kdScientific

Milliliter OEM Pump Module
Users Manual

Model #78-2910

KDS Milliliter OEM Module

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General Safety Summary

Please read the following safety precautions to ensure proper use. If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired.

To Prevent Hazard or Injury:

Use Proper Line Cord

Use only the specified line cord for this product and make sure line cord is certified for country of use. The operating voltage range is 100–240 vac, 50/60 Hz.

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making any connections to the input or output terminals of the product, ensure that the product is properly grounded.

Make Proper Connections

Make sure all connections are made properly and securely.
Any signal wire connections to the unit must be no longer than three meters.

Observe All Terminal Ratings

Review the operating manual to learn the ratings on all connections.

Use Proper Fuse

Use only specified fuses with product.

Avoid Exposed Circuitry

Do not touch any electronic circuitry inside of the product.

Do Not Operate with Suspected Failures

If damage is suspected on or to the product do not operate the product. Contact qualified service personnel to perform inspection.

Orient the Equipment Properly

Do not orient the equipment so that it is difficult to operate the disconnection device.

Place Product in Proper Environment

Review the operating manual for guidelines for proper operating environments.

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Observe All Warning Labels on Product

Read all labels on product to ensure proper usage.

Avoid Pinch Hazard

A pinch hazard exists between the Pusher Block and the End Blocks. Avoid placing fingers between these points while the pump is running.

Caution Notice

The KDS Pump is intended for laboratory use only and can be used in research and development applications. These systems have been designed to meet the standards for electromagnetic compatibility (EMC) intended for laboratory equipment applications as well as the applicable safety requirements for electrical equipment for measurement, control, and laboratory use. The unit itself does not generate waste, but may be used to treat samples that are hazardous. Please use appropriate PPE and ensure disposal in accordance with local regulations and practices.

This product should not be used in the presence of a flammable atmosphere such as an anesthetic mixture with air, oxygen, or nitrous oxide.

Caution

Protective Ground Terminal

CAUTION

Pinch Hazard

KDS Milliliter OEM Module

Introduction

THEORY OF OPERATION:

The "mL" OEM Pump Module is designed as a highly precise, single-syringe infusion/withdrawal pump module capable moderate to high back pressures. The module includes a mechanism, hardware, power supply and user interface cable. There is no keypad or display for this module: it must be connected to a PC..

Typically, the "mL" OEM Pump Module holds one syringe of most makes, from 0.5 µl to 60 ml. The diameter of the syringe is entered via your PC or other controller, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an appropriately rated fire/electrical/mechanical enclosure or cabinet.

FEATURES

Volume
A target volume can be entered for infusion and refill independently, and the pump automatically stops when this volume is reached. The pump displays an initial volume of zero and increases as the dispense proceeds to the target volume. The target volume can be reviewed or changed as the pump continues to operate.

Modes of Operation

Infusion
- Rate and volume settings: pump infuses to the set volume and stops.
- Rate setting only: pump runs until manually stopped, limit switches are hit, or stalls.

Withdrawal
- Rate and volume settings similar to above.

Infusion/withdrawal
- Infusion automatically followed by withdrawal. Rate and volume settings can be made independently for infusion and withdrawal, hence the pump can infuse at one rate and volume and then change to a different withdrawal flow rate and volume setting.

Withdrawal/infusion
- Withdrawal immediately followed by infusion. Separate settings for rate and volume can be made for withdrawal and infusion.
- Continuous operation
- The pump cycles from infusion to withdrawal continuously. The volume is identical in infuse and withdrawal directions.

INFUSE and WITHDRAW LIMIT SWITCHES
An infuse limit switch is located on the syringe block and an adjustable actuator is located on the pusher block. When the pusher block actuator contacts the limit switch, infusing is stopped. Adjust the actuator appropriately such that the syringe plunger does not bottom out in the syringe barrel.

The withdraw limit switch is located in the pulley cover, which is connected to a movable guide rod. The guide rod is equipped with an adjustable clamp collar. When the pusher block comes in contact with the adjustable clamp collar, the withdraw limit switch is actuated and pusher block movement is halted. Adjust the clamp collar appropriately such that the syringe plunger does not pull out of the syringe barrel.

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Introduction (continued)

STALL DETECTION
The motor is monitored by an optical encoder to confirm the programmed movement. If the back pressure increases due to jamming or flow restriction, then the motor may stall. Stall detection by the encoder results in a pump shutdown.

NON-VOLATILE MEMORY
All operational settings are stored in non-volatile memory for convenience, and are used to set the pump when first powered on.

SELECTION OF RATE AND VOLUME UNITS
Units of volume (μ or ml) and flow rate (μ/ml per min/hr) can be changed if required.

Input Connections
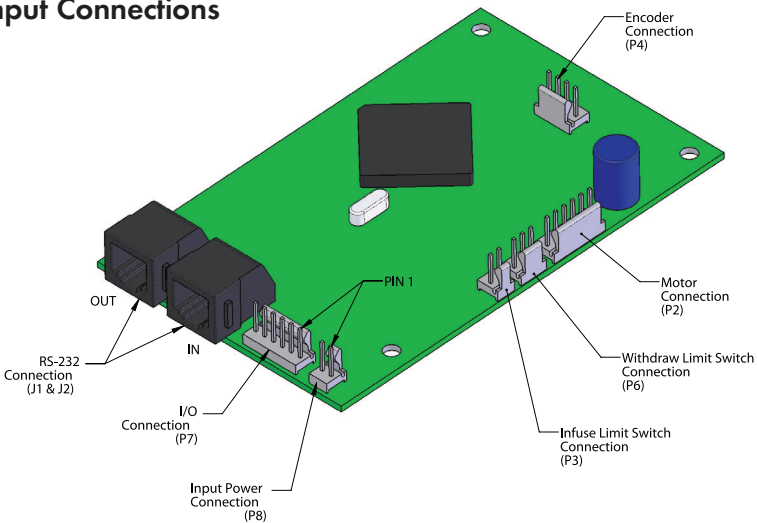
Pin-outs

Input Power	Power	P8-1
Connection	Return	P8-2
Digital I/O	Run IND	P7-1
Connection	VCC	P7-2
	EXT ENABLE	P7-3
	Ground	P7-4
	Run/Stop	P7-5
	Ground	P7-6

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Installation

LOCATION REQUIREMENTS
FOR THE SYRINGE PUMP

- A sturdy, level, clean and dry surface
- Minimum of one inch (2.5cm) clearance around the pump
- Appropriate environmental conditions
- Mount into an appropriately rated enclosure or cabinet
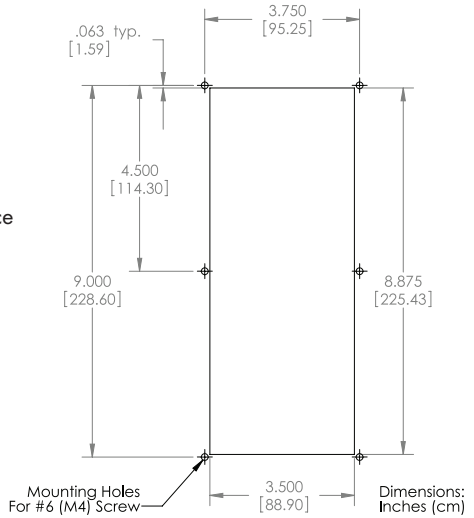- Required clearance below mounting panel: 2.00" (5cm).

.063 typ.
[1.59]

3.750
[95.25]

4.500
[114.30]

9.000
[228.60]

8.875
[225.43]

Mounting Holes
For #6 (M4) Screw

3.500
[88.90]

Dimensions:
Inches (cm)

LOADING THE SYRINGE

1. Release the syringe pusher (2) by pressing the bronze button (1) on the side of the pusher.
2. While holding the bronze button 'in', slide the pusher to the left.
3. Raise the spring loaded syringe retainer (4) and swing it out of the way.
4. Lay the loaded syringe in the 'V' shaped holder.
5. Swing the retainer so it holds the syringe in place.
6. Move the pusher so it makes contact with the syringe plunger.
7. Adjust pusher block bracket (3) & Syringe retainer knobs (5) to capture plunger & body of syringe.
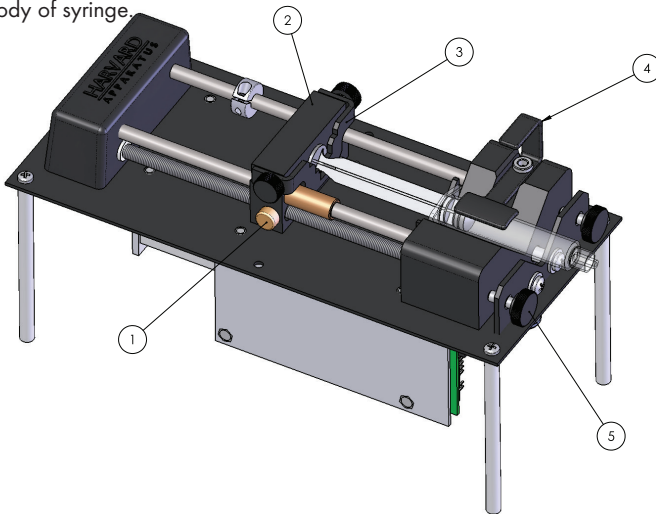
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Operation

GETTING STARTED
Plug one end of the power cable into P8 connection on board. Connect communication cable from PC to J1 connector. Refer to page 6 of this manual to reference the board connections.

WORKING WITH THE PUMP
The safest way to use the "ML" OEM Pump Module is in the volume dispense mode. The pump will automatically stop when target volume is dispensed.

Enable must be tied to ground (Hardwire P7-3 to P7-4 or connect through switch).

CHECK SYRINGE OFTEN
The "mL" OEM Pump Module will shut itself off when the syringe is empty or is otherwise overloaded. Although this presents no hazard to the user or the pump, it is prudent to check the syringe from time to time.

MAINTENANCE
Keep the "mL" OEM Pump Module clean and dry. Avoid liquid spills that may find their way into the electronics.

A small tube of grease is provided for periodic lubrication of the lead screw. It is important to keep the lead screw clean and lubricated.

To clean the exterior surfaces above the base plate, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened with water or an aqueous solution of 75% isopropyl alcohol.

If the pump does not work properly, contact KD Scientific for appropriate instructions.

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Protecting Small, Fragile Syringes

The "mL" OEM Pump Module will hold micro liter size syringes down to 0.5μl size. These small syringes have fine wire plungers that may be damaged if allowed to bottom out. The limit switches for the "mL" OEM Pump Module can be adjusted by loosening the mounting hardware which attaches the switch to the base plate bracket, moving the switch to the desired location, and re-tightening the switch mounting hardware.

Infuse Limit Switch

Infuse Limit Switch Actuator

Infuse Limit Switch Actuator Adjusting Knob

Withdraw Limit Switch Actuator
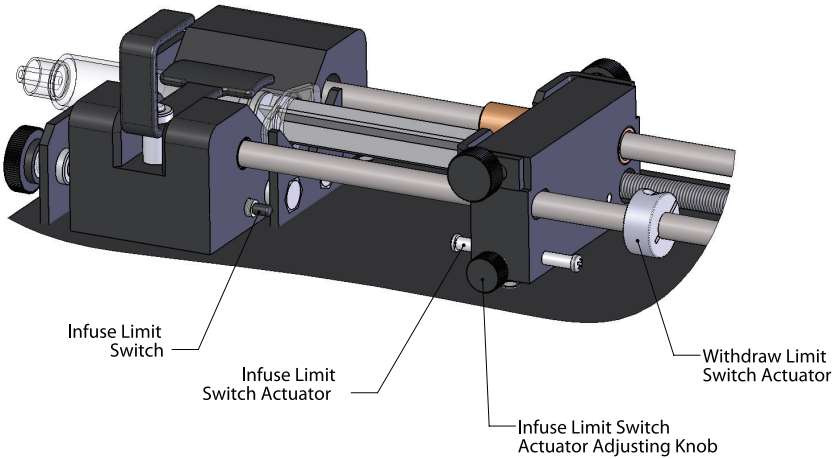
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HYPER-TERMINAL: Terminal Emulation Software

REMOTE CONTROL VIA THE RS-232 INTERFACE USING HYPERTERMINAL*

* Normally included with most Windows® operating systems.

Milliliter Modular Syringe Pump Component

1. Connect the RS-232 cable between the "µL" OEM Pump Module RS-232 IN port and a PC's serial port.
2. On the PC (running a Microsoft Windows Operating System), select START – PROGRAMS – ACCESSORIES – HYPERTERMINAL – HYPERTERMINAL to start the HyperTerminal application. If HyperTerminal is not available, install it from the Microsoft Windows Operating System Install disks or CD ROM.
3. Set up the appropriate COMPORT for the following:
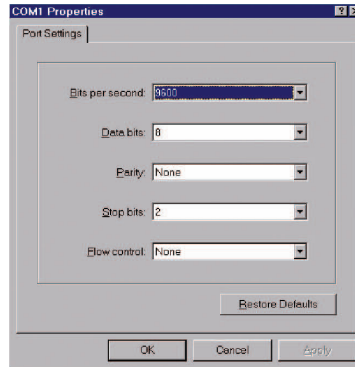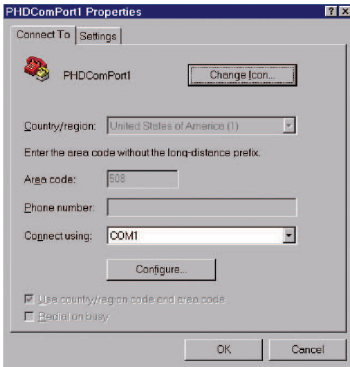
Configure:

Baud Rate:	9600
Data Bits:	8
Parity:	None
Stop Bits:	2
Flow Cntrl:	None
Emulation:	Auto Detect

ASCII Setup:

Echo typed characters locally

Line delay: 0

Character delay: 0

Wrap lines

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HYPER-TERMINAL: Terminal Emulation Software (continued)
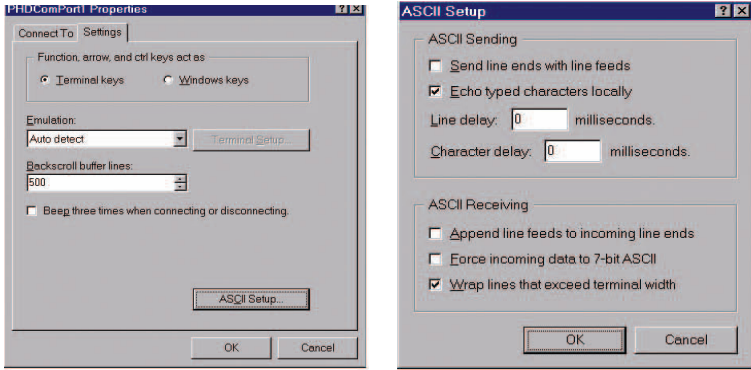
You may want to save the setup information under a descriptive filename.

4. At the PC, launch HyperTerminal with the above setup specifications (if it is not already running). Type PROM? at the PC keyboard and verify that the pump module's version is displayed at the PC terminal.

5. Type RUN to start the pump; type STOP to stop the pump. After starting the pump, > should be displayed, indicating pump is infusing. After stopping the pump, : should be displayed.

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Appendix A: Specifications

Accuracy	±1.0%
Number of Syringes	One
Syringe Sizes	0.5µL (min), 50/60 mL B-D Plastic (max)
Flow Rate:	
Minimum	0.001µL/hr (w/ 0.5µL syringe (0.103mm dia.))
Maximum	44.283 mL/min (w/ 50/60 mL syringe (26.7mm dia.))
Linear Force	20lbs (peak min.) Adjustable
Drive	Motor: 0.9° Stepper
Control	Constant Current Drive, 0.50A peak per phase
	1/4 & 1/16 stepping
Drive Ratio	2.4:1
Leadscrew Pitch	20tpi
Encoder	Optical, 100 line (for stall detection)
Step Rate:	
Minimum	3.8 sec/step
Maximum	250 µsec/step
Pusher Travel Rate:	
Minimum	0.001 mm/min
Maximum	83.4mm/min
Display	None
Keypad	None
Interface	RS-232
Connectors	Power: 2 –pin Header, .1 centers
	Digital I/O: 6-pin Header, .1 centers RS-232: RJ-11p phone jack
Power	+12 to +30VDC +/- 5%, 0.5A max
Dimensions	9.50" x 4.25" x 4.78" (L x W x H) 24.1cm x 10.8cm x 12.14cm
Mounting Dimensions	9.00" x 3.75" (Mounting holes for (6) #6 screws) 22.9cm x 9.5cm
Ground Stud	#6-32 UNC Thread
Weight	2.72 lbs (1.23kg)
Environmental Operating:	
Temp	+5 to +40°C (natural convection cooling)
Humidity	20% to 80% RH non-condensing
Storage:	
Temp	-30 to +45°C
Humidity	10% to 90% RH non-condensing
Pollution Degree	Class 1
Compliance	Lead Free, RoHS Compliant

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The pump is set to the following default parameters on power-up and after an external enable command.

DEFAULT SETTINGS

Syringe Diameter:	2.300 mm
Rate:	3.000 ul/min
Range:	ul/min
Force:	100%
Address:	00
Baud Rate:	9600

I/O Specifications: Inputs

RUN/STOP
This is an active low, TTL level input, pulled up to +5V through a 10K ohm resistor. It is ESD protected through a TVS device and filtered with a 0.1uF capacitor to ground. Each pulse to a logic low toggles the pump between the RUN and STOP states.

EXT_ENABL/
This is an active low, TTL level input, pulled up to +5V through a 10K ohm resistor. It is ESD protected through a TVS device and filtered with a 0.1uF capacitor to ground. A transition from logic high to logic low causes the processor to reset to its default state and enables the motor drive. A transition from logic low to logic high disables the motor drive through hardware (independent of firmware). This input may be used for an emergency stop function.

To enable pump, the unit or connector P7 pin 3, must be connected to ground

Outputs

RUN_IND/
This is an active low output driven by two 74HCT14 inverters in parallel. An on-board resistor may be placed in series with this output to provide current limiting. The default resistor value is zero ohms. A logic low indicates RUN. A logic high indicates STOP.

INDICATORS:
Power-on LED

When illuminated, indicates that board is powered on and +5VDC supply is operating.

RUN LED
When illuminated, indicates that pump is running. When extinguished, indicates pump is stopped.

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Appendix B: Syringe Inside Diameter

Terumo

Size	Diameter
3.0 cc	8.95 mm
5	13.00
10	15.80
20	20.15
30	23.10

Sherwood–Monoject Plastic

Size	Diameter
1.0 cc	4.674 mm
3	8.865
6	12.600
12	15.621
20	20.142
35	23.571
60	26.568

Stainless Steel

Size	Diameter
2.5 cc	4.790 mm
8	9.525
20	19.130
50	28.600

Becton Dickinson Plastic "Plasticpak"

Size	Diameter
1.0 cc	4.78 mm
3	8.66
5	12.06
10	14.50
20	19.13
30	21.70
50	26.70
60	26.70

Air–Tite "All Plastic"

Size	Diameter
2.5 cc	9.60 mm
5	12.45
10	15.90
20	20.05
30	22.50

SGE Scientific GlassEngineering

Size	Diameter
25.0 µl	0.73 mm
50	1.03
100	1.46
250	2.30
500	3.26

Size	Diameter
1.0 ml	4.61 mm
2.5	7.28
5	10.30
10	14.57

Hamilton–Microliter Series Gastight

Size	Diameter
0.5 µl	0.103 mm
1	0.1457
2	0.206
5	0.3257
10	0.460
25	0.729
50	1.031
100	1.46
250	2.30
500	3.26

Size	Diameter
1.0 ml	4.61 mm
2.5	7.28
5	10.30
10	14.57
25	23.00
50	32.60

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Appendix C: Flow Rates

nominal syringe size	nominal diameter (mm)	ul/hr		ul/min		ml/hr		ml/min	
		min	max	min	max	min	max	min	max
0.5 µ	0.103	0.001	39.837	0.001	0.664	0.001	.0398	0.001	0.001
1 µ	0.150	0.002	84.489	0.001	1.408	0.001	0.084	0.000	0.001
2 µ	0.210	0.003	165.600	0.001	2.760	0.001	0.165	0.001	0.002
5 µ	0.330	0.007	408.932	0.001	6.815	0.001	0.408	0.001	0.006
10 µ	0.460	0.013	794.584	0.001	13.243	0.001	0.794	0.001	0.013
25 µl	0.730	0.033	2001.100	0.001	33.351	0.001	2.001	0.001	0.033
50 µ	1.030	0.066	3983.814	0.001	66.396	0.001	3.983	0.001	0.066
100 µ	1.460	0.131	8004.429	0.001	133.406	0.001	8.004	0.001	0.133
250 µ	2.300	0.325	9999.999	0.005	331.076	0.001	19.864	0.001	0.331
500 µ	3.260	0.653	9999.999	0.012	665.133	0.001	39.907	0.001	0.665
1 ml	4.610	1.306	9999.999	0.022	1330.072	0.001	79.804	0.001	1.330
2.5 ml	7.280	3.256	9999.999	0.054	3316.072	0.003	199.015	0.001	3.316
3 ml	8.660	4.533	9999.999	0.076	4693.633	0.005	281.617	0.001	4.693
5 ml	10.300	6.517	9999.999	0.109	6639.691	0.007	398.381	0.001	6.639
10 ml	14.570	13.040	9999.999	0.217	9999.999	0.013	797.156	0.001	13.285
20 ml	20.050	22.291	9999.999	0.372	9999.999	0.023	1509.570	0.001	25.159
30 ml	23.100	28.631	9999.999	0.477	9999.999	0.029	2003.773	0.001	33.396
50 ml	26.700	43.460	9999.999	0.724	9999.999	0.043	2656.920	0.001	44.282

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Appendix D: Serial Communication

COMMANDS, QUERIES AND RESPONSES
After each transmission to the pump terminating with a CR character (ASCII 13),

the pump enters remote mode and responds with the character sequence:

CR LF PROMPT

The prompt characters indicate the status of the pump as follows:

prompt	meaning	ASCII code
:	Stopped	(ASCII 58 decimal)
>	Running forward	(ASCII 62 decimal)
<	Running reverse	(ASCII 60 decimal)
*	Stalled	(ASCII 42 decimal)
*I	Infuse Limit switch actuated	(ASCII 42 decimal + ASCII 73 decimal)
*W	Withdraw Limit Switch actuated	(ASCII 42 decimal + ASCII 87 decimal)
*D	Disabled by emergency stop	(ASCII 42 decimal + ASCII 68 decimal)
*T	Target volume reached	(ASCII 42 decimal + ASCII 84 decimal)

Serial commands and their meanings:

COMMANDS:

run	Start running to present settings
stop	Stop motor
dir rev	Reverses pumping direction
clv	Clears volume accumulator to zero (Infuse Direction)
clvw	Clears volume accumulator to zero (Withdraw Direction)
clt	Clears target volume to zero (Infuse direction)
cltw	Clears target volume to zero (withdraw direction)
mode i	Sets Mode to infuse
mode w	Sets Mode to withdraw
mode i/w	Sets Mode to infuse/withdraw
mode w/i	Sets Mode to withdraw/infuse
mode con	Sets Mode to continuous

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Appendix D: Serial Communication (continued)

COMMANDS WITH NUMBERS (must have space before number):

ratew nnnnn u/u	Set withdrawal rate
dia nn.nn	Set syringe diameter in mm. n = 0 to 9
ratei nnnnn u/u	Set infusion rate nnnnn is 0 to 9 and u/u is units
ratew nnnnn u/u	Set withdrawal rate
voli nnnnn uu	Set infusion target volume nnnnn is 0 to 9 and uu is units
volw nnnnn u/u	Set withdrawal target volume
for p	Force setting as percentage p is 0 to 100

QUERIES:

prom?	queries the software version
run?	run status
dia?	present diameter setting
ratei?	infusion rate
ratew?	withdrawal rate
del?	delivered volume
voli?	infusion target volume
volw?	withdrawal target volume
dir?	current pumping direction
mode?	current mode
frc?	force setting as a percent

QUERIES WITH STRING RESPONSE:

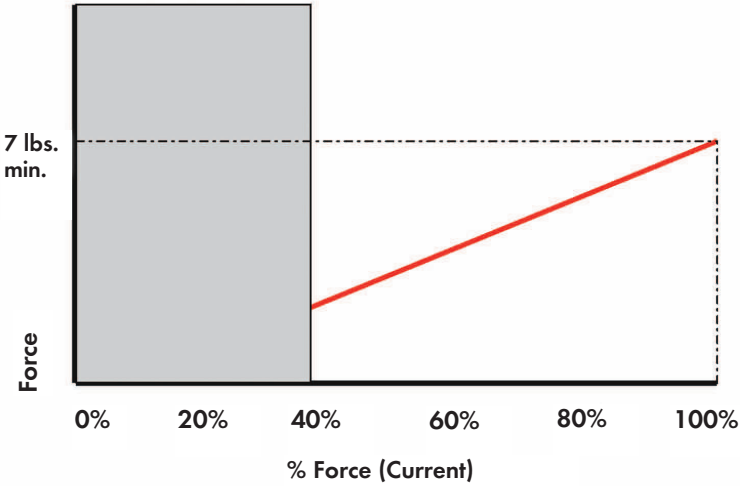|	
LIM	Returns "infuse", "withdraw", or "False"; indicating limit switch actuation status.
EMG	Returns emergency stop input status (True/False); True = Emergency Stop

ERROR MESSAGES:

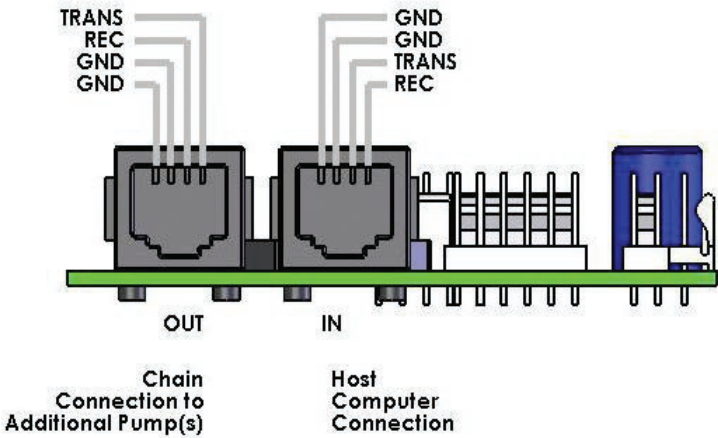|	
CR Lf E	Unrecognized command
CR Lf OOR	Entered value is out of range

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Appendix D: Serial Communication

***Note: Adjustable force settings

Due to differences in mechanical drug forces, we do not
recommend operating the pump below 40% force level.

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Appendix E: Optional – Daisy-Chaining

The RS-232 Connection to the first board in the daisy-chain is made through the 9-pin D-Sub connector or RJ-11 input (J1). Use an appropriate adapter to connect a 9-pin or 25-pin D-Sub at a PC to the RJ-11 input. A straight-through RJ-11 to RJ-11 cable is used to connect from the RJ-11 output (J2) of the first board to the input of the next board in the daisy-chain. Set each board in the chain to be at a unique address (00 to 15) by setting the DIP switches (SW1) as follows:
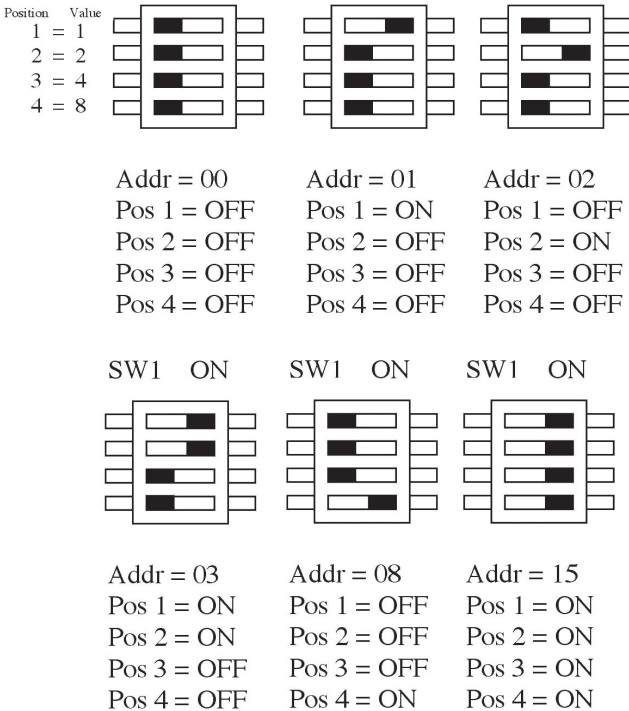
Position	Value
1	= 1
2	= 2
3	= 4
4	= 8

Addr = 00	Addr = 01	Addr = 02
Pos 1 = OFF	Pos 1 = ON	Pos 1 = OFF
Pos 2 = OFF	Pos 2 = OFF	Pos 2 = ON
Pos 3 = OFF	Pos 3 = OFF	Pos 3 = OFF
Pos 4 = OFF	Pos 4 = OFF	Pos 4 = OFF

SW1   ON   SW1   ON   SW1   ON

Addr = 03	Addr = 08	Addr = 15
Pos 1 = ON	Pos 1 = OFF	Pos 1 = ON
Pos 2 = ON	Pos 2 = OFF	Pos 2 = ON
Pos 3 = OFF	Pos 3 = OFF	Pos 3 = ON
Pos 4 = OFF	Pos 4 = ON	Pos 4 = ON

Fig. 1 - 5 Examples of the 16 Possible Address Configuration Settings
To communicate with each board in the daisy-chain, prefix commands and queries with the address. Addresses must be two digits (i.e. 00 to 15). These addresses are based on the principle of binary notation. Add up your address value by moving the appropriate switch to the "on" position.

Pump must be power-cycled or reset for address change to be recognized.

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Appendix F: Packing list & Optional Accessories

PACKING LIST

1) Main Unit

2) Universal input 100/250 VAC, 50/60 Hz, 18 watt power supply

3) Line Cord

4) RS-232Communications cable

5) I/O & E-Stop Cable

6) Power Connection Cable

7) User documentation

8) 6 oz. tube of grease

9) Allen wrench

KDS Milliliter OEM Module

Research Only

KDS

84 October Hill Rd
Holliston, MA 01746, USA

Phone: 508-429-6809
Fax: 508-893-0160
Web: www.kdscientific.com

Warranty

KDS warranties the pumps for a period of two years from the date of purchase.
At its option, KDS will repair or replace the unit if it is found to be defective as to
workmanship or materials. This warranty does not extend to any instrumentation
which has been (a) subjected to misuse, neglect, accident or abuse, (b) repaired or
altered by anyone other than KDS without KDS express and prior approval, (c) used
in violation of instructions furnished by KDS. This warranty extends only to the original
customer purchaser. IN NO EVENT SHALL KDS BE LIABLE FOR INCIDENTAL OR
CONSEQUENTIAL DAMAGES. Some states do not allow exclusion or limitation of
incidental or consequential damages so the above limitation or exclusion may not apply
to you. THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS
FOR A PARTICULAR USE, OR OF ANY OTHER NATURE. Some states do not allow
this limitation on an implied warranty, so the above limitation may not apply to you.
Without limiting the generality of the foregoing, KDS shall not be liable for any claims
of any kind whatsoever, as to the equipment delivered or for non-delivery of equipment,
and whether or not based on negligence. Warranty is void if the instrument is changed
in any way from its original factory design or if repairs are attempted without written
authorization by KDS. Warranty is void if parts not manufactured by KDS are used with
the instrument. If a defect arises within the warranty period, promptly contact
KDS, 84 October Hill Road, Building 7, Holliston, Massachusetts, USA 01746-1388
508-429-6809 (E-mail: info@kdscientific.com). Goods will not be accepted for return
unless an RMA (Returned Materials Authorization) number has been issued by our
customer service department. The customer is responsible for shipping charges. Please
allow a reasonable period of time for completion of repairs, replacement and return.
If the unit is replaced, the replacement unit is covered only for the remainder of the
original warranty period dating from the purchase of the original device. This warranty
gives you specific rights, and you may also have other rights, which vary from state
to state.

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Out of Warranty Service

Proceed exactly as for Warranty Service above. If our service department can assist you by phone or other correspondence, we will be glad to help at no charge.

Repair service will be billed on the basis of labor and materials. A complete statement of time spent and materials used will be supplied. Shipment to KDS should be prepaid. Your bill will include return shipment freight charges.

Disassembly by the user is prohibited. Service should only be carried out by experienced KDS technicians.

Repair Facilities and Parts

KDS stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample photo or drawing.

Caution Notice

The KDS pumps are intended for laboratory use only and can be used in research and development applications. These systems have been designed to meet the standards for electromagnetic compatibility (EMC) and safety intended for laboratory equipment applications.

This product should not be used in the presence of a flammable atmosphere such as an anesthetic mixture with air, oxygen, or nitrous oxide.

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Notes

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Notes