TITEL: **Serial Protocol Remote Mode**

PROJECT: VIAFLO\_Pipettes

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| V11 | Released | TWe | 02. March 2020 | Update Status Code  Add new action “Get Battery Info” |
| V12 | Released | MCa | 04. June 2020 | Correction Byte# SetAction command |

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# Introduction

## Purpose

This document explains the serial communications between the Integra VIAFLO pipette and an external Host (PC) for remote control. The communication works over Quasi-RS232 (2.7V).

**This document describes the DLL Version 01.09.00.00. This version works with INTEGRA RemoteControl Version 03.21.00.00 and with the Pipet Firmware V04.21 or higher.**

## Abbreviations, Acronyms and Definitions

|  |  |
| --- | --- |
| **Abbr. / Def.** | **Description** |
| Byte# | Byte number counted from start of message (w/o STX) |
| Host | Master device (generally a PC) who sends commands to the pipette |

## Setup connection Host – Pipette

The connection between the host and the Integra pipette is 2stablished over Bluetooth or wire.

Activate the communication mode: Go to the “Toolbox” and enter the menu “Communications”, select “Remote Mode” and press “OK”.

Note: In the Remote Mode the pipettes automatically Power Off is deactivated! The device stays in the mode until you press ‘Disconnect’, send an ‘Exit Remote’ or ‘Power Off’ command or the battery is discharged.

## Bluetooth

For this insert a Bluetooth module in to the pipette.

Setup a Bluetooth connection on the PC. The Pipette and PC need to be paired. Please refer to the help of your PC to learn how to pair Bluetooth devices. The following pairing code might be required: *12345*.

## Wire

The communication is on the same interface as the USB stand / USB-cable is connected (back side of Pipette).

Note: The interface offers a quasi RS232 interface on a 2.7V level (not +/-12V).

# Serial Protocol

All Messages from Host to pipette are Master-Slave. All transmissions occur at:

|  |  |
| --- | --- |
| Baud rate | 115’200 bit/sec |
| Data bit | 8 |
| Parity bit | None |
| Stop bit | 1 |
| Handshake | None |

NOTE: To allow “reserved” characters to be contained in binary messages an ESC byte is sent before each of the following bytes:

|  |  |
| --- | --- |
| Character | Value (hex) |
| STX (start-of-text) | 0x02 |
| ETX (end-of-text) | 0x03 |
| ESC | 0x1B |

Multi byte values:

|  |  |  |  |
| --- | --- | --- | --- |
| “4 Byte Data” (Buffer) | | | |
| Byte0 (Buffer[i+3]) | Byte1 | Byte2 | Byte3 (Buffer[i]) |

C code would be:

value = (buffer[i] \* 256 \* 256 \* 256) + (buffer[i+1] \* 256 \* 256) + (buffer[i+2] \* 256) + buffer[i+3];

|  |  |
| --- | --- |
| “2 Byte Data” (Buffer) | |
| Byte0 (Buffer[i+1]) | Byte1 (Buffer[i]) |

C code would be:

value = (buffer[i] \* 256) + buffer[i+1] ;

## Messages frame from Host to Pipette (Input)

The length is the number of bytes between the STX and the EXT excluding any leading ESC character.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | **STX** | **Length** | **Checksum** | **Sequence**  **number** | **Resend**  **flag** | **Message**  **type** | **Data (Body)** | **ETX** |
| Default | 0x02 |  |  |  |  |  |  | 0X03 |
| Bytes | 1 | 2 | 1 | 2 | 1 | 2 | n | 1 |
| Byte# |  | 0 | 2 | 3 | 5 | 6 | 8 |  |

Details:

|  |  |
| --- | --- |
| <STX> | start-of-text |
| <2 byte binary length> | The length is the number of bytes between <STX> and <ETX> excluding any  leading <ESC> characters. |
| <1 byte binary checksum> | The sum of all bytes between <STX> and <ETX> excluding any leading <ESC> characters. Result of the sum is truncated to just the lower 8 bits and subtracted  from 256. |
| <2 byte binary sequence number> | This number is generated by Host to identify each message and should be echoed by the pipette. |
| <1 byte binary resend flag> | This is normally a 0 but set to 1 if the message is a repeat of the previous  transmission. The sequence number will be the same as the previous message |
| <2 byte binary message  type> | Message type |
| <n byte binary data> | This is the data to be read from or written to the pipette. |
| <EXT> | end-of-text |

Example “Get Info” command:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | **STX** | **Length** | **Checksum** | **Sequence**  **number** | **Resend**  **flag** | **Message**  **type** | **Data (Body)** | **ETX** |
| Default | 0x02 | 0x00,0x08 | 0xF6 | 0x00,0x01 | 0x00 | 0x00,0x01 | - | 0X03 |

## Responses from Pipette to Host (Output)

The responses from the pipette have nearly the same format to the sent messages (except error code).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | **STX** | **Length** | **Checksum** | **Sequence**  **number** | **Resend**  **flag** | **Message**  **type** | **Status**  **code** | **Data**  **(Body)** | **ETX** |
| Default | 0x02 |  |  |  |  |  | 0 |  | 0X03 |
| Bytes | 1 | 2 | 1 | 2 | 1 | 2 | 2 | n | 1 |
| Byte# |  | 0 | 2 | 3 | 5 | 6 | 8 | 10 |  |

Details:

|  |  |
| --- | --- |
| <STX> | start-of-text |
| <2 byte binary length> | The length is the number of bytes between <STX> and <ETX> excluding any  leading <ESC> characters. |
| <1 byte binary checksum> | The sum of all bytes between <STX> and <ETX> excluding any leading <ESC> characters. Result of the sum is truncated to just the lower 8 bits and subtracted  from 256. |
| <2 byte binary sequence  number> | This number is generated by Host to identify each message and should be  echoed by the pipette. |
| <1 byte binary resend flag> | This is normally a 0 but set to 1 if the message is a repeat of the previous  transmission. The sequence number will be the same as the previous message |
| <2 byte binary message  type> | Message type |
| <2 byte status code> | Status code |
| <n byte binary data> | This is the data to be read from or written to the pipette. |
| <EXT> | end-of-text |

## Status code

|  |  |  |
| --- | --- | --- |
| **Value:** | **Status:** | **Comment:** |
| 0 | Command accepted |  |
| 1 | Unknown message type |  |
| 2 | Command value/parameter out of range | At least one value is out of range or invalid number of parameters / bytes |
| 3 | Hardware error | Use GetActionStatus to get more information. |
| 4 | Command not accepted | Use GetActionStatus to get more information. |

## Data flow control

No Flow Control, all the commands will be responded within 100ms.

# Message types

## Type 1 (0x01): Get Info

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |

|  |  |  |  |
| --- | --- | --- | --- |
| 8-9 | 2 | Status code |  |
| 10 | 1 | Firmware version major |  |
| 11 | 1 | Firmware version minor |  |
| 12-13 | 2 | Hardware Version (Electronics) |  |
| 14-17 | 4 | Serial Number |  |
| 18-19 | 2 | Model number\* |  |

\*The model number depends on FW version. It is different between version 03.xx and 04.xx! Table model number:

|  |  |  |
| --- | --- | --- |
| **Model #** | **FW 03.xx** | **FW 04.xx** |
| 0 | None | 12.5 µl SC |
| 1 | 12.5 µl MC | 12.5 µl MC 8ch |
| 2 | 12.5 µl Voyager 8ch | 12.5 µl MC 12ch |
| 3 | 12.5 µl Voyager 12ch | 12.5 µl MC 16ch |
| 4 | 125 µl MC | 12.5 µl VOYAGER 8ch |
| 5 | 125 µl Voyager 8ch | 12.5 µl VOYAGER 12ch |
| 6 | 125 µl Voyager 10ch | 50 µl SC |
| 7 | 125 µl Voyager 12ch | 50 µl MC 8ch |
| 8 | 300 µl MC | 50 µl MC 12ch |
| 9 | 300 µl Voyager 4ch | 50 µl MC 16ch |
| 10 | 300 µl Voyager 5ch | 50 µl VOYAGER 8ch |
| 11 | 300 µl Voyager 6ch | 50 µl VOYAGER 12ch |
| 12 | 300 µl Voyager 8ch | 125 µl SC |
| 13 | 300 µl Voyager 10ch | 125 µl MC 8ch |
| 14 | 1250 µl MC | 125 µl MC 12ch |
| 15 | 1250 µl Voyager 4ch | 125 µl MC 16ch |
| 16 | 1250 µl Voyager 5ch | 125 µl VOYAGER 8ch |
| 17 | 1250 µl Voyager 6ch | 125 µl VOYAGER 12ch |
| 18 | 1250 µl Voyager 8ch | 300 µl SC |
| 19 | 12.5 µl SC | 300 µl MC 8ch |
| 20 | 125 µl SC | 300 µl MC 12ch |
| 21 | 300 µl SC | 300 µl VOYAGER 4ch |
| 22 | 1250 µl SC | 300 µl VOYAGER 6ch |
| 23 | 5000 µl SC | 300 µl VOYAGER 8ch |
| 24 | STEP1100 (for testing) | 1250 µl SC |
| 25 | 50 µl SC | 1250 µl MC 8ch |
| 26 | 50 µl MC | 1250 µl MC 12ch |
| 27 | - | 1250 µl VOYAGER 4ch |
| 28 | - | 1250 µl VOYAGER 6ch |
| 29 | - | 1250 µl VOYAGER 8ch |
| 30 | - | 5000 µl SC |
| 31 | - | STEP1100 (for testing) |

## Type 2 (0x02): Get Action Status

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |
| 10-11 | 2 | Action status |  |
| 12-13 | 2 | Hardware error code |  |

Action status:

|  |  |  |
| --- | --- | --- |
| **Value:** | **Status:** | **Comment:** |
| 0 | Ready |  |
| 1 | Wait for BlowIn | Send ‘BlowIn’ as next |
| 2 | Wait for RUN Key |  |
| 3 | Busy | An action is executed |
| 4 | Pipette not homed | Send ‘Home pipette’ as next |
| 5 | User abort | Action or ‘Wait RUN key’ aborted |
| 6 | Error Spacer |  |
| 7 | Battery too low | Pipet version 04.21 or higher |

Hardware error code:

|  |  |  |
| --- | --- | --- |
| **Value:** | **Error:** | **Comment:** |
| 0 | No hardware error |  |
| 5 | Critical error: ADC overrun | **Device inoperable!** |
| 18 | Critical error: Battery voltage too high |
| 20 | Critical error: Overload charge current |
| 21 | Critical error: Vref out of range |
| 30 | Critical error: SW/HW incompatible |
| 98 | Critical error: µC Quartz failed (HSE) |

## Type 3 (0x03): Get Calibration Factor

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |
| 10-11 | 2 | Calibration factor ‘Pipet’ | multiplied by 10’000 |
| 12-13 | 2 | Calibration factor ‘Repeat’ | multiplied by 10’000 |

## Type 4 (0x04): Set Calibration Factor

Data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Calibration factor ‘Pipet’ | multiplied by 10’000 |
| 10-11 | 2 | Calibration factor ‘Repeat’ | multiplied by 10’000 |

Calibration Range: 9000 – 11000

1. decimal places so the actual calibration factors are 0.9000 – 1.1000 (Default 1.0000) Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

Settings will be stored in the none volatile memory.

## Type 5 (0x05): Set Action

Data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8 | 1 | Action:  1 = Aspirate  2 = Dispense1  3 = Mix1  4 = Purge1  5 = BlowOut  6 = BlowIn  7 = Dispense with no BlowOut  8 = Home pipette2  9 = Space (Voyager only)  10 = Home Spacer (Voyager only)  11= Mix with no BlowOut  12 = Relative Mix, Aspirate first  13 = Relative Mix, Dispense first |  |
| 9 | 1 | Speed | 1…10  Note: for actions ‘Aspirate’, ‘Dispense’, ‘Dispense with no BlowOut’, ‘Mix’ and ‘Purge’ otherwise ignored, BlowOut / BlowIn are executed with the last used  speed. |
| 10-11 | 2 | volume\_value = real\_volume [µl] \* Factor[1/ µl] | Factor[1/ µl] depends on maximum volume of pipette model.4  (for actions ‘Aspirate’, ‘Dispense’, ‘Dispense with no BlowOut and ‘Mix’) |
| 12 | 1 | Mix cycles | 1…30  Note: for Mix actions otherwise ignored |
| 13 | 1 | RUN confirmation | Value not 0:  The pipette screen shows ‘Press RUN’  and the action will executed after pressing RUN. |
| 14-33 | 20 | Message string3 | Message is showed on screen. Allowed characters: ASCII 32..255 |
| 34-35 | 2 | Spacing5 | Spacing range is dependent upon pipette  model, but all values are in  1 mm.  10  Note: for Space action only otherwise  ignored |

* + 1. The last dispense or mix to volume = 0 or purge will add an automatic BlowOut. The host must send a BlowIn before the next aspirate.
    2. The ‘Home Pipette’ command set the speed to default (8).
    3. The message is showed in a proportional font. The maximum of visible characters depends on the string content.
    4. The factor and the min. - and max. value depends on type of pipette model:

|  |  |  |  |
| --- | --- | --- | --- |
| **Volume type** | **Factor[1/ul]** | **Min. volume\_value** | **Max. volume\_value** |
| 12.5ul | 100 | 50 | 1250 |
| 50ul | 100 | 100 | 5000 |
| 125ul | 10 | 20 | 1250 |
| 300ul | 10 | 50 | 3100 |
| 1250ul | 10 | 250 | 12500 |
| 5000ul | 10 | 1000 | 50000 |

Example calculation for a volume of 250ul with a 300ul pipet: volume\_value[ ] = Factor[1/ul] \* real\_volume[ul] volume\_value[ ] = 10/ul \* 250ul = **2500**

* + 1. Pipette model spacing dependencies

|  |  |  |  |
| --- | --- | --- | --- |
| **# of channels** | **Volume type** | **Spacing [mm]** | |
| **Min.** | **Max.** |
| 4 | 300 / 1250 | 9.0 | 33.0 |
| 6 | 300 / 1250 | 9.0 | 19.8 |
| 8 | 12.5 / 50 / 125 | 4.5 | 14.1 |
| 8 | 300 / 1250 | 9.0 | 14.1 |
| 12 | 12.5 / 50 / 125 | 4.5 | 9.0 |

Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

After starting an action read the action status periodical (Get Action Status).

## Type 6 (0x06): Exit Remote mode (Disconnect)

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

After receiving the command the pipette sends the answer and terminates the remote mode. The command is not accepted if the Action Status is ‘Busy’.

## Type 7 (0x07): Power Off

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

After receiving the command the pipette sends the answer, waits 200ms and switches off the power.

The command is not accepted if the Action Status is ‘Busy’.

## Type 8 (0x08): Abort Command

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

Note: Abort the “Wait for RUN Key” status or the commands: ‘Aspirate’, ‘Dispense’, ‘Purge’ and ‘Mix’. After canceling an active command it is necessary to home the pipette.

## Type 9 (0x09): Set Screen

Data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Number of Screen1 | 0 to 3 |

Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

* + 1. Screen Numbers

0: Default remote control screen 1: Custom screen 1

2: Custom screen 2

3: Black screen

Note: This value will not be stored. After a reset the default ‘Remot Control’ screen will be active.

## Type 10 (0x10): Set Brightness

Data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Display Brightness | 0 (Off) to 10 |

Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 8-9 | 2 | Status code |  |

Note: This value will not be stored. After a reset the brightness which is set in the pipet settings will be reloaded.

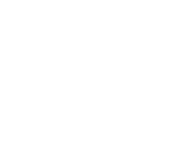
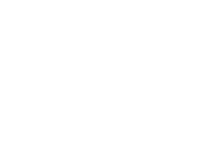
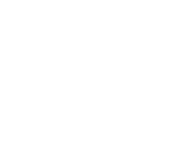
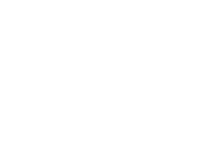
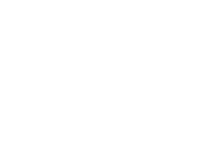
## Type 1 (0x11): Get Battery Info

No data (body). Response data (body):

|  |  |  |  |
| --- | --- | --- | --- |
| **Byte#:** | **Bytes:** | **Info:** | **Comment:** |
| 10 | 1 | State of charge [%] | 0 to 100 [%]  255 means the value could not be read out. |
| 11 | 1 | State Bits:  Bit 0: External supply |  |

# Example procedure ‘Set Action’

After a pipette action with the response status code “Command accepted” the pipette action runs until the action status “Ready” is received.



# Example Hex-code messages

* + Aspirate: (Vol: 1000ul; Speed: 8; Mix Cycles: 3; Message: “Integra”; No RUN key confirm.)

02 00 24 76 00 00 00 00 05 01 08 1B 03 E8 1B 03 00 49 6E 74 65 67 72 61 20 20 20 20 20 20 20

20 20 20 20 20 20 00 00 03

* + Mix: (Vol: 1000ul; Speed: 8; Mix Cycles: 3; Message: “Integra”; RUN key confirm.)

02 00 24 73 00 00 00 00 05 1B 03 08 1B 03 E8 1B 03 01 49 6E 74 65 67 72 61 20 20 20 20 20 20

20 20 20 20 20 20 20 00 00 03

* + Purge: (Vol: 0ul; Speed: 5; Mix Cycles: 0; Message: “Integra”; No RUN key confirm.)

02 00 24 64 00 00 00 00 05 04 05 00 00 00 00 49 6E 74 65 67 72 61 20 20 20 20 20 20 20 20 20 20

20 20 20 00 00 03