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CLS-700T Communications Technical Information

The Corrosive Liquid Sampler (CLS) model 700T is a computer controlled device that works in conjunction with a LiQuilaz® sensor.

Commands are issued to the CLS-700T and internal LiQuilaz through either the RS-232 or RS-485 port on the back panel of the CLS-700T. The CLS-700T supports what is referred to as Slow Protocol. The LiQuilaz supports Slow Protocol but can also utilize a Fast Protocol which is described separately in the LiQuilaz Operations Manual.

This paper outlines the communication requirements as applied to a CLS-700T / LiQuilaz instrument combination. Both devices must be communicated with separately via different network addresses. The CLS-700T employs hardware lines to control when the LiQuilaz is actively sampling. Only the CLS-700T command/response sequence pairs are described in detail here. Refer to the LiQuilaz Operations Manual for a complete description of the LiQuilaz communication requirements.

System Hardware Transmission Parameters

Baud Rate	9600
Parity	None
Bits Transmitted	8
Stop Bits	1

Slow Protocol Command Packeting and Formatting

The general communication procedure defined by the Slow Protocol requires what is called a *command/response sequence pair*. For each command directed to a CLS-700T, an appropriate response is generated by the CLS-700T. The content of the response is dependent on the particular command (refer to the Slow Protocol Command Summary List below for a complete set of CLS-700T commands). Both the commands and responses are formatted and packeted to ensure error free communication. The formatting and packeting process is discussed in the following paragraphs.

Formatting and Packeting Process

The process of building a packet can be divided into the following three steps:

Step 1

The address of the device is added to the beginning of the command/response data, and a checksum is added to the end of the command/response data. This produces the following unformatted data structure:

ADDRESS HIGH BYTE | ADDRESS LOW BYTE | FIRST DATA BYTE | SECOND DATA BYTE | ... | LAST DATA BYTE | CHECKSUM HIGH BYTE | CHECKSUM LOW BYTE

Note 1: The use of "|" is for readability and does not appear in the actual data packet.

Note 2: The CHECKSUM entry is a 16 bit unsigned integer sum of the unformatted data including the address with the carry bit ignored if an overflow occurs during the calculation.

Step 2

Minimizes difficulties when the network includes devices such as modems. Only visible ASCII characters (32-126), with the exception of the packet delimiting STX and ETX characters, are transmitted on the network. Non-visible and non-ASCII characters

are run through the conversion formula shown below before they are transmitted.

Value of Byte		Character(s) Transmitted (i.e., byte 1H, byte 2H)
Byte	< 20H	7BH, byte + 20H
7B	<+ byte < 80H	7CH, byte - 5BH
80H	<= byte < COH	7DH, byte - 60H
COH	<= byte	7EH, byte - AOH
Otherwise		Byte

Step 3

Preface the ASCII packet formed in Step **2** with an STX (STX = 2) character and terminate the ASCII packet with an ETX (ETX = 3) character.

Note 3: The STX and ETX characters are used as packet delimiters and are not visible characters but do not cause problems as the NUL, DEL and other 8 bit data characters can. The STX and ETX characters are not included in the checksum.

Slow Protocol Command Summary List for the CLS-700T

Command	Response	Purpose
CFLUSH n	RFLUSH n	Flush Mode
CPURDR n	RPURDR n	Purge Drain Mode
CPURIN n	RPURIN n	Purge Inlet Mode
CPURSEN n	RPURSEN n	Purge Sensor Mode
CRF	RRF	Clear Error Flags
CSCT n	RSCT n	Set Compress Time
CSDRAIN n	RSDRAIN n	Set Drain Timeout
CSET n	RSET n	Set Valve Configuration
CSFILL n	RSFILL n	Set Fill Timeout
CSMAN	RSMAN n	Manual mode
CSR	RSR	Software reset
CSS	RSS n	Start Sample
CSSENSOR n	RSSENSOR n	Set Sample Timeout
CSTARE n	RSTARE n	Set Tare Time
CSTATUS	RSTATUS ...	Get Sampler Status
CTS	RTS	Terminate Sample
CVAC n	RVAC n	Set Vacuum Time
CVER	RVER n	Get Software Version

Slow Protocol Command Descriptions for the CLS-700T

Command	Response	Function
CFLUSH n	RFLUSH n	Flush Mode
Where: n = 0 Off, n = 1 On		
This command will put the CLS-700T into **Flush Mode**. This mode will only be accepted if the CLS-700T is currently in an idle state. This mode sets a valve configuration such that clean water can be applied to the sample inlet and flushed through the system and exited via the system outlet.		

Command	Response	Function
CPURDR n	RPURDR n	Purge Drain Mode
Where: n = 0 Off, n = 1 On		
This command will put the CLS-700T into a **Purge Drain Mode**. This mode will only be accepted if the CLS-700T is currently in an idle state. This mode applies internal pressure and sets a valve configuration such that the drain path is purged of residual fluid. Care must be used when requesting this mode of operation as pressurized fluid and gas are purged via the sampler outlet.		

Command	Response	Function
CPURIN n	RPURIN n	Purge Inlet Mode
Where: n = 0 Off, n = 1 On		
This command will put the CLS-700T into a **Purge Inlet Mode**. This mode will only be accepted if the CLS-700T is currently in an idle state. This mode applies internal pressure and sets a valve configuration such that the inlet path is purged of residual fluid. Care must be used when requesting this mode of operation as pressurized fluid and gas are purged via the sampler inlet.		

Command	Response	Function
CPURSEN n	RPURSEN n	Purge Sensor Mode
Where: n = 0 Off, n = 1 On		
This command will put the CLS-700T into a **Purge Sensor Mode**. This mode will only be accepted if the CLS-700T is currently in an idle state. This mode applies internal pressure and sets a valve configuration such that the sample path is purged of residual fluid. Care must be used when requesting this mode of operation as pressurized fluid and gas are purged via the sampler outlet.		

Command	Response	Function
CRF	RRF	Clear Error Flags
This command will clear any error bits presented in the Error Mask portion of the RSTATUS response of the CLS-700. All errors are persistent and require the use of the CRF command to be cleared.		

Command	Response	Function
CSCT n	RSCT n	Set Compress Time
Where: n = Integer Time in seconds		
This command will set a compression time in seconds. Compression can be used to help force bubbles back into solution prior to forcing the liquid through the particle counter. Compression is applied after Vacuum but prior to the Tare and Sample states.		

Command	Response	Function
CSDRAIN n	RSDRAIN n	Set Drain Timeout
Where: n = Integer Time in seconds		
This command will set a drain timeout in seconds. Drain timeout is used to quantify a maximum amount of time that can pass before the CLS-700T sets an error in the Error Mask portion of the RSTATUS response. A drain timeout signifies an error in the fluid handling process or on-board fluid detection system.		

Command	Response	Function
CSET n	RSET n	Set Valve Configuration
Where: n = 0 refused, n = 1 accepted		
This command will set a manually set-up hardware configuration internal to the CLS-700. This mode will only be accepted if the CLS-700T is currently in a Manual state. Care must be used when setting internal hardware configurations, as fluid and gas can be purged via the sampler inlet, outlet, and vent ports.		

Command	Response	Function
CSFILL n	RSFILL n	Set Fill Timeout
Where: n = Integer Time in seconds		
This command will set a fill timeout in seconds. Fill timeout is used to quantify a maximum amount of time that can pass before the CLS-700T sets an error in the Error Mask portion of the RSTATUS response. A fill timeout signifies an error in the fluid handling process or on-board fluid detection system.		

Command	Response	Function
CSMAN	RSMAN n	Manual Mode
Where: n = 0 refused, n = 1 accepted		
This command will put the CLS-700T into a **Manual Control Mode**. This mode will only be accepted if the CLS-700T is currently in an idle state. This mode will allow subsequent CSET commands to be issued that will manually set up a hardware configuration internal to the CLS-700. Care must be used when setting internal hardware configurations, as fluid and gas can be purged via the sampler inlet, outlet, and vent ports.		

Command	Response	Function
CSPT n	RSPT	Set Purge Time
Where: n = Integer Time in 20msec increments		

Command	Response	Function
CSR	RSR	Software Reset
This command will force the CLS-700T to perform a full software reset. After a reset or a power-up sequence the CLS-700T will apply a safe hardware configuration.		

Command	Response	Function
CSS	RSS n	Start Sample
Where: n = 0 refused, n = 1 accepted		
This command will start the CLS-700T to perform a single sample sequence.		

Command	Response	Function
CSSENSOR n	RSSENSOR n	Set Sample Timeout
Where: n = Integer Time in seconds		
This command will set a sample timeout in seconds. Sample timeout is used to quantify a maximum amount of time that can pass before the CLS-700T sets an error in the Error Mask portion of the RSTATUS response. A sample timeout signifies an error in the fluid handling process or on-board fluid detection system.		

Command	Response	Function
CSTARE n	RSTARE n	Set Tare Time
Where: n = Integer Time in seconds		
This command will set a tare time in seconds. Tare can be used to ensure that the small amount of fluid that remained between the CLS-700T and the LiQuilaz from the last sample is pushed through the sensor prior to counting particles. Tare is applied just prior to the Sample state.		

Command	Response	Function
CSTATUS	RSTATUS n1 n2 n3 n4 n5	Get Sampler Status
Where:	n1 = Valve Mask n2 = Sensor Mask n3 = State n4 = Error Mask n5 = Fill Time	
This command will request the current status of the CLS-700T. The CLS-700T status is comprised of a number of fields. The values that each field can take are described at the end of this section. The fields are described as follows: Valve Mask - Current valve settings Sensor Mask - Current state of the fluid detectors & pressure switch State - Current state of the system Error Mask - Any detected errors Fill Time - Last measured fill time in seconds		

Command	Response	Function
CTS	RTS	Terminate Sample
This command will stop the CLS-700T regardless of where it is in the sample sequence. Care should be taken when using this command, as the CLS-700T could be left with fluid in the Burette, Overflow, Drain, and sensor.		

Command	Response	Function
CVAC n	RVAC n	Set Vacuum Time
Where: n = Integer Time in seconds		
This command will set a vacuum time in seconds. Vacuum can be used to help pull excess bubbles out of solution prior to forcing the liquid through the particle counter. Vacuum is applied before Compression and prior to the Tare and Sample states.		

Command	Response	Function
CVER	CVER s	Get Software Version
Where: s = Software Version String		
This command will request the current firmware version of the CLS-700.		

Command	Response	Function
XXXXX	R??	All other commands
Any unrecognized command will be processed as depicted above.		

RSTATUS Error Mask Values

Leak	0x01	Leak Detected
Pressure	0x02	Low pressure detected
Drain	0x04	Drain still wet after compress time
Sample	0x08	Sample not wet at beginning of sample
Fill Timeout	0x10	Fill timeout expired
Drain Timeout	0x20	Drain timeout expired
Sample Timeout	0x40	Sample timeout expired
Trigger Abort	0x80	Trigger went from ON to OFF during sample

RSTATUS Sensor Mask Values

Pressure Switch	0x01	Set = Bad
Drain Fluid Detect	0x10	Set = Wet
Sensor Fluid Detect	0x20	Set = Wet
Overflow Fluid Detect	0x40	Set = Dry
Leak Fluid Detect	0x80	Set = Dry

RSTATUS State Values

Idle	0
Fill	1
Drain	2
Vacuum	3
Compress	4
Tare	5
Sample	6
Post Sample	7
Vent	8
Flush	9
Purge Inlet	10
Purge Sensor	11
Purge Drain	12
Leak	13
Manual	14
Trigger	15

RSTATUS Valve Mask Values

Compress Valve	0x01	Set = Closed	Normally Closed
Vacuum Valve	0x02	Set = Closed	Normally Closed
Vent Valve	0x04	Set = Open	Normally Open
Fill Valve	0x08	Set = Closed	Normally Closed
Sample Valve	0x10	Set = Closed	Normally Closed
Drain Valve	0x20	Set = Closed	Normally Closed

Typical Initialization and Start Sample Sequence

Command	Device	Function
CFQ	Sensor	Clear data queue
CMODE 0	Sensor	Set sampler mode
CSIZE n ...	Sensor	Set channel sizes
CSDRAIN n	Sample	Set drain timeout
CSSENSOR n	Sampler	Set sensor timeout
CSFILL n	Sampler	Set fill timeout
CSCT n	Sampler	Set compress time
CSTARE n	Sampler	Set tare time
CVAC n	Sampler	Set vacuum time
CSS	Sampler	Start sample

Typical Poll Sequence

Command	Device	Function
Fast Protocol	Sensor	Check sub-sample data & sample queue
CSTATUS	Sampler	Check sampler status

Alternatively

Command	Device	Function
CQC	Sensor	Check for sample queued data
CSTATUS	Sampler	Check sampler status

Typical Sample Data Sequence

Command	Device	Function
CTD	Sensor	Get top data queued
CPQ	Sensor	Pop the data queue

Typical Sample Flow Rate Processing

The flow rate of the system can be approximated using the following calculation. The approximation will only be good for the next sample processed after the last system adjustment.

The definition of terms is as follows:

Variable	Symbol	Units	Source
Burette Volume	BV	ml	Known (Nominal 48)
Flow Interval	FI	sec	Calculated
Flow Rate	FR	ml/min	Calculated
Sample Interval	SI	sec	Reported
Sample Volume	SV	ml	Calculated
Tare Interval	TI	sec	Known

The calculations are as follows:

$FI = SI + TI$

$FR = (BV / FI) * (60 \text{ sec} / 1 \text{ min})$

$SV = BV - (FR * TI) * (1 \text{ min} / 60 \text{ sec})$

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