The Instruction Set
of the
Liquid Dispenser

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2. Introduction

Communication interface:
The Liquid Dispenser device communicates via a serial COM port interface, independent of the Liquid Dispenser type (upright, inverse). The default setting is 57600,8,1,N.

Instruction syntax:
The instructions and parameters are sent as cleartext ASCII strings with a terminating carriage return [CR], which is 0x0d hex. Characters may be upper-, lower- or camel-case. The parameters are separated by a space character.
This provides easy access to all functions by using a simple terminal program such as HyperTerminal. A typical instruction syntax is as follows:

[!,?][instruction][SP][parameter1][SP][parameter2] [etc…] [CR]

[!,?] Read/write specifier, required by all instructions:
> **!** (exclamation mark) = to write parameter, execute an instruction etc.
> **?** (question mark)   = to read data (returns settings, or status, etc.)

[instruction]	Is the instruction word itself.
[SP]	Space (ASCII 0x20 hex) as separation.
[parameter]	Usually integer or floating point numbers, floating point uses decimal point, no comma.
[CR]	Termination (ASCII 0x0d hex), causes instruction execution.

A read instruction may return more than one parameter.

For some instructions that return fractional numbers (e.g. ?timebase and ?voltages) the number of returned fractional digits is fixed.

Syntax examples:
!save	Save parameter settings to device nonvolatile memory
!drop 6	Generate 6 drops (Liquid Dispenser upright)
!interval 60 10	Set interval to 60 s and dispensing to 10 s (interval mode)
?drop	Returns drop/time counter (counting since it's been resetted)
version	Returns device type and detailed firmware version

Settings:
Most settings can be stored permanently in the Liquid Dispenser device, so they are available from power on. When stored once, this reduces initialization overhead of the application software. Refer to the **'save'** instruction for further information. Parameters that are saved can be identified by a 'Y' in the Save column of the **brief instruction set description** later in this document.

Character limits:
To prevent the input buffer from overflow, please do not send more than 255 characters at once.
Such may occur when sending the setup sequence to the Liquid Dispenser device. A good practice is to request the **'?err'** state after each setup instruction. This will return the information if the parameters were accepted or not while preventing overflow.

3. Hint for Device Initialization

The Liquid Dispenser device must be configured to meet the hardware require-
ments.
The configuration can be stored permanently with the **'save'** instruction.
It is recommended to save and reboot the device after changing the setup parame-
ters (e.g. **!dropmode, !initsystem, !leadtime**) to ensure all changes will be ap-
plied.

- The operating mode: !**dropmode** (depending on Liquid Dispenser type)
- The system initialization: **!initsystem** (pressure build-up at system start)
- The lead time of the diaphragm pump: !**leadtime**

Brief Description of the Liquid Dispenser Instruction Set

Device Informations

Instruction		Example	Save	Brief description	Page
(?)	version	version	-	Read device type and detailed firmware version	7
?	voltages	?voltages	-	Read current values of operating voltages (5.03 V, 0.00 V)	7
?	powersupply	?powersupply	-	Read current voltage source (USB or external I/O-Interface)	8

System Instructions

Instruction		Example	Save	Brief description	Page
(!)	save	save	-	Save parameters to device nonvolatile memory	9
(!)	firmwaredefaults	firmwaredefaults	-	Reset device to factory settings (use is not recommended)	9

Dispenser States and Error Messages

Instruction		Example	Save	Brief description	Page
! ?	status	?status	-	Read status information of the dispensing process	10
(?)	err	err	-	Read error number	11

General Adjustments

Instruction		Example	Save	Brief description	Page
! ?	dropmode	!dropmode 0	Y	Set operating mode to drop counter	12
! ?	timebase	!timebase 1.0	Y	Set timebase to 1.0 second	13
! ?	leadtime	!leadtime 8	Y	Set lead time to 8 seconds (depending on set timebase)	14
! ?	initsystem	!initsystem 1	Y	Enable system initialization (pressure build-up at start-up)	15
! ?	inittime	!inittime 5	Y	Set pressure build-up time at system start to 5 seconds	15
! ?	dropnr	!dropnr 4	Y	Set dispensing quantity to 4 drops/seconds (start/stop-button)	16
! ?	interval	!interval 40 2	Y	Set interval to 40 s and dispensing to 2 s (interval mode)	17
! ?	keymode	!keymode 3	Y	Enable functionality & LED light of the start/stop button	18

Dispensing Instructions

Instruction		Example	Save	Brief description	Page
! ?	dropctr	?dropctr	-	Read amount of drops/time since counter was resetted	19
! ?	drop	!drop 6	-	Generate 6 drops or dispense immersion medium for 6 sec.	20
(!)	stop	stop	-	Force a stop condition	21
! ?	intervalstate	!intervalstate 1	-	Start interval dispensing (interval mode)	21
! ?	pump	!pump 1	-	Switch diaphragm pump manually on	22
!	pressurize	!pressurize	-	Pressure is built-up once for the specified lead time	23

4. Instruction Syntax Description

Most instructions work in both directions (reading and writing). (?)! means the instruction accepts write and read access. The device identifies a read instruction by a preceding '?', while '!' indicates writing to a parameter or executing an instruction. More information can be found in the **Introduction** chapter of this document.

Some examples of legal instruction syntax:
!*Instruction parameter1 parameter2*
!*Instruction parameter*
!*Instruction*
?*Instruction*

5. Error Numbers and Their Possible Root Cause

```
0     no error
1     reserved
2     no executable instruction
3     too many characters in command line
4     invalid instruction
5     number is not inside allowed range
6     wrong number of parameters
7     either ! or ? is missing

20    drop sensor overdriven
21    no drop sensor connected
```

6.   Device Informations

The firmware version may be read by sending the **'version'** instruction to the device.

6.1.   version (Read Detailed Version Information)

```
Syntax:            version or ?version
Parameter:         none

Support:           Liquid Dispenser upright, Liquid Dispenser inverse

Description:       Read the device type and detailed firmware version.

Response syntax:   Character string including device type, firmware version and
                   build date separated by a comma, e.g.
                   Liquid Dispenser, Version 1.03, June 10 2015

                   Liquid Dispenser   Device type
                   Version 1.03       Firmware version number
                   June 10 2015       Firmware build date

Example:
?version   ==> Liquid Dispenser, Version 1.03, June 10 2015
```

6.2.   voltages (Read Values of Supply Voltages)

```
Syntax:            ?voltages
Parameter:         none

Support:           Liquid Dispenser upright, Liquid Dispenser inverse

Description:       Read current values of supply voltages.
                   The device has two different supply voltages, the USB voltage
                   and the external I/O-Interface voltage. The Liquid Dispenser
                   can be supplied via one or both of these voltages. The optimal
                   voltage values are 5.00 V.
                   The supply voltages are returned with two decimal places.

Response:          Current values of supply voltages, e.g.
                   4.98 5.02

                   4.98  => USB voltage
                   5.02  => External I/O-Interface voltage

Example:
?voltages   ==> 5.03 0.00     Only the USB voltage is connected to the device
```

6.3. powersupply (Get Voltage Source)

```
Syntax:          ?powersupply
Parameter:       none

Support:         Liquid Dispenser upright, Liquid Dispenser inverse

Description:     Read the current voltage source.
                 The device can be powered via the USB interface or the exter-
                 nal I/O-Interface. Are both supply voltages connected, the
                 Liquid Dispenser is automatically supplied from the higher
                 voltage.

                 0  => USB interface
                 1  => External I/O-Interface, e.g. TANGO controller

Response:        Current voltage source

Example:
?powersupply  ==> 0     The device is supplied by the USB interface
```

7.   System Instructions

7.1.   save (Save Parameters)

```
Syntax:            save or !save, saveconfig or !saveconfig
Parameter:         none

Support:           Liquid Dispenser upright, Liquid Dispenser inverse

Description:       The save instruction permanently stores the parameter settings
                   (e.g. operating mode, discharge quantity (start/stop-button),
                   timebase, lead time) to the Liquid Dispenser device. These pa-
                   rameters will be applied as default values after each consecu-
                   tive power-on. Executing a save command always returns the
                   "OK..." string when writing to the internal memory has com-
                   pleted successfully.

Response:          ASCII string "OK..." or "ERR"

Example:
!save   ==> OK...    The currently used device parameters are saved and from
                     now on used as defaults
```

7.2.   firmwaredefaults (Restore Factory Settings)

```
Syntax:            firmwaredefaults or !firmwaredefaults
Parameter:         0 or 1

Support:           Liquid Dispenser upright, Liquid Dispenser inverse

Description:       Reset Liquid Dispenser device to factory settings.
                   Software reset is performed automatically.

                   0  => Current parameter settings are retained
                   1  => Restore factory settings

                   Notice
                   When resetting the device to factory settings, the configured
                   user settings will be lost and set to the default values.
                   Resetting the device to factory settings is not recommended.

Remarks:           All user settings will be lost.

                   After the automatically performed software reset, no connec-
                   tion can be established via the USB interface.
                   To establish a new connection over the virtual COM port, the
                   opened connection must be closed and the Liquid Dispenser de-
                   vice must be restarted again. A device restart can be forced
                   by disconnecting the power supply (removing the USB cable and
                   the cable of the external I/O-Interface from the device).

Response:          none

Example:
!firmwaredefaults 1    Reset device to factory settings
```

8.   Dispenser States and Error Messages

8.1.   status (Dispensing Status)

```
Syntax:              ?status, !status
Parameter:           none

Support:             Liquid Dispenser upright, Liquid Dispenser inverse

Description:         The instruction ?status returns the status information of a
                     dispensing process and the state of the stop input.
                     This instruction can be used to check whether a dispensing
                     process is currently active, completed, was aborted or is in
                     pressurizing mode. In addition, the state of the stop input
                     can be determined. The status information will be re-set and
                     updated by the next dispensing process or at a signal change
                     at the stop input.
                     The status information may be cleared to zero by sending the
                     instruction !status.


Response:            Status information of the dispensing process as decimal value

                     The returned decimal value contains a one byte status infor-
                     mation. The following table shows the status information. Each
                     bit represents a status information if the bit is set.
```

Status Byte

Bit	8	7	6	5	4	3	2	1
Status	Hardware error	Timeout	Stop input active	-	-	Pressurizing	Dispensing aborted	Dispensing active

```
Example:
?status   ==>   0    Dispensing completed or status cleared by !status
?status   ==>   1    Dispensing is active
?status   ==>   2    Dispensing was aborted by start/stop button, instruction,
                     hardware error, timeout or stop signal
?status   ==>   4    Pressure is built-up → Pump is on and valve is closed
                     (This bit is 0, when pump is on and valve is opened)
?status   ==>  32    Stop input is active → Stops the pump and close the valve
?status   ==>  34    Dispensing was aborted by stop input (input still active)
?status   ==>  66    Dispensing was aborted by a timeout (66 = 0x42 = b01000010)
                     (Timeout: Within 60 seconds no drop could be dispensed)
?status   ==> 130    Dispensing was aborted by a hardware error (130 = 0x82)
                     (Hardware error cause can be checked by ?err)

!status      Clear status information
```

8.2. err (Read Error Number)

```
Syntax:           err or ?err, !err
Parameter:        none

Support:          Liquid Dispenser upright, Liquid Dispenser inverse

Description:      The instructions err or ?err return the device error state or
                  0, if no error occurred. The error state will be updated or
                  re-set by the next instruction.
                  If not a permanent error (like e.g. 20 or 21) the error state
                  may be cleared to zero by sending !err.

Response:         Error number as decimal value
                  (refer to Chapter 5. "Error Numbers")

Example:
?err   ==> 0     May return a 0
err    ==> 0     Same as ?err
?err   ==> 4     Error number 4 (invalid instruction)

!err     Clear error state if no permanent error
```

9.   General Adjustments

With the following instructions the parameters of the device are widely scalable to the given mechanic construction and to customer requirements. The device is adaptable to the requested requirements.

9.1.   dropmode (Operating Mode)

```
Syntax:             !dropmode or ?dropmode
Parameter:          0, 1 or 2

Support:            Liquid Dispenser upright, Liquid Dispenser inverse

Description:        Operating mode of the Liquid Dispenser.
                    This instruction sets or reads the current operating mode of
                    the device. There are several modes for the upright and in-
                    verse variant of the Liquid Dispenser.
```

1) Liquid Dispenser upright
```
                    0  => Drop Counter (Dropper)        (default)
```

2) Liquid Dispenser inverse
```
                    1  => Time Counter (manual Mode)    (default)
                    2  => Interval (automatic Mode)

Response:           Currently selected operating mode

Example:
!dropmode 0    Set operating mode to drop counter (Liquid Dispenser upright)
!dropmode 1    Set operating mode to time counter (Liquid Dispenser inverse)

?dropmode   ==> 0     Read currently selected operating mode
```

9.2. timebase (Timebase)

```
Syntax:              !timebase or ?timebase
Parameter:           0.1 or 1.0

Support:             Liquid Dispenser inverse

Description:         Setting the timebase (0.1 second or 1.0 second).
                     This instruction sets or reads the timebase, which defines the
                     dispensing quantity of immersion medium and the lead time.

                     0.1  => 0.1 second
                     1.0  => 1.0 second    (default)
```

1) Operating Mode Manual and Interval
All settings regarding the dispensing quantity and lead time depend on the defined timebase. Each dispensing of immersion medium is based on the selected timebase.

Dispensing immersion medium [second] = Quantity x Timebase

2) Control by an External I/O-Interface
Using the input "DROP_IN", immersion medium can dispensed for 0.1 second or 1.0 second depending on the selected timebase. For each received pulse (signal = "high") flows for 0.1 s or 1.0 s immersion medium.

```
Remarks:             This instruction is only available for inverse devices.

Response:            Current timebase as floating point number

Example:
!timebase 0.1    Set timebase to 0.1 second
!timebase 1.0    Set timebase to 1.0 second

?timebase   ==> 0.1    Read currently set timebase
```

9.3. leadtime (Lead Time of the Diaphragm Pump)

```
Syntax:             !leadtime or ?leadtime
Parameter:          0 to 600

Support:            Liquid Dispenser inverse

Description:        Defines lead time (0-600 seconds).
                    This instruction sets or reads the lead time of the diaphragm
                    pump. The lead time depends on the set timebase.
```

Lead time = Parameter x Timebase

Operating Mode Manual and Interval
Using the lead time, a pressure in the laboratory glass bottle
can be set up before each dispensing of immersion medium.
During the lead time only the diaphragm pump is turned on, the
magnetic valve is closed. The previous switching on of the di-
aphragm pump ensures that there is always enough pressure in
the laboratory glass bottle available and the immersion medium
can be delivered safely from the beginning.

Notice
When operating mode interval is selected, the following equa-
tion cannot be greater than the specified second interval.

Second interval > [(Lead time + Quantity) x Timebase]

```
Remarks:            This instruction is only available for inverse devices.

Response:           Currently set lead time


Example:
!leadtime 10     Set lead time to 10 seconds (timebase: 1.0 second)
!leadtime 50     Set lead time to 5 seconds  (timebase: 0.1 second)

?leadtime  ==> 10     Read actual lead time → 10 seconds (timebase: 1.0 second)
?leadtime  ==> 10     Read actual lead time → 1 second   (timebase: 0.1 second)
```

9.4. initsystem (Pressure Build-Up at System Start)

Syntax: !initsystem or ?initsystem
Parameter: 0 or 1

Support: Liquid Dispenser upright, Liquid Dispenser inverse

Description: This instruction enables or disables the system initializa-
                    tion.
                    If the system initialization is activated, the diaphragm pump
                    is switched on for a specified time [seconds] when turning on
                    the Liquid Dispenser. The switching on of the diaphragm pump
                    at start-up ensures that there is enough pressure in the la-
                    boratory glass bottle available and the immersion medium can
                    be delivered safely from the beginning.

                    0 => Disable system initialization
                    1 => Enable system initialization

Remarks: How long the diaphragm pump is switched on at start-up can be
                    set using **'inittime'** instruction.

Response: Current system initialization setting

Example:
!initsystem 1   Enable system initialization
!initsystem 0   Disable system initialization

?initsystem   ==> 1   Read currently set system initialization state

9.5. inittime (Set Pressure Build-Up Time at System Start)

Syntax: !inittime or ?inittime
Parameter: 0 to 60 [seconds]

Support: Liquid Dispenser upright, Liquid Dispenser inverse

Description: Defines pressure build-up time at start-up (0-60 seconds).
                    This instruction sets or reads the pressure build-up time of
                    the system initialization.

                    The pressure build-up time specifies how long the diaphragm
                    pump is switched on at startup when the system initialization
                    is enabled. The switching on of the pump at startup ensures
                    that there is enough pressure in the laboratory glass bottle
                    available and the immersion medium can be delivered safely
                    from the beginning.

                    It is ensured by design that the maximum pressure won't be ex-
                    ceeded.

Remarks: The system initialization can be activated using **'initsystem'**
                    instruction.

Response: Currently set pressure build-up time in seconds

Example:
!inittime 0   Set pressure build-up time to 0 seconds (initialization disabled)
!inittime 10   Set pressure build-up time to 10 seconds

?inittime   ==> 5   Read currently set pressure build-up time → 5 seconds

9.6.   dropnr (Dispensing Quantity Start/Stop-Button)

```
Syntax:             !dropnr or ?dropnr
Parameter:          1 to 6000

Support:            Liquid Dispenser upright, Liquid Dispenser inverse

Description:        This instruction sets or reads the quantity, which is dis-
                    pensed by pressing the start/stop-button of the Liquid Dis-
                    penser.
                    The definition of the dispensing quantity depends on the de-
                    vice type and the selected operating mode.

                    1) Liquid Dispenser upright
                    Define dispensing quantity (1 to 6000 drops).
                    Configure the start/stop-button of the Liquid Dispenser for
                    the dropper operating mode.
                    This instruction sets the number of drops which are dispensed
                    when the start/stop-button of the device is pressed.

                    Number of drops = Parameter

                    2) Liquid Dispenser inverse
                    Define dispensing quantity (1 to 600 seconds).
                    Configure the start/stop-button of the Liquid Dispenser for
                    the manual operating mode.
                    The dispensing quantity defined by this instruction and the
                    time base specify how long immersion medium is dispensed when
                    the start/stop-button of the device is pressed.

                    Dispensing immersion medium [seconds] = Quantity x Timebase

Response:           Current setting of the dispensing quantity (start/stop-button)

Example:
!dropnr 5      Set dispensing quantity to 5 drops (Liquid Dispenser upright)
!dropnr 20     Set dispensing quantity to 2 s  (inverse device/timebase 0.1 s)
!dropnr 20     Set dispensing quantity to 20 s (inverse device/timebase 1.0 s)

?dropnr  ==> 2   Read actual dispensing quantity → 2 drops (upright device)
?dropnr  ==> 8   Read dispensing quantity → 8 s (inverse device/timebase 1.0 s)
```

9.7. interval (Interval Mode Configuration)

```
Syntax:            !interval or ?interval
Parameter:         1 to 6000 [Interval]
                   0 to 6000 [Dispensing amount]

Support:           Liquid Dispenser inverse

Description:       This instruction sets or reads the parameters of the automatic
                   mode (interval).
                   When the automatic mode is active, immersion medium will be
                   dispensed at specified time intervals. This mode also can be
                   used for timed pressurization, by setting the dispensing
                   amount to zero.

                   The instruction syntax to write parameter is as follows:

                   !interval [Interval] [Dispensing amount]

                   Parameter [Interval]
                   Interval setting (1-6000 seconds).
                   The interval value specifies at which time intervals a defined
                   amount of immersion medium is dispensed automatically. The im-
                   mersion medium delivery occurs continuously.
                   The interval depends on the set timebase.
```

Interval [seconds] = Interval x Timebase

```
                   Parameter [Dispensing amount]
                   Dispensing amount setting (0-6000 seconds).
                   The dispensing amount specifies how long the immersion medium
                   is dispensed at every interval. If the dispensing amount is
                   set to zero, the automatic mode can be used for timed pressur-
                   ization.
```
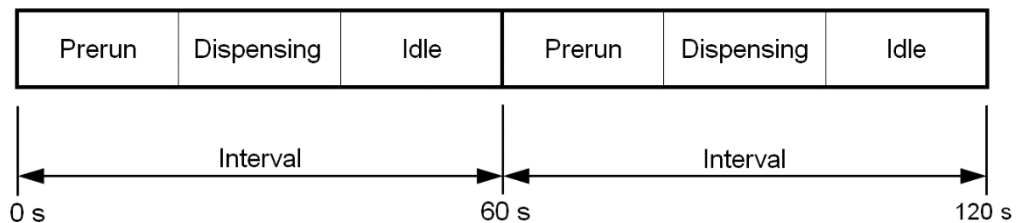
Dispensing amount [seconds] = Dispensing amount x Timebase

```
                   Schedule as an example of an interval time of 60 s:
```

Prerun	Dispensing	Idle	Prerun	Dispensing	Idle

Interval	Interval
0 s 60 s	120 s

Notice
Interval > [(Lead time + Dispensing amount) x Timebase]

```
Remarks:           The prerun time can be set with the 'leadtime' instruction.
                   This instruction sets or reads the lead time of the diaphragm
                   pump.
                   The timebase can be set with the 'timebase' instruction.

Response:          Current values of interval mode configuration, e.g.
                   60 10

                   60  => Interval → 60 seconds (timebase 1.0 s)
                   10  => Dispensing amount → 10 seconds (timebase 1.0 s)
```

```
Example:
!interval 60 10    Set interval to 60 s and dispensing to 10 s (timebase 1.0 s)
!interval 10 5     Set interval to 1.0 s and dispensing to 0.5 s (timebase 0.1 s)
!interval 30 0     Set interval to 30 s and dispensing to 0 s (timebase 1.0 s)
                   (Timed pressurization → Pressurization for the set lead time)

?interval                  Read actual interval mode configuration
?interval   ==> 60   1     Interval: 60 s, Dispensing: 1 s (timebase 1.0 s)
?interval   ==> 20   15    Interval: 2.0 s, Dispensing: 1.5 s (timebase 0.1 s)
?interval   ==> 120  0     Interval: 120 s, Dispensing: 0 s (timebase 1.0 s)
```

9.8. keymode (Start/Stop Button Configuration)

```
Syntax:            !keymode or ?keymode
Parameter:         0, 1, 2 or 3

Support:           Liquid Dispenser upright, Liquid Dispenser inverse

Description:       Configuration  of  the  start/stop  button  on  the  Liquid  Dis-
                   penser.
                   This  instruction  sets  or  reads  the  current  configuration  of
                   the start/stop button. Functionality and LED light of the but-
                   ton can be enabled/disabled.
                   There are four different modes available:

                   0  => Disable functionality & disable LED light
                   1  => Enable  functionality & disable LED light
                   2  => Disable functionality & enable  LED light
                   3  => Enable  functionality & enable  LED light

Response:          Current start/stop button configuration

Example:
!keymode 0    Disable functionality & LED light of the start/stop button
!keymode 3    Enable functionality & LED light of the start/stop button

?keymode   ==> 3    Read currently set start/stop button configuration
```

10. Dispensing Instructions

10.1. dropctr (Dispensing Counter)

```
Syntax:              !dropctr or ?dropctr
Parameter:           0
```

```
Support:             Liquid Dispenser upright, Liquid Dispenser inverse
```

Description: The instruction ?dropctr reads back the amount of generated drops or time, depending on the Liquid Dispenser device.

The instruction supports both variations of the dispenser:

1) Liquid Dispenser upright
Reads back the amount of generated drops since the counter was resetted.

Generated drops = Counter

2) Liquid Dispenser inverse
Reads the amount of dispensing time since the counter was re-setted. The readouted counter value depends on the set time-base.

Dispensing time = Counter x Timebase

The counter may be set to zero by sending '!dropctr 0'.

```
!drop 0  Resets the counter to zero
?drop    Reads amount of drops/time since counter was resetted
```

Remarks: The amount of generated drops or time can also read out using **'drop'** instruction.

Response: Amount of counted drops or time, depending on the device type

```
Example:
!dropctr 0     Reset the counter to zero

?dropctr  ==> 18     Read amount of drops → 18 drops (Liquid Dispenser upright)
?dropctr  ==> 60     Read amount of time → 6 s (inverse device/timebase 0.1 s)
?dropctr  ==> 24     Read amount of time → 24 s (inverse device/timebase 1.0 s)
```

10.2. drop (Dispense Immersion Medium)

```
Syntax:            !drop or ?drop
Parameter:         1 to 6000 or 0
                   5 to 600 (optional and only used by Liquid Dispenser upright)
```

```
Support:           Liquid Dispenser upright, Liquid Dispenser inverse
```

Description: Dispense immersion medium or read back the amount of generated drops or time, depending on the Liquid Dispenser device.

The instruction supports both variations of the dispenser:

1) Liquid Dispenser upright
Drops are generated and counted.

In addition, the second parameter can be used to define a specific timeout for this dispensing process. The timeout can be set from 5 to 600 seconds. If the second parameter is not specified, the timeout is 60 seconds by default.

2) Liquid Dispenser inverse
This instruction is only available for manual mode (time counter).

Immersion medium is dispensed for the specified amount of seconds or 1/10 seconds (depends on timebase setting).
The dispensing time is counted. How long immersion medium was dispensed can be calculated by the counter value and the set timebase.

Dispensing time = Counter x Timebase

```
!drop N   Generates N drops/seconds etc. (N=1...6000)
!drop 0   Resets the counter to zero
?drop     Reads amount of drops/time since counter was resetted
```

Response: Amount of counted drops or time, depending on the device type

```
Example:
!drop 6       Generate 6 drops (Liquid Dispenser upright)
!drop 5 90    Generate 5 drops and set the timeout to 90 s (upright device)
!drop 10      Generate 10 drops and use standard timeout [60 s] (upright device)
!drop 15      Dispense immersion medium for 1.5 s (inverse device/timebase 0.1 s)
!drop 4       Dispense immersion medium for 4 s (inverse device/timebase 1.0 s)

!drop 0    Reset the drop counter for '?drop'

?drop   ==> 58   Read the drop/time counter (counting since it's been resetted)
?drop   ==> 10   Read amount of drops → 10 drops (Liquid Dispenser upright)
?drop   ==> 40   Read amount of time → 4 s (inverse device/timebase 0.1 s)
?drop   ==> 25   Read amount of time → 25 s (inverse device/timebase 1.0 s)
```

10.3. stop (Force a Stop Condition)

```
Syntax:         stop or !stop
Parameter:      none

Support:        Liquid Dispenser upright, Liquid Dispenser inverse

Description:    The dispensing of immersion medium is discontinued immediate-
                ly. The diaphragm pump is turned off and the magnetic valve
                closed. All further operations are terminated.

Response:       none
```

Example:
```
!stop      Force a stop condition
stop       Same as !stop
```

10.4. intervalstate (Interval Mode State)

```
Syntax:         !intervalstate or ?intervalstate
Parameter:      0 or 1

Support:        Liquid Dispenser inverse

Description:    This instruction starts or stops the automatic dispensing of
                immersion medium in interval mode.
                When the automatic mode is active, immersion medium will be
                dispensed at specified time intervals. The dispensing interval
                and time can be set using the instructions 'interval' and
                'timebase'.

                0  => Stop interval dispensing
                1  => Start interval dispensing

Response:       Current interval mode state

Remarks:        This instruction can only be used when the Liquid Dispenser is
                in automatic mode (interval).
                The operating mode can be switched using the 'dropmode' in-
                struction.
```

Example:
```
!intervalstate 1     Start interval dispensing
!intervalstate 0     Stop interval dispensing

?intervalstate   ==> 1    Read actual interval mode state → Dispensing is active
```

10.5. pump (Manually Add Air Pressure)

```
Syntax:             !pump or ?pump
Parameter:          0 or 1

Support:            Liquid Dispenser upright, Liquid Dispenser inverse

Description:        Manually overwrites the diaphragm pump.
                    Can be used to ensure sufficient pressure before dispensing
                    immersion medium in inverted applications (time counter mode).
                    The Liquid Dispenser switches the pump on and off automatical-
                    ly, but in case of the time counter mode it might be safer to
                    ensure sufficient pressure before dispensing by this instruc-
                    tion.
                    For generating drops it might not be required to ensure pres-
                    sure because they are counted. It then just may take longer.
```

1) Liquid Dispenser upright
It is not necessary to switch the pump manually on and off.

2) Liquid Dispenser inverse
In time counter mode (manual mode) it can be useful to switch
the pump manually on and off before dispensing immersion medi-
um. The manually switching on of the pump ensures that there
is enough pressure in the laboratory glass bottle available
and the immersion medium can be dispensed safely from the be-
ginning.

```
                    0  => Diaphragm pump off
                    1  => Diaphragm pump on
```

It is ensured by design that the maximum pressure won't be ex-
ceeded.

```
Response:           Diaphragm pump state

Remarks:            An alternative to the 'pump' instruction is the 'leadtime'
                    instruction.
                    Using the lead time, a pressure in the laboratory glass bottle
                    can be set up before each dispensing of immersion medium. This
                    instruction is recommended and more comfortable.

Example:
!pump 1     Switch diaphragm pump on
!pump 0     Switch diaphragm pump off

?pump  ==> 0     Read current diaphragm pump state → Pump is off
```

10.6. pressurize (Timed Pressurization)

```
Syntax:           !pressurize
Parameter:        none

Support:          Liquid Dispenser inverse

Description:      When this instruction is executed, pressure is built-up once
                  for the specified lead time. No immersion medium is dispensed.
                  Using the timed pressurization, a pressure in the laboratory
                  glass bottle can be set up before a dispensing of immersion
                  medium.

Response:         none

Remarks:          The lead time can be set with the instruction 'leadtime'.

Example:
!pressurize    Pressure build-up for 5 seconds   (set lead time: 5 s)
!pressurize    Pressure build-up for 10 seconds  (set lead time: 10 s)
```

11. Document Revision History

No.	Revision	Date	Changes	Remarks
00	A	09.05.2016	-	Initial version
01	B	13.06.2016	Added instructions: firmwaredefaults, operatingmode, timebase, leadtime, inittime, interval, dropctr, intervalstate, pump	Based on Liquid Dispenser firmware 1.04
02	C	25.08.2016	Removed instruction: operatingmode	Based on Liquid Dispenser firmware 1.05
03	D	20.07.2018	Added instructions: status, keymode	Based on Liquid Dispenser firmware 1.07
04	E	04.03.2019	Extended status description	Based on Liquid Dispenser firmware 1.09
05	F	12.07.2019	Extended descriptions: status, interval, drop	Based on Liquid Dispenser firmware 1.10
06	G	30.07.2019	Added instruction: pressurize	Based on Liquid Dispenser firmware 1.11