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Autosampler serial protocol Rev. 1.03

Autosampler works as a finite state machine. All variables unsigned. Protocol is based on DOMP (Device Object Manager Protocol).`

When turned on autosampler is in *State = 101*, preparing to become ready *State = 0*.

Information parameters

Variable Name	Type	Description
B1 State	**[int]**	**Describes current operation autosampler performs**
- 0 - Ready		
- 11 - Tray + Arm moving		
- 12 - Needle down		
- 13 - Syringe		
- 14 - Home (Needle up, Arm back, Needle down)		
- 15 - Injection Start (Valve rotated)		
- 16 - Getting Ready (Valve back and needle up)		
- 21 - Washing		
- 100 - Error occurred, *ErrorCode = [what happened]*, waits for *Command=0*		
- 101 - Getting ready when initializing or after aborted command. Finishes in *State = 0*		
- 102 - Low level command was executed, use *B3 = 0* to get ready		
B2 ErrorCode	**[int]**	**Describes an error, occurred while working**
- 00000000 - no error		
- 00000001 - tray not present		
- 00000010 - tray rotation error		
- 00000100 - arm rotation blocked		
- 00001000 - needle moving error		
- 00010000 - syringe moving error		
- 00100000 - valve rotation error		
- 2^32 - aborted		

Control parameters

Variable Name	Type	Description
B3 Command	[int]	Controls an autosampler, any low-level command will be interrupted.
- 0 - Get Ready	From any *State != 0* it will cancel operation, makes *State = 101* & *ErrorCode = 2^32*, then back to *State = 0* & *ErrorCode = 0*	
- 1 - Injection	If *State == 0*, then *State = 11*	
- 2 - Wash needle	If *State == 0*, then *State = 21*, then *State = 0*	
- 3 - Shaking		
B4 1.Vial	[int]	Vial number
B5 1.Amount	[int] µL	Amount of sample in microliters
B6 1.ValveTime	[int] ms	How long to wait for sample injection. *State = 15*
B7 1.Depth	[int] mm	Needle offset from the highest possible needle position. 0 - highest / 45 - lowest. In millimeters.
B8 2.WashCycles	[int]	Number of cycles
B9 3.ShakingMode	[int]	Specify shaking mode

- **B10 3.ShakingDuration**

Serial communication standard

To update control parameters use command pattern

Send	>1 B[number:int]=[value:int]
Receive on success	<1 B[number:int]=[value:int]
Receive on error	<1 B[number:int]![error:str]

Ex:

>1 B4=21	// To specify *Vial = 21*
<1 B4=21	// Autosampler will answer to confirm
>1 B5=3	// To specify *Amount = 3*
<1 B5=3	// Autosampler will answer to confirm
>1 B3=1	// To start *injection*
<1 B3=1	// Autosampler will answer to confirm if *State == 0*
>1 B3=1	// To start *injection*
<1 B3!NotReady	// Autosampler will decline if *State != 0*
>1 B3=0	// To abort and get ready
<1 B3=0	// Autosampler will answer to confirm abortion

To read information parameters use command pattern

Send	>1 B[number:int]?
Receive	<1 B[number:int]=[value:int]

Ex:

>1 B1?	// Request *state* value
<1 B1=0	// Autosampler is ready
>1 B1?	// Request *state* value
<1 B1=15	// Injection start state
>1 B1?	// Request *state* value
<1 B1=100	// Error occurred
>1 B2?	// Request *error* value
<1 B2=00000110	// Errors: tray rotation error & arm rotation blocked
>1 B2?	// Request *error* value
<1 B2=0	// No error

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Low level commands

Low level commands will work only when *B1 State == [0, 100, 102]* calling low-level command will change state to *State = 102*.

Valve - "**G**"

Variable	*Name*		*Type*	*Units*	*Description*
G1	**Valve**		**[int]**	**-**	**Valve rotation**
Set G1		Rotate valve			
	-	0-5	Go to position [0, 5]		
	-	10001	Recalibrate		
	-	10002	Abort		
Get G1		Get current valve position or state			
	-	0-5	Not moving and valve position is 0-5		
	-	20000-20005	Moving to 0-5		
	-	1000x	Error occurred		

Vial (Arm & Tray) - "**E**"

Variable	*Name*		*Type*	*Units*	*Description*
E1	**Vial**		**[int]**	**-**	**Move tray and arm**
Set E1		Choose vial			
	-	0	Go home. *E1 = [0, 41]* Will not work if needle *F1 != 0*		
	-	1-40	Go to position 1-40		
	-	999	Got to washing		
	-	10001	Recalibrate		
	-	10002	Abort		
Get E1		Read current vial or state			
	-	0	Not moving at home		
	-	1-40	Not moving and vial is 1-40		
	-	999	Not moving on washing		
	-	20000-20040	Moving home or to vial 1-40		
	-	20999	Moving to wash		
	-	1000x	Error occurred		

Needle - "**F**"

Variable	*Name*		*Type*	*Units*	*Description*
F1	**Needle**		**[int]**	**mm**	**Control needle position**
Set F1 Needle		Control needle			
	-	0-38	Move needle	0mm - top, 38mm - bottom. Works only if *E1 != [20000-20040, 20999]*	
	-	10001	Recalibrate		
	-	10002	Abort		
Get F1 Needle					
	-	0-38	Not moving and position is 0-38		

- 20000-20038 Moving up to position 0-38
- 30000-30038 Moving down to position 0-38
- 10001 Position unknown
- 1000x Error occurred

Tray - "D"

Variable	*Name*	*Type*	*Units*	*Description*
D1	**PositionUstep_0_102400**	**[int]**	**µStep**	**Tray angle in microsteps**

Set D1 — Set tray angle in microsteps
- 0 - 102400 Rotate tray to destination microsteps

Get D1 — Get current tray angle
- 0 - 102400 Tray angle in microsteps
- 10000001 Lost tray position
- 10000002 No tray

Variable	*Name*	*Type*	*Units*	*Description*
D2	**PositionAngle_0_360**	**[float]**	**degrees**	**Tray angle**

Set D2 — Set tray angle
- 0.00 - 360.00 Destination in degrees

Get D2 — Get current tray angle
- 0.00 - 360.00 Position in degrees
- 1001.00 Lost tray position
- 1002.00 No tray

Variable	*Name*	*Type*	*Units*	*Description*
D3	**Shaking_0_3**	**[int]**	**-**	**Shaking mode**

Set D3 — Set shaking mode
- 0 No shaking
- 1 Enable shaking mode 1
- 2 Enable shaking mode 2
- 3 Enable shaking mode 3

Get D3 — Get shaking mode
- 0 - 3 Current shaking mode

Variable	*Name*	*Type*	*Units*	*Description*
D4	**ShakingTimeSec_0_10000**	**[int]**	**sec**	**Shaking time**

Set D4 — Set shaking time
- 0 - 10000

Get D4 — Get time left
- 0 - 10000

Syringe - "H"

Variable	*Name*	*Type*	*Units*	*Description*
H1	**PlungerPosition_uL_0_4200**	**[int]**	**µL**	**Plunger Position**

Set H1 — Set plunger position (0 - empty)
- 0-4200 Go to amount 0-4200ul in case of big syringe
- 0-1000 Go to amount 0.1-100 ul in case of small syringe

If was not calibrated - setting value returns error
- 10001 Recalibrate zero (go to find zero, position will be 0)
- 10002 Abort (Stop doing anything with syringe)

Get H1 Get plunger position
- 0 - 4200 Current plunger position
- 20000-24200 Refilling to 0-4200 (1,2,3...)
- 30000-34200 Drawing to 0-4200 (3,2,1…)
- 10000001 Unknown plunger position and not moving
- 10000002 Unknown plunger position and calibrating

Variable	*Name*	*Type*	*Units*	*Description*
H2	**DrawSpeed_uLM_0_48000**	**[int]**	**µL/min**	**Draw Speed**

Set H2 Set draw flow rate (3,2,1...)
- 1 - 48000

Get H2 Get draw flow rate
- 1 - 48000

Variable	*Name*	*Type*	*Units*	*Description*
H3	**RefilSpeed_uLM_0_48000**	**[int]**	**µL/min**	**Refill Speed**

Set H3 Set refill flow rate (1,2,3...)
- 1 - 48000

Get H3 Get refill flow rate
- 1 - 48000

Syringe Ex:

```
>1 H2=1000          // To specify Draw Speed = 1000
<1 H2=1000          // Autosampler will answer to confirm
>1 H3=20000         // To specify Refill Speed = 20000
<1 H3=20000         // Autosampler will answer to confirm

>1 H1=10001         // To calibrate syringe zero, use Position = 10001
<1 H1=10000003      // Autosampler will answer it's moving, Position = 10000003

>1 H1=3000          // To move syringe to Position = 3000
<1 H1=21325         // Autosampler will answer it's moving (2xxxx) and current Position = 21325
>1 H1?              // Request state
<1 H1=22653         // Autosampler will answer it's moving and current Position = 22653
>1 H1?              // Request state
<1 H1=3000          // Autosampler will answer it stopped and current Position = 3000
```