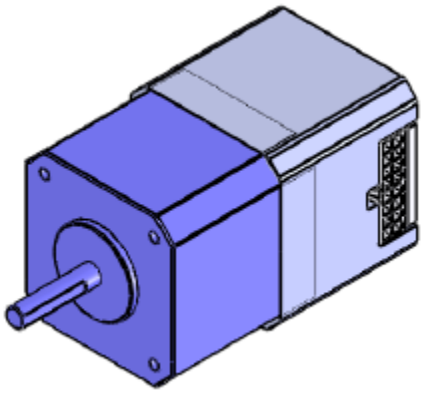
Accuriss™ 42 Series

Integrated Motor, Drive & Control System

USA42

USER'S MANUAL



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USAutomation© Accuriss™ Series User's Guide

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Revision Notes

Rev	*Description*	*Date*
1.0	Version 1 released	5-7-12
1.1	Corrected output pin labeling	7-25-12

Using This Manual

The Accuriss Series is a unique motor, drive and control all in one package. The USA42 is the 42mm version in this series and it is designed to be interactively controlled with a computer or other industrial controller or may be preprogrammed to run complex subroutines from programs stored in non-volatile RAM.

This manual provides the basic information necessary to unpack, set up, and configure the USA42. If additional information is required beyond what is presented here, please refer to the Support section of our website or contact USAutomation Applications Engineering.

Product Returns

All returns for warranty or out-of-warranty repairs must first receive an RMA (Return Material Authorization) number. Please contact USAutomation Customer Service Department with information about the return and an RMA number will be issued if warranted.

Products returned to the factory will be examined and tested for failure mode and cause. USAutomation Customer Service will contact the customer with the repair cost if the required repair is out of warranty.

Unpacking

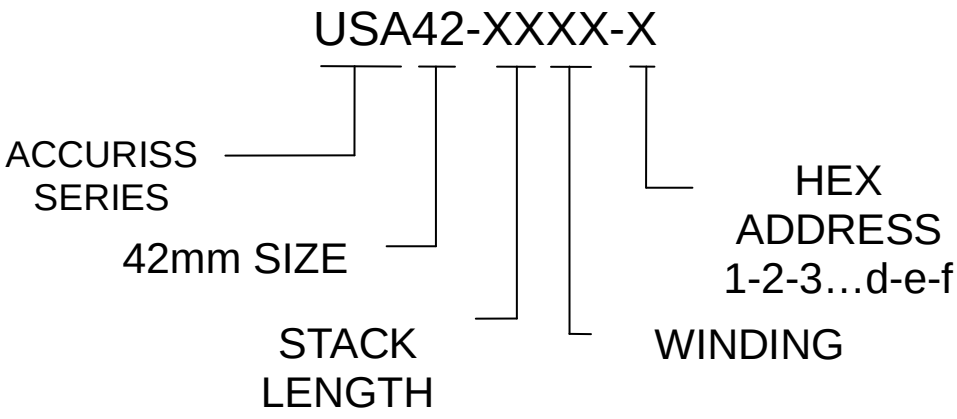
Carefully remove the USA42 from its shipping box and inspect the unit for any evidence of shipping damage. Report any damage immediately to USAutomation. Please save the shipping box for damage inspection or its use in returning product if necessary.

Please observe the following guidelines for handling and mounting of your USA42:

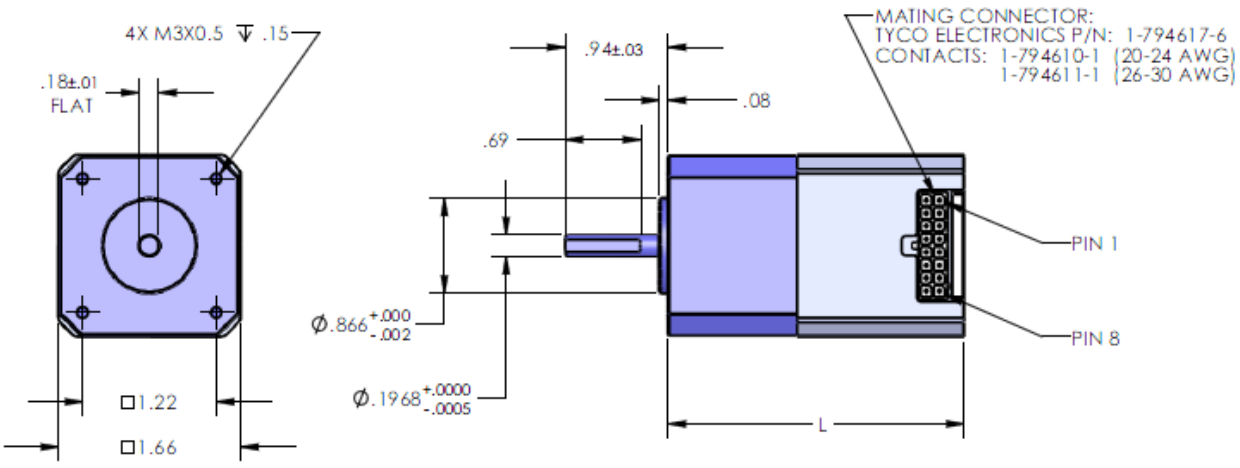
- Do not drop the unit on any hard surface or subject it to any impact loads. Dropping the unit or other impact loads may result in bearing damage or misalignment.
- Do not drill holes into the motor. Drilling holes into the unit can generate particles and machining forces that may affect the operation of the unit. USAutomation can supply the USA42 with modifications to your drawing. Please contact the factory for a quote.
- Do not expose the USA42 to mist, spray or submersion in liquids.
- Do not disassemble the USA42. Unauthorized adjustments may alter the specifications and void the product warranty.

Part Number Configuration

The part number for the Microstage USA42 is determined as follows:



Dimensions and Connection Pinout



Part #	"L" Dimension
USA42-2106	2.46"
USA42-2206	2.70"
USA42-2306	3.01"
USA42-2406	3.48"

Pin #	Function	Color Code
1	Power Ground (-V)	Black
2	Output 2	White/Brown
3	Direction (DIR) Input	White/Yellow
4	Opto isolated STEP & DIR +5VDC Power Input	White/Red
5	Input 2	Violet
6	Internal Power for Opto-sensors	Orange
7	Input 3	Gray
8	RS485 A	Yellow
9	+12 to +40 VDC (+V)	Red
10	Output 1	White/Black
11	STEP Input	White/Orange
12	Signal Ground	Blue
13	Input 1	Brown
14	Input 4	Green
15	RS485 B	White
16	N/C	

Mounting the USA42

Threaded mounting holes are located on the front of the Accuriss 42. There are four M3 x .5 threaded holes. See Dimensions section for exact locations.

Mounting a Load to the USA42

The Accuriss 42 has 0.197 in. diameter shaft for mounting the load (see dimensions page). Care should be used in isolating the motor bearing from thrust and axial loads. It is not advisable to couple loads to the Accuriss shaft with a solid coupling as that may impose radial loads on the motor bearings which will shorten the life of the motor. A flexible coupling, such as those made by Helical (www.heli-cal.com), should be used.

Accuriss Communications

Communications to the Accuriss is possible with any RS485 compatible communication device and any commonly available terminal program. Most computers have either an RS232 or USB port (sometimes both). USAutomation offers software drivers for both on our web site or in our Starter Kit. Commercially available USB to RS485 and RS232 to RS485 converters will allow communications with the Accuriss from most computers using only a compatible terminal program.

Also available as a software tool is the Accuriss Terminal software, which is available as a no charge download from our web site, or it is included in our Starter Kit.

Communication Specifications

Electrical Characteristics	In conformance with EIA-485 Use a twisted pair cable (TIA/EIA-568B CAT5e or higher is recommended) and keep the total wiring distance including extension to 50 m (164 ft.) or less.
Baud rate	Selectable from 9420 bps, 19200 bps, 38400 bps (9420 is default)
Physical layer	Asynchronous mode (8 bits, 1 stop bit, no parity)

Starter Kit

The Accuriss Starter Kit is recommended for any first time user of the Accuriss 42. This kit contains a USB to RS485 converter, an I/O break out board, two input switches, and a CD that includes catalogs, manuals, and software.

Executing Commands

In order to execute a command or a series of commands, the following syntax should be used:
[/][Device Address][Command][Value]…{[Command]{[Value]}[R][<CR>]
Where,
/ = the start character. Data following the "/" character will be loaded into the communication buffer.
Device Address = the device address. (Factory Preset)
Command = the command to be executed.
Value = a valid value for the command to be executed (position value, speed, etc).
Note: Up to fourteen (14) Commands and Values can be in a single command string.
R = Execute the command(s) in the communication buffer already received .
<CR> = Carriage Return+Line Feed (CR+LF) and indicates that the command string is complete.
Example 1:
/1A1000R<CR>

"/" is the start of character. Lets Accuriss know that a command string is coming.
"1" is the device address. (This is preset at the factory)
"A" Instructs motor to move to an absolute position.
"1000" sets the absolute position to +1000 steps from the zero position.
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" tells Accuriss that the command string is complete and causes the command(s) to be executed since the R was included in the command string.

Example 2:
Command string 1: /1A2000A0<CR>
Command string 2: /1R<CR>
For command string 1:

"/" is the start of character. Lets Accuriss know that a command string is coming.
"1" is the device address. (This is preset at the factory)
The first "A" instructs motor to move to an absolute position.
"2000" sets the absolute position to +2000 steps relative to the zero position.
The second "A" instructs motor to move to an absolute position.
"0" sets the absolute position to the zero position.
"<CR>" tells Accuriss that the command string is complete. Nothing is executed at this time because the R command was not included in the command string.

For command string 2:

"/" is the start of character. Lets Accuriss know that a command string is coming.
"1" is the device address. (This is preset at the factory)
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" tells Accuriss that the command string is complete and causes both of absolute position the commands to be executed since an R command is included in the command string.

Command Set

Command Set Table

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n	System Control	Set Accuriss mode	36
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b	Communication	Set baud rate	39
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M	Program Control	Wait for X milliseconds	41
ar	System Control	Reset the Accuriss processor	42
aP	System Control	Controller Response delay	43
d	I/O	Switch debounce delay	44
K	Motion	Backlash compensation factor	45
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J	I/O	Turn Accuriss outputs on or off	48
?aa	System Control	Read back analog to digital converter values	49
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?at	System Control	Read back analog to digital threshold values	51
ao	System Control	Position potentiometer offset value	52
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Command: **A** **Absolute move in positive direction**

Type: Motion Command

Syntax: An

Range: n = 0 to 2,147,483,648

Description: Move motor to a positive absolute position relative to the 0 (zero) position. Once at a given absolute position, executing the same command will not move the motor again since the absolute position has already been reached.

Example: /1**A**1000R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"A1000"	***Instructs motor to move to an absolute position of positive 1000 steps from the 0 (zero) position***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **P** **Index move in positive direction**

Type: Motion Command

Syntax: **P**n

Range: 0 to 2,147,483,648 steps

Description: Move motor in a **positive** direction relative to the current position. The distance to be moved is n steps. A distance n of zero will cause the motor to continuously in the positive direction relative to the current position. The speed of the motion will be the speed last set by the "V" (velocity) command. (Note: An endless move can be terminated by the T command)

Example: /1**P**1000R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"P1000" ***Instructs motor to move to a position 1000 steps in the positive direction from its current position***
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **D** **Index move in negative direction**

Type: Motion Command

Syntax: **D**n

Range: n = 0 to 2,147,483,648 steps

Description: Move motor in a negative direction relative to the current position. The distance to be moved is n steps. A distance n of zero will cause the motor to continuously in the negative direction relative to the current position. The speed of the motion will be the speed last set by the "V" (velocity) command. (Note: An endless move can be terminated by the T command)

Example: /1**D**1000R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"D1000" ***Instructs motor to move to a position 1000 steps in the negative direction from its current position***
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **Z** **Move to home sensor**

Type: Motion Command

Syntax: **Z**n

Range: n = 0 to 2,147,483,648

Initial Value: 400

Description: The “Z” command is used to set the maximum number of steps allowed for the motor to move to a known position by seeking a home sensor. When issued, the motor will turn toward the 0 position until the home opto-sensor is interrupted. If the home sensor is already interrupted, the motor will back off of the sensor in the opposite direction and then come back in until the home sensor is re-interrupted. The motor position counter is set to zero. The homing motion is done at the current speed “V”. The maximum number of steps allowed to go towards home without encountering the sensor is defined by the Z command operand (n) + 400 steps. The maximum number of steps away from home (while sensor is interrupted) is 10000 steps.

To set up the home flags:

First ensure that a positive move e.g. /1P100R moves away from home and the home flag. If motor does not go away from home, flip the connections to only one of the windings of the stepper.

The Default condition expects the output of the Home flag to be low when away from the home sensor (as is the case in an opto). If the Home flag is high when away from the home sensor (as in the case of a “Normally Open” switch) then issue the command /1f1R to reverse the polarity that is expected of the home flag.

Issue the command e.g. /1Z100000R or /1f1Z100000R as necessary.

Homing should be done at a slow speed, especially if homing to a narrow Index pulse on an encoder, which may be missed at high speeds.

Opto and flag should be set up to be unambiguous, i.e. when motor is all the way at one end of travel, flag should cut the opto, when at other end of travel flag should not cut opto. There should only be one black to white transition possible in the whole range of travel. Home can be done to an opto (N1 Mode) or Index Pulse (N2 Mode). See Appendix A

Example: /1**Z**1000R<CR>

“/” Is the start character. Lets Accuriss know that a command string will follow.

“1” Is the device address, (this is preset at the factory).
“Z1000” Instructs motor to move toward a zero position a maximum of 1000 steps
“R” Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>” Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **z** **Set current position counter**

Type: Motion Command

Syntax: **z**n

Range: n = 0 to 2,147,483,648 steps

Description: Set the position counter to a new value without moving.

Example: /1**z**1000R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"z1000"	***Sets the current position to positive 1000 steps***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **f** **Home Flag Input Level**

Type: I/O Command

Syntax: **f**n

Range: n= 0: Opto signal is TTL high when at/on the opto (Normally open)

1: Opto signal is TTL high when away from the opto (Normally closed)

Initial Value: 0 (normally open)

Description: This command sets the home flag polarity. The default value is 0 (zero).

Example: /1**f**1R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"f1"	***Sets the home flag position sensor to Normally closed***
"R"	Instructs Accuriss to run the command that it has just receive
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **F** **Set Positive Direction**

Type: System Control Command

Syntax: **F**n

Range: n = 0: Motor rotation away from home is the positive direction

1: Motor rotation toward home is the positive direction

Initial Value: 0

Description: Change direction of rotation considered positive. (Note: this command should only be used once after the power is on.)

Example: /1**F**1R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"F1"	***Sets the direction to rotate toward home to positive***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **V** **Running Velocity**

Type: Motion Variable Command

Syntax: **V**n

Range: n = 1 to 16,777,216 microsteps per second

Initial Value: 305,064 microsteps per second

Description: In position mode, this command is used to set the maximum (or slew) speed of the motor. Units are microsteps per second. The microstep step angle should be taken into account when issuing this command, the default is 1/8th step per full step of the motor.

Note: If the encoder ratio command "aE" is set, the units of velocity change to encoder counts per second

Example: /1**V**1420R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"V1420" ***Sets maximum velocity to 1 revolution per second. (For a 200 step/rev motor and a microstep resolution of 1/8th)***
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **L** **Acceleration Rate**

Type: Motion Variable Command

Syntax: **L**n

Range: n = 0 to 5000 microsteps/sec^2

Initial Value: 1000 microsteps/sec^2

Description: Sets the acceleration to a value

Note: The acceleration rate does not scale with the encoder ratio “aE”

Example: /1**L**1000R<CR>

“/”	Is the start character. Lets Accuriss know that a command string will follow.
“1”	Is the device address, (this is preset at the factory).
“L1000”	***Sets acceleration to 1000 microsteps/sec^2***
“R”	Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>”	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **B** **Jog Distance**

Type: Motion Command

Syntax: **B**n

Range: n = 0 to 65000 microsteps

Description: Sets the distance for jog moves when in n1 Mode.

Example: /1**B**1000R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"B1000"	***Sets jog distance to 1000 microsteps***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **g** **Begin Loop Block**

Type: Program Control Command

Syntax: **g**

Range: N/A

Description: This command signifies the beginning of a loop

Example: /1**g**P1000M1000D1000M500G10R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"g"	***Informs Accuriss a loop is beginning***
"P1000"	Move 1000 steps in positive direction
"M1000"	Wait 1000 milliseconds
"D1000"	Move 1000 steps in negative direction
"M1000"	Wait 1000 milliseconds
"G10"	Repeat all commands between the "G10" command and the "g" command loop 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **G** **End Loop Block**

Type: Program Control Command

Syntax: **G**n

Range: n = 0 to 30000

Description: This command signifies the end of a loop and defines the number of loops to be performed. Loops can be nested up to four levels. A value of “0” (zero) causes an infinite loop. (A “T” command will terminate an infinite loop) If no value is given, the Accuriss will use “0” (zero) as the assumed number.

Example: /1gP1000M1000D1000M500**G**10R<CR>

“/”	Is the start character. Lets Accuriss know that a command string will follow.
“1”	Is the device address, (this is preset at the factory).
“g”	Informs Accuriss a loop is beginning
“P1000”	Move 1000 steps in positive direction
“M1000”	Wait 1000 milliseconds
“D1000”	Move 1000 steps in negative direction
“M1000”	Wait 1000 milliseconds
“G10”	***Repeat all commands between the “G10” command and the “g” command loop 10 times***
“R”	Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>”	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **H** **Halt Command String**

Type: Program Control Command

Syntax: **H**n

Range: n = See below

Description: Halt the current command string and wait for a specific switch input condition to become true. If an edge is detect is desired, a look for Low and a look for High can be placed adjacent to each other, i.e. H01H11, to define a rising edge detect. A halted operation can also be resumed by entering "/1R". An "H" command with no following number will wait for switch # 2 to close (low).

01	Wait for low input 1 (switch # 1)
11	Wait for high input 1 (switch # 1)
02	Wait for low input 2 (switch # 2)
12	Wait for high input 2 (switch # 2)
03	Wait for low input 3 (switch # 3)
13	Wait for high input 3 (switch # 3)
04	Wait for low input 4 (switch # 4)
14	Wait for high input 4 (switch # 4)

Example: /1g**H**01P1000G10R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"g"	Informs Accuriss a loop is beginning
"H01"	***Wait for switch "1" to go low then execute move***
"P1000"	Move 1000 steps in positive direction
"G10"	Loop 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **S** **Skip Command**

Type: Program Control Command

Syntax: **S**n

Range: n = See below

Description: Skip next command depending on status of a specific switch input condition. Program branching to a complex subroutine can be implemented by making the next instruction a stored string execution. Loops can be escaped by branching to a stored string with no commands.

01	Skip next instruction if input 1 (switch # 1) is low
11	Skip next instruction if input 1 (switch # 1) is high
02	Skip next instruction if input 2 (switch # 2) is low
12	Skip next instruction if input 2 (switch # 2) is high
03	Skip next instruction if input 3 (switch # 3) is low
13	Skip next instruction if input 3 (switch # 3) is high
04	Skip next instruction if input 4 (switch # 4) is low
14	Skip next instruction if input 4 (switch # 4) is high

Example: /1g**S**02P1000G10R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"g"	Informs Accuriss a loop is beginning
"S02"	***Skip loop if switch # 2 is low***
"P1000"	Move 1000 steps in positive direction
"G10"	Loop 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **s** **Store Command String**

Type: Program Control Command

Syntax: **s**n

Range: n = 0 to 15

Description: Stores the command string that follows to program storage locations 0 to 15. Program 0 is executed on start up. Up to fourteen (14) commands per string maximum are allowed.

Note: It takes approximately 1 second for the command string to be written to the EEPROM.

Example: /1**s**1gP1000M1000G10R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"s1"	***Tells Accuriss to store the command string that follows to storage location # 1***
"g"	Informs Accuriss a loop is beginning
"P1000"	Move 1000 steps in positive direction
"M1000"	Wait 1000 msec
"G10"	Loop 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **e** **Execute Stored Command String**

Type: Program Control Command

Syntax: **e**n

Range: n = 0 to 15

Description: Executes the command string stored in program locations 0 to 15. Program 0 is executed on start up. Up to fourteen (14) commands per string maximum are allowed.

Example: /1**e**1R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"e1"	***Instructs Accuriss to execute the command string in storage location # 1***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **R** **Run Command String**

Type: Program Control Command

Syntax: **R**

Range: None

Description: Run the command string that is currently in the execution buffer

Example: /1**R**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"R"	***Instructs Accuriss to run the command that is currently in the buffer***
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **X** **Repeat Command String**

Type: Program Control Command

Syntax: **X**

Range: None

Description: Repeat running the command string that is currently in the execution buffer

Example: /1**X**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"X"	***Repeats all of previous string still in buffer***
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **m** **Run Current**

Type: System Control Command

Syntax: **m**n

Range: n = 0 to100 % of rated current

Initial Value: 25

Description: Sets maximum current applied to the motor while the unit is moving

Example: /1**m**15R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"m15"	***Informs Accuriss to set run current at 15% of maximum .7 amps (0 .05 amps)***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **h** **Hold Current**

Type: System Control Command

Syntax: **h**n

Range: n = 0 to 50 % or rated current

Initial Value: 10

Description: Sets maximum holding current while unit is not moving. This value should be set as low as possible to prevent the motor from overheating.

Example: /1**h**50R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"h50"	***Informs Accuriss to set hold current at 50% of maximum .7 amps (0.35 amps)***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **p** **Ping Command**

Type: System Control

Syntax: **p**n

Range: n = 0 to 650000

Initial Value: 0

Description: This command sends the numeric string that immediately follows it back to the host. (Note: This command may “tie” up the RS485 connection for an extended period of time).

Example: /1gA1000**p**345A0G0R<CR>

“/”	Is the start character. Lets Accuriss know that a command string will follow.
“1”	Is the device address, (this is preset at the factory).
“g”	Informs Accuriss a loop is beginning
“A1000”	Instructs the motor to move to move to an absolute position of 1000
“p345”	***Instructs Accuriss to send the numeric string “345” to the host each time the command string is looped (repeated)***
“A0”	Instructs the motor to move to move to an absolute position of 0
“G0”	Repeat all of the commands between the “G0” command and the “g” command indefinitely
“R”	Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>”	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **j** **Microstep Resolution**

Type: System Control Command

Syntax: **j**n

Range: n = 1, 2, 4, 8, 16, 32, 64, 128 or 256 microsteps per full step

Initial Value: 256 microsteps per full step

Description: Sets the number of microsteps per full motor step
(i.e. 200 step/rev * 256 microsteps = 51200 steps per rev)

Example: /1**j**256R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"j256"	***Informs Accuriss to set 256 microsteps per full step***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **N** **Potentiometer Position Feedback Mode**

Type: System Control Command

Syntax: **N**n

Range: n = 1: Encoder with No Index. Home to opto-sensor

2: Encoder with Index. Home to Index

3: Use potentiometer 1 as an encoder. (See appendix F)

4: First Home to opto-sensor and then home to Index

Initial Value: 1: Encoder with No Index. Home to opto-sensor

Description: Sets the potentiometer position feedback input mode.

Example: /1**N**2R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"N2"	***Informs Accuriss to set the encoder mode to use the Index channel***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **n** **Set Modes**

Type: System Control Command

Syntax: **n**n

Range: n = 0 to 128000. See table below

Initial Value: 0

Description: Set Modes – The combination of Binary Bits specified enables additional operating modes for the Accuriss.

Bit 0	/1n1R: Enables the Pulse Jog Mode. Jog distance is given by “B” command, and velocity is given by “V” command. The switch inputs becomes Jog Inputs
Bit 1	/1n2R: Enables hardware limits. The level of the limits is set by the “f” command.
Bit 2	/1n4R: Enables continuous jog mode. Continuously run motor while an input switch is closed, at a velocity set by the “V” command. Note: Moves below zero position are possible. If this is undesirable, use the “z” command to define a zero position that insures that a number underflow will not occur.
Bit 3	/1n8R Enables Position Correction mode. See Appendix E.
Bit 4	/1n16R Enabled Overload Report Mode. See Appendix E.
Bit 5	/1n32R Enable Step And Direction Mode if (1) or enable Dual Encoder Mode if (0) E.g. /1n96R<CR> (96=32+64) Enables step and dir mode and slaves the motor to it. (/1?10 reads the count) See Appendix I.
Bit 6	/1n64R Enable Motor slave to encoder/step-dir.
Bit 7	/1n128R Used for Joystick mode. See Appendix F.
Bit 8	/1n256R When set, this bit will disable the response from the drive. (future release)
Bits 9	When set, these bits will execute one of the stored

& 10	programs 13, 14 or 15 whenever the feedback shuts down the drive due to an overload or an error. (“au” retries are exhausted). See Appendix E. /1n512R will execute program 13. /1n1024R will execute program 14. /1n1536R will execute program 15. See Appendix E for an example..
Bits 11 & 12	Reserved
Bit 13	/1n8192R Uses potentiometer 2 to command the motion of the motor. See Appendix F.
Bit 14	/1n16384R When Set, this bit will kill any move if switch 1 is pushed. See also “d” command.
Bit 15	/1n32768R When Set, this bit will kill any move if switch 2 is pushed. . See also “d” command.
Bit 16	/1n65536R When Set, potentiometer on Opto 2 input will set velocity. (Joystick Mode) See Appendix F.

Example: /1**n**4R<CR>

“/” Is the start character. Lets Accuriss know that a command string will follow.
“1” Is the device address, (this is preset at the factory).
“n” ***Informs Accuriss a “n” command is coming***
“4” ***Enables the Continuous Jog Mode (Bit 2)***
“R” Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>” Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **an** **Limit Switch Control**

Type: I/O

Syntax: **an**n

Range: n = 16384 or 0

Initial Value: 0

Description: Switches the end-of-travel limits on the main axis from the two opto inputs (inputs 3 & 4) to the two switch inputs (inputs 1 & 2). The second axis limits remain unchanged at 1 &2. (Software V 6.998+)

Example: /1**an16384**R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"an16384"	***Informs Accuriss to switch the limit switches to inputs 1 & 2***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **b** **Baud Rate**

Type: Communication Command

Syntax: **b**n

Range: n = 9420: 9420 bps

19200: 19200 bps

38400: 38400 bps

Initial Value: 9420

Description: Sets the baud rate. This command is usually stored in program zero, which is executed on power up

Example: /1**b**19200R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"b19200" Sets the baud rate to 19200 bps
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: o **Microstep Waveform Correction**

Type: System Control Command

Syntax: **o**n

Range: n = 0 to 3000

Initial Value: 1500

Description: Allows the user to correct any unevenness in microstep size. It is best to adjust this with a current probe, but adjusting for lowest audible noise is a good approximation. This command can be executed while the motor is running. Try values very near 1500, for example, 1470.

Example: /1**o**1470R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"o1470"	***Sets the microstep waveform correction factor to 1470***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **M** **Wait for Specified Time**

Type: Program Control Command

Syntax: **M**n

Range: n = 0 to 30000 msec

Description: M causes the command string execution to wait for the indicated time before proceeding to the next command.

Example: /1**M**10000R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"M10000" Sets wait time of 10000 msec (10 seconds)
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: ar **Reset Processor**

Type: System Control Command

Syntax: **ar**n

Range: n = 5073

Initial Value: N/A

Description: This command will reset the processor. This reset has the same effect as cycling the power to the Accuriss. The operand of 5073 was chosen to avoid inadvertent resets.

Example: /1**ar**5073R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"ar5073"	***Performs a reset of the Accuriss***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **aP** **Controller Response delay**

Type: System Control Command

Syntax: **aP**n

Range: n = 0 to 3000 msec

Initial Value: 5 mec

Description: This command sets the Accuriss response delay. The Accuriss receiving the command will respond to the master after this delay time has passed.

Example: /1aP30R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"aP30"	***Sets the Accuriss response delay to set 30 msec***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: d **Switch Debounce Time**

Type: I/O

Syntax: **d**n

Range: n = 0 to 65000

Initial Value: 10

Description: Sets the minimum Kill command switch ON time for switches 1 & 2. The debounce time is n x 50μsec

Example: /1**d**10R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"d10"	***Sets the debounce time to 10 * 50 μsec = 500 μsec***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **K** **Backlash Compensation**

Type: System Control Command

Syntax: **K**n

Range: n = 0 to 65000 microsteps

Initial Value: 0

Description: When a non zero value of K is specified, the drive will always approach the final position from a direction going more negative in order to take up any backlash in the system. If going more positive, the drive will overshoot by an amount K and then go back. By always approaching from the same direction, the positioning will be more repeatable.

Example: /1**K**7R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"K7"	***Informs Accuriss to go past the final position 7 extra microsteps prior to reaching the final position***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: aA **Oscillating (Sinusoidal) Motion Distance**

Type: Motion Command

Syntax: **aA**n

Range: n = 0 to 2,147,483,648 microsteps

Description: Sets the number of microsteps the motor will move in each direction during an oscillating (sinusoidal) move. Any changes in this value will become valid as the motion passes through the zero position.

Example: /1aA51200R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"aA51200"	***Sets the oscillation distance to 51200 microsteps in each direction***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: aW **Oscillating (Sinusoidal) Motion Frequency**

Type: Motion Command

Syntax: **aW**n

Range: n = 0 to 2,147,483,648

Description: Sets the frequency of oscillation of an oscillating (sinusoidal) move. The frequency is determined by: n * 20000/(1024 * 65536).

Example: /1aW51200R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"aW200" ***Sets the oscillation frequency to 200 * 20000/(1024 * 65536) = 0.059 hz***
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **J** **Output Control**

Type: I/O Command

Syntax: **J**n

Range: n = 0: No outputs ON (Binary 00)

1: Output 1 ON and output 2 OFF (Binary 01)

2: Output 1 OFF and output 2 ON (Binary 10)

3: Output 1 ON and output 2 ON (Binary 11)

Initial Value: 0

Description: Turn the system outputs ON or OFF. Enter as a 2 bit binary value.

Example: /1**J**3R<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"J3" ***Turns both driver outputs ON***
"R" Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>" Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: ?aa Read Back Analog to Digital Converter Values

Type: System Control Command

Syntax: **?aa**

Range: n = N/A

Description: Reads back the values of the four (4) Analog to Digital inputs. Read back order is channel 4,3,2,1

Example: /1**?aa**R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?aa"	***Requests the value of the four Accuriss ADC inputs***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Response to the **?aa** command looks similar to:
16256,16272,16271,16256 No Error

Command: **at** **Analog to Digital Converter Threshold**

Type: System Control Command

Syntax: **at**n

Range: n = 100000 to 116368 (for channel 1), or
n = 200000 to 216368 (for channel 2)**,** or
n = 300000 to 316368 (for channel 3), or
n = 400000 to 416368 (for channel 4)

Initial Value: 6144

Description: The "at" command sets the threshold, upon which a "one" or "zero" is determined for each of the 4 channels. The Number represents the channel number followed by a 5 digit number from 00000-16368 which represents the threshold on a scale from a 0-3.3V. The default values are 6144 for all 4 channels which represents 1.24V.

Threshold voltage = (n/16368) * 3.3V

Changing the threshold allows the H (Halt command) and S (Skip next command) commands to work as a variable analog input value which essentially allows the program to act upon an analog level. This can be used, for example, to regulate pressure to a given level, by turning a motor on/off at a given voltage.

Note: Be sure to include leading zeros, if required, to ensure that all threshold values are 5 digits, plus the leading channel number

Example: /1**at209567**R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"at204567"	***Sets the threshold of channel 2 to 9567 or 1.93V***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **?at** **Read Back Analog to Digital Threshold Values**

Type: System Control Command

Syntax: **?at**

Range: n = N/A

Description: Reads back the threshold values of the four (4) Analog to Digital inputs. Read back order is channel 4,3,2,1

Example: /1**?at**R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?at"	***Requests the value of the four Accuriss ADC input threshold values***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Response to the **?at** command looks similar to:
6144,6144,6144,6144 No Error

Command: **ao** **Potentiometer Position Offset**

Type: System Control Command

Syntax: **ao**n

Range: n = 0 to 2000

Initial Value: 0

Description: This offset value is added to the potentiometer value "**aa**" multiplied by the "**am**" command to obtain the position command. See Appendix F.

Example: /1**ao**500R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"ao500"	***Sets the potentiometer position offset value to 500***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **am** **Potentiometer Position Multiplier**

Type: System Control Command

Syntax: **am**n

Range: n = 0 to 20000

Initial Value: 256

Description: The potentiometer value "**aa**" multiplied by this value and divided by 256 equals the position command. See Appendix F.

Example: /1**am**512R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"am512"	***Sets the potentiometer value multiplier to 512***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **ad** **Position Potentiometer Deadband Value**

Type: System Control Command

Syntax: **ad**n

Range: n = 0 to 20000 microsteps

Initial Value: 50 microsteps

Description: Sets the deadband (in microsteps) on the potentiometer value which must be exceeded before a command is issued to cause the motor to move. See Appendix F.

Example: /1**ad**25R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"ad25"	***Sets the dead band value to 25 microsteps***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **aC** **Position Correction Mode Deadband Value**

Type: System Control Command

Syntax: **aC**n

Range: n = 0 to 65000 quadrature encoder counts

Initial Value: 50 quadrature encoder counts

Description: Sets the allowable position correction mode deadband for the coarse positioning motion. When in position correction mode, this is the position error the motor is allowed to be off (in quadrature encoder counts) before the motor will try to correct itself. The "*aC*" value is monitored continuously while the motor is in motion and is used to determine if the motor has been stalled. See Appendix E.

Encoder Quadrature Count= (encoder counts/rev) * 4

For example, a stepping motor is hooked up to a 400-line encoder.

Therefore, aC= 400 x 4 = 1420 quadrature encoder counts

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**aC**100R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"aC100"	***Sets the position correction deadband value to 100 quadrature encoder counts***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **aE** **Encoder to Microstep Resolution Ratio Value**

Type: System Control Command

Syntax: **aE**n

Range: n = 1000 to 1,000,000

Initial Value: 1000

Description: Sets the ratio between the encoder resolution (counts/rev) and the motor resolution (microsteps/rev). See Appendix E.

Encoder Ratio = ((motor microsteps/rev) / (encoder quadrature counts/rev)) * 1000

For example, a 1.8-degree stepping motor (running in 1/256th step mode), which has 200x256 microsteps /rev, is hooked up to a 400-line encoder that has 1420 quadrature encoder counts.

Therefore, aE= ((200x256)/(400x4)) x 1000 = 32000

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**aE**32000R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"aE32000"	***Sets the encoder resolution to motor resolution ratio to value to 32000***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **au** **Overload Detection Retry Limit Value**

Type: System Control Command

Syntax: **au**n

Range: n = 0 to 65000

Initial Value: 10

Description: Sets the number of times the Accuriss will retry to move the motor if a stall condition occurs. Once the number of retries is exhausted, the motor will exit the feedback mode report an overload error (Error 9). See Appendix E.

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**au**25R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"au25"	***Sets the move retry value to 25 retries***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **x** **Fine Position Integration Period Value**

Type: System Control Command

Syntax: **x**n

Range: n = 0 to 10000

Initial Value: 10

Description: Sets the fine position mode integration value. This value is used to clear any small remaining position error once the coarse position motion is completed. The speed of the correction is affected by the value of the integration period. Smaller values of "x" lead to faster corrections, but can lead to instability. See Appendix E.

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**x**15R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"x15"	***Sets the fine position correction integration period value to 15***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **ac** **Fine Position Final Error Range Value**

Type: System Control Command

Syntax: **ac**n

Range: n = 0 to 65000 quadrature encoder counts

Initial Value: 50 quadrature encoder counts

Description: Sets the allowable position correction mode deadband for the fine positioning motion. When in position correction mode, this is the final position error the motor is allowed to be off (in quadrature encoder counts) before the motor stops tring to correct itself. See Appendix E.

Encoder Quadrature Count= (encoder counts/rev) * 4

For example, a stepping motor is hooked up to a 400-line encoder.

Therefore, aC= 400 x 4 = 1420 quadrature encoder counts

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**ac**25R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"ac25"	***Sets the fine position final deadband value to 25 quadrature encoder counts***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **u** **Error Recovery Retry Limit Value**

Type: System Control Command

Syntax: **u**n

Range: n = 0 to 65000

Initial Value: 0

Description: Sets the number of times error recovery scripts 13, 14, or 15 are run prior to calling upon final recovery script 12. See Appendix E.

Note: The microstep resolution must be set to the divide by 256 value "*j256*" in order for correct operation of the feedback mode.

Example: /1**u**5R<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"u5"	***Sets the error recovery script retry value to 5 attempts***
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **T** **Terminate Command or Loop**

Type: System Control Command

Syntax: **T**

Range: None

Description: Terminate current command or loop.

Example: /1**T**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"T"	***Terminates the current command string***
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Command: **?0** **Report Current Commanded Position**

Type: System Status Command

Syntax: ?0

Range: 0

Description: Returns the current position of the commanded motor.

Example: /1**?0**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?0"	***Report current commanded position***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **?2** **Report Current Maximum Speed**

Type: System Status Command

Syntax: ?2

Range: 2

Description: Returns the current Slew/Max speed for Position mode of the commanded motor.

Example: /1**?2**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?2"	***Report current running speed***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **?4 Report Input Status**

Type: System Status Command

Syntax: ?4

Range: 0 to 15

Description: Returns the status of all four inputs in 4 bit binary format, 0 to15, of the commanded motor.

Input	Contribution to ?4 response if active
Switch 1	1
Switch 2	2
Opto 1	4
Opto 2	8

Example: /1**?4**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?4"	***Report current input status***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **?6** **Report Current Microstep Size**

Type: System Status Command

Syntax: ?6

Range: 1, 2, 4, 8 microsteps per full step

Description: Returns the current microstep size of the commanded motor.

Example: /1**?6**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?6"	***Report the current microstep size***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **?9 Erase EEPROM**

Type: System Control Command

Syntax: ?9

Range: N/A

Description: Erases all commands in the EEPROM of the commanded motor.

Example: /1**?9**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?9"	***Erases the system's EEPROM***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **?10 Second Encoder (n = 0) or Step & Direction (n = 32) Input Count**

Type: System Status Command

Syntax: **?10**

Range: N/A

Initial Value: N/A

Description: Requests the second encoder (n = 0) or step & direction (n = 32) input count value.

Example: /1**?10**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"?10"	***Requests the second encoder or step & direction input count***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **&** **Return Firmware Version**

Type: System Status Command

Syntax: &

Range: None

Description: Requests firmware version of the commanded motor.

Example: /1**&**<CR>

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"&"	***Requests firmware revision***
"<CR>"	Tells Accuriss that the command string is complete.

Command: **Q Status Request**

Type: System Status Command

Syntax: Q

Range: 0 to 3

0: No error

1: Initialization error

2: Invalid Command

3: Operand out of range

Description: Query the Accuriss for its current status.
Returns the Ready/Busy status as well as any error conditions in the "Status" byte of the return string. The return string consists of the start character (/), the master address (0) and the status byte. Bit 5 of the status byte is set when the Accuriss is ready to accept commands. It is cleared when the Accuriss is busy. The least significant four bits of the status byte contain the completion code.

Errors in OpCode will be returned immediately, when errors in Operand range will be returned only when the next command is issued. See Appendix B

Example: /1**Q**<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"Q" ***Requests Accuriss status***
"<CR>" Tells Accuriss that the command string is complete.

Command: $ Status Request

Type: System Status Command

Syntax: $

Range: N/A

Description: Returns the currently executing command string
Example: /1**$**<CR>

"/" Is the start character. Lets Accuriss know that a command string will follow.
"1" Is the device address, (this is preset at the factory).
"$" ***Returns the command string currently be executed***
"<CR>" Tells Accuriss that the command string is complete.

Programming Examples

Example #1 (Move to an Absolute Position of 12345 steps)

/1A12345R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"A12345"	Causes the motor turn to an Absolute position 12345 steps
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Note: HyperTerminal issues each character as you type it in. Therefore, it is not possible to cut and paste in HyperTerminal. Backspace is allowed only up to the address character. If backspace is used, all characters "backspaced" must be retyped in. If a typing error is made, typically hit enter and type it all in again – what was typed in will be overwritten as long as the R command at the end was not present.

Example #2 (Loop absolute moves with a wait in between)

/1gA1000M500A0M500G10R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"g"	Indicates the start of a loop block
"A1000"	Causes the motor move to the Absolute position of 1000 steps
"M500"	Causes the Accuriss to wait for 500 Milliseconds.
"A0"	Makes the motor turn to Absolute position 0.
"M500"	Is another wait command of 500 Milliseconds.
"G10"	Will make all commands between here and starting location of the small "g" repeat 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

To terminate the above loop while in progress type "/1T".

Example #3 (Program Storage and Recall)

This example stores a command string to storage location #2 for later execution:

/1s2gA10000M500A0M500G10R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"s2"	Tells Accuriss to store the command string that follows to storage locations #2
"g"	Indicates the start of a loop block
"A1000"	Causes the motor move to the Absolute position of 1000 steps
"M500"	Causes the Accuriss to wait for 500 Milliseconds.
"A0"	Makes the motor turn to Absolute position 0.
"M500"	Is another wait command of 500 Milliseconds.
"G10"	Will make all commands between here and starting location of the small "g" repeat 10 times
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

(Note: program 0 is always executed on power up, if we had used storage location 0 instead of storage location 2 in the above example, then this program would execute automatically on power up).

This example executes the command string stored in the above example.

/1e2R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"e2"	Instructs the Accuriss to execute the command string in storage location #2.
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Example #4 (Set move and hold Current values, Wait for Switch 2 closure then Home to Opto #1)

/1s0m75h10gJ3M500J0M500G10HZ10000A1000A0R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"s0"	Stores the command string that follows in storage location #0 (command strings stored in storage location #0 are executed on power up).
"m75"	Sets the move current to 75% of max
"h10"	Sets the hold current to 10% of max
"g"	Start a loop block
"J3"	Turns ON both driver outputs.
"M500"	Wait 500 msec
"J0"	Turn OFF both driver outputs.
"M500"	Wait 500 msec
"G10"	Will make all commands between here and starting location of the small "g" repeat 10 times
"H"	Waits for a switch 2 closure. (Switch 2 is automatically selected since no number was specified)
"Z10000"	Home the stepping motor to opto #1. Maximum steps allowed to find opto #1 = 10000 steps.
"A1000"	Move to absolute position 1000
"A0"	Move to absolute position 0
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Note: This program string will abort after the "Z10000" command if it does not find a flag.

Example #5 (Nested loop example)

/1gA100A1000gA100A10G10G100R<CR>

This breaks down to:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"g"	Start an outer loop block
"A100"	Go to Absolute position 100
"A1000"	Go to Absolute position 1000.
"g"	Start an inner loop block.
"A100"	Go to Absolute position 100.
"A10"	Go to Absolute position 10.
"G10"	Repeat inner loop block 10 times. (End of Inner Loop)
G100	Repeat outer loop block 100 times. (End of outer loop)
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.
"<CR>"	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

To terminate either of the above loops while in progress type "/1T".

Example #6 (Skip / Branch instruction)

/1s0gA0A1000S13e1G0R<CR>
/1s1gA0A100S03e0G0R<CR>

Two “Programs” are stored in storage locations 0 and 1, respectively, and the code in these programs switches from one program to the other depending on the state of input #3. In the example below, the code will cycle the motor between position A0 and A1000 if input #3 is High and between A0 and A100 if input #3 is Low.

Stored command string 0: */1s0gA0A1000S13e1G0R<CR>*

This breaks down to:

“/”	Is the start character. Lets Accuriss know that a command string will follow.
“1”	Is the device address, (this is preset at the factory).
“s0”	Store command string that follows to storage location #0 (executed on power up).
“g”	Start loop block
“A0”	Go to Absolute position 0
“A1000”	Go to Absolute position 1000.
“S13”	Skip next instruction if input # 3 is High
“e1”	Execute (Jump to) command string in storage location #1
“G0”	End of loop block (infinite loop since value is 0).
“R”	Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>”	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Stored command string 1: */1s1gA0A100S03e0G0R<CR>*

This breaks down to:

“/”	Is the start character. Lets Accuriss know that a command string will follow.
“1”	Is the device address, (this is preset at the factory).
“g”	Start loop block
“A0”	Go to Absolute position 0
“A1000”	Go to Absolute position 100.
“S03”	Skip next instruction if input 3 is Low
“e0”	Execute (Jump to) command string in storage location #0
“G0”	End of loop block (infinite loop since value is 0).
“R”	Instructs Accuriss to run the command(s) that are in the communication buffer.
“<CR>”	Tells Accuriss that the command string is complete and causes the command to be executed since an R is included in the command string.

Appendix A

Homing Algorithm in Detail

The “Z” command is used to move the motor to a known position by seeking a home sensor. When issued, the motor will turn toward the 0 position until the home opto-sensor is interrupted. If the home sensor is already interrupted, the motor will back off of the sensor in the opposite direction and then come back in until the home sensor is re-interrupted. The motor position counter is set to zero. The homing motion is done at the current speed “V”. The maximum number of steps allowed to go towards home without encountering the sensor is defined by the Z command operand (n) + 400 steps. The maximum number of steps away from home (while sensor is cut) is 10000 steps.

To set up the home flags:

First ensure that a positive move e.g. /1P100R moves away from home and the home flag. If motor does not go away from home, flip the connections to only one of the windings of the stepper.

The Default condition expects the output of the Home flag to be low when away from the home sensor (as is the case in an opto). If the Home flag is high when away from the home sensor (as in the case of a “Normally Open” switch) then issue the command /1f1R to reverse the polarity that is expected of the home flag.

Issue the command e.g. /1Z100000R or /1f1Z100000R as necessary.

Homing should be done at a slow speed, especially if homing to a narrow Index pulse on an encoder, which may be missed at high speeds.

The home opto sensor and flag should be set up to be unambiguous, i.e. when motor is all the way at one end of travel, the flag should interrupt the home opto sensor. When at other end of travel, the flag should not interrupt the home opto sensor. There should only be one High to Low transition possible in the whole range of travel. A Homing routine can be done to either an opto sensor (N1 Mode) or to an Index Pulse (N2 Mode).

The Main axis homes to opto1 (input #3). This opto is also the lower limit.
The Main axis uses opto 2 (input #4) as its upper limit.

Note that limits are engaged by the command “/1n2R “ (lower case “n”). The default (n0) mode does not check the limits when moving.

Default “f” mode (f0) expects the inputs to be Low when the axis is away from the limits/home. The command “/1f1R” reverses this.

Also the opto sensors and switches are interchangeable. If four opto sensors are desired, power for the extra opto sensors can be drawn from the 5V supply on the encoder connector. These extra opto sensors may require an external resistor in series with the LED. When connecting any external switches, connect them between any input and ground.

Main Axis Homing Details:

There are four full steps in a single electrical cycle that moves the stepping motor. (A+, B+, A-, B-). For repeatability in homing, the home position is set to first step in that cycle (A+) that occurs after the flag edge has been seen. (This means that the home position is defined some ways beyond the middle of the flag).

However, there is a small but finite chance that an ambiguity in home position may occur in the rare case that the exact point of switching into A+ occurs at the same point at which the flag is interrupted. In the case where a 4 step ambiguity in home position may exist because the flag may sometimes be interrupted just before and sometimes just after, the procedure below describes a method by which the ambiguity can be removed. However, this procedure need not be followed if a 4 step inaccuracy in Home position is acceptable.

To eliminate the home position ambiguity, first issue the Z command, allow the motor to home. Then move 2 full steps (in any direction), now mechanically move the flag edge (or sensor) such that it trips in the middle of the sensor by adjusting it while watching the status LED on the board which shows the status of the home sensor. This will ensure that the flag trips at A- and thus the motor will home to a unique position of A+.

Another way to do this, if it is not hazardous, is to put the motor in an endless homing loop "/1gZ10000GR", then move the flag/opto around while the motor is homing. It will be noticed that the motor will home to two distinct positions that are 4 steps apart. Make sure the High to Low transition point of the Opto sensor is NOT near these positions (exact position does not matter as long as it is not near the place where it homes to).

Second Axis Homing Details:

The second axis will home to the exact transition of the home flag, and does not seek a Phase A zero. The second axis uses the switch inputs for homing and limits.

Manual homing:

Motors can be manually homed to any input by the use of a polling loop such as:

/1s1z0R Set the current position to zero and store to storage location #1
/1z100000gD1S04e1GR Move backwards in an endless loop until input #4 goes High .

Homing to a hard stop:

It is possible to send the motor against a hard stop and then force the position counter to zero or some other value as necessary. The command string "/1z0R" zeros the position counter. The command string "/1z333R" will set the position to 333, etc.

Appendix B

Device Response Packet

The Accuriss responds to commands by sending messages addressed to the “Master Device”. The Master Device (which for example is a PC) is assumed to always have Address zero. The master device should parse the communications on the bus continuously for responses starting with /0. (Do NOT, for example, look for the next character coming back after issuing a command because glitches on the bus when the bus reverses direction can sometimes be interpreted as characters)

After the /0, the next piece of information is the “Status Character” which is actually a collection of 8 bits.
These Bits are:
Bit7 … Reserved
Bit6 … Always Set
Bit5 … Ready Bit - Set when Accuriss is ready to accept a command.
Bit4 … Reserved

Bits 3 thru 0 form an error code from 0-15
0 = No Error
1 = InitError
2 = Bad Command (illegal command was sent)
3 = Bad Operand (Out of range operand value)
4 = N/A
5 = Communications Error (Internal communications error)
6 = N/A
7 = Not Initialized (Controller was not initialized before attempting a move)
8 = N/A
9 = Overload Error (Physical system could not keep up with commanded position)
10 = N/A
11 = Move Not Allowed
12 = N/A
13 = N/A
14 = N/A
15 = Command Overflow (unit was already executing a command when another command was received)

Note that RS485 Bus devices must respond right away, after the master sends a command, before the success or failure of the execution of the command is known. Due to this reason some error messages that come back are for the previous command, for example, “failure to find home”.

A program that receives these responses must continuously parse for /0 and take the response from the bytes that follow the /0. The first Character that comes back may be corrupted due to line turn around transients, and should not be used as a “timing mark”.

Example Initialization Error Response:

Note that the Upper Nibble only typically takes on values of 4 or 6 (Hex)
An initialization error has response has 1 in the lower Nibble. So the response is 41 Hex or 61 Hex, which corresponds to ASCII character upper case “A” or lower case “a”, depending on if the device is busy or not.

Example Invalid Command Response:

Note that the Upper Nibble only typically takes on values of 4 or 6 (Hex)
An invalid command has response has 2 in the lower Nibble. So the response is 42 Hex or 62 Hex, which corresponds to ASCII character upper case “B” or lower case “b”, depending on if the device is busy or not.

Example Operand Out of range Response:

Note that the Upper Nibble only typically takes on values of 4 or 6 (Hex)
An operand out of range has response has 3 in the lower Nibble. So the response is 43 Hex or 63 Hex, which corresponds to ASCII character upper case “C” or lower case “c”, depending on if the device is busy or not.

Example Overload Error Response:

Note that the Upper Nibble only typically takes on values of 4 or 6 (Hex)
An overload error has response has 7 in the lower Nibble. So the response is 47 Hex or 67 Hex, which corresponds to ASCII character upper case “I” or lower case “i”, depending on if the device is busy or not.

Example Response to command /1?4

FFh: RS485 line turn around character. It’s transmitted at the beginning of a message.
2Fh: ASCII “/”Start character. The DT protocol uses the ‘/’ for this.
30h: ASCII “0” This is the address of the recipient for the message.
In this case ASCII zero (30h) represents the master controller.
42h: This is the status character (as explained above
31h:
31h: These two bytes are the actual answer in ASCII.
This is an eleven which represents the status of the four inputs.
The inputs form a four bit value. The weighting of the bits is:
Bit 0 = Switch 1
Bit 1 = Switch 2
Bit 2 = Opto 1
Bit 3 = Opto 2
03h: This is the ETX or end of text character. It is at the end of the answer string.
0Dh: This is the carriage return…
0Ah: ...and line feed.

Command Response Modification

Requires Firmware Revision 7.08+

Note that it is possible to change the response from the device to include device address and other parameters such as current position.

/1Q1<CR> will modify every subsequent response to include the device address
/1Q2<CR> will modify every subsequent response to include the current position

If more than one command is used then both parameters will be reported back with a comma delimited response.

Appendix C

Heat Dissipation

Most stepper applications require intermittent moving of the motor. In the Accuriss, the current is increased to the “move” current, the move is performed, and the current is then reduced to the “hold” current automatically. The heat dissipation in the drive is proportional to the current flowing in the drive and, therefore, the dissipation occurs primarily during the “move”.

When the Drive generates heat, the heat first warms the circuit board and housing.

Only then does the heat transfer to the surroundings. For intermittent moves that are less than one minute in duration, the Drive primarily cools using this thermal inertia of the board and housing, and not by steady state dissipation to the surrounding ambient.

The electronics for the Accuriss are fully capable of running at the rated voltage and current. However, due to the small size of the boards, which limits the steady state heat transfer to the ambient, care must be taken when the drive is used in high duty cycle and/or high current applications. For conservative operation, it is recommended that the duty cycle be reduced linearly, from 100% duty at 50% of rated current, to 25% duty at 100% of rated current. (Duty cycle means the percentage of the time that the drive is moving the load – averaged over 5 minutes). Conservatively, the maximum continuous run at 100% current is about 1 minute. An on board thermal cutout typically trips after about 2 minutes at 100% current. (This cutout is self-resetting when the drive cools). Of course, at 50% of current, the drive will run continuously with no time limit.

Most “intermittent move” applications will NOT require derating of the drive.

In case the Accuriss is required to run 100% of the time at 100% current, forced air cooling or mounting to an aluminum structure is required.

Accuriss drives are designed with parts rated at 85°C or better. This means the PCB copper temperature must remain below 85°C. The ambient air temperature allowed depends on the airflow conditions.

MTBF is 20000Hrs at 85°C PCB copper temperature and doubles for every 10°C lower than 85°C.

Appendix D

Step Loss Detection using an Opto-sensor

For some applications, which operate without encoder feedback, it may be necessary to detect loss of steps due to the mechanism stalling for any reason.

Step loss is easily detected by following the algorithm below:

1. Home the stepper to the opto using the *Z* Command.
2. Move out of the flag a little by issuing, for example, an *A100* command.
3. Figure out the exact step on which the flag gets cut by issuing *D1* commands followed by */1?4* commands to read back the opto. Let's call this value *i*. (This only needs to be done once during initial setup).
4. Execute the move sequence for which step loss detection is needed.
5. Issue a command to go back to absolute position Y+1.
6. Check the opto; it should not be cut (read opto back with the */1?4* command).
7. Now issue a command to go to position Y-1.
8. Check the opto; it should be cut (read opto back with the */1?4* command).
9. If the opto was not at the state expected, steps may have been lost.

NOTE: Step loss detection can also be done by looking for changes on the other inputs.

Appendix E

Position Correction Mode and Overload Report Mode

Position Correction Mode (Software version 6.7 or higher)

Position correction mode, when enabled, will move until the encoder reads the correct number. Once enabled, positions are given in quadrature encoder counts of the encoder (not in microsteps). If the motor stalls during a move, the mode will re-attempt the move until the encoder reads the correct number. This algorithm runs while the stepper is in motion and will detect a stalled motor during a move.

There are two main types of feedback methods:

1. The first method is to place the encoder on the motor shaft.
2. The second method is to place the encoder on the component that is closest to the actual item being positioned, and may be only be loosely coupled to the motor due to backlash etc.

The Accuriss will work with either feedback method.

Setting Up Encoder Feedback

1. Set the encoder ratio "aE".

NOTE: the encoder ratio should be changed when at the zero position for best performance.

Encoder Ratio = (microsteps/rev divided by quadrature encoder counts/rev) x 1000.

The encoder ratio must preferably be a whole number after the multiply by 1000. (If this is not a whole number, see discussion further down).

The motor must be left in 256th microstep mode for correct operation of feedback mode.

For example, a 1.8-degree stepper (running in 1/256th step mode), which has 200x256 microsteps /rev, is hooked up to a 400-line encoder that has 1420 quadrature encoder counts.

aE= ((200x256)/(400x4)) x1000=32000

Issue the command */1aE32000R* to set this encoder ratio.

NOTE: If the encoder ratio is unknown, do the following:

1. Leave the encoder ratio at its power-up default of 1000.
2. Ensure that the encoder increases its count when the motor moves in the positive direction. If not, switch the A & B output lines of the encoder, which will reverse the count

direction; or switch the wires to one of the windings on the stepper motor, which will reverse the direction of rotation (do not use the *F* command).

3. Issue a "*/1n0R"* command to clear any special modes.
4. Issue a "*/1z0R"* command, which will zero both the encoder position and step position.
5. Issue "*/1A100000R"* command and ensure that the move completes at a velocity that does not cause the motor to stall.
6. Issue a "*/1?0"* command, which reads back the current position. This current position value should be 100000.
7. Issue a "*/1?8"* command, which reads back the encoder position.
8. Issue a "*/1aE0R"* command, which auto divides these two numbers.
9. Issue a "*/1?aE"* command, which reads back the encoder ratio computed.

This value read-back is only a rough guide, and will be off by a few counts due to inaccuracies in the motor position and run-out in the encoder.

NOTE: The value read-back MUST be overwritten by the EXACT value that represents ratio.

10. Issue a *"/1aE32000R"* command, or whichever exact number represents the encoder ratio.

2. (Optional) Set the error in quadrature encoder counts allowed before a correction is issued.

E.g. /1aC50R (default is 50)

3. (Optional) Set the Overload Timeout Value.

This is the number of retries allowed under a stall condition.

E.g. */1au10000R* (default is 100)

4. Enable the feedback mode.

1.

Zero positions just prior to enabling feedback mode by issuing a "*/1z0R"* command. (Or issue */1z10000R* etc. if you need to at this time.)

Enable position correction mode by issuing a "*/1n8R"* command.

Example (Software version V6.7 or higher):

/1z0aC50h40m40au100aE32000V1000n8R starts the position correction mode, where:

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"z0"	Set the current position to zero
"aC50"	Set the allowable step error band to 50 microsteps
"h40"	Set maximum hold current to 40%
"m40"	Set maximum run current to 40%
"au100"	Set the overload detection retry count to 100
"aE32000"	Set the encoder to microstep resolution ratio to 32000
"V1000"	Set speed of motor to 1000 microsteps per second

"n8"	Enables the position correction mode
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.

Fine position correction (V6.99+)

When in *n8* mode, there are two position correction algorithms:

- The COARSE ALGHORITHM, as described above, operates to bring the motors to within the value given by "aC" (upper case C).). This algorithm runs all the time (while the stepper is in motion) and will detect a motor that is stalled or lagging by more than the value of "aC" during a move. When a problem is detected, the axis will stop and reissue a move starting from zero velocity so as to slowly spin up motor that may have stalled at high speed.

- In firmware version 6.99+, a fine position correction integrator algorithm (FINE ALGORITHM) is engaged once the major move is completed to zero out any small residual position error. The speed of this correction is affected by the "x" integration period value. /1x10R is default. Smaller values of x correct faster but may lead to oscillations, e.g., /1x3R. The fine position correction deadband is set by "ac" (lower case c) E.g.: /1ac10R, the default ac is 20 encoder counts. This can be adjusted down to zero, if desired but it may take time to settle depending on system stiction and backlash, especially if the encoder is decoupled from the motor. The integration algorithm runs at the hold current value, and this may need to be adjusted to a reasonably high number, depending on the load. It is also best to run at a hold current equal to the move current so that the motor does not "relax" and move to a detent position at the end of the move. The move complete (non busy) signal will be asserted when the move completes to within "ac" for the first time. Subsequent disturbances greater than "ac" but less than "aC" will be corrected by the fine correction algorithm and will not be reported as "busy". Only disturbances greater than "aC" will result in the coarse correction algorithm being engaged and the busy signal being asserted.

Example: (V6.99+) */1z0aC50ac10x10h40m40au100aE32000n8R*

"/"	Is the start character. Lets Accuriss know that a command string will follow.
"1"	Is the device address, (this is preset at the factory).
"z0"	Set the current position to zero
"aC50"	Set the allowable step error band to 50 microsteps
"ac10"	
"h40"	Set maximum hold current to 40%
"m400"	Set maximum run current to 40%
"au100"	Set the overload detection retry count to 100
"aE3200"	Set the encoder to microstep resolution ratio to 32000
"n8"	Enables the position correction mode
"R"	Instructs Accuriss to run the command(s) that are in the communication buffer.

Notes On Feedback Mode

- If motor consistently stops during a move:
  If a very fine line count encoder is used such that, for example, the encoder ratio is around 2000, or if the encoder is decoupled from the motor shaft, or if the encoder ratio has some fractional component and is non integer, increase the error (*aC*) allowed for the coarse algorithm. For example set *aC* to *2000*. This way a move that is in progress will not be halted and restarted because the coarse algorithm has detected that the following error is too large. Instead, the move will complete with some error, and the fine algorithm integrator will null out the error to within the lower case "*ac*" value at the end of the move.

- Busy/Non Busy Status:
  The status will read busy until any move is reached to within the "ac" value; however, once a move is complete any subsequent disturbance is handled by the fine integrator as long as it is less than "aC" (upper-case C). These subsequent corrections by the fine algorithm will not read busy; however, if the error becomes greater than "aC" the deadband reckoning algorithm is turned on, and a formal correction move is initiated. This move changes the drive status to busy, and no external commands will then be accepted. It is important to set the coarse deadband reckoning (aC value) to a reasonable number (for example, 50) or else the drive will always be attempting to correct.

Other Notes

- When position correction mode is enabled (*/1n8R*) the drive will keep retrying any stalled moves until the number of "*au*" retries are exhausted, and will NOT halt any strings or loops upon detection of a stall.

- During position correction mode, the *"/1T"* command will halt any move, but there is a possibility that the drive may instantly reissue itself a position correction command, especially if it is fighting a constant disturbance. It may be necessary to issue a *"/1n0R"* command to positively halt a move in progress.

- If the encoder ratio is changed from its default of 1000, the allowed max position will be decreased from +2,147,483,648 by the same ratio. The max position counter will rollover from positive to negative range when this limit is exceeded.

- Do not use the upper case "*F*" (reverse direction) command when using encoder feedback mode. Instead, switch the encoder AB lines or the lead wires to one phase of the motor.

- Jog mode will not work with encoder feedback on

Arbitrary Measurement Units

It is not necessary to use feedback mode or even have an encoder, in order to set the encoder ratio */1aE32000R* etc. Setting the encoder ratio thus allows positioning in any units of the user's choice.

Overload Report Mode

In n8 feedback mode, the drive will automatically correct any stalled moves up to the limit given by the "*au*" command. Only then will it report Error 9 of an overload.

However, it may be desirable to detect a stall but not correct it. The n16 mode does just this. The encoder value is continuously compared against the commanded position and Error 9 is set when these do not match to within the error band specified by the "*aC*" command. When this error occurs, the drive will exit from any loops or remaining command strings it may be executing.

The overload report mode is enabled by the */1n16R* command, and requires the encoder ratio to be entered correctly via the "*aE*" command. Issue */1zR* to zero both the encoder and position counter just prior to issuing */1n16R* command string.

When an overload occurs, the drive can be set to execute stored strings 13, 14, or 15. See auto recovery scripts below.

Auto Recovery in Feedback Mode

Auto Recovery Scripts (Available in V6.997+)

In n8 mode, the Accuriss determines a stalled or overload condition by checking to see if the encoder is tracking the commanded trajectory. If the encoder is not following the commanded trajectory within the error specified by "*ac*", a number of retries given by the "*au*" command are executed.

When an overload condition is detected (retry counter has exceeded the "*au*" value), it will be reported back as an upper or lower case *I* (Error 9) when the status is queried. This status can be used by an external computer to execute a recovery script.

However, it may be desired that the drive recover by itself in the case of a stand-alone application. For this purpose, the "n" mode bits n512 and n1024 can be used.

It is necessary to combine these bits with n8 so, for example, n512+n8 = n520.

Depending on which of these bits is set, the Accuriss will execute stored program 13, 14 or 15 when an overload is detected. Program 12 is also executed as a last resort, if programs 13, 14, or 15 cannot auto recover after retrying the number of times given by the "*au*" command.

NOTE: an overload error on any motor, if enabled, will execute error recovery.

Example:

1. Enter */1s13p1202n520R.* This sets error recovery script to send "1202" on every recovery.

   /1s12p1201R sets final script to send "1201."

2. Enter /1aM1m5h5z0aC50au5u3aE12800L100n520R. This sets h= 5 and m=5 so that we can stall the motor easily.
3. Setup encoder ratio as appropriate: /1aE32000R etc.
4. Zero Encoder and Position Counter */1z0R*

5. Set *au* = 5 so that 5 retries max are allowed
6. Set *u* = 5 so that program 13 is run a maximum of 3 times.
7. Set *n* =520 = *n8* + n512 so that stored program 13 will be issued on error condition.
8. Now move the motor shaft so that the motor tries to correct 5 times and then gives up.
9. After the 5th retry the motor will execute stored program 13 and will attempt to send a "1202" on the 485 bus. Then the feedback turns on and 5 more tries are made. If the motor is held stalled, the "1202" will be sent 32 times followed by a "1201" as the final recovery script, stored program 12, is run.

Typical reasons that the following error is too great:

- "*m*" value (current) set too low.
- "*L*" value (acceleration) set too high for torque available from motor.
- "V" value (velocity) set too high for torque available from motor.
- Physical obstruction, or excessive friction.

Appendix F

Analog Inputs and Analog Feedback

Analog Inputs

The four inputs of the Accuriss are all ADC inputs.

- The ADC values can be read via RS485, E.g., */1?aa<CR>*. These values are on a scale of 0-16368 as the input varies from 0-3.3V. The inputs as shipped are good to about 7 bits resolution, but can be made to be better than 10 bits with the removal of the input overvoltage protection circuitry (call factory for details).

- The threshold upon which a digital "one" or "zero" is called can be varied with the "*at*" command and affect the Halt H command or Skip S command.

  Example:

  Enter */1at309999R<CR>*. This sets the threshold on input 3 to 09999. Note that it is necessary to insert leading zeros after the input number (3), since the threshold value must always be entered as five digits (00000-16368).

- The thresholds for all four inputs can be read back with the */1?at<CR>* command. The Accuriss has a default threshold value of 6144 (1.24V).

- It is possible, for example, to regulate pressure by turning a pump on or off depending on an analog value read back, by designating the threshold of the One/Zero call as the regulation point. E.g. */1at308000gS03P1000G0R*.

A potentiometer can be wired to the Accuriss and its position read back via the */1?aa<CR>* command. Note that the supply provided (which normally drives an LED) has 200 ohms in series with 5V, so the use of a 500-ohm potentiometer will give a range of almost 0-3.3V range on the inputs.

Potentiometer Position Command

Potentiometer 2 can be used to command the position of the motor. The value read back on potentiometer 2, from 0-16368, is multiplied by the multiplier "*am*" and then divided by 256. Then an offset given by "*ao*" is added. The motor will use this number just as if it had been commanded by a */1A12345R*-type command. Further, there is a "deadband" command, "*ad*", which sets a dead band on the 0-16368 potentiometer value read back such that a value outside this deadband must be seen before a command is issued to cause a move.

The command */1aM1ao100ad100am1000n8192R<CR>* enables potentiometer command mode.

Step motor position = ((analog value from potentiometer/ 256) x ("*am*" multiplier)) + ("*ao*" offset value)

Use 500-ohm potentiometer (see product wiring diagram).

Supply pin of potentiometer already has 200 ohms in series on the board to 5V

Value from potentiometer = 0 to 16368 for 0-3.3V on wiper.

E.g. Enter */1ao1228R<CR>.* This sets the "*ao"* offset to 1228. Default is 0.

E.g. Enter */1am256R<CR>.* This sets the "*am"* multiplier to 256. Default is 256.

E.g. Enter */1ad100<CR>.* This sets the deadband in microsteps to 100. Default is 50).

Potentiometer Velocity Mode (joystick Mode)

This feature is available in firmware version 6.7+.

Potentiometer 2 (see product wiring diagram) can be used to command the velocity of the motor. The value read back on potentiometer 2, from 0-16368, is multiplied by the multiplier "*am*" and then divided by 256. The motor uses this number just as if it had been commanded by a *V* command.

1. Enter a */1n65536R* to enter velocity mode.

   Once in this mode, a */1z0R command* will set zero velocity to the current position on the potentiometer.
2. Enter a */1P0* command to start an endless move based on the velocity as read from the potentiometer.

   - */1zxxxR,* where *xxx* is non zero, will set zero to that value of the potentiometer.
   - *"ad"* sets the dead band on the potentiometer about mid scale.
   - *"am"* sets the multiplier where:

   Velocity in microsteps/sec or encoder ticks/sec = [(potentiometer value(0to16368) – (potentiometer zero value from "z" command) - ("*ad*" deadband value/2)] x (*am*/256)

So,

Entering a */1ad100am1000n65536z0P0R command* starts the mode.

To terminate this mode, enter

/1n0<CR> followed by

/1T<CR>

The actual velocity can be read back by a */1?V<CR>* command.

It is also possible to use the potentiometer to set the magnitude of the velocity and Switch1 input to be the direction of the velocity. Bit 7 Enables this.

Entering a */1ad100am1000n65664z0P0R* command starts the mode. (65664=65536+128)

This feature is available in Firmware V6.998+.

Further, it is possible to know if the shaft is following the commanded velocity, by using a shaft encoder for feedback and setting the encoder ratio (*aE*) and the following error (*aC*), and setting n16 mode to report overloads 65552 = (65536 + 16).

Example: */1ad100aC400am128n65552aE12800z0P0R*

If the potentiometer velocity mode is to be used with limit switches, the limits can be switched to the two switch inputs, so as not to interfere with the potentiometer. The command to do this is */1an16384R*.

Example: */1ad100am1000an16384n65538z0P0R* switches the limits to the alternate inputs, and enables limits (65536 +2 = 65538).

Potentiometer Position Feedback

This feature is available in Firmware V6.7+.

Potentiometer 1 can be used as an encoder for the motor. The value read back is from 0-16368.

NOTE: Please read Appendix E on encoder feedback mode first. Operation in potentiometer position feedback mode is identical to encoder feedback mode except that the potentiometer acts as an encoder which generates positions between 0 and 16386.

The command */1N3R* designates Potentiometer 1 as the encoder (in place of the quadrature encoder).

To use this mode:

1. Wire a 500-ohm linear taper potentiometer to the Potentiometer 1 position.
2. Connect the motor shaft to the shaft of the potentiometer, such that a move in the positive direction for the motor increases the value read from the potentiometer using the */1?aa* command.
3. Turn the potentiometer all the way to zero by issuing a *D* command, e.g. */1D1000R*.
4. Issue a */1z0R* command to zero the motor position.
5. Issue a */1N3R* command to enable the potentiometer as encoder.
6. Move motor by issuing *P* commands until it is at about ¾ of the potentiometer range.
7. Issue a */1aE0R* command to automatically work out the “encoder ratio” for the potentiometer.
8. Issue a */1n8R* command to enable feedback mode.

Note that if the motor shaft is forced, a correction will be issued to return the motor to its original position.

If the shaft oscillates at some positions, this may be because of a nonlinearity in the potentiometer. Try increasing the dead band set by the “*aC”* command. Or it could be because the zero position was not set correctly. Another cause of oscillations is a “scratchy” potentiometer. Try adding a 0.1µF capacitance between the wiper terminal and ground.

NOTE: To start feedback at a non-zero potentiometer position, read the current potentiometer value (position) with */1?aa* , say it's 2345, then issue a */1z2345N3n8R* command.

Example: (V6.7+) :

/1aM1z0aC50h40m40au100aE32000V1000N3n8R

Example (V6.99+, with fine position correction):

/1aM1z0aC50ac10x10h40m40au100aE32000L100N3n8R

NOTE: See Appendix E for parameter explanations.

To exit this mode, type

/1n0R followed by

/1T

Appendix G

Oscillating (sinusoidal) Scan

The Sinusoidal scan feature requires firmware V6.7+.

The Accuriss can be commanded to automatically scan in an oscillating (sinusoidal) manner.

The amplitude of the oscillating motion is set by the "*aA*" command.

Example: Entering a */1aA51200R* command sets the number of microsteps the motor will move in each direction during an oscillating (sinusoidal) move. Any changes in this value will become valid as the motion passes through the zero position.

The frequency of the oscillating motion is set by the "*aW*" command.

Example: Entering a */1aW1000R* command sets frequency to be:

f = (X)*20000 / (1024*65536), where *X* is 1000 in this example.

To exit from this mode, set the amplitude to zero with a */1aA0R* command.

Appendix H

On-the-fly Parameter Change

The Accuriss firmware version 6.9981+ allows on-the-fly position, velocity, and acceleration changes. This allows virtually any trajectory to be generated.

Once moving, commands can be issued ONE AT A TIME without the "*R*."

Example:

- A /*1A10000000R<CR>* command will start the move.
- *A /1V10000<CR>* command will change the velocity while moving.
- *A /1A0<CR>* command will make the drive automatically decelerate and then head back to the zero position.

For example: a "*P200"* command, if issued while moving, will cause the motor to go 200 steps from the current position (not the original final target).

The *following commands can be changed on-the-fly:*

A: (Absolute position)

P: (Index motion is positive direction)

D: (Index motion is negative direction),

L: (Acceleration rate) and,

V: (Position mode maximum velocity

Appendix I

Encoders and Step & DIR Pulse Input

The Accuriss has dual encoder inputs. Any quadrature encoder with A, B and (optional) index output is acceptable. In addition, step and direction style position counting is also supported on the secondary encoder.

Read-Only Mode

In this, the simplest mode, the encoder values are simply read back.

The command */1?8* reads the primary encoder on the 5-pin connector, and */1?10* reads back the secondary encoder on the 8-pin connector. The primary encoder is always in quadrature encoder mode and expects quadrature pulses on the A & B lines. The secondary encoder can be placed in quadrature encoder or in step and direction counting mode, depending on whether or not */1n32R* mode is enabled.

The */1?8* command reads back the primary encoder when in *aM1* mode.

Encoder/Step and Direction Following Mode

In this mode, the motor takes the count from the secondary encoder and uses this count as a commanded position. The count can come in from another A, B quadrature style encoder, or from step and direction pulses.

1. Select A & B mode or step and direction mode using */1n32R* etc.
2. Turn on "Motor Slave to Encoder2" by issuing */1n64R*.

Examples: A */1n96R* (96=32+64) command enables step and direction mode and slaves the motor to it. A */1n64R* command enables the encoder mode and slaves the motor to it.

The input step count (readable by */1?10*) is related to the motor position by the following relationship:

Step motor position = ("am" multiplier / 256) x (step and direction count or encoder count).

Counts are in the number of microsteps set by the "*j*" command.

Main Axis Encoder Feedback Mode

The main axis can use the primary encoder for feedback and the secondary encoder for "command." Please see Appendix E

Electrical

Please see the appropriate product wiring diagram for wiring details.

The encoder(s) must draw a total current of <100mA from the 5V pin.

Encoders must have 0.2V Low to 4V High swing at the input of the connector.

Appendix J

Jog Modes and Limit Switches

Jog

The Accuriss can be placed in a mode that will allow the two switch inputs to “Jog” the motor backwards and forwards. The command for this is */1n4R*. Once issued, the motor can be moved by pressing switch 1 or 2. Internally these inputs are “pulled up” with 10K ohms to 3.3V. A closure to ground is all that is required.

Note that these are inputs 1 and 2, and that the status of the switches can be read via firmware by */1?4*. This command returns a binary number between 0-15, which represents the status of the four inputs.

Limit Modes

The Accuriss uses the two opto inputs as limits. These are inputs 3 and 4. It should be noted that these inputs are general-purpose inputs and can be driven by switch closures or any device that produces a voltage change. The inputs are actually ADC inputs, and the One/Zero threshold can be set by the “*at*” command.

Input 3 is the lower limit and also the home switch. Input 4 is the upper limit. Both limits are simultaneously turned on by the */1n2R* command.

The default setting of the Accuriss expects the optos to be low when not on the limit. This polarity can be changed by issuing a */1f1R* command, for example when normally open switches are used for limits. (NOTE: normally closed switches are better for limits, since any disconnect of the wires will shut down the motion). When n2 mode is engaged, the motor will not move in the direction in which a limit is active, but will back out of the limit.

In V 6.998 and later firmware, the limits can be moved to the switch inputs 1, 2 if desired by issuing the command */1an16384R*.

Note that limit switches can be used to kill moves. For example, a */1n2gA100000A0GR* command will loop between *A100000* and *A0,* but if the positive limit is cut during the *A100000* motion, then that command is terminated and the *A0* command is executed.

Noise Considerations

The inputs are relatively high impedance at 10K ohms and will pick up noise if bundled with the motor wires, etc. For long cable runs, each input line should be shielded. The addition of a 0.1µF ceramic capacitor from the input to ground at the board connector may be an alternative to shielding, but may slow the response.