



ARCTIC RAYS
SUBSEA TECHNOLOGIES

Hammerhead Series Miniature Subsea Positioners

1000m / 6000m



USER MANUAL

HW Rev.M - FW v4.5 - 02 August, 2022

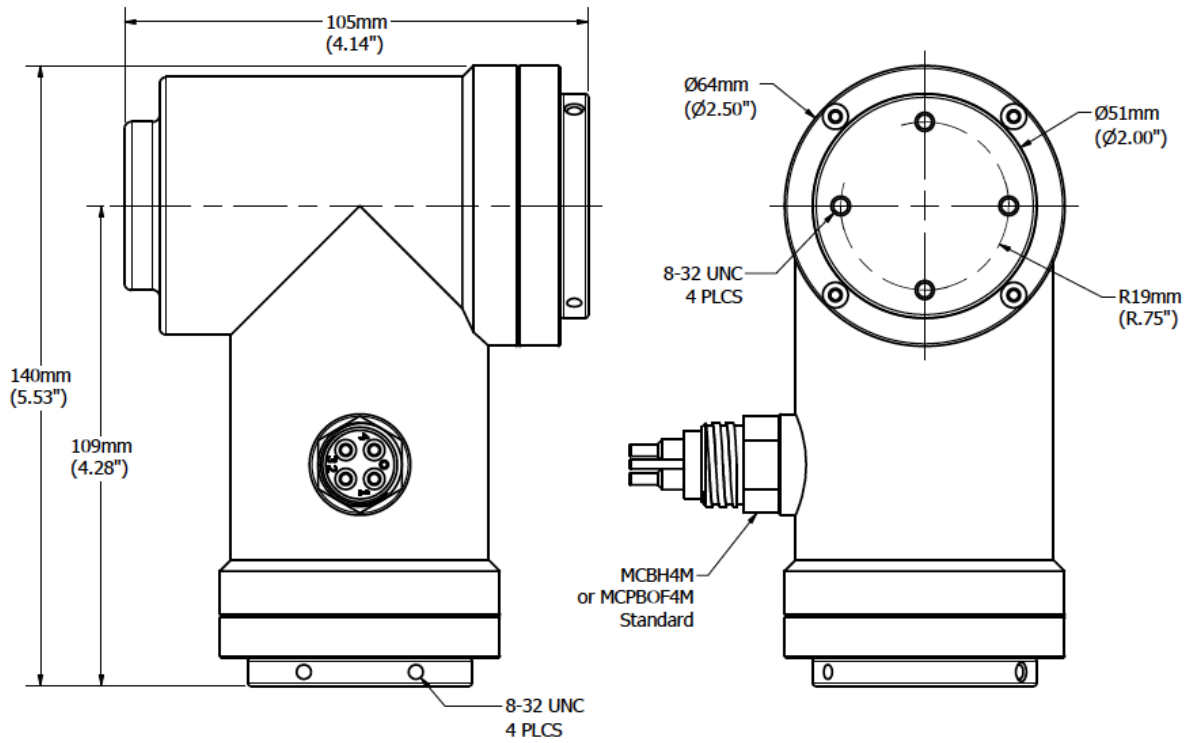
I. INTRODUCTION:

The Arctic Rays Hammerhead is a series of ultra-compact subsea motorized positioners, rated to 1000m (dry) or 6000m (oil-filled). They are available with addressable multi-drop RS232 or RS485 serial communications. With proportional variable speed control, integral absolute position feedback, user-settable soft-limits, continuous rotation, electronic braking, and high torque, they are ideally suited for positioning of lights, cameras, and small sonar systems.

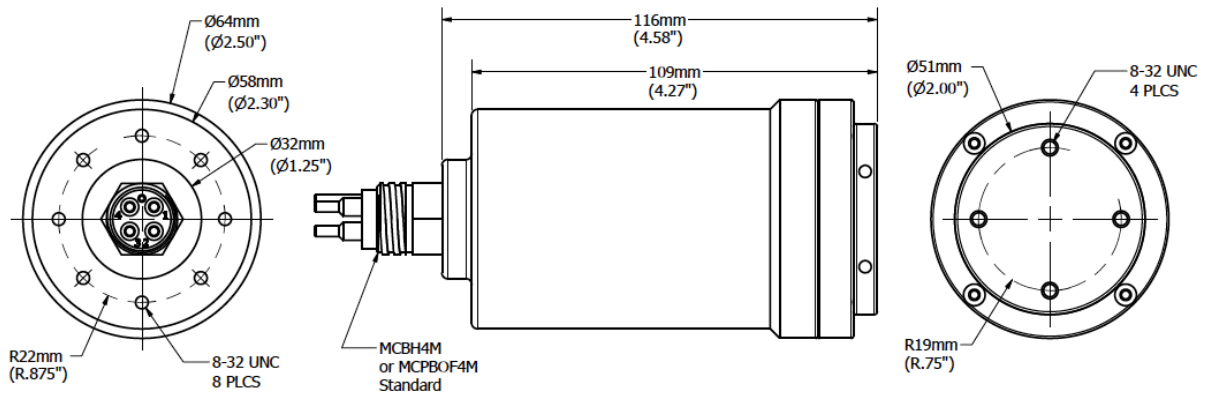
The standard Hammerhead (HH) is a 2-axis pan & tilt positioner unit designed for applications where space constraints are critical. The Hammerhead XT is a slightly larger version of the standard Hammerhead, with higher torque, reduced backlash, and a more robust gearbox. The Hammerhead Rotator (HHR) and XT Rotator (XTR) are single-axis versions of these units.

PARAMETER	SPECIFICATION
Depth Rating	1000m (3300ft) air-filled, 6000m (19700 ft) oil-filled
Input Voltage	10 – 40 VDC
Rated Torque (per axis @ 24V)	HH: 6.8 N-m (5 ft-lb) XT: 13.6 N-m (10 ft-lb)
Max Current Draw (per axis @ 24V)	No-Load: 120mA Rated: 425mA (HH) , 750mA (XT) Limit: 450mA (HH), 850mA (XT)
Rotation Range (per axis)	Unlimited. Soft limits may be set by user commands.
Speed Range (per axis)	Continuously variable 0-100%, in 1% increments.
No Load Speed (per axis)	HH: 5.5 rpm (33°/sec) XT: 6.3 rpm (38°/sec)
Payload	10kg (22lbs)
Position Feedback (per axis)	Absolute. Resolution: 0.1° Accuracy: 0.2°
Gearbox Backlash	HH: 1.7° (100 arc-min) XT: 1.0° (60 arc-min) <i>*Backlash is measured and reported by encoders.</i>
Control	Multi-drop RS232 or RS485 (2-wire). 254 soft-addresses.
Housing Material	316 Stainless Steel (standard) or Hard-Anodized Aluminum
Weights In Air (air-filled)	316SS: HH: 2.3kg (5.1 lbs), HHR: 1.3kg (2.9lbs) XT: 2.8kg (6.2 lbs), XTR: 1.6kg (3.6 lbs) 6061AL: HH: 1.3kg (2.8 lbs), HHR: 600g (1.3 lbs) XT: 1.6kg (3.5 lbs), XTR: 825g (1.8 lbs)
Weights in Water (air-filled)	316SS: HH: 1.6kg (3.5 lbs), HHR: 800g (1.8 lbs) XT: 2.0kg (4.4 lbs), XTR: 1.1kg (2.4 lbs) 6061AL: HH: 600g (1.3 lbs), HHR: 100g (0.2 lbs) XT: 800g (1.8 lbs), XTR: 325g (0.7 lbs)
Operating Temperature	-10°C to 40°C
Connector Pinout (Subconn MCBH4M or MCPBOF4M standard)	1: GND 2: +10-40Vdc 3: RS232 RX(IN) OR RS485(A)- 4: RS232 TX(OUT) OR RS485(B)+ <i>*Additional pins on custom connectors will be left unused.</i>

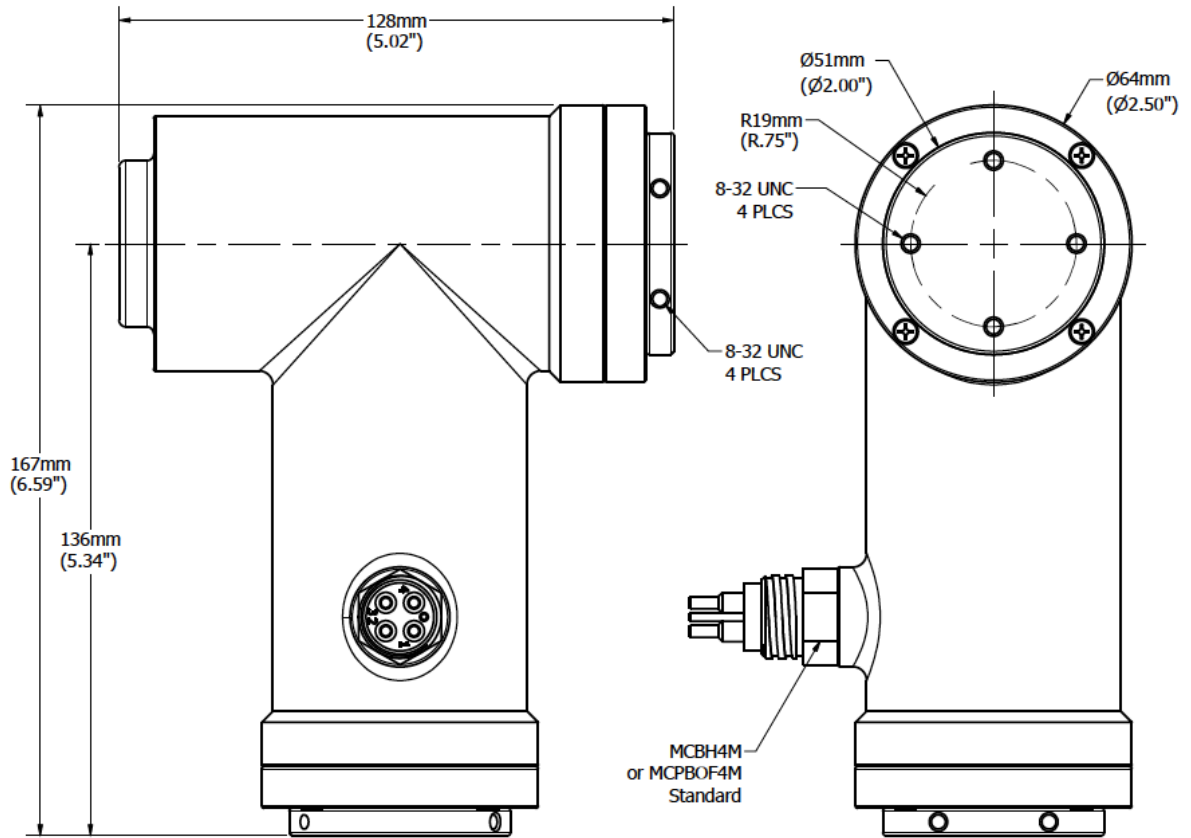
Overall Dimensions – Hammerhead P&T (Standard 2-axis Positioner):



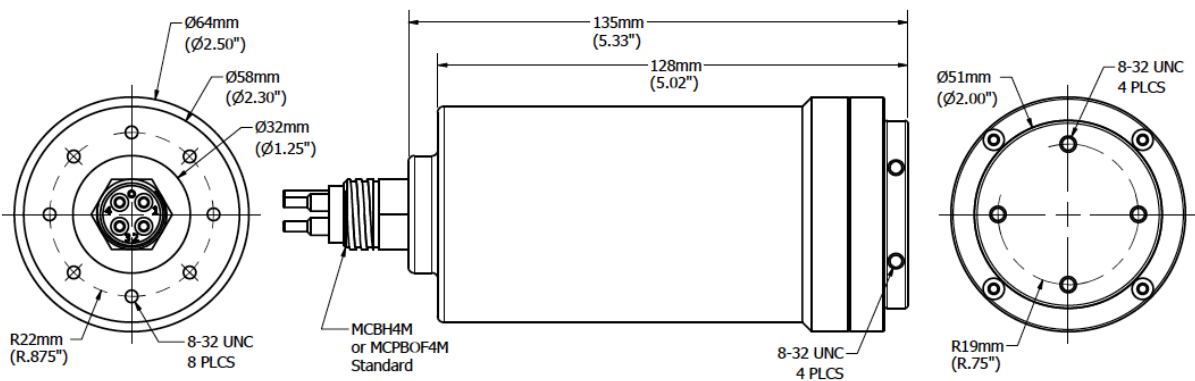
Overall Dimensions – HH Rotator (Single-Axis Positioner):



Overall Dimensions – Hammerhead XT (High-Torque 2-axis Positioner):

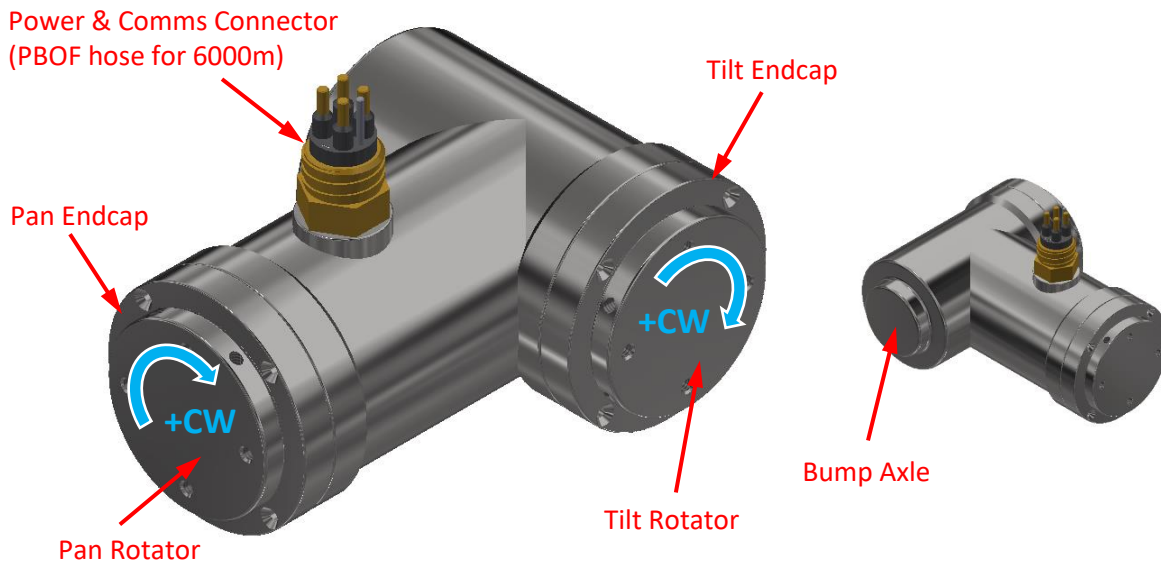


Overall Dimensions – XT Rotator (High-Torque Single-Axis Positioner):



II. SETUP

The base Hammerhead unit is shown below, on its back. Pressure-balanced-oil-filled versions (6000m) utilize a PBOF version of the same connector on a flexible Tygon hose, which serves as a static pressure compensator. Various brackets may be added to adapt the rotator plates for the device being moved.



Mechanical: The Hammerhead has two rotational axes. The XT Rotator has one. Each rotator plate has 4x 8-32 UNC threaded holes on its face, and 4x 8-32 UNC threaded holes on its circumference. Any of these holes may be used to attach mounting brackets. In addition, the circular “bump axle” on the opposite side of the tilt axis may be used with a collar bushing as a rotational bearing surface for brackets or plates which span the width of the tilt axis, and require an additional support.

When looking at either axis face-on, clockwise (CW) rotation is considered positive (+), and counter clockwise (CCW) is considered negative (-), by default. Both axes will rotate continuously in either direction, unless soft-stops are enabled (discussed later).

***WARNING:** *DO NOT MANUALLY DRIVE THE ROTATOR PLATES! Back-driving the rotators, even when the unit is powered-off, could result in increased gearbox backlash or permanent damage to the drive trains. Always move the axes by commanding the unit.*

O-ring seals: Hammerheads utilize several o-ring seals: one for each drive shaft, one for each endcap, and one for the bulkhead connector or barb. None of these seals should be serviced by the user. The unit should be sent to the factory for seal replacement every 1-2 years, depending on use.

Thrust Washers: Hammerheads utilize two PTFE (Teflon) thrust washers on each axis for smooth movement. The outer (black) washer is located under the rotator plate of each axis. These should

be kept free of debris, with no visible gaps or play, and inspected periodically. If a gap or play develops between the rotator plate and the endcap, the unit should be returned for service.

Oil-Filled Units: Hammerheads with depth ratings greater than 1000m will be pressure balanced and oil-filled (PBOF). The connector is set at the end of a length of flexible, oil-resistant tygon tubing, which acts as a pressure compensator. This compensator hose should be regularly inspected to make sure that the unit is full of oil, without any large air bubbles present. If the unit needs to have its oil changed or topped-up, use only a technical-grade, low-viscosity, high-dielectric oil such as white mineral oil (McMaster-Carr P/N: 3190K291).

Power: The Hammerhead should be powered from a 24Vdc nominal power. The hammerhead does not require a regulated supply, as it has its own internal voltage regulators, but current draw and performance may vary when using supplies near the edges of the input range.

Communications: Hammerhead communicates via either a RS232 or two-wire RS485 serial port (configured at the factory when ordered), operating at **19200bps, 8-N-1-N**. In both cases, a single host serial port may be used with up to 255 Hammerheads sharing the same two wires. Each unit is assigned a unique soft-address (0-254), and behaves as a slave device on the network. That is to say, it is always listening, but will only obey and respond to commands or queries from the master (host PC or control box), when the command matches its address. It is important that devices on the same serial port do not share the same address, or collisions will result. Address 255 is reserved as a “broadcast” address (all receive and all reply). Address 0 is the factory default setting.

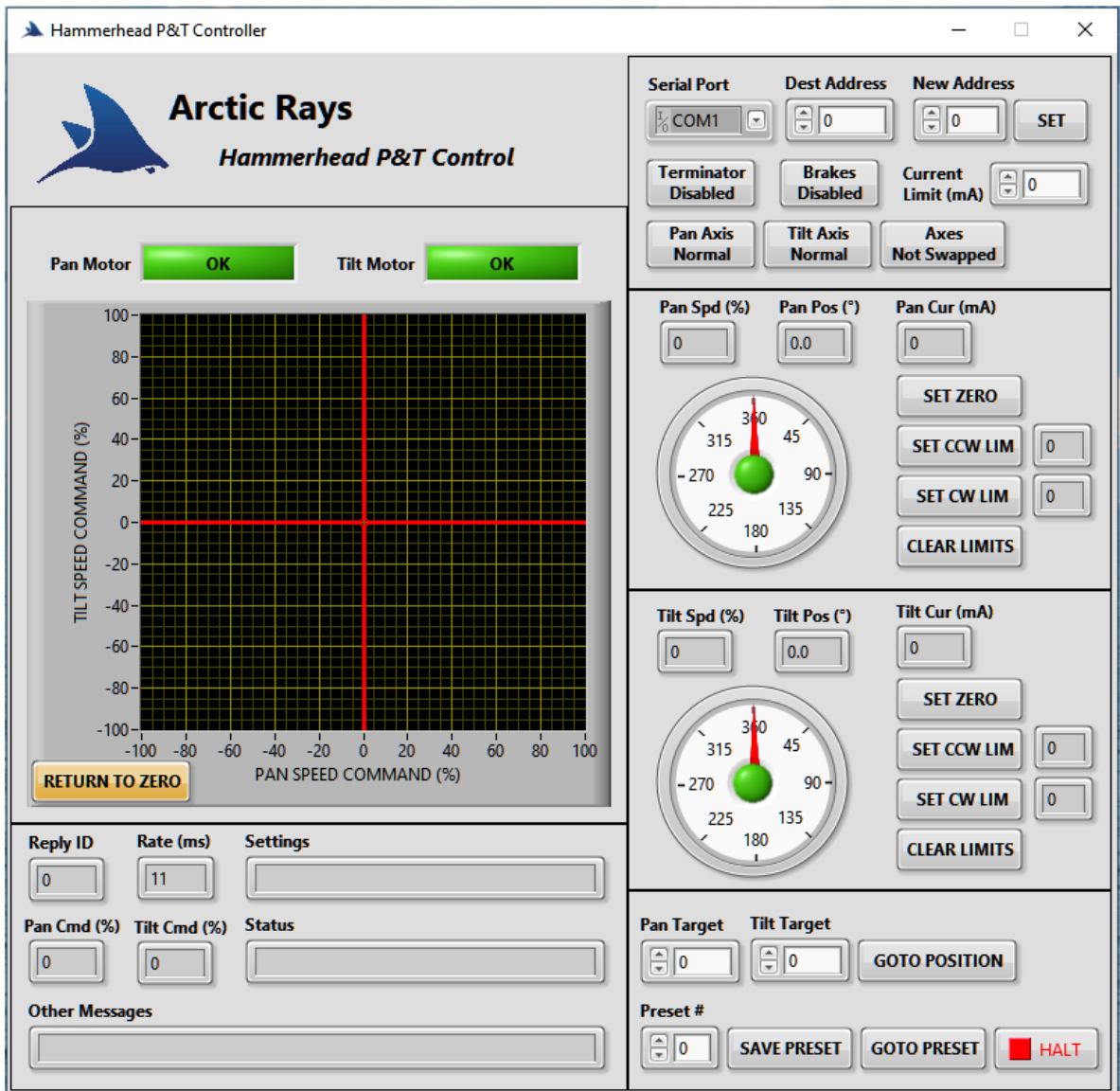
Network Termination: In multi-drop serial networks, termination resistor(s) are often required to ensure reliable communications over extended distances. Hammerhead has its own internal termination resistors that can be enabled or disabled through a serial command (discussed later). In the case of RS485, the master (host PC or control box) and the Hammerhead at the end of the chain (i.e. furthest from the master) should both have resistors enabled. Termination resistors are disabled by default for both RS232 and RS485. It is possible to operate without proper termination, especially at the relatively low baudrate of 19200bps, but if communications problems are experienced, you may need to enable or disable termination resistors in the Hammerheads.

III. **SOFTWARE CONTROL**

Hammerhead positioners come with a free Windows-based application which provides a basic graphical user interface (GUI) for setup and control of Hammerhead units. While multiple devices can be present on the same port, the GUI only controls one at a time. The GUI supports all Hammerhead series positioners, including Hammerhead, Hammerhead XT and XT Rotators.

****NOTE: XT Rotators (single-axis units) will only report data for the PAN axis. Information or errors on the TILT axis should be ignored when using an XTR with the Hammerhead GUI.***

To install the Hammerhead GUI, ensure that your computer is running Windows 7 or newer, and run the “setup.exe” program included with your product. Open the application from the start menu or desktop shortcut. The application screen is shown below.



Communications Settings: Before attempting to move the P&T, verify the serial port and destination address for the unit you are trying to communicate with are correct. Address “255” is considered “broadcast” and will be answered by all devices. Use address 255 when setting up a new unit, or when only one unit is connected to the port and you are unsure of its address. Address 0 is factory default.

To change the address of a unit, set the “New Address” field, verify that the destination address is correct, and press the “SET” button. Address changes do not take effect until the unit is rebooted via power-cycle.

To enable/disable the serial termination resistor, toggle the “Terminator” button. Its color and text will indicate the current state of the resistor (**GREEN** = enabled).

Motor Brake Mode: To enable/disable the motor brakes, toggle the “Brake” button. Its color and text will indicate the brake mode (**GREEN** = brake enabled when a motor is stopped, **GREY** = brakes always off).

Current Limit: This parameter sets the current limit in mA for each axis (0-1000mA). Default is 450mA for HH/HHR and 850mA for XT/XTR. The current limiter is a self-protection feature which helps prevent mechanical damage in the event of a full-stall. If the motor reaches its current limit, it will halt rotation and raise a fault flag (shown as a **RED** “OVER CURRENT” warning light). All move commands to that motor will be locked-out for 1 second. After this “overcurrent timeout” period, the motor will try to move again when commanded.

Axis Modes: The Hammerhead P&T can be set to have inverted axis directions and/or to swap the pan/tilt axes, to accommodate various mounting configurations. **GREY** buttons are normal operation. **GREEN** buttons indicate an inverted configuration. See “i,j,k” commands in the serial protocol section below for more information.

Speed Control Joystick: The 2D plot provides a “soft joystick” which resembles a red cursor with two axes. To move the P&T in both axes simultaneously, click and drag the center dot to vary the motor speed commands from -100% (full speed CCW) to +100% (full speed CW). To move only one axis at a time, click and drag along one of the cursor bars instead of the center dot.

When the “RETURN TO ZERO” button is illuminated, the cursor will snap back to center and the P&T will stop moving when the mouse button is released (default). Click the “RETURN TO ZERO” button to disable this feature and hold a fixed continuous speed. As the P&T is moving, the “Pan Spd” and “Tilt Spd” numeric indicators will show actual speed.

****NOTE: If communications are severed, or the application is exited, the move commands will timeout in 1 second and the motors will stop, to prevent the unit from crashing.***

Position Feedback: The two dial indicators provide real-time feedback of absolute pan & tilt axis positions along with any movement limits. The **BLUE** needles and the “Pan Pos” and “Tilt Pos” numeric indicators show current position. If there is a position encoder fault, the value will read “-1” and the dial indicator will be greyed-out.

Set Soft-Limits: The user can set two rotational limits for each axis (CCW & CW), which, when enabled, are displayed as **RED** needles on the dial indicators. If an axis reaches a limit, its motor will stop and the LED in the center of the dial will turn **RED**. In order to move again, the command must be in the opposite direction, away from the limit. If an axis finds itself outside the limits for any reason, the motor must move in the direction of the closest limit until it passes into the allowed range. Initially, the unit has no built-in limits, and the encoder zero positions are arbitrary. Follow the steps below to zero the axes and set-up soft-limits:

1. Move the axis to the desired zero location and press the “SET ZERO” button.
2. Move the axis to the CCW limit position and press the “SET CCW LIMIT” button. One **RED** needle will appear.
3. Move the axis to its CW limit position and press the “SET CW LIMIT” button. A second **RED** needle will appear, and limits will now be enabled. Limits are not enabled until both are set.

4. To disable limits and allow continuous rotation, press the “CLEAR LIMITS” button.

**NOTES: When limits are cleared, their value is displayed as “-1”. If both limits are set to the same value, the axis will behave the same as if its limits were cleared (continuous rotation allowed). Limits and zero-position are stored in non-volatile memory and retained after power cycle.*

Goto Functions: Hammerhead P&Ts implement automatic GOTO and preset functions (F/W v4.4 and later). These functions will slew the P&T axes to a desired destination position and stop.

**NOTE: These functions do NOT attempt to hold position (i.e. servo) at their destination.*

There are two methods of performing a GOTO move:

- 1.** Explicit GOTO. Specify pan and tilt angles (in whole degrees, 0-359), and press the “GOTO POSITION” button.
- 2.** Preset GOTO. Hammerheads can store 10 preset positions. Position 0 is the “home” position (0,0), and cannot be changed by the user. The other presets (1-9) may be changed by pressing the “SAVE PRESET” button. This stores the current pan & tilt angles in the specified preset number. To execute a preset from anywhere, simply enter the preset number (0-9) and press the “GOTO PRESET” button.

Halt Button: During an automatic (goto) move, Hammerhead will obey all soft-limits (if set-up), and the built-in current limits, in order to prevent collision and damage. However, if something goes wrong, or if you simply wish to cancel the automatic move, press the HALT button.

Reply Information: The ReplyID field shows which unit replied to the last command. This address should match the “Destination Address”, unless you are in broadcast mode (dest address = 255). The “Rate” field shows the period between updates. This should be approximately 100ms (10Hz) or faster. The “Status”, “Settings”, and “Other Messages” fields display the most recent raw-text reply messages from the unit (see communications protocol).

IV. SERIAL COMMUNICATIONS PROTOCOL:

The protocol explained below can be used for 3rd party devices to communicate with and control Hammerhead Series Positioners. As mentioned previously, the Hammerhead communicates via RS232 or half-duplex (two-wire) RS485, at **19200bps, 8-N-1-N**. All Hammerheads are considered “slave” devices. That is to say, they will not obey or reply to any commands from the master (host PC or control box) unless they are properly addressed.

All commands are sent as ASCII text, beginning with the ‘\$’ (0x24) character, and are terminated by a carriage return <CR> (0x0D) or line feed <LF> (0x0A) character. The command format is a comma-delimited string as follows:

“\$Address,Cmd,Param1,...ParamN<LF>”

Where “Address” is the destination address, “Cmd” is the command from the host, and “param1...N” are the command parameters (if needed). Normal addresses are 0-254 (0 is default). Address 255 is a “broadcast” address, and will be obeyed by all units on the port.

Replies begin with the '#' (0x23) character followed by the address of its origin, the reply type, and the message content. No replies will be issued for broadcast (address 255) commands. The reply format is as follows:

"#Address,Type,Message<CRLF>"

COMMAND LIST:

The following is a list of supported commands for all Hammerhead Series Positioners. Single-axis units (XT Rotators) only utilize first-axis parameters (PAN). Single axis units will still report the status of a second (TILT) axis, but the values will be erroneous, and should be ignored.

"?": GET STATUS. Return all current motion parameters.

EXAMPLE COMMAND: "\$1,?<LF>"

REPLY FORMAT:

"#Addr,?,PanSpd,TiltSpd,PanPos,TiltPos,PanFlags,TiltFlags,PanCur,TiltCur<CRLF>"

Where the reply fields are...

"#": This is a reply message.

"Addr": Address of the unit replying

"?": The message type (status)

"PanSpd": Current pan axis motor speed (-100% CCW to 100% CW)

"TiltSpd": Current tilt axis motor speed (-100% CCW to 100% CW)

"PanPos": Current pan axis absolute position in degrees (0.0-359.9).

"TiltPos": Current tilt axis absolute position in degrees (0.0-359.9).

"PanFlags": Hexadecimal value that indicates limits or faults on the Pan axis (0x00 = All OK).

"TiltFlags": Hexadecimal value that indicates limits or faults on the Tilt axis (0x00 = All OK).

BIT ASSIGNMENTS:

Bit 0: CCW limit reached.

Bit 1: CW limit reached.

Bit 2: Encoder fault.

Bit 3: Motor over-current fault.

"PanCur": Pan axis motor current in mA.

"TiltCur": Tilt axis motor current in mA.

***NOTE:** *If there is an encoder fault or no encoder installed, its position will read "-1" and flags bit 2 will be set. The motor will continue to function (unless it too has failed), but no position feedback or soft-limits will be available.*

"s": GET SETTINGS. The settings command returns all stored settings as follows:

EXAMPLE COMMAND: "\$1,s<LF>"

REPLY FORMAT:

"#Addr,S,Term,PanCCW,PanCW,TiltCCW,TiltCW,BrkMode,CurLim,NA,InvP,InvT,Swap<CRLF>"

Where the reply fields are...

“#”: This is a reply message.

“Addr”: address of the unit replying

“S”: The message type (settings)

“Term”: State of the serial termination resistor (0=disabled, 1=enabled)

“PanCCW”: Pan axis CCW position limit, in whole-degrees (0-359, -1=no limit set)

“PanCW”: Pan axis CW position limit, in whole-degrees (0-359, -1=no limit set)

“TiltCCW”: Tilt axis CCW position limit, in whole-degrees (0-359, -1=no limit set)

“TiltCW”: Tilt axis CW position limit, in whole-degrees (0-359, -1=no limit set)

“BrkMode”: Motor brake mode (0=always disabled, 1=enabled when motor stopped)

“CurLim”: Motor current limit (mA)

“NA”: Unused field. Ignore this parameter.

“InvP”: Pan axis inversion state (0=normal, 1=inverted)

“InvT”: Tilt axis inversion state (0=normal, 1=inverted)

“Swap”: Axes swap state (0=normal, 1=swapped)

“v”: **VERSION.** Displays device and firmware version information. Reply is a version (V) message.

EXAMPLE COMMAND: “\$1,v<LF>”

EXAMPLE REPLY: “ #1,V,Arctic Rays Hammerhead. FW:v3.2 Mar 15 2019 12:01:04 L.Frey”

“m”: **MOVE.** Move the motors. Reply is a status (?) message.

COMMAND FORMAT: “\$Addr,m,PanSpdCmd,TiltSpdCmd<LF>”

Where the command fields are...

“Addr”: destination slave address

“m”: Move command.

“PanSpdCmd”: Commanded speed of the pan axis in percent (-100% CCW to +100% CW)

“TiltSpdCmd”: Commanded speed of the tilt axis in percent (-100% CCW to +100% CW)

***NOTE:** *In order to prevent the motors from continuing to run after a communications failure, the move command has a built-in 1-second timeout. Thus, the command must be re-issued within 1 second or else both motors will stop. Soft limits always function, regardless of communications with the host.*

***NOTE:** *If a motor over-current limit is reached, the faulted motor will raise its overcurrent fault flag and halt for 1 second before trying to move again. To avoid motor damage in case of an over-current condition, reduce speed to zero and clear the obstruction before resuming.*

“a”: **SET ADDRESS.** Sets new slave address and saves in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message, originating from the OLD address. ***NOTE:** *Unit must be power-cycled before address change takes effect.*

EXAMPLE COMMAND: “\$1,a,10<LF>”

“r”: **SET TERMINATION RESISTOR.** Enables or disables the serial termination resistor and saves in non-volatile memory for preservation after power-cycle. Follow command with a single parameter: 0=disable or 1=enable. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,r,0<LF>”

“b”: **SET BRAKE MODE.** Sets the motor brake mode and saves in non-volatile memory for preservation after power-cycle. If set to “1”, the electronic brake will be engaged whenever a motor is stopped. If set to “0”, the brakes will always be OFF (“coast”, default). Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,b,1<LF>”

“x”: **PAN AXIS ZERO.** Zeros the pan-axis position encoder and saves it in non-volatile memory for preservation after power-cycle. Reply is a status (?) message.

EXAMPLE COMMAND: “\$1,x<LF>”

“y”: **TILT AXIS ZERO.** Zeros the tilt-axis position encoder and saves it in non-volatile memory for preservation after power-cycle. Reply is a status (?) message.

EXAMPLE COMMAND: “\$1,y<LF>”

“1”: **SET PAN CCW LIMIT.** Sets the pan-axis CCW limit to the current position (rounded down to the nearest degree) and saves it in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,1<LF>”

“2”: **SET PAN CW LIMIT.** Sets the pan-axis CW limit to the current position (rounded down to the nearest degree) and saves it in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,2<LF>”

“3”: **SET TILT CCW LIMIT.** Sets the tilt-axis CCW limit to the current position (rounded down to the nearest degree) and saves it in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,3<LF>”

“4”: **SET TILT CW LIMIT.** Sets the tilt-axis CW limit to the current position (rounded down to the nearest degree) and saves it in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,4<LF>”

“p”: **CLEAR PAN LIMITS.** Clears all pan-axis limits (sets to -1) and saves in non-volatile memory for preservation after power-cycle. Clearing the limits allows continuous rotation. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,p<LF>”

“t”: **CLEAR TILT LIMITS.** Clears all tilt-axis limits (sets to -1) and saves in non-volatile memory for preservation after power-cycle. Clearing the limits allows continuous rotation. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,t<LF>”

“i”: **INVERT PAN AXIS.** Inverts the rotation of the pan axis, and saves in non-volatile memory for preservation after power-cycle. If set to “1”, the motor is inverted (i.e. negative-sign speed commands rotate CW). If set to “0”, the motor behaves normally (i.e. negative-sign speed commands rotate CCW). Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,i,1<LF>”

“j”: **INVERT TILT AXIS.** Inverts the rotation of the tilt axis, and saves in non-volatile memory for preservation after power-cycle. If set to “1”, the motor is inverted (i.e. negative-sign speed commands rotate CW). If set to “0”, the motor behaves normally (i.e. negative-sign speed commands rotate CCW). Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,j,1<LF>”

“k”: **SWAP AXES.** Swaps the pan & tilt axes operations. If set to “1”, pan commands operate the tilt axis, and tilt commands operate the pan axis. If set to “0”, the axes behave normally. Reply is a settings (S) message. **NOTE: Inversion states are always associated with their related motor, and do not change if the axes are swapped.*

EXAMPLE COMMAND: “\$1,k,1<LF>”

“u”: **SET MOTOR CURRENT LIMIT.** Sets the motor current limit (mA) and saves in non-volatile memory for preservation after power-cycle. Reply is a settings (S) message.

EXAMPLE COMMAND: “\$1,u,450<LF>”

“g”: **GOTO ABSOLUTE POSITION.** Performs an automatic move to go to a specified pan & tilt position. The target angles are specified in the command in whole degrees, from 0°-359°.

EXAMPLE COMMAND: “\$1,g,45,264<LF>”

REPLY FORMAT: “#Address,G,PanPos,TiltPos,PanTarget,TiltTarget <CRLF>”

Where the reply fields are...

“#”: This is a reply message.

“Address”: address of the unit replying

“G”: The message type (goto)
“PanPos”: Current pan axis absolute position in degrees (0.0-359.9).
“TiltPos”: Current tilt axis absolute position in degrees (0.0-359.9).
“PanTarget”: Pan axis target position in whole degrees (0-359).
“TiltTarget”: Tilt axis target position in whole degrees (0-359).

When the example command above is issued, the hammerhead starts its move to 45° and 264°, respectively. It will continue to move until both axes are within <1° of the desired position, or the HALT command is issued. ****NOTE: The GOTO command does not continually servo to hold position, it simply moves to a desired position and stops.***

“e”: **GOTO PRESET POSITION.** Performs an automatic move to go to a specified PRESET pan & tilt position. Hammerhead P&Ts offer up to 10 numbered preset positions, which are stored in non-volatile memory. Using this command recalls the preset by number (0-9), and performs an automatic GOTO move to that stored position. ****NOTE: Preset 0 is the “home” position (0,0) and cannot be changed by the user. Executing preset 0 will always bring the unit back to its home position.***

EXAMPLE COMMAND: “\$1,e,6<LF>”

REPLY FORMAT: “#Address,E,Pnum,PanPos,TiltPos,PanTarget,TiltTarget <CRLF>”

Where the reply fields are...

“#”: This is a reply message.
“Address”: address of the unit replying
“E”: The message type (execute preset)
“Pnum”: Preset number being recalled.
“PanPos”: Current pan axis absolute position in degrees (0.0-359.9).
“TiltPos”: Current tilt axis absolute position in degrees (0.0-359.9).
“PanTarget”: Pan axis target position in whole degrees (0-359).
“TiltTarget”: Tilt axis target position in whole degrees (0-359).

“d”: **SAVE PRESET.** Saves the current position as a numbered preset in non-volatile memory. The command is followed by a preset number to store the position in (1-9). Preset 0 cannot be changed by the user, and is always set to the home (0,0) position.

EXAMPLE COMMAND: “\$1,d,6<LF>”

REPLY FORMAT: “#Address,D,Pnum,PanPos,TiltPos <CRLF>”

Where the reply fields are...

“#”: This is a reply message.
“Address”: address of the unit replying
“D”: The message type (save preset)
“Pnum”: Preset number being saved.
“PanPos”: Current pan axis absolute position being saved, in whole degrees (0-359).
“TiltPos”: Current tilt axis absolute position being saved, in whole degrees (0-359).

“h”: **HALT.** Immediately halts all movement in both axes. This command is useful during automatic moves in case something goes wrong. Reply is a status (?) message.

EXAMPLE COMMAND: “\$1,h<LF>”

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