TRICONTINENT™
HANDLING LIQUIDS...PRECISELY

Z-Series Pump
Operator's Manual
200 µL, 1000 µL, 2000 µL and 5000 µL Models

8694-08 F

CONTENTS

INTRODUCTION

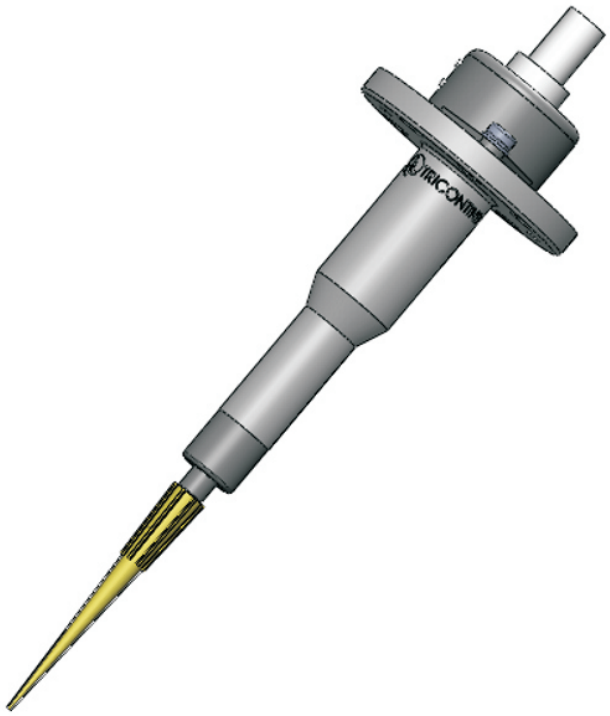
Z-SERIES INTRODUCTION

The 200 µL, 1000 µL, 2000 µL and 5000 µL Z-Series pumps are classified as electronic air-displacement pipettors. All volumes can be used in static applications or mounted on moving components within automated instrumentation.

TriContinent Z-Series pumps operate via a reliable, precise stepper motor mated to an inert PTFE piston encased within a precision borosilicate glass syringe. As the pump's piston moves inward, it creates a partial vacuum inside the tip, drawing fluid through the tip. As the piston moves outward, it creates a positive pressure, forcing fluid from the tip.

Motor travel is .001" per full step with a maximum 700 full steps available per full syringe stroke. For better resolution, the pump can be half-stepped or microstepped using the optional TriContinent M-Series Controller/Driver or any suitable 24VDC bipolar chopper driver.

All Z-Series pumps are especially suited for pipetting and aliquoting small volumes up to 5000 microliters. For best precision and accuracy, it is best to select a pump with a capacity slightly larger than the largest sample to be aspirated.



Z-Series Pump

SPECIFICATION

Downloadable specifications can be found on the TriContinent website at www.tricontinent.com.

Z-Series Pump Data Sheet	4 pages	MKT90024 pg01.pdf

OPERATING PRACTICES

Tip Adapter

The tip adapter to be ordered with each pump tightens to the Z-Series pump in a clock-wise direction. Care should be taken not to cross-thread when installing. Hand-tighten the tip adapter until it securely seats against the shoulder of the Z-Series pump.

Note: Manually removing the disposable tips can cause loosening of the tip adapter if a counter-clockwise rotation is applied. Care should be taken to use a clockwise rotation or straight pull when removing disposable tips.

Disposable Tip Loading

It is important that disposable tips be properly installed on the tip adapter. Loose fitting tips diminish accuracy whereas tight fitting tips result in difficult de-tipping or damage to the tip adapter.

Note: As with all air-displacement devices, never allow the Z-Series pump to be inverted such that fluid from the tip enters the pump body once fluid is aspirated into a disposable tip.

Manual Loading

Utilize similar techniques normally applied to handheld pipettes. Using the least amount of force to ensure secure fit will enable easier de-tipping.

Automated Loading

Similar general guidelines apply to automated systems as manual loading tips. There are some additional items to be considered:

· Ensure the tip loading station and arm movements are level. Inconsistencies will make it impossible to get adequate engagement in all rack positions.

· Make sure arm positioning for each tip loading position is centered in the tip to avoid adapter damage.

· Springs located under a rack of disposable tips will ensure that a consistent spring rate and insertion force is used on all tips.

· In utilizing TriContinent's tip adapter and recommended disposable tips, a gap between the tip adapter shoulder and top of disposable tips is maintained for all sizes of tips to allow use of a fixed stripper foot in automated testing stations. Refer to online pump specifications for specific gaps.

Tip Selection

The TriContinent tip adapter has been engineered to work optimally with the disposable tips TriContinent offers for each Z-Series pump. Use of other manufacturer's disposable tips may result in poor performance due to sub-optimal fit between the disposable tip and tip adapter. If other disposable tips are required for a specific application, it is necessary to confirm adequate fit and performance through individual system testing using TriContinent's tip adapter.

Tip adapter internal geometry is provided within all specification drawings if there is a need to create an alternate tip adapter for use with a different choice of tips. This critical pump/adapter interface should be used to ensure proper, leak free operation. Additional helpful hints regarding the creation of alternate tip adapters are:

· For best performance, the smallest volume disposable tips and pump that aspirates the largest required volume should be selected.

· Disposable tip geometry must be consistent from tip to tip. Accuracy and precision will be affected if these conditions are not met.

· To increase accuracy and reproducibility, both interior/exterior tip adapter and disposable tip surfaces should be smooth and hydrophobic to avoid excess residual volume in tips after each dispense.

Planning for Good Fluidic Movement

Using the Z-Series pump requires programming the syringe movements. Although final programming steps can only be determined through empirical testing, some good practices and general guidelines are listed below.

Initial Air-gap - A small initial air-gap (piston travel in aspirate direction after piston is stalled at end of stroke) should be taken before any fluid is aspirated into tip. This initial air-gap serves important functions of providing backlash compensation and air blowout.

Backlash Compensation - Using an initial air-gap eliminates hysteresis present when the piston is driven to end of stroke, ensuring the actual aspiration of fluid is done without lost movement. Normally 5 full steps will be adequate to ensure any backlash does not negatively impact accuracy.

Air-Blowout - An initial air-gap creates an air-blowout (air spring) to minimize or eliminate the potential for excess residual volumes collecting within the disposable tip that can cause poor precision and accuracy. Using an air-blowout also creates the necessary force to shear fluid droplets when dealing with higher viscosity fluids.

Note: Residual volumes can cause cross contamination if disposable tips are re-used.

In most cases, a 5 µL to 10 µL air-gap is all that is required, but optimum volumes should be determined through testing. Utilize the smallest volume that eliminates residual fluid within disposable tips after dispensing. Even if residual volumes are not seen, the initial air-gap of 5 µL should be used to offset hysteresis.

Tip Immersion Guidelines - The tip should be submersed into fluid approximately .08 in. to .15 in. (2 mm to 4 mm) below surface, not touching sides or bottom of vessel. Deeply immersed tips will retain fluid due to surface tension on the plastic disposable tip. Retained fluid can cause contamination and poor performance. Removing the tips from fluid slowly and consistently also helps minimize fluid retention. Touching tips to the sides or bottom of the well can restrict proper aspiration.

Aspiration

Speed - Slower aspiration speeds typically perform better than fast speeds. Slow and fast are relative parameters subject to fluid types, tip sizes, throughput requirements, etc. As with other settings, empirical testing will confirm what works best in a system.

Adding Pause to Aspiration - With all pipettors, if the tip is removed from the fluid immediately following the aspiration, vacuum in the tip will continue to aspirate a very small volume of fluid, affecting precision and accuracy. Fluidic performance is then dependent upon fluid viscosity, aspiration speed, tip orifice size, pump capacity, etc. A delay of 500 ms to 1000 ms before withdrawing a tip from fluid is usually sufficient, but empirical testing will help set guidelines.

Adding Overdraw to Aspiration - As with any disposable tip product, residual volume left in the tip can result in low volume dispense. This may be adjusted by adding extra volume (equal to volume shortage) to an aspiration.

Traveler Air-Gap - After withdrawing a tip completely from fluid, a small air-gap should be taken that elevates the sample completely inside the tip. An air-gap will be dependent upon tip size. Assuming that a tip was installed properly and no leaks were present, the traveler air-gap will ensure no fluid loss occurs during pump movement to the dispensing station caused by vibrations, abrupt stops, etc.

Dispensing

Depth of Tip/ "Touching Off" - To prevent a drop of fluid from collecting at the end of a disposable tip following a dispense, end each dispense with the tip positioned very close to fluid level. Doing this will attract small drops of fluid from the disposable tip into the dispense cup. Due to system requirements, positioning low is not always possible. If this is not possible then keep the tip as low as possible to minimize errant spray that may occur from a tip, especially if dispensing at faster speeds. Consistent depths will greatly improve accuracy and precision values. "Touching off" refers to contacting the end of a disposable tip with the inside of the dispense cup which will attract hanging drops of fluid into the cup.

Dispense Speed - Similar to aspiration, fast and slow are relative terms but generally faster speeds will provide the best results. This allows for "fluid shear" and the air blowout established with an initial air-gap to work. Side spray or splashing are indicators of too high a dispense speed.

MAINTENANCE

Maintenance and Cleaning

The Z-Series pump utilizes a sealed design that requires no routine maintenance. Cleaning can be accomplished by removing the tip adapter and wiping the body of the pump with a soft cloth, slightly dampened with water and a 5% bleach solution.
Note: Should fluid accidentally be aspirated into a pump, internal pump components are constructed of PTFE, Borosilicate glass, Acetal and trace amounts of silicone lubricant. The Z-Series pumps are not designed for autoclaving.

Accessories and Replacements

To view or download Accessories and/or Replacement items for the Z-Series, please visit our website http://www.tricontinent.com/products/z-series-syringe-pump

Ordering Information/Customer Service

Assistance with the operation or repair of the Z-Series is available by contacting:
TriContinent, 12555 Loma Rica Drive, Grass Valley, CA 95945.
From with the United States, telephone (8000) WE-PIPET (800-937-4738).
From outside of the United States, telephone (530) 273-8888.
FAX (530) 273-2586

Warranty and Returns

TriContinent is an ISO 13485 Registered company that operates under a stringent quality assurance program. We design and manufacture our products to be the most reliable products available. We stand behind the Z-Series pumps with an industry-leading 2-year warranty on material and workmanship, excluding misuse and abuse. During the warranty period, should a Z-Series pump fail, just call us with an explanation of malfunction and TriContinent will issue a Return Material Authorization (RMA) for repair or replacement free of charge.

Please refer to the TriContinent website www.tricontinent.com for detailed warranty and return information.

Software/Quick Start Guide

Instructions to get the pump with M-Series controller electronics operating quickly:

1. Verify Jumpers are in the default positions (figure A), and the Address Switch is set to the “0” position (figure B).

2. Connect Z-Pump motor connector to the Controller (figure B).

3. Connect 24 VDC, GND, RS485A, RS485B to the Controller (figure B).

4. If using the RS485/USB or RS485/RS232 converter (figure C):
   a. Connect the converter to the PC communication port.
   b. Connect power (red) and ground (black) wires to a 24 V power supply.
   c. Connect the interface cable to the Controller.
   d. Install USB Driver CP210X from the TriContinent website on the downloads tab of the Z-Series page.

5. Run TCS Commander (or other terminal emulator program) to communicate to the Controller*.

6. Set the proper COM port and com settings (9600-8-N-1).

7. Turn on the power supply.

8. Send the following string commands (case sensitive):

/1z1600A0A10z0R	*These commands initialize the pump to home*
/1V1000a1000R	*This sets velocity to 1000 half steps/second and aspirate to 1000 half steps*
/1A0R	*This will dispense 1000 half steps*

For reference, pump volume resolutions per half step are as follows:

200 uL Z-pump:	.1905 uL
1000 uL Z-pump:	.7635 uL
2000 uL Z-pump:	1.904 uL
5000 uL Z-pump:	3.808 uL

CAUTION: ALWAYS TURN OFF THE POWER BEFORE MAKING CONNECTIONS TO THE PUMP!

*Contact TriContinent for TCS Commander download instructions.

Connection Diagrams

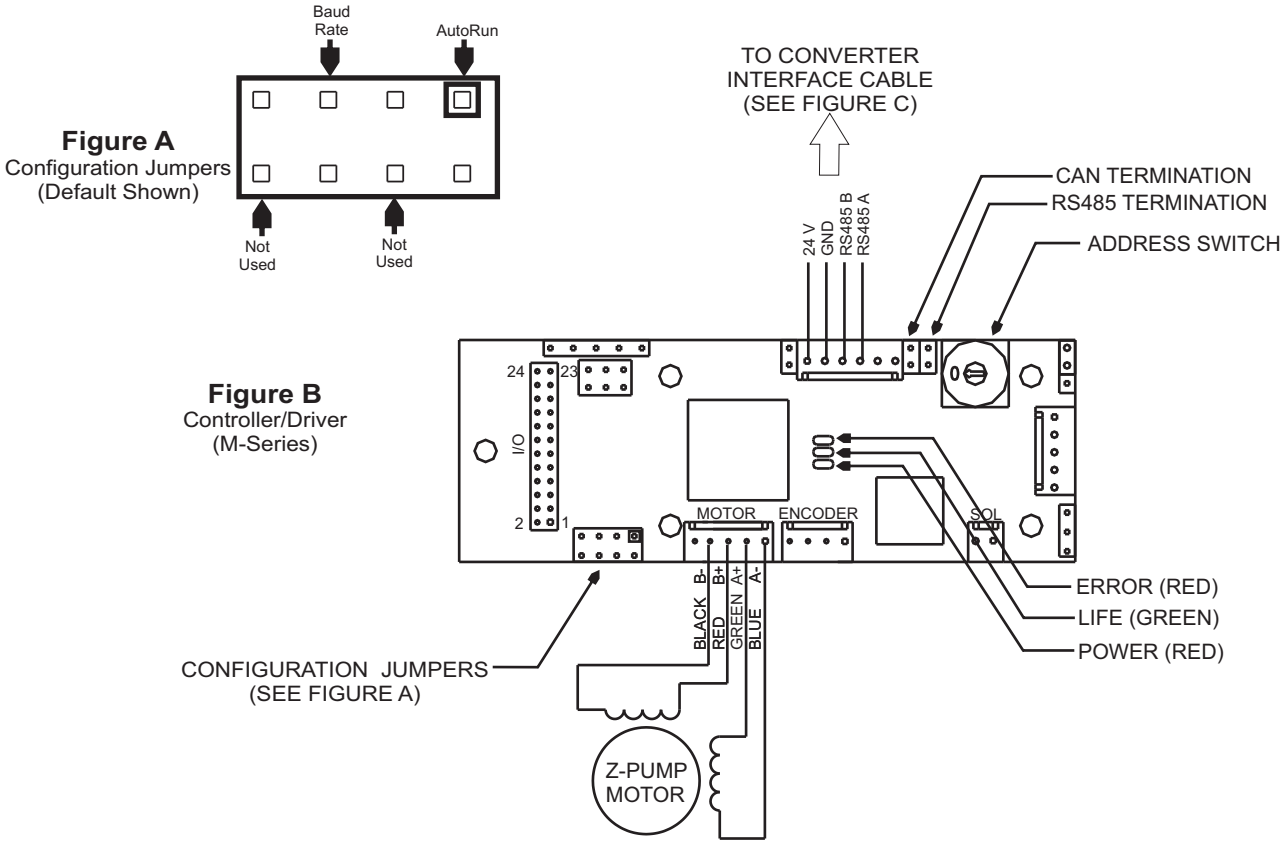


Figure A
Configuration Jumpers
(Default Shown)

Figure B
Controller/Driver
(M-Series)

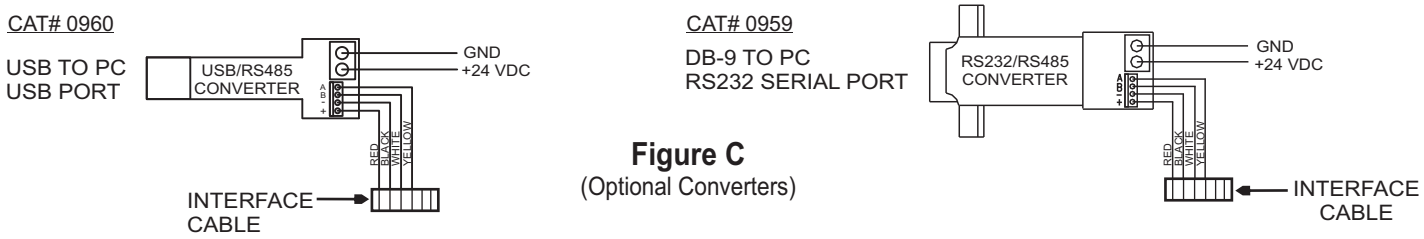


Figure C
(Optional Converters)

Configuration Jumpers (location shown above)

Function	Location	Action	Default
AutoRun	JP1	Installed = AutoRun EEPROM String	Not Installed
Not Used	JP2	Reserved	Not Installed
Baud Rate	JP3	Installed = 38.4 K, Not Installed = 9600	Not Installed
Not Used	JP4	Reserved	Not Installed

Address Switch

The software Pump Address is always one value greater than the Switch Address setting.
For example: Switch Address is 0, Pump Address is 1.

Communications Protocol and Command Set
M-Series Motion Controller

(for complete programming instructions, refer to TCS M-Seris software manual)

RS232 Communications Settings

Baud Rate = 9600 or 38400, jumper selectable, default = 9600
Data bits = 8
Parity = None
Flow Control = None

DT Protocol

Command Block (from host) ("ASCII Character")
- Start Character (" / " or 2FH)
- H = Hexidecimal valve
- Pump Address (switch setting + 1) (1-9 = "1-9" or 31H-39H) (A = ":" or 3AH)
  - (B = ";" or 3BH) (C = "<" or 3CH) (D = "=" or 3DH)
  - (E = ">" or 3EH) (F = "?" or 3FH)
- Data Block (Command(s))
- Carriage Return ([CR(enter)] "?" or 0DH)

Answer Block (from pump) ("ASCII Character")
- Start Character (" / " or 2FH)
- Master Address (" 0 " or 30H)
- Status Character:
  - No Error
    - Not Busy (" ` " or 60H)
    - Busy (" @ " or 40H)
  - Initialization Error
    - Not Busy (" a " or 61H)
    - Busy (" A " or 41H)
  - Invalid Command
    - Not Busy (" b " or 62H)
    - Busy (" B " or 41H)
  - Invalid Operand
    - Not Busy (" c " or 63H)
    - Busy (" C " or 43H)
  - Device Not Initialized
    - Not Busy (" g " or 67H)
    - Busy (" G " or 47H)
  - Command OverFlow
    - Not Busy (" o " or 6FH)
    - Busy (" O " or 4FH)
  - Plunger overload (if optional encoder is installed)
    - Not Busy (" i " or 69H)
    - Busy (" I " or 49H)
  - CAN Bus failure (if optional CAN Bus installed)
    - Not Busy (" h " or 68H)
    - Busy (" H " or 48H)
- ETX (" ? " or 03H)
- Carriage Return ([CR(enter)] "?" or 0DH)
- Line Feed (" ? " or 0AH)

OEM Protocol

Command Block_ (from host) ("ASCII Character")
- Start Character (" ^B " or 02H)
- Pump Address (switch setting + 1) (1-9 = "1-9" or 31H-39H) (A = ":" or 3AH)
  (B = ";" or 3BH) (C = "<" or 3CH) (D = "=" or 3DH)
  (E = ">" or 3EH) (F = "?" or 3FH)
- Sequence number (0-7 = “0-7” or 30H-37H)
- Data Block (Command(s))
- ETX (" ^C "or 03H)
- CheckSum 8 bit XOR

Answer Block (from pump) ("ASCII Character")
- Start Character (" ^B " or 02H)
- Master Address (" 0 " or 30H)
- Status Character
  - Same at DT protocol
- Data Block (length n)
- ETX (" ^C “ or 03H)
- CheckSum 8 bit XOR

Command Set

- All commands, except Report commands, will only be executed if followed by a [R] (execute) command. For example: the command [A1000R] moves the motor 1000 steps from the Home (0) position. If an [R] is not included, the command will be stored in a command buffer, which will be executed on the next [R] command.
- When a command is sent, the controller answers immediately. If an invalid command is sent, the controller reports an error immediately. If there is an invalid operand in a command containing a Movement Command, the controller executes the command up to the invalid operand and will stop.

Control Commands

R	Execute the command string or a previously sent command string. Will also resume command execution if halted with the [H] command.
X	Repeat the last command string.
H	Halt current command string. To resume execution, a [R] command must be sent.
T	Terminate current command.
M (5-30000)	Delay for specified milliseconds.
G (0-3000)	Repeat the command sequence the specified number of times. A value of 0 causes an infinite loop that must be terminated with a [T] command. Loops can be nested up to 10 levels using the [g] command.
g	Mark the start of a repeat loop.
s (0-14)	Store string (0-14) into EEPROM. Each string has a max. of 100 characters.
e (0-14)	Executes stored string (0-14).

Set Commands

V (5-6000)	Set top speed in half steps per second.	Default = 1400
v (0-1000)	Set start speed in half steps per second.	Default = 0
c (50-2700)	Set stop speed in half steps per second.	Default = 900
S (0-40)	Set top speed using speed codes.	Default = 11
L (1-20)	Set acceleration factor (accel="L"*2.5 kHz/sec.)	Default = 14

m (0-100) Sets the Motor Run current in a % of maximum (500mA peak). For example, m50R will set the run current to 50% of its maximum (250mA). Similar to the [u2] command, only this setting will be lost when the power is cycled, or it is volatile. Whereas the [u2] is non-volatile.

h (0-100) Sets the Motor Hold current in a % of maximum (500mA peak). For example, h10R will set the hold current to 10% of its maximum (50mA). Similar to the [u1] command, only this setting will be lost when the power is cycled, or it is volatile. Whereas the [u1] is non-volatile.

N (0-1) N = 0, all motor positions are in half steps; N=1, positions are in micro- steps, 8 micro-steps per half-step. Default N = 0 or half-step mode.

K (0-31) Sets number of backlash steps. Default K = 0.

k (0-80) Syringe dead volume. After initialization, the plunger will move this many half-steps to minimize the dead volume. Default k = 0.

u (n_X) Will load pump configuration and calibration info into the internal EEPROM. Note, these parameters are only read on power up. Thus they will only take effect when the power is cycled. Note this command, unlike the Set commands, does not require an [R] to execute.

1.	(1_XXX)	Motor holding current, 0 –100% (100% = 500mA peak)
2.	(2_XXX)	Motor running current, 0 –100%
3.	(3_XXX)	Max home steps in 100 half-step increments (1-250)
4.	(4_XXX)	Max home speed in 100 half-steps/sec increments (1-100)
5.	(5_XXX)	Homing back-steps in 100 half-steps increments(1-250)
6.	(6_XXX)	Default max V in 100 half-steps/sec increments (1-100)
7.	(7_XXX)	Max plunger stroke in 100 half-step increments (1–250)
8.	(8_XXX)	Home position at top, X= 1, at bottom X= 0
9.	(9_XXX)	Number of user settable outputs(0–4)
10.	(10_X)	No homing opto, X=0. Homing opto installed, X=1
11.	(11_X)	Stall guard level for no-opto homing (1-7)
12.	(12_X)	Solenoid daughter installed, X=1, not installed X=0
13.	(13_X)	CAN Bus option installed, X=1, not installed X=0
14.	(14_X)	Number of backlash steps
15.	(15_X)	Motor winding for LT, X=1, for Z-Pump X=0
16.	(16_X)	Home sensor polarity low = blocked, X=1, low = unblocked X=0
17.	(17_X)	Self test mode string

Initialization Commands

z (0-1600) Sets current position and initializes the plunger to the value defined by the operand. (0-12,800 in micro-step mode)

Movement Commands

Note: The limits below assume 1600 half-steps per stroke. The limits for micro-step mode [N =1] will always be 8X that of the half-step [N=0] mode.

A (0-1600)	Move motor to absolute position (0-12,800 in micro-step mode).
a (0-1600)	Same as [A], but will give a non-busy status code.
P (0-1600)	Move motor relative number of steps in the aspirate direction (0-12,800 in micro-step mode).
p (0-1600)	Same as [P], but will give a non-busy status code.
D (0-1600)	Move motor relative number of steps in the dispense direction (0-12,800 in micro-step mode).
d (0-1600)	Same as [D], but will give a non-busy status code.

Report Commands

Q	Returns the status character. (refer to DT Protocol, Answer Block)
? or ?0	Returns current absolute position.
?1	Returns start speed.
?2	Returns top speed.
?3	Returns stop speed.
?7	Reports max homing steps.
?8	Reports homing speed.
?9	Reports homing back steps.
?10	Reports syringe dead volume.
?11	Reports backlash steps.
?24	Reports syringe dead volume.
?25	Reports motor hold current.
?26	Reports motor run current.
? (30-44)	Reports user program strings loaded into external or user EEPROM. ?30 reports string 0, ?31 string 1, and so on.
&	Returns the firmware revision and date.
F	Reports command buffer status. If the buffer is empty, the pump returns status code 0. If a command string is sent to the pump with the [R] command, the buffer status will return 1.