



Application Note

# ExiGo<sup>®</sup> API Overview

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## 1. Introduction

This document gives an overview of the serial communication framing and format as well as a detailed description of the commands available to control the ExiGo Pump via serial communication.

## 2. Serial communication framing and format

Serial communication with ExiGo pump is ASCII based and therefore all the information to be transmitted must be converted to ASCII prior being sent to the pump.

For instance, to transfer the decimal number 100 (0h64) must be converted to the ASCII code "100" (0h313030).

The set of commands available in order to control the ExiGo Pump can be classified in:

- Set commands
- Query commands
- Miscellaneous commands
- Repeat commands
- Error commands
- ACK/NACK commands.

Every command included in the categories listed above must be framed (using flag bytes) in order to allow either the Pump or the host software application to detect the beginning and end of these commands. Flag bytes are special bytes which denote when a frame begins and when a frame ends

Table 1: Structure of a valid ExiGo pump command

START Flag	DATA	END Flag
---------------	------	-------------

The value of these special flags is defined within the table below:

Table 2: Definition of START and END flag bytes

Flag	Hex value	ASCII character
START	0h1B	Escape
END	0h00	Null

As all the set of commands are comprised by “human readable” ASCII characters there is no need to use byte stuffing technique as it is not expected to receive either a START flag or END flag as part of valid DATA field.

### 3. Set Commands

The commands allocated within this group are used to define configuration parameters within the ExiGo pump (Syringe type, Flow rate, etc).

Some of the commands described below are only valid when the ExiGo pump is within certain status or statuses and/or when some prerequisites are satisfied. Please refer to individual command description for further information.

#### 3.1. Set syringe type

This command sets the type of syringe used during the experiment. There are two different set of syringes already preset on the device:

##### Hamilton Syringes<sup>1</sup>:

700 Series	
Part Number	Description
<a href="#">80601</a>	100 µL, Model 710 LT SYR
<a href="#">80701</a>	250 µL, Model 725 LT SYR
<a href="#">80801</a>	500 µL, Model 750 LT SYR
1000 Series Gastight Syringes	
Part Number	Description
<a href="#">81301</a>	1 mL, Model 1001 LT SYR

<sup>1</sup> Part Number indicated here belongs to Luer tip termination. Different syringe tips are also supported.

## BD Plastipak Syringes:

Part Number	Description
300013	1 ml Syringe. Luer tip
300185	2.5 ml Syringe. Luer tip
302187	5 ml Syringe. Luer tip

### 3.1.1.Syntax

Table 3: Set Syringe syntax

<b>ESC</b>	<b>S</b>	<b>Y</b>	<b>Syringe Type</b>	<b>NULL</b>
------------	----------	----------	---------------------	-------------

### 3.1.2.Field description

Table 4: Set syringe field description

Field	Format	Values
Syringe Type	Uint16	0 = Hamilton 100uL 1 = Hamilton 250uL 2 = Hamilton 500uL 3 = Hamilton 1 mL 4 = BD PlastiPak 1mL 5 = BD PlastiPak 2.5mL 6 = BD PlastiPak 5mL

### 3.1.3.Valid conditions

Table 5: Set Syringe command valid conditions

Pump valid statuses	Command prerequisites
All	None

## 3.2. Set Flow Rate

When running in manual mode, the desired flow rate at which the pump is perfusing can be set by means of the following command:

### 3.2.1.Syntax

Table 6: Set Flow Rate syntax

<b>ESC</b>	<b>S</b>	<b>F</b>	<b>Flow Rate</b>	<b>NULL</b>
------------	----------	----------	------------------	-------------

### 3.2.2.Field condition

Table 7: Flow Rate command field description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Flow Rate	double	Depending on the syringe. Flow rate unit nl/min <sup>2</sup>

### 3.2.3.Valid conditions

Table 8: Flow rate command valid conditions

<b>Pump valid statuses</b>	<b>Command prerequisites</b>
Running Stopped	Syringe must be defined

Flow rates can be positive or negative. A positive flow rate means that the ExiGo pump will move forward (perfuse) while a negative flow rate means that the ExiGo pump will move backward (pick up) at the desired rate.

## 3.3. Set PID parameters

When running an experiment using ExiGo sensor, the pump can be controlled using a PID controller. Each of the PID parameters (proportional, integral and differential) can be set independently as well as the PID can be enabled or disabled completely.

### 3.3.1.Syntax

Table 9: Set PID command syntax

<b>ESC</b>	<b>S</b>	<b>I</b>	<b>PID state</b>	<b>SPC<sup>3</sup></b>	<b>P value</b>	<b>SPC</b>	<b>I value</b>	<b>SPC</b>	<b>D value</b>	<b>SPC</b>	<b>C Value</b>	<b>NULL</b>
------------	----------	----------	------------------	------------------------	----------------	------------	----------------	------------	----------------	------------	----------------	-------------

<sup>2</sup> The maximum flow rate to be set depends on the selected syringe. Flow rates must be sent in nanoliters per minute.

<sup>3</sup> Space character (SPC) hexadecimal equivalent is 0h30.

### 3.3.2.Field description

Table 10: Set PID command field description

Field	Format	Values
PID state	boolean	0: OFF 1: ON
P value	double	Proportional value: 0 to 10000
I value	double	Integral value:0 to 1
D value	double	Differential value: 0 to 10000
C value	double	0 to 1 (0 recommended)

### 3.3.3.Valid conditions

Table 11: Set PID command valid conditions

Pump valid statuses	Command prerequisites
Running Stopped	ExiGo sensor must be plugged in

## 3.4. Set Action

The ExiGo pump can be programmed in order to perform an automated assay. This assay is comprised of interconnected elements (constant flow rate, ramp, pulse, pause, etc) of certain duration forming the desired flow rate waveform

### 3.4.1.Syntax

Table 12: Set action command syntax

ESC	S	A	Action Index	SPC	Total of Actions	SPC	Action Information	NULL
-----	---	---	--------------	-----	------------------	-----	--------------------	------

### 3.4.2.Field Description

Table 13: Set action command fields description

Field	Format	Values
Action Index	Uint16	0 to 255
Total of Actions	Uint16	0 to 255
Action Information	mixed	Every action has its own syntax. Please read description

		below
--	--	-------

- **Action Information: Constant Flow Rate**

Table 14: Constant flow rate action information syntax

C	SPC	Flow Rate	SPC	Time min	SPC	Time secs
---	-----	-----------	-----	----------	-----	-----------

Table 15: Constant flow rate action information fields description

Field	Format	Values
Flow Rate	double	Depending on the syringe used
Time min	UInt32	0 to 12000 minutes
Time secs	UInt32	0 to 60 seconds

- **Action Information: Ramp**

Table 16: Ramp action information syntax

R	SPC	Initial Flow Rate	SPC	Time min	SPC	Time secs	SPC	Final Flow Rate
---	-----	-------------------	-----	----------	-----	-----------	-----	-----------------

Table 17: Ramp action information fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe type
Final Flow Rate	double	Depending on the syringe type
Time min	UInt32	0 to 12000 minutes
Time secs	UInt32	0 to 60 seconds

- **Action Information: Pulse**

Table 18: Pulse action information syntax

P	SPC	Initial Flow Rate	SPC	Final Flow Rate	SPC	Period min	SPC	Period secs	SPC	Repetitions	SPC	Duty Cycle
---	-----	-------------------	-----	-----------------	-----	------------	-----	-------------	-----	-------------	-----	------------

Table 19: Pulse action information fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe type
Final Flow Rate	double	Depending on the syringe type
Period min	UInt32	0 to 12000 minutes
Period secs	UInt32	0 to 60 seconds
Repetitions	UInt32	1 to 999

Duty Cycle	Uint32	0 to 100
------------	--------	----------

- **Action Information: Sine**

Table 20: Sine action information syntax

S	SPC	Initial Flow Rate	SPC	Period min	SPC	Period secs	SPC	Repetitions	SPC	Phase	SPC	Offset
---	-----	-------------------	-----	------------	-----	-------------	-----	-------------	-----	-------	-----	--------

Table 21: Sine action information fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe type
Period min	Uint32	0 to 12000 minutes
Period secs	Uint32	0 to 60 seconds
Repetitions	Uint32	1 to 999
Phase	Uint32	0 to 360
Offset	Uint32	Depending on the syringe type

### 3.4.3.Valid conditions

Pump valid statuses	Command prerequisites
Stopped	None

### 3.4.4.Examples

Example 1:

This example shows how to program the ExiGo pump for the following assay:

Number	Element	Settings															
1	Constant Flow rate	Initial Flow Rate: 1000 nl/min Time min: 1 min Time seconds: 20 seconds															
Command:																	
<table><tr><td>ESC</td><td>S</td><td>A</td><td>0</td><td>SPC</td><td>2</td><td>SPC</td><td>C</td><td>SPC</td><td>1000</td><td>SPC</td><td>1</td><td>SPC</td><td>20</td><td>NULL</td></tr></table>			ESC	S	A	0	SPC	2	SPC	C	SPC	1000	SPC	1	SPC	20	NULL
ESC	S	A	0	SPC	2	SPC	C	SPC	1000	SPC	1	SPC	20	NULL			
2	Ramp	Initial Flow Rate: 1000 nl/min Final Flow Rate: 3000 nl/min Time min: 1 min															

											Time seconds: 45 seconds					
Command:																
ESC	S	A	1	SPC	2	SPC	R	SPC	1000	SPC	3000	SPC	1	SPC	45	NULL
3				Constant Flow rate						Initial Flow Rate: 3000 nl/min Time min: 1 min Time seconds: 0 seconds						
Command:																
ESC	S	A	2	SPC	2	SPC	C	SPC	3000	SPC	1	SPC	0	NULL		

In order to program the pump successfully the 3 commands described above need to be sent to the pump IN ORDER:

- Step 1: Send the first command

ESC	S	A	0	SPC	2	SPC	C	SPC	1000	SPC	1	SPC	20	NULL
-----	---	---	---	-----	---	-----	---	-----	------	-----	---	-----	----	------

- Step 2: Get ACK from the pump<sup>4</sup>
- Step 3: Send the second command

ESC	S	A	1	SPC	2	SPC	R	SPC	1000	SPC	3000	SPC	1	SPC	45	NULL
-----	---	---	---	-----	---	-----	---	-----	------	-----	------	-----	---	-----	----	------

- Step 4: Get ACK from the pump
- Step 5: Send the third and last command

ESC	S	A	2	SPC	2	SPC	C	SPC	3000	SPC	1	SPC	0	NULL
-----	---	---	---	-----	---	-----	---	-----	------	-----	---	-----	---	------

- Step 6: Get ACK from the pump

---

<sup>4</sup> This step is not mandatory but recommended



### 3.5. Set LED type

This command turns ON or OFF the LED lights on the Exigo and UniGo pumps. The current LED status is displayed on the bit number 6 of the status word (see point 4.1)

#### 3.5.1. Syntax

Table 22: Set LED syntax

<b>ESC</b>	<b>S</b>	<b>L</b>	<b>LED ON/OFF</b>	<b>NULL</b>
------------	----------	----------	-------------------	-------------

#### 3.5.2. Field description

Table 23: Set LED field description

Field	Format	Values
<b>LED ON/OFF</b>	boolean	0 = LED ON 1 = LED OFF

#### 3.5.3. Valid conditions

Table 24: Set LED command valid conditions

Pump valid statuses	Command prerequisites
All	None

### 3.1. Set ECO mode

This command turns ON or OFF the ECO mode on the Exigo pump. The current ECO status is displayed on the bit number 7 of the status word (see point 4.1)

#### 3.1.1. Syntax

Table 25: Set ECO syntax

<b>ESC</b>	<b>S</b>	<b>E</b>	<b>ECO ON/OFF</b>	<b>NULL</b>
------------	----------	----------	-------------------	-------------

### 3.1.2.Field description

Table 26: Set ECO field description

Field	Format	Values
<b>ECO ON/OFF</b>	boolean	0 = ECO ON 1 = ECO OFF

### 3.1.3.Valid conditions

Table 27: Set ECO command valid conditions

Pump valid statuses	Command prerequisites
All	None

## 4. Query Commands

This group of commands are used to retrieve information from the ExiGo Pump such as pump status, flow rate measurements, PID parameters, etc.

Query commands can be performed independently of the status of the pumps.

### 4.1. System Status query

This query retrieves the overall status of any pump connected.

#### 4.1.1.Syntax

Table 28: System Status query syntax

<b>ESC</b>	<b>Q</b>	<b>S</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.1.2. Answer

Table 29: System Status query answer

<b>ESC</b>	<b>A</b>	<b>S</b>	<b>Pumps Connected</b>	<b>SPC</b>	<b>Status Word(1)</b>	<b>NULL</b>
------------	----------	----------	------------------------	------------	-----------------------	-------------

### 4.1.3. Field description

Table 30: System Status query fields description

Field	Format	Values			
Pumps Connected	Uint16	0 to 3			
Status Word(1)	Uint32	Bit Index	Size	Information	
		28-31	4 bits	Pump Status: 0 = Stopped 1 = Running 2 = Displacing 3 = Initializing 4 = Not Initialized	
		24-27	4 bits	0 = No limits reached 1 = Back limit reached 2 = Front limit reached	
		8-23	16 bits	Step Index (0 to 3175) 4095 if no initialized (0xFFFF)	
		7	1bits	ECO mode 1 = ON 0 = OFF	
		6	1bits	LED mode 1 = ON 0 = OFF	
		5	1 bits	Sensor Plugged 1 = YES 0 = NO	
		4	1 bits	Syringe Placed 1 = YES 0 = NO	
		0-3	4 bits	Pump Programmed 1 = YES 0 = NO	
		(1) Should more than one pumps be connected:			
Status Word Pump 1	SPC	Status Word Pump 2	...	Status Word Pump n	NULL

### 4.2. Syringe query

Retrieves the type of syringe placed in every pump connected.

#### 4.2.1.Syntax

Table 31: Syringe query command syntax

<b>ESC</b>	<b>Q</b>	<b>Y</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.2.2. Answer

Table 32: Syringe query command answer

<b>ESC</b>	<b>A</b>	<b>Y</b>	<b>Syringe Type (1)</b>	<b>NULL</b>
------------	----------	----------	-------------------------	-------------

#### 4.2.3.Field Description

Table 33: Syringe query command answer fields description

Field	Format	Values
Syringe Type (1)	int	-1 = No Syringe installed 0 = Hamilton 100uL 1 = Hamilton 250uL 2 = Hamilton 500uL 3 = Hamilton 1 mL 4 = BD PlastiPak 1mL 5 = BD PlastiPak 2.5mL 6 = BD PlastiPak 5mL
(2) Should more than one pumps be connected:		
<b>Syringe Type Pump 1</b>	<b>SPC</b>	<b>Syringe Type Pump 2</b> ... <b>Syringe Type Pump n</b> <b>NULL</b>

### 4.3. Flow Rate query

This command retrieves the last flow rate measurement performed by the flow sensor for every pump.

#### 4.3.1.Syntax

Table 34: Flow rate query syntax

<b>ESC</b>	<b>Q</b>	<b>F</b>	<b>NULL</b>
------------	----------	----------	-------------

### 4.3.2. Answer

Table 35: Flow rate query answer

<b>ESC</b>	<b>A</b>	<b>F</b>	<b>Flow Rate(1)</b>	<b>NULL</b>
------------	----------	----------	---------------------	-------------

### 4.3.3. Field description

Table 36: Flow rate query answer fields description

Field	Format	Values
Flow Rate (1)	double	*Values depending on the flow sensor If there is no sensor connected the flow rate retrieved is equal to 0
(1) Should more than one pumps be connected:		
<b>Flow Rate Pump 1</b>	<b>SPC</b>	<b>Flow Rate Pump 2</b>
<b>...</b>	<b>...</b>	<b>Flow Rate Pump n</b>
<b>NULL</b>	<b>NULL</b>	<b>NULL</b>

## 4.4. PID parameters query

This command retrieves the parameters of the PID controller set within the ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

### 4.4.1. Syntax

Table 37: PID parameters query syntax

<b>ESC</b>	<b>Q</b>	<b>I</b>	<b>NULL</b>
------------	----------	----------	-------------

### 4.4.2. Answer

Table 38: PID parameters query answer

<b>ESC</b>	<b>A</b>	<b>I</b>	<b>PID State</b>	<b>SPC</b>	<b>KP</b>	<b>SPC</b>	<b>KI</b>	<b>SPC</b>	<b>KD</b>	<b>SPC</b>	<b>KC</b>	<b>NULL</b>
------------	----------	----------	------------------	------------	-----------	------------	-----------	------------	-----------	------------	-----------	-------------

### 4.4.3. Field description

Table 39: PID parameters query answer fields description

Field	Format	Values
PID state	boolean	0: OFF

		1: ON
KP	double	Proportional value: 0 to 10000
KI	double	Integral value:0 to 1
KD	double	Differential value: 0 to 10000
KC	double	0 to 1

#### 4.5. Number of actions query

Using this query the number of actions programmed within a given ExiGo pump can be retrieved

##### 4.5.1.Syntax

Table 40: Number of actions query syntax

<b>ESC</b>	<b>Q</b>	<b>N</b>	<b>NULL</b>
------------	----------	----------	-------------

##### 4.5.2.Answer

Table 41: Number of actions query answer

<b>ESC</b>	<b>A</b>	<b>N</b>	<b>Number of Pumps</b>	<b>SPC</b>	<b>Number of Actions(1)</b>	<b>NULL</b>
------------	----------	----------	------------------------	------------	-----------------------------	-------------

##### 4.5.3.Field Description

Table 42: Number of actions query answer fields description

Field	Format	Values
Number of Pumps	UInt16	0 to 3
Number of Actions (1)	UInt32	0 to 255
(1) Should more than one pumps be connected:		
Number of Actions Pump 1	SPC	Number of Actions Pump 2 ... Number of Actions Pump n NULL

## 4.6. Action details query

Use this query to retrieve detailed information about a particular assay action programmed within the ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

This command must be preceded of a *Number of Actions* Query in order to determine how many Assay Actions are programmed within the given pump and send an Action index accordingly to the received values.

### 4.6.1. Syntax

Table 43: Action details query syntax

<b>ESC</b>	<b>Q</b>	<b>A</b>	<b>Action index</b>	<b>NULL</b>
------------	----------	----------	---------------------	-------------

### 4.6.2. Answer

Table 44: Action details query answer

<b>ESC</b>	<b>A</b>	<b>A</b>	<b>Pump Number</b>	<b>SPC</b>	<b>Action index</b>	<b>SPC</b>	<b>Number of Actions</b>	<b>SPC</b>	<b>Action Details</b>	<b>NULL</b>
------------	----------	----------	--------------------	------------	---------------------	------------	--------------------------	------------	-----------------------	-------------

### 4.6.3. Field description

Table 45: Action details query answer fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Pump Number	Uint16	0 to 3
Action Index	Uint16	0 to 255
Number of Actions	Uint16	0 to 255
Action Details	mixed	Every action has its own syntax. Please read description below:

- **Constant Flow rate**

Table 46: Constant flow rate action details syntax

<b>C</b>	<b>SPC</b>	<b>Flow Rate</b>	<b>SPC</b>	<b>Time min</b>	<b>SPC</b>	<b>Time secs</b>
----------	------------	------------------	------------	-----------------	------------	------------------

Table 47: Constant flow rate action detail fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
--------------	---------------	---------------

Flow Rate	double	Depending on the syringe
Time min	Uint32	0 to 12000 minutes
Time secs	Uint32	0 to 60 seconds

- **Ramp**

Table 48: Ramp action details syntax

<b>R</b>	<b>SPC</b>	<b>Initial Flow Rate</b>	<b>SPC</b>	<b>Time min</b>	<b>SPC</b>	<b>Time secs</b>	<b>SPC</b>	<b>Final Flow Rate</b>
----------	------------	--------------------------	------------	-----------------	------------	------------------	------------	------------------------

Table 49: Ramp action detail fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe
Final Flow Rate	double	Depending on the syringe
Time min	Uint32	0 to 12000 minutes
Time secs	Uint32	0 to 60 seconds

- **Pulse**

Table 50: Pulse action details syntax

<b>P</b>	<b>SPC</b>	<b>Initial Flow Rate</b>	<b>SPC</b>	<b>Final Flow Rate</b>	<b>SPC</b>	<b>Period min</b>	<b>SPC</b>	<b>Period secs</b>	<b>SPC</b>	<b>Repetitions</b>	<b>SPC</b>	<b>Duty Cycle</b>
----------	------------	--------------------------	------------	------------------------	------------	-------------------	------------	--------------------	------------	--------------------	------------	-------------------

Table 51: Pulse action detail fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe
Final Flow Rate	double	Depending on the syringe
Period min	Uint32	0 to 12000 minutes
Period secs	Uint32	0 to 60 seconds
Repetitions	Uint32	0 to 999
Duty Cycle	Uint32	0 to 100

- **Sine**

Table 52: Sine action details syntax

<b>S</b>	<b>SPC</b>	<b>Initial Flow Rate</b>	<b>SPC</b>	<b>Period min</b>	<b>SPC</b>	<b>Period secs</b>	<b>SPC</b>	<b>Repetitions</b>	<b>SPC</b>	<b>Phase</b>	<b>SPC</b>	<b>Offset</b>
----------	------------	--------------------------	------------	-------------------	------------	--------------------	------------	--------------------	------------	--------------	------------	---------------



Table 53: Sine action detail fields description

Field	Format	Values
Initial Flow Rate	double	Depending on the syringe
Period min	Uint32	0 to 12000 minutes
Period secs	Uint32	0 to 60 seconds
Repetitions	Uint32	0 to 999
Phase	Uint32	0 to 360
Offset	Uint32	Depending on the syringe

## 4.7. Pump position query

Query used to request the position (in steps and micro-steps) of every pump.

### 4.7.1.Syntax

Table 54: Pump position query syntax

<b>ESC</b>	<b>Q</b>	<b>P</b>	<b>NULL</b>
------------	----------	----------	-------------

### 4.7.2.Answer

Table 55: Pump position query answer

<b>ESC</b>	<b>A</b>	<b>P</b>	<b>Steps</b>	<b>SPC</b>	<b>Microsteps</b>	<b>NULL</b>
------------	----------	----------	--------------	------------	-------------------	-------------

### 4.7.3.Field description

Table 56: Pump position query answer fields description

Field	Format	Values
Pump Number	Uint16	0 to 3
Steps	Uint16	0 to 3175
Micro-steps	Uint16	0 to 5000

## 4.8. Assay run status query

This query can be used to retrieve the status of the pump while running in assay mode.

#### 4.8.1.Syntax

Table 57: Assay run status query syntax

ESC	Q	R	NULL
-----	---	---	------

#### 4.8.2.Assay run status query answer

Table 58: Assay run status query answer

ESC	A	R	Action index	SPC	Time (min)	SPC	Time (sec)	NULL
Assay run information (1)								

#### 4.8.3.Field description

Table 59: Assay run status query answer fields description

Field	Format	Values
Action Index	Uint16	0 to 255
Time (min)	Uint16	0 to 12000
Time (sec)	Uint16	0 to 60 seconds
(1) Should more than one pumps be connected:		
Assay run info Pump 1	SPC	Assay run info Pump 2 ... Assay run info Pump n NULL

### 4.9. Firmware version query

This command retrieves the firmware version of of a particular ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

#### 4.9.1.Syntax

Table 60: Firmware version query syntax

ESC	Q	V	NULL
-----	---	---	------

#### 4.9.2. Answer

Table 61: Firmware version query answer

<b>ESC</b>	<b>A</b>	<b>V</b>	<b>SPC</b>	<b>Pump No</b>	<b>SPC</b>	<b>Firmware Version</b>	<b>SPC</b>	<b>Build Date</b>	<b>SPC</b>	<b>Build Time</b>	<b>SPC</b>	<b>NULL</b>
------------	----------	----------	------------	----------------	------------	-------------------------	------------	-------------------	------------	-------------------	------------	-------------

#### 4.9.3. Field description

Table 62: Firmware version query answer fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Pump Number	Uint16	0 to 3
Firmware Version	ASCII string	X.X.X (i.e 1.0.0)
Build Date	ASCII string	Example: "Jun 3 2014"
Build Time	ASCII string	Example: "09:47:12"

### 4.10. Flow rate set-point query

Use this query to retrieve the flow rate set-point of a particular ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

#### 4.10.1. Syntax

Table 63: Flow rate set-point query syntax

<b>ESC</b>	<b>Q</b>	<b>W</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.10.2. Answer

Table 64: Flow rate set-point query answer

<b>ESC</b>	<b>A</b>	<b>W</b>	<b>SPC</b>	<b>Pump No</b>	<b>SPC</b>	<b>Flow Rate Setpoint</b>	<b>NULL</b>
------------	----------	----------	------------	----------------	------------	---------------------------	-------------

### 4.10.3. Field description

Table 65: Flow rate set-point query answer fields description

Field	Format	Values
Flow Rate Set-point	double	

## 4.11. Sensor details query

Use this query to retrieve the sensor details plugged to an ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

### 4.11.1. Syntax

Table 66: Sensor details query syntax

ESC	Q	C	NULL
-----	---	---	------

### 4.11.2. Answer

Table 67: Sensor details query answer

ESC	A	C	SPC	Part Number	SPC	Serial Number	NULL
-----	---	---	-----	-------------	-----	---------------	------

### 4.11.3. Field description

Table 68: Sensor details query answer fields description

Field	Format	Values
Part Number	ASCII string	<ul style="list-style-type: none"> <li>LG16-0025-: 1.5ul/min</li> <li>LG16-0150-: 7 ul/min</li> <li>LG16-0430D: 50ul/min</li> <li>LG16-1000D: 1000 ul/min</li> </ul>
Serial Number	ASCII string	<ul style="list-style-type: none"> <li>WWYYXXXXX WW = week YY = year XXXXX = device number</li> </ul>

## 4.12. PCB Info query

Use this query to retrieve the PCB details of an ExiGo pump. Each individual pump needs to be queried independently (use repeat command).

#### 4.12.1. Syntax

Table 69: PCB info query syntax

<b>ESC</b>	<b>Q</b>	<b>B</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.12.2. Answer

Table 70: PCB info query answer

<b>ESC</b>	<b>A</b>	<b>B</b>	<b>SPC</b>	<b>PCB Serial No</b>	<b>SPC</b>	<b>PCB Version</b>	<b>SPC</b>	<b>EEPROM Programmed</b>	<b>SPC</b>	<b>Wifi FW Ver</b>	<b>NULL</b>
------------	----------	----------	------------	------------------------------	------------	------------------------	------------	------------------------------	------------	----------------------------	-------------

#### 4.12.3. Field description

Table 71: PCB info query answer fields description

Field	Format	Values
<b>PCB Serial No</b>	ASCII string	<ul style="list-style-type: none"> <li>YYMMXXXX YY = year MM = Month XXXXXX = device number</li> </ul>
<b>PCB Version</b>	ASCII string	<ul style="list-style-type: none"> <li>X.Y (i.e. 1.8) X = Mayor Revision Y = Minor revision</li> </ul>
<b>EEPROM programmed</b>	boolean	0: Not programmed 1: Programmed
<b>WIFI FW ver</b>	ASCII string	<ul style="list-style-type: none"> <li>Not Implemented</li> </ul>
<b>Flow Rate Set-point</b>	double	

### 4.13. Syringe details query

Use this query to retrieve the syringe details when a customized syringe is set. Each individual pump needs to be queried independently (use repeat command).

#### 4.13.1. Syntax

Table 72: Syringe details query syntax

<b>ESC</b>	<b>Q</b>	<b>H</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.13.2. Answer

Table 73: Syringe details query answer

<b>ESC</b>	<b>A</b>	<b>H</b>	<b>SPC</b>	<b>Syringe Volume</b>	<b>SPC</b>	<b>Syringe Length</b>	<b>NULL</b>
------------	----------	----------	------------	-----------------------	------------	-----------------------	-------------

#### 4.13.3. Field description

Table 74: Syringe details query answer fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
<b>Syringe Volume</b>	double	Volume in nanoliters
<b>Syringe Length</b>	double	Length in mm

### 4.14. Pressure reading query

This command retrieves the last pressure measurement performed by the pressure sensor for every pump.

#### 4.14.1. Syntax

Table 75: Pressure query syntax

<b>ESC</b>	<b>Q</b>	<b>K</b>	<b>NULL</b>
------------	----------	----------	-------------

#### 4.14.2. Answer

Table 76: Pressure query answer

<b>ESC</b>	<b>A</b>	<b>K</b>	<b>Flow Rate(1)</b>	<b>NULL</b>
------------	----------	----------	---------------------	-------------

#### 4.14.3. Field description

Table 77: Pressure query answer fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Flow Rate (1)	double	*Values depending on the pressure sensor in mbar If there is no sensor or the pump is not an UniGo pump it will return 0

(1) Should more than one pumps be connected:

<b>Pressure Pump 1</b>	<b>SPC</b>	<b>Pressure Pump 2</b>	<b>...</b>	<b>Pressure Pump n</b>	<b>NULL</b>
------------------------	------------	------------------------	------------	------------------------	-------------

## 4.15. Device type query

This command retrieves the type of device connected.

### 4.15.1. Syntax

Table 78: Device type query syntax

<b>ESC</b>	<b>Q</b>	<b>O</b>	<b>NULL</b>
------------	----------	----------	-------------

### 4.15.2. Answer

Table 79: Device type query answer

<b>ESC</b>	<b>A</b>	<b>O</b>	<b>Device type(1)</b>	<b>NULL</b>
------------	----------	----------	-----------------------	-------------

### 4.15.3. Field description

Table 80: Device type query answer fields description

Field	Format	Values						
Device type (1)	ascii	<ul style="list-style-type: none"><li>• EXI = ExiGo pump</li><li>• UNI = UniGo pump</li><li>• BAR = 4U/Barletta pump</li></ul>						
<p>(1) Should more than one pumps be connected:</p> <table><tr><td>Device type 1</td><td>SPC</td><td>Device type 2</td><td>...</td><td>Device type n</td><td>NULL</td></tr></table>			Device type 1	SPC	Device type 2	...	Device type n	NULL
Device type 1	SPC	Device type 2	...	Device type n	NULL			

## 5. Dynamic Commands

The commands under this group control the movement of the ExiGo pump.

Some of the commands described below are only valid when the ExiGo pump is within certain status or statuses and/or when some prerequisites are satisfied. Please refer to individual command description for further information.

## 5.1. Initialize command

This command initializes the pump and moves the plunger to the home position.

### 5.1.1. Syntax

Table 81: Initialize command syntax

<b>ESC</b>	<b>I</b>	<b>NULL</b>
------------	----------	-------------

### 5.1.2. Valid Conditions

Table 82: Initialize command valid conditions

Pump valid statuses	Command prerequisites
Not initialized Stopped	None

## 5.2. Manual run command

Run the pump with the last flow rate set (using the Set flow rate command)

### 5.2.1. Syntax

Table 83: Manual run command syntax

<b>ESC</b>	<b>M</b>	<b>NULL</b>
------------	----------	-------------

### 5.2.2. Valid conditions

Table 84: manual run command valid conditions

Pump valid statuses	Command prerequisites
Stopped	Syringe must be defined A flow rate must be set: If flow rate set is negative: Pump must have



	not reached rear limit If flow rate set is positive: Pump must have not reached front limit
--	--

### 5.3. Run assay command

Run the last assay programmed within the pump. The pump must be previously programmed by means of the Set Action command.

#### 5.3.1. Syntax

Table 85: Run assay command syntax

<b>ESC</b>	<b>T</b>	<b>NULL</b>
------------	----------	-------------

#### 5.3.2. Valid conditions

Table 86: Run assay command valid conditions

Pump valid statuses	Command prerequisites
Stopped	Syringe must be defined Pump must be programmed Pump must have enough steps to perform desired assay

### 5.4. Stop command

This command stops the pump.

#### 5.4.1. Syntax

Table 87: Stop command syntax

<b>ESC</b>	<b>P</b>	<b>NULL</b>
------------	----------	-------------

#### 5.4.2. Valid conditions

Table 88: Stop command valid conditions

Pump valid statuses	Command prerequisites
---------------------	-----------------------

All	<p>If displacement is forward: Pump must have not reached rear limit</p> <p>If displacement is backward: Pump must have not reached front limit</p>
-----	---

## 5.5. Displacement command

This command moves the plunger to an absolute position defined by the number of steps and micro-steps in regards to the home position.

### 5.5.1. Syntax

Table 89: Displacement command syntax

<b>ESC</b>	<b>D</b>	<b>Step Index</b>	<b>SPC</b>	<b>Micro-step Index</b>	<b>NULL</b>
------------	----------	-------------------	------------	-------------------------	-------------

### 5.5.2. Field description

Table 90: Displacement command fields description

Field	Format	Values
Step index	Uint16	0 to 3175
Micro-steps index	Uint16	0 to 5000

### 5.5.3. Valid conditions

Table 91: Displacement command valid conditions

Pump valid statuses	Command prerequisites
Stopped	None

## 6. How to communicate with slave ExiGo pumps

The communication protocol used within the ExiGo pumps is a Master-Slave based. This implies that all the information going to any of the pumps of the system must go through the Master pump. However there is no difference between master and slave pumps in terms of hardware or software. A master pump can act as a slave pump and

vice-versa depending on how they are interconnected; therefore the structure of the commands is the same for a slave and for a master pump.

However, it is required to wrap the command in such a way that the Master pump understands that is directed towards one of the slave pumps in the system and thereby, it will forward the command onto the selected slave pump.

In order to achieve this, it is necessary to add an indicator that the command is directed to a slave pump (R character) as well as the address of the slave pump which the command is directed towards.

This combination is also defined as a repeat command:

### 6.1.1.Syntax

Table 92: Repeat command syntax

<b>ESC</b>	<b>R</b>	<b>Pump Address</b>	<b>SPC</b>	<b>Command to Send</b>	<b>NULL</b>
------------	----------	---------------------	------------	------------------------	-------------

### 6.1.2.Field description

Table 93: Repeat command fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Pump Address	Uint16	1 to 3
Command to Send	mixed	Any of the standard set, query or miscellaneous commands <sup>5</sup>

## 6.2.Examples

### Example 1: Initialize Slave 1

Table 94: Example 1 syntax

<b>ESC</b>	<b>R</b>	<b>1</b>	<b>SPC</b>	<b>I<sup>6</sup></b>	<b>NULL</b>
------------	----------	----------	------------	----------------------	-------------

### Example 2: Set 1000 nl/min as flow rate Slave 3

<sup>5</sup> Some of the query commands such as Status query or Syringe query collect already information from all the pumps in the system and therefore they cannot be used within a Repeat command.

<sup>6</sup> The ESC character of the Command to send must be omitted as the pump would consider it as a new command.

Table 95: Example 2 syntax

<b>ESC</b>	<b>R</b>	<b>3</b>	<b>SPC</b>	<b>S</b>	<b>F</b>	<b>1000</b>	<b>NULL</b>
------------	----------	----------	------------	----------	----------	-------------	-------------

Valid conditions using the repeat command are the same than when using direct master communication. Please refer to individual command description for further information.

## 7. ACK/NACK commands

In order to have a robust and stable communication, a system is required to determine if an ExiGo pump received a particular command correctly or not.

In general, query commands will not receive an ACK command but the requested information instead.

### 7.1. ACK command

The pump answers ACK if the command sent is received properly.

#### 7.1.1. Syntax

Table 96: ACK command syntax

<b>ESC</b>	<b>A</b>	<b>ACK</b>	<b>Pump Address</b>	<b>SPC</b>	<b>Command ID</b>	<b>NULL</b>
------------	----------	------------	---------------------	------------	-------------------	-------------

#### 7.1.2. Field Description

Table 97: ACK command fields description

Field	Format	Values
ACK	Uint16	0h06
Pump Address	Uint16	1 to 3
Command ID	mixed	Contains the 1 or 2 ASCII characters that determine the type of command received. I.e.: "SF" for Set flow rate command, "QI" for PID query command, etc.

### 7.2. NACK Command

The pump answers NACK if the command sent is not received properly or contains wrong information (START or END flag missing, etc.)

### 7.2.1.Syntax

Table 98: NACK command syntax

<b>ESC</b>	<b>A</b>	<b>NACK</b>	<b>Pump Address</b>	<b>SPC</b>	<b>Command ID</b>	<b>NULL</b>
------------	----------	-------------	---------------------	------------	-------------------	-------------

### 7.2.2.Field Description

Table 99: NACK command fields description

<b>Field</b>	<b>Format</b>	<b>Values</b>
NACK	Uint16	0h15
Pump Address	Uint16	1 to 3
Command ID	mixed	Contains the 1 or 2 ASCII characters that determine the type of command received. I.e.: "SF" for Set flow rate command, "QI" for PID query command, etc.

## 8. Error command

This command indicates if there was an error trying to perform the sent command.

### 8.1.1.Syntax

Table 100: Error command syntax

<b>ESC</b>	<b>A</b>	<b>E</b>	<b>SPC</b>	<b>Pump Address</b>	<b>SPC</b>	<b>Command ID</b>	<b>SPC</b>	<b>Error Code</b>	<b>NULL</b>
------------	----------	----------	------------	---------------------	------------	-------------------	------------	-------------------	-------------

### 8.1.2.Field description

Table 101: Error command field description

<b>Field</b>	<b>Format</b>	<b>Values</b>
Pump Address	Uint16	1 to 3
Command ID	mixed	Contains the 1 or 2 ASCII characters that determine the type of command received. I.e.: "SF" for Set flow rate command, "QI" for PID query command, etc.
Error Code	Uint16	Code indicating the type or error

## 8.2. Error codes and explanation

Code	Name	Description
1	Pump not programmed	The ExiGo Pump response with this error under the following situations: <ul style="list-style-type: none"> <li>Run assay command sent when the pump is not programmed</li> <li>Action details command sent when the pump is not programmed</li> </ul>
2	Action out of range	This error appears when an Action details query command with an index bigger than the total number of actions defined is requested.
3	CAN communication error	The requested command could not being transmitted to the selected slave pump.
4	Pump not detected	The pump acting as a receiver for the sent command could not have being detected.
5	Pump already displacing	The Displace command was sent while the pump was performing a previous displace command.
6	Pump initializing	Receiver pump is currently initializing and the command could not have being set.
7	Pump not initialized	The pump must be initialized prior to perform the requested command.
8	Pump running	The receiver pump must be stopped prior to perform the requested command.
9	Syringe not defined	The Syringe type of the receiver pump must be defined prior to perform the requested command.
10	Pump has reached front limit	The receiver pump cannot continue forward because it has reached its physical front limit.
11	Pump has reached rear limit	The receiver pump cannot continue forward because it has reached its physical rear limit.
12	Flow rate too high	The flow rate is too high for the pump to run.
13	Pump undefined error	General pump error
14	Wrong Action Index	The index received was different of the expected
15	Pump booting	Pump is booting

16	Sensor disconnected	The flow sensor was disconnected while the pump was running with PID on
17	Negative Flow	When trying to set a negative flow in a UniGo pump

Table 102: Revision history

Date	Version	Changes
10-Dec-13	V1.0	First release

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