



ProbeGuard

Clean Sensors and Clean Data



ProbeGuard II Manual v2.32



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1. Introduction

ProbeGuard (PG) is essentially an underwater garage for various moored sensors. It protects instruments and prevents biofouling by enclosing the sensors inside the Sampling Chamber while waiting to sample and periodically bathes the sensors and the sampling chamber in an anti-fouling solution. Before instrument sampling, ProbeGuard opens the garage and flushes the chamber and sensors with ambient water via a high efficiency, magnetically coupled stirrer inside the sampling chamber. Additional ambient flow flushing is achieved by leaving the sampling chamber open for a programmed duration before data is collected. To insure that only fresh ambient water is sampled, ProbeGuard and the protected instrument must be synchronized which can be achieved in two ways. Most commonly, ProbeGuard acts as a one channel data logger that can power and communicate with the slave instrument. Alternatively, a separate data logger/controller can be used to issue commands to ProbeGuard (open, flush, close and inject biocide) and to collect data from the protected instrument. Both of these methods are described further in section 7.

Major ProbeGuard elements:

ProbeGuard MCU: ProbeGuard is controlled by a low power micro control unit (MCU) that operates the Sampling Chamber and Stirrer with commands issued over the user interface, or by putting ProbeGuard into logging mode where all sampling actions are automatically repeated at a fixed interval. The MCU is equipped with two RS232 serial ports (user interface and instrument), 12-bit analog to digital voltage converter, and a 12 volt output to power the instrument. The MCU also stores up to 2 GB of data on a standard, non-volatile SD card. A real-time clock is used to automate logging cycles and time stamp data.

Sampling Chamber: The ProbeGuard Sampling Chamber (Fig. 1) is formed by two concentric cylinders referred to as the Inner and Outer Cups. Each cup has four equally spaced windows. While the outer cup is static and serves as the physical connection to the instrument,

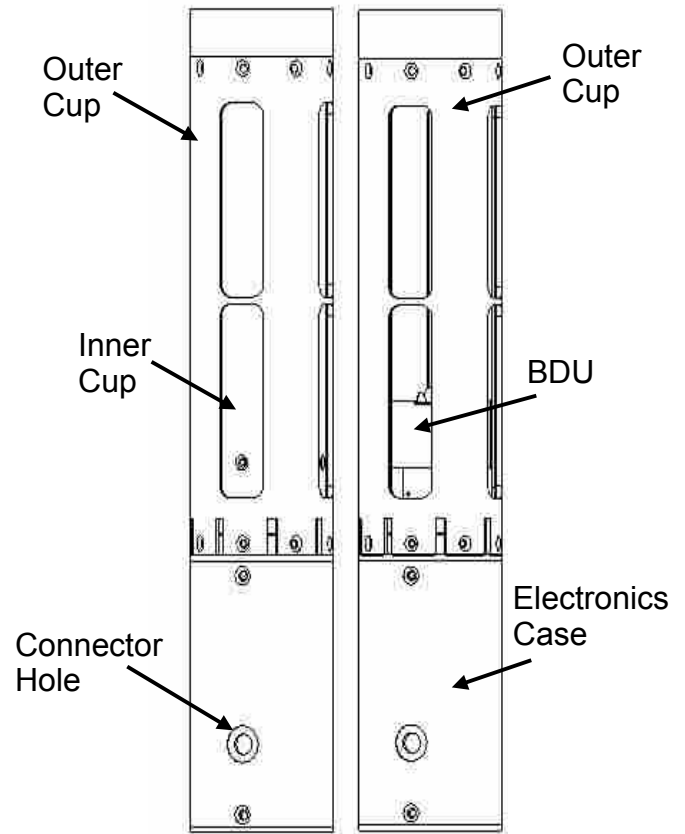


Fig. 1: ProbeGuard units with Sampling Chamber in open position (right) and closed position (left)



the Inner Cup rotates such that the windows can be staggered to close the Sampling Chamber or aligned to allow ambient water to flow freely past the enclosed sensors.

Biocide Dispensing Unit (BDU): Prior to deployment, the BDU (Figs. 2, 3 and 4) is filled with solid biocide pellets (chlorine recommended). At the start of the deployment, the BDU is primed by opening the vent and valve, allowing it to flood with ambient water that form a saturated biocide solution inside. During dosing, a small volume of the biocide solution is released from the BDU into the Sampling Chamber when the Inner Cup is rotated such that the valve and vent pegs ride up the actuating ramps to open the chamber. As the dense biocide solution exits through the valve on the bottom, ambient water enters through the vent holes on top. A saturated biocide solution is maintained until all the solid biocide is dissolved. The volume of the biocide dose can be adjusted by altering the duration the Valve and Vent Pegs rest on top of the Ramps (Configuration Address 6 – Biocide Open; Default = 3s) during dosing. After the biocide release is complete, ProbeGuard moves the Inner Cup and the Valve/Vent Pegs off the Ramp and into the “parked” position with the Sampling Chamber windows fully closed. The propeller is started just prior to release of the biocide and runs an additional ten (10) seconds to mix the biocide and bathe the sensors in the anti-fouling solution. During the ProbeGuard logging cycle, **the Sampling Chamber is only treated with biocide after “clean” data is collected and is fully flushed before more environmental data is collected.** Data collected after a dose is for diagnostic purposes only and is flagged as “Dosed”. Environmental data is flagged as “Clean”.

Biocide: Common “swimming pool” chlorine tablets (trichloroisocyanuric acid - available at swimming pool supply stores) have been used very successfully in multiple environments. ProbeGuard is supplied with a BDU pre-filled with crushed tri-chlor pellets that fit easily inside the chamber and provide adequate pore space for liquid flow. Users are encouraged to purchase additional crushed tri-chlor from Green Eyes as needed or

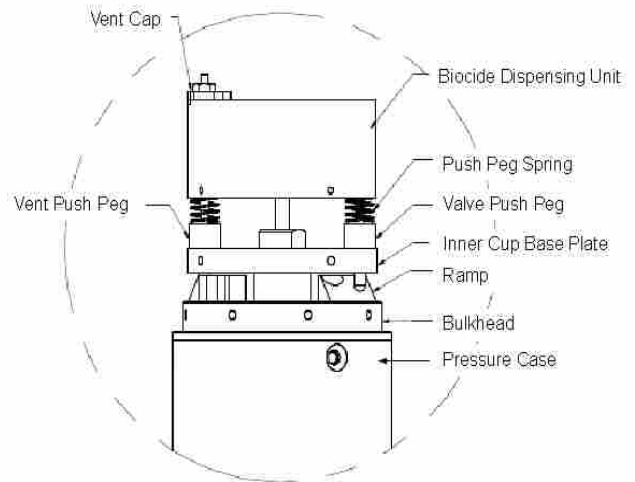
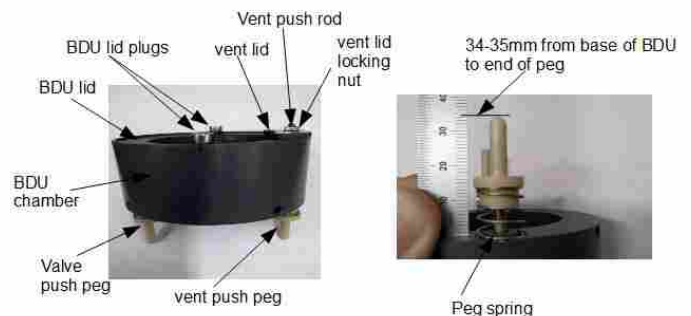


Fig. 2: Biocide Dispensing Unit and Ramp actuators



Note: Vent and valve springs and push pegs are interchangeable

Fig. 3: Detail of BDU parts



request instructions to purchase and crush the tablets own their own. Users are free to **experiment** with other biocides, but they must be soluble in the ambient water of the deployment (fresh or salt) and **conform to all local, state and federal laws**.

ProbeGuard is factory configured to release approximately 3mg of chlorine (3s Biocide Open configuration value) into the closed sampling chamber on each dose. Thorough testing in high fouling environments indicates that four (4) tri-chlor doses of this size per day are sufficient to prevent any fouling. It is strongly suggested that this dosing regime be followed on initial deployments and only modified if necessary.

Inner Cup and Flushing Control: ProbeGuard is equipped with high efficiency motors to run the magnetically coupled Stirrer and the Inner Cup. Output from an optical encoder mounted on the Inner Cup shaft is fed into the microprocessor for precise positioning. Stirrer flushing, ambient flow flushing and biocide mixing times are user programmable (see section 3, Configuration Parameters).

2. ProbeGuard and Protected Instrument Synchronization

The flushing and dosing of ProbeGuard, and the data collection from the protected instrument must be synchronized to insure data quality. There are currently three ways to synchronize ProbeGuard and the protected instrument.

1. When ProbeGuard is the master and the instrument the slave, ProbeGuard acts as a single channel data logger that issues sampling commands to, and collects/stores data from the “slave” instrument. All data is saved on an internal, non-volatile SD card inside the ProbeGuard electronic case. ProbeGuard can also switch the instrument off and on via the instrument power wires in the cable. Drivers for a variety of commonly deployed sondes (e.g. YSI 6 series, YSI EXO series, Hach Hydrolab, Measurement Specialists Manta) are included in the ProbeGuard firmware, but must be selected along with the instrument baud rate in the configuration table (Section 3). Contact Green Eyes if a desired instrument is not listed. Flushing times and sampling frequency used in logging mode are also set in the configuration table.

2. ProbeGuard actions can also be synchronized with the instrument via external control mode where both ProbeGuard and the Instrument are controlled by a third device such as a data logger (e.g. Campbell, or Sutron) or field computer. In this mode, the data logger issues a single command to ProbeGuard to open the sampling chamber, flush and pause for ambient flow flushing before closing. After flushing is complete, the data logger collects data from the instrument and ProbeGuard closes the sampling chamber (see command Y5 in Section 5). At the designated interval (4x daily recommended), the data logger must also issue the biocide dosing command (Y6) to ProbeGuard. Stirrer flushing and ambient flow flushing times set in the configuration table are still used when the Y5 command is issued as well as the biocide open time for the Y6 dosing command.



3. ProbeGuard and the instrument can be synchronized via their individual clocks as well. Because there are no communications between the instrument and ProbeGuard in **Clock Synchronization mode**, the instrument and ProbeGuard communication cables do not need to be connected which may simplify deployments.

Note: The Instrument configuration value should be set to 0 for Clock Synchronization mode or ProbeGuard will generate communication timeout errors when it attempts to communicate with an instrument that is has no communications with.

ProbeGuard will open, flush with the stirrer, pause with the windows open and close at the schedule set by the Delayed Start value (command W1) and the Logging Interval. Biocide dosing will execute as specified by the Dose Frequency configuration parameter in the same fashion as when ProbeGuard is configured as the master (method 1. above).

In order to simplify synchronization of ProbeGuard flushing and sonde sampling, the delayed start time entered will be adjusted for the minutes of stirrer and ambient flow flushing (windows open and no stirring) already programmed. This way, users can enter the same Delayed Start time into ProbeGuard that is used for the Sonde. The adjustment is calculated based on the sum of the flushing times rounded down to the nearest integer value minute (e.g. 150s of total flushing = 2.5 minutes adjusted to a 2 minute Delayed Start adjustment). An Open Flush value of at least 120s is recommended for Clock Synchronization Mode and 20s is automatically added to the Open Flush value (not used in the adjustment calculation) to insure the windows remain open when the sonde collects data.

Ex: Stir Flush = 30 (s), Open Flush = 120 (s), Sample interval = 15 Delayed Start Time = 06/21/16 12:00:00 (ENTERED)
==> Adjusted Delayed Start Time = 06/21/16 11:58:00
==> Hourly flushing begins at 13, 28, 43 and 58 minutes after every hour

This example assumes that the instrument is programmed to start sampling at 06/21/16 12:00:00 and thus the same time is entered into the ProbeGuard Delayed Start Time.

In the event of a power interruption, a new Delayed Start time is calculated based on the current time and a factor of the Sampling Interval. For example, if the interval is set to 15 minutes, ProbeGuard will reset the schedule so that the chamber is flushed out for data collection at 15, 30, 45 and 00 minutes of each hour (whichever minute time comes first after power returns). **For this reason, it is important to enter an initial delayed start of a factor of the interval (e.g. Samplign Interval = 15, Delayed Start Time minutes equals 00, 15, 30 or 45.** This will insure that the original sampling schedule is maintained during a power interruption.



Important: The J1 command must be sent after setting all configuration parameters and the Delayed Start to initiate logging.

3. Configuration Parameters

The following parameters are used to control ProbeGuard during bench testing, and in both logging and external control deployment modes. Individual parameters are set with the c (lower case) command where the argument after c is the address of the configuration parameter. ProbeGuard will then prompt the user for the associated value for the designated parameter (see c command in Section 5 for complete configuration procedure and example).

Configuration Table

Configuration Parameter	Addr.	Description	Range	Used with
Stir Flush	2	Seconds stirrer is run to flush Sampling Chamber after opening	10 to 60	Logging, Y5, Y7
Open Flush	4	Seconds Sampling Chamber is left open after Stir Flush to allow for continued ambient flow flushing	0 to 120	Logging, Y5, Y7
Biocide Open	6	Seconds BDU is opened to release biocide	0-10 default = 3	Logging, Y6
Dose Frequency (See Dose Frequency Note below)	8	Number of consecutive sample sequences before a biocide dose.	1 to 100	Logging
Index to Open	10	Number of encoder tics from encoder index to Sampling Chamber windows fully open	Factory set, do not change	Logging, Y3, Y5, Y7
Index to Dose	12	Number of encoder tics from encoder index to BDU open	Factory Set, do not change	Logging, Y6, Y13
Slave Instrument (see slave instrument table below)	14	Controls how ProbeGuard communicates with, and powers the protected instrument	0 to 4	Logging, Y7, Y12
Instrument Warm-up	16	Seconds ProbeGuard will pause after powering instrument or instructing instrument to sample before collecting data	5 to 180	Logging, Y7, Y12
Instrument Baud	18	Instrument Baud Rate for RS232 communications	1200, 2400, 4800, 9600, 19200, 38400, 57600	Logging, Y7, Y12
Logging Interval	20	Minutes between sampling while in Logging Mode	5 to 120	Logging



Auto Logging (See Auto Logging note below)	22	When enabled (1), ProbeGuard will automatically enter Logging Mode when re-powered if a Ctrl-c character (ASCII 3) is not received.	0 (off) or 1 (on)	Logging
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Dose Frequency Note: The Dose Frequency is used in Logging Mode in conjunction with the Logging Interval to set the number of biocide additions per deployment day. In a typical deployment, the Logging Interval is set to 30 minutes and the Dose Frequency is set to 12 so that immediately after the 12th sampling action (6 hours after Sample 1) ProbeGuard will run its biocide dosing routine. The next sampling activity will begin on schedule 30 minutes after the previous one and the sensors will be cleaned with biocide every six hours (four (4) times daily). ProbeGuard will collect instrument data immediately after mixing the biocide throughout the closed sampling chamber for dosing diagnostic purposes. All flushed environmental data is labeled “clean” and all biocide treated data is labeled “dosed”. Instrument data lines are also flagged with a sample index value. In the example above, clean data would be flagged 1-12 and the dosed data would be flagged with 13.

Auto Logging Note: As described in the Configuration Table above, setting Auto Logging to 1, configures ProbeGuard to automatically return to logging mode after a power interruption (e.g. loose connection or dead battery) and not to wait for commands (command mode). Auto Logging is automatically turned on (1) when Logging Mode is initiated with the J1 command. If Logging mode is terminated with a Ctrl-c character between sampling actions, Logging mode is automatically turned off (0). Once Logging Mode is turned on either manually (with c command) or automatically (J1 command), a user must send the Ctrl-c character at power up to enter command mode. ProbeGuard will prompt the user for the Ctrl-c character at power up.



Slave Instrument Table: Specific drivers for slave instruments

Slave Instrument value	Setup Instructions
0	No communication with protected instrument. Used when ProbeGuard and instrument are synchronized by each device's clock.
1	<p>Power up from ProbeGuard and Sample</p> <ul style="list-style-type: none"> • Generic mode for various instruments • ProbeGuard instrument power wires need to be connected to instrument power in and batteries should be removed from instrument. • ProbeGuard male serial cable connects to instrument female serial cable. • Instrument must be configured to output repeating data lines at power up without any command • Instrument baud rate set on ProbeGuard (Config. 18) must match instrument baud rate • Known to work with YSI 6 series, EXO via the Serial Output Adapter, and Hach Hydrolab (currently only method for Hydrolab)
2	<p>YSI 6 poll</p> <ul style="list-style-type: none"> • For use with YSI 6 sondes • Sonde must be powered continually with internal batteries or another external source source and do not wire ProbeGuard power to sonde • ProbeGuard male serial cable connects to instrument female serial cable • ProbeGuard sends "run" command to sonde while it's at the # prompt and returns it back to the # prompt after data collection • Waits for instrument warmup (config. 16) after sending "run" before collecting a data line and storing it on the SD card
3	<p>EXO poll</p> <ul style="list-style-type: none"> • For use with EXO I or II • ProbeGuard instrument power wires are connected to EXO Serial Output Adapter (SOA) adapter 9-16 volt DC in (red wire) and GND (black wire) terminals • ProbeGuard EXO SOA adapter cable connected between ProbeGuard instrument RS-232 cable and SOA 232-Tx, 232-Rx, GND terminals • EXO cable connected to SOA adapter as directed in EXO manual • ProbeGuard powers SOA and pauses for instrument warmup (config. 16) • ProbeGuard sends "data" command to SOA and stores resultant data line on its internal SD card
4	<p>Measurement Specialists Manta II sonde.</p> <ul style="list-style-type: none"> • ProbeGuard instrument wires are connected to Manta power in wires and batteries must be removed from instrument. • ProbeGuard powers sonde and pauses instrument warmup (config. 16) period before sending "read" command to sonde • Resultant data line is stored on SD card



4. ProbeGuard Cable Setup

Users configure, test and control ProbeGuard via the supplied cable that provides 1) power to ProbeGuard, 2) User Interface RS-232 communication to and from ProbeGuard, 3) RS-232 communications between ProbeGuard and the protected instrument, and 4) power from ProbeGuard to the protected instrument. Follow the cable connection steps below to bench test ProbeGuard.

1. Plug the rubber, wet mateable connector into ProbeGuard being careful to properly align the pins on the ProbeGuard connector with the holes on the cable connector.
2. Plug the User Interface serial cable into a computer serial port (Windows, Mac or Linux) or a “known good” USB to serial converter (MOXA recommended)
3. Connect the ProbeGuard power wires to a 12 volt power source (e.g. power supply or battery that can deliver at least 500 mA, 10-15 volts range). Red wire to +12 volts and black wire to negative.

If also testing the ProbeGuard and Instrument communications:

4. Connect the ProbeGuard male serial cable to the instrument female serial cable cable.
5. If ProbeGuard will power the instrument, connect the ProbeGuard instrument power wires to the instrument power connections. As with the ProbeGuard power wires, connect the Red wire to +12 volts and black wire to negative of the instrument supply. Remove the batteries from the instrument.

Note: Follow the instructions in the Slave instrument Table above that are specific to your instrument. If you have difficulty with step 5, please contact Green Eyes for assistance.

5. Terminal Control

When steps 1 – 3 of the ProbeGuard cable setup are complete, open a terminal program on the computer such as Green Eyes' ComScript, Terra Term, PuTTY (free download at download.com), Hyperterminal or ProComm. Configure the serial port to: 19200 baud, no parity, 8 data bits, 1 stop bit, no hand shaking or flow control. When ProbeGuard is powered, a boot up message including the firmware version will be displayed. Contact Green Eyes if you are not seeing the boot up message.

Individual commands are typed at the “>” command prompt in the following format:

[Command Letter][Argument(s)][Enter]

The command letter is case sensitive, but currently only commands c and d are lower case. After typing the command and arguments, the Enter character (ASCII 13) must be sent to initiate the command.



Messages

@CMD - In command mode

@OK - Command acknowledged

@IDX - Inner cup was moved to encoder index position

@ENC - Encoder steps Inner Cup was successfully moved

@INV - Invalid command issued (usually incorrect format)

@ARG - Invalid or missing argument

Commands

?(1)

Displays the supported command set and abbreviated explanations.

Upper Case Commands

A(arg)

Averages the number of readings specified by arg from the 12 bit analog to digital converter. Output is in bits from: supply voltage, inner cup motor current and stirrer motor current.

C(arg)

Opens a direct serial communication pipe between the user interface and the instrument. The pipe is broken when the instrument line transmits a character specified by the ascii character code in arg (e.g. CR = 13).



D(arg)

SD card functions and Data Retrieval

arg	SD card function
0	Initialize SD card, diagnostic purposes only
1	Write ProbeGuard time stamp event to a test file on SD card
2	Display the contents of the test file
3	Delete the test file
6	Display the contents of the Instrument/ProbeGuard data file Note: this is the command used to retrieve deployment data
7	Delete the Instrument/ProbeGuard data file (user prompted for a verifying Y or y)
8	Display the contents of the ProbeGuard error file
9	Delete the ProbeGuard error file (user prompted for a verifying Y or y)
10	Display the contents of the Instrument/ProbeGuard temporary file
11	Delete the ProbeGuard temporary file (no verifying character is requested)

F(arg)

Command F moves the Inner Cup in the forward direction (clockwise when looking down at the Sampling Chamber) the number of steps specified in the argument. ProbeGuard counts 632 steps for a complete revolution or 79 from open to closed and vice versa.

H(1)

Displays the ProbeGuard unit header info.

I(arg)

Commands ProbeGuard to find the nearest of two encoder indexes that are 180° apart. The arg is the max number of steps to move while looking for the index. ProbeGuard returns the number of steps traveled and the inner cup motion error code (ICME)(0=no error, 1=motion error).

J(1)

Launches ProbeGuard into its automated logging cycle. ProbeGuard will immediately run the BDU prime routine and then check for the delayed start time. As soon as the delayed passes, ProbeGuard immediately begins the logging cycle. At the completion of every sampling sequence, ProbeGuard will enter low power (~ 100 microA) sleep until the Logging Interval expires.



M(args)

Command M provides crude control of the Inner Cup and stirrer motors, and should only be used for diagnostic purposes. **Excessive inner cup motion in the forward direction will unnecessarily wear the ramp retaining springs and could lead to inner cup motion failure.**

The first character in the argument selects the motor (1=inner cup, 2=stirrer), the second turns the selected motor on or off (0=off, 1=on) and the third selects the direction to move (0=backwards, 1=forwards,).

Examples:

M111 = Cup motor on forward
M210 = Stirrer motor on reverse
M200 = Stirrer motor off

Note: Command S is more convenient to stop the motors.

R(arg)

Command R moves the Inner Cup in the reverse direction (counter-clockwise when looking down at the Sampling Chamber) the number of steps specified in the argument. ProbeGuard counts 632 steps for a complete revolution or 79 from open to closed and vice versa.

S(arg)

Command S turns off the motor specified in arg (1=inner cup motor, 2=stirrer motor).

T(1)

Command T sets the Real Time Clock date and time. Enter the current date and time in the following format and the clock is reset when the last character is entered.

MMDDYYhhmmss

W(1)

Sets the delayed start time. Enter the desired start date and time in the format specified below which will be stored in memory when the last character is entered. When the logging command (J1), is issued, ProbeGuard will immediately prime the BDU, so it should be in the water when J1 is issued. Flushing will begin prior to the Delayed Start Time based on the amount of flushing programmed (see Synchronization method 3.) so that users can enter the same delayed starts into both ProbeGuard and the sonde. It is



strongly suggested to verify the correct delayed start time has been set with the header command (H1).

MMDDYYhhmmss

Ex: >W1@OK!
Setting Delayed Start *** Using Current Flushing Settings ***

Delayed Start will be adjusted for flushing; Sampling Interval follows thereafter

Format: MMDDYYhhmmss - no spaces, slashes or colons

Seconds should be 00

[062216121500]Flushing will begin =02 previous at:

06/22/16 12:13:00
>

X(1)

Resets CPU.

Y(arg)

The Y command provides **primary utilities** to control ProbeGuard. They should be used for bench testing, but certain commands are designed specifically for deployments in external control mode.

arg	ProbeGuard Action
1	Move inner cup to index position
2	Move inner cup to index position and then to home position (windows fully closed)
3	Move inner cup to index position and then to fully open position
4	Move inner cup forward 1/8 of a revolution (fully open to closed)
5	Open chamber, run stirrer for <i>stir flush</i> (config. value 2), pause for <i>open flush</i> (config value 4) and close chamber
6	Introduce biocide into the sampling chamber. <i>Biocide open</i> (config. value 6) is used to control the size of the dose.
7	Sample test: A complete test of Inner Cup motion, stirring and instrument communication with the protected instrument. Configuration settings for stirring and pauses as well as instrument setup are used.
10	Turn instrument power off
11	Turn instrument power on
12	Test instrument communication only; no Inner cup motion or stirring
13	Prime BDU: Opens BDU vent and valve for 10s to fill chamber with ambient water. Done



automatically when put into logging mode. Should be run at the start of a deployment when using external control mode.

Z(1)

Puts CPU into low power sleep. Send any character to wake CPU and return to command mode.

Lower Case Commands

c(arg):

Prompts the user for a new value for the configuration parameter specified in arg (see Configuration Table in Section 3 above). When arg is 999, ProbeGuard will display the current configuration table, but will not prompt the user for any new values.

Ex: sending 'c20[enter]' then '15[enter]' sets the Sampling Interval to 15 minutes
>c20@OK!
Old Configuration Value=5
Enter new configuration value

15
@OK!

New Configuration Value=15

d(arg):

ProbeGuard displays the individual configuration value for the parameter specified in arg.

6. Bench Testing

Follow the procedures outlined in Section 4 (ProbeGuard Cable Set Up) before attempting to bench test your ProbeGuard unit.

Sending commands:

Open the terminal program and configure it as described in section 5 above. Make sure that the PG power red wire is connected to +12 volts and the black wire to negative and turn on the power source. The terminal should display the following message:

```
PGII 2.30  
Restart (12)  
@CMD  
>
```

To test communications send an Enter character and ProbeGuard should respond with

Green Eyes LLC Easton, MD 21601 +1.443.746.2175
info@gescience.com <http://www.gescience.com>



the following message:

```
@INV  
>
```

Now send Y5[Enter] and ProbeGuard should run its Open-Flush-Pause-Close routine. You should see output similar to that below:

```
@OK!  
Opening Sampling Chamber
```

```
@IDX(0)  
@ENC(36)
```

```
Open Complete  
Stirrer Back-flushing  
Stirrer Flushing
```

```
@ENC(79)
```

```
Close Complete  
>
```

At this point, other Y commands should be run to familiarize yourself with ProbeGuard operation.

Slave Instrument control and communications:

Once the ProbeGuard Slave Instrument configuration settings (values 14,16 and 18) are set for your specific instrument, connect the ProbeGuard cable to the Slave Instrument cable as outlined in section 4 (ProbeGuard Cable Setup) above.

To test data collection, use the Y12 command which does not include any ProbeGuard Inner Cup or Stirrer actions and attempts to collect a line of data from the instrument immediately after the Instrument Warmup period (configuration 16) has elapsed. If successful, the data will be displayed on the terminal and saved on ProbeGuard's internal SD card. If a Data Timeout error is displayed, there is either a cable or configuration problem. Check all cable connections and repeat. A null modem cable may (but not usually) be necessary between ProbeGuard and the Instrument. Also verify that the above configuration values are correct for your instrument. **If problems persist, please contact Green Eyes for support.** All Instrument and ProbeGuard data can be retrieved with the D6 command. See the D command describe in Section 5 for other data handling options.

7. Deployment

Biocide Chamber: The Biocide Chamber should be filled with dry biocide (Fig. 4) in the laboratory prior to deployment if not purchased full from Green Eyes. If filling your own chamber, be sure not to add pellets above the vent bushing or the lid will not fit correctly and the



Green Eyes LLC Easton, MD 21601 +1.443.746
info@gescience.com <http://www.gescience.com> Fig. 4: Biocide Chamber filled with crushed tri-chlor pellets



BDU will not seal properly. If using your own biocide, powdered or fine granular biocide is not recommended as it can clog the chamber and prevent liquid biocide from reaching the valve. Green Eyes currently recommends the use of **Trichloroisocyanuric Acid** (tri-chlor) biocide that is available in most swimming pool supply stores. Pieces used in the BDU should be in pellet form with an average diameter of 3-5mm so there is space for liquid to flow through the chamber. The BDU is automatically filled with ambient water (primed) when the unit is launched into logging mode (J1 command) so no liquid should be added to the BDU in the lab. If deploying PG in external control mode, the Y13 (BDU prime) command should be issued at the start of the deployment. **Appropriate protective wear (e.g. gloves and goggles) should be used when handling biocides. Consult the Material Safety Data Sheet of the chosen biocide for specific safety information.**

Configuration and Mechanics Check: Be sure to confirm all configuration parameters before the deployment. They can be easily viewed and edited with the c command as described in section 5 (Terminal Control). It is then advisable to verify that the Inner Cup and stirring actions are smooth, the window alignments are correct, and the BDU vent and valve are actuating correctly. The Y5 and Y6 commands will demonstrate all of these functions and fully close the sampling chamber when complete.

If deploying in logging mode with data collection from the slave instrument, it is critical to verify data collection as described in Section 6 (Bench Testing) with the Y7 and Y12 commands.

Deployment Screen: The Sampling Chamber should be fitted with the coarse copper screen provided with your ProbeGuard unit around the outside of the sampling chamber to prevent fish and debris from entering and potentially obstructing the motion of the Inner Cup or Propeller (not necessary if deploying inside 4 inch pipe). The screen should rest on a large cable tie secured at the top of the electronics case so that the windows are fully covered, but **no cable ties should be tightened around the screen over Sampling Chamber** (Fig. 5).

ProbeGuard Logging Mode: The J1 command will launch ProbeGuard into its automated logging cycle using flushing, sampling interval and other parameters set with the c configuration command. J1 also automatically sets auto logging to 1 (config. 22) which will restart the logging cycle in the event of a power interruption. If the logging cycle is interrupted by sending a Ctrl-c character (ascii 3) after waking it up from deployment sleep, auto logging is set back to 0 (off). Any Character will wake ProbeGuard from deployment sleep, thus sending two Ctrl-c characters in a row, or an enter (ascii 13) and a Ctrl-c characters will terminate the logging session and return the user to command mode.

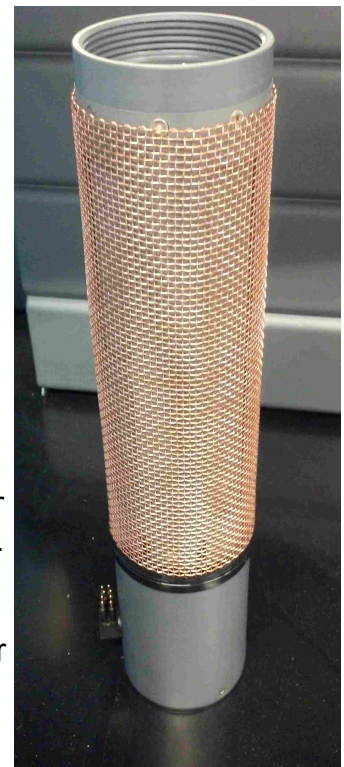


Fig. 5: ProbeGuard with copper deployment screen loosely fitted around Sampling Chamber



Data Format: Each Instrument data line collected by ProbeGuard is appended with ProbeGuard specific data in the following format.

[Instrument data line] 'PG:' [PG date] [PG time] [PG volts] [Smp. index] [Dose frequency] [Dose flag]

Instrument Data Line: The exact line of data sent out by the slave instrument. Users should configure the instrument to their own needs. **Green Eyes assumes no responsibility for instrument data configuration or calibration.**

PG: Included to clearly indicate that the following data is specific to ProbeGuard

PG date: ProbeGuard date when data was collected from the instrument. See command T1 to set PG date and time.

PG time: ProbeGuard time when data was collected from the instrument. See command T1 to set PG data and time.

Smp. index: Set to zero at the start of the deployment and after each biocide addition.

Dose frequency: Configuration value 8, that indicates the number of clean, untreated samples collected before the addition of biocide.

Dose flag: 'Clean' for regular environmental samples collected after flushing and 'Dosed' when collected immediately after the addition of biocide to a closed sampling chamber.

Interpreting sample Indexes and Data Flags: In addition to the scheduled instrument data collected after opening the sampling chamber ("Clean" data), ProbeGuard collects diagnostic "dosed" data after biocide has been added to the closed sampling chamber. To avoid any confusion, all data lines are labeled with either a "Clean" or "Dosed" flag. So that users can easily identify the relative order of both clean and dosed data, the sample index and dose frequency values are also appended to each data line. The sample index will be one larger than the dose frequency when data is flagged with "Dosed". The sample index will be reset to one after the biocide addition.

Data Logger Control: If using an external device such as a data logger or computer to synchronize the sample activities of ProbeGuard and the protected instrument, the ProbeGuard instrument power and communications cables do not need to be connected to the instrument. Instead, the instrument and ProbeGuard are controlled directly by the data logger. Users should configure flushing and dosing parameters accordingly.

To begin the deployment, it is important to first send the Y13 command to prime the biocide chamber with ambient water. To sample clean, flushed data, send ProbeGuard the Y5 (Open-Flush-Pause-Close) command and program the data logger to collect data just before the sampling chamber closes. To treat the sampling chamber and sensors with biocide, send the Y6 (Dose) command at the desired interval and immediately after a



Y5 command is completed. If power is very limited, users can put ProbeGuard into low power sleep by sending the Z1 command after the Y5 command is completed. **It is then critical to send a wake up character (any character) before additional commands or they will not execute.** See the ProbeGuard spec. sheet for power consumption details.

8. SDI-12 Interface

ProbeGuard can be controlled in field deployments by SDI-12 data loggers with the SDI-12 to ProbeGuard converter (Figs. 6 and 7). The converter supports required SDI-12 commands such as I – information, and A for address changes as well as M – measure commands to control ProbeGuard operation (see SDI-12 table below). For a deployment, the instrument that is protected by ProbeGuard would also be on the data logger's SDI-12 bus so the data logger can synchronize ProbeGuard's flushing and chlorine injection with the Instrument sampling.

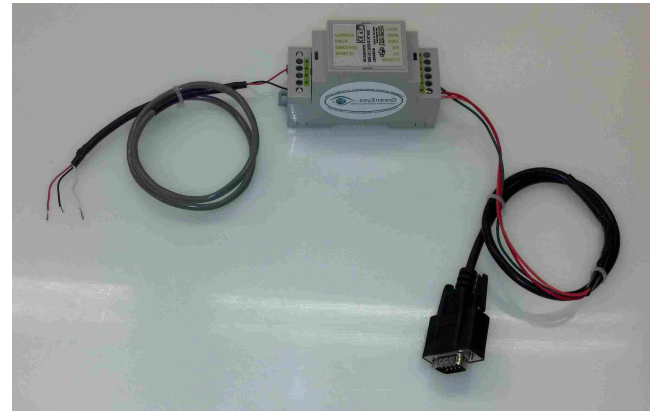


Fig. 6: SDI-12 to ProbeGuard converter

Connections:

The db9 serial cable plugs directly into the user interface and the SDI12 cable (three conductor cable on left in Fig. 6) is connected to the SDI-12 terminals (power, ground, and data) on the data logger.

SDI-12 converter wiring table:

SDI-12 to ProbeGuard RS232 Converter			
Wire color	SDI-12 side	ProbeGuard Side	Wire color
		Shield (S)	optional
optional	(S) Shield	Tx (T)	orange
black	(G) SDI-12 Grd	Rx (R)	red
white	(D) SDI-12 Data	Grd (G)	green
unused	(P) Power	Grd (G)	unused
		SDI-12 +12V (P)	red (from SDI-12 logger)



SDI-12 commands for ProbeGuard

The SDI-12 commands coming from the data logger are actually converted to standard RS232 flushing and biocide injection commands (see Y command in section 5) necessary to control ProbeGuard during a deployment.

The specific commands are:

SDI-12	Converter	ProbeGuard
aM!	→	Y5 (Open, Flush, Pause, Close)
aM1!	→	Y6 (Add chlorine and mix)
aM2!	→	Y13 (Prime BDU)
aM3!	→	Z1 (low power sleep, must wake)
aM4!	→	Wake (must wake before sending new command)



Fig. 7: ProbeGuard SDI-12 convertor showing +12V supply wire along side of unit

Other generic SDI-12 commands such as a!, A!!, aAb, and ?! are also supported.

9. Telemetry and Real Time Data Collection

When deploying ProbeGuard in logging mode, real-time data from the slave instrument can be collected by either capturing data lines that are transmitted out the user interface immediately after collection, or by polling ProbeGuard between samples for data with the D command. To poll for data, a wake up character (any character) must be sent when PG is in low power sleep between samples. Within 5 seconds of wake up, a D (ASCII 68) character should be sent to which ProbeGuard will respond by outputting the contents of the temporary data file. ProbeGuard will then delete the temporary data file so that each time the D command is received, ProbeGuard only outputs “new” data. **All data is also stored on the permanent data file and not effected by the D command.** Although many systems exist capable of collecting and processing real time data, Green Eyes' ComScript software (www.gescience.com, see products menu) has been pre-configured to collect, store, plot and publish PG-Instrument data on the web. ComScript currently runs on Windows and Linux operation systems and can be deployed on a low-power, low cost, Raspberry Pi computer ideal for field monitoring systems. Please visit the ComScript page to learn about its unique time saving features.

Minute messages from ProbeGuard: While in logging mode, ProbeGuard briefly wakes every minute to output a message with data that indicates that it's in logging mode, how many minutes until the next sample and the current Clean and Dosed cycle position.

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Minute message format:

[PG date] [PG time] [Minute Counter] [Logging Interval] [Smp. index] [Dose frequency]

Minute Counter: Elapsed minutes since the last sample was initiated

Logging Interval: Config. Value 20, minutes between samples

Note: Other variables described above



10. Field Servicing

ProbeGuard requires minimal servicing in the field between deployments, but some cleaning is required that can be done at the field site with a scrubby sponge, a medium sized bottle brush and some soapy water (water from the field site is fine if no fresh water is available). The used BDU should also be replaced with a full one. Field servicing should require no more that 20 minutes and less for experienced users.

Field servicing procedure:

1. Remove the copper deployment screen and wash as necessary.
2. Note the orientation of the Sampling Chamber. Unless ProbeGuard was stopped in the middle of a sampling or dosing activity, the windows should be fully closed.
3. Remove the eight m4 screws at the base of the Outer Cup and lift it off the ProbeGuard electronics case.
4. Remove the four m4 screws that fasten the Inner Cup to the Inner Cup Disk.
5. Remove the BDU by unscrewing the four m4 screws that fasten it to the Inner Cup. Place the used BDU in a chemically resistant container as it may still contain biocide.
6. Hand wash the inside and outside cups as necessary with the bottle brush and scrubby sponge.
7. Gently wash any sediment from the ramp area under the Inner Cup Disk. **Be gentle near the latex ramp springs.**
8. Fasten the replacement BDU into the Inner Cup with four m4 screws.
9. Screw the Inner Cup and BDU onto the Inner Cup Disk. Be sure the BDU pegs penetrate the holes in the Inner Cup Disk and are not positioned on top of the ramps. There is no “right or wrong” orientation of the Inner Cup and BDU.
10. Place the Outer Cup back on the electronics case so that the alignment line on the Outer Cup and electronics case are aligned. The Sampling chamber should be in the same orientation as it was when you removed the Outer Cup.
11. If a PC is available, it is useful to send the Y5 command to test proper reassemble and function. **When the Y5 command concludes, the Sampling Chamber windows should be fully closed.** If they are fully open, the Outer Cup needs to be rotated so the windows are fully closed. Because the BDU should be dry and



will not release any biocide during a test, it is also suggested to run the Y6 command to test proper dosing function.

12. Slide the cleaned copper screen back onto ProbeGuard.

13. ProbeGuard is now ready to begin another deployment.

11. Annual Servicing and Support

ProbeGuard units that are in regular service should be returned to Green Eyes for annual servicing. Green Eyes will completely disassemble the unit and inspect all moving parts for signs of wear. All springs and sealing o-rings will be replaced and the unit will be run through a diagnostic check before return within two weeks or less of receipt. See current ProbeGuard price sheet for servicing costs.

Contact Green Eyes (info@gescience.com) to schedule annual servicing.

12. Warranty and Disclaimers

Warranty

Green Eyes LLC warrants the ProbeGuard against faulty materials and workmanship for a period of one year from the date the unit originally ships to the owner.

Faulty units will be repaired or replaced at Green Eyes option free of charge provided they are delivered to Green Eyes LLC's premises at the owners/users expense, and providing

all manufacturers recommendations with regard to operation, servicing and storage have been followed. In particular, the warranty will not apply if the fault has been caused by misuse, attempted repair or modifications in a manner unauthorized by Green Eyes LLC.

Limited Liability

Green Eyes LLC disclaims all product liability risks arising from the use or servicing of this equipment. Green Eyes LLC cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers as it has no way of controlling the use of this equipment or selecting the personnel to operate it. Acceptance of this system by the customer shall be deemed to include a covenant by the customer to defend, indemnify, and hold Green Eyes LLC harmless from all product liability claims arising from the use or servicing of this system.



Disclaimers

All information in this manual is believed to be accurate and reliable. However, no responsibility is assumed by Green Eyes LLC for inaccuracies. While every effort has been made to ensure that this document is correct, errors can occur. If you find any errors or omissions please let us know. Green Eyes LLC reserves the right to change product design, operation, specifications and documentation without notice.

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