+1+6.7+23.33<CR><LF>
aR2!, aRC2!	Response data format: a<±TemperatureCalibed><±Temperature>[<CRC>]<CR><LF>	**Temperature Calibed and Temperature Original Measurement** **Example (<±TOffset>=0.00):** Request: 0R2! Response: 0+23.53+23.53<CR><LF>
aXR_TUNIT!	aTUNIT=<TemperatureUnit><CR><LF> <TemperatureUnit> is temperature unit: C: degrees Centigrade F: degrees Fahrenheit	**Query temperature unit** **Example:** Request: 0XR_TUNIT! Response: 0TUNIT=C<CR><LF>
aXW_TUNIT_	aTUNIT=<TemperatureUnit><CR><	**Configure temperature unit**

<TemperatureUnit>!	LF>	**Example:** Request: 0XW_TUNIT_C! Response: 0TUNIT=C<CR><LF>
aXR_TOffset!	aTOffset=<±TOffset><CR><LF> <±TOffset>: Temperature offset value. Range: -10.00~10.00, Default: 0.00, The offset value will be applied from the next measurement command. <±TemperatureCalibed> = <±Temperature> + <±TOffset>	**Query temperature offset value** **Example:** Request: 0XR_TOffset! Response: 0TOffset=+1.00<CR><LF>
aXW_TOffset_<±TOffset>!	aTOffset=<±TOffset><CR><LF>	**Configure temperature offset value** **Example:** Request: 0XW_TOffset_+1.00! Response: 0TOffset=+1.00<CR><LF>
aXR_CALMETHOD!	aCALMETHOD=<CalibMethod><CR><LF> <CalibMethod> Gas concentration calibration method. **0: Calibrate with sensor sensitivity.** If the specific Sensitivity value of the sensor is known, the sensitivity calibration of the sensor can be carried out by setting the parameter <±Sensitivity>. **1: Calibrate with standard gas.** Two-point calibration is carried out using standard gas. For instance, 0ppm is selected as the standard gas for zero calibration and 100ppm as the standard gas for span calibration to calibrate the sensor. Refer to the parameter <GasCalibZeroValue> for zero Calibration and <GasCalibSpanValue> for span calibration.	**Query Gas concentration calibration method** **Example:** Request: 0XR_CALMETHOD! Response: 0CALMETHOD=0<CR><LF>
aXW_CALMETHOD_<CalibMethod>!	aCALMETHOD=<CalibMethod><CR><LF>	**Configure Gas concentration calibration method** **Example:** Request: 0XW_CALMETHOD_0! Response: 0CALMETHOD=0<CR><LF>
aXR_SENSITIVITY!	aSENSITIVITY=<±Sensitivity><CR><LF> <±Sensitivity>：The sensitivity of	**Query sensitivity of the gas sensor** **Example:**

	the gas sensor when the gas concentration calibration method is "Calibrate with sensor sensitivity". Range: -32768~32767 Unit： nA/ppm or nA/1% or nA/mg/m3 Please Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	Request: 0XR_SENSITIVITY! Response: 0SENSITIVITY=+135<CR><LF>
aXW_SENSITIVITY_<±Sensitivity>!	aSENSITIVITY=<±Sensitivity><CR><LF>	**Configure sensitivity of the gas sensor** **Example:** Request: 0XW_SENSITIVITY_135! Response: 0SENSITIVITY=+135<CR><LF>
aXW_CALZERO_<GasCalibZeroValue>!	aCALZERO=<GasCalibZeroValue>,<GasCalibZeroValueInternalRef><CR><LF> <GasCalibZeroValue>: The concentration value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas". <GasCalibZeroValueInternalRef>: The internal reference value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas".	**Zero Calibration** **Example: In this example, the concentration value of the standard gas used for zero calibration is 0 ppm** Request: 0XW_CALZERO_0! Response: 0CALZERO=0,0.00<CR><LF>
aXW_CALSPAN_<GasCalibSpanValue>!	aCALSPAN=<GasCalibSpanValue>,<GasCalibSpanValueInternalRef><CR><LF> <GasCalibSpanValue>: The concentration value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas". <GasCalibSpanValueInternalRef>: The internal reference value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard	**Span Calibration** **Example: In this example, the concentration value of the standard gas used for span calibration is 100 ppm** Request: 0XW_CALSPAN_100! Response: 0CALSPAN=100,380.00<CR><LF>

	gas"	
aXR_CAL!	aCAL=<GasCalibZeroValue>,<GasCalibSpanValue>,<GasCalibZeroValueInternalRef>,<GasCalibSpanValueInternalRef><CR><LF>	**Query Zero and Span calibration value and internal reference value.** **Example:** Request: 0XR_CAL! Response: 0CAL=0,100,0.00,380.00<CR><LF>
aXW_RESETCALIB!	aRESETCALIB=0<CR><LF> Reset the calibration data, including: <±Sensitivity> <GasCalibZeroValue> <GasCalibSpanValue> <TCCoef0> ~ <TCCoef12>	**Reset the gas calibration value to factory default.** **Example:** Request: aXW_RESETCALIB! Response: 0RESETCALIB=0<CR><LF>
aXW_RESETSYSTEM!	aRESETSYSTEM=0<CR><LF> Equivalent to powering on.	**Restart the sensor** **Example:** Request: 0XW_RESETSYSTEM! Response: 0 RESETSYSTEM=0<CR><LF>
aXR_TCOMPEN!	aTCOMPEN=<TemperatureCompensateEn><CR><LF> <TemperatureCompensateEn>: Temperature compensation enable for gas concentration 0: Enable 1: Disable After enabling temperature compensation, the sensor will perform temperature compensation for the gas concentration output according to the set temperature coefficient.	**Query Temperature compensation enable for gas concentration** **Example:** Request: 0XR_TCOMPEN! Response: 0TCOMPEN=0<CR><LF>
aXW_TCOMPEN_<TemperatureCompensateEn>!	aTCOMPEN=<TemperatureCompensateEn><CR><LF>	**Configure Temperature compensation enable for gas concentration** **Example:** Request: 0XW_TCOMPEN_0! Response: 0TCOMPEN=0<CR><LF>
aXR_TCC!	aTCC=<TCCoef0>,<TCCoef1>,<TCCoef2>,<TCCoef3>,<TCCoef4>,<TCCoef5>,<TCCoef6>,<TCCoef7>,<TCCoef8>,<TCCoef9>,<TCCoef10>,<TCCoef11>,<TCCoef12><CR><LF>	**Query Temperature compensation coefficient for gas concentration.** **Example:** Request: 0XR_TCC! Response:

	<TCCoef0> ~ <TCCoef12>: Temperature compensation coefficient for gas concentration. From -40℃ to 80℃, there is a compensation coefficient every 10℃, totaling 13. Among them: The coefficient @ -40℃ is <TCCoef0>. The coefficient @ -30℃ is <TCCoef1>. ... The coefficient @ +70℃ is <TCCoef11>. The coefficient @ +80℃ is <TCCoef12>. **Note: The unit of the values <TCCoef0> to <TCCoef12> is "%".** **Note: The temperature compensation coefficient can be found in the data sheet of the specific gas sensor.**	0TCC=88,90,92,94,96,98,100,102,104,106,108,110,112<CR><LF> In which: The coefficient @ -40℃ is 88%; The coefficient @ -30℃ is 90%; The coefficient @ -20℃ is 92%; The coefficient @ -10℃ is 94%; The coefficient @ 0℃ is 96%; The coefficient @ +10℃ is 98%; The coefficient @ +20℃ is 100%; The coefficient @ +30℃ is 102%; The coefficient @ +40℃ is 104%; The coefficient @ +50℃ is 106%; The coefficient @ +60℃ is 108%; The coefficient @ +70℃ is 110%; The coefficient @ +80℃ is 112%;
aXW_TCC_<TCCoef0>,<TCCoef1>,<TCCoef2>,<TCCoef3>,<TCCoef4>,<TCCoef5>,<TCCoef6>,<TCCoef7>,<TCCoef8>,<TCCoef9>,<TCCoef10>,<TCCoef11>,<TCCoef12>!	aTCC=<TCCoef0>,<TCCoef1>,<TCCoef2>,<TCCoef3>,<TCCoef4>,<TCCoef5>,<TCCoef6>,<TCCoef7>,<TCCoef8>,<TCCoef9>,<TCCoef10>,<TCCoef11>,<TCCoef12><CR><LF>	**Configure Temperature compensation coefficient for gas concentration.** **Example:** Request: 0XW_TCC_88,90,92,94,96,98,100,102,104,106,108,110,112! Response: 0TCC=88,90,92,94,96,98,100,102,104,106,108,110,112<CR><LF>
aXR_SN!	aSN=<ssssssss><CR><LF> <ssssssss> is 8-digits serial number	**Query serial number** **Example:** Request: 0XR_SN! Response: 0SN=12345678<CR><LF>
aXW_SN_<ssssssss>!	aSN=<ssssssss><CR><LF>	**Configure serial number** **Example:** Request: 0XW_SN_ABCDEFGH! Response: 0SN=ABCDEFGH <CR><LF>

6 RS485 Communication

6.1 Modbus Protocol

Modbus Protocol is widely used to establish master-slave communication between intelligent devices or sensors. A MODBUS message sent from a master to a slave contains the address of the slave, the function code (e.g. 'read register' or 'write register'), the data, and a check sum (LRC or CRC).

The sensor is RS485 interface with Modbus protocol. The default serial communication settings is slave address 1, modbus rtu, 9600bps, 8 databits and 1 stop bit. All communication settings can be changed with modbus command, and take effective after re-power up the sensor.

Following modbus function code are supported by sensor.

Modbus Function Code 0x03 : used for reading holding register.

Modbus Function Code 0x04 : used for reading input register.

Modbus Function Code 0x06 : used for writing single holding register.

Modbus Function Code 0x10: used for writing multiple holding register.

6.2 Modbus Register

Parameters	Register Addr. (HEX/DEC)	Data Type	Modbus Function Code(DEC)	Range and Comments	Default Value
Gas Type ID <GasType>	0x0000 /0	UINT16 RO	3/4	Gas Type ID. Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	N/A
Gas Concentration Full Range <FullRange>	0x0001 /1	UINT16 RO	3/4	Full range of gas concentration. Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	N/A
The decimal places of the gas concentration value <DecimalPointNum>	0x0002 /2	UINT16 RO	3/4	0-2; The decimal point of the gas concentration value, Refer to chapter “Gas Quick Reference” or	N/A

				separate sensor data sheet.	
Gas Concentration <Gas>	0x0003 /3	UINT16 RO	3/4	0-65535; Convert to physical value of the concentration based on the decimal place. The decimal place can be found in chapter "Gas Quick Reference" or separate sensor data sheet. User can also get the decimal place in register <DecimalPointNum>.	N/A
Temperature(Calibrated) <TemperatureCalibed>	0x0004 /4	INT16 RO	3/4	-4000-8000 indicates -40.00-80.00 (℃); -4000-17600 indicates -40.00-176.00 (℉)	N/A
RESERVED	0x0005 /5	INT16 RO	3/4	Reserved	0
RESERVED	0x0006 /6	INT16 RO	3/4	Reserved	0
RESERVED	0x0007 /7	INT16 RO	3/4	Reserved	0
RESERVED	0x0008 /8	INT16 RO	3/4	Reserved	0
RESERVED	0x0009 /9	INT16 RO	3/4	Reserved	0
RESERVED	0x000A /10	INT16 RO	3/4	Reserved	0
RESERVED	0x000B /11	INT16 RO	3/4	Reserved	0
RESERVED	0x000C /12	INT16 RO	3/4	Reserved	0
RESERVED	0x000D /13	INT16 RO	3/4	Reserved	0
RESERVED	0x000E /14	INT16 RO	3/4	Reserved	0
RESERVED	0x000F /15	INT16 RO	3/4	Reserved	0

Temperature Unit <TemperatureUnit>	0x0020 /32	UINT16 R/W	3/6/16	0: ℃ 1: ℉	0
Temperature Offset <±TOffset>	0x0021 /33	INT16 R/W	3/6/16	-1000～1000 indicates -10.00～10.00℃	0
Floating Point Register Byte Order <FloatByteOrder>	0x0022 /34	INT16 R/W	3/6/16	Configure floating point register byte order. 0: Big-endian [ABCD] 1: Little-endian[DCBA] 2: Big-endian byte swap [BADC] 3: Little-endian byte swap[CDAB]	3
Temperature compensation enable for gas <TemperatureCompensateEn>	0x0023 /35	UINT16 R/W	3/6/16	0: Enable 1: Disable	0
Gas concentration calibration method <CalibMethod>	0x0030 /48	UINT16 R/W	3/6/16	0: Calibrate with sensor sensitivity 1: Calibrate with standard gas	0
The sensitivity of the gas sensor when the gas <±Sensitivity>	0x0031 /49	INT16 R/W	3/6/16	Range: -32768~32767; Unit: nA/ppm or nA/1% or nA/mg/m3; The sensitivity of the gas sensor when the gas, concentration calibration method is "Calibrate with sensor sensitivity"	N/A
The concentration value of the standard gas used for zero calibration <GasCalibZeroValue>	0x0040 /64	UINT16 R/W	3/6/16	The concentration value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas"	N/A
The concentration value of the standard gas used for span calibration, when the	0x0041 /65	UINT16 R/W	3/6/16	The concentration value of the standard gas used for span calibration, when the gas concentration	N/A

gas concentration <GasCalibSpanValue>				calibration method is "Calibrate with standard gas"	
The internal reference value of the standard gas used for zero calibration <GasCalibZeroValueInternalRef>	0x0042 /66	UINT16 RO	3/6/16	The internal reference value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas"	N/A
The internal reference value of the standard gas used for span calibration <GasCalibSpanValueInternalRef>	0x0043 /67	UINT16 RO	3/6/16	The internal reference value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas"	N/A
Reset the gas calibration value to factory default <ResetCalib>	0x0050 /80	UINT16 R/W	3/6/16	The reading value is 0. Writing 0xFFFF to reset calibration data.	N/A
Restart the sensor <ResetSystem>	0x0051 /81	UINT16 R/W	3/6/16	The read value is 0; Writing 0xFFFF to restart the sensor (equivalent to repowering on).	N/A
Temperature compensation coefficient <TCCoef0>	0x0060 / 96	UINT16 R/W	3/6/16	The coefficient @ -40℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef1>	0x0061 / 97	UINT16 R/W	3/6/16	The coefficient @ -30℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef2>	0x0062 / 98	UINT16 R/W	3/6/16	The coefficient @ -20℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient	0x0063 / 99	UINT16 R/W	3/6/16	The coefficient @ -10℃; 0-500 indicates 0%-500%.	N/A

<TCCoef3>					
Temperature compensation coefficient <TCCoef4>	0x0064 / 100	UINT16 R/W	3/6/16	The coefficient @ 0℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef5>	0x0065 / 101	UINT16 R/W	3/6/16	The coefficient @ +10℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef6>	0x0066 / 102	UINT16 R/W	3/6/16	The coefficient @ +20℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef7>	0x0067 / 103	UINT16 R/W	3/6/16	The coefficient @ +30℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef8>	0x0068 / 104	UINT16 R/W	3/6/16	The coefficient @ +40℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef9>	0x0069 / 105	UINT16 R/W	3/6/16	The coefficient @ +50℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef10>	0x006A / 106	UINT16 R/W	3/6/16	The coefficient @ +60℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef11>	0x006B / 107	UINT16 R/W	3/6/16	The coefficient @ +70℃; 0-500 indicates 0%-500%.	N/A
Temperature compensation coefficient <TCCoef12>	0x006C / 108	UINT16 R/W	3/6/16	The coefficient @ +80℃; 0-500 indicates 0%-500%.	N/A
Modbus Slave Address <SlaveAddress>	0x0200 /512	UINT16 R/W	3/6/16	1-255	1

RS485 baudrate <Baudrate>	0x0201 /513	UINT16 R/W	3/6/16	0-5 0: 1200bps 1: 2400bps 2: 4800bps 3: 9600bps 4: 19200bps 5: 38400bps	3: 9600bps
RS485 Protocol <Protocol>	0x0202 /514	UINT16 R/W	3/6/16	0 0: Modbus RTU	0: Modbus RTU
RS485 parity <Parity>	0x0203 /515	UINT16 R/W	3/6/16	0-2 0: NONE 1: EVEN 2: ODD	0: NONE
RS485 data bits <DataBits>	0x0204 /516	UINT16 R/W	3/6/16	1 1: 8 bits	1: 8 bits
RS485 Stopbits <StopBits>	0x0205 /517	UINT16 R/W	3/6/16	0-1 0: 1 stopbit 1: 2 stopbits	0: 1 stopbit
Reserved	0x0206 /518	UINT16 R/W	3/6/16	Reserved	0
Reserved	0x0207 /519	UINT16 R/W	3/6/16	Reserved	0
User Defined Serial Number USERSN	0x0220 /544 0x0221 /545 0x0222 /546 0x0223 /547	UINT16 R/W	3/16	0x0000000000000000- 0xFFFFFFFFFFFFFFFF Those four registers should be read/write in one command.	N/A
Gas Type ID <GasType_Float>	0x1000 /4096	FLOAT RO	3/4	Gas Type ID, Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	N/A
Gas Concentration Full Range <FullRange_Float>	0x1002 /4098	FLOAT RO	3/4	Full range of gas concentration, Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	N/A
The decimal places of the gas concentration	0x1004 /4100	FLOAT RO	3/4	0-2; The decimal point of the	N/A

value <DecimalPointNum_Float>				gas concentration value, Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	
Gas Concentration <Gas_Float>	0x1006 /4102	FLOAT RO	3/4	0-65535; Gas concentration	N/A
Temperature(Calibrated) <TemperatureCalibed_Float>	0x1008 /4104	FLOAT RO	3/4	-40.00-80.00 (℃) -40.00-176.00 (℉)	N/A
Reserved_FLOAT	0x100A /4106	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x100C /4108	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x100E /4110	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x1010 /4112	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x1012 /4114	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x1014 /4116	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x1016 /4118	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x1018 /4120	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x101A /4122	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x101C /4124	FLOAT RO	3/4	Reserved	0
Reserved_FLOAT	0x101E /4126	FLOAT RO	3/4	Reserved	0

UINT16:16 bit unsigned integer

INT16:16bit signed integer

RO: Register is Read Only

R/W: Register is Read/Write

HEX: Hexadecimal (data with 0x/0X prefix)

DEC: Decimal

FLOAT: Floating point register, the byte order is configured by “Floating Point Register Byte Order,

FloatByteOrder" register. Please refer to "Modbus Register Detail Description" for more details.

The register value will be set as following when there is sensor error:

Error Value	Register Address	Error
65535	Gas Concentration value	sensor broken
65535	Temperature value	sensor broken

6.3 Modbus Register Detail Descripton

GasType：Gas Type ID，UINT16 GasType_Float：Gas Type ID，FLOAT		
Range	Gas Type ID, Refer to chapter "Gas Quick Reference" or separate sensor data sheet.	Default: N/A
Parameter Save	N/A	

FullRange：Full range of gas concentration，UINT16 FullRange_Float：Full range of gas concentration，FLOAT		
Range	Full range of gas concentration, Refer to chapter "Gas Quick Reference" or separate sensor data sheet.	Default: N/A
Parameter Save	N/A	

DecimalPointNum：The decimal point of the gas concentration value，UINT16 DecimalPointNum_Float：The decimal point of the gas concentration value，FLOAT		
Range	The decimal point of the gas concentration value, Refer to chapter "Gas Quick Reference" or separate sensor data sheet.	Default: N/A
Parameter Save	N/A	

Note: It is used to convert the value reading from the integer register "Gas Concentration (Gas)" into the physical value of gas concentration. For example, when the reading value of the "Gas Concentration" register is 1000:
(1) If the decimal point of the gas concentration value is 0, then the physical value of the gas concentration 1000
(2) If the decimal point of the gas concentration value is 1, then the "physical value of the gas concentration is 1000/10=100.0
(3) If the decimal point of the gas concentration (register "DecimalPointNum") value is 2, then the "physical value of the gas concentration is 1000/100=10.00

Note: User can obtain the number of decimal point either through this register, or refer to chapter "Gas Quick Reference" or separate sensor data sheet.

Gas：Gas Concentration，UINT16		
Range	0-65535;	Default: N/A

	Convert to physical value of the concentration based on the decimal place. The decimal place can be found in chapter “Gas Quick Reference” or separate sensor data sheet. User can also get the decimal place in register <DecimalPointNum>.	
Parameter Save	N/A	

Note: User can convert the reading value of this register into physical value. For example, when the reading value of the "Gas Concentration" register is 1000:
(1) If the decimal point of the gas concentration (register “DecimalPointNum”) value is 0, then the physical value of the gas concentration 1000
(2) If the decimal point of the gas concentration (register “DecimalPointNum”) value is 1, then the "physical value of the gas concentration is 1000/10=100.0
(3) If the decimal point of the gas concentration (register “DecimalPointNum”) value is 2, then the "physical value of the gas concentration is 1000/100=10.00

Gas_Float：Gas Concentration，FLOAT		
Range	The physical value of gas concentration data, no conversion required.	Default: N/A
Parameter Save	N/A	

Note: The byte order is configured by “Floating Point Register Byte Order, FloatByteOrder” register.

TemperatureCalibed: Temperature(Calibrated), INT16 Temperature: Temperature(Original), INT16		
Range	-4000-12500 indicates -40.00-125.00 (Temperature Unit set to ℃); -4000-25700 indicates -40.00-257.00 (Temperature Unit set to ℉)	Default: N/A
Parameter Save	N/A	

Note: Temperature measurement value

TemperatureCalibed_Float: Temperature(Calibrated), FLOAT Temperature_Float: Temperature(Original), FLOAT		
Range	-40.00-125.00 (Temperature Unit set to ℃); -40.00-257.00 (Temperature Unit set to ℉)	Default: N/A
Parameter Save	N/A	

Note: Temperature measurement value. The byte order is configured by “Floating Point Register Byte Order, FloatByteOrder” register.

TemperatureUnit: Temperature Unit, UINT16		
Range	0: ℃ 1: ℉	Default: 0

Parameter Save	YES	

Note: Temperature Unit.

TOffset: Temperature Offset, INT16		
Range	-1000～1000 indicates -10.00～10.00℃	Default: 0
Parameter Save	YES	

Note: Temperature Offset.

TemperatureCalibed = Temperature + TOffset;

TemperatureCalibed_Float = Temperature_Float + TOffset / 100.00;

FloatByteOrder：Floating Point Register Byte Order, INT16		
Range	0: Big-endian [ABCD] 1: Little-endian[DCBA] 2: Big-endian byte swap [BADC] 3: Little-endian byte swap[CDAB]	Default: 3
Parameter Save	YES	

Note: Configure floating point register byte order.

Example: The 123456.00 in IEC754 is 0x47F12000 (A=47, B=F1, C=20, D=00), then

0: Big-endian [ABCD]

1: Little-endian[DCBA]

2: Big-endian byte swap [BADC]

3: Little-endian byte swap[CDAB]

TemperatureCompensateEn：Temperature compensation enable for gas，UINT16		
Range	0: Enable 1: Disable	Default: 0
Parameter Save	Immediate	

Note: When enabled, the sensor will perform temperature compensation for the gas concentration output according to the set temperature coefficient.

CalibMethod：Gas concentration calibration method，UINT16		
Range	Gas concentration calibration method. **0: Calibrate with sensor sensitivity.** If the specific Sensitivity value of the sensor is known, the sensitivity calibration of the sensor can be carried out by setting the parameter <±Sensitivity>. **1: Calibrate with standard gas.**	Default: 0

	Two-point calibration is carried out using standard gas. For instance, 0ppm is selected as the standard gas for zero calibration and 100ppm as the standard gas for span calibration to calibrate the sensor. Refer to the parameter <GasCalibZeroValue> for zero Calibration and <GasCalibSpanValue> for span calibration.	
Parameter Save	Immediate	

Sensitivity：The sensitivity of the gas sensor，INT16		
Range	Range: -32768~32767 Unit：nA/ppm or nA/1% or nA/mg/m3 The sensitivity of the gas sensor when the gas concentration calibration method is "Calibrate with sensor sensitivity". Refer to chapter “Gas Quick Reference” or separate sensor data sheet.	Default: 0
Parameter Save	Immediate	

GasCalibZeroValue：The concentration value of the standard gas used for zero calibration，UINT16		
Range	The concentration value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas". When calibrating, place the sensor in zero point standard gas. Once the data reading stabilizes, write the gas concentration value, such as 0 (ppm) or 0 (%), into this register.	Default: N/A
Parameter Save	Immediate	

GasCalibSpanValue：The concentration value of the standard gas used for span calibration，UINT16		
Range	The concentration value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas". When calibrating, place the sensor in span point standard gas. Once the data reading stabilizes, write the gas concentration value, such as 100 (ppm) or 100 (%), into this register.	Default: N/A
Parameter Save	Immediate	

GasCalibZeroValueInternalRef：The internal reference value of the standard gas used for zero calibration，INT16		
Range	The internal reference value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas".	Default: N/A
Parameter Save	Immediate	

GasCalibSpanValueInternalRef：The internal reference value of the standard gas used for span calibration，INT16		
Range	The internal reference value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas".	Default: N/A
Parameter Save	Immediate	

TCCoef0~ TCCoef12：Temperature compensation coefficient for gas concentration，UINT16		
Range	0-500 indicates 0%-500%. From -40℃ to 80℃, there is a compensation coefficient every 10℃, totaling 13. Among them: The coefficient @ -40℃ is <TCCoef0>. The coefficient @ -30℃ is less than TCCoef1. ... The coefficient @ +70℃ is <TCCoef11>. The coefficient @ +80℃ is <TCCoef12>. Note: The unit of the values <TCCoef0> to <TCCoef12> is "%". Note: The temperature compensation coefficient can be found in chapter “Gas Quick Reference” or separate sensor data sheet.	Default: N/A
Parameter Save	Immediate	

ResetCalib：Reset the gas calibration value to factory default，UINT16		
Range	The reading value is 0. Writing 0xFFFF to reset calibration data. Following register will be reset to factory default: <±Sensitivity> <GasCalibZeroValue>	Default: N/A

	<GasCalibSpanValue> <TCCoef0> ~ <TCCoef12>	
Parameter Save	Immediate	

ResetSystem：Restart the sensor，UINT16		
Range	The read value is 0; Writing 0xFFFF to restart the sensor (equivalent to repowering on).	Default: N/A
Parameter Save	Immediate	

SlaveAddress: Modbus Slave Address, UINT16		
Data Range	1-255 Note: 0 is modbus broadcast address.	Default: 1
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

Baudrate: Serial Comm Baudrate, UINT16		
Data Range	0-5 0:1200bps 1:2400bps 2:4800bps 3:9600bps 4:19200bps 5:38400bps	Default: 3
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

Protocol: Serial Comm Protocol, UINT16		
Data Range	0 0:Modbus RTU	Default: 0
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

Parity: Serial Comm Parity, UINT16		
Data Range	0-2 0:NONE	Default: 0

	1:EVEN 2:ODD	
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

DataBits: Serial Comm Databits, UINT16		
Data Range	1 1:8 databits	Default: 1
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

StopBits: Serial Comm Stopbits, UINT16		
Data Range	0-1 0:1 stopbit 1:2 stopbits	Default: 0
Parameter Storage	YES	

Note: Please power up the sensor to take effective after set.

USER_SN--- User Serial Number		
Data Range	0x0000000000000000-0xFFFFFFFFFFFFFFFF User Serial Number. These four registers should be read and write together from start address 0x0220 with quantity 4.	Default: N/A
Parameter Storage	YES	

7 Calibration and Temperature Compensation

7.1 Calibrate With Sensor Sensitivity

Calibrate by setting the sensitivity of the electrochemical gas sensor. If the specific sensitivity of the electrochemical gas sensor is known, a command can be used to set this sensitivity into the sensor for output calibration.

7.1.1 SDI-12 Interface

Calibration is performed by setting the sensitivity of the sensor, where "a" is the SDI-12 address of the sensor:

Steps	Comment	SDI-12 Command
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with sensor sensitivity".	Request：aXW_CALMETHOD_0!
Step 2: Set the sensor sensitivity	If the specific Sensitivity value of the sensor is known, the sensitivity calibration of the sensor can be carried out by setting the parameter <±Sensitivity>. Please refer to chapter “Gas Quick Reference” or separate sensor data sheet for sensitivity value.	Request：aSENSITIVITY=<±Sensitivity><CR><LF> In which, the sensitivity of the gas sensor when the gas, concentration calibration method is "Calibrate with sensor sensitivity". Range：-32768~32767 Unit：nA/ppm or nA/1% or nA/mg/m3

The following is the calibration of the Ammonia sensor (with a range of 100 ppm). The calibration process is as follows:

Steps	Comment	SDI-12 Command
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with sensor sensitivity".	Request：aXW_CALMETHOD_0!
Step 2:	Check the data sheet of the	Request：aXW_SENSITIVITY_135!

Set the sensor sensitivity	electrochemical sensor. For Honeywell's Ammonia sensor with part number CLE-1012-401, its sensitivity is 0.135±0.035 uA/ppm. Typical value is converted to 135nA/ppm, then set <±Sensitivity> as 135.	

7.1.2 RS485 Interface

Calibration is performed by setting the sensitivity of the sensor:

Steps	Comment	Operation
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with sensor sensitivity".	Write 0 to register <CalibMethod> , “Gas concentration calibration method”.
Step 2: Set the sensor sensitivity	If the specific Sensitivity value of the sensor is known, the sensitivity calibration of the sensor can be carried out by setting the parameter <±Sensitivity>. Please refer to chapter “Gas Quick Reference” or separate sensor data sheet for sensitivity value.	Write sensitivity to register <±Sensitivity>, “The sensitivity of the gas sensor” Range：-32768~32767 Unit：nA/ppm or nA/1% or nA/mg/m3

The following is the calibration of the Ammonia sensor (with a range of 100 ppm). The calibration process is as follows:

Steps	Comment	Operation
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with sensor sensitivity".	Write 0 to register <CalibMethod> , “Gas concentration calibration method”.
Step 2: Set the sensor sensitivity	Check the data sheet of the electrochemical sensor. For Honeywell's Ammonia sensor with part number CLE-1012-401, its sensitivity is 0.135±0.035 uA/ppm. Typical value is converted to 135nA/ppm, then set <±Sensitivity> as 135.	Write 135 to register <±Sensitivity>, “The sensitivity of the gas sensor”

7.2 Calibrate with standard gas

Span calibration involves exposing the sensor to a known concentration of the target gas and adjusting the sensor's output to match this concentration. This process ensures that the sensor's accurately measuring the gas concentration in the operational range.

Generally speaking, the sensor is exposed to two types of gases, the first with no target gas (Zero Calibration) and the second with a known amount of target gas (Span Calibration).

For the first step (Zero Calibration), the sensor is exposed to inert gas like nitrogen or argon with zero amount of the target gas. For example, if a sensor is made to detect ammonia gas, it will give a 0 ppm reading for it, and this reading will be stored in the memory chip of the sensor.

For the second step (Span Calibration), the sensor is exposed to a known amount of target gas. Usually, the highest amount the sensor is rated to test. A 100 ppm ammonia sensor is exposed to 100 ppm ammonia gas, and again this reading is saved in the sensor's memory.

Once these two readings are stored on the sensor, the sensor can detect a linear response to the gas concentration between the two points.

7.2.1 SDI-12 Interface

Calibrate the sensor by exposing it in the standard gas of zero and span, where "a" is the SDI-12 address of the sensor:

Steps	Comment	SDI-12 Command
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with standard gas".	Request: aXW_CALMETHOD_1!
Step 2: Zero calibration	The sensor is exposed to inert gases such as nitrogen or argon with zero amount of the target gas. And wait for the reading to stabilize.	Request: aXW_CALZERO_<GasCalibZeroValue>! In which, <GasCalibZeroValue> isthe concentration value of the standard gas used for zero calibration, when the gas concentration calibration method is "Calibrate with standard gas"
Step 3: Span calibration	The sensor is exposed to a known amount of the target gas. Generally, the maximum rated test quantity of a	Request: aXW_CALSPAN_<GasCalibSpanValue>!

	sensor. And wait for the reading to stabilize.	In which, <GasCalibSpanValue> is the concentration value of the standard gas used for span calibration, when the gas concentration calibration method is "Calibrate with standard gas"

The following is the calibration of the Ammonia sensor (with a range of 100 ppm). The calibration process is as follows:

Steps	Comment	SDI-12 Command
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with standard gas".	Request: aXW_CALMETHOD_1!
Step 2: Zero calibration	The sensor is exposed to air free of Ammonia (0 ppm). And wait for the reading to stabilize.	Request: aXW_CALZERO_0!
Step 3: Span calibration	The sensor was exposed to 100 ppm of Ammonia gas. And wait for the reading to stabilize.	Request: aXW_CALSPAN_100!

7.2.2 RS485 Interface

The following is the calibration of the Ammonia sensor (with a range of 100 ppm). The calibration process is as follows:

Steps	Comment	Operation
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with standard gas".	Write 1 to register <CalibMethod>, “Gas concentration calibration method”.
Step 2: Zero calibration	The sensor is exposed to inert gases such as nitrogen or argon with zero amount of the target gas. And wait for the reading to stabilize.	Write the concentration value of the standard gas used for zero calibration to the register <GasCalibZeroValue>
Step 3: Span calibration	The sensor is exposed to a known amount of the target gas. Generally, the maximum rated test quantity of a sensor. And wait for the reading to stabilize.	Write the concentration value of the standard gas used for span calibration to the register <GasCalibSpanValue>

The following is the calibration of the Ammonia sensor (with a range of 100 ppm). The calibration process is as follows:

Steps	Comment	Operation
Step 1: Set the gas concentration calibration method.	Set the gas concentration calibration method to "Calibrate with standard gas".	Write 1 to register <CalibMethod>, “Gas concentration calibration method”.
Step 2: Zero calibration	The sensor is exposed to air free of Ammonia (0 ppm). And wait for the reading to stabilize.	Write 0 to the register <GasCalibZeroValue>
Step 3: Span calibration	The sensor was exposed to 100 ppm of Ammonia gas. And wait for the reading to stabilize.	Write 100 to the register <GasCalibSpanValue>

7.3 Temperature Compensation

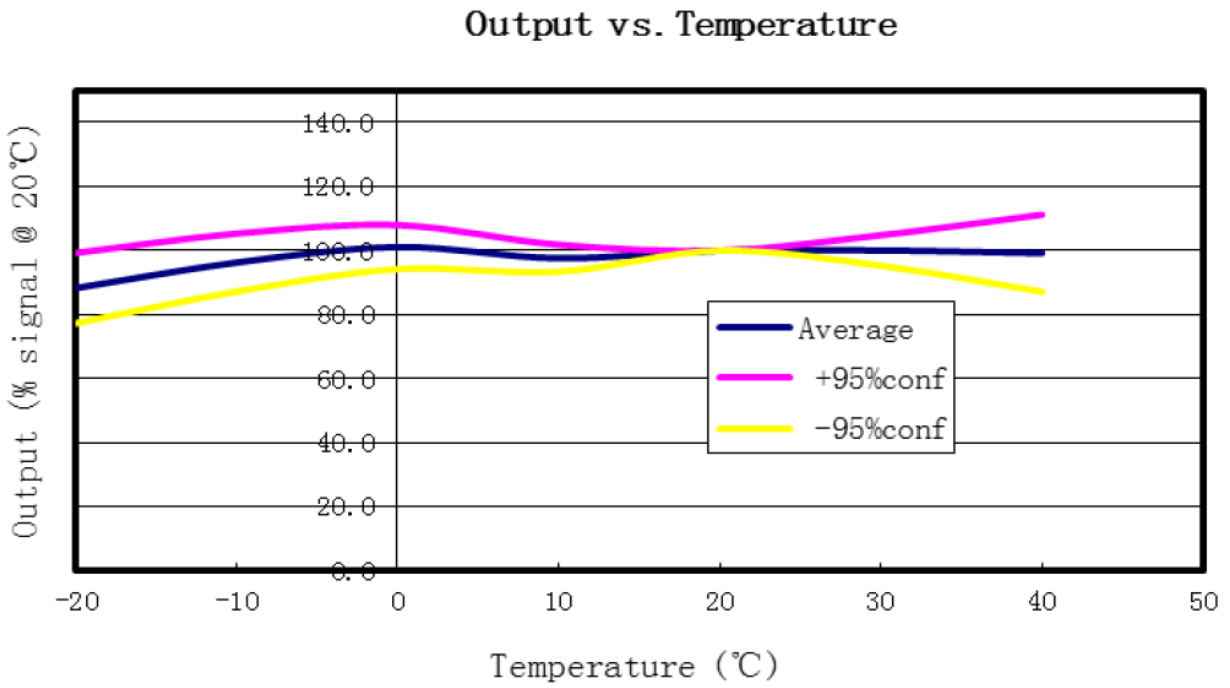
To compensate for the impact of temperature changes on the output signal of the electrochemical gas sensor, temperature compensation can be enabled to correct the signal output at different temperatures.

For the DigiGas-TOXIC sensor, a temperature correction coefficient can be set at intervals of 10℃ within the range of -40 to 80℃ to compensate for the influence of temperature changes on the output of the electrochemical sensor. The compensation coefficients can be obtained from the data sheet of the electrochemical gas sensor used according to its ordering information.

This chapter takes the Ammonia (0-100 ppm) [Honeywell Part Number: CLE-1012-401] sensor with Gas Type ID 0001 as an example to set the temperature compensation coefficient. Based on the relationship between the sensor output signal and temperature in the data sheet (as shown in the following figure), 13 temperature compensation coefficients <TCCoef0> to <TCCoef12> within the range of -40 to 80℃ can be determined every 10℃. These temperature compensation coefficients can be written into the sensor and the temperature compensation function can be enabled.

Please refer to chapter “Gas Quick Reference” or separate sensor data sheet for temperature compensation curve.

Honeywell CLE-1012-401Ammonia - Relationship between the output signal and temperature



Temperature (℃)	Temperature Compensation Coefficients（%）	Comment
-40	<TCCoef0>=	When the temperature is below -20℃, the compensation coefficient should be the same as that at -20℃
-30	<TCCoef1>=	When the temperature is below -20℃, the compensation coefficient should be the same as that at -20℃
-20	<TCCoef2>=	-
-10	<TCCoef3>=	-
0	<TCCoef4>=	-
+10	<TCCoef5>=	-
+20	<TCCoef6>=	-
+30	<TCCoef7>=	-
+40	<TCCoef8>=	-
+50	<TCCoef9>=	When the temperature is above +40℃, the compensation coefficient should be the same as that at +40℃
+60	<TCCoef10>=	When the temperature is above +40℃, the compensation coefficient should be the

		same as that at +40℃
+70	<TCCoef11>=	When the temperature is above +40℃, the compensation coefficient should be the same as that at +40℃
+80	<TCCoef12>=	When the temperature is above +40℃, the compensation coefficient should be the same as that at +40℃

7.3.1 SDI-12 Interface

Enable temperature compensation through the SDI-12 instruction, where "a" is the SDI-12 address of the sensor:

Steps	Comment	SDI-12 Command
Step 1: Enable temperature compensation for gas	Enable the temperature compensation for gas concentration.	Request: aXW_TCOMPEN_0!
Step 2: Set the temperature compensation coefficient for the gas concentration	Write the temperature compensation coefficients <TCCoef0> to <TCCoef12> into the sensor.	Request: aXW_TCC_88,90,92,94,96,98,100,102,104,106,108,110,112!

7.3.2 RS485 Interface

Enable temperature compensation via Modbus instructions:

Steps	Comment	Operation
Step 1: Enable temperature compensation for gas	Enable the temperature compensation for gas concentration.	Write 0 to register <TemperatureCompensateEn>
Step 2: Set the temperature compensation coefficient for the gas concentration	Write the temperature compensation coefficients <TCCoef0> to <TCCoef12> into the sensor.	Write “88,90,92,94,96,98,100,102,104,106,108,110,112” to register <TCCoef0> ~ <TCCoef12>.

Appendix A SDI-12 Sensor Testing and Settings

The user can test the communication or set the parameters with the SDI-12 sensors in the following method.

■ Use any kind of master device that supports the SDI-12 interface (such as data acquisition device, data logger, etc.) to communicate with the sensor or set the parameters.

■ Use a computer to communicate with the sensor through the SDI-12 converter (such as the SDI12ELF20 converter) and to set the parameters.

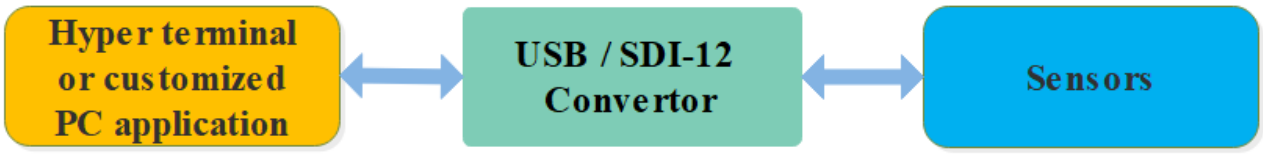
This chapter mainly introduces the communication or parameter setting on a computer for sensor through the SDI-12 converter (SDI12ELF20).

A.1 Testing SDI-12 Sensors with SDI12ELF20 Converter

SDI12ELF20 is a communication converter between USB master device and SDI-12 sensor. It supports bidirectional transparent transmission of SDI-12 communication data and is used to control or test SDI-12 compatible sensors or devices. The USB master device can be a computer, Raspberry PI and other hosts that support USB interface.

SDI12ELF20 Converter User Manual
https://www.infwin.com/sdi12elf20-sdi-12-to-usb-converter/

In this example, a computer is used as a USB host to connect the sensor through the SDI12ELF20 converter for SDI-12 communication test.



Installation steps:

■ Install USB Virtual COM port driver on PC, laptop or other USB master device. The converter uses the CH340C as the USB bridge chip. Download and install the CH340C driver and install it. After the converter is connected to the PC, a COM port is added to the system port. Use this port number in the debugging software to debug the communication with the converter.

Driver Download
https://www.infwin.com/resource-usb-to-serial-port-driver-ch340-series

■ Connect the converter to a PC, laptop or other USB master device through USB port

■ Connect the sensor of the SDI-12 port to the converter

■ The sensor can be powered by the power output that comes with the converter or by an external power supply which has common POWER GROUND with the converter power supply

■ Users can use any serial communication software for SDI-12 communication, such as Terminal or HyperTerminal, The default communication parameters of SDI12ELF20 is 9600bps, none parity, 8 data bits, 1 stop bit. Please use ASCII mode to send and receive data.

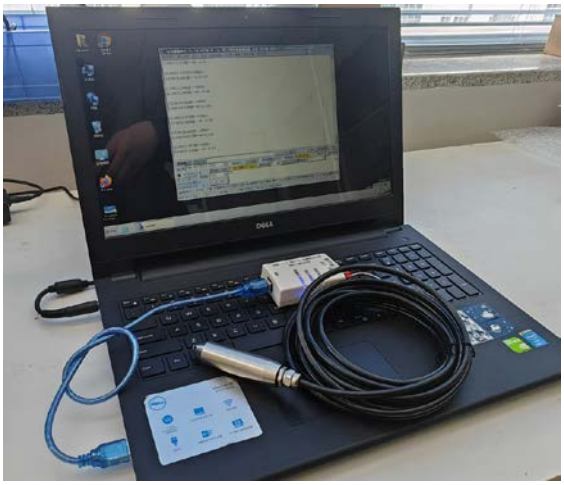
Testing Software Download	
Terminal (universal serial port debugging tool)	https://www.infwin.com/resource-serial-port-com-development-tool/
HyperTerminal (universal serial port debugging tool)	https://www.infwin.com/resource-serial-port-com-development-tool/
SensorOneSetSDI12 (SDI-12 sensor configuration utility)	https://www.infwin.com/resource-sensoronesetsdi12-configuration-utility-for-sdi-12-sensors/

A.2 Testing Example

In this example, we use the SDI12ELF20 converter to communicate between a computer and the rugged temperature sensor DigiTEMP, The power supply of DigiTEMP is also provided by SDI12ELF20.

DigiTEMP Rugged Temperature Sensor User Manual
https://www.infwin.com/digitemp-rugged-digital-temperature-sensor-sdi12-rs485-modbus/

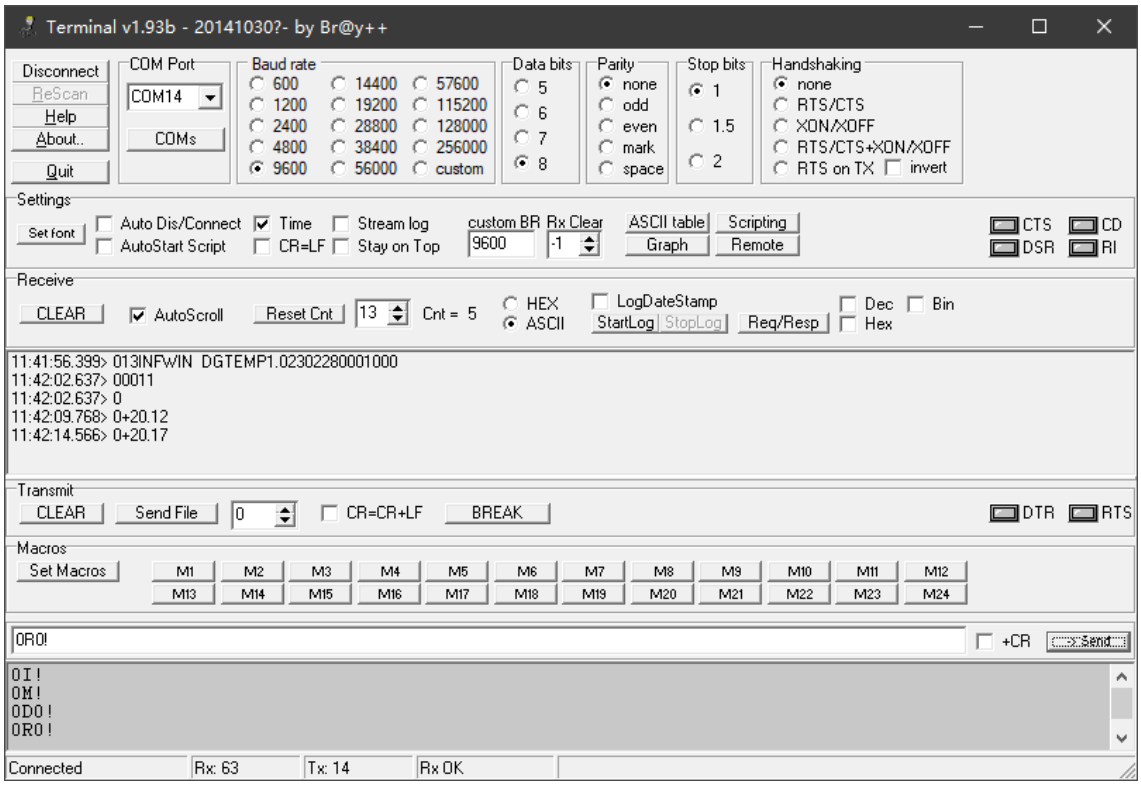
■ **Connections**



■ **Testing with serial port utility "Terminal"**

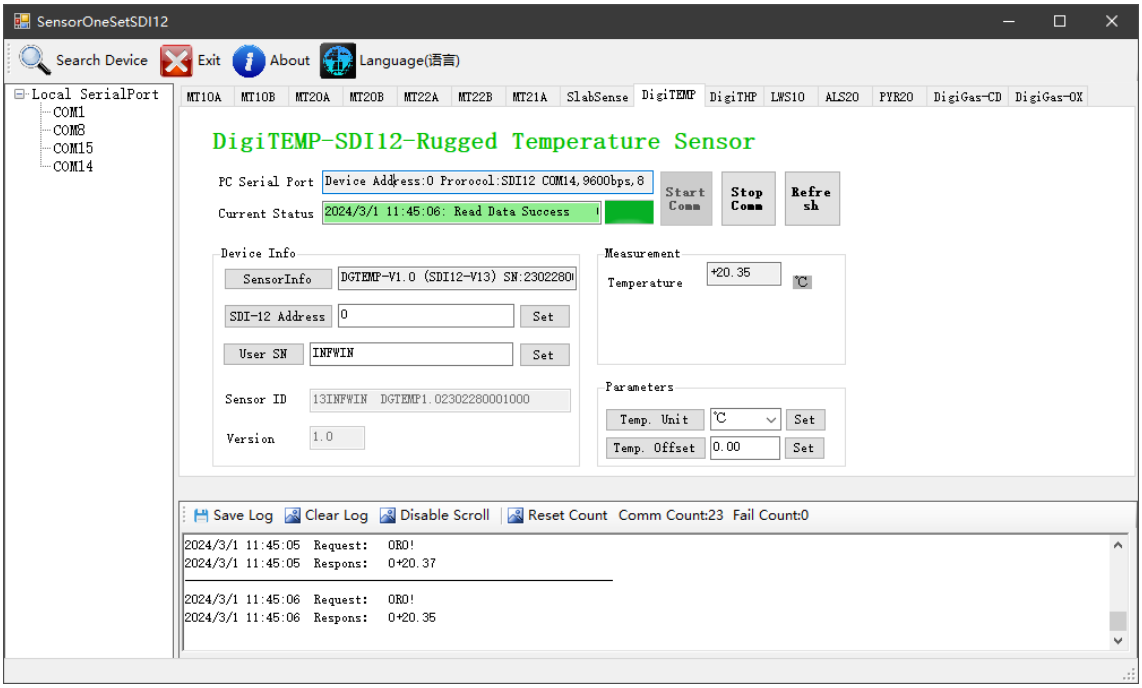
Take "Terminal" as an example, when debugging, please select the corresponding serial port number, baudrate is set to 9600bps, none parity, 8 data bits, 1 stop bit (the default communication Settings of SDI12ELF20), open the serial port and input the SDI-12 command and send. Please note

that the ASCII format should be used for data communication.



■ Testing with SDI-12 sensor configuration utility “SensorOneSetSDI12”

Start up the application, select the corresponding product page DigiTEMP, click "start communication" and choose the proper serial port number, 9600bps, none parity, 8 data bits, 1 stop bit (SDI12ELF20 default communication Settings) and start communication.



Appendix B RS485 Sensor Testing and Settings

User can test the communication or set parameters for the sensors with RS485 interface in the following method.

■ Use any kind of master device that supports the RS485 interface (such as data acquisition device, data logger, etc.) to communicate with the sensor or set the parameters.

■ Use a computer to communicate with the sensor through the RS485 converter (such as the USB/RS85 converter) to set the parameters.

This chapter mainly introduces the communication or parameter setting on a computer for sensor through the USB/RS485 converter.

B.1 Testing RS485 Sensors with RS485 Converter

RS485 converter is a communication converter between USB master device and RS485 sensor. It supports bidirectional transparent transmission of RS485 communication data and is used to control or test RS485 compatible sensors or devices. The USB master device can be a computer, Raspberry PI and other hosts that support USB interface.

In this example, a computer is used as a USB host to connect the sensor through the USB/RS485 converter for communication testing.

Installation steps:

■ Install USB Virtual COM port driver on PC, laptop or other USB master device. After the converter is connected to the PC, a COM port is added to the system port. Use this port number in the debugging software to debug the communication with the converter.

■ Connect the converter to a PC, laptop or other USB master device through USB port

■ Connect the sensor to the RS485 port to the converter

■ The sensor can be powered by the power output that comes with the converter or by an external power supply.

■ Users can use any Modbus serial communication software for RS485 communication, such as QModbus.

Testing Software Download	
QModbus (Modbus Debug Tool (For Serial Port))	https://www.infwin.com/modbus-debug-tool-for-serial-port/
SensorOneSet (sensor configuration utility)	https://www.infwin.com/sensoroneset-configuration-utility-for-rs485-sensors/

B.2 Testing Example

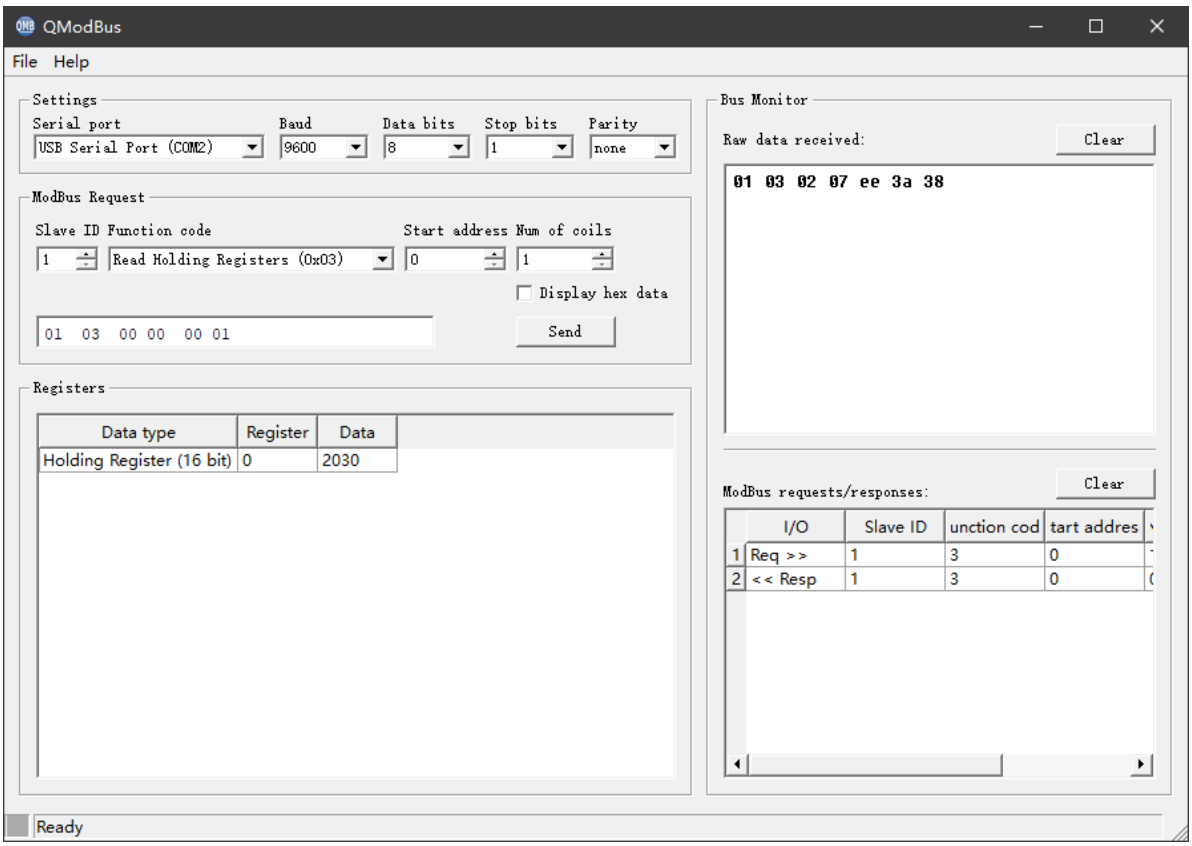
In this example, we use the USB/RS485 converter to communicate between a computer and the rugged temperature sensor DigiTEMP, The power supply of DigiTEMP is also provided by USB/RS485 converter.

DigiTEMP Rugged Temperature Sensor User Manual
https://www.infwin.com/digitemp-rugged-digital-temperature-sensor-sdi12-rs485-modbus/

■ Connections

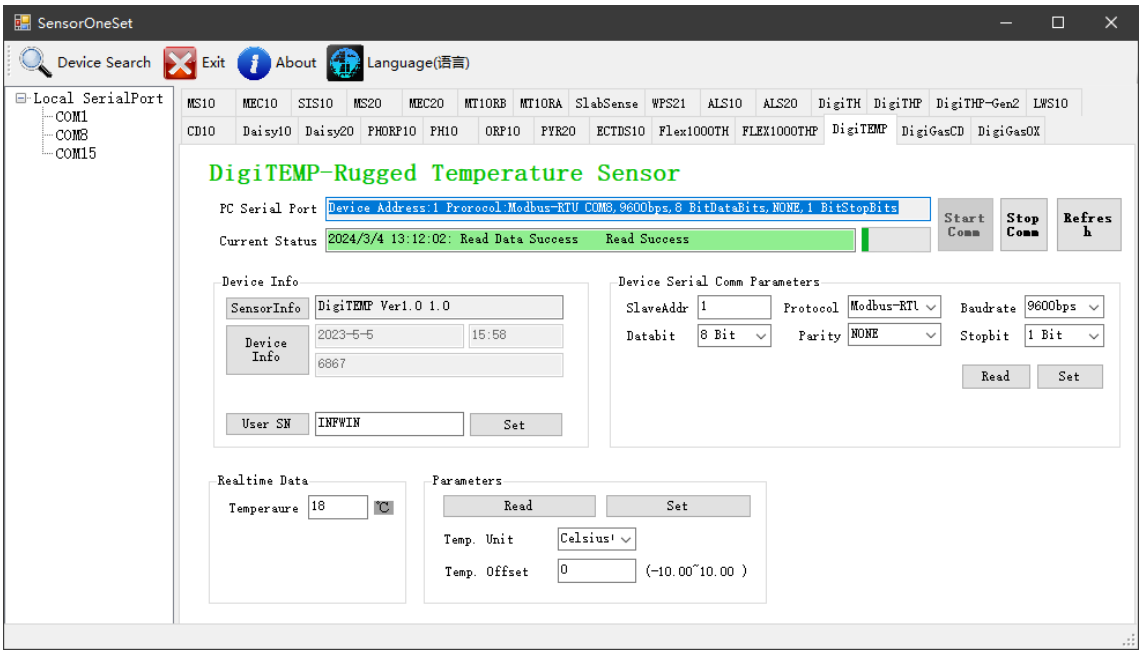
■ Testing with serial port utility “QModbus”

Take “QModbus” as an example, when debugging, please select the corresponding serial port number, baudrate is set to 9600bps, none parity, 8 data bits, 1 stop bit (the default communication Settings of DigiTEMP), open the serial port and input the Modbus-RTU command and send.



■ Testing with RS485 sensor configuration utility “SensorOneSet”

Start up the application, select the corresponding product page DigiTEMP, click "start communication" and choose the proper serial port number, 9600bps, none parity, 8 data bits, 1 stop bit (DigiTEMP default communication Settings) and start communication.



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