



HydroMetrics

Operations Manual

GW50 Groundwater Optical Nitrate Sensor

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Version 2.2

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1. INTRODUCTION

The HydroMetrics GW50 Groundwater Optical Nitrate Sensor monitors the concentration of nitrate in groundwater via monitoring wells. Its slim profile enables deployment in 50 mm bores with either an internal data logger or SDI-12 / Modbus RTU interface for connection to third party data loggers and PLC's. Low power consumption makes the HydroMetrics sensor compatible with solar powered installation.

The sensor utilises optical technology and operates on the basic principle of nitrate absorbing UV light at a specific wavelength and, through calibration, is converted to a nitrate-nitrogen concentration.

1.1 Initial inspection

- Upon receiving the sensor, inspect the packaging and contents for damage. Any damage claims should be filed with the shipping company.
- Immediately check package contents against the shipping documentation. If there are discrepancies, contact Lincoln Agritech Ltd or your supplier.

1.2 General specifications

- Groundwater deployment to measure nitrate concentrations.
- Designed for installation in 50 mm or larger diameter wells, reducing the overall installation cost.
- Remote data-logging capability for real-time data or SDI-12 / Modbus RTU interface for integration to third party data loggers and PLC's.
- A low cost, fit-for-purpose nitrate sensor enabling deployment across multiple sites at the catchment or farm scale.
- Low power consumption.
- Low maintenance, only periodic cleaning is required.
- Continuous monitoring as opposed to laboratory analysis; deployment in the environmental and agricultural community is rapidly growing due to increased data frequency.

1.3 Technical specifications

Measurement technology (light source)	Xenon flash
Measurement principle	UV Absorbance
Measurement cell	8 mm tube
Parameter	NO ₃ -N
Measurement range	0 – 50 mg/L (without measurement cell alteration)
Measurement accuracy	+/- 5% + 0.1 mg N/L (against standards)
Turbidity compensation	Yes
Data logger	~ 16 GB internal storage
Measurement interval	≥ 1 min
Housing material	316 stainless steel
Dimensions (ø x L)	42.2 mm x 455 mm
Weight	3.44 kg including 10 m of cable
Interface	SDI-12 / Modbus RTU / RS-232 (TTL levels)
Power consumption	< 100 mW
Power supply	11.5 – 15.5 VDC
Warranty	1 year
Max pressure	2.0 bar as standard

1.4 Measurement properties

The sensor utilises UV absorbance for the measurement principle and measures absorbance at two wavelength bands, the first centred on 220 nm and the second on 270 nm. The 220 nm signal is the primary nitrate estimation signal, while the 270 nm absorbance is used to correct for non-nitrate interferences. We deliver factory-calibrated sensors. The sensors are calibrated against KNO₃ and formazine turbidity standards.

1.4.1 Turbidity

Turbidity and absorption at both wavelengths are correlated. However, the amount of interference caused by turbidity will depend on the size and shape of particles present. For turbidity up to 45 NTU, interferences are negligible and normally well compensated for with the built-in calibration. As the absorption properties of turbidity can vary, absolute accuracy may be affected even at lower turbidity.

Increasing turbidity does reduce the upper range of the sensor. While 50 mg/L NO₃-N can normally be measured in very clean water with little non-nitrate absorbance, the presence of turbidity reduces the measurement range.

1.4.2 Other non-nitrate interferences

1.4.2.1 Conductivity

As conductivity is a result of a number of different ions that may be present in the water, the exact effect of conductivity on the accuracy of the sensor, especially when combined with other non-nitrate interferences, cannot always be predicted. Laboratory testing has indicated the sensor calibration is not significantly affected below 2000 uS/cm for nitrate concentrations below 30 mg/L.

1.4.2.2 Dissolved organic carbon (DOC)

DOC can provide a significant challenge for an optical nitrate sensor calibration as its absorbance peak is similar to nitrate, making correction difficult. If the groundwater you plan to measure has elevated DOC levels, then the accuracy of the nitrate measurement may be reduced.

1.4.2.3 Biofilms

Some wells can be biologically active and biofilms may develop on the measurement tube. In most instances the non-nitrate interference correction that is part of the calibration built into the sensor will manage some level of biofilm build up; however, the sensor will require cleaning periodically to reduce potential error in the nitrate calculation. Some wells grow biofilms very rapidly; if this problem occurs it may be necessary to sterilise the bore.

2. INSTALLATION

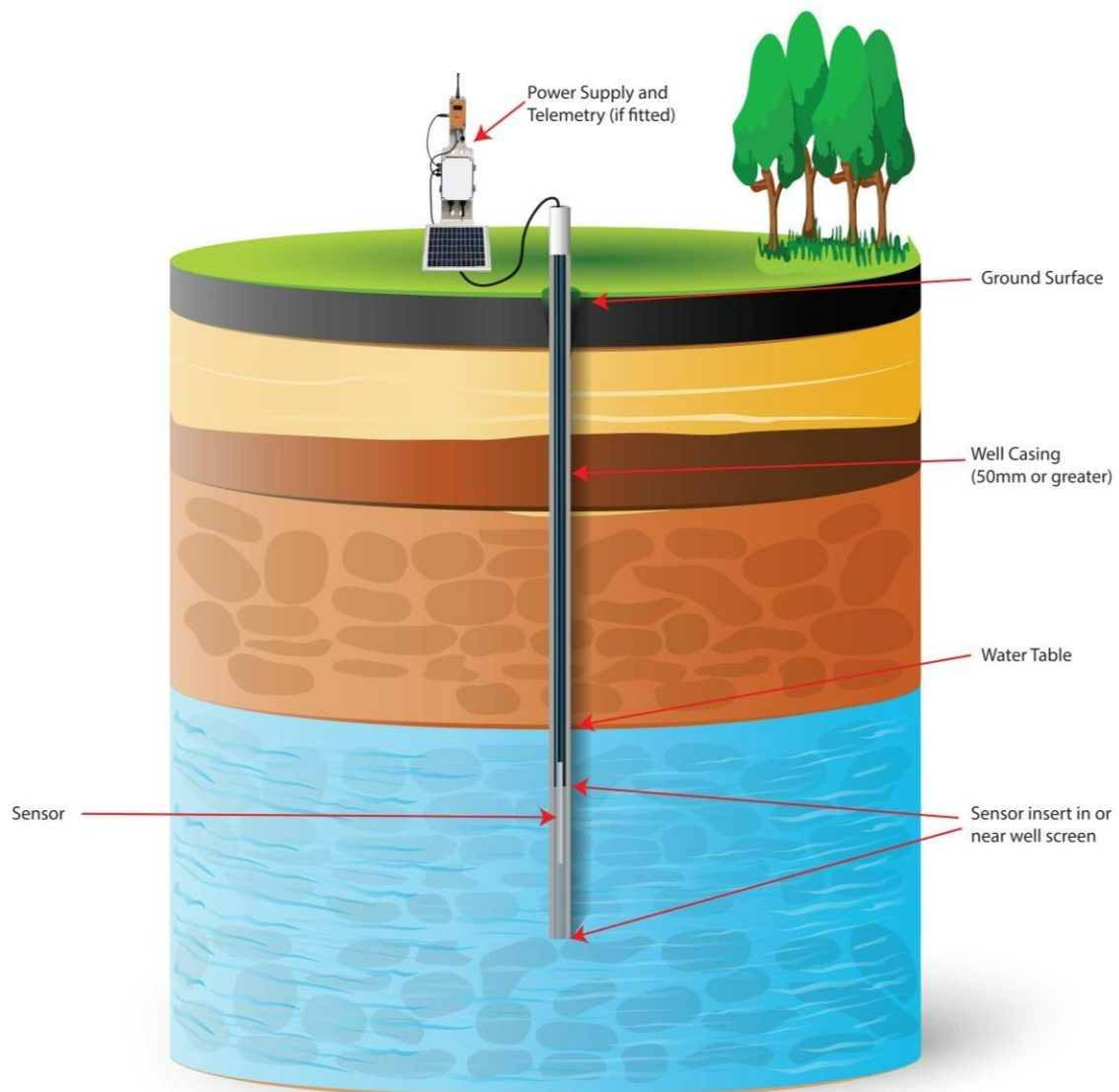
2.1 Site selection

The GW50 sensor is designed for groundwater installation where the sensor is located in a groundwater sampling bore. The sensor is designed to be installed in a 50 mm or larger Nominal Bore (NB) well casing, but be careful these smaller diameter bores have not deformed during installation as this increases the risk of a sensor becoming lodged in the bore. If installing the sensor in a production bore, the effect of pumping and electrical interferences from submersible pumps cannot be predicted and should ideally be avoided. Low DOC and turbidity levels increase the chances of a successful installation.

We recommend installation of the sensor in the screened area of the bore to ensure regular water exchange and reduced risk of nitrate stratification that may develop and affect readings.

Sufficient water in the bore is required to ensure the sensor's measurement chamber is submersed.

Where there is a bore 65 mm or larger nominal bore (NB), the pump cleaner model may be installed.



Where there is no room for a sensor to be fitted down a bore as the bore is smaller than 50 mm NB or there is a production pump installed down the bore, the GW50FC Flow Cell unit can be used. The water is pumped through the sensor at the surface near the bore. Either the production pump or a fit for purpose pump would be used to pump the water through the sensor. A pressure reducer may be required if water pressure is above 2 bar.

Surface water installations are achievable where the turbidity and DOC is within an acceptable range for the site. Careful consideration around the installation method must be thoroughly planned to meet the changing conditions, high rainfall events, weed and organic organisms and changing water levels are a few of the common ones. Using a pipe to protect the sensor from a lot of these factors helps mitigate their impact, as well as where the sensor is mounted in case of a flooding event.

2.2 Installation procedure

2.2.1 Bore installations

DO NOT hang the sensor by the data cable.

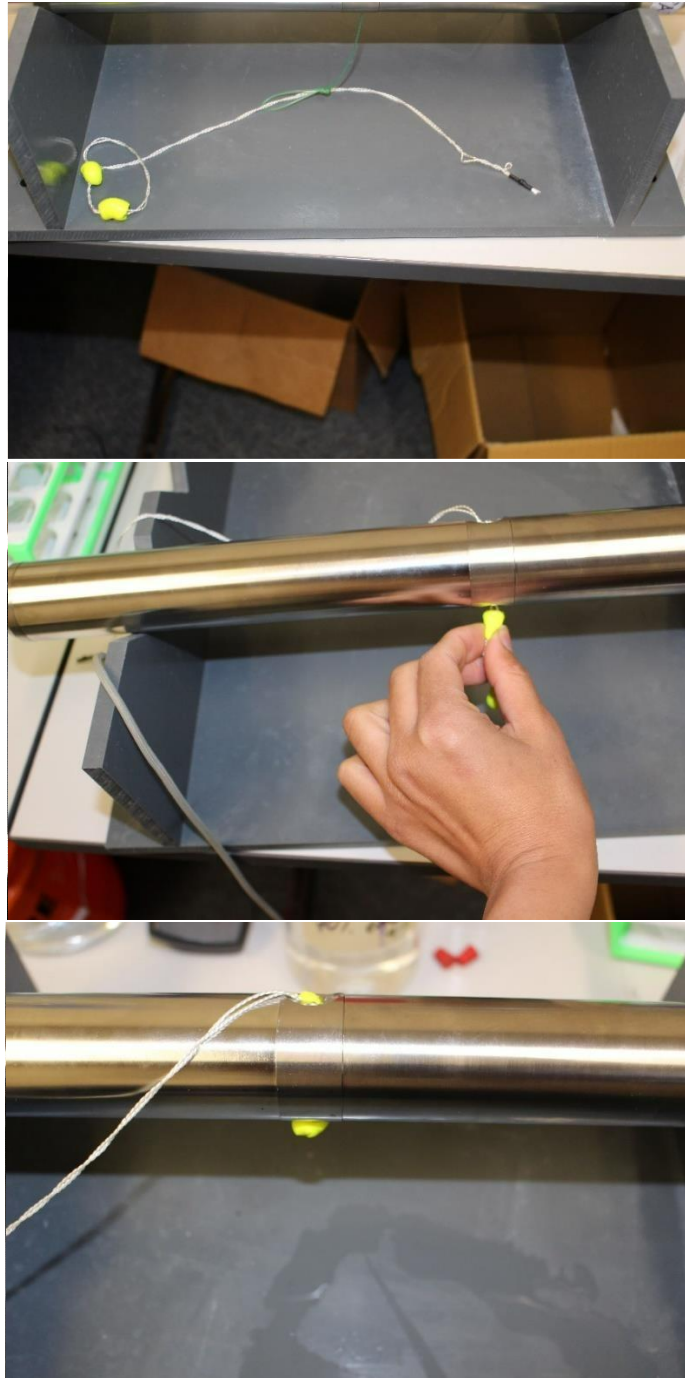
Before installing, the sensor should be cleaned even if it is new. There will be a film on the sensor tube that needs to be removed to ensure the sensor is operating correctly.

A mounting bracket and shackle is provided at the top of the sensor and a suitable wire or rope should be attached to lower the sensor in the well casing. 1.5 mm nylon covered stainless wire rope is ideal for this, but nylon cord or similar is also effective. Ensure the cable is securely anchored at the top of the well to prevent the probe being lost down the well. Taping the rope or cable to the data cable at intervals of approximately 1 m is a useful way to prevent the data cable and suspension rope from tangling while installing or removing the sensor. Make sure a little slackness in the data cable between taping points is maintained to ensure the sensor weight is supported on the suspension cable or rope.

During submersion of the sensor, material on the walls of the bore such as algal growth, could enter the measurement cell and air could also become trapped. To remedy this, a cloth or plugs are inserted into the sensor measurement cell during installation and are attached to a fine cable, such as a fishing line; by applying pressure, post-installation, this can be removed from the measurement cell and extracted to the surface. Thus ensuring no air is trapped, or foreign matter is scraped into the measurement cell during the installation.

The GW50PC unit is easy to clear any air bubbles trapped or any foreign material by simply running the pump for a few seconds.

Once the sensor has been installed, take a reading from the sensor to ensure it is operating correctly. If the sensor has an air bubble the ABS270 and ABS220 will read approximately 0.4-0.5 units for each. If there was a large build-up of matter the ABS220 and ABS270 value will be reading NAN.



Photos: Foam earplugs threaded onto a string act as a tube cleaner after installation (do not apply ethanol to plugs to clean the tube as they will dissolve).

During installation ensure the sensor does not touch the bottom of the bore as this can stir up sediments that may settle in the measurement cell creating some interference.

2.3 Wiring

The sensor is designed for three modes of operation.

1. Standalone sensor utilising its inbuilt data logger for data collection. The data is downloaded via a serial protocol using the 0-5 volt (TTL) communication lines and the GW50Log software supplied.

2. SDI-12 is a three wire interface only requiring the Power, Ground and SDI-12. The SDI-12 wire is connected to a suitable port on a SDI-12 recording device such as a Campbell Scientific, Unidata data logger or other IoT datalogger telemetry system.

2.3.1 Wiring colour code

Wire Colour	Serial Connection	Modbus RTU Connection
Braid	Not Connected	Not Connected
Black	Ground	Ground
Red	12 Volts DC	12 Volts DC
Yellow	TX (0-5 Volts)	TX (0-5 Volts) *
Orange	RX (0-5 Volts)	RX (0-5 Volts) *
Green	SDI-12	SDI-12
Blue	Output (Open Drain)	Output (Open Drain)

* The Modbus RTU connection on the GW50 is a standard 5V UART output. By using a HydroMetrics GW50-MOD converter will allow ModBus RTU RS485 connection.

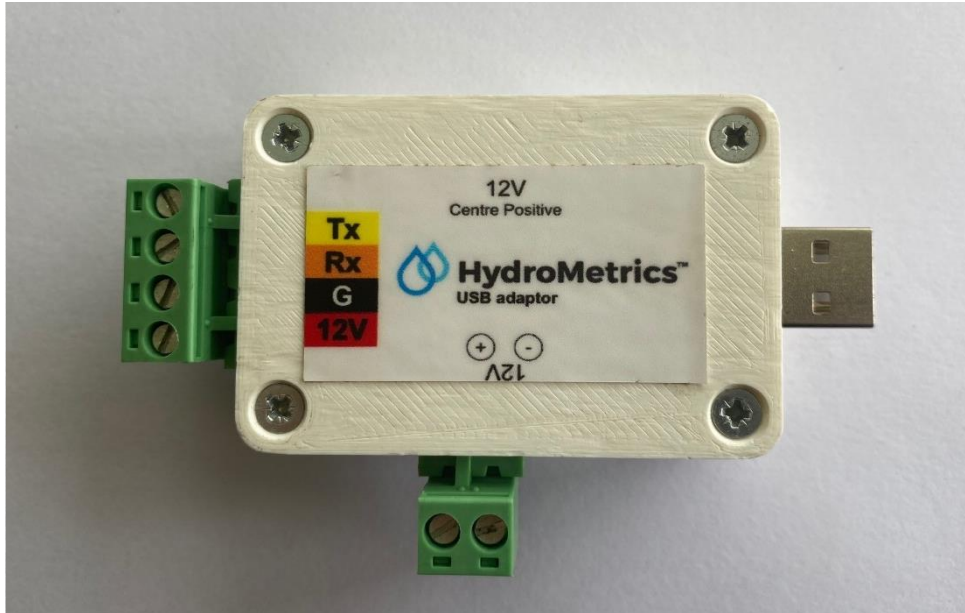
2.3.2 USB interface and serial telemetry connection

Ensure correct voltage levels are applied to the RX and TX lines (0-5V) to avoid potential damage.

An FTDI interface module (USB to 0-5V Serial) is typically used for this purpose as a standard serial port on a PC (now days not commonly fitted) is not suitable.

A purpose built interface (HydroMetrics GW50-USB) is available from your supplier if required and has terminal for powering the sensor as well as connecting a battery or mains plug pack.

The sensor can be connected to a third party device, such as a cellular IP modem, if remote interrogation is required. Again, ensure the voltage levels of this device's communication port are correct and, if not, deploy a suitable voltage level shifter.



2.3.3 Modbus RTU connection

Ensure correct voltage levels are applied to the RX and TX lines (0-5V) to avoid potential damage.

A purpose built Modbus interface (HydroMetrics GW50-Mod) is available from your supplier if required and has terminal for powering the sensor as well as connecting a battery or 12Vdc power supply.

The sensor can be connected to a Modbus RTU Master device to allow the sensor to be connected to a control or datalogging system. Again, ensure the voltage levels of this device's communication port are correct and, if not, deploy a suitable voltage level shifter.

2.3.4 Output control line

The sensor is fitted with a software configurable control line for use with low voltage DC loads. Applications of this include switching power to a cleaning pump or telemetry equipment. The output is an Open Drain configuration and when activated connects the line to the power supply ground, otherwise its voltage will float unless held up by a suitable pull-up resistor. See Section 3.8 for software configuration options.

The Output control line is set from time based event, configurable from 1 – 1440 mins and can have an offset incorporated to allow flexibility to switch auxiliary equipment outside of the measurement event.

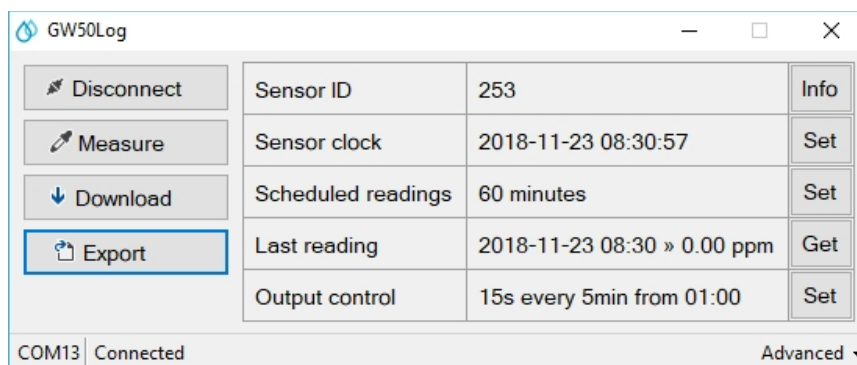
Maximum Voltage: 16 VDC

Maximum Current: 1.5 Amps

While the control line has the capacity to switch small loads, most applications would utilise a relay or solid state switch that is driven by the control line to protect the sensor from potential damage.

3. GW50 LOG SOFTWARE INTERFACE GW50 LOG

The GW50Log software allows you to interact with the HydroMetrics GW50 nitrate sensor. The programme is a single file executable that can be stored at a location of your preference on the PC. To run the program double click on the file or create a shortcut for your desktop for convenience.



3.1 Features

- Download data from the sensor.
- Export data to CSV.
- Configure the scheduled reading interval.
- Take manual readings.
- See the last measurement result.
- Set the sensor clock.
- Set timing for the output control line.

3.2 Connecting directly to a sensor

1. Connect the USB cable (USB to 0-5 volt coms adapter) to your PC and to the GW50 sensor. See Section 2.3.2.
2. Open GW50Log.
3. Click Connect and choose the serial port to connect to *Click Connect* to connect to the sensor.

3.3 Connecting to a remote sensor

As well as a direct serial connection, the GW50Log software also supports connecting to sensors over a TCP connection. This would typically be a cellular to serial bridge. To connect via TCP, click the *Connect* button and select the *TCP* tab. You can enter the IP address and port directly, or you can create an alias by clicking the plus button and entering the required details. This allows you to quickly select from a list of known devices. You can use the minus button to remove an alias or the pencil button to edit it.

3.4 Downloading data

To download data from the sensor, click the *Download* button. A progress bar will be displayed during the download. Once the download has successfully completed, a graph will be shown of the measured nitrate nitrogen values.

The data is stored in a database in "My Documents\GW50Log\GW50Log.db". Each time you download data, only new data that is not in the database will be downloaded.

To export the downloaded data to CSV, click the *Export* button. You can choose which sensor to export data for, the date range to export, and where to store the result. The default output folder is "My Documents\GW50Log\exported\". The CSV file will be named with the sensor ID number and the date range. Export is available with no sensor connected to the PC.

3.5 Taking manual readings

Click the *Measure* button to take a reading. Once the sensor has finished taking the reading (approximately 20 seconds) the last reading display will be updated with the result.

3.6 Configuring the sensor

3.6.1 Setting the clock

Click the *Set* button next to the sensor clock display. Choose the time zone from the dropdown box for the sensor's clock. The default is the non-daylight savings time for your PC clock's local time zone, e.g. UTC+12 (NZST) for New Zealand. Note that the sensor's clock will not change for daylight savings. A preview of the sensor's clock is shown below the dropdown box. Click *Save* to set the sensor's clock or *Cancel* to close the window without saving.

3.6.2 Setting the reading schedule

Click the *Set* button next to the scheduled readings display.

- If you are using SDI-12 with the aM! (start measurement) command, set the interval to 720 minutes, then un-tick the Enable scheduled readings check box. In this configuration, the SDI-12 logger will control when the sensor takes readings, or you can connect and take readings manually.
- If you are using the GW50 as a standalone sensor, or using SDI-12 with the aRn! (continuous measurement) command, tick the Enable scheduled readings check box. In this configuration the sensor will take readings at regular intervals. Enter the reading interval (between 1 and 720 minutes) in the box provided.

Click *Save* to write the configuration to the sensor or *Cancel* to close the window without saving.

In both configurations the sensor writes all data to its internal storage and can be downloaded later via the GW50Log software.

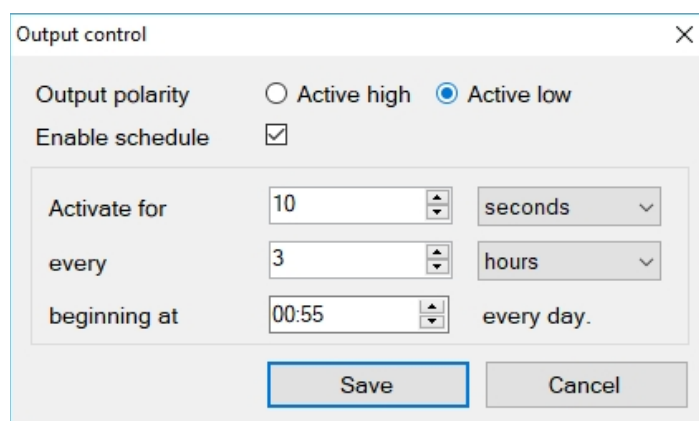
Note that when using in SDI-12 with aM! Command, the sensor schedule should be set to 720 minutes to reduce power consumption.

3.7 Getting information about the sensor

Click *Info* to get detailed information about the connected sensor, e.g. firmware version, battery voltage, and temperature.

3.8 Configuration of the output control line

On selection of the *Set* button beside the Output Control section of the main screen a configuration window will open. The schedule can be turned on or off using the *Enable Schedule* check box, but you must *Save* on exit to make any changes take effect.



3.8.1 Output polarity

The output is configurable to allow multiple uses. You can select *Active High* or *Active Low*. This allows the user to decide if during activation they wish the control line to be floating or held up by a pull-up resistor (Active High) or locked to sensor ground (Active Low).

3.8.2 Schedule design

There are three configurable parameters that control the schedule. “Activate for” is the time the input will operate and can be up to 24 hours. You can select run times in units of seconds, minutes or hours. “Every” defines the frequency and this is limited to minutes and hours. “Beginning at” allows you to control the activation time. This is particularly important if activation may interfere with sensor readings. For instance, if a cleaning pump was deployed to run every 3 hours for 10 seconds, it may not be desirable for this to occur during a reading. If the reading interval was set to 60 minutes, this would occur every hour on the hour. We can avoid conflicts by “beginning at” 00:55 so the three hourly activations will always be 5 minutes before the sensor reading. The schedule will run on power up and the output enter the state defined by the three parameters.

3.8.3 Disconnecting from the sensor

When you are finished, click *Disconnect* to disconnect from the sensor. Alternatively, just close the GW50Log window and it will disconnect when the programme closes.

If you need to connect to multiple sensors you can open multiple instances of the GW50Log software and connect to one sensor in each.

3.9 Advanced settings

There are a number of advanced functions the average user may not use on a day to day basis. The advanced settings are accessed by the *Advanced* drop down menu in the bottom right corner.

3.9.1 Show log

Selecting *Show Log* opens a log window that displays information on the sensor activities and may be useful in diagnosing issues relating to the sensor use.

3.9.2 Export log

A support agent may require access to the log files relating to the session for support purposes. Selecting *Export Log* from *Advanced* menu enables a txt file to be saved in a location of the user's choice that can be forwarded to the support team.

3.9.3 Export advance data

Additional diagnostic data may be obtained for support purposes when using the *Export Advance Data* option.

3.9.4 Clear sensor memory

The sensor has a very large file storage memory allocation and regular clearing of the data is not required. One situation where clearing the memory may be advantageous is when connecting to the sensor for the first time with a different computer that has not downloaded the data previously. In this situation it will download all new data (which potentially includes old data that you are not interested in) and this can take some time if the memory has a large number of readings. The software will prompt you for confirmation that you wish to clear the memory before proceeding (note, this action is not reversible).

4. SDI-12 INTERFACE

4.1 Overview

This document describes the SDI-12 interface on GW50 nitrate sensors. For background information on SDI-12, including a complete technical specification, please refer to <http://www.sdi-12.org>.

SDI-12 stands for serial data interface at 1200 baud. It is a standard to interface battery powered data recorder with micro-processor-based sensors designed for Environmental Data Acquisition (EDA). EDA is accomplished by means of a sensor, or sensors, and a data recorder that collects and saves the data. SDI-12 is a standard communications protocol that provides a means to transfer measurements taken by an intelligent sensor to a data recorder. An intelligent sensor typically takes a measurement, makes computations based on the raw sensor reading, and outputs the measured data in engineering units.

The GW50 nitrate sensor's implement version 1.4 of the SDI-12 protocol.

4.2 Operation

The sensor's usual mode of operation is to periodically take measurements at some defined interval. When operating this way, the SDI-12 data recorder should be configured to poll the *Continuous measurement* (§4.6.4) results at the same rate (with some offset to avoid interrupting the sensor while it takes a measurement).

It is also possible to disable the sensor's scheduled measurements and send *Start measurement* commands (§4.6.1) to take measurements on demand.

4.3 Data format

4.3.1 On-demand measurements

Measurements initiated by the *Start measurement* or *Start concurrent measurement* commands return the following values:

Parameter	Units	Description
VBAT	Volts	Battery voltage
TEMP	°C	Temperature
220		Absorbance at 220 nm
270		Absorbance at 270 nm
PPM	ppm	Nitrate Nitrogen (NO ₃ -N) concentration
FAIL		Number of errors

4.3.2 Continuous measurements

Measurements read back using the *Continuous measurement* command return the same values as above with following values appended:

Parameter	Units	Description
DATE	yymmdd	Measurement date
TIME	hhmmss	Measurement time

4.4 Supported commands

The command/response terms in this section (e.g. a, ttt, nn, <CR><LF>, etc.) are the same as used in the SDI-12 specification document. Please refer to that document for full details.

4.5 Basic commands

4.5.1 Address query

Command	Response
?!	a<CR><LF>

Responds with the sensor address. Note that if more than one sensor is connected to the bus they will all respond, causing bus contention.

4.5.2 Acknowledge active

Command	Response
a!	a<CR><LF>

Acknowledges the presence of the sensor with address 'a' on the bus.

4.5.3 Send identification

Command 命令	Response 响应
a!	allccccccmmmmmmvvvxxx...xxx<CR><LF>

Responds with information about the sensor.

Field	Width	Value
SDI-12 compatibility	2	"14" (v1.4)
Vendor name	8	"LAL"
Sensor model	6	"GW50"
Extra info	13	Sensor ID number, e.g. "123"

4.5.4 Change address

Command	Response
aAb!	b<CR><LF>

Changes the address of the sensor to 'b' and responds with the new address. The new address will be stored in non-volatile memory, so it will be remembered when the sensor is power-cycled.

4.6 Measurement commands

4.6.1 Start measurement

Command	Response
aM!	atttn<CR><LF>
aMC!	

Responds with the time 'ttt' in seconds until the measurement will be ready, and the number of values 'n' that will be returned. Once this time has elapsed, or if the sensor sends a service request, use the *Send data* command to read back the measured values. The data recorder must not communicate with any other sensors on the bus between starting a measurement and reading back the data.

The 'aMC!' variant causes a CRC to be returned with the response to subsequent *Send data* commands.

4.6.2 Start concurrent measurement

Command	Response
aC!	atttn<CR><LF>
aCC!	

Responds with the time 'ttt' in seconds until the measurement will be ready, and the number of values 'n' that will be returned. Once this time has elapsed, use the *Send data* command to read back the measured values. (Note: the sensor will not send a service request.) The data recorder is allowed to communicate with other sensors on the bus while waiting for the measurement to finish.

The 'aCC!' variant causes a CRC to be returned with the response to subsequent *Send data* commands.

4.6.3 Send data

Command	Response
aD0! ... aD9!	a<values><CR><LF> a<values><CRC><CR><LF>

Responds with values from the latest *Start (concurrent) measurement* command. If not all 'n' values are returned by 'D0', call 'D1' and so on until all of the values are returned.

The values will be returned with a CRC appended if the 'aMC!' or 'aCC!' command was used to start the measurement.

4.6.4 Continuous measurement

Command	Response
aR0! ... aR9!	a<values><CR><LF>
aRC0! ... aRC9!	a<values><CRC><CR><LF>

Responds with all the values from the n'th last measurement (e.g. R0 for the most recent measurement, R1 for the next most recent, etc.). Note that manually initiated measurements (e.g. by *Start measurement*) are included when counting which measurement to return.

If a non-existent measurement is requested, all values will be returned as 'NaN'.

4.7 Metadata commands

4.7.1 Identify measurement

Command	Response
aIM!	atttn<CR><LF>
aIMC!	
aIC!	atttnn<CR><LF>
aICC!	

Responds with the same information that would be returned by a *Start (concurrent) measurement* command but doesn't actually start a measurement.

4.7.2 Identify measurement parameter

Command	Response
aIM_001! ... aIM_009!	a,field1,field2;<CR><LF>
aIC_001! ... aIC_099!	
aIRO_001! ... aIRO_099!	
aIMC_001! ... aIMC_009!	a,field1,field2;<CRC><CR><LF>
aICC_001! ... aICC_099!	
aIRC0_001! ... aIRC0_099!	

Responds with information about the individual values returned by each type of measurement. The first comma-separated field contains a short identifier of the parameter, the second field contains the units of the parameter, and any further fields contain extra information.

4.8 Extended commands

4.8.1 Read setting

Command	Response
aXGs!	annn<CR><LF>

Responds with the value 'nnn' of the setting 's'. Valid values for 's' are given in the table below:

Setting	Description
r	Scheduled reading interval (in minutes)
u	Enable scheduled readings (0/1)

4.8.2 Write setting

Command	Response
aXSnnn!	annn<CR><LF>

Sets the value of setting 's' to 'nnn' and responds with the new value.

4.8.3 Get date/time

Command	Response
aXc!	aYYYY-MM-DD hh:mm:ss<CR><LF>

Responds with the current date and time of the sensor real-time clock.

4.8.4 Get firmware version

Command	Response
aXv!	aX.Y.Z-C-gHHHHHHH<CR><LF>

Responds with the full version number of the sensor firmware.

5. MODBUS RTU INTERFACE

5.1 Overview

This document describes the Modbus/RTU interface on the Hydrometrics GW50 nitrate sensor. Information about the Modbus standard is available at <https://modbus.org/>.

5.2 Operation

The sensor's usual mode of operation is to periodically take measurements at some defined interval. When operating this way, the Modbus master should be configured to poll the results at the same rate (with some offset to avoid interrupting the sensor while it takes a measurement).

It is also possible to disable the sensor's scheduled measurements and have the Modbus master trigger measurements on demand.

5.3 Hardware

Modbus/RTU typically uses RS485 as the transport layer, but the GW50 only exposes a 5V UART. An external RS485-to-UART adaptor with automatic flow control is needed to connect a GW50 sensor to a Modbus/RTU master over RS485.

Baud rate	19200
Data bits	8
Parity	Even
Stop bits	1

5.4 Timing

The GW50 spends most of its time in a low-power sleep mode. It takes the sensor 2 ms to wake up when it receives data on the serial port. This means that the first command sent when the sensor is asleep will not receive a response, it will just wake the sensor up. Subsequent commands will receive a response as normal.

While the sensor is awake, all commands will receive a response within 100 ms except for reading holding registers 13-14 (TEMP) which will respond within 800 ms.

The GW50 returns to sleep one second after the last Modbus command was handled.

Note that the sensor will not respond to Modbus commands while it is taking a reading.

5.5 Register Map

All data addresses in this document are 1-based, as used in the Modbus application-layer data model, not 0-based as encoded on the wire. Depending on the Modbus master you use, you may need to subtract 1 from these addresses. Alternatively, some other Modbus masters may require you to add 40000 to the addresses shown here to indicate that they are holding registers.

5.5.1 Holding registers

Type	Description
U16	Unsigned 16-bit big-endian integer (one register)

U32	Unsigned 32-bit big-endian integer (two registers)
F32	32-bit big-endian floating-point (two registers)

Access	Description
R	Read-only (function code 3)
W	Write-only (function codes 6, 16)
RW	Read and write

5.5.2 Sensor information and control

Address	Type	Access	Name	Description
1	U16	R	API_VERSION	The Modbus API version. This specification is for API version 2.
2	U16	R	ID	The sensor ID number.
3	U16	R	VERSION	The firmware version running on the sensor. Represented as an integer, e.g. 10234 \Rightarrow v1.2.34.
4	U16	R	MAX_TIME	The maximum time (in seconds) required for the sensor to take a reading.
5	U16	R	NUM_READINGS	The number of readings available to read back via Modbus.
6	U16	W	READ	Write a non-zero value to this register to begin a reading.
7	U16	R	DATE_YEAR	The current date/time.
8	U16	R	DATE_MONTH	
9	U16	R	DATE_DAY	
10	U16	R	TIME_HOUR	
11	U16	R	TIME_MIN	
12	U16	R	TIME_SEC	
13-14	F32	R	TEMP	The case temperature ($^{\circ}$ C).
15-16	F32	R	VBAT	The supply voltage (V).

5.5.3 Settings

These registers configure the internal operation of the GW50 sensor.

Address	Type	Access	Name	Description
51	U16	RW	MODBUS_ENABLED	Whether Modbus is enabled (1) or disabled (0).
52	U16	RW	MODBUS_SLAVE_ADDR	The Modbus slave address (1 – 247).
53	U16	RW	TAKE_SCHEDULED_READINGS	Whether the sensor's internal schedule is enabled (1) or disabled (0).
54	U16	RW	READING_INTERVAL_MIN	The interval between scheduled readings in minutes.
55	U16	RW	OUTPUT_POLARITY	Whether the control output is active-high (1) or active-low (0).
56	U16	RW	OUTPUT_START_TIME	The first time each day at which to turn the control output on. Represented as an integer, e.g. 615 ⇒ 6:15 am.
57	U16	RW	OUTPUT_INTERVAL_MIN	The interval between turning the control output on in minutes.
58	U32	RW	OUTPUT_DURATION_SEC	How long to turn on the control output for each time in seconds.

5.5.4 Data

Up to the 9 most recent readings since the sensor was powered on are available to be read back via Modbus. Read register 5 (§5.5.2) to find out how many are available.

The data is arranged in blocks of 17 registers beginning on multiples of 101. For example, the most recent reading is held in registers 101-117, the second most recent is in registers 201-217, and so on up to the 9th most recent in registers 901-917.

Address	Type	Access	Name	Description
101	U16	R	READING_DATE_YEAR	The date/time at which the reading was taken.
102	U16	R	READING_DATE_MONTH	
103	U16	R	READING_DATE_DAY	
104	U16	R	READING_TIME_HOUR	
105	U16	R	READING_TIME_MIN	

106	U16	R	READING_TIME_SEC	
107-108	F32	R	READING_VBAT	Battery voltage (V)
109-110	F32	R	READING_TEMP	Temperature (°C)
111-112	F32	R	READING_N220_RATIO	Absorbance at 200 nm
113-114	F32	R	READING_T270_RATIO	Absorbance at 270 nm
115-116	F32	R	READING_NITRATE_PPM	Nitrate concentration (ppm)
117	U16	R	READING_NUM_FAILURES	Number of errors

5.6 Typical Usage

The typical sequence for taking a reading and retrieving the result is outlined below:

1. Send a command to wake the sensor up. It is recommended to read holding register 1 to do this.
2. Within one second of the previous command, read holding register 1 and ensure that the API version is 2.
3. Within one second of the previous command, read holding register 3 to find the maximum reading time.
4. Write 1 to holding register 6 to start a reading.
5. Wait for the number of seconds returned in step 3.
6. Send a command to wake the sensor up.
7. Within one second of the previous command, read holding registers 101-117 to retrieve the result.

6. MAINTENANCE

6.1 Overview

Routine cleaning includes thoroughly cleaning the sensor to remove any dissolved organic matter or biofilm growth. Often you will see a significant increase in the Abs270 reading in the data set and this can indicate a biofilm has started to grow. A 70% solution of ethanol is ideal for cleaning as it is very water-soluble. IPA is good for removing any biological build up within the sensor.

6.2 Equipment Required

1. Clean soft rag
2. Rubber plug
3. Circular brush
4. Ethanol 70% solution and / or IPA (Isopropyl Alcohol)
5. Clean water - DI (De-Ionised) or distilled water to check the cleaning process
6. Foam plugs with string for re-installation for GW50 sensor only (not needed with GW50FC or GW50PC)
7. Gloves

Warning – Read the product MSDS sheets before using to ensure all safety measures are taken.

6.3 Process - Cleaning the sensor

1. Removal of Sensor

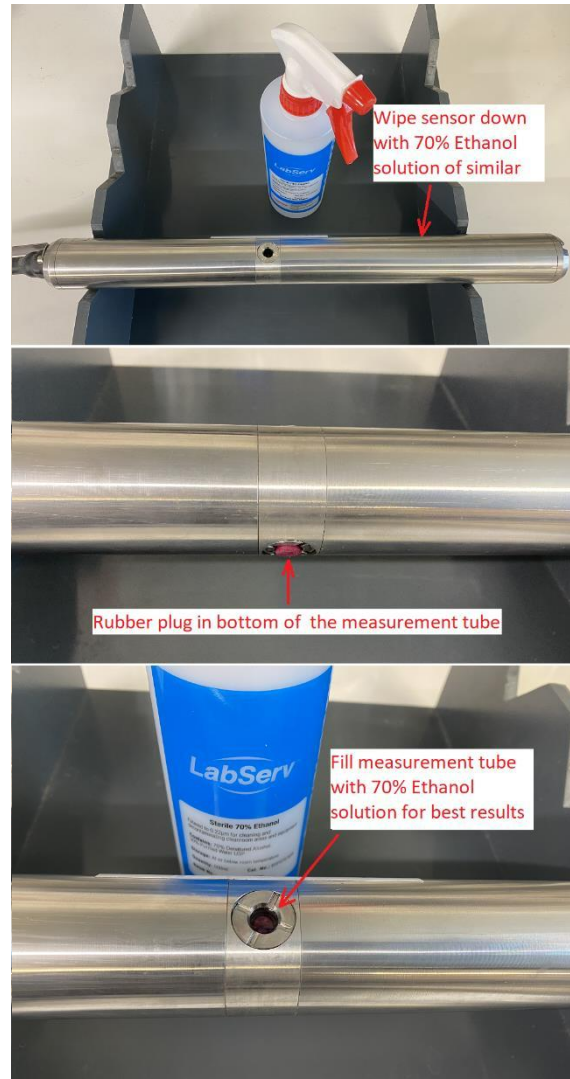
- GW50 & GW50PC - Lift the sensor out of the measurement container (bore / well, distilling well, tank, etc) by the suspension rope / cable. Do not lift by the sensor data cable and take particular care to not damage the insulation by rubbing on any sharp edges.
- GW50FC - Isolate the water supply to the sensor, then remove the tubing off each side.

- ### 2.
- Using a clean soft cloth, wipe down any contaminates and / or biofilms that have started to form on the cabling and sensor casing. You can use 70% ethanol if required to help remove the build-up.

- ### 3.
- Lay the sensor flat with the measurement tube facing you. Ensure there is access to both sides of the tube.

- ### 4.
- Place a rubber plug in the bottom of the measurement tube and fill with 70% ethanol or IPA.

- ### 5.
- Using the supplied brush, twist it gently, let the weight of the brush descent into the measurement tube until it hits the bottom of the rubber plug. Remove the rubber plug so the

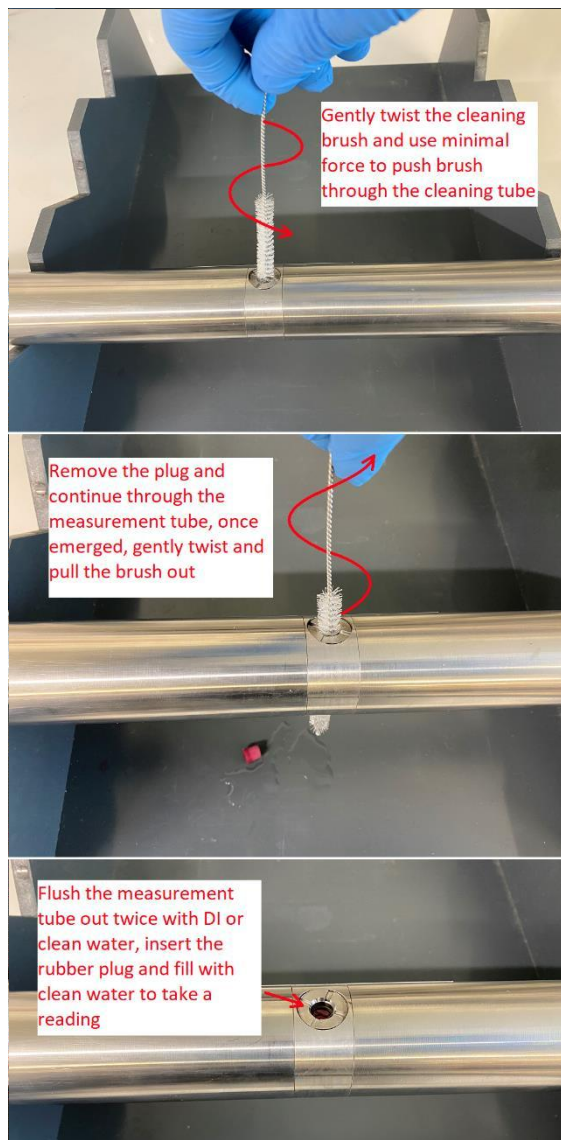


brush can emerge out the other side of the sensor. Again, gently twist and pull the brush back out the top of the measurement cell. **Warning!** Excessive force when cleaning the measurement tube can damage or dislodge the quartz tube inside the sensor.

6. Flush the measurement tube out with De-ionised Water (DI) or distilled water twice to remove any residue.

7. Re-insert the rubber plug in the bottom of the measurement tube and fill with clean water, check the reading of the sensor with a laptop connected to the probe with the GW50 software or the connected datalogger / telemetry device.

8. With fresh DI water, the Abs 220 and Abs 270 readings will typically be < 0.05 if the sensor is clean. If these values are not under these specified readings, then repeat from Step 4. It may take multiple attempts to clean the sensor before the readings are below these parameters or the readings do not reduce any further. If the readings are still not satisfactory, repeat the process with IPA, if used 70% Ethanol first, or vice versa. Some biofilms will be more easily removed by IPA and others by 70% Ethanol. After completing several attempts to clean the sensor and the numbers are still not satisfactory there may be a need to use a dilute acid to effectively remove any build-up of a non-organic matter. See Note: If the DI or distilled water is not fresh, the Abs 220 and 270 value maybe higher.



Reading	
Deviceld	325
Time	21/05/2021 11:00 am
CaseTemperature	21.37
Abs220	0.01557368
Abs270	-0.00398448
Ppm	0.195146754

9. Reinstallation of the sensor – refer to the installation manual for full set of instructions.

- GW50 – Insert the foam plugs with string carefully into the measurement cell tube and carefully lower the sensor into the measurement container, taking particular care not to damage the data cable on any sharp edges and using the suspension rope or cable to carry the weight. Once the sensor is in place, gently pull the string so the foam plugs come out of the measurement tube and remove any air bubbles that may be present.
 - GW50PC - Carefully lower the sensor into the measurement container, taking particular care not to damage the data cable on any sharp edges and using the suspension rope or cable to carry the weight. Once the sensor is in place, run the pump manually to flush out any air bubbles that may be present.
 - GW50FC – Reattach the tube each side of the sensor and turn the water supply back on. Check there are no leaks and the measurement tube has filled with water.
10. Run a manual test to check the readings post cleaning, in particular the Abs270 reading, which is the general indicator of the interference build up.
 11. Make a note as to the date and time of the cleaning process, as there may be irregular and erroneous readings during this process.

Calibration is not required unless specific conditions require this. These may be, for example, elevated DOC or turbidity. Cleaning is the regular normal maintenance that is required.

6.4 HCL Acid Cleaning Solution

Where typical cleaning is not effective, there may be a build-up that has accumulated over time, or the sensor has been stored in air for some time. A solution of Hydrochloric Acid (HCl 0.1 MOL) can effectively remove a range of contaminants that brushing with IPA or Ethanol can't remove.

Simply clean the sensor tube with IPA or Ethanol first, flush with DI water 3 times, insert the rubber plug in one side of the sensor and pour the solution in the sensor tube. It is simply left in the tube for several minutes for a small build-up, to several hours for a very bad build up. Once the time has passed, simply flush out the acid solution with DI Water, repeat a wash with IPA or Ethanol and check the Abs220 and Abs270 readings.

Note: follow all safety and handling precautions when using HCL 0.1 MOL solution.

7. CONTACT INFORMATION



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