

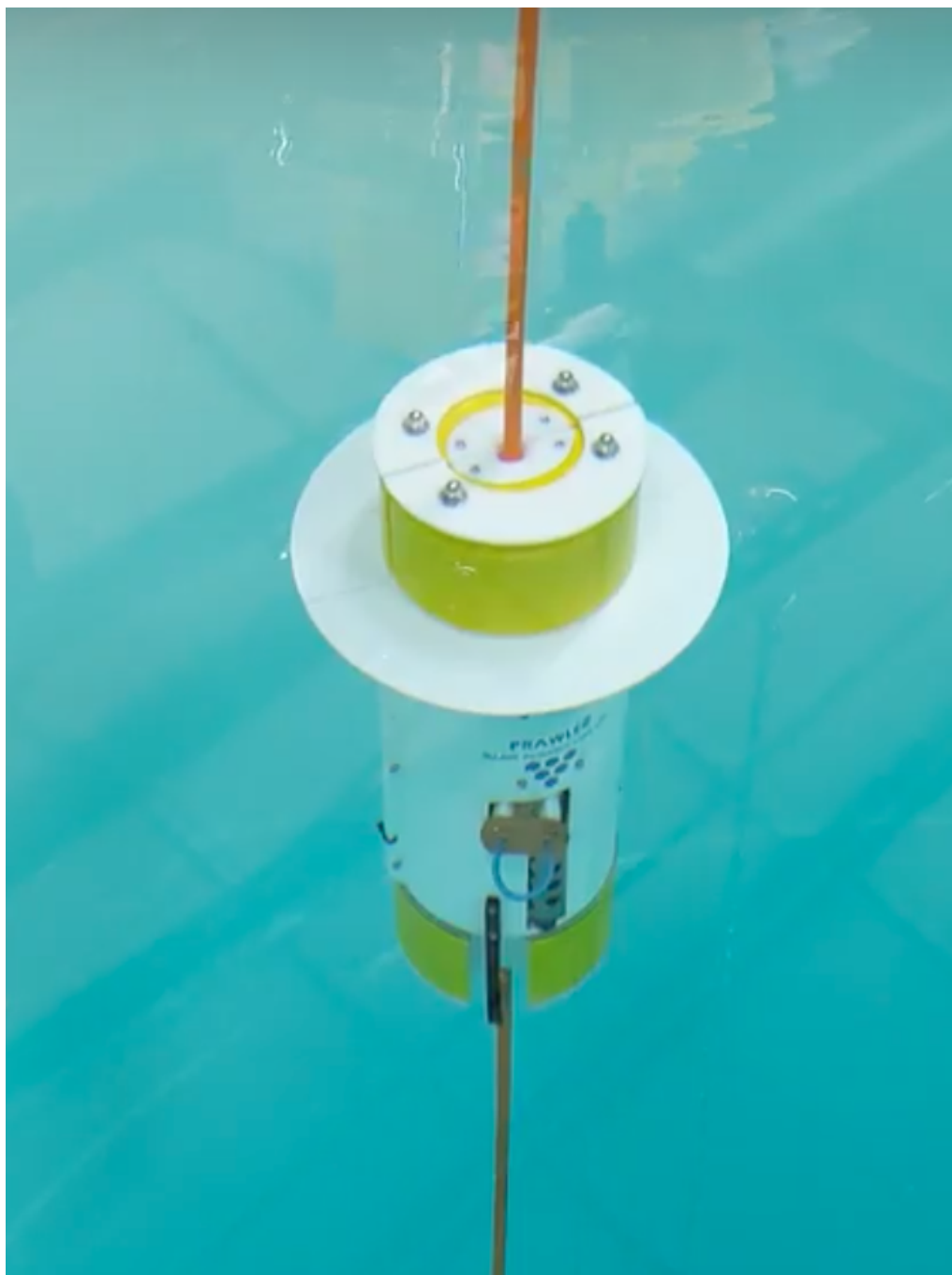
Profilers Samplers Flotation



mclanelabs.com

PRAWLER

User Manual



©2024 McLane Research Laboratories, Inc., Rev. 24.C.18
Tel: +1 (508) 495-4000
mclane@mclanelabs.com

Skype: mclane_research
www.mclanelabs.com

Prawler User Manual Table of Contents

Chapter 1 Introduction and System Description	1-1
McLane Prawler	1-1
Deployment	1-2
Sensors	1-2
Prawler Drawing	1-2
Profiling Modes	1-3
Using this Manual	1-4
User Key	1-4
Customer Resources	1-4
Technical Support	1-5
Mechanical Components	1-6
System Components	1-6
Outer Shell	1-6
Core	1-6
Battery Tubes	1-6
Top End cap	1-6
Ratcheting cam	1-6
Optode tube	1-7
Mooring Wire	1-7
Wire Rope:	1-7
Prawler Wire Jacketing:	1-7
End Caps and O-Rings	1-7
Motor Housing	1-7
Prawler Toolkit	1-8
Electronics Components	1-9
System Files	1-9
Communications Bulkhead Connector Styles	1-10
6-Pin COM Connector	1-10
Battery	1-11
Chapter 2 Getting Started	2-1
Connecting the Prawler to a Computer	2-1
Connecting to a Computer	2-1
Powering on the Prawler	2-2
Opening the Core Assembly	2-2
Establishing Communication with the Firmware	2-6
Waking the Prawler from Low Power Sleep Mode	2-6
Powering Off the Prawler	2-6

Chapter 3 User Interface.....	3-1
COM Port Communication.....	3-1
Terminal Commands.....	3-1
Science Board Commands.....	3-11
Chapter 4 Operations.....	4-1
Ballasting.....	4-1
Programming a Deployment.....	4-2
Standard profiling mode.....	4-2
Station keeping profiling mode.....	4-2
Committing to the Deployment.....	4-5
Starting a deployment.....	4-5
Final Deployment Operations.....	4-5
Closing and Sealing the Controller Housing.....	4-5
Attaching the Dummy Plug and Connecting the Battery.....	4-5
Attaching the Prawler to the Mooring Wire.....	4-6
Mooring Example.....	4-8
Chapter 5 Deployment and Recovery.....	5-1
Deployment Termination.....	5-1
Battery Drain.....	5-1
Recovery Procedure.....	5-1
Offloading deployment data.....	5-2
Data Format.....	5-2
CTD Data Format.....	5-3
Optode Data Format.....	5-3
Fluorometer Data Format.....	5-3
Chapter 6 Maintenance and Storage.....	6- 1
O-Rings.....	6-1
Bulkhead and Cable Connectors.....	6-2
Stainless Steel Hardware.....	6-2
Cam Cleats and Springs.....	6-2
Replacement of Cam cleats and springs.....	6-3
Battery Maintenance.....	6-9
Sensor Maintenance.....	6-9
Packaging and Storing.....	6-10
Storing the Battery.....	6-10

Chapter 1

Introduction and System Description

McLane Prawler

The Prawler is a wave actuated wire crawling profiler that uses the movement of the mooring line to climb up. The Prawler can climb from a maximum depth of 500m to the surface. After reaching the programmable upper limit, the Prawler will fall at an approximate rate of 30 cm/s to the programmable lower limit. The Prawler is constantly moving, reducing biofouling on the line and the vehicle. Data collection profiles can be programmed to occur anywhere from 1 to 24 profiles per day. Deployments can last up to one year depending on frequency of data profiles, depth, and power requirements of installed sensors. Sensors are powered using four 30Ah lithium batteries for a total of 120Ah. Year-long deployments are possible depending on science profile frequency, depth, and power requirements of installed sensors.

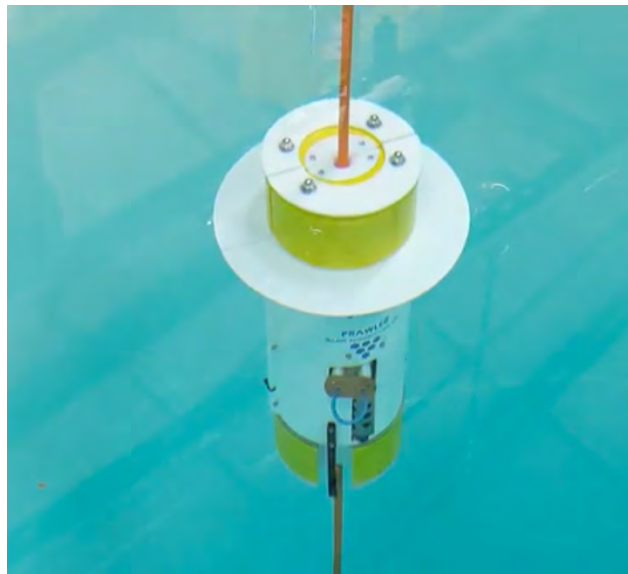


Figure 1-1: Prawler

Sensors are user-selected based on the scientific needs of the project. Other software used with the Prawler includes inductive communications are included with the Prawler for near real-time data transfer (this function requires a customer-supplied surface package).

Deployment

For best results, deploy the Prawler where wave action is consistent. Deployments in low wave action is possible but will affect Prawler performance.



The Prawler requires a surface buoy to move with the waves for movement on the mooring line. Deployment in low wave areas such as bays and large lakes is possible but may impact timing of science profiles.

Sensors

The Prawler supports a Sea-Bird Prawler CTD (based on the Sea-Bird 37 CTD model), a Sea-Bird optical ECO (optional sensor), and an Aanderaa Oxygen Optode (optional sensor). Sensors start collecting data during an upward profile one meter below the upper limit. The Prawler then collects data at a user specified rate up to 1 sample every 4 seconds. Data is stored on a MICRO SD card, and transmitted through an Inductive Modem Module (IMM) at the end of each science profile.

Prawler Drawing

The Prawler Drawing shown next illustrates the mechanical design and construction of a standard Prawler with an example CTD, oxygen optode, and optical sensor installed.

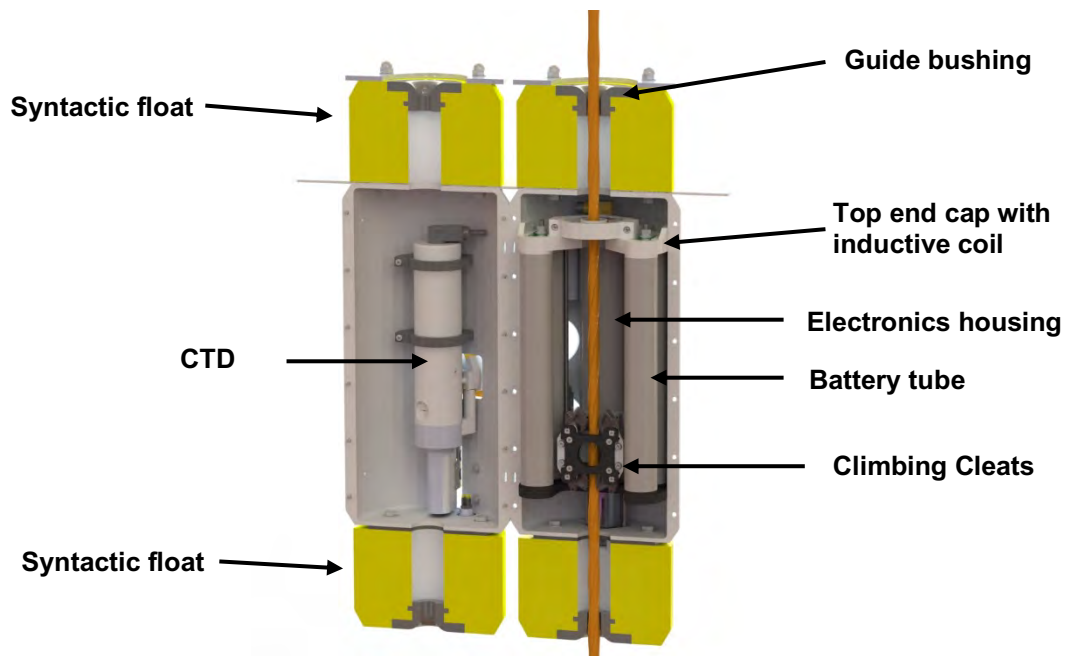


Figure 1-2: Prawler Line Drawing

Profiling Modes

The Prowler is constantly profiling between the upper and lower limit. Science profiles can be performed from 1-24 times per day. The Prowler has Standard and Station keeping science profiling modes. The Prowler is set to standard mode by default. A description of profiling modes is provided below.

Profiling Mode	Deployment Requirements	Other Considerations
Standard	The Prowler will turn on sensors 1 meter below the upper limit. The Prowler will continue to sample at a user specified sample rate on a downward profile, data is saved to the SD card and transmitted via IMM.	The user can also program an inflection point depth. A second sample rate can occur past this depth. Typically used to decrease sample rate to save battery life and increase data density for a desired depth.
Station Keeping	For Station keeping profiles, the user can specify up to 10 depths for the Prowler to park and sample. After reaching the upper limit, the Prowler will fall to the first station and park. After the sample is completed, data is saved and the Prowler will fall to next station depth. After all samples are complete, the Prowler will fall to the lower limit and transmit the data via IMM.	The user can specify the depth, number of samples taken, wait time before sampling, and sample rate for each station. Wait time allows the sensors to reach equilibrium with the surrounding water before sampling.

Using this Manual

This user manual describes the operation and maintenance of the McLane Prawler, an autonomous, wire crawling instrument that collects time-series, in situ data at user defined depths. Read this manual and keep a copy as a reference if you plan on using a Prawler. McLane user manuals are updated frequently and the current version can always be downloaded from our website. Operators and technicians should read this manual and keep a copy as a reference.

This User Manual provides:

- Descriptions and specifications of mechanical and electrical parts of the system.
- Operating instructions.
- Suggested maintenance procedures to extend sampler performance.

User Key

This user manual contains the following symbols that call attention to information:



Note

This symbol indicates information and tips that are helpful for operating the instrument.



Important

This symbol indicates information that could affect key product operations.



Caution

This symbol indicates information that must be followed to prevent instrument damage or user injury.

Customer Resources

McLane Research Laboratories is on the Web at: <https://mclanelabs.com/prawler/> or via email at mclane@mclanelabs.com. The [Prawler pages](#) on the McLane website contain links to documentation including Technical Bulletins, and scientific papers that describe the development and use of the Prawler.

Technical Support

When contacting McLane for technical support, please provide the following:

- Firmware version and Prowler serial number. Serial number is printed on a label attached to the controller housing and outer shell.
- A description of the problem.
- Any relevant capture files (deployment setup, offload data, and so on – capturing all your communications is critical for successful technical support).

Mechanical Components

System Components

The Prowler has two main components; the outer shell and the core. The outer shell protects sensors and system components, holds the drag plate, and guides the vehicle on the mooring wire. The core consists of smaller assemblies, battery tubes, top end cap, electronics housing, motor housing, and oxygen optode tube (if installed).

Outer Shell

The Prowler has an outer shell made from cast plastic with glass fiber fill for added stiffness. The outer shell has syntactic foam floats on top and bottom, along with a 35 cm diameter polypropylene drag disk. The outer shell holds components together while also adding drag to increase climbing speed and reduce fall speed for increased data density.



The Prowler shell is abrasion-resistant. However, use care during handling. The shell and drag plate can be damaged by dragging or drops.

Core

The inner core consists of four battery tubes and an electronics housing connected through the top end cap rated for 500 m depth. The electronics housing connects to the motor housing, with the optional Optode tube protruding from the bottom of the motor housing.

Battery Tubes

The Prowler has four separate battery tubes. Each composite fiberglass battery tube holds a lithium primary battery pack. All batteries packs are connected in parallel through the top endcap.

Top End cap

The top end cap connects the main electronics housing with the battery tubes, CTD and Sea-Bird bulkhead, and inductive coil. The 100-turn inductive coil is molded into the top end cap for Inductive Modem Module (IMM) communication.

Ratcheting cam

The climbing mechanism consists of (4) titanium cam cleats, (2) elgiloy springs, and a plastic cam for opening and closing the cleats. The Prowler has four positions of the cam: Fall, Park, Climb Up, and Climb Down. The Prowler is negatively buoyant. During a typical profile the Prowler will ratchet up the line to the shallow pressure stop. The cam cleats are moved to the fall position and the Prowler free-falls to the deep pressure stop. The Prowler can park on the line for stationary data

collection, and can also ratchet down the line in the case of high currents or updraft preventing the Prawler from falling under its own weight.

Optode tube

The bottom tube houses a leak detection board and the Aanderaa Oxygen Optode (if connected). The Aanderaa Optode is protected by the surrounding syntactic foam.

Mooring Wire

The mooring wire must be purchased from McLane, as it is specially designed for the Prawler's ratcheting action.

Wire Rope:

- Wire rope is 3/8" diameter, 3X19 construction, galvanized, improved plow steel.
- Wire rope has low rotation construction.
- Wire has a minimum breaking strength of 12,500 pounds.
- Wire is provided on heavy duty wooden reels with a center hole of not greater than 4" diameter, with a 1" diameter drive hole located within 10" of the center of the reel.

Prawler Wire Jacketing:

- Wire rope is over jacketed with a polyurethane extrusion. This extrusion will be manufactured from Texin 9-90 shore A 90 durometer orange polyurethane (PU).
- The PU jacket has external Ridges for Strum Suppression (RSS). The RSS will be a 9 parallel ridge design, equally spaced around the line (over 360°), with a 36" period (can be clockwise then counter-clockwise then clockwise again, etc.), and a nominal ridge height of .015".
- The outer diameter of the jacketing will be 0.543", not including the RSS ridges.
- The jacketing will be extruded so that it penetrates the wire rope, leaving no void spaces between the wire lays.

Contact mclane@mclanelabs.com for more information.

End Caps and O-Rings

The top end cap has (8) 2-125 o-rings for the battery tubes, and (2) 2-141 for the main housing. O-rings and surfaces should be regularly cleaned with isopropyl alcohol. O-rings should be lubricated with provided Parker O-Lube and replaced when necessary. The toolkit has spare o-rings. More o-rings can be purchased from McLane.

Motor Housing

The motor housing has an end cap with a 2-149 and 2-038 70A durometer o-ring and an 8-038 90A durometer backup ring. The front balseal has a cavity with filled with Mobil SHC 630 oil. This

balseal has (2) Lip seals and 2 2-018 70A durometer o-rings. More information can be found in the maintenance and repair section.

The motor uses a worm gear to rotate the camshaft. A rear cam presses one of 4 microswitches to note alignment of the cam for the four directions: Fall, Park, Climb Up, Climb Down.

The Prawler uses an 6-pin MCIL connector for communication. Older systems may have an Impulse IE55 6 pin Bulkhead. Wiring diagrams for both are shown in the Electronics section of this Chapter.

Prawler Toolkit

Each Prawler is shipped with a toolkit that contains the necessary tools, materials and devices to use the instrument. The toolkit and contents are referred to throughout this User Manual, and should remain with the instrument at all times.



Figure 1-3: Toolkit



The Prawler toolkit in Figure 1-3 is shown only as an example. Do not use the photo to compare with your actual toolkit contents.

Electronics Components

The Prawler Truck firmware runs on a TI MSP-430. The Truck controls the cam motor, secondary pressure transducer, and IMM. The Truck also controls power to the science board which is turned on during science profiles. The Science board uses a Motorola MC68332. The science board communicates with the sensors, stores data, and controls the real time clock.

Prawler electronics include the following components:

Truck Board	TI MSP 430, controls cam motor, secondary pressure transducer, IMM modem, and battery power to science payload
Science Board	Motorola MC68332, Communicates with sensors, real time clock and micro SD card for data storage.
Cables	COM cable connects the Prawler to an external computer and can power truck board. Sensor cables connect sensors to the electronics.
Communications	USB and inductive communications provide transfer of data from the Prawler.
Sensor sampling	Sensors are sampled at the user-specified interval and data is stored on the Prawler micro SD card. Supported sensors include CTD, Optical ECO, and Dissolved oxygen.
Watchdog circuit	A real-time clock chip that sends periodic interrupt requests to the microcontroller. An unacknowledged request signals the microcontroller to restart. The watchdog is powered by the main battery and is also backed up by a Lithium coin cell battery. This battery should be replaced periodically. Contact mclane@mclanelabs.com for details.

System Files

The micro SD card stores the system files. Data is saved to a user specified file name that is configurable using the science board format command.

The Prawler electronics communicate using USB communications and a terminal emulator, McLaneTerm. See Chapter 2 in this User Manual. “Getting Started” for more information about McLaneTerm, a program that is provided with the system and must be installed on the computer that will connect to the Prawler. A communications cable included in the toolkit connects the Prawler controller with a computer.

Communications Bulkhead Connector Styles

The communications cable bulkhead connector is a 6-pin MCIL connector located on the left side of the motor housing. The communications cable is accessible through the back of the outer shell.

6-Pin COM Connector

The wiring diagram for communication cable is shown below.

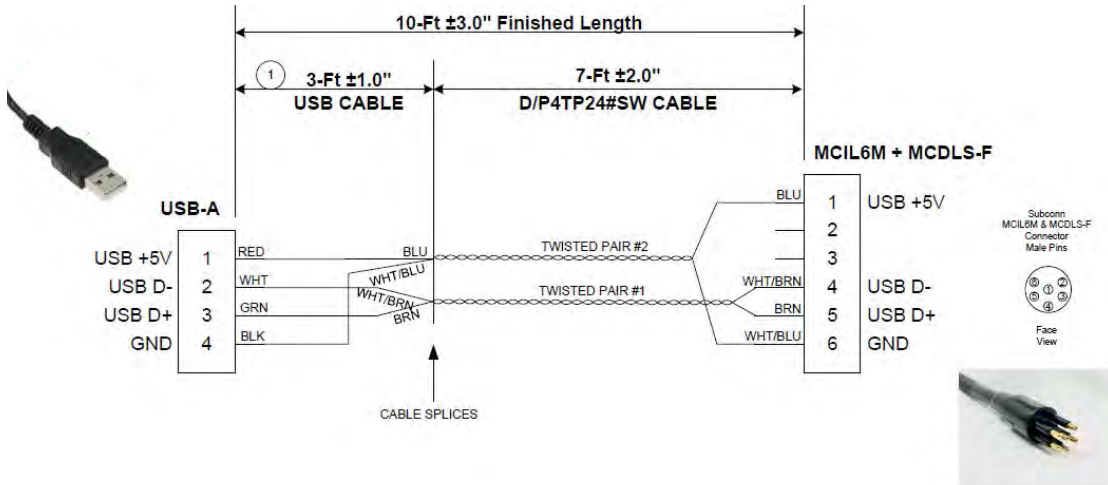


Figure 1-4: COM Connector Diagram (6-Pin)



Figure 1-5: 6-Pin COM Connector

Battery

The four Prawler battery packs are Lithium battery packs, D type cells Lithium Bromine Chloride chemistry, non-rechargeable. This battery requires shipping per UN 38.3 DOT regulations.

See Chapter 2, 'Getting Started' for details on connecting the battery.



Figure 1-6: Lithium battery pack



All batteries must be removed from the Prawler before return to McLane. A hazardous waste disposal fee will apply to any lithium batteries that are shipped to McLane.

Chapter 2

Getting Started

Topics Covered:

- Connecting to a computer.
- Installing and configuring McLaneTerm terminal emulation software on a computer.
- Powering up the Prowler.
- Communicating with the Prowler.
- Waking a Prowler from low power sleep mode.

To complete the steps in this chapter, **you will need** the McLaneTerm software and McLaneTerm User Manual that shipped with the instrument. This tool can also be downloaded at <https://mclanelabs.com/software-utilities/>.

Connecting the Prowler to a Computer

Communicating with your instrument requires installing and configuring the terminal emulation program McLaneTerm, and connecting the communications cable to the computer.

Connecting to a Computer

After McLaneTerm is installed on your computer, locate the COM cable (in the instrument's toolkit) that connects the instrument and a computer. This cable plugs directly into a USB port. Your computer may require installation of a driver to communicate with the Prowler.



Figure 2-1: Communications Cable

Powering on the Prowler

A USB connection will power on the truck board to set deployment parameters. However, the science payload and motor commands will not be available without batteries connected. The Prowler runs on four, 15 Vdc lithium primary batteries connected in parallel. These batteries are held in four separate battery housings. All housings are accessible by removing the main end cap. This step requires opening the core assembly. The core assembly contains the electronics and lithium batteries. Be sure to perform this procedure in a dry area and familiarize yourself with steps.

Opening the Core Assembly

1. If the Aanderaa optode is installed, remove the bottom float surrounding the Aanderaa optode using a 9/16” wrench and nut driver.



Figure 2-2: Remove Aanderaa optode bottom float

2. Use a Phillips head screws driver to remove the 12 screws holding the core to the outer shell.

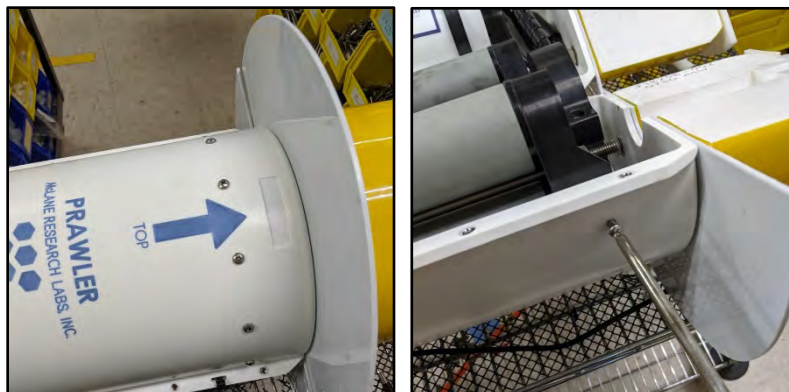


Figure 2-3: Remove screws that attach core to outer shell

3. Disconnect the CTD cable from the top end cap of the core assembly.



Figure 2-4: Disconnect CTD cable

4. Slide the core assembly out of the outer shell assembly.
5. Use a 7/16" nut driver to loosen the four 1/4-20 nuts on the top end cap. Keep nuts on the end of the tie rods.

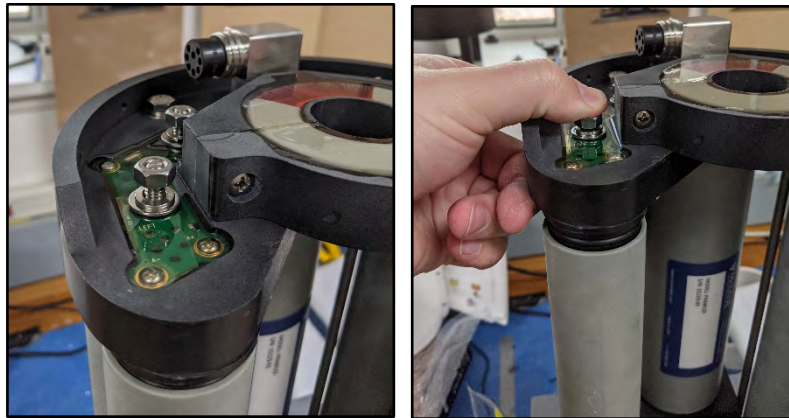


Figure 2-5: Loosen nuts on top end cap and carefully pull away from housings

6. Carefully remove the top end cap by pulling the top end cap away from housings. Keep endcap level.

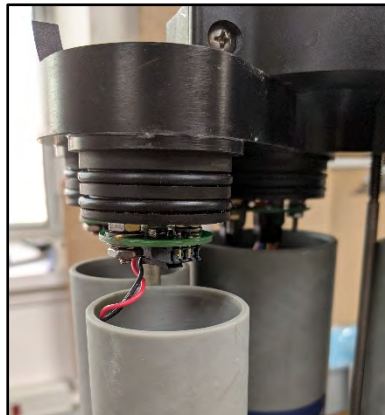


Figure 2-6: Carefully remove top end cap

7. Once the second set of o-rings are visible, fully remove 1/4-20 nuts and gently lift the end cap and remove all cables from the end cap.



Carefully remove the end cap to avoid damaging the wires and connectors.

8. Slide one battery into each battery housing. Be sure there is foam in the bottom of the tube. Place another foam disc on top of the battery, keep wire on top of foam.

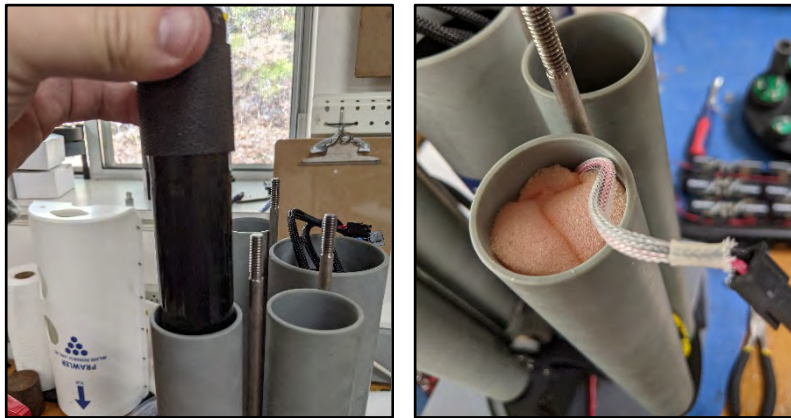


Figure 2-7: Slide one battery into each housing and place foam discs

9. Plug all four battery cables into the top end cap, then plug in connectors in electronics housing. Once power is connected, the cam motor will rotate once, ending on the fall position if battery power is turned on.
10. Make sure all cables are fully in housings, slide tie rods through the top end cap, and align housings with plugs in the top cap.
11. Push end cap onto housings and tighten 1/4-20 nuts onto tie rods. Housings should be flush with the end cap.

12. Place core assembly into the outer shell and reconnect CTD cable.

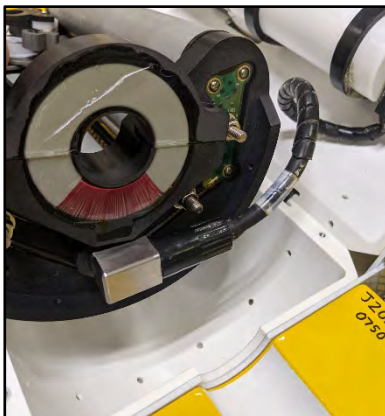


Figure 2-8: Reconnect CTD cable

13. Re-attach core assembly to the outer shell using 12 8-32 x 1/2" pan head screws.



Figure 2-9: Re-attach core assembly to outer shell

14. Attach the bottom float using 3/8-16 hex nuts.

Establishing Communication with the Firmware

1. After system initialization, press any key to wake the firmware.



Disconnect the main battery before shipping to prevent electrical system damage during transit. Before disconnecting power, turn off battery power using the turnoff command.

Waking the Prowler from Low Power Sleep Mode

The profiler will enter a low power mode if it sits idle for more than 30 seconds. To wake the system from this suspended state, press any key. After waking, the Hotkey Menu will display (Figure 2-10).

If the system does not wake, check the previous sections of this chapter to make sure procedures were followed correctly.

```
Hotkey Menu
P = print statement on/off
S = sim mode on/off
A = standalone mode on/off
Y= terminal mode
N= log mode
```

Figure 2-10: Main Menu

Powering Off the Prowler

To power off the Prowler, complete the following steps:

1. Connect communications cable
2. Press any key to wake system.
3. Enter terminal mode by pressing 'y'.
4. Enter the 'turnoff' command.
5. Disconnect the lithium battery pack.

Chapter 3

User Interface

This chapter introduces the user interface including com port communication and IMM communication.

COM port Communication

Once connected to the com port, press any key to bring up the Hotkey menu. Pressing the corresponding key will turn on or enter the corresponding mode. The system will time out and return to logging mode after a few seconds.

```
Hotkey Menu
P = print statement on/off
S = sim mode on/off
A = standalone mode on/off
Y= terminal mode
N= log mode
LOGGGING IS STOPPED!!
```

Figure 3-1: Press any key to display Hotkey menu

P = print statement on/off
Turning print statements on will display debug information over the com port while profiling.

S = sim mode on/off
Sim mode sends out communication data for bench testing (factory use only).

A = standalone mode on/off
Toggles the output of the Prawler data messages between Binary and ASCII.

Y= terminal mode
Terminal mode allows the user to change and view parameters.

N= log mode
Log mode will deploy the system based on the defined parameters.

Terminal Commands:

To enter terminal mode, press any key to wake the Prawler and type “Prawler” to enter terminal mode.



All commands must be terminated in McLaneTerm with <CTRL> ENTER.

Command	description
help	Display the command set.
version	Show the current software version
log	Exit terminal mode and go to log mode
sreset	Restart electronics stack
turnon	Turn on main battery power.
turnoff	Turn main battery power off.
liststations	List all station keeping station parameters.
status	Show current status of Prawler.
park	Change cam direction to park position.
fall	Change cam direction to fall position.
climb	Change cam direction to climb position.
ul= [meters]	Set upper limit of profile. Minimum depth 0m.
ll= [meters]	Set depth limit of profile. Max depth 500m.
timeout= [seconds]	Set profile timeout of Prawler in seconds..
np= [number of profiles]	Set number of scientific profiles per day, 1-24.
samplerate= [seconds]	Set sample rate of science profile in seconds, min 4 seconds.
ip= [meters]	Set depth of inflection point on scientific profile.
irate= [seconds]	Set sample rate after inflection point depth, min 4 seconds.
nowrate= [seconds]	set sample rate of now command, max speed of sampling is 4 seconds
station= [ID] [depth] [# of samples] [wait time] [sam rate]	Set station keeping parameters for station keeping profile.
maxstation= [number]	Set maximum number of stations from 1 to 10.
calnum xx	Set how often the secondary pressure transducer is calibrated.
standon	Change Prawler IMM Communication from Binary to ASCII
standoff	Change Prawler IMM Communication from ASCII to Binary
testsensor	Test all configured sensors.
camdown	Turn on camdown mode.

camoff	Turn off camdown mode.
wateron	Turn on the leak detection inside the Prawler.
wateroff	Turn off leak detection inside of Prawler.
printon	Turn on debug print statements.
printoff	Turn off debug print statements.
scicon	Communicate directly with the science payload board.

Help:

Description: Display the command set.

Syntax: Help

Example:

```

>help
***** Command List *****
help This list
version Show current software version number
log log mode
sreset software reset
liststations List all of the stations
status status of the Prawler limits
*****motor *****
park turn to the park position
fall turn to the fall position
climb turn to the climb position
*****Setting truck limits menu *****
ul= xx set upper limit for Prawler
ll= xxx set lower limit for Prawler
np= xx set number of sensor profile
ip= xx set inflection point for Prawler
timeout= xxxx set timeout for Prawler
station= xx Number of stations for Prawler
maxstation= xx max stations up to 10
samplerate= xx sample sensors rate fastest is 4 seconds
nowrate= xx sample sensors now rate fastest is 4 seconds
iprate= xx sample sensors rate after the inflection point fastest
is 4 seconds
mbs= xxxx,xxxx set pressure calibration, * number by 1000
calnum number calibrations 0 = off
*****debugging menu *****
simon sends out data to the pressure simulator
simoff turn off simulator
standon sends out engineering status in ASCII
standoff turn stand off
scicon pass thru to science payload
sensortest test the science payload
*****options menu *****
camdown camd own
camoff cam down off
wateron water detect on
wateroff water detect off
printon turn on usb print statements
printoff turn off usb print statements
turnon turn on battery power
turnoff turn off battery power

```

Version:

Description: Show the current software version

Syntax: version

Example:

```
ICM_Prawler>>>version  
version 02.02.01
```

Log:

Description: Exit terminal mode and go to log mode

Syntax: log

Example:

```
ICM_Prawler>>>log  
  
ICM_Prawler>>>  
Going to logging mode
```

Software Reset:

Description: Restart electronics stack

Syntax: sreset

Example:

```
ICM_Prawler>>>sreset  
  
No comms to IMM  
checking limits...OK  
  
***ICM term ***  
ICM_Prawler  
version 02.02.01  
  
Going to logging mode
```

Turn Power On:

Description: Turn on main battery power. The truck board can be powered on via USB, however cam and science board functionality are disabled. Connect and turn on battery power to enable features.

Syntax: turnon

Example:

```
ICM_Prawler>>>turnon
```

Turn Power Off:

Description: Turn main battery power off.

Syntax: turnoff

Example:

```
ICM_Prawler>>>turnoff
```

Liststations:**Description:** List all station keeping station parameters.**Syntax:** liststations**Example:**

```
ICM_Prawler>>>liststations
Station 0 = Meters= 5 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 1 = Meters= 10 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 2 = Meters= 15 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 3 = Meters= 20 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 4 = Meters= 25 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 5 = Meters= 30 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 6 = Meters= 35 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 7 = Meters= 40 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 8 = Meters= 45 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 9 = Meters= 50 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
```

Status:**Description:** Show current status of Prawler.**Syntax:** status**Example:**

```
ICM_Prawler>>>status
meter=0000
dir=9
NP=8
sam_rate=8
IP_rate=15
ul=004
ll=500
INF=250
err=2500
rt=0002
aborts=0000
vacuum=1003
pkt=0000
water=0
mode=0
climb=0
cal#=0
```

Status Line	Format	description
meter	xxxx (meters)	Current depth of Prowler
dir	x (1=climb, 2=fall, 3=park, 4=climb down, 9=unknown)	Position of climbing cam
np	xx (number)	Number of science profiles per day
sam rate	xx (seconds)	sample rate of science profile
ip rate	xx (seconds)	sample rate of science profile after inflection point depth
ul	xxx (meters)	upper limit of profile depth
ll	xxx (meters)	lower limit of profile depth
INF	xxx (meters)	inflection point depth (changes sample rate of science profile)
error	xxxx (seconds)	Error timeout for profile
rt	xxxx (number)	number of profiles completed
aborts	xxxx (number)	number of times error timeout reached
vacuum	xxxx	internal vacuum pressure
pkt	xxxx (seconds)	park at lower limit for x seconds
water	x (0= no water, 1= water)	water detect status
mode	x (0= standard profile, 1= station keeping)	science profile mode
climb	x (0= free fal, 1= Climb down)	downward profile mode
cal#	xx (number)	number of pressure calibrations per day

Cam Cleat Commands:

Park:

Description: Change cam direction to park position.

Syntax: park

Example:

```
ICM_Prowler>>>park
```

Fall:

Description: Change cam direction to fall position.

Syntax: fall

Example:

```
ICM_Prowler>>>fall
```

Climb Up:

Description: Change cam direction to climb position.

Syntax: climb

Example:

```
ICM_Prowler>>>climb
```

Deployment Parameters:

Upper Limit:

Description: Set upper limit of profile. Minimum depth 0m.

Syntax: ul= [meters]

Example:

```
ICM_Prawler>>>ul= 10
```

Lower Limit:

Description: Set depth limit of profile. Max depth 500m.

Syntax: ll= [meters]

Example:

```
ICM_Prawler>>>ll= 500
```

Timeout:

Description: Set profile timeout of Prawler in seconds. Prawler will complete profile and change directions when timeout is reached.

Syntax: timeout= [seconds]

Example:

```
ICM_Prawler>>>timeout= 240
```

Number of Profiles:

Description: Set number of scientific profiles per day, 1-24. Changes in profile number will occur the next day when sample schedule is made.

Syntax: np= [number of profiles]

Example:

```
ICM_Prawler>>>np=24
```

Sample Rate:

Description: Set sample rate of science profile in seconds, minimum delay between samples is 4 seconds.

Syntax: samplerate= [seconds]

Example:

```
ICM_Prawler>>>samplerate= 4
```

Inflection Point:

Description: Set depth of inflection point on scientific profile. Scientific profile sample rate changed to inflection point sample rate after inflection point depth.

Syntax: ip= [meters]

Example:

```
ICM_Prawler>>>ip= 50
```


Inflection Point Sample Rate:

Description: Set sample rate after inflection point depth, minimum delay between samples is 4 seconds.

Syntax: iprate= [seconds]

Example:

```
ICM_Prawler>>>iprate= 8
```

Now Sample Rate:

Description: set sample rate of now command, max speed of sampling is 4 seconds

Syntax: nowrate= [seconds]

Example:

```
ICM_Prawler>>>nowrate= 4
```

Station:

Description: Set station keeping locations for Prawler. Station parameters are: Station ID 1-10, depth in meters, number of samples to take at station, wait time before sample in seconds, and sample rate in seconds per sample.

Syntax: station= [station ID] [depth] [number of samples] [wait before sample] [sample rate]

parameter	description	range
station ID	specify which station to change	00-09 stations
depth	depth of station	1-500 meters
number of samples	number of times to sample sensors to take at station	1-340 samples
wait before sample	wait time for sensors to acclimate, time starts from time of park	10-999 seconds
sample rate		5-60 seconds

Example:

```
ICM_Prawler>>>station= 00 5 15 60 8
```

Max Stations:

Description: Set maximum number of stations from 1 to 10.

Syntax: maxstation= [number]

Example:

```
ICM_Prawler>>>maxstation= 10
```

Calibration Number:

Description: Set the number of times the Prawler will calibrate the secondary pressure transducer. On a scientific profile, the Prawler can use the pressure data from the seabird CTD to calibrate the secondary pressure transducer located inside the Prawler motor housing. This transducer is used for depth control of the Prawler.

Syntax: calnum xx

Example:

```
ICM_Prawler>>>calnum 1
```

Standalone Mode On:

Description: Change Prawler IMM Communication from Binary to ASCII

Syntax: standon

Example:

```
ICM_Prawler>>>standon
```

Standalone Mode Off:

Description: Change Prawler IMM Communication from ASCII to Binary

Syntax: standoff

Example:

```
ICM_Prawler>>>standoff
```

Sensor Test:

Description: Test all configured sensors. Collects one sample from each sensor and displays reading.

Syntax: testsensor

Example:

```
ICM_Prawler>>>testsensor
waiting for CTD response (~20 seconds)
CTD 06/23/2021 17:54:04 08 00
0.000000 22.789301 0.019460
```

Cam Down On:

Description: Turn on camdown mode. Cam down mode will use the cam cleats to aid in the downward profile of the Prawler. Use this mode if the Prawler is unable to fall under its own weight due to high current or updraft.

Syntax: camdown

Example:

```
ICM_Prawler>>>camdown
```

Cam Down Off:

Description: Turn off camdown mode.

Syntax: camoff

Example:

```
ICM_Prawler>>>camoff
```

Water Detect On:

Description: Turn on the leak detection inside the Prawler. Check leak detection using the status command. Leak detection board located in bottom of optode tube.

Syntax: wateron

Example:

```
ICM_Prawler>>>wateron
```

Water Detect Off:

Description: Turn off leak detection inside of Prawler.

Syntax: wateroff

Example:

```
ICM_Prawler>>>wateroff
```

Print Statements On:

Description: Turn on debug print statements.

Syntax: printon

Example:

```
ICM_Prawler>>>printon
```

Print Statements Off:

Description: Turn off debug print statements.

Syntax: printoff

Example:

```
ICM_Prawler>>>printoff
```

Science Board Config:

Description: Communicate directly with the science payload board.

Syntax: scicon

Example:

```
ICM_Prawler>>>scicon
Enable Pass-Thru to the science computer, Ctrl-z to quit

scicon:>
```

Science Board Commands

The Science board Controls the real time clock, communicates with sensors and saves data to a micro SD Card.

Command	description
config	Configure science board.
dir	show available commands
status	Show configuration of the science board.
time	Show Prawler clock time.
time= [hh mm ss]	Set the Prawler clock time.
date	Show Prawler clock date.
date= [mm dd yyyy]	Set the Prawler clock date.
clear	Clear data on the SD card. Recommended before each deployment.
format	Format drive, set volume and file names for Micro SD card.

Configure:

Description: Configure science board.

Syntax: config

Example:

```
:>config
Prawler Science Serial Number: [010] :
Number of Profiles [8]
Sensor configuration: CTD and Optode
type '1' for CTD Only
type '2' for CTD and Optode
type '3' for CTD,Optode and wetlab
```

Directory:

Description: show available commands

Syntax: dir

Example:

```
scicon:>dir
***** Command List *****
dir                this list

config            show current config
status            show current config.
time=              set time
Date=              set date
```

```
time          show time
date          show date

log           log data

clear         Clear flash drive
format        format flash drive
testsensor    test sensors

scicon:>
```

Status:

Description: Show configuration of the science board.

Syntax: status

Example:

```
scicon:>status
Prawler Science Serial Number: 02rofiles: 8
Sensor configuration: CTD Only
```

Time:**Description:** Show Prowler clock time.**Syntax:** time**Example:**

```
scicon:>time
time= 10:00:05
```

Set Time:**Description:** Set the Prowler clock time.**Syntax:** time= [hh mm ss]**Example:**

```
scicon:>time= 10 08 00
```

Date:**Description:** Show Prowler clock Date.**Syntax:** date**Example:**

```
scicon:>date
date= 06/24/2021
```

Set Date:**Description:** Set Prowler clock Date.**Syntax:** date= [mm dd yyyy]**Example:**

```
scicon:>date= 06 24 2021
```

Clear:**Description:** Clear data on the SD card. Recommended before each deployment.**Syntax:** clear**Example:**

```
scicon:>clear
Flash File size 0
Volume name is      12345-67
Volume size is      1024 Mbytes
File name is        PRAW.TXT
File size is         0.0 Kbytes
File start date is  06/25/2021
File end date is    06/25/2021
```

Format:

Description: Format drive, set volume and file names for Micro SD card. When prompted, Sd card name must be 1-11 characters. File name must be 1-8 characters followed with [.txt]. If system goes to sleep while formatting the card must be reformatted to save data properly.

Syntax: format

Example:

```
scicon:>format

sd to spi i = 35 Flash turn on first time!

Formatting Flash card

Enter volume name(1 to 11 characters): 12345-67

Enter file name(8.3 format): praw.txt

drive size is 1024. Formatting will take up to 16 minute(s)
time= 10:37:13

one fourth done formatting
time= 10:37:45

two fourths done formatting
time= 10:38:18

three fourths done formatting
Flash File size 0
Volume name is      12345-67
Volume size is      1024 Mbytes
File name is        PRAW.TXT
File size is        0.0 Kbytes
File start date is   06/25/2021
File end date is     06/25/2021
Boot sector = 32
Sectors per cluster = 8
Sectors per fat = 1830
First Fat1 sector = 64
First Fat2 sector = 1894
First data sector = 3724
First directory cluster 2, sector 3724
First file cluster 4, sector 3740
Write pointer = 3740
```

IMM Communication

The Prawler contains an integrated Sea-Bird Scientific IMM (SBE Model IMM.100). To communicate through IMM, custom firmware must be uploaded onto a Seabird inductive modem module. Contact McLane for more details.

Typically, a user supplied surface controller is used to communicate to the Prawler IMM. Prawler communication is initiated by sending #PB01 followed by a command to the Prawler via the IMM.

IMM Commands

Command	Description	Response
reboot	Reboot Prawler	none
camd	Turn on climb down wire mode	status
camu	Turn off climb down wire mode	status
station	Turn station keeping science profile mode on	Station list
free	Free fall science profile mode	status
wato	Water leak detection on	status
watf	Water leak detection off	status
stat	Status of Prawler	status
sta= xx	Number of station keeping points, up to 10	Station list
var= xx	Number of pressure calibrations per day	status
change	Change Prawler direction (fall to climb or climb to fall)	status

Command	Description	Response
ul= xxx	Upper limit depth (meters)	status
ll= xxx	Lower limit depth (meters)	status
np= xx	Change the number of science profiles per day (01-24)	status
ip= xxx	Change the inflection point depth (meters)	status
Now = xx	Perform a science profile on the next fall (sample rate in seconds)	status
mbs= xxxx,Pawler	Pressure Calibration Fit	No response
em= xxxx	Profile time limit	Xxxx= seconds * 6
mrk= xx xxx xxx xxx xx	Station Parameters: Station ID, meters, number of sample, wait before sample, rate	Station list
keeping	List of stations	Station list
sam= xx	Science profile sample rate (seconds)	status
inr= xx	Inflection point sample rate (seconds)	status
fall	Change to fall direction	status
climb	Change to climb direction	status
park	Change to park direction	status
unpark	Unpark and turn to previous direction	status
pks= xxx Pawler	Park at xxx meters and sample for Pawler seconds at science sample rate	status

Command	Description	Response
pkt= xxxx	Park at lower limit for XXXX seconds	status
pktoff	Turn off park at lower limit	status

Message definition

STATUS

Every time the PRAWLER reaches a lower or upper limit, the truck status will be transmitted. The STATUS message is defined as follows:

Message Breakdown Big Endian format
header = @@@ (bytes 0-2)
crc = bytes 3-4 (Not currently implemented)
length = bytes 5-6 (Number of Bytes after ID)
ID = byte 7 (ID = 0x47)
Meters = bytes 8-9 (current location of Prawler)
Direction = byte 10 (1 = climb, 2 = fall, park = 3, error = 9) binary
Profiles = byte 11 (number of science profiles)
Sample rate = byte 12 (sample rate for science profiles)
Inflection rate = byte 13 (sample rate after the inflection point)
Upper limit = byte 14 (in meters)
Lower limit = bytes 15-16 (in meters)
Inflection point = bytes 17-18 (in meters)
Error timeout = bytes 19- 20
Direction count = bytes 21-22 (how many ups and downs)
Error count = bytes 23-24 (counts error timeout)
Vacuum = bytes 25-26 (vacuum level in main motor case)
Park timer = bytes 27-28 (park time at lower limit 0 = off)
Water detect = byte 29 (water is in main case 0 = ok, 1 = water) ascii numbers
Prawler mode byte 30 (0 = free fall, 1 = station keeping) ascii numbers)
Climb down = byte 31 (0 = free fall, 1 = climb down) ascii numbers)
Calibration = byte 32 (number of calibrations per day) ascii numbers)
Followed by a null character <CR><LF> x00 x0D0A

Chapter 4

Operations

Prawler operations include deployment programming and pre-deployment preparation. Topics covered:

- Ballasting.
- Programming a deployment (two modes, patterned and standard).
- Final deployment operations (closing and sealing the controller housing, attaching the profiler to a mooring wire).

Ballasting

Accurate ballasting is critical to Prawler operation. Ballasting requires precise measurements of the Prawler air weight and water weight in water of some known density. The measured weights along with an empirical ballasting calculation determines the appropriate amount of ballast required for optimal performance. A new Prawler is ballasted before shipment, and the appropriate quantity of lead ballast for the initial deployment is based on in situ density and deployment defined pressure information provided by the customer. The completed ballast sheet is provided with the files on the customer USB drive. Ballast sheet calculations Are recommended for each new deployment.

The required weight of lead ballast can be calculated for a particular deployment if the density, pressure, and temperature of the water at the neutral point of the planned profile are known.



Any weight change must be considered in the ballast calculation. Variables that affect ballast include adding sensors, changing the battery pack or swapping existing sensors. Contact McLane for ballast re-calculation assistance.

Programming a Deployment

Deployment parameters control profiler travel. Programming requires an understanding of the deployment location condition and other information such as the data density desired. A deployment schedule has profiles, intervals between profiles, and profile stops. Either Patterned or Standard programming mode is available.

Standard profiling mode

- Deployment is programmed directly in the Prawler firmware. Deployment Parameters can be checked with the status command.
- Science profiles are performed 1-24 times per day
- Profiles start at the upper limit and end at the lower limit on a downward profile.

Station keeping profiling mode

- Deployment is programmed directly in the Prawler firmware. Deployment Parameters can be checked with the liststations command.
- Science profiles are performed 1-24 times per day
- Can park and collect samples at up to 10 stations per profile.
- Prawler will fall from upper limit to first station depth and sample, then fall to next station.

Standard Profiling

Standard Profiling is programmed on the truck firmware. Parameters can be checked using the status command. The status lines highlighted in figure 6-2 are deployment parameters.

meter=0000	Current depth
dir=2	Current Cam Direction
NP=2	Science Profiles per day
sam_rate=4	Science Profile Sample Rate
IP_rate=8	Inflection Point Sample Rate
ul=002	Upper Limit Depth
ll=110	Lower Limit Depth
INF=050	Inflection point Depth
err=240	Profile Timeout
rt=0002	Number of profiles preformed
aborts=0000	number of times timeout reached
vacuum=1029	Internal vacuum
pkt=0000	park at lower limit
water=0	Water detect status
mode=0	Science Profile Mode
climb=0	Climb down status
cal#=1	pressure calibrations per day

Figure 4-1: Example status message with highlighted science profile parameters

Station Keeping

Station keeping mode can be enabled using the “station” command through IMM communication.

Station parameters can be checked with the liststations command. Stations can be changed using the station= command.

```
liststations
Station 0 = Meters= 25 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 1 = Meters= 50 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 2 = Meters= 100 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 3 = Meters= 150 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 4 = Meters= 200 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 5 = Meters= 250 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 6 = Meters= 300 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 7 = Meters= 350 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 8 = Meters= 400 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
Station 9 = Meters= 450 Number_of_Samples= 15 Wait_before_Sample = 30 sample_rate = 8
```

1. Set the upper and lower limits for the Prawler.
2. Set error timeout.
3. Set the number of science profiles per day.
4. Set the number of stations you want to program, 00-09.

```
ICM_Prawler>>>maxstation= 10
```

5. Program parameters for each station. Parameters for the station command are:station=[station ID] [depth] [number of samples] [wait before sample] [sample rate]

parameter	description	range
station ID	specify which station to change	00-09 stations
depth	depth of station	1-500 meters
number of samples	number of times to sample sensors to take at station	1-340 samples
wait before sample	wait time for sensors to acclimate, time starts from time of park	10-999 seconds
sample rate		5-60 seconds

```
ICM_Prawler>>>station= 00 25 15 30 8
ICM_Prawler>>>station= 01 50 15 30 8
ICM_Prawler>>>station= 02 100 15 30 8
ICM_Prawler>>>station= 03 150 15 30 8
ICM_Prawler>>>station= 04 200 15 30 8
ICM_Prawler>>>station= 05 250 15 30 8
ICM_Prawler>>>station= 06 300 15 30 8
ICM_Prawler>>>station= 07 350 15 30 8
ICM_Prawler>>>station= 08 400 15 30 8
ICM_Prawler>>>station= 09 450 15 30 8
```

Committing to the Deployment

Starting a deployment

Check deployment parameters using the status command.

Once parameters are verified, check the scicon board for time, configuration, and SD card status.

After all parameters are set, use the turnon command from the truck board to start a deployment.

The Prawler starts counting down time for a science profile when the turnon command is given.

Final Deployment Operations

Final deployment operations are to close the housing, attach the Prawler to the mooring wire, close the outer shell, and deploy the mooring..

Closing and Sealing the Controller Housing

Always inspect o-rings for signs of wear and the presence of any foreign material (which can cause leaks). See Chapter 2, “System Description”, for critical details about placement of the end cap and o-rings before sealing the end cap to the controller housing.

Attaching the Dummy Plug and Connecting the Battery

When you are ready to attach the profiler to the mooring wire first complete these steps:

1. Disconnect the communications cable and attach the dummy plug.
2. Slide cable into com holder inside the outer shell

Attaching the Prawler to the Mooring Wire

An example of attaching to a simple mooring is provided next for reference.

1. Remove screws on edge of Prawler and slide outer shell front up for drag plate clearance. Open outer shell of Prawler.



Figure 4-2: Remove screws on Prawler outer edge

2. Remove screws on inductive floater and bridge plate.



Figure 4-3: Remove screws on inductive floater

3. Place cable into Prawler. Be sure the top of the Prawler is facing the surface buoy.

4. Attach bridge plate to Prawler over mooring wire.

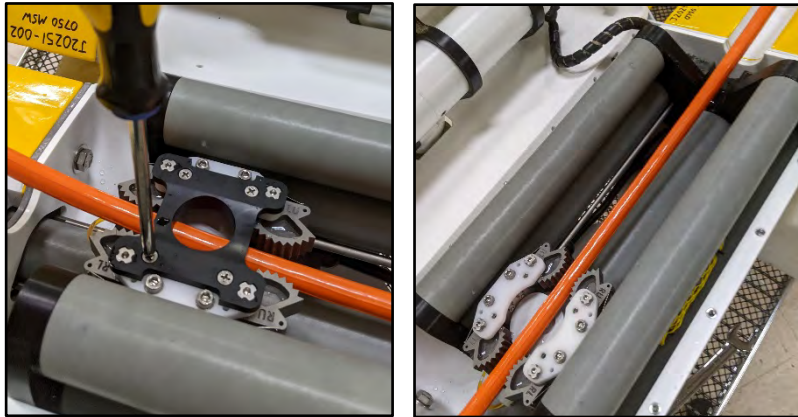


Figure 4-4: Attach bridge plate over mooring wire

5. Attach inductive floater to Prawler.



Figure 4-5: Attach inductive floater

6. Close Outer shell. Be sure that the CTD cable is not pinched and does not touch the mooring cable.
7. Secure outer shell using screws, check com cable and deploy.

Mooring Example

A simple mooring has a surface buoy, a single, continuous length of jacketed cable, an acoustic release, and an anchor. Padded stoppers are mounted on the mooring, typically placed 5 meters to 50 meters outside the range defined by the upper and lower limits to keep the profiler in the desired depth range on the mooring. These stoppers are made by McLane specifically for use with the profiler.

Actual stopper placement depends on the anticipated dynamics of the mooring and the placement of other mooring components. More complex moorings may have additional instruments above and/or below the physical stops.



The Prawler requires motion of the mooring to move and a surface buoy and wave motion to profile.

A simple mooring example is shown in Figure 4-6 for reference.

7 Typical Mooring

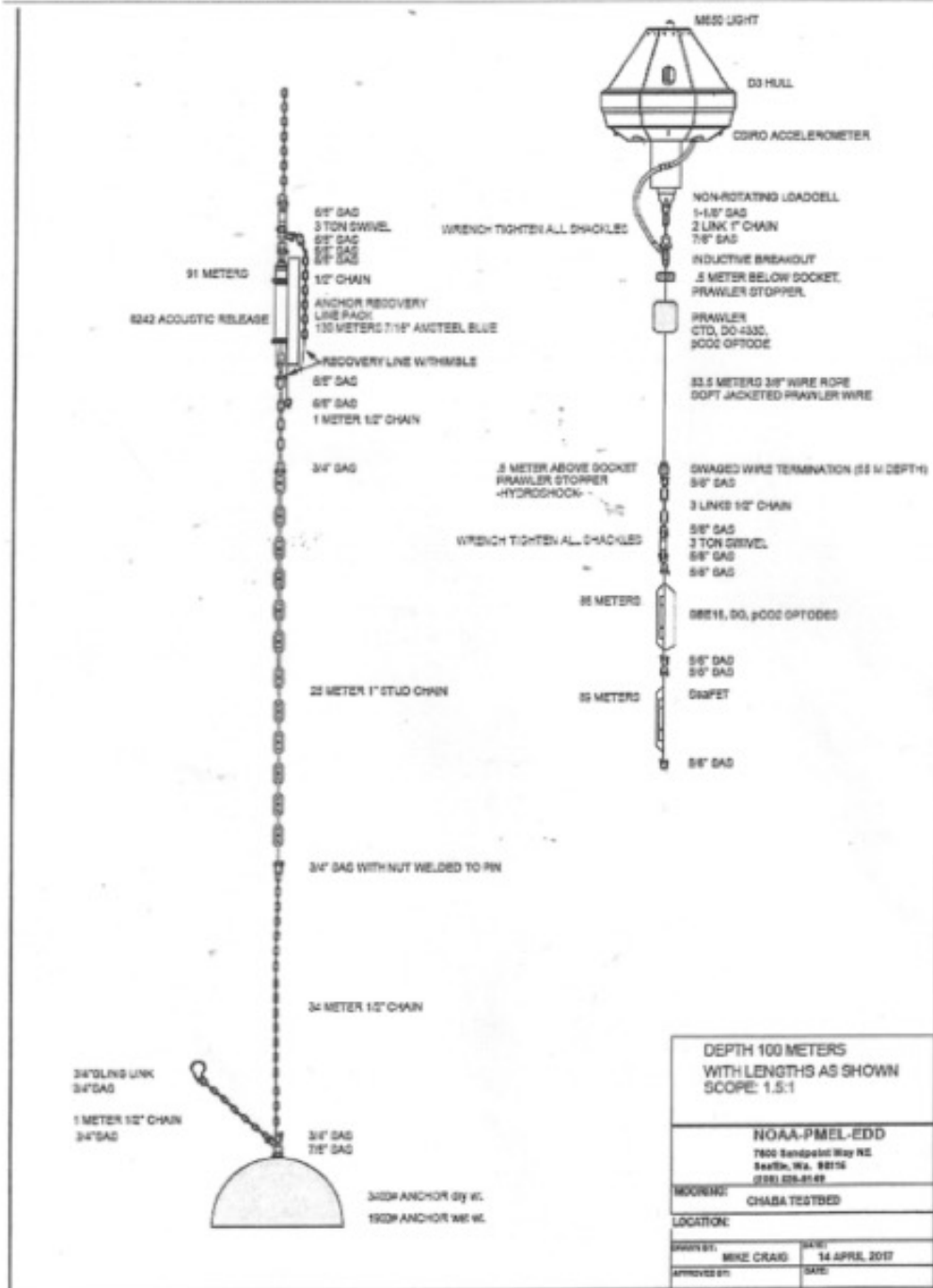


Figure 4-6: Simple Mooring

Notes

Chapter 5

Deployment and Recovery

Deployment Termination

A deployment ends when the batteries are drained or the turnoff command is manually given to the Prawler.

Battery Drain

The lithium battery voltage output is nominally 14V until ~90% of the available energy is gone.

Recovery Procedure

A sample recovery procedure is provided next for reference. Mooring detail is not included because mooring design will differ greatly based on design. Be aware the Prawler is not buoyant in air and will change direction to the fall position.

1. When the top bumper is reached, remove 4 screws on the side on the bumper. Remove bumper from line.
2. Continue to wind cable onto winch. The Prawler will be on the tether somewhere based on its current cycle in its profile. When the Prawler reaches the surface, it may change from climbing to the fall position and fall to the bottom bumper.
3. Continue to wind the cable onto the winch. In the absence of entanglement or severe biofouling, the Prawler will be resting against the bottom bumper. The Bumper will sustain the full weight of the Prawler and can be used to lift the Prawler out of the water. If you recover the bottom of the mooring first, the top bumper can be used to lift the Prawler.
4. Once the Prawler is lifted clear, pull the Prawler onto the deck and remove it from the tether.
5. Move the Prawler to a stable location and immediately **rinse with fresh water**. Rinse the top end cap of the core of the housing first as you will need to remove the end cap to review and recover the deployment data. Move the

Prawler to a dry location before opening the controller housing to recover data.



Do not expose the electronics or flash card to salt water. Move the profiler to a stable dry area before opening the pressure housing. If the electronics get wet with salt water, immediately disconnect power, immerse in fresh water (do not immerse the lithium batteries) and dry.

Offloading deployment data

To offload data, remove the MicroSD card from the Science board and connect to a computer. Copy file to computer. File can be viewed with any text edit software.

Data Format

The sensor data are stored on a single user specified file on a MicroSD card located on the science board. The data from each profile is written to the end of the file starting with the CTD, optode, then fluorometer if equipped. The header at the top of each data string indicates the sensor the data is from, followed by the start date and time of the profile, sample rate, and science profile number.

```
CTD 12/31/2020 10:30:47 08 006
0.000000 21.492800 0.000000
0.000000 21.493799 0.000000
0.000000 21.493900 0.000000
0.000000 21.495001 0.000000
0.000000 21.495899 0.000000
0.000000 21.496599 0.000000

AADI 12/31/2020 10:30:47 08 006
247.249 21.456 30.064 31.088 38.363 7.275 476.000 798.500 223.100
247.275 21.463 30.060 31.084 38.372 7.288 476.000 798.500 222.900
247.277 21.470 30.057 31.081 38.373 7.292 476.000 798.400 222.700
247.190 21.477 30.058 31.082 38.377 7.294 475.900 798.300 222.400
247.203 21.484 30.055 31.079 38.374 7.296 475.800 798.300 222.200
247.125 21.491 30.055 31.079 38.377 7.298 475.800 798.400 222.000

WETL 12/31/2020 10:30:47 08 006
0700 4130 0695 0490 0460
0700 0238 0695 0049 0460
0700 0236 0695 0048 0460
0700 0237 0695 0049 0460
0700 0238 0695 0049 0460
0700 0264 0695 0049 0460
```

Figure 5-1: Sensor data

CTD Data Format

Header: CTD MM/DD/YYYY HH:MM:SS [sample rate] [profile number]

Data: [depth[dBar]] [Temperature [Deg C]] [conductivity[mmho/cm]]

```
CTD 12/31/2020 10:30:47 08 006
0.000000 21.492800 0.000000
0.000000 21.493799 0.000000
0.000000 21.493900 0.000000
0.000000 21.495001 0.000000
0.000000 21.495899 0.000000
0.000000 21.496599 0.000000
```

Figure 5-2: CTD data

Optode Data Format

Header: AADI MM/DD/YYYY HH:MM:SS [sample rate] [profile number]

Data: [O2Concentration[uM]] [Temperature[Deg.C]] [CalPhase[Deg]] [TCPhase[Deg]]

[C1RPh[Deg]] [C2RPh[Deg]] [C1Amp[mV]] [C2Amp[mV]] [RawTemp[mV]]

```
AADI 12/31/2020 10:30:47 08 006
247.249 21.456 30.064 31.088 38.363 7.275 476.000 798.500 223.100
247.275 21.463 30.060 31.084 38.372 7.288 476.000 798.500 222.900
247.277 21.470 30.057 31.081 38.373 7.292 476.000 798.400 222.700
247.190 21.477 30.058 31.082 38.377 7.294 475.900 798.300 222.400
247.203 21.484 30.055 31.079 38.374 7.296 475.800 798.300 222.200
247.125 21.491 30.055 31.079 38.377 7.298 475.800 798.400 222.000
```

Figure 5-3: Aanderaa optode data

Fluorometer Data Format

Header: WETL MM/DD/YYYY HH:MM:SS [sample rate] [profile number]

Data: [wavelength] [signal] [wavelength] [signal] [wavelength]

```
WETL 12/31/2020 10:30:47 08 006
0700 4130 0695 0490 0460
0700 0238 0695 0049 0460
0700 0236 0695 0048 0460
0700 0237 0695 0049 0460
0700 0238 0695 0049 0460
0700 0264 0695 0049 0460
```

Figure 5-4: Sea-Bird/Wetlabs Fluorometer data

Notes

Chapter 6

Maintenance and Storage

Several maintenance procedures are recommended for the Prowler. Before deployment, after recovery, and before and after storage, inspect the following:

- O-rings
- Bulkheads and cable connectors
- Stainless Steel Hardware
- Cam Cleats and Springs

Once the MicroSD card has been recovered, and the endcap has been reinstalled, rinse or immerse the Prowler in fresh water more thoroughly. If possible, immerse the Prowler in fresh water. Warm water with soap or mild detergent will remove salt and other substances. Common soaps will not damage the Prowler, do not use solvents.



Thoroughly rinsing the Prowler in fresh water immediately after recovery is a critical maintenance procedure to extend the system life and prevent future problems. Salt crystals can form on o-rings and o-ring sealing surfaces as seawater evaporates, leaving grit that can cause future leaks.

O-Rings

Before and after every deployment, inspect the radial seals on both end of the controller and battery housings. This critical check can prevent housing flooding. Look for small cracks and feel for bumps, grit, or hair. O-rings must stay in position as the end cap is inserted into the cylinder. The Toolkit includes spare o-rings and Chapter 2, “System Description” has the part numbers.

After you inspect the o-rings, apply a thin, even coating of lubricant. McLane recommends Parker O-Lube, a barium-based grease made by Parker Seals, for use with pressure housing o-rings. O-Lube is environmentally safe and can be cleaned up with soap or mild detergent.

Bulkhead and Cable Connectors

All of the connectors are threaded into their end caps and sealed with o-rings. These are long-term seals and do not require regular inspection as long as the connectors and end caps are thoroughly rinsed/soaked in fresh water after recovery. The pins and bodies of the bulkhead connectors and the sockets and cowls of the cable connectors must be regularly inspected, cleaned, and greased to prevent leaks.

Connectors that are regularly connected and disconnected, such as those on the end cap of the controller housing, require regular maintenance. This is particularly true of the communications cable, bulkhead connector, and dummy plug. Apply a thin coating of grease to all contact surfaces, including pins, sockets, cowls, and bodies. McLane recommends Dow-Corning 55, an o-ring lubricant, for this purpose. Silicon-based products such as Dow-Corning 4 or Dow-Corning 5 are also suitable. All of these lubricants are environmentally safe and can be cleaned up with soap or mild detergent.

Stainless Steel Hardware

The Prowler Toolkit contains spare screws and bolts. Contact McLane if additional spares are needed. The hex nuts washers and lock washers on the tie rods holding the endcap in place are 316 Stainless Steel. Do not overtighten nuts. A thin coating of non-metal, anti-seize, thread compound should be applied to the nuts before they are threaded onto the titanium tie rods. McLane recommends Lub-O-Seal's NM-91 non-metal anti-seize thread compound for the Prowler tie rod nuts and outer shell screws. Replacement nuts used with the titanium tie rods should be 316 stainless steel. The end cap should slide smoothly into the pressure housings. Visually check that wires are not caught between the end cap and the housing.

A thin coating of non-metal, anti-seize, thread compound should be applied to the pan head screws that hold the outer shell front and back together.

Cam Cleats and Springs

The Prowler uses four cam cleats and two leaf springs to move. These parts can wear overtime and lead to decreased performance of the Prowler. Inspect the teeth of the cams and arms of the leaf springs for wear. Replacements can be purchased from McLane.

If the cleats are worn so that the mooring line makes contact with more than 3 teeth, replacement is recommended.

The leaf springs make contact with the rear surface of the cam cleats. It is recommended that the springs are replaced after each deployment.

Replacement of Cam cleats and springs

Cam cleats and springs should be inspected for wear before and after every deployment. The tools needed to replace cam cleats and springs:



Figure 6-1: Tools for replacing Cam cleat and springs

- 5/32" hex driver
- 1/8" hex driver
- #1 Phillips head driver
- #2 Phillips head driver
- 1/4" Combination wrench
- Bostik Black Molly anti-seize
- Cotton swab or lint free wipe

1. Remove cleat bridge plate by loosening 4 screws on plate with #2 Phillips head driver.



Figure 6-2: Remove cleat bridge

2. Remove 4 screws holding cam cleats with 1/8" hex driver.



Figure 6-3: Remove cam cleat screws

3. Remove cleat side and front plates with 5/32" hex driver.

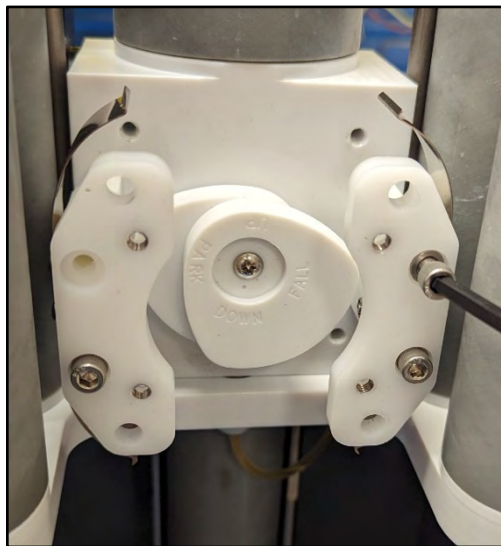


Figure 6-4: Remove cleat side and front plates

4. Remove springs from side plate using #1 Phillips head driver and 1/4" combination wrench.

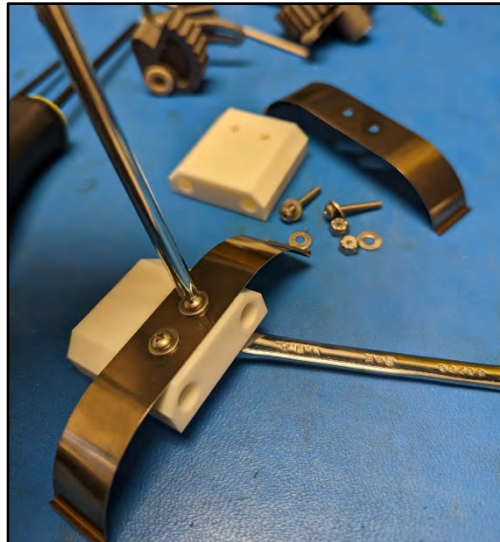


Figure 6-5: Remove springs from side plate

5. Attach springs to side plate using 4-40 screws, washers, and nuts using #1 Phillips driver and 1/4" combination wrench. Keep spring parallel with top of cleat side plate. Improper alignment will lead to increased wear on spring and cam cleat.

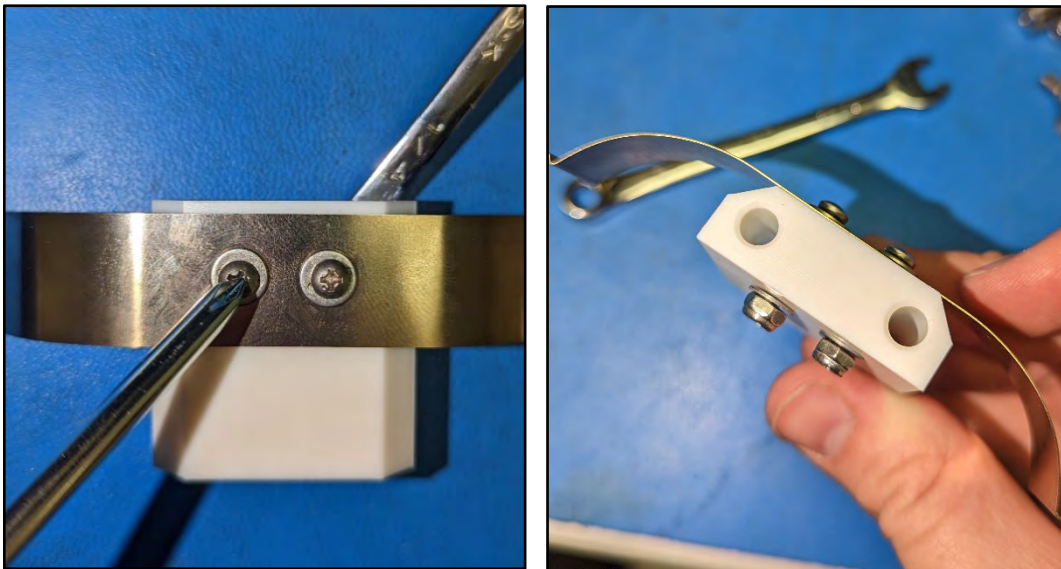


Figure 6-6: Attach springs to side plate

- Loosely attach cleat top plate and side plate using 10-24 screws and lock washers by hand.
Do not tighten fully.

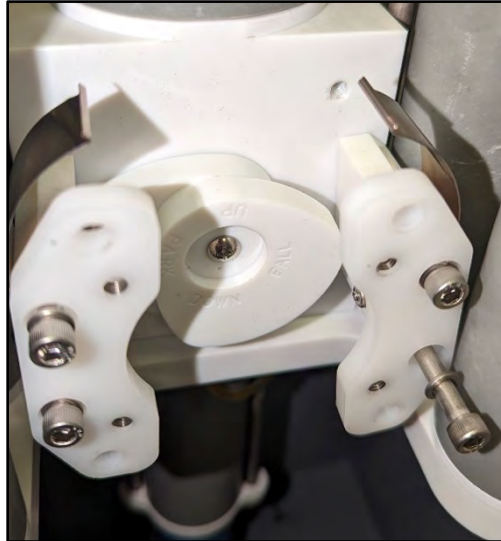


Figure 6-7: Loosely attach cleat top plate

- Apply a thin coating of Bostik Black Moly anti-seize to the back of each cam cleat using cotton swab, lint free wipe or hand.



Figure 6-8: Apply thin coating of Bostik Black Moly anti-seize to each cam cleat

- Attach cam cleats to motor housing. Look at top face of cleat for location.
 - LU–Left Upper cleat
 - RU–Right Upper cleat
 - LL–Left Lower cleat
 - RL–Right Lower cleat

9. Tighten cleats fully by hand then loosen 1 full rotation of the screw using 1/8" hex driver. Check that cleat moves freely.



Figure 6-9: Fully tighten cleats

10. Attach bridge plate to assembly. Rotation of cam cleat screws may need to be adjusted for bridge plate attachment.



Figure 6-10: Attach bridge plate to assembly

11. Secure Cleat bridge plate to assembly with 6-32 screws using a #2 Phillips head driver.

12. Tighten cleat side plate screws fully using 5/32" hex driver.



Figure 6-11: Fully tighten side plate screws

Battery Maintenance

The Prowler is powered by four high capacity lithium battery packs. The standard pack is four D-cell packs assembled in a line. Electrically the pack is four cells in series with each battery pack powering the Prowler in parallel. The nominal delivered voltage is 14V. The nominal energy capacity of each battery pack is 15Ahr, The nominal energy capacity for a full Prowler with four packs is 60Ahr.



The lithium in the battery pack qualifies as Class 9 hazardous goods. U.S. and international regulations require shipping the main lithium battery via an approved hazardous goods shipper.

Sensor Maintenance

Sensors should be fully calibrated at a properly equipped facility before and after deployments. The calibration results allow investigators to account for sensor drift during data post-processing. Calibration can be performed by the sensor manufacturer. If you can provide an environment of known characteristics for the sensor, you can also perform this test to provide a quick verification of function and accuracy.

Packaging and Storing

Keep the Prawler assembled for shipping or storage. The shipping box is a fitted, reusable, international freight container for shipping and storing the Prawler. Requirements for international transport by ground, ocean, or air freight carriers are in compliance. If storing the Prawler for more than one month, properly archive any data stored on the MicroSD card. Disconnect the four main lithium battery packs from the controller end cap. Check the o-rings, reassemble the housing and core, and perform any necessary maintenance procedures, including a fresh water rinse. Storage facility temperatures between 0° C and 40° C are recommended. Temperatures above this range should not cause damage, however, temperatures below 0°C could cause damage if water is still present in crevices or seals.

Storing the Battery

If the batteries are not fully discharged, cover the connectors with insulating tape and store the batteries within the 0° C and 40° C temperature range. Refer to the battery safety sheet provided on your profiler USB drive for proper storage and handling guidelines. If the batteries are fully discharged, they should be disposed in accordance with safety and environmental regulations.