PHD Ultra - Pump Chain Commands

Introduction

PHD Ultra commands are entered via the RS232 or USB port with a terminal program such as HyperTerm, or by using a controlling computer.

Commands may be abbreviated to the first four letters, i.e. address would be abbreviated addr. A space must follow the command if arguments are included.

If the pump address is nonzero, the one or two-digit pump address precedes the command without any separator. For example, to set the infuse rate for pump 12, the command would look like "12irat 3.2 ul/min". If the pump address is one digit, it doesn't have to be preceded by a 0. Note that if the USB port is used on a pump with a nonzero address, the pump address doesn't need to be used.

For times, volumes, and rates, only the first letter needs to be entered. For example, ml can be entered as m, sec can be entered as s, and ul/min can be entered as u/m.

Every line of the response from a pump with a nonzero address is prefixed by the two digit pump address (prefixed with a 0 if necessary) followed by a colon. No colon is used to separate the pump address from the prompt however.

Many commands that change pump run parameters such as diameter or rate will update the GUI screen. To disable the GUI update for a command, the command is prefixed with "@", i.e. @irate 100 ul/min. This is especially useful for computer controlled pumps where the rate is based on an outside measurement such as pressure and needs to be changed rapidly.
WARNING: It is advisable to turn off the NVRAM when controlling the pump from a PC, as (if care is not take), the PC can send commands at a high enough rate to switch settings or even damage the NVRAM. The command is:
nvram none

In the command list below, the following convention is used:

{ }	Required parameter
[ ]	Optional parameter
|	Separator between parameter choices
#	Numeric value without preceding zeros
###	Numeric value with preceding zeros
#-#	A range of values
<cr>	Carriage return
<lf>	Line feed
<sp>	Space
[prefix]	Pump address prefix in the format #: if the pump address is not zero
<prompt>	Prompt (see below)

The following prompts are returned after a command is executed:

:	The pump is idle
>	The pump is infusing
<	The pump is withdrawing

*	The pump stalled
T*	The target was reached
>*	The infuse limit switch was hit
<*	The withdraw limit switch was hit

If the pump is in poll mode, an XON character is added after the prompt.

If the pump address is nonzero, the pump address is prefixed to the prompt without a colon.

In the following list of commands:

- The pump address is prefixed to every response line followed by a colon if the pump address is not zero.
- <lf>[##]<prompt> is the response unless otherwise noted.
- There are no carriage returns or prompts in remote polling mode.

All command responses in this document assume polling mode is set to off.

Error messages

Error messages are displayed if the entered command cannot be executed for some reason. The error message will take up two lines with the first line being the message type and the second line describing the error itself. The second line may be up to 80 characters long.

Command errors

Command errors are displayed when the command is unrecognized, entered in the wrong mode, or the state of the pump keeps the command from executing (i.e. using the IRUN command if a limit switch is active).

The command error has the following format:

```
<lf>[##:]Command error:<cr>
<lf>[##:]<sp><sp><sp>{error message}<cr>
<lf>[##]<prompt>
```

In remote polling mode the command error has the following format:

```
<lf>##:Command error:
<lf>##:<sp><sp><sp>{error message}
<lf>
```

Argument errors

Argument errors are displayed when a command argument is unrecognized or out of range. The argument in question will be displayed except in the case of missing arguments.

The argument error has the following format:

```
<lf>[##:]Argument error: [bad argument]<cr>
<lf>[##:]<sp><sp><sp>{error message}<cr>
<lf>[##]<prompt>
```

In remote polling mode the argument error has the following format:

```
<lf>##:Argument error: [bad argument]
<lf>##:<sp><sp><sp>{error message}
<lf>
```

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System commands

address

Sets or displays the pump address. Valid range is 0 to 99.

Command format:

address [0-99]

Query response:

```
<lf>[##:]Pump address is #<cr>
<lf>[##]<prompt>
```

Notes:

Pumps with an address of 0 are masters, and pumps with an address between 1 and 99 are slaves.

ascale

Sets or displays the analog scaling percentage. Valid range is 1 to 100.

Command format:

ascale [1-100]

Query response:

```
<lf>[##:]Pump address is #<cr>
<lf>[##]<prompt>
```

Notes:

The scaling percentage adjusts the maximum speed of the pump. For example, if "ascale 50" is entered, the full range of the analog input will run the pump between 0% and 50% speed.

baud

Sets or displays the RS232 port baud rate. Valid baud rates are 9600, 19200, 38400, 57600, 115200, 128000, 230400, 256000, 460800, and 921600. Note that some computers may not be able to handle baud rates above 115200.

Command format:

baud [9600 | 19200 | 38400 | 57600 | 115200 | 128000 | 230400 | 256000 | 460800 | 921600]

Query response:

```
<lf>[##:]# baud<cr>
<lf>[##]<prompt>
```

Notes:

If this command is entered via RS232, the prompt is displayed at the previous baud rate and then the baud rate is changed.

Running at 921,600 baud may cause missed characters.

boot

Enter the boot loader.

Command format:

boot

catalog

Displays a catalog of methods stored in the pump.

Command format:

cat

Query response:

```
<lf>[##:]Method name      Size<cr>
<lf>[##:]---------------  ----<cr>
<lf>[##:]{method name}       #<cr>   This line is repeated for each file on the disk
<lf><lf>[##:]# file(s) using # steps<cr>
<lf>[##]<prompt>
```

Notes:

The file size is the number of steps in the method plus one for the file information header.

The last line shows the number of files and the total number of steps being used on the disk.

cmd

Sets or displays the command set. The pump is capable of operating in the Ultra command set or the legacy Model 22 or PHD 44 command sets. Valid command sets are ultra, 22, and 44.

Command format:

cmd [{command set}]

Query responses:

```
<lf>[##:]Ultra<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]22<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]44<cr>
<lf>[##]<prompt>
```

Notes:

If the pump is in any command set other than Ultra, only `cmd ultra` will be accepted.

config

Changes some of some of the pump metrics. The following are the metrics that can be changed:

a: Steps per rev
g: Gear ratio
p: Pulley ratio
t: Lead screw
b: Motor polarity
n: Min syringe size
x: Max syringe size
e: Encoder

Typing config without any parameters displays the above list along with the current settings. To change the settings, use the parameter letter above followed by the new setting. For example, to set the number of steps per revolution to 400, "config a400" is used. Multiple metrics may be changed by separating the metrics with commas, e.g. "config a400,n0.1,e100". Spaces may not be used within the metric parameter.

Steps per rev: 200 for a 1.8 degree stepper motor, 400 for a 0.9 degree motor. Valid values are 10 to 400.
Gear ratio: The gear ratio without the :1. A 2:1 ratio is just 2.
Pulley ratio: The pulley ratio without the :1. A 1.6:1 ratio is just 1.6.
Lead screw: Lead screw threads per inch. If negative, threads per cm.
Motor polarity: Direction the motor runs when the pump runs forward. Pumps with pulleys need to be in reverse polarity. Valid values are f or r.
Minimum syringe size: Minimum size of the syringe in mm. Must be greater than zero.
Maximum syringe size: Maximum size of the syringe in mm. Must be greater than the minimum.
Encoder: Encoder line count. Zero disables the encoder. Valid range is 0 to 400.

Typing "config ?" displays the help text.

WARNING! AFTER SETTING THE METRICS, THE PUMP MUST BE POWER CYCLED!

Command format:

config [{metric list}|?]

delmethod

Deletes a method stored in the pump.

Command format:

delmethod {method}

dim

Sets or displays the backlight level in percent. Valid range is 0 to 100. Note that specifying 0 will turn the backlight off so that the screen will not be visible.

Command format:

dim [0-100]

Query response:

```
<lf>[##:]Backlight is set to #%<cr>
<lf>[##]<prompt>
```

echo

Sets or displays the RS232/USB echo state. Valid states are on or off.

This command is illegal in remote polling mode.

Command format:

echo [on|off]

Query response:

```
<lf>[##:]Echo is OFF<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]Echo is ON<cr>
<lf>[##]<prompt>
```

free

Displays the number of free method steps left on the disk.

Command format:

free

Query response:

```
<lf>[##:]# steps used<cr>
<lf>[##:]# steps free<cr>
<lf>[##:]# total steps<cr>
<lf>[##]<prompt>
```

The number of steps displayed is a four digit number, right justified, and padded with spaces.

force

Sets or displays the infusion force level in percent. Valid range is 1 to 100.

Command format:

force [1-100]

Query response:

<lf>[##:]#%<cr>
<lf>[##]<prompt>

ftswitch

Sets or displays the foot switch setting.

The foot switch may be used in a toggle on or off mode (momentary), a press to run mode (rising), or a release to run mode (falling).

Command format:

ftswitch [mom|rise|fall]

Query response:

<lf>[##:]Momentary<cr>
<lf>[##]<prompt>

or:

<lf>[##:]Active high<cr>
<lf>[##]<prompt>

or:

<lf>[##:]Active Low<cr>
<lf>[##]<prompt>

mode

Displays the current pump mode.

Command format:

mode

Query response:

<lf>[##:]Quick Start – {Quick Start mode}<cr>
<lf>[##]<prompt>

or:

<lf>[##:]Method – {method name}<cr>
<lf>[##]<prompt>

poll

Sets or displays the polling mode state.

When polling mode is off, prompts are displayed when an event happens, such as a target reached.

When polling mode is on, prompts are not displayed when an event happens, and an XON character is output when the pump is ready for another command.

When polling mode is in remote mode, the following occurs:

- Prompts are not displayed.
- Carriage returns are not displayed.
- The pump address is displayed even if 0.
- Echo is forced off and the echo command is illegal.

Valid states are on, off, or remote.

Command format:

poll [on|off|remote]

Query response:

```
<lf>[##:]Polling mode is OFF<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]Polling mode is ON<cr>
<lf>[##]<prompt><xon>
```

or:

```
<lf>##:Polling mode is REMOTE
<lf>
```

remote

Sets or displays the remote pump address. Valid range is 0 to 99. If 0 is entered, no remote is used.

Command format:

remote [0-99]

Query response:

```
<lf>[##:]No remote pump defined.
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]Remote pump address is #<cr>
<lf>[##]<prompt>
```

Notes:

A pump with an address of 0 cannot be used as a remote.

tilt

Calibrates the tilt sensor. The pump must be level when this command is entered.

Command format:

tilt

time

Sets or displays the date and time.

Command format:

time [mm/dd/yy] [hh:mm:ss]

Query response:

```
<lf>[##:]##/##/## ##:##:## #M<cr>
<lf>[##]<prompt>
```

The date order and time format are dependent on the settings made when setting the date from the touch screen.

ver

Displays the short version string.

Command format:

ver

Query response:

```
<lf>[##:]PHD Ultra #.#.#<cr>
<lf>[##]<prompt>
```

version

Displays the full version string.

Command format:

version

Query response:

```
<lf>[##:]Firmware:      v#.#.#<cr>
<lf>[##:]Pump address:  #<cr>
<lf>[##:]Serial number: #######<cr>
<lf>[##:]DeviceID:      ########<cr>
<lf>[##]<prompt>
```

Run commands

irun

Runs the pump in the infuse direction. Quick Start mode only.

Command format:

irun

rrun

Runs the pump in the opposite direction. Quick Start mode only.

Command format:

rrun

stop / stp

Stops the pump.

Command formats:

stop
stp

wrun

Runs the pump in the withdraw direction. Quick Start mode only.

Command format:

wrun

Syringe commands

diameter

Sets or displays the syringe diameter in mm. Quick Start mode only.

Command format:

diameter [{syringe diameter}]

Query response:

```
<lf>[##:]#.#### mm<cr>
<lf>[##]<prompt>
```

gang

Sets or displays the syringe count. Quick Start mode only.

Command format:

gang [{syringe count}]

Query response:

```
<lf>[##:]# syringes<cr>
<lf>[##]<prompt>
```

svolume

Sets or displays the syringe volume in ul or ml. Quick Start mode only.

Command format:

svolume [{syringe volume} {ul|ml}]

Query response:

```
<lf>[##:]#.#### ul<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]#.#### ml<cr>
<lf>[##]<prompt>
```

syrmanu

Sets or displays the syringe manufacturer. Quick Start mode only.

Valid 3-character manufacturer codes are shown in the table below. Not all syringe manufacturers may be available depending on the pump model.

air	Air-Tite, HSW Norm-Ject
bdg	Becton Dickinson, Glass (all types)
bdp	Becton Dickinson, Plasti-pak
cad	Cadence Science, Micro-Mate Glass
cps	Cole Parmer, Stainless Steel
hm1	Hamilton Glass 700
hm2	Hamilton Glass 1000
hm3	Hamilton Glass 1700
hm4	Hamilton Glass 7000

hos	Hoshi
kgl	KDS Glass
nat	Natsume
nip	Nipro
sge	SGE (Scientific Glass Engineering)
smp	Sherwood-Monoject, Plastic
sst	Stainless Steel
ter	Terumo
top	Top

Typing syrm with no arguments displays the current syringe setting.

Typing syrm ? displays a list of manufacturers with their associated 3-letter codes.

Typing syrm {code} ? shows a list of syringe sizes associated with the specified manufacturer.

Command format:

syrm [?|{3 char code} ?|{volume} ul|ml]

Query response:

```
<lf>[##:]{manufacturer}, {diameter} mm<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]Custom, {diameter} mm<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]{code} {manufacturer}<cr>   This line is repeated for each syringe manufacturer
<lf>[##]<prompt>
```

or:

```
<lf>[##:]{volume} {unit}<cr>         This line is repeated for each syringe size.
<lf>[##]<prompt>
```

Rate commands

crate

Displays the current rate that the motor is running at. If the motor is stopped, the current rate is 0. Quick Start mode only.

Command format:

crate

Query response:

```
<lf>[##:]Infusing at # xl/xxx<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]Withdrawing at # xl/xxx<cr>
<lf>[##]<prompt>
```

iramp

Sets or displays the target infusion rate while ramping. Quick Start mode only. The rate and units arguments may be replaced by "max" or "min" to set the maximum or minimum rate, respectively.

Command format:

iramp [max|min|{start rate} {start units} max|min|{end rate} {end units} {ramp time in seconds}]

Query response:

```
<lf>[##:]Ramp not set up.<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]# xl/xxx to # xl/xxx in # seconds<cr>
<lf>[##]<prompt>
```

irate

Sets or displays the infusion rate. Quick Start mode only. The rate argument may be replaced by "max" or "min" to set the maximum or minimum rate, respectively. "lim" may be used to display the range limits.

Command format:

irate [max|min|lim|{rate} {rate units}]

Query response:

```
<lf>[##:]# xl/xxx<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]# xl/xxx to # xl/xxx<cr>
<lf>[##]<prompt>
```

wramp

Sets or displays the target withdraw rate while ramping. Quick Start mode only. The rate and units arguments may be replaced by "max" or "min" to set the maximum or minimum rate, respectively.

Command format:

wramp [{start rate} {end rate} {rate units} {ramp time in seconds}]

Query response:

```
<lf>[##:]Ramp not set up.<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]# xl/xxx to # xl/xxx in # seconds<cr>
<lf>[##]<prompt>
```

wrate

Sets or displays the withdraw rate. Quick Start mode only. The rate argument may be replaced by "max" or "min" to set the maximum or minimum rate, respectively. "lim" may be used to display the range limits.

Command format:

wrate [max|min|lim|{rate} {rate units}]

Query response:

```
<lf>[##:]# xl/xxx<cr>
<lf>[##]<prompt>
```

Volume commands

civolume

Clears the infused volume. Quick Start mode only.

Command format:

civolume

ctvolume

Clears the target volume. Quick Start mode only.

Command format:

ctvolume

cvolume

Clears both the infused and withdrawn volumes. Quick Start mode only.

Command format:

cvolume

cwvolume

Clears the withdrawn volume. Quick Start mode only.

Command format:

cwvolume

ivolume

Displays the infused volume. Quick Start mode only.

Command format:

ivolume

Query response:

```
<lf>[##:]# xl<cr>
<lf>[##]<prompt>
```

tvolume

Sets or displays the target volume. Quick Start mode only.

Command format:

tvolume [{target volume} {volume units}]

Query response:

```
<lf>[##:]Target volume not set<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:] # xl/xxx<cr>
<lf>[##]<prompt>
```

wvolume

Displays the withdrawn volume. Quick Start mode only.

Command format:

wvolume

Query response:

```
<lf>[##:]# xl<cr>
<lf>[##]<prompt>
```

Time commands

citime

Clears the infused time. Quick Start mode only.

Command format:

citime

ctime

Clears both the infused and withdrawn times. Quick Start mode only.

Command format:

ctime

cttime

Clears the target time. Quick Start mode only.

Command format:

cttime

cwtime

Clears the withdrawn time. Quick Start mode only.

Command format:

cwtime

itime

Displays the infused time. Quick Start mode only.

Command format:

itime

Query response:

```
<lf>[##:]# seconds<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]##:##:##<cr>
<lf>[##]<prompt>
```

ttime

Sets or displays the target time. Quick Start mode only.

Command format:

ttime [{target time}]

Query response:

```
<lf>[##:]Target time not set<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]# seconds<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]##:##:##<cr>
<lf>[##]<prompt>
```

wtime

Displays the withdrawn time. Quick Start mode only.

Command format:

wtime

Query response:

```
<lf>[##:]# seconds<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]##:##:##<cr>
<lf>[##]<prompt>
```

Digital I/O commands

input

Reads and displays the trigger input port status.

Command format:

input

Query response:

```
<lf>[##:]Low<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]High<cr>
<lf>[##]<prompt>
```

output

Sets the level on one of the output ports.

Command format:

output {1|2} {high|low}

sync

Sets the level on the sync port.

Command format:

sync {high|low}

valve

Displays or sets the valve state. When the valve is set to auto, the motor direction determines whether the valve is on or off.

Command format:

valve {on|off|auto}

Query response:

```
<lf>[##:]Off<cr>
<lf>[##]<prompt>
```

or:

```
<lf>[##:]On<cr>
<lf>[##]<prompt>
```

Computer control commands

The Ultra series pumps may be controlled by a computer through the RS232 and USB ports. The computer control commands make it possible to control a remote pump without having to access the touch screen.

---

isprog

Displays whether or not the pump is programmable.

Command format:

isprog

Query response:

```
<lf>[##:]Y<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]N<cr>
<lf>[##]<prompt>
```

lock

Puts the pump into satellite mode.

Satellite mode is a special mode similar to Quick Start mode that is used for computer control. While in this mode, the only items displayed are the satellite number; pump name; and syringe, force, and rate information. A stop button is also supplied in case the pump needs to be stopped for an emergency.

Entering the lock command with no arguments displays the current lock status (off, on, or the pump name). "Lock on" will lock the pump with no pump name. Lock followed by the name will name the pump and the name will be displayed just below the satellite number.

The pump name can be changed by sending a lock command with the new name. If the pump is named and the lock on command is sent, the name will be erased.

If the stop button is pressed while the pump is running, emergency stop mode is entered. The prompt becomes "A*" and the pump cannot be run until the condition is cleared with the "stop" command.

Command format:

lock
lock on
lock {pump name}

Query responses:

<lf>[##:]off<cr>
<lf>[##]<prompt>

Or:

<lf>[##:]on<cr>
<lf>[##]<prompt>

Or:

<lf>[##:]{pump name}<cr>
<lf>[##]<prompt>

load

Loads a method or displays the currently loaded method.

This command will load the mode or method and display the appropriate screen (either Quick Start or method).

Although the load command may be used to display the mode while in satellite mode, it cannot be used to leave satellite mode. Use the unlock command instead.

Command format:

load
load {method name}
load qs {i|w|iw|wi}

Query responses:

```
<lf>[##:]Quick Start - Infuse Only (qs i)<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]Quick Start - Withdraw Only (qs w)<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]Quick Start - Infuse/Withdraw (qs iw)<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]Quick Start - Withdraw/Infuse (qs wi)<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]{method name}<cr>
<lf>[##]<prompt>
```

Or:

```
<lf>[##:]Satellite<cr>
<lf>[##]<prompt>
```

Or (for analog pumps):

```
<lf>[##:]Analog<cr>
<lf>[##]<prompt>
```

run

Simulates a key press of the run button located in the lower right corner of the screen.

Command format:

run

smooth

Enters smooth running mode. This is a mode that eliminates motor stops between run segments, and also suppresses prompts at the end of a run or during a stall.

Command format:

smooth {on|off}

status

Displays the raw status for use with a controlling computer.

Command format:

status

Notes:

- The output is in three integer fields and one flag field, all separated by spaces and terminated by a carriage return/linefeed pair.
- The first integer is the current rate in femtoliters per second.
- For Firmware versions 1.X.X, The second integer is the infuse time in clock cycles. One clock cycle is $^{1}/_{60,000,000}$ second. The time has a granularity of 1 millisecond. For Firmware versions 2.X.X, The second integer is the infuse time in milliseconds.
- The third integer is the infused volume in femtoliters. All three values are for the current direction.
- The flag field consists of six flags.
- The first flag is the motor direction and will be "i" if the pump is infusing and "w" if the pump is withdrawing. If the letter is lower case, the pump motor is idle. If upper case, the pump motor is running.
- The second flag is the limit switch status. If the infuse limit switch was hit, "I" is displayed. If the withdraw limit switch was hit, "W" is displayed. If no limit switch was hit or the pump doesn't have limit switches, "." is displayed.
- The third flag is the stall status and will be "S" if the pump has stalled or "A" if an abnormal stop was detected. Otherwise it will be ".".
- The fourth flag is the trigger input state and will be "T" if high and "." if low.
- The fifth flag is the direction port state and will be "I" for infuse and "W" for withdraw.
- The sixth flag is the foot switch flag state and will be "F" for active and "." if not.
- The seventh flag is the target reached status and will be "T" if the target time or volume was reached and "." if not.

unlock

Takes the pump out of satellite mode. The pump will return to the prior mode before satellite mode was entered.

Command format:

unlock

Internal commands

Internal commands are used by the pump when connected to a controlling computer, but are not meant to be entered by the user. They are listed here for completeness.

---

mend

Defines the end of an exported method transfer.

Command format:

mend

---

method

Defines the file header for an exported method.

Command format:

method {hex data}

---

mstep

Defines a step in an exported method.

Command format:

mstep {hex data}

---

send

Sends a method to the PC.

Command format:

send {method name}

Analog Syringe load commands

mdiam

In analog mode, will set the syringe diameter for analog mode ONLY. Does not work when pump is in Quick start mode.

Format is:
mdiam [{method name} {syringe diameter}]

For example:
Mdiam analog_mode 12

---

msvol

In analog mode, will set the syringe volume for analog mode ONLY. Does not work when pump is in Quick start mode

Format is:
msvol [{method name} {syringe volume} {ul|ml}]

For example:
Msvol analog_mode 20 ml

To set the syringe diameter in quick start, you will have to issue the diameter and svolume commands while the pump is in the Quick start mode.