NSC-A1

Single Axis Stepper Motor Controller + Micro-step Driver
USB 2.0 / RS-485 communication

Firmware Compatibility:

†V231BL

†If your module's firmware version number is less than the listed value, contact Newmark Systems, Inc for the appropriate documentation. Newmark Systems, Inc reserves the right to change the firmware without notice.

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1. Introduction

NSC-A1 is an integrated controller and stepper driver motion product. Feature highlights include: encoder support (closed-loop position verification) and analog inputs (joystick control).

Communication to the NSC-A1 can be established over USB or RS-485. It is also possible to download a stand-alone program to the device and have it run independent of a host.

Windows and Linux drivers as well as sample source code are available to aid you in your software development.

Features

NSC-A1

- USB 2.0 communication
- RS-485 ASCII communication
  - 9600, 19200, 38400, 57600, 115200 bps
- Digital IO communication
  - 4 bit motion profile select inputs (DI3-DI6)
  - One start motion input (DI1)
  - One abort/clear motion input (DI2)
  - One in position output (DO1)
  - One error output (DO2)
- A/B/Z differential encoder inputs
  - StepNLoop closed loop control (position verification)
- 2 x 10-bit analog inputs
  - Joystick control
- Opto-isolated I/O
  - 6 x inputs
  - 2 x outputs
  - 1 x High speed position capture latch input
  - +Limit/-Limit/Home inputs
- Homing routines:
  - Home input only (high speed)
  - Home input only (high speed + low speed)
  - Limit only
  - Z-index encoder channel only
  - Home input + Z index encoder channel
- S-curve or trapezoidal acceleration profile control
- On-the-fly speed change
- Stepper driver
  - 12-24 VDC
  - 3.0 Amp max current setting (peak current)
  - 2 to 500 micro-step setting

- 1 MHz max pulse support

Contacting Support

For technical support contact: contact@newmarksystems.com.

Or, by phone at 949-830-0621.

2. Electrical and Thermal Specifications

Power Requirement

Regulated Voltage:	**+12 to +24 VDC**
Current (Max):	**3 A (peak)**

Temperature Ratings †

Operating Temperature:	**-20°C to +80°C**
Storage Temperature:	**-55°C to +150°C**

† Based on component ratings

Digital Inputs †

Type:	**Opto-isolated NPN inputs**
Opto-isolator supply:	**+12 to +24 VDC**
Maximum forward diode current:	**45 mA**

† Includes limit, home and latch

Digital Outputs

Type:	**Opto-isolated open-collector NPN outputs**
Max voltage at collector:	**+24 VDC**
Max sink current at 24VDC	**†90 mA**

† A current limiting resistor is required

Analog Inputs

Type:	**Voltage**
Voltage input	**+0 to +5VDC**
Max current	**22 mA**

3. Dimensions

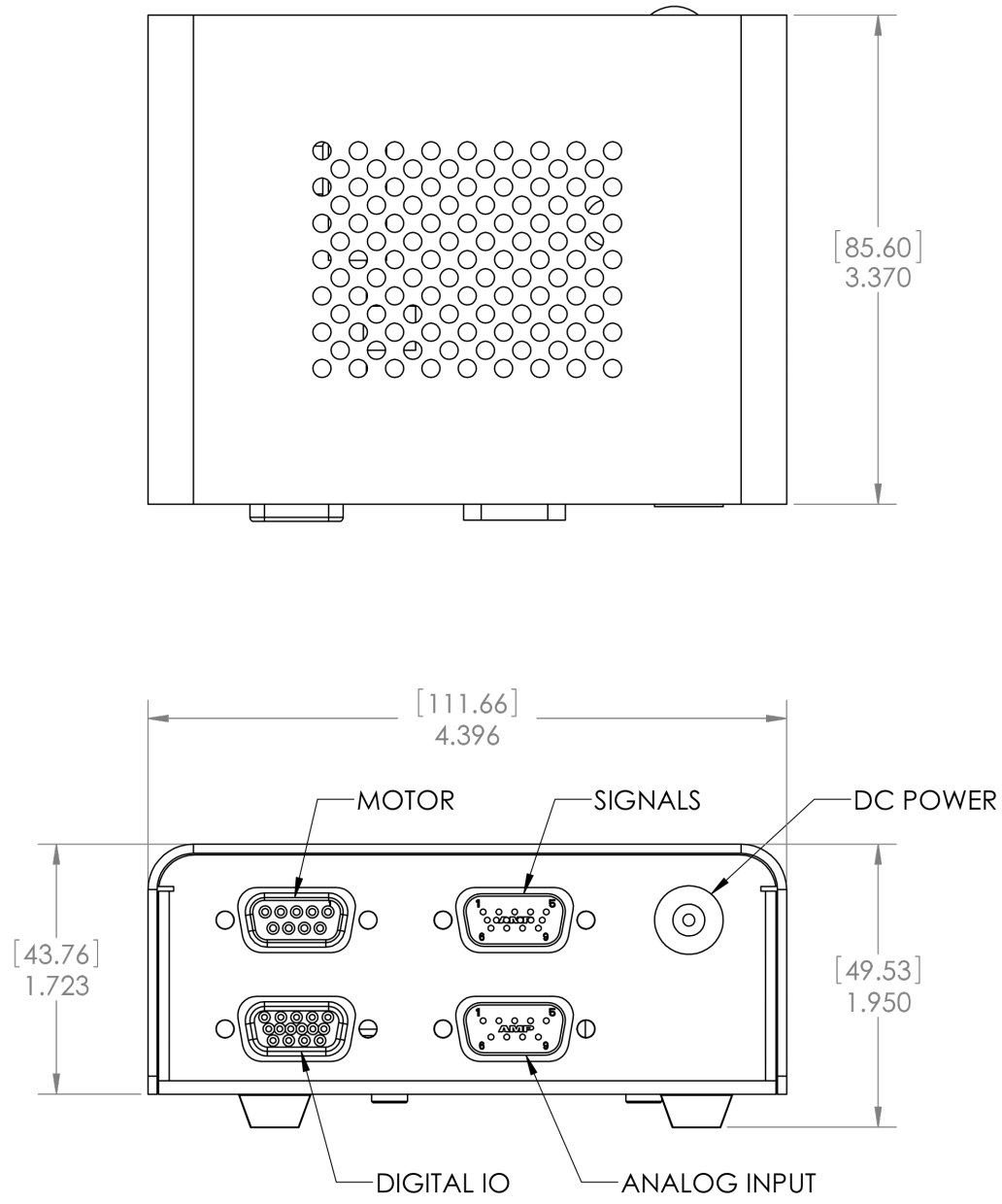


Figure 3.0

[mm]
inches

4. Connections

Motor Connector DB-9 Female

Pin #	In/Out	Name	Description
1	**O**	**/A**	Bi-polar Step Motor – Phase /A
2	**O**	**A**	Bi-polar Step Motor – Phase A
3	**O**	**B**	Bi-polar Step Motor – Phase B
4	O	/B	Bi-polar Step Motor – Phase /B

Table 4.0

DC Power Jack (2.1 mm x 5.5 mm)

Pin #	In/Out	Name	Description
Outer	**I**	**G**	Ground
Center	I	V+	Power Input +12 to +24 VDC

Table 4.1

Signals Connector DB-9 Male (Non Encoder Version)

Pin #	In/Out	Name	Description
1	**I**	**+LIM**	Plus limit input
2	**I**	**-LIM**	Minus limit input
3	**O**	**GND**	Ground
4	**I**	**HOME**	Home input
5	**O**	**5V**	5V output from controller – from on-board regulator

Table 4.2

Signals Connector HD-15 Male (Encoder Version)

Pin #	In/Out	Name	Description
1	**I**	**+LIM**	Plus limit input
2	**I**	**-LIM**	Minus limit input
3	**O**	**GND**	Ground
4	**O**	**GND**	Ground
5	**O**	**5V**	5V output from controller – from on-board regulator
6	**I**	**/Ae**	Differential encoder /A channel
7	**I**	**Ae**	Differential encoder A channel
8	**I**	**Be**	Differential encoder B channel
9	**I**	**/Be**	Differential encoder /B channel
10	**I**	**Ze**	Differential encoder Z channel
11	**I**	**/Ze**	Differential encoder /Z channel
12	**I**	**HOME**	Home input

Table 4.3

Digital IO Connector HD-15 Female

Pin #	In/Out	Name	Description
1	**O**	**GND**	Ground
2	**I**	**LATCH**	Latch input
3	**I**	**DI1**	Digital Input 1. When DIO control mode is enabled, DI1 is designated as the (Start) signal.
4	**I**	**DI2**	Digital Input 2. When DIO control mode is enabled, DI2 is designated as the (Abort/Clear) signal.
5	**I**	**DI3**	Digital Input 3. When DIO control mode is enabled, DI3 is designated as the LSB bit for motion profile selection (Select 1).
6	**I**	**DI4**	Digital Input 4. When DIO control mode is enabled, DI4 is designated as the 2nd bit for motion profile selection (Select 2).
7	**I**	**DI5**	Digital Input 5. When DIO control mode is enabled, DI6 is designated as the 3rd bit for motion profile selection (Select 3).
8	**I**	**DI6**	Digital Input 6. When DIO control mode is enabled, DI6 is designated as the 4th bit for motion profile selection (Select 4).
9	**O**	**DO1**	Digital Output 1. When DIO control mode is enabled, DO1 is designated as the (In Pos) signal.
10	**O**	**DO2**	Digital Output 2. When DIO control mode is enabled, DO2 is designated as the (Error) signal.
11	**O**	**GND**	Ground
12	**I**	**485-**	RS-485 minus signal
13	**I**	**485+**	RS-485 plus signal

Table 4.4

Joystick Input Connector DB-9 Male

Pin #	In/Out	Name	Description
1	**I**	**AI1**	Analog Input 1
2	**I**	**AI2**	Analog Input 2
3			Not Used
4	**O**	**5V**	5V output from controller – from on-board regulator
5	**O**	**GND**	Ground
6			Not Used
7	**I**	**DI1**	Digital Input 1. When DIO control mode is enabled, DI1 is designated as the (Start) signal.
8	**I**	**DI2**	Digital Input 2. When DIO control mode is enabled, DI2 is designated as the (Abort/Clear) signal.

Table 4.5

NSC-A1 Interface Circuit

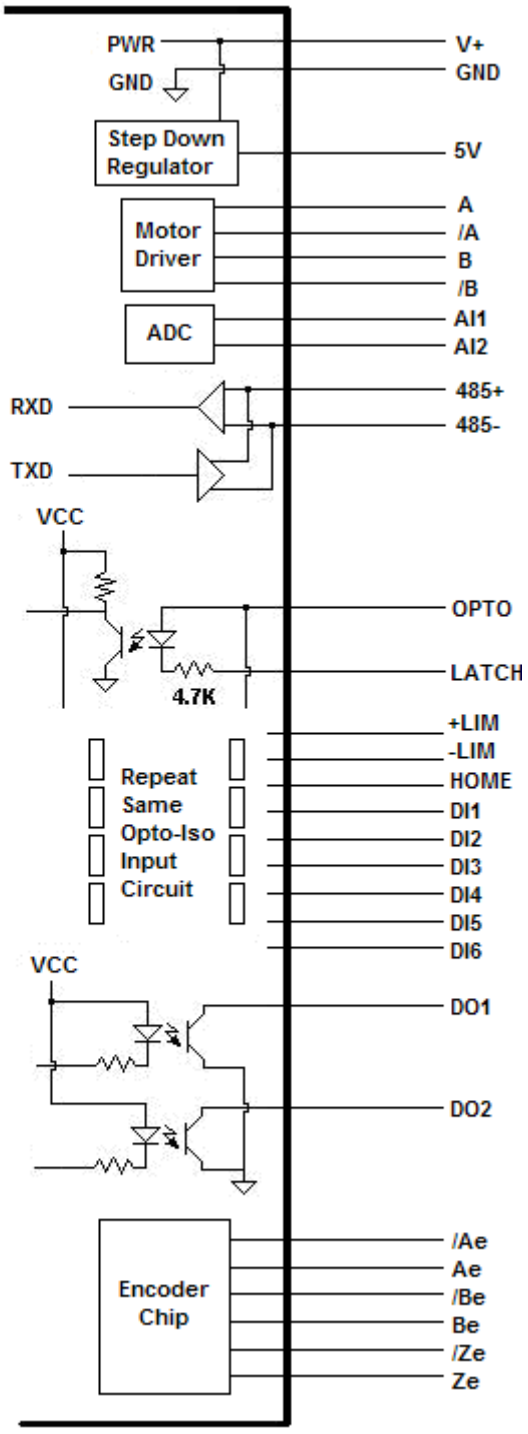


Figure 4.2

Digital Outputs

Figure 4.3 shows an example wiring to the digital output.

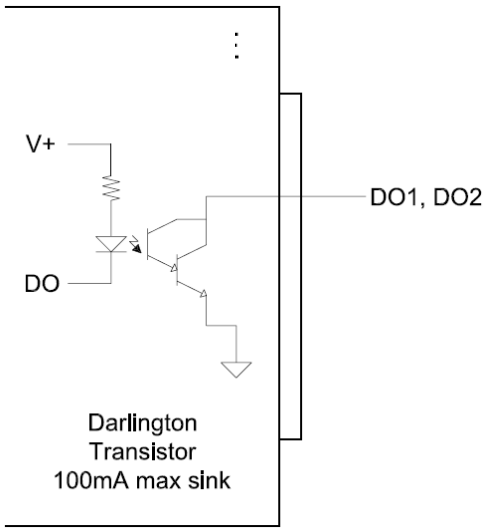


Figure 4.3

WARNING: The maximum sink current for digital outputs is 90 mA. Take caution to select the appropriate external supply and pull-up resistance to limit the sink current below this level.

Digital Inputs

Figure 4.4 shows the detailed schematic of the opto-isolated inputs.

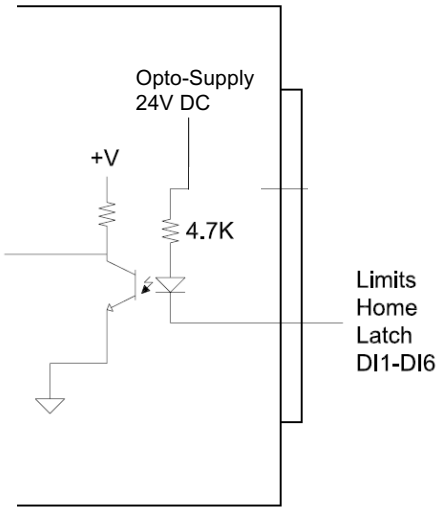


Figure 4.4

Encoder Input Connection

Both single-ended and differential quadrature encoder inputs are accepted.

When using single-ended encoders, use the /A, /B, and /Z inputs.

+5V supply and Ground signals are available to power the encoder. Make sure that the total current usage is less than 200mA for the +5V.

The maximum encoder frequency is 3MHz.

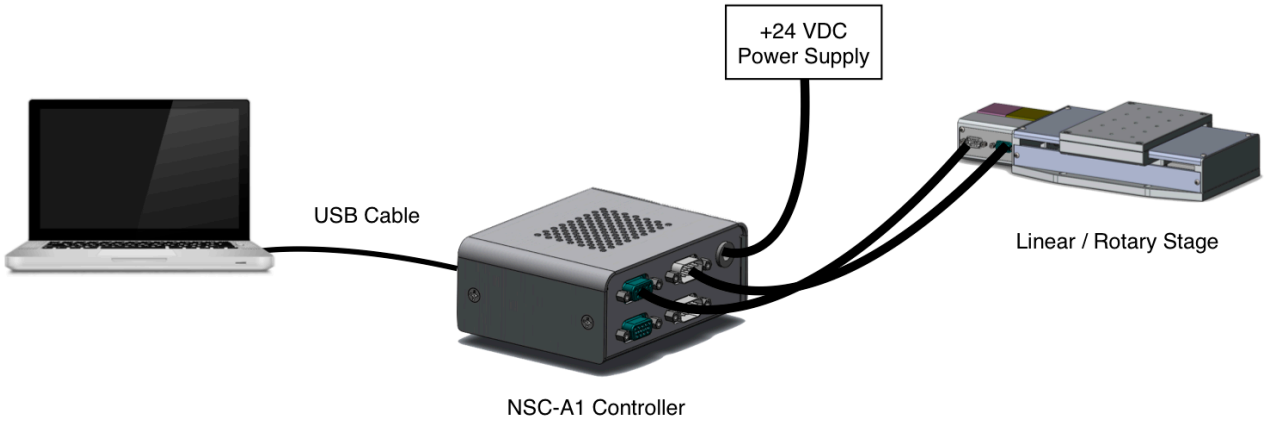
Motor Connection

NSC-A1 supports 4 wire bi-polar stepper motors.

WARNING: Do not disconnect the motor wires or motor connector while the driver is powered. Make sure to turn off the power when disconnecting or connecting the motor. Not doing so may damage the driver.

5. Getting Started

Typical Setup



1. Download and install the USB driver from the Newmark Systems website. http://www.newmarksystems.com/motion-controllers/nsc-a1/

2. Download and install the QuickMotion - NSC-A1 User Interface program from the Newmark Systems website. http://www.newmarksystems.com/motion-controllers/nsc-a1/

3. Connect the NSC-A1 to the linear or rotary stage and the PC similar to the above diagram. Note: Some linear and rotary stages only have a motor connector

4. Apply power to the NSC-A1 controller.

5. Open the QuickMotion NSC-A1 software.

6. Select the device from the list.

7. Click OK to continue. The main interface will open.

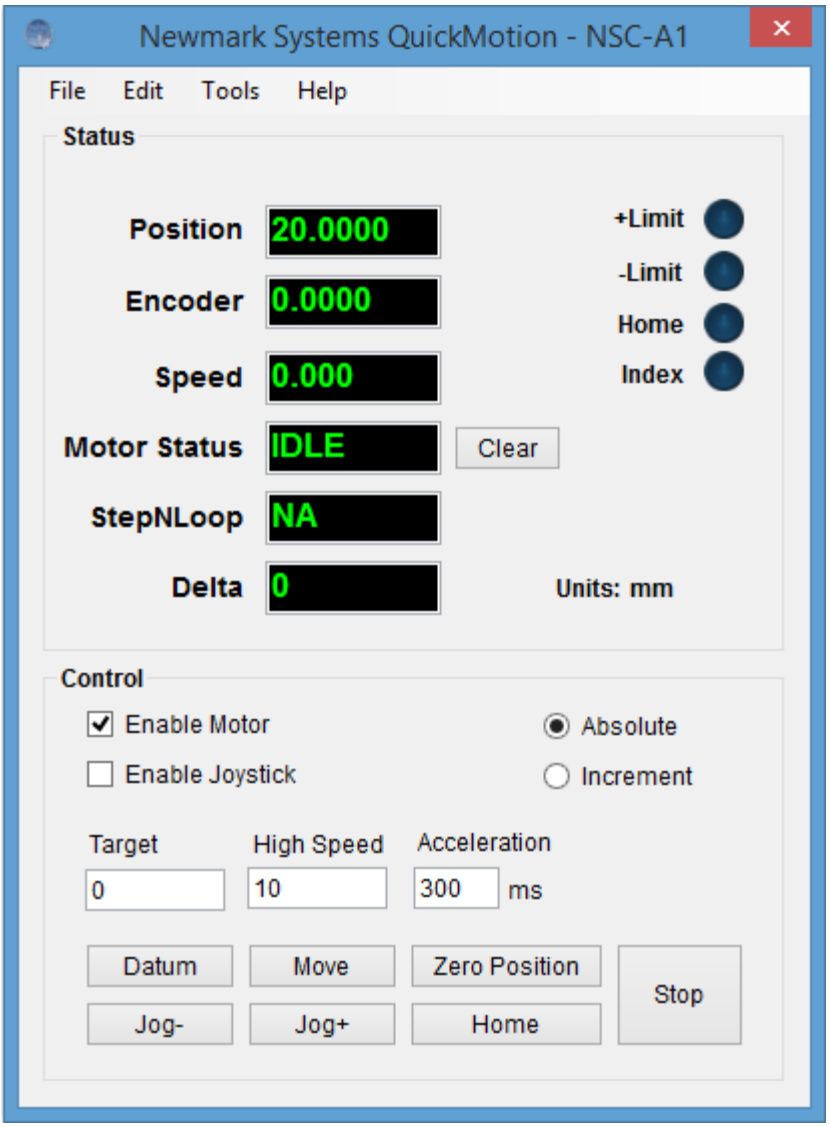
8. From the Tools menu, select Setup.

9. In the Setup window select the type of stage (rotary or linear), the series and model from the dropdown list.

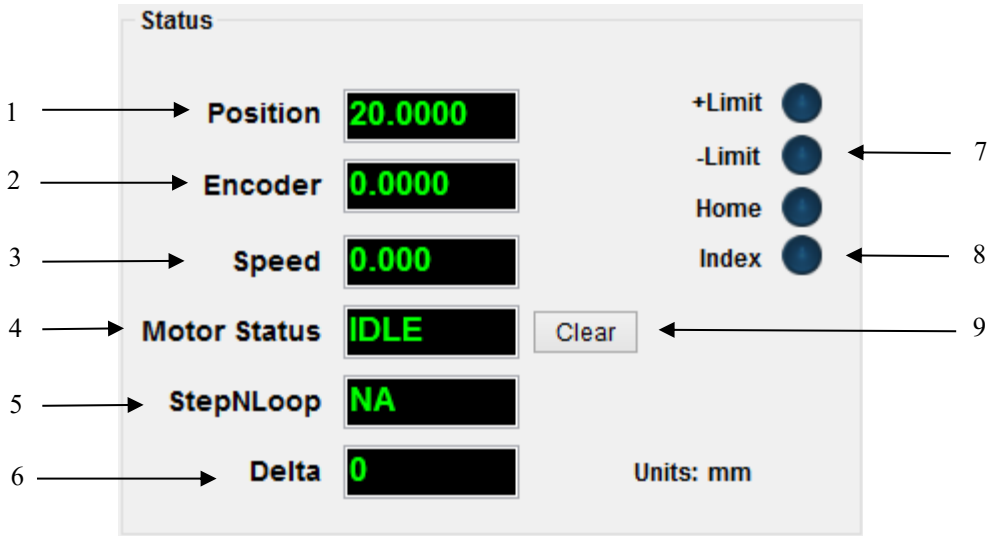
10. Finally, click OK to download the settings to the controller.

6. QuickMotion Software Overview

Main Control Screen



Status Display



1. **Position** – Displays the current motor position in the units selected by the user.
2. **Encoder** – Displays the current encoder position.

3. **Speed** – Displays the current motor pulse speed output rate. Value is in units/second. While the controller is in StepNLoop mode, this value shows encoder input speed in units/second.

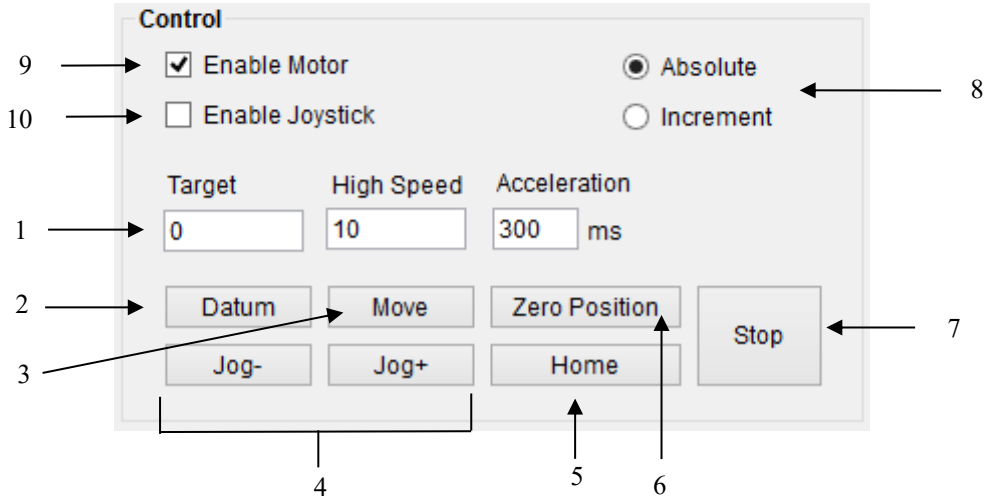
4. **Motor Status** – Displays current motor status by displaying one of the following status:
   - IDLE: motor is not moving
   - ACCEL: motion is in acceleration
   - DECEL: motion is in deceleration
   - CONST: motion is in constant speed
   - -LIM ERR: minus limit error
   - +LIM ERR: plus limit error
5. **StepNLoop Status** – valid only when StepNLoop is enabled and displays current StepNLoop status by displaying one of the following:
   - NA: StepLNoop is disabled
   - IDLE: motor is not moving
   - MOVING: target move is in progress
   - JOGGING: jog move is in progress
   - HOMING: homing is in progress
   - LHOMING: limit homing in progress
   - Z-HOMING: homing using Z-index channel in progress
   - ERR-STALL: StepNLoop has stalled.
   - ERR-LIM: plus/minus limit error

6. **Delta Counter** – Valid only for StepNLoop. Displays the difference between the motor position and the encoder position.

7. **Limit/Home Input Status** – Limit and Home input status.

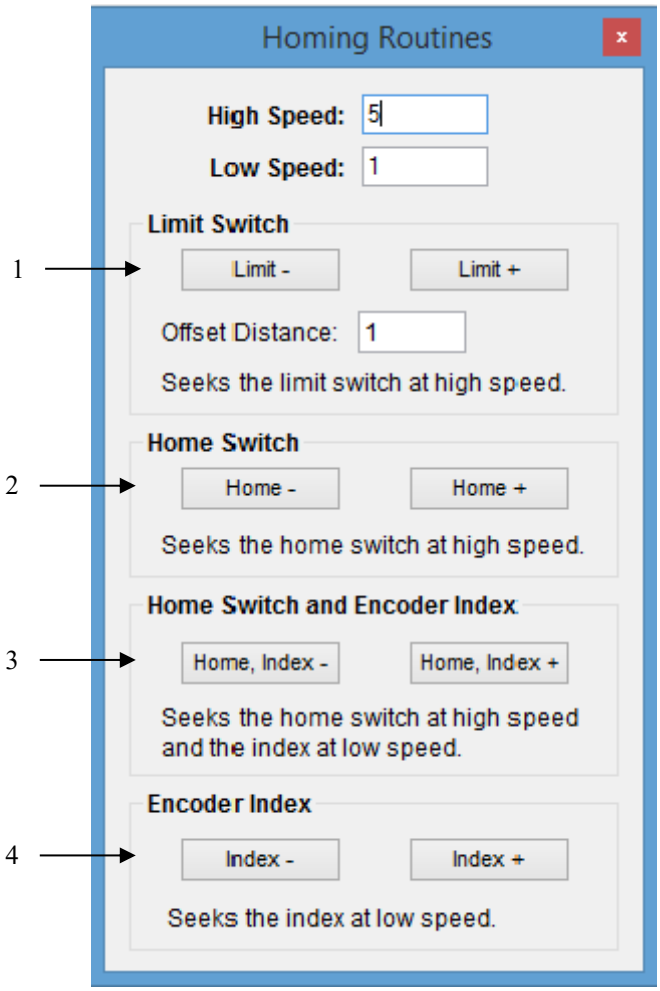
8. **Encoder Z Index Channel Status** – Encoder Z index channel status is displayed.
9. **Clear** – Clears a motor status error or a StepNLoop error.

Control



1. **Target Position/Speed/Accel**
   - Target: use this to set the target position.
   - High Speed: use this to set the speed of the move.
   - Accel: acceleration value in milliseconds
2. **Datum** – use this to move the motor to the zero target position.
3. **Move** – use this to move the motor to the target position.
   When in absolute mode, the axis will move to the absolute target position.
   When in incremental mode, the axis will move incrementally.
4. **Jogging** – jog motor in either positive or negative direction
5. **Home** – use this button to open the various homing routines.
6. **Zero Position** – use this button set the current position to zero.
7. **Stop** – use this button to stop the motion with deceleration.
8. **Absolute/Increment** – use this to switch between absolute and incremental mode.
9. **Enable Motor** – check this button to enable and disable the power to the stepper motor.
10. **Enable Joystick** – check this button to enable and disable the joystick.

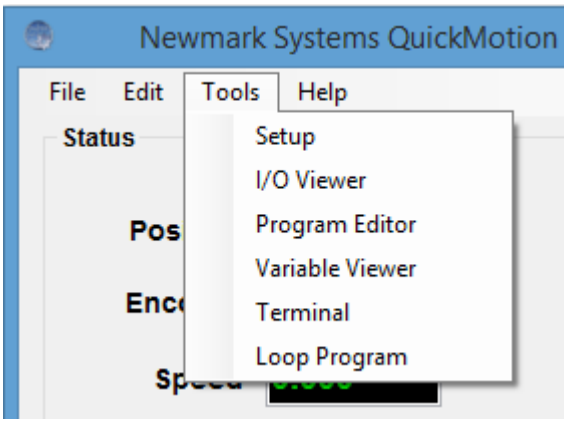
Homing Routines



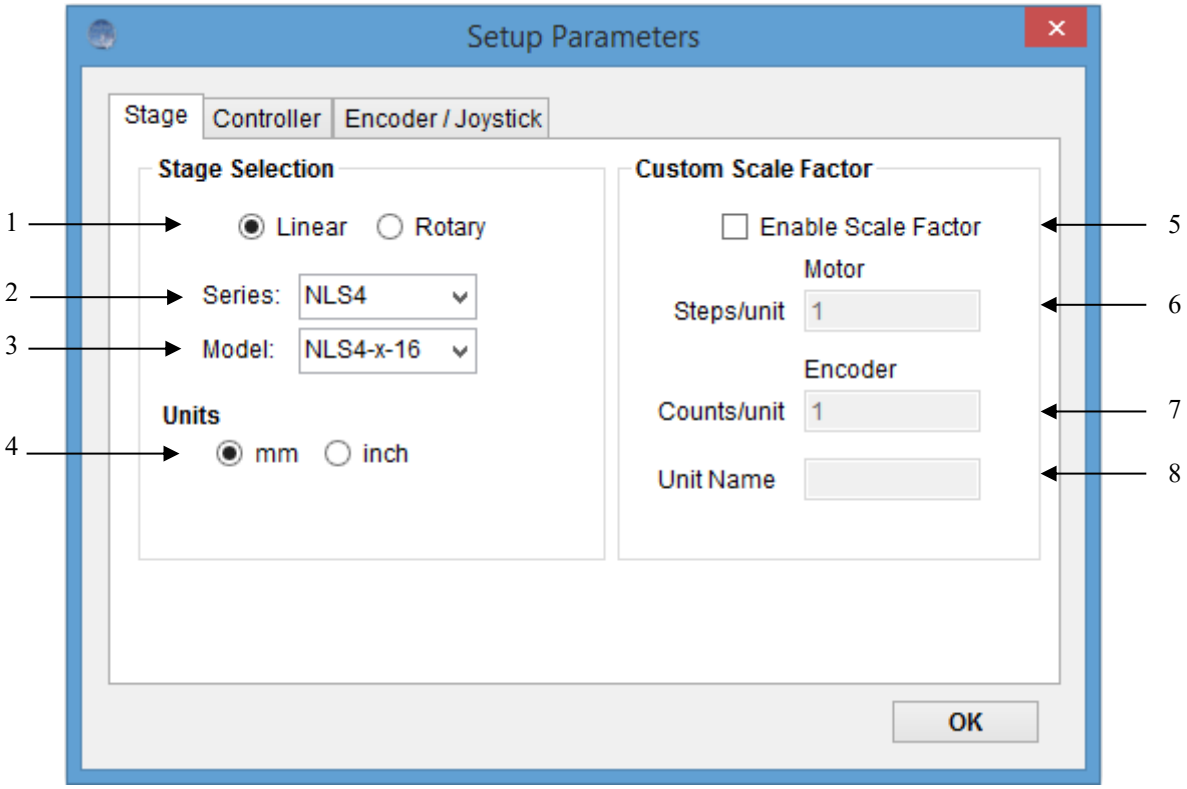
1. **Limit+ / Limit-** – Home the stage using only the limit switch. Uses the high speed value to seek the limit switch. The offset distance moves the stage a given amount from the limit switch.
2. **Home+ / Home-** – Home the stage at high speed using only the home switch.
3. **Home, Index+ / Home, Index-** – Both encoder index and home switch used for homing. Seeks the home switch at high speed and uses low speed for finding the index.
4. **Index+ / Index-** – Only encoder index channel used for homing. Uses low speed value.

Tools Menu in Main Control Screen

The windows on the following pages are accessed via the Tools Menu.



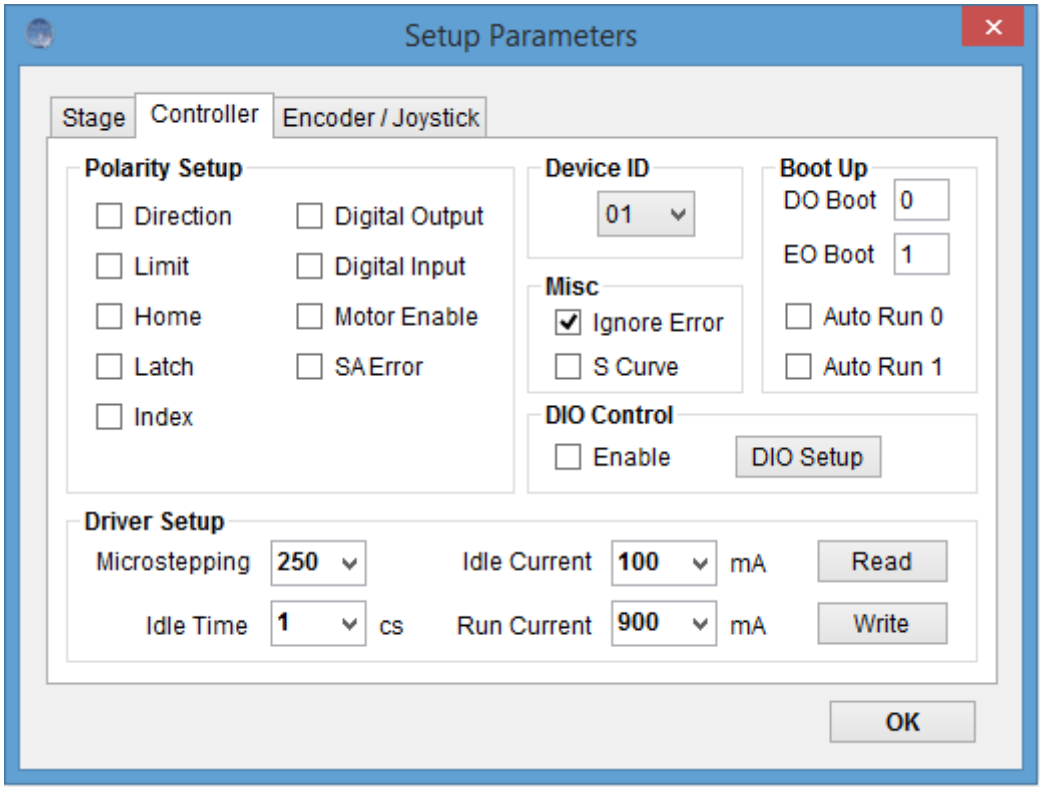
Setup Parameters - Stage



1. Select between Linear or Rotary Stages
2. Select stage Series from drop-down menu
3. Select the Model type. This will load the correct parameters for that stage.
4. Select between millimeters and inches.
5. Enable/disable custom scale factor. The custom scale factor is used to define different units (cm, microns, radians).

6. Steps/unit is used to define the number of motor steps to move one unit of distance.
7. Counts/unit is used to define the number of encoder counts to move one unit of distance.
8. This is used to set the name of the custom units (cm, microns, radians).

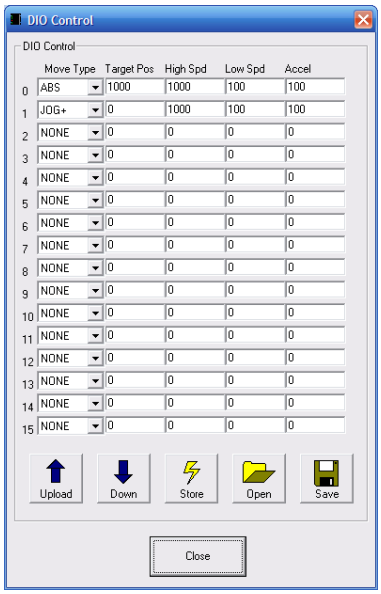
Setup Parameters - Controller



1. **Polarity Setup** – the following polarity parameters can be configured
   - Dir: direction of the motion (clockwise or counter-clockwise)
   - Home: home input polarity
   - Limit: limit input polarity
   - Latch: latch input polarity
   - Z-Index: Encoder Z index channel
   - Output: digital output polarity
   - Input: digital input polarity
   - SA Err: stand-alone error jump line.
     - Low: jump to previous line
     - High: jump to line 0
   - Enable: enable output polarity
2. **Driver Setup** – Following micro-step driver settings can be configured:
   - Micro-step: 2 to 500 micro-steps

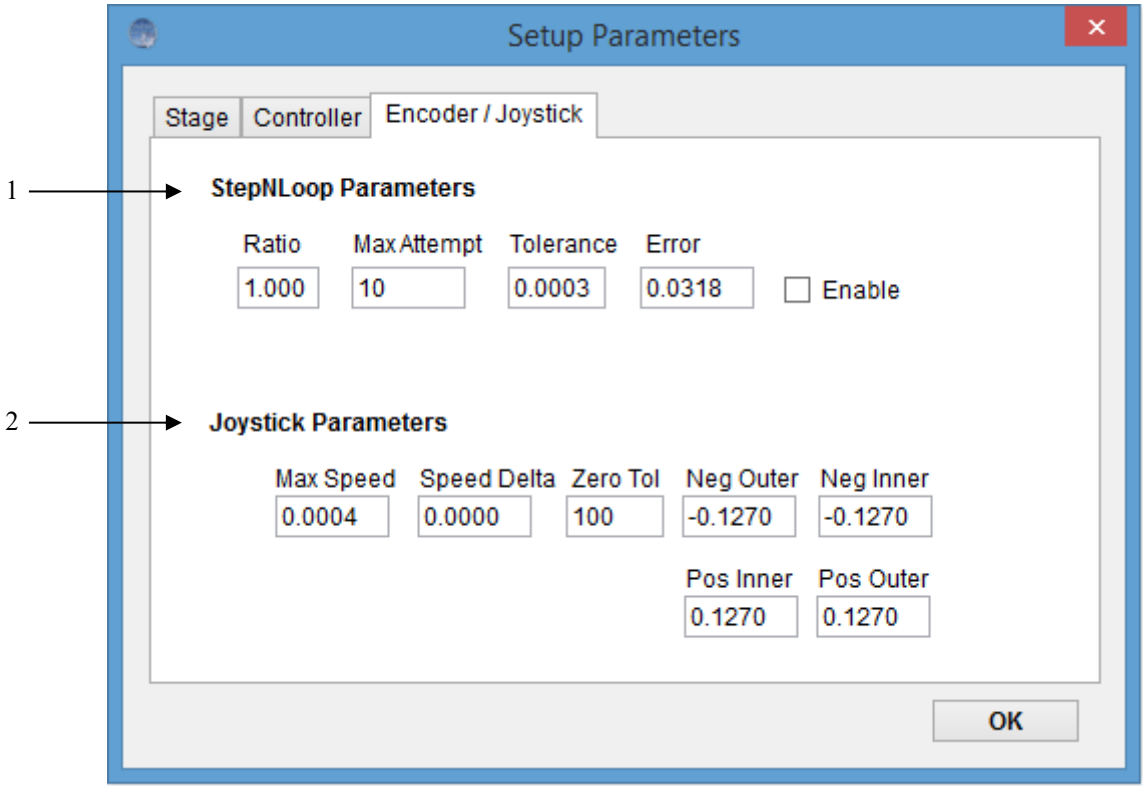
- Run Current: 100mA to 3Amp
- Idle Current: 100mA to 3Amp
- Idle Time:1 to 100 centi-second (10 centi-second = 1 second)

3. **Device ID**
   - Device ID configuration allows multiple devices on the RS-485 or USB communication network.
4. **DIO Control** – Digital IO motion control allows motion profiles to be triggered through the digital inputs. See DIO motion control section for details. The following dialog box is shown for the DIO motion control.



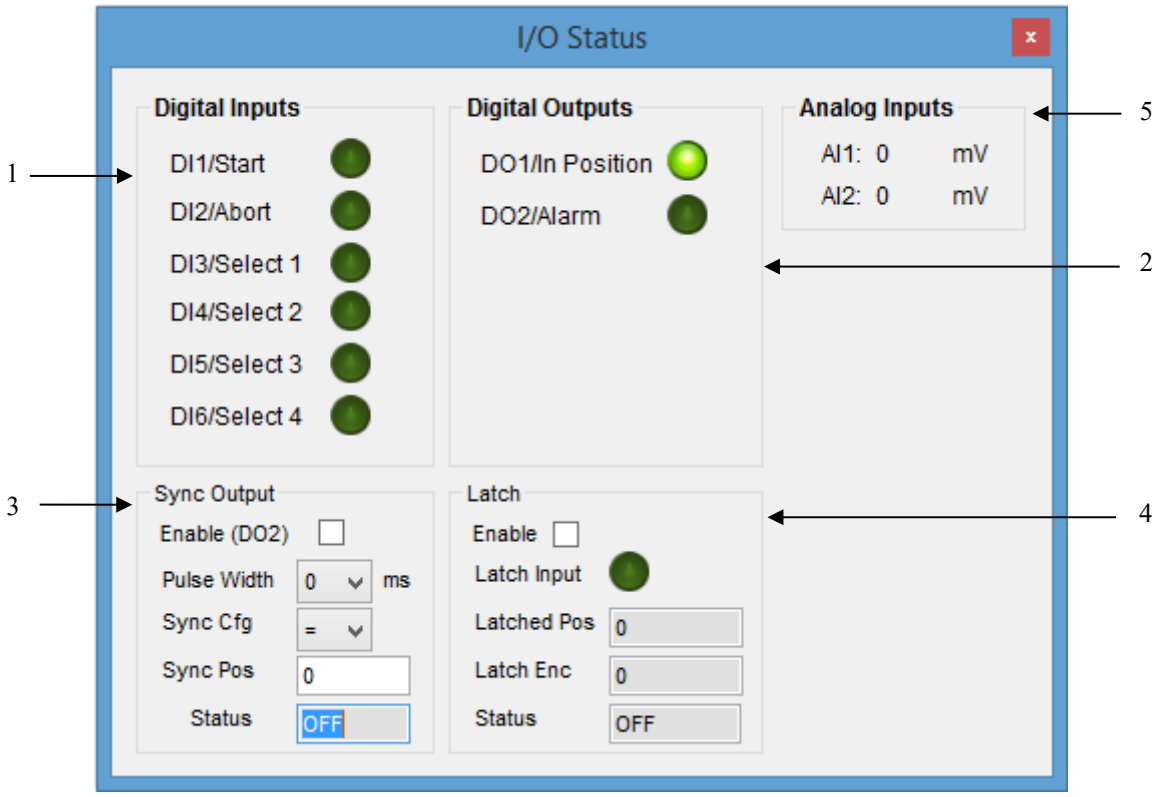
5. **Misc Settings**
   - IERR: Ignore limit error, will not generate an error when a limit switch is triggered.
   - S Curve: Turns on S curve profile
6. **Boot Up**
   - Auto Run 0: Run stand-alone program 0 on boot-up.
   - Auto Run 1: Run stand-alone program 1 on boot-up.
   - EOBOOT: Configure enable output boot-up state
   - DOBOOT: Configure digital output boot-up state

Setup Parameters – Encoder / Joystick



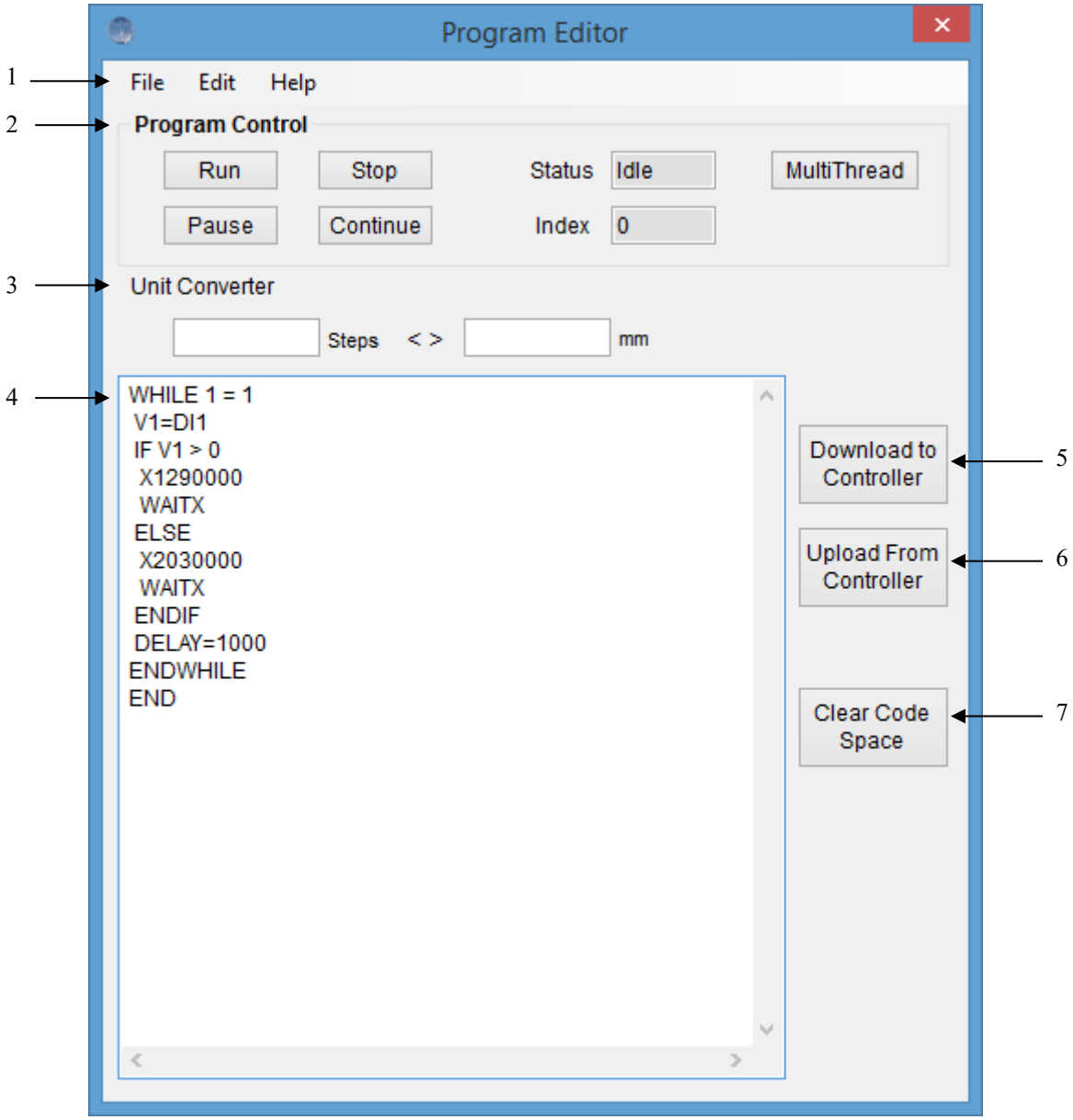
1. **StepNLoop Control** – Using the encoder input, StepNLoop control allows closed loop position verification and correction for the moves. See StepNLoop control section for details.
2. **Joystick Control** – NSC-A1 allows joystick control using the analog input 1. See joystick control section for details of the joystick parameters.

Digital I/O Status



1. **Digital Input Status** – digital inputs can be used for DIO move control or as general purpose use. Refer to the setup screen to disable and enable the DIO move control.
2. **Digital Out Status and Control** – digital outs are used for StepNLoop or general purpose output use. When used as general purpose outputs, the outputs can be triggered by clicking on the circle.
3. **Sync Output** – digital outputs can be triggered
4. **Latch** - encoder and pulse positions can be captured/latched with an input trigger.
5. **Analog Input** – Two analog input channels are available for general purpose use or for joystick control use. The analog values are in mV.

Standalone Program Editor

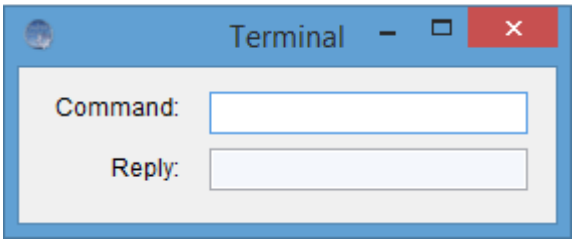


1. **File Menu:**
    a. **New** – Clear the standalone program editor
    b. **Open** – Open a standalone program
    c. **Save** – Save a standalone program
2. **Program Control**:
    a. **Run** –Standalone program is run.
    b. **Stop** – Program is stopped
    c. **Pause** – Program that is running can be stopped
    d. **Continue** – Program that is paused can be continued

e. **MultiThread** - Open the Standalone Program Control for all standalone programs

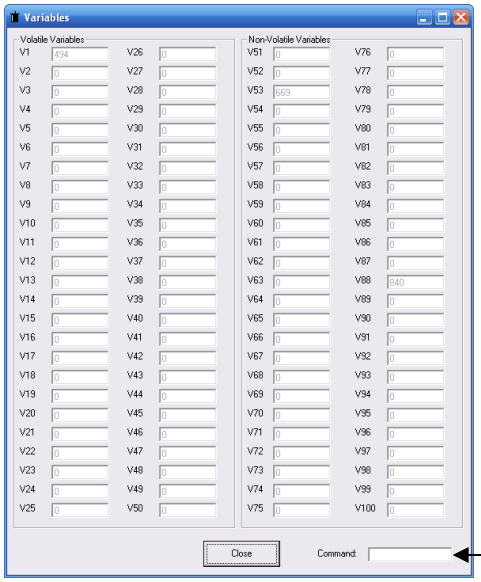
3. **Unit Converter** – Converts between motor steps and millimeters or inches. This is useful when writing standalone programs.
4. **Text Program –** Text box for writing and editing a standalone program. Programs must use motor steps, not millimeters or inches.
5. **Download** - Download the standalone program into memory.
6. **Upload** - Upload standalone code that is currently on your NSC-A1
7. **Clear Code Space –** Clear the code space on the NSC-A1.

Terminal



Terminal dialog box allows manual testing of the commands from a terminal screen as shown in Figure 5.8

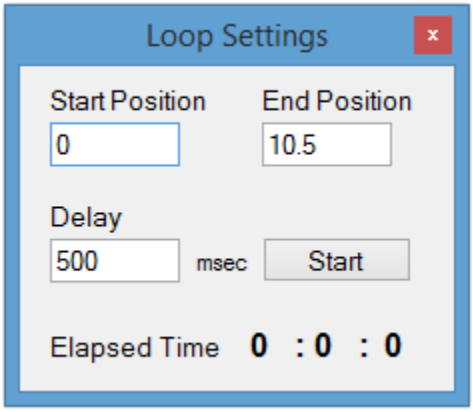
Variable Viewer



View the status of variables 1-100. Note that this window is read-only.

1. **Command line** – To write to variable, use V[1-100] = [value] syntax.

Loop Program



Allows the user to initiate a loop between a start and end position.

1. **Delay** – Sets a delay between each cycle.
2. **Start / Stop** – Starts and stops the loop program.
3. **Elapsed Time** – Displays the current duration the loop has been running.

6. Motion Control Overview

Important Note: All the commands described in this section are interactive commands and are not analogous to stand-alone commands. Refer to the "Standalone Language Specification" section for details regarding stand-alone commands.

Motion Profile

By default, a trapezoidal velocity profile is used. See Figure 6.0.

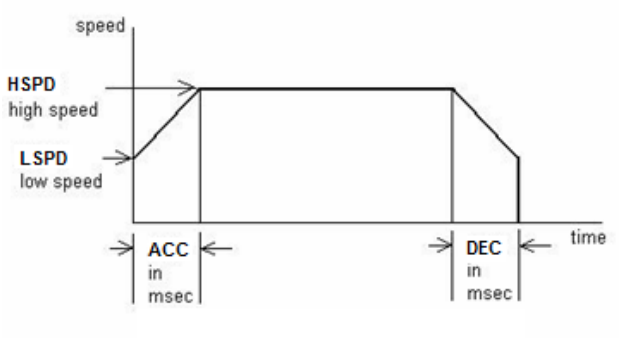


Figure 6.0

High speed and low speed are in pps (pulses/second). Use **HSPD/LSPD** commands to modify the high speed and low speed settings.

Acceleration and deceleration time are in milliseconds. Use the **ACC/DEC** command to modify the acceleration and deceleration values.

S-curve velocity profile can also be achieved by using the **SCV** command. See Figure 6.1.

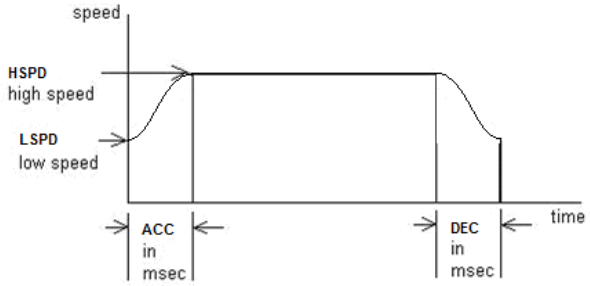


Figure 6.1

Notes:

By default, the deceleration is defined by the value set in the **ACC** parameter. In order to decelerate using the value set in the **DEC** parameter, set **EDEC** to 1.

The minimum and maximum acceleration values depend on the high speed and low speed settings. Refer to Table A.0 and Figure A.0 in **Appendix A** for details.

On-The-Fly Speed Change

On-the-fly speed change can be achieved with the **SSPD** command. In order to use the **SSPD** command, s-curve velocity profile must be disabled.

SSPD Mode

The correct speed window must be selected in order to use the SSPD command. To select a speed window, use the **SSPDM** command. Refer to **Appendix A** for details.

During on-the-fly speed change operation, you must keep the initial and destination speeds within the speed window.

For non on-the-fly speed change moves, set **SSPDM=0**.

Analog Inputs

Get the analog input status of the NSC-A1 by using the **AI1** and **AI2** commands. Return value is 0-5000 mV.

Joystick Control

Using analog input 1, speed control using analog input can be done. Analog input of 0V to 2.5V represents negative joystick direction and analog input of 2.5 to 5V represents positive joystick direction. 2.5V represents the zero joystick position. To set tolerance of the zero joystick position, use **JV5** variable. For example, if **JV5** is set to 100, then the zero range for X axis joystick control will be from 2.4V to 2.6V.

Maximum joystick speed is set using **JV1** variable

Summary of joystick control parameters

Command	Description
JV1	X axis Maximum Joystick Speed at 5V and 0V.
JV3	X axis Maximum speed change
JV5	X axis zero tolerance range for analog input

Table 6.0

Maximum speed change (**JV3**) variable affects the maximum amount that the speed can change due to change in analog input.

Joystick control also has soft limit control. Limits are broken down into positive inner and outer limits and negative inner and outer limits. When moving in positive direction, as soon as positive inner limit is crossed, the speed is reduced. If position crosses over the outer limit, the joystick speed is set to zero. Same goes for negative direction and negative limits.

Summary of joystick soft limit parameters

Command	Description
JL1	X axis Negative Outer Soft Limit

JL2	X axis Negative Inner Soft Limit
JL3	X axis Positive Inner Soft Limit
JL4	X axis Positive Outer Soft Limit

Table 6.1

To enable joystick control use **JO** command. The disable joystick control use **JF** command or **ABORT** command.

The behavior of the limits of the joystick control is explained by Figure 6.2.

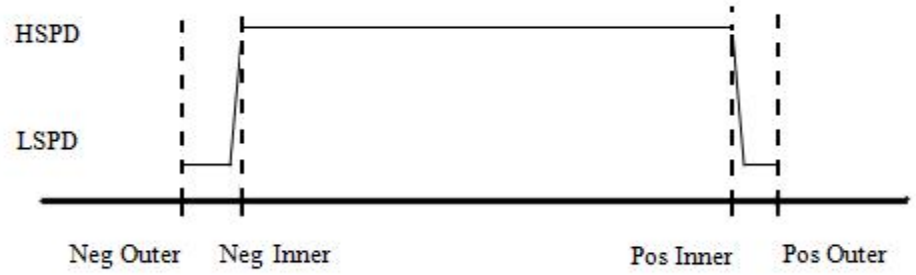


Figure 6.2

Digital Inputs/Outputs

NSC-A1 module comes with 6 digital inputs and 2 digital outputs which are can be used for DIO control. When DIO control is disabled, these can be used for general digital output. Enable/disable DIO control mode by using the **EDIO** command.

Inputs

Read digital input status using the **DI** command.
Digital input values can also be referenced one bit at a time by the **DI[1-6]** commands.
Note that the indexes are 1-based for the bit references (i.e. DI1 refers to bit 0, not bit 1)

Bit	Description	Bit-Wise Command
0	Digital Input 1 (Start)	DI1
1	Digital Input 2 (Abort/Clear)	DI2
2	Digital Input 3 (Select 1)	DI3
3	Digital Input 4 (Select 2)	DI4
4	Digital Input 5 (Select 3)	DI5
5	Digital Input 6 (Select 4)	DI6

Table 6.2

If digital input is on (i.e. input is pulled to GND of opto-supply), the bit status is 0. Otherwise, the bit status is 1.

Outputs

When DIO control is disabled, you can drive DO1 and DO2 by using the **DO** command. DO value must be within the range of 0-3.

Digital output values can also be referenced one bit at a time by the **DO[1-2]** commands. Note that the indexes are 1-based for the bit references (i.e. DO1 refers to bit 0, not bit 1)

Bit	Description	Bit-Wise Command
0	Digital Output 1 (In Position)	DO1
1	Digital Output 2 (Alarm)	DO2

Table 6.3

When DIO control is enabled, DO1 and DO2 are used as In Position and Alarm outputs.

If digital output is turned on (i.e. the output is pulled to GND), the bit status is 1. Otherwise, the bit status is 0.

The initial state of both digital outputs can be defined by setting the **DOBOOT** register to the desired initial digital output value. The value is stored to flash memory once the **STORE** command is issued.

Motor Power

Using the **EO** command, the motor power can be enabled or disabled. By default, the enable output is turn on at boot-up.

The initial state of the enable output can be defined by setting the **EOBOOT** register to the desired initial enable output value. The value is stored to flash memory once the **STORE** command is issued.

Polarity

Using the **POL** command, polarity of following signals can be configured:

Bit	Description	
0	Reserved	
1	Direction	
2	Reserved	
3	Reserved	
4	Limit	
5	Home	
6	Latch	
7	Z-channel index	
8,9	Encoder decoding	
	00	1X
	01	2X
	10	4X

10	Digital Output
11	Digital Input
12	Jump to line 0 on error†
13	Enable Output

Table 6.4

†Used for error handling within standalone operation. If this bit is on, the line that is executed after SUB31 is called will be line 0. Otherwise, it will be the line that caused the error.

Positional Moves

NSC-A1 can operate in either incremental or absolute move modes. Use **X** command to make moves. Use **INC** and **ABS** commands move modes. Use **MM** command to read the current move mode.

Note: If a motion command is sent while the controller is already moving, the command is not processed. Instead, an error response is returned.

On-The-Fly Target Position Change

On-the-fly target position change can be achieved using the **T[value]** command. While the motor is moving, **T[value]** will change the final destination of the motor. If the motor has already passed the new target position, it will reverse direction once the target position change command is issued.

Note: If a **T** command is sent while the controller is not performing a target move, the command is not processed. Instead, an error response is returned.

Jogging

Jogging is available for continuous speed operation. Use **J+** and **J-** commands to jog in positive or negative direction.

Stopping Motor

When motor is moving, jogging, or homing, using the **ABORT** command will immediately stop the motor. Using the **STOP** command will decelerate the motor to low speed and then stop.

Homing

Home search sequence involves moving the motor towards the home or limit switches and then stopping when the relevant input is detected. The NSC-A1 has four different homing routines:

Home Input Only (High speed only)

Use the **H+/H-** command. Figure 6.5 shows the homing routine.

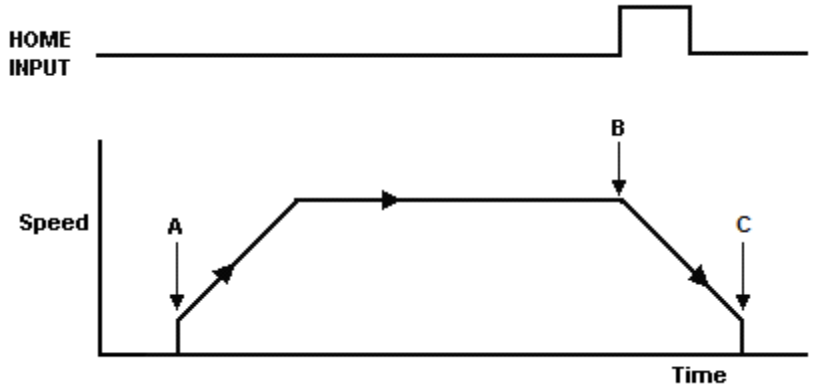


Figure 6.5

A. Starts the motor from low speed and accelerates to high speed.
B. As soon as the home input is triggered, the position counter is reset to zero and the motor begins to decelerate to low speed. As the motor decelerates, the position counter keeps counting with reference to the zero position.
C. Once low speed is reached, the motor stops. The position is non-zero.

Home Input Only (High speed and low speed)

Use the **HL+/HL-** command. Figure 6.6 shows the homing routine.

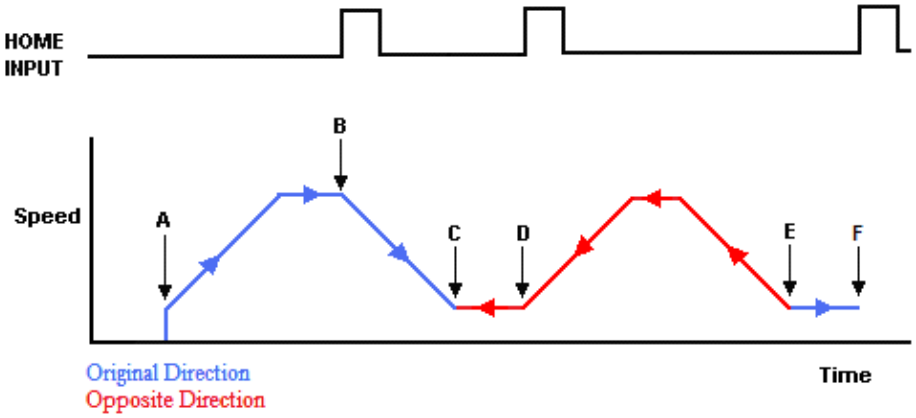


Figure 6.6

A. Starts the motor from low speed and accelerates to high speed.
B. As soon as the home input is triggered, the position counter is reset to zero and the motor decelerates to low speed.
C. Once low speed is reached, the motor reverses direction to search for the home switch.
D. Once the home switch is reached, it will continue past the home switch by the amount defined by the home correction amount (**HCA**) at high speed.
E. The motor is now past the home input by the amount defined by the home correction amount (**HCA**). The motor now moves back towards the home switch at low speed.
F. The home input is triggered again, the position counter is reset to zero and the motor stops immediately

Limit Only

Use the **L+/L-** command. Figure 6.7 shows the homing routine.

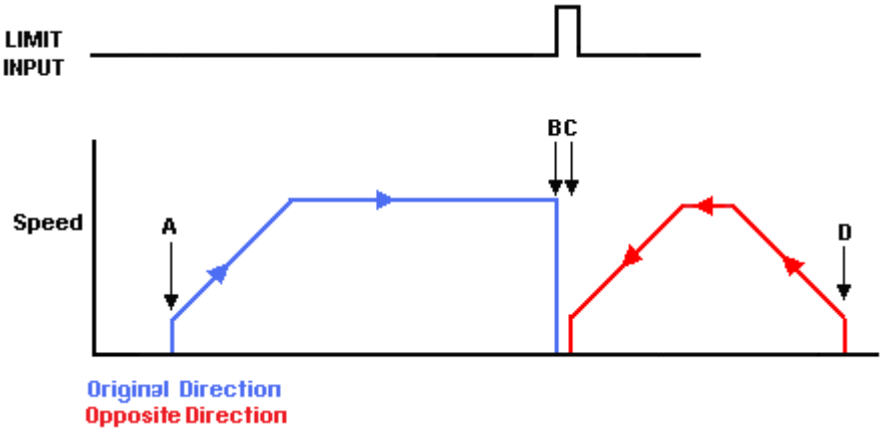


Figure 6.7

A. Issuing a limit home command starts the motor from low speed and accelerates to high speed.
B. The corresponding limit is triggered and the motor stops immediately.
C. The motor reverses direction by the amount defined by the limit correction amount (**LCA**) at high speed.
D. The zero position is reached.

Home Input and Z-index

Use the **ZH+/ZH-** command. Figure 6.8 shows the homing routine.

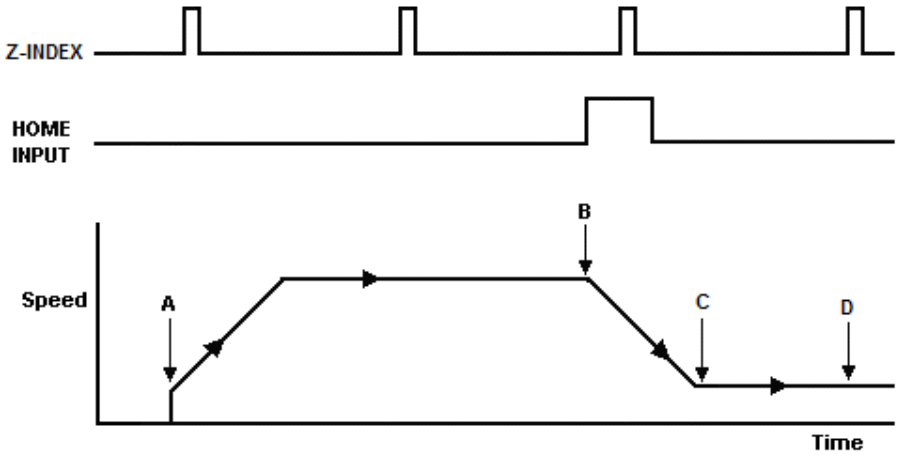


Figure 6.8

A. Issuing a limit home command starts the motor from low speed and accelerates to high speed.
B. As soon as the home input is triggered, the motor decelerates to low speed
C. Once low speed is reached, the motor begins to search for the z-index pulse.
D. Once the z-index pulse is found, the motor stops and the position is set to zero.

Z-index Only

Use the **Z+/Z-** command. Figure 6.9 shows the homing routine.

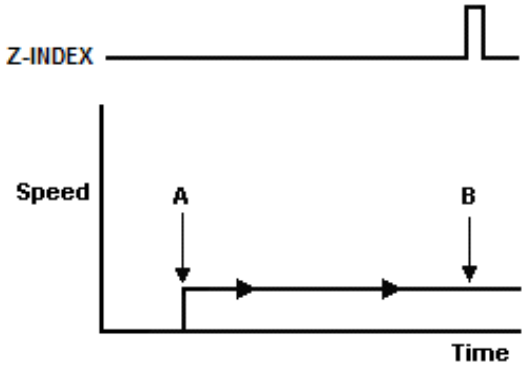


Figure 6.9

A. Issuing a limit home command starts the motor at low speed.
B. Once the z-index pulse is found, the motor stops and the position is set to zero.

Note: For **H**, **HL** homing routines, it is possible to have the motor automatically return to the zero position. To do so, set the **RZ** register to 1.

Motor Position

Motor position can be set and read by using the **PX** command.
Encoder position can be set and read by using the **EX** command.

Motor Status

Motor status can be read anytime by reading the response to the **MST** command. The following is the bit representation of motor status:

Bit	Description
0	Motor running at constant speed
1	Motor in acceleration
2	Motor in deceleration
3	Home input switch status
4	Minus limit input switch status
5	Plus limit input switch status
6	Minus limit error. This bit is latched when minus limit is hit during motion. This error must be cleared using the **CLR** command before issuing any subsequent move commands.
7	Plus limit error. This bit is latched when plus limit is hit during motion. This error must be cleared using the **CLR** command before issuing any subsequent move commands.
8	Latch input status
9	Z-index status
10	TOC time-out status

Table 6.5

Examples:

- When motor status value is 0, motor is idle and all input switches are off.
- When motor status value is 2, motor is in acceleration.
- When motor status value is 9, motor is moving in constant high speed and home input switch is on.
- When motor status value is 64, motor is in minus limit error. Use **CLR** command to clear the error before issuing any more move commands.

Limit Inputs

If positive limit switch is triggered while moving in positive direction, the motor will immediately stop and the motor status bit for positive limit error is set. The same is for the negative limit while moving in the negative direction. Once the limit error is set, use the **CLR** command to clear the error. Once the error is cleared, move the motor out of the limit switch.

The limit error state can be ignored by setting **IERR**=1. In this case, the motor will still stop when the limit switch is triggered; however, it will not enter an error state.

Latch Input

The NSC-A1 module provides the following high speed position latch input.

This input performs high speed position capture of both pulse and encoder positions but does not reset the pulse or encoder position counters.

Note: When StepNLoop mode is enabled, the position value should be ignored.

Use the **LT** command to enable and disable latch feature. To read the latch status, use **LTS** command.

Following are return value description for **LTS** command.

Return Value	Description
0	Latch off
1	Latch on and waiting for latch trigger
2	Latch triggered

Table 6.6

Once the latch is triggered, the triggered position can be retrieved using **LTP** (latched pulse position) and **LTE** (latched encoder position) commands.

StepNLoop Closed Loop Control

NSC-A1 features a closed-loop position verification algorithm called StepNLoop (SNL). The algorithm requires the use of an incremental encoder.

SNL performs the following operations:

1) Position Verification: At the end of any targeted move, SNL will perform a correction if the current error is greater than the tolerance value.
2) Delta Monitoring: The delta value is the difference between the actual and the target position. When delta exceeds the error range value, the motor is stopped and the SNL Status goes into an error state. Delta monitoring is performed during moves – including homing and jogging. To read the delta value, use the **DX** command.

See Table 6.7 for a list of the SNL control parameters.

SNL Parameter	Description	Command
StepNLoop Ratio	†Ratio between motor pulses and encoder counts. This ratio will depend on the motor type, micro-stepping, encoder resolution and decoding multiplier. Value must be in the range [0.001 , 999.999].	**SLR**
Tolerance	Maximum error between target and actual position that is considered "In Position". In this case, no correction is performed. Units are in encoder counts.	**SLT**
Error Range	Maximum error between target and actual position that is not considered a serious error. If the error exceeds this value, the motor will stop immediately and go into an error state.	**SLE**
Correction Attempt	Maximum number of correction tries that the controller will attempt before stopping and going into an error state.	**SLA**

Table 6.7

†A convenient way to find the StepNLoop ratio is to set EX=0, PX=0 and move the motor +1000 pulses. The ratio can be calculated by dividing 1000 by the resulting EX value. Note that the value must be positive. If it is not, then the direction polarity must be adjusted. See Table 6.4 for details.

To enable/disable the SNL feature use the **SL** command. To read the SNL status, use **SLS** command to read the status.

See Table 6.8 for a list of the **SLS** return values.

Return Value	Description
0	Idle
1	Moving
2	Correcting
3	Stopping
4	Aborting
5	Jogging
6	Homing
7	Z-Homing
8	Correction range error. To clear this error, use **CLRS or CLR** command.
9	Correction attempt error. To clear this error, use **CLRS or CLR** command.
10	Stall Error. **DX** value has exceeded the correction range value. To clear

	this error, use **CLRS or CLR** command.
11	Limit Error
12	N/A (i.e. SNL is not enabled)
13	Limit homing

Table 6.8

See Table 6.9 for SNL behavior within different scenarios.

Condition	SNL behavior (motor is moving)	SNL behavior (motor is idle)
δ <= SLT	Continue to monitor the **DX**	In Position. No correction is performed.
δ > SLT AND δ < SLE	Continue to monitor the **DX**	Out of Position. A correction is performed.
δ > SLT AND δ > SLE	Stall Error. Motor stops and signals and error.	Error Range Error. Motor stops and signals and error.
Correction Attempt > SLA	NA	Max Attempt Error. Motor stops and signals and error.

Table 6.9

Key
[δ]: Error between the target position and actual position
SLT: Tolerance range
SLE: Error range
SLA: Max correction attempt

Notes:
Once SNL is enabled, position move commands are in term of encoder position. For example, X1000 means to move the motor to encoder 1000 position.

Once SNL is enabled, the speed is in encoder speed. For example HSPD=1000 when SNL is enabled means that the target high speed is 1000 encoder counts per second.

If DIO mode is on while SNL is enabled, DO1 is dedicated as the "In Position" output and DO2 is dedicated as the "Alarm" output. In order to use the digital outputs for general purpose, disable DIO by setting **EDIO=0**.

Device Number

NSC-A1 module provides the user with the ability to modify the unique device number. In order to make these changes, first store the desired number using the **DN** command. Note that this value must be within the range [SDE01,SDE99].

To write the values to the device's flash memory, use the **STORE** command. After a complete power cycle, the new device number will be written to memory. Note that before a power cycle is completed, the settings will not take effect.

By default: Device name is set to: **SDE01**

Baud Rate Setting

NSC-A1 provides the user with the ability to set the desired baud rate of the serial communication. In order to make these changes, first store the desired baud rate by using the **DB** command.

Return Value	Description
1	9600
2	19200
3	38400
4	57600
5	115200

Table 6.10

To write the values to the device's flash memory, use the **STORE** command. After a complete power cycle, the new device number will be written to memory. Note that before a power cycle is completed, the settings will not take effect.

By default: Baud rate is set to: **1 (9600 bps)**

Sync Output

NSC-A1 has a designated synchronization digital output (DO2). The synchronization signal output is triggered when the encoder position value meets the set condition.

While this feature is enabled, the designated digital output (DO2) cannot be controlled by user.

Use **SYNO** to enable the synchronization output feature.

Use **SYNF** to disable the synchronization output feature.

Use **SYNP** to read and set the synchronization position value. (28-bit signed number)

Use **SYNC** to set the synchronization condition.

1 – Turn the output on when the encoder position is EQUAL to sync position. If the synchronization output is done during motion, the sync output pulse will turn on only when the encoder position and sync position are equal.
2 – Turns output on when the encoder position is LESS than the sync position.
3 – Turns output on when the encoder position is GREATER than sync position.

Use **SYNT** to set the pulse width output time (ms). This parameter is only used if the synchronization condition is set to 1. Note the maximum pulse width is 10 ms. If this parameter is set to 0, the output pulse will depend on how long the encoder value is equal to the sync position.

Use **SYNS** to read the synchronization output status.

0 – Sync output feature is off
1 – Waiting for sync condition
2 – Sync condition occurred

When sync output feature is first enabled, the digital output turns on (i.e. the output is pulled to GND and DO2=1). Once sync output is triggered, the digital output turns off (i.e. the output is pulled to Vs and DO2=0).

Broadcasting over RS-485

The address '00' is reserved for broadcasting over an RS-485 bus. Any ASCII command prefixed by '@00' will be processed by all NSC-A1 modules on the RS-485 bus. When a broadcast command is received by an NSC-A1 module, no response is sent back to the master.

Response Type

It is possible to choose between two types of response string formats. This parameter can be set using the **RT** command.

Format 1 (default): [Response][CR]

Examples:
For querying the encoder position
Send: @01EX[CR]
Reply: 1000[CR]

For jogging the motor in positive direction
Send: @01J+[CR]
Reply: OK[CR]

To achieve this response string type, set **RT=0**.

Format 2: #[DeviceName][Response][CR]

Examples:
For querying the encoder position
Send: @01EX[CR]
Reply: #011000[CR]

For jogging the motor in positive direction
Send: @01J+[CR]
Reply: #01OK[CR]

To achieve this response string type, set **RT=1**.

To write the response type parameter to flash memory, use the STORE command. After a complete power cycle, the new response type will take effect. Note that before a power cycle is done, the setting will not take effect.

Micro-step Driver Configuration

The built in driver of NSC-A1 can be configured via software. See below for commands relating to driver configuration.

Command	Description
DRVMS	Micro-stepping value of the driver [2-500].
DRVRC	Run current value of the driver [100-3000 mA] (peak current)
DRVIC	Idle current value of the driver [100-2800 mA] (peak current)
DRVIT	Idle time value of the driver [1-100 centi-sec]. This is the amount of time the driver waits before dropping from the run current to idle current value
RR	Get driver parameters. DRVMS/DRVRC/DRVIC/DRVIT values will not be valid until the controller reads the driver parameters by issuing the RR command. Once this command is issued, communication to NSC-A1 will not be available for 2 seconds.
R2	Get the read operation status. After issuing the RR command and waiting 2 seconds, get the read operation status by using the R2 command. A return value of 1 signifies a successful read. All other return values signify a failed read operation.
RW	Write driver parameters. After DRVMS/DRVRC/DRVIC/DRVIT parameters are set by the user, they are not actually written to the driver until the RW command is sent. Once this command is issued, communication to NSC-A1 will not be available for 2 seconds.
R4	Get the write operation status. After issuing the RW command and waiting 2 seconds, get the write operation status by using the R4 command. A return value of 1 signifies a successful write. All other return values signify a failed write operation.

Table 6.11

Notes:
Driver configuration can also be done via standalone code.

While reading or writing to the micro-step driver, StepNLoop, joystick control and DIO control modes must be disabled. These control modes may interfere with the driver configuration.

Standalone Programming

Standalone Program Specification:
Memory size: 1785 assembly lines ~ 10.5 KB.
Note: Each line of pre-compiled code equates to 1-4 lines of assembly lines.

WAIT Statement: When writing a standalone program, it is generally necessary to wait until a motion is completed before moving on to the next line. In order to do this, the WAIT statement must be used. See the examples below:

In the example below, the variable V1 will be set immediately after the X10000 move command begins; it will not wait until the controller is idle.

```
X10000          ;* Move to position 0
V1=100
```

Conversely, in the example below, the variable V1 will not be set until the motion has been completed. V1 will only be set once the controller is idle.

```
X10000          ;* Move to position 0
WAITX           ;* Wait for the move to complete
V1=100
```

Multi-Threading: The NSC-A1 supports the simultaneous execution of two standalone programs. Program 0 is controlled via the **SR0** command and program 1 is controlled via the **SR1** command. For examples of multi-threading, please refer to the **Example Stand-alone Programs** section.

Note: Sub-routines can be shared by different threads.

Error Handling: If an error occurs during standalone execution (i.e. limit error), the program automatically jumps to SUB 31. If SUB 31 is NOT defined, the program will cease execution and go to error state. If SUB 31 is defined by the user, the code within SUB 31 will be executed. The return jump line will be determined by bit 12 of the **POL** register. See Table 6.4 for details.

Calling subroutines over communication: Once a subroutine is written into the flash, they can be called via USB communication using the **GS** command. The subroutines are referenced by their subroutine number [0-31]. If a subroutine number is not defined, the controller will return with an error.

Standalone Run on Boot-Up: Standalone can be configured to run on boot-up using the **SLOAD** command. See description below:

Bit	Description
0	Standalone Program 0
1	Standalone Program 1

Table 6.12

Note: DIO communication is not allowed while a standalone programming is running. If DIO communication is enabled while a standalone program begins execution, DIO communication will be automatically disabled.

Communication Time-out Feature (Watchdog)

NSC-A1 allows for the user to trigger an alarm if the master has not communicated with the device for a set period of time. When an alarm is triggered bit 10 of the **MST** parameter is turned on. The time-out value is set by the **TOC** command. Units are in milliseconds. This feature is usually used in stand-alone mode. Refer to the **Example Stand-alone Programs** section for an example. In order to disable this feature set **TOC=0**.

Storing to Flash

The following items are stored to flash:

ASCII Command	Description
DB	Serial communication baud rate
DN	Device name
DNM	†Modbus device number
DOBOOT	DO configuration at boot-up
DRVMS, DRVRC, DRVIC, DRVIT	Micro-step driver settings
EDEC	Unique deceleration enable
EDIO, MP	DIO communication settings
EOBOOT	EO configuration at boot-up
HCA	Home correction amount
IERR	Ignore limit error enable
JO, JF, JV1, JV3, JV5, JL1-4	Joystick settings
LCA	Limit correction amount
POL	Polarity settings
RSM	†Modbus enable
RT	ASCII response type
RZ	Return to zero position after homing
SL, SLR, SLE, SLT, SLA	StepNLoop parameters
SLOAD	Standalone program run on boot-up parameter
TOC	Time-out counter reset value
V51-V100	Note that on boot-up, V1-V50 are reset to value 0

Table 6.13

† See “Modbus_Addition_Addendum_A” document for details.

Note: When a standalone program is downloaded, the program is immediately written to flash memory.

7. Communication – USB

NSC-A1 USB communication is USB 2.0 compliant.

Communication between the PC and NSC-A1 is done using Windows compatible DLL API function calls as shown below. Windows programming language such as Visual BASIC, Visual C++, LABView, or any other programming language that can use DLL can be used to communicate with the Performax module.

Typical communication transaction time between PC and NSC-A1 for sending a command from a PC and getting a reply from NSC-A1 using the **fnPerformaxComSendRecv**() API function is in single digit milliseconds. This value will vary with CPU speed of PC and the type of command.

USB Communication API Functions

For USB communication, following DLL API functions are provided.

BOOL **fnPerformaxComGetNumDevices**(OUT LPDWORD lpNumDevices);

- This function is used to get total number of all types of Performax and Performax USB modules connected to the PC.

BOOL **fnPerformaxComGetProductString**(IN DWORD dwNumDevices,
OUT LPVOID lpDeviceString,
IN DWORD dwOptions);

- This function is used to get the Performax or Performax product string. This function is used to find out Performax USB module product string and its associated index number. Index number starts from 0.

BOOL **fnPerformaxComOpen**(IN DWORD dwDeviceNum,
OUT HANDLE* pHandle);

- This function is used to open communication with the Performax USB module and to get communication handle. dwDeviceNum starts from 0.

BOOL **fnPerformaxComClose**(IN HANDLE pHandle);

- This function is used to close communication with the Performax USB module.

BOOL **fnPerformaxComSetTimeouts**(IN DWORD dwReadTimeout,
DWORD dwWriteTimeout);

- This function is used to set the communication read and write timeout. Values are in milliseconds. This must be set for the communication to work. Typical value of 1000 msec is recommended.

BOOL **fnPerformaxComSendRecv**(IN HANDLE pHandle,
IN LPVOID wBuffer,
IN DWORD dwNumBytesToWrite,

IN DWORD dwNumBytesToRead,
OUT LPVOID rBuffer);

- This function is used to send command and get reply. Number of bytes to read and write must be 64 characters.

BOOL ***fnPerformaxComFlush***(IN HANDLE pHandle)

- Flushes the communication buffer on the PC as well as the USB controller. It is recommended to perform this operation right after the communication handle is opened.

USB Communication Issues

A common problem that users may have with USB communication is that after sending a command from the PC to the device, the response is not received by the PC until another command is sent. In this case, the data buffers between the PC and the USB device are out of sync. Below are some suggestions to help alleviate this issue.

1) **Buffer Flushing:** If USB communication begins from an unstable state (i.e. your application has closed unexpectedly, it is recommended to first flush the USB buffers of the PC and the USB device. See the following function prototype below:

   BOOL ***fnPerformaxComFlush***(IN HANDLE pHandle)

   Note: fnPerformaxComFlush is only available in the most recent PerformaxCom.dll which is not registered by the standard USB driver installer. A sample of how to use this function along with this newest DLL is available for download on the website

8. Communication – RS-485 (ASCII)

When communicating on RS-485 (ASCII), it is recommended to add 120 Ohm terminating resistor between 485+ and 485- signal on the last module.

Communication Port Settings

Parameter	Setting
Byte Size	8 bits
Parity	None
Flow Control	None
Stop Bit	1

Table 8.0

ASCII Protocol

Sending Command

ASCII command string in the format of

@[DeviceName][ASCII Command][CR]

[CR] character has ASCII code 13.

Receiving Reply

The response will be in the format of

[Response][CR]

[CR] character has ASCII code 13.

Examples:

For querying the x-axis polarity

Send: @00POL[CR]
Reply (if RT=0): 7[CR]
Reply (if RT=1): #007[CR]

For jogging the x-motor in positive direction

Send: @00J+[CR]
Reply (if RT=0): OK[CR]
Reply (if RT=1): #00OK[CR]

For aborting any motion in progress

Send: @00ABORT[CR]
Reply (if RT=0): OK[CR]
Reply (if RT=1): #00OK[CR]

Note: RT is a parameter that sets the response type of the device.

9. Communication - DIO

DIO communication allows the user to store 16 different types (see Table 9.1) of moves into NSC-A1 flash memory. These moves can be referenced using the **select bits** (**DI3-DI6**) and triggered by using the **start bit** (**DI1**). Motion can be aborted by triggering the **abort/clear bit** (**DI2**). If an error occurs, it can also be cleared by triggering the **abort/clear bit** (**DI2**).

DIO Latency

Digital input response time to a trigger from **start bit (DI1)** is about 10 micro seconds. The actual amount of time from trigger to the beginning of the motion move depends on the command.

Setting Up DIO Parameters

In order to use this feature, you must first enable DIO mode (using **EDIO** command) as well as configure the appropriate DIO parameters via USB.

The DIO parameters are set using the **MP[X][Y]** command.

To view parameters, use command **MP[X][Y]**. To set values, use **MPXY=[value].**

X Parameter:
This parameter corresponds to the 2^4=16 selections that can be selected by DI3-DI6. This character must be written in hexadecimal (i.e. 0-F).

Y Parameter:
This parameter corresponds to the 5 different values that correspond to each DIO move. See the table below.

Note that some move operations do not need all 5 parameters. In this case, any extra move values that are entered will be ignored. For example, the STOP command does not need a "Target Position". Any value entered here will be ignored in this case.

Y Parameter

Y	Description
0	DIO Move reference (see Table 9.1)
1	Target Position
2	Low Speed
3	Acceleration
4	High Speed

Table 9.0

DIO Move List

Move Reference	Command
0	None
1	STOP
2	X[Target Position]
3	INC+ [Current Position + Target Position]
4	INC- [Current Position - Target Position]
5	J+
6	J-
7	H+
8	H-
9	EO=0
10	EO=1
11	ZH+
12	ZH-
13	SSPD[High Speed]
14	SCV=1
15	SCV=0
16	SL=1
17	SL=0
18	PX=[Target Position]
19	EX=[Target Position]
20	Z+
21	Z-
22	SSPDM=[High Speed]

Table 9.1

Examples

1. **Make DIO selection "0" correspond to the J+ command with the following parameters:**

   Target Position = NA
   Low Speed = 100
   Acceleration = 300
   High Speed = 1000

   Send commands:

```
MP00 = 5        ` Set move reference for "0" to J+
MP01 = 0        ` Set target position to 0 (value will be ignored)
MP02 = 100      ` Set low speed to 100
MP03 = 300      ` Set acceleration to 300
MP04 = 1000     ` Set high speed to 1000
```

2. **Make DIO selection "0xF" correspond to the X800 command with the following parameters:**

   Target Position = 800
   Low Speed = 500
   Acceleration = 500
   High Speed = 5000

   Send commands:

```
MPF0 = 2          ` Set move reference for "F" to X[value]
MPF1 = 800        ` Set target position to 800
MPF2 = 500        ` Set low speed to 500
MPF3 = 500        ` Set acceleration to 500
MPF4 = 5000       ` Set high speed to 5000
```

Using DIO

1. First drive the **select bits (DI3-DI6).**
2. Then pull **start bit (DI1)** low to begin the move. (falling-edge triggered)
3. Trigger **abort/clear bit (DI2)** to abort motion command if desired.

Figure 9.0 shows a timing diagram using DIO control.

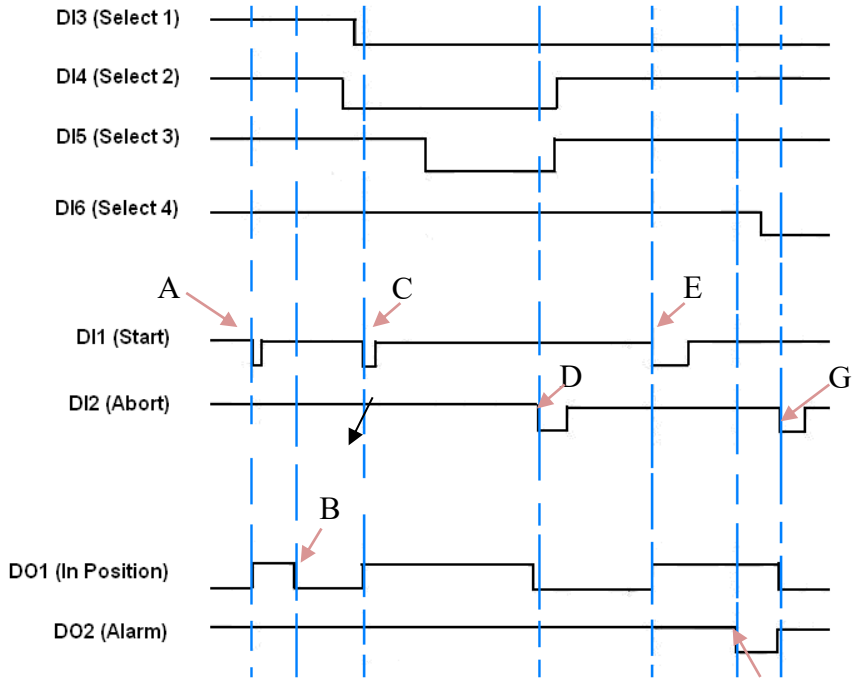


Figure 9.0

A) On falling edge of **Start**, motion command stored in memory location 0 (0000) is triggered. **In Position** turns off.

B) After motion command 0 (0000) is complete, **In Position** turn on.

C) On falling edge of **Start**, motion command stored in memory location 12 (1100) is triggered. **In Position** turns off.

D) On falling edge of **Abort**, motion stops immediately. **In Position** turns on. Note: If move was an absolute move type, and target position was not reached, **In Position** will instead remain off.

E) On falling edge of **Start**, motion command stored in memory location 8 (1000) is triggered. **In Position** turns off.

F) Motion error occurs (i.e. limit error or StepNLoop error). **Alarm** turns on. **In Position** stays off. Controller is now in error state.

G) On falling edge of **Abort**, error state is cleared. **In Position** turns on.

Notes:
DIO communication is not allowed while a standalone programming is running. If DIO communication is enabled while a standalone program begins execution, DIO communication will be automatically disabled.

Triggering the **start bit (DI1)** will not trigger a motion move if the **abort bit (DI2)** is on, or if the controller is in error state. If the controller is in error state, first clear the error by triggering the **abort/clear bit (DI2)**.

The alarm bit output is on whenever there is either a SNL or limit error.

The in position bit output is on whenever the motor is in position.

Signals are active low.

10. ASCII Language Specification

Important Note: All the commands described in this section are interactive commands and are not analogous to stand-alone commands. Refer to the "Standalone Language Specification" section for details regarding stand-alone commands.

NSC-A1 language is case sensitive. All command should be in capital letters.
Invalid command is returned "?". Always check for proper reply when command is sent.

For **USB communication**, send commands identical to the ones in the following table.

For **RS-485 ASCII communication**, append "@XX" to the command before sending, where "XX" is the device number. Ex: To send the "J+" command to device number 05, send the following: **"@05J+"**

Command	Description	Return
ABORT	Immediately stops the motor if in motion. For decelerate stop, use STOP command. This command can also be used to clear a StepNLoop error	OK
ABS	Set move mode to absolute	OK
ACC	Returns current acceleration value in milliseconds.	Milli-seconds
ACC=[Value]	Sets acceleration value in milliseconds. Example: ACC=300	OK
AI1, AI2	Get analog input status (0-5000 mV)	Milli-volts
CLR	Clears limit error as well as StepNLoop error	OK
CLRS	Clears StepNLoop error. Note CLR also clears a StepNLoop error	OK
DB	Return the current baud rate of the device	See Table 6.10
DB=[Value]	Set the baud rate of the device	OK
DEC	Get deceleration value in milliseconds. Only used if EDEC=1	Milli-seconds
DEC=[Value]	Set deceleration value in milliseconds. Only used if EDEC=1	OK
DI	Return status of digital inputs	See Table 6.2
DI[1-6]	Get individual bit status of digital inputs	0,1
DO	Return status of digital outputs	2-bit number
DO=[Value]	Set digital output 2 bit number. Digital output is writable only if DIO is disabled.	OK
DO[1-2]	Get individual bit status of digital outputs	See Table 6.3
DO[1-2]=[Value]	Set individual bit status of digital outputs	OK
DOBOOT	Get DO boot-up state	See Table 6.3
DOBOOT=[Value]	Set DO boot-up state	OK
DN	Get device name	[SDE01-SDE99]
DN=[Value]	Set device name	OK
DNM	Get Modbus device number	1-127
DNM=[Value]	Set Modbus device number	OK
DX	Returns the delta value during StepNLoop control	28-bit number
DRVIC	Get driver idle current setting. Value is only valid after reading parameters using the "RR" command.	[100 – 3000] mA (peak current)
DRVIC=[Value]	Set driver idle current setting. Value is only written to the driver after using the "RW" command.	OK
DRVIT	Get driver idle time setting. Value is only valid after reading parameters using the "RR" command.	[1-100] centi-sec
DRVIT=[Value]	Set driver idle time setting. Value is only written to the driver after using the "RW" command.	OK
DRVMS	Get driver micro-step setting. Value is only valid after reading parameters using the "RR" command.	[2-500] micro-stepping
DRVMS=[Value]	Set driver micro-step setting. Value is only written to the driver after using the "RW" command.	OK

DRVRC	Get driver run current setting. Value is only valid after reading parameters using the "RR" command.	[1-100] centi-sec
DRVRC=[Value]	Set driver run current setting. Value is only written to the driver after using the "RW" command.	OK
EO	Returns driver power enable.	1 – Motor power enabled 0 – Motor power disabled
EO=[0 or 1]	Enables (1) or disable (0) motor power.	OK
EOBOOT	Get EO boot-up state	0 or 1
EOBOOT=[Value]	Set EO boot-up state	OK
EDEC	Get unique deceleration enable	0 or 1
EDEC=[Value]	Set unique deceleration enable	OK
EDIO	Returns DIO mode status	1 – DIO enabled 0 – DIO disabled
EDIO=[0 or 1]	Enables (value 1) or disable (value 0) DIO communication	OK
EX	Returns current encoder counter value	28-bit number
EX=[Value]	Sets the current encoder counter value	OK
GS[0-31]	Call a subroutine that has been previously stored to flash memory	OK
HSPD	Returns High Speed Setting	PPS
HSPD=[Value]	Sets High Speed.	OK
H+	Homes the motor in positive direction	OK
H-	Homes the motor in negative direction	OK
HCA	Returns the home correction amount	28-bit number
HCA=[Value]	Sets the home correction amount.	OK
HL+	Homes the motor in positive direction (with with low speed)	OK
HL-	Homes the motor in negative direction (with low speed)	OK
IERR	Get ignore limit error enable	0 or 1
IERR=[Value]	Set ignore limit error enable	OK
ID	Returns product ID	Ace-Series-SDE
INC	Set move mode to incremental	OK
J+	Jogs the motor in positive direction	OK
J-	Jogs the motor in negative direction	OK
JF	Disable joystick control for analog input 1	OK
JV1	Get max speed for joystick control	28-bit number
JV1=[Value]	Set max speed for joystick control	OK
JV3	Get max speed delta for joystick control	28-bit number
JV3=[Value]	Set max speed delta for joystick control	OK
JV5	Get zero speed tolerance for joystick control	28-bit number
JV5=[Value]	Set zero speed tolerance for joystick control	OK
JL1	Get negative outer limit for joystick control	28-bit number
JL1=[Value]	Set negative outer limit for joystick control	OK
JL2	Get negative inner limit for joystick control	28-bit number
JL2=[Value]	Set negative inner limit for joystick control	OK
JL3	Get positive inner limit for joystick control	28-bit number
JL3=[Value]	Set positive inner limit for joystick control	OK
JL4	Get positive outer limit for joystick control	28-bit number
JL4=[Value]	Set positive outer limit for joystick control	OK
JO	Enable joystick control for analog input 1	OK
JS	Get joystick enable status	0 – joystick operation off 1 – joystick operation on
L+	Limit homing in positive direction	OK
L-	Limit homing in negative direction	OK
LCA	Returns the limit correction amount	28-bit number

LCA=[Value]	Sets the limit correction amount.	OK
LSPD	Returns Low Speed Setting	PPS
LSPD=[Value]	Sets Low Speed	OK
LT=[0 or 1]	Enable or disable position latch feature	OK
LTE	Returns latched encoder position	28-bit number
LTP	Returns latched pulse position	28-bit number
LTS	Returns latch status.	See Table 6.6
MM	Get move mode status	0 – Absolute move mode 1 – Incremental move mode
MST	Returns motor status	See Table 6.5
MPXX	Get DIO parameter	
MPXX=[Value]	Set DIO parameter	OK
POL	Returns current polarity	See Table 6.4
POL=[value]	Sets polarity.	OK
PS	Returns current pulse speed	PPS
PX	Returns current position value	28-bit number
PX=[value]	Sets the current position value	OK
R2	Get driver read operation status	[1] – Driver read successful [2-7] – Driver read failure
R4	Get driver write operation status	[1] – Driver write successful [2-7] – Driver write failure
RR	Read driver parameters	OK
RSM	Get Modbus enable	0 or 1
RSM= [0 or 1]	Set Modbus enable	OK
RT	Get response type value	0 or 1
RT= [0 or 1]	Set response type value	OK
RZ	Get return zero enable. Used during homing	0 or 1
RZ=[0 or 1]	Set return zero enable. Used during homing	OK
RW	Write driver parameters	OK
SASTAT[0,1]	Get standalone program status 0 – Stopped 1 – Running 2 – Paused 4 – In Error	0-4
SA[LineNumber]	Get standalone line LineNumber: [0,1784]	
SA[LineNumber]=[Value]	Set standalone line LineNumber: [0,1784]	
SCV	Returns the s-curve control	0 or 1
SCV=[0 or 1]	Enable or disable s-curve. If disabled, trapezoidal acceleration/ deceleration will be used.	OK
SL	Returns StepNLoop enable status	0 – StepNLoop Off 1 – StepNLoop On
SL=[0 or 1]	Enable or disable StepNLoop Control	OK
SLA	Returns maximum number of StepNLoop control attempt	28-bit number
SLA=[value]	Sets maximum number of StepNLoop control attempt	OK
SLE	Returns StepNLoop correction range value.	28-bit number
SLE=[value]	Sets StepNLoop correction range value.	OK
SLR	Returns StepNLoop ratio value	[0.001 – 999.999]
SLR=[factor]	Sets StepNLoop ratio value. Must be in the range [0.001 – 999.999]	OK

SLS	Returns current status of StepNLoop control	See Table 6.8
SLT	Returns StepNLoop tolerance value	32-bit
SLT=[value]	Sets StepNLoop tolerance value.	OK
SLOAD	Returns RunOnBoot parameter	See Table 6.12
SLOAD=[0 or 1]	Set RunOnBoot parameter	See Table 6.12
SPC[0,1]	Get program counter for standalone program	[0-1784]
SR[0,1]=[Value]	Control standalone program: 0 – Stop standalone program 1 – Run standalone program 2 – Pause standalone program 3 – Continue standalone program	OK
SSPD[value]	On-the-fly speed change. In order to use this command, S-curve control must be disabled. Use SCV command to enable and disable s-curve acceleration/ deceleration control. Note that an "=" sign is not used for this command.	OK
SSPDM	Return on-the-fly speed change mode	[0-9]
SSPDM=[value]	Set on-the-fly speed change mode	OK
STOP	Stops the motor using deceleration if in motion.	OK
STORE	Store settings to flash	OK
SYNC	Read sync output configuration 1 – trigger when encoder equals position 2 – trigger when encoder is LESS than position 3 – trigger when encoder is GREATER than position	1,2,3
SYNC=	Set sync output configuration 1 – trigger when encoder equals position 2 – trigger when encoder is LESS than position 3 – trigger when encoder is GREATER than position	OK
SYNF	Turn off sync output	OK
SYNO	Turn on sync output	OK
SYNP	Get trigger position	28 bit signed number
SYNP=	Set trigger position	28 bit signed number
SYNT	Get pulse width time (ms). Only applicable if sync output configuration is set to 1.	Milli-seconds
SYNT=	Set pulse width time (ms). Only applicable if sync output configuration is set to 1. Max 30ms	OK
T[value]	On-the-fly target change	OK
TOC	Get time-out counter (ms)	32-bit number
TOC=[value]	Set time-out counter (ms)	OK
V[1-100]	Read variables 1-100	28-bit number
V[1-100]=[value]	Set variables 1-100	OK
VER	Get firmware version	VXXX
X[value]	Moves the motor to absolute position value using the HSPD, LSPD, and ACC values.	OK
Z+	Homes the motor in positive direction using the Z index encoder channel ONLY.	OK
Z-	Homes the motor in negative direction using the Z index encoder channel ONLY.	OK
ZH+	Homes the motor in positive direction using the home switch and then Z index encoder channel.	OK
ZH-	Homes the motor in negative direction using the home switch and then Z index encoder channel.	OK

Table 10.0

Error Codes

If an ASCII command cannot be processed by the NSC-A1, the controller will reply with an error code. See below for possible error responses:

Error Code	Description
?[Command]	The ASCII command is not understood by the ACE-SXC
?ABS/INC is not in operation	T[] command is invalid because a target position move is not in operation
?Bad SSPD Command	SSPD move parameter is invalid
?DIO Enabled	Cannot control digital output because DIO mode is enabled
?Index out of Range	The index for the command sent to the controller is not valid.
?Moving	A move or position change command is sent while the ACE-SXC is outputting pulses.
?SA running	Cannot enable DIO mode because stand-alone is running
?SCV ON	Cannot perform SSPD move because s-curve is enabled
?Speed out of range	SSPD move parameter is out of the range of the SSPDM speed window.
?State Error	A move command is issued while the controller is in error state.
?Sub not Initialized	Call to a subroutine using the **GS** command is not valid because the specified subroutine has not been defined.

Table 10.1

11. Standalone Language Specification

;

Description:

Comment notation. In programming, comment must be in its own line.

Syntax:

; [Comment Text]

Examples:

```
; ***This is a comment
JOGX+              ;***Jogs axis to positive direction
DELAY=1000         ;***Wait 1 second
ABORT              ;***Stop immediately all axes including X axis
```

ABORTX

Description:

Motion: Immediately stop motion without deceleration.

Syntax:

ABORTX

Examples:

```
JOGX+           ;***Jogs axis to positive direction
DELAY=1000      ;***Wait 1 second
ABORTX          ;***Stop axis immediately
```

ABS

Description:

Command: Changes all move commands to absolute mode.

Syntax:

ABS

Examples:

```
ABS             ;***Change to absolute mode
PX=0            ;***Change position to 0
X1000           ;***Move X axis to position 1000
WAITX
X3000           ;***Move X axis to position 3000
WAITX
```

ACC

Description:

Read: Get acceleration value
Write: Set acceleration value.
Value is in milliseconds.

Syntax:

Read: [variable] = ACC
Write: ACC = [value]
ACC = [variable]

Examples:

```
ACC=300     ;***Sets the acceleration to 300 milliseconds
V3=500      ;***Sets the variable 3 to 500
ACC=V3      ;***Sets the acceleration to variable 3 value of 500
```

AI[1-2]

Description:

Read: Gets the analog input value. NSC-A1 has 2 analog inputs.
Range is from 0-5000 mV

Syntax:

Read: [variable] = AI[1-2]
Conditional: IF AI[1-2]=[variable]
ENDIF

IF AI[1-2]=[value]
ENDIF

Examples:

```
IF AI1 < 500
    DO=1        ;***If analog input 1 is less than 500, set DO=1
ENDIF
```

DEC

Description:

Read: Get deceleration value
Write: Set deceleration value.
Value is in milliseconds.

Syntax:

Read: [variable] = DEC
Write: DEC = [value]
DEC = [variable]

Examples:

```
DEC=300     ;***Sets the deceleration to 300 milliseconds
V3=500      ;***Sets the variable 3 to 500
DEC=V3      ;***Sets the deceleration to variable 3 value of 500
```

DELAY

Description:

Set a delay (1 ms units)

Syntax:

Delay=[Number] (1 ms units)

Examples:

```
JOGX+           ;***Jogs axis to positive direction
DELAY=10000     ;***Wait 10 second
ABORTX          ;***Stop axis
```

DI

Description:

Read: Gets the digital input value. ACE-SXC has 8 digital inputs.
Digital inputs are active high

Syntax:

Read: [variable] = DI
Conditional: IF DI=[variable]
ENDIF
IF DI=[value]
ENDIF

Examples:

```
IF DI=0
    DO=1        ;***If all digital inputs are triggered, set DO=1
ENDIF
```

DI[1-6]

Description:

Read: Gets the digital input value. NSC-A1 has 6 digital inputs.
If digital input is on (i.e. input is pulled to GND of opto-supply), the bit status is 0. Otherwise, the bit status is 1.

Syntax:

Read: [variable] = DI[1-6]
Conditional: IF DI[1-6]=[variable]
ENDIF
IF DI[1-6]=[0 or 1]
ENDIF

Examples:

```
IF DI1=0
    DO=1        ;***If digital input 1 is triggered, set DO=1
ENDIF
```

DO

Description:

Read: Gets the digital output value
Write: Sets the digital output value
NSC-A1 has 2 digital outputs.
If digital output is turned on (i.e. the output is pulled to GND), the bit status is 1. Otherwise, the bit status is 0.

Syntax:

Read: [variable] = DO
Write: DO = [value]
DO = [variable]
Conditional: IF DO=[variable]
ENDIF
IF DO=[value]
ENDIF

Examples:

```
DO=3        ;***Turn on both bits
```

DO[1-2]

Description:

Read: Gets the individual digital output value
Write: Sets the individual digital output value
NSC-A1 has 2 digital outputs.
If digital output is turned on (i.e. the output is pulled to GND), the bit status is 1. Otherwise, the bit status is 0.

Syntax:

Read: [variable] = DO[1-2]
Write: DO[1-2] = [0 or 1]
DO[1-2] = [variable]
Conditional: IF DO[1-2]=[variable]
ENDIF

```
                IF DO[1-2]=[0 or 1]
                ENDIF
```

Examples:

```
        DO1=1       ;***Turn DO1 on
        DO2=1       ;***Turn DO2 on
```

DRVIC

Description:

Write: Sets the driver idle current parameter

Syntax:

Write: DRVIC=[value]

Examples:

```
        WHILE 1=1
                IF DI1 = 0                  ;***If DI1 is triggered, execute
                        SL=0                ;***Disable StepNLoop
                        DRVMS=100           ;***Micro-step set to 100
                        DRVIT=1             :***Idle-time set to 1 cent-sec
                        DRVIC=100           ;***Idle-current set to 100 mA
                        DRVRC=1000          ;***Run-current set to 1000 mA
                        RW                  ;***Write driver parameters
                        DELAY=2000          ;***Wait 2 seconds for write operation
                        V1=RWSTAT           ;***Check write operation status
                        IF V1=1
                                DO1=1       ;***If write operation was success, DO1=1
                        ELSE
                                DO2=1       ;***Write operation failed, DO2=1
                        ENDIF
                ENDIF
        ENDWHILE
```

DRVIT

Description:

Write: Sets the driver idle time parameter

Syntax:

Write: DRVIT=[value]

Examples: See DRVIC

DRVMS

Description:

Write: Sets the driver micro-step parameter

Syntax:

Write: DRVMS=[value]

Examples: See DRVIC

DRVRC

Description:

Write: Sets the driver run current parameter

Syntax:

Write: DRVRC=[value]

Examples: See DRVIC

ECLEARX

Description:

Write: Clears motor error status. Also clears a StepNLoop error.

Syntax:

Write: ECLEARX

Examples:

```
ECLEARX                 ;***Clears motor error
```

ECLEARSX

Description:

Write: Clears StepNLoop error status. ECLEAR also clears a StepNLoop error

Syntax:

Write: ECLEARSX

Examples:

```
ECLEARSX                ;***Clears StepNLoop error
```

ELSE

Description:

Perform ELSE condition check as a part of IF statement

Syntax:

ELSE

Examples:

```
IF V1=1
        X1000           ;***If V1 is 1, then move to 1000
ELSE
        X-1000          ;***If V1 is not 1, then move to -1000
ENDIF
```

ELSEIF

Description:

Perform ELSEIF condition check as a part of the IF statement

Syntax:

ELSEIF [Argument 1] [Comparison] [Argument 2]

[Argument] can be any of the following:
- Numerical value
- Pulse or Encoder Position
- Digital Output
- Digital Input
- Enable Output
- Motor Status

[Comparison] can be any of the following
- = Equal to
- > Greater than
- < Less than
- >= Greater than or equal to
- <= Less than or equal to
- != Not Equal to

Examples:

```
IF V1=1
    X1000
    WAITX
ELSEIF V1=2
    X2000
    WAITX
ELSEIF V1=3
    X3000
    WAITX
ELSE
    X0
    WAITX
ENDIF
```

END

Description:

Indicate end of program.
Program status changes to idle when END is reached.

Note: Subroutine definitions should be written AFTER the END statement

Syntax:

```
END
```

Examples:

```
X0
WAITX
X1000
WAITX
END
```

ENDIF

Description:

Indicates end of IF operation

Syntax:

```
    ENDIF
```

Examples:

```
    IF V1=1
        X1000
        WAITX
    ENDIF
```

ENDSUB

Description:

Indicates end of subroutine
When ENDSUB is reached, the program returns to the previously called subroutine.

Syntax:

```
    ENDSUB
```

Examples:

```
    GOSUB 1
    END

    SUB 1
        X0
        WAITX
        X1000
        WAITX
    ENDSUB
```

ENDWHILE

Description:

Indicate end of WHILE loop

Syntax:

```
    ENDWHILE
```

Examples:

```
    WHILE V1=1          ;***While V1 is 1 continue to loop
        X0
        WAITX
        X1000
        WAITX
    ENDWHILE            ;***End of while loop so go back to WHILE
```

EO

Description:

Read: Gets the enable output value
Write: Sets the enable output value

Syntax:

Read: [variable] = EO
Write: EO = [value]
EO = [variable]
Conditional: IF EO=[variable]

ENDIF

IF EO=[value]
ENDIF

Examples:

EO=1 ;***Energize motor

EX

Description:

Read: Gets the current encoder position
Write: Sets the current encoder position

Syntax:

Read: [variable] = E[axis]
Write: EX = [0 or 1]
EX = [variable]
Conditional: IF EX=[variable]
ENDIF

IF EX=[value]
ENDIF

Examples:

EX=0 ;***Sets the current encoder position to 0

GOSUB

Description:

Perform go to subroutine operation
Subroutine range is from 0 to 31.

Note: Subroutine definitions should be written AFTER the END statement

Syntax:

GOSUB [subroutine number]

[Subroutine Number] range is 0 to 31

Examples:

```
GOSUB 0
END

SUB 0
    X0
    WAITX
    X1000
    WAITX
ENDSUB
```

HLHOMEX[+ or -]

Description:

Command: Perform homing using current high speed, low speed, and acceleration.

Syntax:

HLHOMEX[+ or -]

Examples:

```
HLHOMEX+  ;***Homes the motor at low speed in the positive direction
WAITX
```

HOMEX[+ or -]

Description:

Command: Perform homing using current high speed, low speed, and acceleration.

Syntax:

HOMEX[+ or -]

Examples:

```
HOMEX+      ;***Homes axis in positive direction
WAITX
```

HSPD

Description:

Read: Gets high speed. Value is in pulses/second
Write: Sets high speed. Value is in pulses/second.
Range is from 1 to 6,000,000.

Syntax:

Read: [variable] = HSPD
Write: HSPD = [value]
HSPD = [variable]

Examples:

```
HSPD=10000  ;***Sets the high speed to 10,000 pulses/sec

V1=2500     ;***Sets the variable 1 to 2,500
HSPD=V1     ;***Sets the high speed to variable 1 value of 2500
```

IF

Description:

Perform IF condition check

Syntax:

IF [Argument 1] [Comparison] [Argument 2]
[Argument] can be any of the following:
Numerical value
Pulse or Encoder Position

Digital Output
Digital Input
Enable Output
Motor Status

[Comparison] can be any of the following

=	Equal to
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to
!=	Not Equal to

Examples:

```
IF V1=1
    X1000
ENDIF
```

INC

Description:

Command: Changes all move commands to incremental mode.

Syntax:

```
INC
```

Examples:

```
INC             ;***Change to incremental mode
PX=0            ;***Change position to 0
X1000           ;***Move axis to position 1000 (0+1000)
WAITX
X2000           ;***Move axis to position 3000 (1000+2000)
WAITX
```

JOGX[+ or -]

Description:

Command: Perform jogging using current high speed, low speed, and acceleration.

Syntax:

```
JOGX[+ or -]
```

Examples:

```
JOGX+       ;***Jogs axis in positive direction
STOPX
WAITX
JOGX-       ;***Jogs axis in negative direction
STOPX
WAITX
```

JOYENA

Description:

Write: Enable/Disable joystick feature

Syntax:

Write: JOYENA=[value]

Examples:

```
JOYENA=1    ;***Enable joystick feature
JOYENA=0    ;***Disable joystick feature
```

JOYHSX

Description:

Write: Set high speed setting for joystick control

Syntax:

Write: JOYHSX= [value]
JOYHSX= [variable]

Examples:

```
JOYHSX=10000        ;***High speed of axis is set to 10,000 pps
```

JOYDELX

Description:

Write: Set maximum delta value of change in speed for joystick control

Syntax:

Write: JOYDELX= [value]
JOYDELX= [variable]

Examples:

```
JOYDELX=100         ;***Speed delta of axis is set to 100 pps
```

JOYNOX

Description:

Write: Set negative outer limit for joystick control

Syntax:

Write: JOYNOX= [value]
JOYNOX= [variable]

Examples:

```
JOYNOX=-10000       ;*** negative outer limit of axis set to -10000
JOYNIX=-9000            ;*** negative inner limit of axis set to -9000
JOYPIX=9000             ;*** positive inner limit of axis set to 9000
JOYPOX=10000        ;*** positive outer limit of axis set to 10000
```

JOYNIX

Description:

Write: Set negative inner limit for joystick control

Syntax:

Write: JOYNI = [value]
JOYNI= [variable]

Examples:

```
JOYNOX=-10000       ;*** negative outer limit of axis set to -10000
JOYNIX=-9000            ;*** negative inner limit of axis set to -9000
JOYPIX=9000             ;*** positive inner limit of axis set to 9000
JOYPOX=10000        ;*** positive outer limit of axis set to 10000
```

JOYPIX

Description:

Write: Set positive inner limit for joystick control

Syntax:

Write: JOYPIX= [value]
JOYPIX= [variable]

Examples:

```
JOYNOX=-10000     ;*** negative outer limit of axis set to -10000
JOYNIX=-9000            ;*** negative inner limit of axis set to -9000
JOYPIX=9000             ;*** positive inner limit of axis set to 9000
JOYPOX=10000      ;*** positive outer limit of axis set to 10000
```

JOYPOX

Description:

Write: Set positive outer limit for joystick control

Syntax:

Write: JOYPOX= [value]
JOYPOX= [variable]

Examples:

```
JOYNOX=-10000     ;*** negative outer limit of axis set to -10000
JOYNIX=-9000            ;*** negative inner limit of axis set to -9000
JOYPIX=9000             ;*** positive inner limit of axis set to 9000
JOYPOX=10000      ;*** positive outer limit of axis set to 10000
```

JOYTOLX

Description:

Write: Set zero tolerance value for joystick control

Syntax:

Write: JOYTOLX = [value]
JOYTOLX= [variable]

Examples:

```
JOYTOLX=10              ;*** zero tolerance value of axis set to 10
```

LHOMEX[+ or -]

Description:

Command: Perform homing using current high speed, low speed, and acceleration.

Syntax:

LHOMEX[+ or -]

Examples:

```
LHOMEX+    ;***Limit homes axis in positive direction
WAITX
```

LSPD

Description:

Read: Get low speed. Value is in pulses/second.
Write: Set low speed. Value is in pulses/second.

Range is from 1 to 400,000.

Syntax:

Read: [variable]=LSPD

Write: LSPD=[long value]

LSPD=[variable]

Examples:

```
LSPD=1000    ;***Sets the start low speed to 1,000 pulses/sec
V1=500       ;***Sets the variable 1 to 500
LSPD=V1      ;***Sets the start low speed to variable 1 value of 500
```

LTX

Description:

Write: Set latch enable

Range is [0,1]

Syntax:

Write: LTX=[0,1]

LTX=[variable]

Examples:

```
LTX=1                              ;***Enable latch
WHILE 1=1
        V2=LTSX             ;***Get latch status
        IF LTSX = 2
                V3=LTEX     ;***Get latch encoder value if latch is triggered
                V4=LTPX     ;***Get latch position value if latch is triggered
        ENDIF
ENDWHILE
```

LTEX

Description:

Read: Get latch encoder value

Syntax:

Read: [variable]=LTEX

Examples:

See LTX

LTPX

Description:

Read: Get latch position value

Syntax:

Read: [variable]=LTPX

Examples:

See LTX

LTSX

Description:

Read: Get latch status

Syntax:

Read: [variable]=LTSX

Examples:

See LTX

MSTX

Description:

Read: Get motor status

Syntax:

Read: [variable]=MSTX

Conditional: IF MSTX=[variable]
ENDIF

IF MSTX=[value]
ENDIF

Examples:

```
IF MSTX=0
    DO=3
ELSE
    DO=0
ENDIF
```

PX

Description:

Read: Gets the current pulse position

Write: Sets the current pulse position

Syntax:

Read: Variable = PX

Write: PX = [value]
PX = [variable]

Conditional: IF PX=[variable]
ENDIF
IF PX=[value]
ENDIF

Examples:

```
JOGX+           ;***Jogs axis to positive direction
DELAY=1000      ;***Wait 1 second
ABORTX          ;***Stop with deceleration all axes including X axis
PX=0            ;***Sets the current pulse position to 0
```

PS

Description:

Read: Get the current pulse speed

Syntax:

Read: Variable = PS

Conditional: IF PS=[variable]
ENDIF

```
                IF PS=[value]
                ENDIF
```

Examples:

```
        JOGX+           ;***Jogs axis to positive direction
        DELAY=1000      ;***Wait 1 second
        ABORTX          ;***Stop without deceleration
        V1=PS           ;***Sets variable 1 to pulse speed
```

RW

Description:

Write: Start driver write operation. Note that after executing RW, wait 2 seconds before any other operation is executing (using DELAY=2000).

Syntax:

Write: RW

Examples:

See DRVIC

RWSTAT

Description:

Read: Get driver write operation status

Syntax:

Read: [variable]=RWSTAT

Examples:

See DRVIC

SCVX

Description:

Write: Set s-curve enable.
Range is from 0 or 1

Syntax:

Write: SCVX=[0 or 1]
SCVX=[variable]

Note: If s-curve is enabled for an axis, on-the-fly speed feature cannot be used for the corresponding axis.

Examples:

```
        SCVX=1      ;***Sets axis to use s-curve acceleration: on-the-fly speed
                    ; change is NOT allowed for this axis.
```

SLX

Description:

Write: Set StepNLoop closed-loop mode
Range is from 0 or 1

Syntax:

Write: SL=[0 or 1]

Examples:

```
SL=1   ;***Sets axis to closed-loop mode
```

SLSX

Description:

Read: Get StepNLoop status

Syntax:

Read: [variable]=SLSX

Conditional:
```
IF SLSX =[variable]
ENDIF
IF SLSX =[value]
ENDIF
```

Examples:

```
IF SLSX != 0
        ECLEARX
ELSE
        ECLEARSX
ENDIF
```

SSPDX

Description:

Write: Set on-the-fly speed change for an individual axis.
Range is from 1 to 6,000,000 PPS

Syntax:

Write: SSPDX=[value]
SSPDX=[variable]

Note: If s-curve is enabled for an axis, on-the-fly speed feature can not be used for the corresponding axis.

Examples:

```
SCVX=0          ;***Disable s-curve acceleration
HSPD=1000       ;***X-axis high speed
LSPD=100        ;***Set low speed
ACC=100         ;***Set acceleration
JOGX+           ;***Jogs to positive direction
DELAY=1000      ;***Wait 1 second
SSPDX=3000      ;***Change speed on-the-fly to 3000 PPS
```

SSPDMX

Description:

Write: Set individual on-the-fly speed change mode
Range is from 0 to 9

Syntax:

Write: SSPDMX=[0-9]
SSPDMX=[variable]

Examples:

```
SCVX=0          ;***Disable s-curve acceleration
HSPD=1000       ;***X-axis high speed
LSPD=100        ;***Set low speed
ACC=100         ;***Set acceleration
JOGX+           ;***Jogs to positive direction
DELAY=1000      ;***Wait 1 second
SSPDMX=1        ;***Set on-the-fly speed change mode to 1
ACC=20000       ;***Set acceleration to 20 seconds
SSPDX=190000    ;***Change speed on-the-fly to 190000 PPS
```

STOPX

Description:

Command: Stop all axes if in motion with deceleration.
Previous acceleration value is used for deceleration.

Syntax:

STOPX

Examples:

```
JOGX+           ;***Jogs axis to positive direction
DELAY=1000      ;***Wait 1 second
STOPX           ;***Stop with deceleration
```

STORE

Description:

Command: Store all values to flash

Syntax:

STORE

Examples:

```
V80=EX          ;***Put encoder value in V80
DELAY=1000      ;***Wait 1 second
STORE           ;***Store V80 to non-volatile flash
```

SYNCFGX

Description:

Write: Set sync output configuration

Syntax:

Write: SYNCFGX=[value]
SYNCFGX =[variable]

Examples:

```
SYNCFGX =1      ;*** Set sync output configuration to 1
```

```
SYNPOSX=3000      ;*** Set sync output position to 3000
SYNTIMEX=10       ;*** Set sync output pulse time to 10 ms
SYNONX            ;*** Turn on sync output feature

V1=1              ;*** Wait until sync output is triggered
WHILE V1 != 2
        V1=SYNSTATX
ENDWHILE

SYNOFFX           ;*** Disable sync output feature
```

SYNOFFX

Description:

Write: Disable sync output feature

Syntax:

Write: SYNOFFX

Examples:

See SYNCFGX

SYNONX

Description:

Write: Enable sync output feature

Syntax:

Write: SYNONX

Examples:

See SYNCFGX

SYNPOSX

Description:

Write: Set sync output position.

Syntax:

Write: SYNPOSX=[value]

Write: SYNPOSX=[variable]

Examples:

See SYNCFGX

SYNSTATX

Description:

Read: Get status for sync output

Syntax:

Read: [variable] = SYNS

Examples:
See SYNCFGX

SYNTIMEX

Description:
Write: Set pulse output width time for sync output
Syntax:
Write: SYN[axis]T=[value]
Examples:
See SYNCFGX

SUB

Description:

Indicates start of subroutine

Syntax:

SUB [subroutine number]

[Subroutine Number] range is 0 to 31

Examples:

```
GOSUB 1
END
SUB 1
    X0
    WAITX
    X1000
    WAITX
ENDSUB
```

V[1-100]

Description:

Assign to variable.

NSC-A1 has 100 variables [V1-V100]

Syntax:

V[Variable Number] = [Argument]

V[Variable Number] = [Argument1][Operation][Argument2]

Special case for BIT NOT:

V[Variable Number] = ~[Argument]

[Argument] can be any of the following:

- Numerical value
- Pulse or Encoder Position
- Digital Output
- Digital Input
- Enable Output
- Motor Status

[Operation] can be any of the following

+	Addition
-	Subtraction
*	Multiplication
/	Division
%	Modulus
>>	Bit Shift Right
<<	Bit Shift Left
&	Bit AND
|	Bit OR
~	Bit NOT

Examples:

```
V1=12345        ;***Set Variable 1 to 123
V2=V1+1         ;***Set Variable 2 to V1 plus 1
```

```
V3=DI          ;***Set Variable 3 to digital input value
V4=DO          ;***Sets Variable 4 to digital output value
V5=~EO         ;***Sets Variable 5 to bit NOT of enable output value
```

WAITX

Description:

Command: Tell program to wait until move on the certain axis is finished before executing next line.

Syntax:

```
WAITX
```

Examples:

```
X10000      ;***Move axis to position 10000
WAITX       ;***Wait until axis move is done
DO=3        ;***Set digital output
X3000       ;***Move axis to 3000
WAITX       ;***Wait until axis move is done
```

WHILE

Description:

Perform WHILE loop

Syntax:

```
WHILE [Argument 1] [Comparison] [Argument 2]
    [Argument] can be any of the following:
        Numerical value
        Pulse or Encoder Position
        Digital Output
        Digital Input
        Enable Output
        Motor Status
    [Comparison] can be any of the following
        =     Equal to
        >     Greater than
        <     Less than
        >=    Greater than or equal to
        <=    Less than or equal to
        !=    Not Equal to
```

Examples:

```
WHILE V1=1          ;***While V1 is 1 continue to loop
    X0
    WAITX
    X1000
    WAITX
ENDWHILE
```

X

Description:

Command: Perform X axis move to target location
With other Axis moves in the same line, linear interpolation move is done.

Syntax:

X[value]
X[variable]

Examples:

```
ABS          ;***Absolute move mode
X10000       ;***Move to position 10000
WAITX
V10 = 1200   ;***Set variable 10 value to 1200
XV10         ;***Move axis to variable 10 value
WAITX
```

ZHOMEX[+ or -]

Description:

Command: Perform Z-homing using current high speed, low speed, and acceleration.

Syntax:

ZHOMEX[+ or -]

Examples:

```
ZHOMEX+      ;***Z Homes axis in positive direction
WAITX
ZHOMEX-      ;***Z Homes axis in negative direction
WAITX
```

ZOMEX[+ or -]

Description:

Command: Perform Zoming (homing only using Z-index) using current high speed, low speed, and acceleration.

Syntax:

ZOMEX[+ or -]

Examples:

```
ZOMEX+       ;***Zomes axis in positive direction
WAITX
ZOMEX-       ;***Zomes axis in negative direction
WAITX
```

12. Example Standalone Programs

Standalone Example Program 1 – Single Thread

Task: Set the high speed and low speed and move the motor to 1000 and back to 0.

```
HSPD=20000        ;* Set the high speed to 20000 pulses/sec
LSPD=1000         ;* Set the low speed to 1000 pulses/sec
ACC=300           ;* Set the acceleration to 300 msec
```

```
EO=1                ;* Enable the motor power
X1000               ;* Move to 1000
WAITX               ;*Wait for X-axis move to complete
X0                  ;* Move to 1000
END                 ;* End of the program
```

Standalone Example Program 2 – Single Thread

Task: Move the motor back and forth indefinitely between position 1000 and 0.

```
HSPD=20000          ;* Set the high speed to 20000 pulses/sec
LSPD=1000           ;* Set the low speed to 1000 pulses/sec
ACC=300             ;* Set the acceleration to 300 msec
EO=1                ;* Enable the motor power
WHILE 1=1           ;* Forever loop
        X1000       ;* Move to zero
        WAITX       ;*Wait for X-axis move to complete
        X0          ;* Move to 1000
ENDWHILE            ;* Go back to WHILE statement
END
```

Standalone Example Program 3 – Single Thread

Task: Move the motor back and forth 10 times between position 1000 and 0.

```
HSPD=20000          ;* Set the high speed to 20000 pulses/sec
LSPD=1000           ;* Set the low speed to 1000 pulses/sec
ACC=300             ;* Set the acceleration to 300 msec
EO=1                ;* Enable the motor power
V1=0                ;* Set variable 1 to value 0
WHILE V1<10         ;* Loop while variable 1 is less than 10
        X1000       ;* Move to zero
        WAITX       ;*Wait for X-axis move to complete
        X0          ;* Move to 1000
        V1=V1+1     ;* Increment variable 1
ENDWHILE            ;* Go back to WHILE statement
END
```

Standalone Example Program 4 – Single Thread

Task: Move the motor back and forth between position 1000 and 0 only if the digital input 1 is turned on.

```
HSPD=20000              ;* Set the high speed to 20000 pulses/sec
LSPD=1000               ;* Set the low speed to 1000 pulses/sec
ACC=300                 ;* Set the acceleration to 300 msec
EO=1                    ;* Enable the motor power
WHILE 1=1               ;* Forever loop
        IF DI1=1        ;* If digital input 1 is on, execute the statements
                X1000   ;* Move to zero
```

```
                WAITX       ;*Wait for X-axis move to complete
                X0          ;* Move to 1000
        ENDIF
ENDWHILE            ;* Go back to WHILE statement
END
```

Standalone Example Program 5 – Single Thread

Task: Using a subroutine, increment the motor by 1000 whenever the DI1 rising edge is detected.

```
HSPD=20000              ;* Set the high speed to 20000 pulses/sec
LSPD=1000               ;* Set the low speed to 1000 pulses/sec
ACC=300                 ;* Set the acceleration to 300 msec
EO=1                    ;* Enable the motor power
V1=0                    ;* Set variable 1 to zero
WHILE 1=1               ;* Forever loop
        IF DI1=1        ;* If digital input 1 is on, execute the statements
                GOSUB 1 ;* Move to zero
        ENDIF
ENDWHILE            ;* Go back to WHILE statement
END

SUB 1
        XV1             ;* Move to V1 target position
        V1=V1+1000      ;* Increment V1 by 1000
        WHILE DI1=1     ;* Wait until the DI1 is turned off so that
        ENDWHILE        ;* 1000 increment is not continuously done
ENDSUB
```

Standalone Example Program 6 – Single Thread

Task: If digital input 1 is on, move to position 1000. If digital input 2 is on, move to position 2000. If digital input 3 is on, move to 3000. If digital input 5 is on, home the motor in negative direction. Use digital output 1 to indicate that the motor is moving or not moving.

```
HSPD=20000              ;* Set the high speed to 20000 pulses/sec
LSPD=1000               ;* Set the low speed to 1000 pulses/sec
ACC=300                 ;* Set the acceleration to 300 msec
EO=1                    ;* Enable the motor power
WHILE 1=1               ;* Forever loop
        IF DI1=1        ;* If digital input 1 is on
                X1000   ;* Move to 1000
```

```
        ELSEIF DI2=1        ;* If digital input 2 is on
                X2000       ;* Move to 2000
        ELSEIF DI3=1        ;* If digital input 3 is on
                X3000       ;* Move to 3000
        ELSEIF DI5=1        ;* If digital input 5 is on
                HOMEX-      ;* Home the motor in negative direction
        ENDIF
        V1=MSTX             ;* Store the motor status to variable 1
        V2=V1&7             ;* Get first 3 bits
        IF V2!=0
                DO1=1
        ELSE
                DO1=0
        ENDIF
ENDWHILE                    ;* Go back to WHILE statement
END
```

Standalone Example Program 7 – Multi Thread

Task: Program 0 will continuously move the motor between positions 0 and 1000. Simultaneously, program 1 will control the status of program 0 using digital inputs.

```
PRG 0                   ;* Start of Program 0
HSPD=20000              ;* Set high speed to 20000pps
LSPD=500                ;* Set low speed to 500pps
ACC=500                 ;* Set acceleration to 500ms
WHILE 1=1               ;* Forever loop
        X0              ;* Move to position 0
        WAITX           ;* Wait for the move to complete
        X1000           ;* Move to position 1000
        WAITX           ;* Wait for the move to complete
ENDWHILE                ;* Go back to WHILE statement
END                     ;* End Program 0

PRG 1                           ;* Start of Program 1
WHILE 1=1               ;* Forever loop
        IF DI1=1        ;* If digital input 1 is triggered
                ABORTX  ;* Stop movement
                SR0=0   ;* Stop Program 1
        ELSE            ;* If digital input 1 is not triggered
                SR0=1   ;* Run Program 1
        ENDIF           ;* End if statements
ENDWHILE                ;* Go back to WHILE statement
END                             ;* End Program 1
```

Standalone Example Program 8 – Multi Thread

Task: Program 0 will continuously move the motor between positions 0 and 1000. Simultaneously, program 1 will monitor the communication time-out parameter and

triggers digital output 1 if a time-out occurs. Program 1 will also stop all motion, disable program 0 and then re-enable it after a delay of 3 seconds when the error occurs.

```
PRG 0                   ;* Start of Program 0
HSPD=1000               ;* Set high speed to 1000 pps
LSPD=500                ;* Set low speed to 500pps
ACC=500                 ;* Set acceleration to 500ms
TOC=5000                ;* Set time-out counter alarm to 5 seconds
EO=1                    ;* Enable motor
WHILE 1=1               ;* Forever loop
        X0              ;* Move to position 0
        WAITX           ;* Wait for the move to complete
        X1000           ;* Move to position 1000
        WAITX           ;* Wait for the move to complete
ENDWHILE                ;* Go back to WHILE statement
END                     ;* End Program 0

PRG 1                   ;* Start of Program 1
WHILE 1=1               ;* Forever loop
        V1=MSTX&1024    ;* Get bit time-out counter alarm variable
        IF V1 = 1024    ;* If time-out counter alarm is on
                SR0=0   ;* Stop program 0
                ABORTX  ;* Abort the motor
                DO=0    ;* Set DO=0
                DELAY=3000;* Delay 3 seconds
                SR0=1   ;* Turn program 0 back on
                DO=1    ;* Set DO=1
        ENDIF
        ENDWHILE        ;* Go back to WHILE statement
END                     ;* End Program 1
```

Appendix A: Speed Settings

HSPD value [PPS] †	Speed Window [SSPDM]	Min. LSPD value	Min. ACC [ms]	δ	Max ACC setting [ms]
1 - 16 K	0,1	10	2	500	((HSPD – LSPD) / δ) × 1000
16K - 30 K	2	10	1	1 K	
30K - 80 K	3	15	1	2 K	
80K - 160 K	4	25	1	4 K	
160K - 300 K	5	50	1	8 K	
300K - 800 K	6	100	1	18 K	
800K - 1.6 M	7	200	1	39 K	
1.6 M - 3.0 M	8	400	1	68 K	
3.0 M – 6.0 M	9	500	1	135 K	

Table A.0

†If StepNLoop is enabled, the [HSPD range] values needs to be transposed from PPS (pulse/sec) to EPS (encoder counts/sec) using the following formula:

EPS = PPS / Step-N-Loop Ratio

Acceleration/Deceleration Range

The allowable acceleration/deceleration values depend on the **LSPD** and **HSPD** settings.

The minimum acceleration/deceleration setting for a given high speed and low speed is shown in Table A.0.

The maximum acceleration/deceleration setting for a given high speed and low speed can be calculated using the formula:

Note: The ACC parameter will be automatically adjusted if the value exceeds the allowable range.

Max ACC = ((HSPD – LSPD) / δ) × 1000 [ms]

Figure A.0

Examples:

a) If **HSPD** = 20,000 pps, **LSPD** = 100 pps:
   a. Min acceleration allowable: **1 ms**
   b. Max acceleration allowable:
   ((20,000 – 100) / 1,000) x 1,000 ms = **19900 ms** (19.9 sec)

b) If **HSPD** = 900,000 pps, **LSPD** = 1000 pps:
   a. Min acceleration allowable: **1 ms**
   b. Max acceleration allowable:
   ((900,000 – 1000) / 39,000) x 1000 ms = **23050** ms (23.05 sec)

Acceleration/Deceleration Range – Positional Move

When dealing with positional moves, the controller automatically calculates the appropriate acceleration and deceleration based on the following rules.

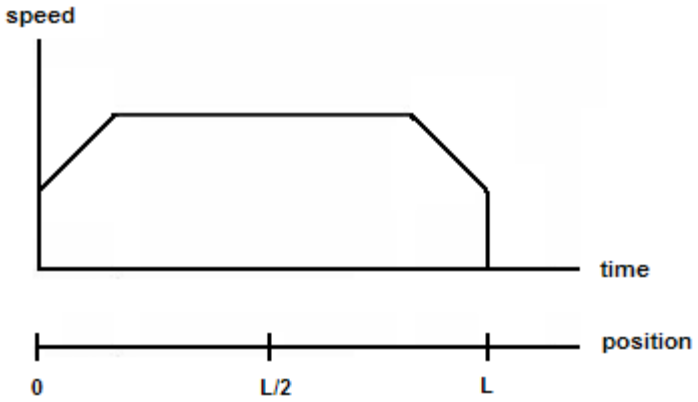


Figure A.1

1) ACC vs. DEC 1: If the theoretical position where the controller begins deceleration is less than L/2, the acceleration value is used for both ramp up and ramp down. This is regardless of the EDEC setting.
2) ACC vs. DEC 2: If the theoretical position where the controller begins constant speed is greater than L/2, the acceleration value is used for both ramp up and ramp down. This is regardless of the EDEC setting.
3) Triangle Profile: If either (1) or (2) occur, the velocity profile becomes triangle. Maximum speed is reached at L/2.

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