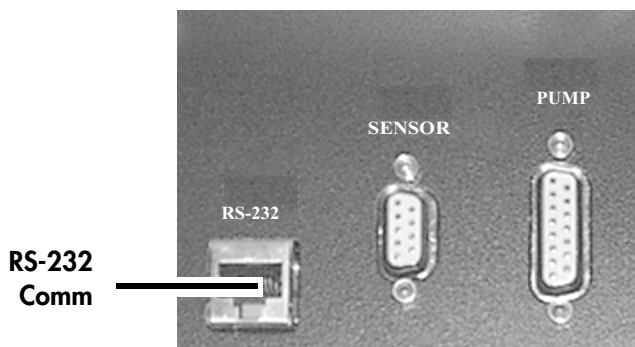


# Appendix D: Integrating the Hydra II Microdispenser Into an Automated Laboratory

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The Hydra II microdispenser is frequently used as a dispensing module within an automated laboratory system controlled by a single host computer. The instrument is designed to be easily integrated in these situations by allowing all functions to be controlled through an RS-232 port using a simple ASCII bi-directional communications protocol. The RS-232 port is located on the back of the microdispenser. See Figure D-1.



**Figure D-1: RS-232 Port Location on Back of Microdispenser**



Note: Contact your equipment provider if you have questions about how to connect your Hydra II microdispenser to the controlling system in an automated laboratory. See page 1-11 for contact information.

## Communications Protocol: Conventions and Specifications

A few commands in the protocol apply only to specific system configurations and are labeled with one of the following indicators:

- [only with X/Y Stage]
- [only with Wash Module or Wash Module plus X/Y Stage]

If you try to execute those labeled commands on a system other than the type indicated by the label, the system ignores the command.

All other commands in the protocol can be executed on any Hydra II system.

**Command block string:** Data sent from the computer to the Hydra II microdispenser.

**Answer block string:** Data sent from the Hydra II microdispenser to the computer.

The checksum is the hex equivalent of the modulo 256 of the sum of the ASCII values of the characters in the command block string, including the STX and ETX commands. If the checksum calculated by the Hydra II microdispenser and the checksum received by the Hydra II microdispenser in the command block are different, an answer block with an error string is sent by the Hydra II microdispenser to the computer. The Hydra II microdispenser remains idle and the operation parameters remain unchanged.

The format of the command string is:

STX Command Block ETX Checksum

Do not insert spaces between elements in the command string.

The Hydra II microdispenser allows 300ms from the time the STX is received for the command string, the ETX command, and the checksum to be received. If the ETX command is not received during the 300ms window, the Hydra II microdispenser waits for a new STX command after it sends an error string to the computer. The Hydra II microdispenser remains idle and the operation parameters remain unchanged.

**Serial communication requirements:** 9600 baud, 8 bits, 1 stop bit, and no parity.

**Cable specifications:**

25-pin cable: Straight through pin to pin.

9-pin cable:

PIN 1 → PIN 8
PIN 2 → PIN 3
PIN 3 → PIN 2
PIN 4 → PIN 20
PIN 5 → PIN 7
PIN 6 → PIN 6
PIN 7 → PIN 4
PIN 8 → PIN 5
PIN 9 → PIN 22

## Commands

Commands are listed in alphabetical order of packet identity in Table D-1. Command descriptions follow the table.

**Table D-1: Command Summary, Listed by Packet ID**

Packet ID	Function Description	Page
'A'	Set Aspirate parameters.	page D-5
'B'	Set LCD display text.	page D-5
'C'	Completion “command”—Response sent by system to host to indicate that a movement or process has been completed.	page D-6
'D'	Set Dispense parameters.	page D-6
'E'	Set Empty parameters.	page D-7
'G'	Request Hydra II to “Go” (execute: Aspirate, Dispense, Empty, or Wash).	page D-7
'H'	Request to HOME X/Ystage. [only with X/Y Stage]	page D-8
'I'	Request input and output state status.	page D-8
'l'	Request to set Pumps 1–3 to On/Off state (uses lowercase letter “L”). [only with Wash Module or Wash Module plus X/Y Stage]	page D-10
'L'	Request to command Pumps 1–3 to turn ON for N seconds. [only with Wash Module or Wash Module plus X/Y Stage]	page D-10
'M'	Request to HOME tray table.	page D-11
'O'	Set Outputs 1–3 to On/Off state. [only with Wash Module or Wash Module plus X/Y Stage]	page D-11
'P'	Poll Hydra II for busy status.	page D-12
'Q'	Request LONG query of system parameters.	page D-13
'R'	Request to MOVE the X-axis and Y-axis of the stage. [only with X/Y Stage]	page D-13
'S'	Set Speed for Dispense, Aspirate, Empty, and Wash operations.	page D-14
'T'	Request to STOP syringe-plunger motor and then return tray table to home position.	page D-14
't'	Request to STOP all motion immediately.	page D-14
'U'	Request position of X-axis, Y-axis, Z-axis (tray table), and Syringes	page D-15
'V'	Request version and Hydra II type (100µL, 290µL, 580µL, 1mL).	page D-15
'W'	Set Wash parameters.	page D-16
'X'	Request MOVE of X-axis of stage. [only with X/Y Stage]	page D-16
'Y'	Request MOVE of Y-axis of stage. [only with X/Y Stage]	page D-17
'Z'	Request MOVE of Z-axis (tray table).	page D-17
'?'	Response that indicates invalid packet ID or checksum.	page D-17

### **Set ASPIRATE parameters**

Sets the aspirate parameters.

#### **Command block string**

**A**XXXXYYYYZZZZ**P**

Where

XXXX is the volume:

- 0.1–110 $\mu$ L in 0.1 $\mu$ L steps for 100 $\mu$ L models.
- 0.5–290 $\mu$ L in 0.5 $\mu$ L steps for 290 $\mu$ L models.
- 0.5–580 $\mu$ L in 0.5 $\mu$ L steps for 580 $\mu$ L models.
- 1.0–1100 $\mu$ L in 1.0 $\mu$ L steps for 1mL models.

YYYY is the tray table/stage height.

ZZZZ is the air gap volume in increments of 0.1/0.5/1.0:

- 0.1–110 $\mu$ L in 0.1 $\mu$ L steps for 100 $\mu$ L models.
- 0.5–290 $\mu$ L in 0.5 $\mu$ L steps for 290 $\mu$ L models.
- 0.5–580 $\mu$ L in 0.5 $\mu$ L steps for 580 $\mu$ L models.
- 1.0–1100 $\mu$ L in 1.0 $\mu$ L steps for 1mL models.

P is the Prime Enable indicator.

#### **Answer block string**

Echoes back the command or returns an error string.

---

### **Set LCD display text**

Places text provided by host on LCD screen.

#### **Command block string**

**B**aXXXXXXXX . . .

Where *a* is one of the following:

- 0 = normal display
- 1 = show banner

XXXXXXXX... is an 80-character string.

#### **Answer block string**

Echoes back the command or returns an error string.

---

### Completion "Command"\*

Response sent by the system to the host when the movement or process is complete.

**CG** = Go process complete.

**CH** = Home X/Y process complete.

**CL** = Timed pump process complete.

**CM** = Home tray table process complete.

**CR** = Move X-axis and Y-axis process complete.

**CX** = Move X-axis process complete.

**CY** = Move Y-axis process complete.

**CZ** = Move Z-axis process complete.



Note: \*You do not enter this "command." It is sent by the system to the host after the movement/process is complete. In the command descriptions in this manual, the completion "command" is shown following the answer block string for each applicable command.

---

### Set DISPENSE parameters

Sets the dispense parameters.

#### Command block string

**DXXXXXXXX**

Where

*XXXX* is the volume:

0.1–110 $\mu$ L in 0.1 $\mu$ L steps for 100 $\mu$ L models.

0.5–290 $\mu$ L in 0.5 $\mu$ L steps for 290 $\mu$ L models.

0.5–580 $\mu$ L in 0.5 $\mu$ L steps for 580 $\mu$ L models.

1.0–1100 $\mu$ L in 1.0 $\mu$ L steps for 1mL models.

*YYYY* is the tray table/stage height.

#### Answer block string

Echoes back the command or returns an error string.

### **Set EMPTY parameters**

Sets the empty parameters.

#### **Command block string**

**EYYYY**

Where *YYYY* is the tray table/stage height.

#### **Answer block string**

Echoes back the command or returns an error string.

---

### **Go Command**

Signals Hydra II microdispenser to begin specified operation.

#### **Command block string**

**GX**

Where *X* is one of the following:

D to initiate full DISPENSE operation.

A to initiate full ASPIRATE operation.

E to initiate full EMPTY operation.

W to initiate full WASH operation.

d to initiate DISPENSE operation with no tray table/stage movement.

a to initiate ASPIRATE operation with no tray table/stage movement.

e to initiate EMPTY operation with no tray table/stage movement.

w to initiate WASH operation with no tray table/stage movement.

#### **Answer block string**

Echoes back the command or returns an error string.

If the Go command was echoed back, then the system returns **CG** (completion “command”).

---

## Move X-axis and Y-axis of stage to home position

Moves stage to X-axis and Y-axis home.

### Command block string

**H**

### Answer block string

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CH** (completion “command”).

---

## Input/Output State Status

Requests input and output state status.

### Command block string

**I**

### Answer block string

**I**ABCDEFGHIJKLMNQRSTU

**A** is the upper syringe limit switch sensor state from MC1, “0” or “1”; Where

0 = Not at limit switch

1 = At limit switch

**B** is the lower syringe limit switch sensor state from MC1, “0” or “1”; Where

0 = Not at limit switch

1 = At limit switch

**C** is the tray table, Z-axis, limit switch sensor state from MC2, “0” or “1”; Where

0 = Not at limit switch

1 = At limit switch

**D** is the X-axis home limit switch sensor state from MC3, “0” or “1”; Where

0 = Not at limit switch

1 = At limit switch

**E** is the Y-axis home limit switch sensor state from MC3, “0” or “1”; Where

0 = Not at limit switch

1 = At limit switch

**F** is the tray 1 switch sensor state from P2, “0” or “1”; Where

0 = Tray 1 not installed

1 = Tray 1 installed

**G** is the tray 2 switch sensor state from P2, “0” or “1”; Where

0 = Tray 2 not installed

1 = Tray 2 installed

**H** is the tray 3 switch sensor state from P2, “0” or “1”; Where

0 = Tray 3 not installed

1 = Tray 3 installed

- I** is the input 1 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- J** is the input 2 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- K** is the input 3 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- L** is the input 4 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- M** is the input 5 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- N** is the input 6 state from J2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; +5V at input
- O** is the wash sensor input from P3, “0” or “1”; Where  
0 = Wash well not full (liquid is below sensor)  
1 = Wash well full
- P** is the empty output state from P3, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V
- Q** is the fill 2 output state from P3, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V
- R** is the fill 1 output state from P3, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V
- S** is the empty 1 output state from P2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V
- T** is the empty 2 output state from P2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V
- U** is the output 3 state from P2, “0” or “1”; Where  
0 = CLOSED; tied to GROUND  
1 = OPEN; pulled to +5V

---

### Turn pumps on/off

[only with Wash Module or Wash Module plus X/Y Stage]

Turns pumps on Wash Module on and off as specified.

#### Command block string

**LXX**

Where *XX* is one of the following:

- 11 = Pump 1 on
- 10 = Pump 1 off
- 21 = Pump 2 on
- 20 = Pump 2 off
- 31 = Pump 3 on
- 30 = Pump 3 off

#### Answer block string

Echoes back the command or returns an error string.

Note: "l" as the first character in the preceding commands is lowercase letter "L".



---

### Turn pumps ON for N seconds

[only with Wash Module or Wash Module plus X/Y Stage]

Turns pumps on Wash Module on and off for specified duration.

#### Command block string

**LXDD**

Where *X* is

- 1 for pump 1
- 2 for pump 2
- 3 for pump 3 (Empty pump)

*DD* is duration in seconds that the pump is on.

#### Answer block string

Echoes back the command or returns an error string.

If the Turn pumps ON command was echoed back, then the system returns **CL** (completion "command").

### **Move Z-axis (tray table) to home position**

Moves the tray table to its home (Z-axis) position.

#### **Command block string**

**M**

#### **Answer block string**

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CM** (completion “command”).

---

### **Set Output 1-3 On/Off**

[only with Wash Module or Wash Module plus X/Y Stage]

Sets output states for Wash Module pumps.

#### **Command block string**

**OXX**

Where *XX* is

11= Output1 On; 10 = Output 1 Off

21= Output 2 On; 20 = Output 2 Off

31= Output 3 On; 30 = Output 3 Off

#### **Answer block string**

Echoes back the command or returns an error string.

### **Poll unit**

Polls the microdispenser to determine the busy or idle status of the machine. The microdispenser will only process commands when it is in the Idle state. You do not need to use this command, because the system sends a Completion “command” to the host when the Go and Move commands complete successfully. You can verify that the Completion command was sent just by looking for the C that appears at the beginning of that command.

### **Command block string**

**P**

### **Answer block string**

**PX**

Where *X* is the current machine status:

0 for idle; 1 for busy

or returns an error string.

## Query

Queries for microdispenser status and current operation parameters. This command returns all of the current settings and the state of the Hydra II microdispenser. “Busy” is unable to receive and process commands. “Idle” is available to receive and process commands.

### Command block string

Q

### Answer block string

QDXXXXXXYYYYAXXXXXYYYEYYYYWYYYYXXZZZAABBCCDEVGGGGPH

or returns an error string.

Where

*GGGG* is the current volume:

0.1–110µL in 0.1µL steps for 100µL models.

0.5–290µL in 0.5µL steps for 290µL models.

0.5–580µL in 0.5µL steps for 580µL models.

1.0–1100µL in 1.0µL steps for 1mL models.

*H* is the current machine status:

0 for idle

1 for busy

A, D, F, E, and W parameters are formatted as described in their “Set” commands. P is the Poll unit command, described above.

---

## Move X-axis and Y-axis stage

Moves X-axis and Y-axis stage absolute.

### Command block string

RXXXXXXYYYY ; X-axis and Y-axis stage  
absolute

Where *XXXXX* and *YYYYY* are the number of steps, 00000–99999 only.

### Answer block string

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CR** (completion “command”).

---

## Speed Control

Sets syringe-motor speed for Aspirate, Dispense, Empty, and Wash operations.\*

### Command block string

*SDAEW*

Where

*D* is the dispense speed number, 1–5.

*A* is the aspirate speed number, 1–5.

*E* is the empty speed number, 1–5.

*W* is the wash speed number, 1–5.

### Answer block string

Echoes back the command or returns an error string.



Note: \*If you do not set the speed for an operation, the speed setting will default to **1** when that operation is executed.

---

## Terminate

Immediately terminates the motion of the syringe-plunger motor and then returns the tray table/stage to the Z-axis home position.

### Command block string

**T**

### Answer block string

Echoes back the command or returns an error string.

---

## terminate

Immediately terminates all motion. The tray table/stage does not return to the Z-axis home position.

### Command block string

**t**

### Answer block string

Echoes back the command or returns an error string.

### Query stage position

Returns X, Y, Z, and syringe (dispensing head) positions.

#### Command block string

U

#### Answer block string

UXXXXXYYYYYZZZZZSSSSS

Where

XXXXX is the X-axis location in 1mm steps from home.

YYYYY is the Y-axis location in 1mm steps from home.

ZZZZZ is the Z-axis location (tray table/stage position) in 1mm steps from home.

SSSSS is the syringe (dispensing head) location in 1mm steps from home.

or returns an error string.

---

### Firmware/model version query

Requests firmware and model versions.

#### Command block string

V

#### Answer block string

VXXXXMVVV

or returns an error string.

Where

XXXX is the syringe volume in microliters.

M is the model type:

S for standard (base unit only) models

W for models with Automatic Syringe Wash Module

P for models with X/Y Plate Stage

VVV is the firmware version.

---

## Set WASH parameters

Sets the wash parameters.

### Command block string

`WYYYYXZZZAABBCCDE`

Where

*YYYY* is the tray table/stage height.

*XX* is the number of washes (wash cycles), 1–8.

*ZZZ* is the wash volume:

10–110 $\mu$ L in 10 $\mu$ L steps for 100 $\mu$ L models.

10–290 $\mu$ L in 10 $\mu$ L steps for 290 $\mu$ L models.

10–580 $\mu$ L in 10 $\mu$ L steps for 580 $\mu$ L models.

10–1100 $\mu$ L in 10 $\mu$ L steps for 1mL models.

*AA* is time for pump 1 to fill the reservoir.\*

*BB* is time for pump 2 to fill the reservoir.\*

*CC* is time for pump 3 to empty the reservoir.\*

*D* is number of times (the Step1 value) pump 1 fills the reservoir.\*

*E* is number of times (the Step2 value) pump 2 fills the reservoir.\*

### Answer block string

Echoes back the command or returns an error string.

---

## Move X-axis stage

Move X-axis stage absolute.

### Command block string

`XSSSSS ; X-axis stage absolute`

Where *SSSSS* is the number of steps, 00000–99999 only.

### Answer block string

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CX** (completion “command”).

### **Move Y-axis stage**

Moves the Y-axis stage absolute.

#### **Command block string**

```
YXXXXX ; Y-axis stage absolute
```

Where XXXXX is the number of steps, 00000–99999 only.

#### **Answer block string**

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CY** (completion “command”).

---

### **Move Z-axis stage**

Moves the Z-axis stage absolute.

#### **Command block string**

```
ZXXXXX ; Z-axis stage absolute
```

Where XXXXX is the number of steps, 00000–99999 only.

#### **Answer block string**

Echoes back the command or returns an error string.

If the Move command was echoed back, then the system returns **CZ** (completion “command”).

---

### **Error string**

#### **Command block string**

None

Data receipt error. Reply from Hydra II microdispenser indicating invalid packet ID or checksum.

#### **Answer block string**

?

## Sample Command

### Dispense

Command structure:

STX + GD + ETX + CHECKSUM

ASCII command:

^BGD^C90

Checksum calculation:

Character	HEX Value
STX	2
G	47
D	44
ETX	3
TOTAL	<b>90</b>
Checksum	<b>90</b>