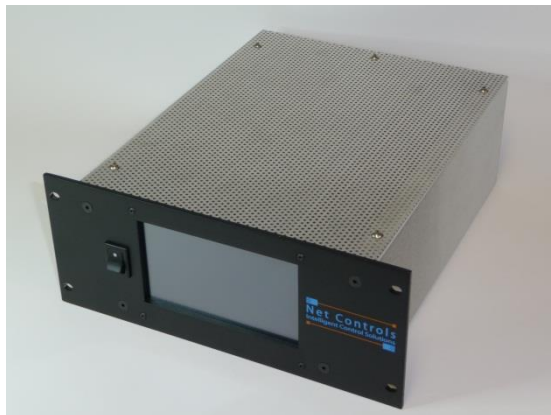


9x Series Motor Controllers/Drivers



Operator's Manual



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Please note:

This manual from Net Controls, LLC is the latest version for the revision indicated. The information contained herein is subject to change without notice. It is advised that if this information is used in a critical application, that it be verified with Net Controls, LLC.

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Safety Information

This manual utilizes the three icons below to alert the reader to particular areas of importance where special attention should be focused.



Note: *Special uses of the controller and installation pointers are revealed.*



CAUTION: *Heed warning to prevent damage to controller or other equipment.*



WARNING: *Controller hazards that could create serious bodily harm or death.*

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Section One: General Information

Introduction

Congratulations on purchasing the 9x Series Motor Controller/Driver(s) from Net Controls, LLC! We are glad you chose the 9x-0x-99xx for your application and it is our goal to provide excellent service and support should you need it.

Prior to installation, read this manual to insure you are thoroughly familiar with the controller's capabilities and operational characteristics. If you have any problems or questions, please contact Net Controls Customer Service at (530) 894-3358 or visit our website at www.n-controls.com.

The 9x Series Controllers/Drivers are designed for various automation tasks including xyz positioning. Typical applications are for vacuum system motion and manipulation. The 9x Series small footprint incorporates all control electronics and associated control software. Two versions are available: "remote" with separate controller and "integrated" with the controller and/or driver attached to the motor itself.

Remote operation and monitoring can be done with the default serial RS-232 communication interface. All controllers are also equipped with an RS485 interface with the appropriate jumper settings. An alternate Ethernet communications connection is available on "e" version controllers, USB on "u" version controllers, and CAN on "c" version controllers.

Controller Models Covered

This manual is applicable to the following controller models:

9x-0x-99xx Models

Compatibility

All controllers are compatible with any hybrid stepper motor. However, some functionality may be lost if high-resolution encoders are not installed. See connection and motor selection in section three (3) for details. Additionally, all controllers can either be accessed via computer or from an optional touch screen available from Net Controls. Integrated controllers are packaged on the motor. Remote controllers are separate boxes that can be located up to 8 feet from the motor. Net Controls offers a variety of cables to facilitate installation.

Manual Organization

This manual is organized to provide instructions on installation, set-up, operation, and troubleshooting. Before proceeding, make sure you are familiar with the caution and warning figures outlined at the beginning of the manual. Pay careful attention to all warning and caution indications found within the following pages.

Section One, *General Information*, outlines the product.

Section Two, *Installation*, details the unpacking of the product and environmental considerations for the application of the product.

Section Three, *Overview*, describes the front and rear panel of the 9x Series Controller, electrical connections, and theory of operation.

Section Four, *System Set Up*, explains initialization, general configuration, set points, manual positioning, recipe setup and selection, and normal operation.

Section Five, *Operation*, highlights how the controller is used, common commands, and requests/responses used.

Appendix A, *Command and Request Reference*, lists the ASCII commands.

Appendix B, *ASCII Request and Response Reference*, lists the RS-232 requests and responses.

Appendix C, *Warranty*, enumerates the Net Controls, LLC warranty for the 9X Series Motor Controller/Driver.

Customer Support

If you encounter any questions or difficulties during the installation, set-up, or use of the controller, please contact Net Controls Customer Support.

Contact Phone Number: (530) 894-3358.

Website: www.n-controls.com

If it is found necessary to return the controller to Net Controls, contact Customer Support to obtain additional instructions and a Return Materials Authorization (RMA) number.



WARNING: All returned products to Net Controls must be free of all contaminants, including harmful, corrosive, radioactive, or toxic materials.

Section Two: Installation

Unpacking the 9X Series Motor Controller

Inspect the shipping container prior to unpacking

Report any damage to Net Controls or to the transportation company

As the product is removed from the box, look for any damage

If you must return the product to Net Controls, please contact Net Controls Customer Service to obtain a Return Material Authorization (RMA) Number.



Note: *Keep the packing materials until you are sure the controller is satisfactory*

Unpacking Checklist

9x Series Motor Controller/Driver

Optional Motor(s)

Optional Supplied Cables

1. Interface Cable for connection to HOST computer: DB-9/DB-9 connector to controller.
2. Motor Drive Cable(s): DB-9/Molex Micro-Fit connector to motor.
3. AC power cord for Touch-Screen or AC remote controller.

Preliminary Controller Check

All products are stringently tested and then carefully packed for shipment. However, sometimes shipment can cause damage to occur. Therefore, it is advisable to check the unit prior to installation. We recommend the user:

- Connect the 9x Series controller to a motor and suitable power source.
- After the power is turned on, initialize a motor via touch screen or HOST computer. The attached motor will complete a 30 second initialization sequence during which the motor will cycle CW/CCW and perform a calibration (see ASCII Commands section). **YOU MAY NOT SEE THE MOTOR MOVE.**
- Home the motor. The motor will move to a home reference (see ASCII Commands section).
- For touch-screen controllers, refer to Section 5 (Operation) for instructions on navigating to the “Motor Control Center.”
- For Integrated Controllers, the HOST system needs to be connected to Initialize and Home. See Section 4 (System Set-Up).
- Contact Net Controls Technical Support if the controller does not operate as outlined above.

Safety Conditions



WARNING: *Keep body parts and other items away from moving parts due to potential pinching hazards.*



CAUTION: *Check to make sure the voltage (DC) is correct for your local electrical source. The power supply must be plugged into a properly grounded outlet.*

Product Location and Requirements

The “remote version” controller (90/91/92 Series) may be mounted away from the motor(s) in any orientation, up to 8 feet away. Four (4) mounting holes are located on the controller case to facilitate mounting. It is recommended to mount the controller such that the LEDs or switches on the front panel can be seen by an operator or technician for troubleshooting purposes. Environmental conditions required for proper operation:

- Operating temperature: 65°C
- Acceptable ambient humidity: 0 to 95% non-condensing
- Allow at least 3-1/2” of access at the rear panel for connections (remote model)
- Allow at least 3-1/2” of access at the front panel for debug port clearance (remote model)
- Allow at least 3-1/2” of access to the side of the integrated controller where connectors are located



Note: *The Interface Cable (RS-232 Serial Communications) must be an overall braided shielded cable, properly grounded, to meet CE specifications.*

Section Three: Overview

Rear Panel Remote Controller

Figure 3.1 below shows the rear panel layout of the 9X SERIES REMOTE Controller. Tables 3.1 and 3.2 detail the pin-outs required for each connector.

Figure 3.1 Back Panel 91/92 Series

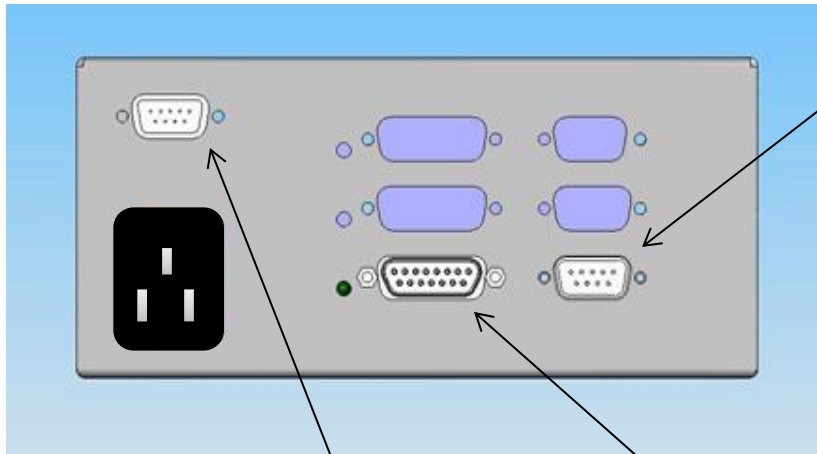


Table 3.1 Motor

Pin	Function
1	Motor Phase A+
2	Motor Phase A-
3	Motor Phase B-
4	Motor Phase B+
5	Ground (Encoder)
6	Encoder Index
7	Encoder Channel A
8	Encoder Channel B
9	+5V (Encoder)

Table 3.3 Serial

Pin	Function
1	RS485 B
2	RS485 A
3	NC
4	NC
5	Ground
6	NC
7	NC
8	NC
9	NC

Table 3.2 I/O

Pin	Function
1	+5V
2	Ground
3	Output 1 Collector
4	Output 2 Collector
5	Input 1 (5V)
6	Input 2 (5V)
7	Input 3 (5V)
8	Input 4 (5V)
9	+5V
10	Ground
11	Output 1 Emitter
12	Output 2 Emitter
13	Ground
14	Ground
15	Chassis Ground

Section Four: System Setup

Defaults

The 9x series controllers require certain default settings in order to operate in a particular application. The defaults are:

Table 4.1 Default Motor/Motion Settings

Defaults	Description	Setting
Run Current	Peak motor current during motion (%)	16*
Hold Current	Peak motor current during stand still (%)	2
Motor Acceleration	Acceleration in steps/sec ²	1,000
Motor Velocity (Max)	Max speed in steps/sec	2,000
Current Scale	High/Low current scale	0 (high)*
CW/CCW Direction	CW or CCW when position is increasing	CW
Encoder CPR	Counts/rev of encoder if equipped	800/4095*
Loading Error	Allowable Error when using encoder	12800**
Initialization Loading Error	Separate Load Error when Homing the motor	32
Micro Step Resolution	Micro steps/step	64-256*

*These settings are determined by the motor type.

**Initial setting. Should be changed after initial setup to a lower number

Table 4.2 Default ASCII Serial Commands

ASCII Command	Description	Notes
:aAxxx	Set Default Acceleration	xxx = 0-65535 (a = Motor Address)
:aOx	Set Current Scale	x = 0 High Current x = 1 Low Current
:aExxx	Set Encoder CPR	xxx = 0 - 8192
:aSxxx	Set Default Velocity	xxx = 0-65535
:aLxxx	Loading Error Adjustment	xxx = 32-65535
:aMxx	Micro Steps	xxx = 4,8,16 / 1,2,4,8,16,32,64,128,256*
:aHxx	Holding Current	xx = 0-100 / 0-31*
:aRxx	Run Current	xx = 0-100 / 0-31*
:aCx	Direction Bit	x = 0 Direction is CW x = 1 Direction is CCW
:alxx	Initializing Load Error	Xx = 1-65535

*Indicates Settings for Devices with Rev. 1.3 or higher Firmware



CAUTION: Check the motor specifications before setting run and hold currents. Damage may result if settings are outside of the rated phase currents.

Inputs and Outputs

The 9x Series controllers feature 4 inputs and 2 outputs. The inputs are single-ended and are 5VDC compatible. They are internally pulled up to the 5V supply. The outputs are optically isolated open-collector capable of driving 50mA at 24VDC. The outputs also feature an emitter connection to allow for source or sink configurations. See table 3.2 for pin outs.

Inputs can be configured for rising or falling DC voltage levels and can be set to stop the motor abruptly (Hard) or in a controlled deceleration (Soft). See table below.

Table 4.3 Input Configuration

Setting	Trigger	Function
0	Not Present	Disabled
1	Rising Edge	Motor Hard Stop
2	Rising Edge	Motor Soft Stop
3	Falling Edge	Motor Hard Stop
4	Falling Edge	Motor Soft Stop

Outputs can be configured for automatic activation when certain events occur (See table 4.4). The user can also activate outputs via the serial interface. See section five for actual command string examples.

Table 4.4 Output Configuration

Setting	Function
0	User Defined
1	Motor Error
2	Motor Moving
3	Motor Stopped

Table 4.5 I/O ASCII Commands

ASCII Command	Description
:aTx (Input 1)	Set Input Function a = Motor Address x = Function Setting 0-4
:aUx (Input 2)	
:aVx (Input 3)	
:aWx (Input 4)	
:aJx :aKx	Set Output Function x = Function Setting



Note: Serial Communication Settings are 38400, 8, N, 1 for RS232, RS485, and USB.

Section Five: Operation

Messages sent to the 9X SERIES Controller are either commands that instruct the controller to change an operating parameter, or requests that prompt the controller to report status information. Responses sent by the 9X SERIES controller reply to a request message issued by your computer's RS-232 communication software or the Touch Screen's software.

All messages must use a carriage return (CR) as the end-of-line delimiter. The line feed character is not used. Use your HOST computer's communication software to assign the CR action to the Enter key. All communication port settings are 38400,8,N,1 unless otherwise specified.

Operation of the 9X SERIES Controller is done through the commands and requests/responses which are listed in **Appendices A and B**.

ASCII Command and Request/Response Examples

Commonly used command and request/response examples are detailed below. Oftentimes reading or verifying of commands is done immediately after inputting commands. The 9X SERIES serial command protocol **IS** case sensitive. The **Bold typed** letter/number combinations that follow represent the commands and requests/responses. To input commands, type the **bold** faced letters/numbers as shown and press Enter. See **Appendix A** for a complete table of requests and responses, or "Get" requests. See **Appendix B** for a complete table of commands, or "Set" commands.

Multi-Axis Commands

All commands in multi-axis controllers begin with a valid address to communicate with axis 1-15. The address begins with a colon followed by the ASCII Hex axis number.

Ex. :**2xyz**<CR> Sends a command or request to Axis 2

Ex. :**Fxyz**<CR> Sends a command or request to Axis 15



Note: All Multi-Axis addresses start with Axis 1, 0 (Zero) is reserved for the Master and for Global Commands.

Using the Set points

The set points are used to manipulate the motors automatically. The sequence is:

1. Determine the optimum Acceleration and Velocity values for the motion desired
2. Define Set point value, acceleration value, and velocity (max speed) value
3. Execute set point

The set point commands are communicated from the HOST by inputting:

:1012800,5000,6000<CR> Sets motor 1 Set Point 0 to:

12800 Position

5000 Velocity

6000 Acceleration

:1d0<CR> Motor 1 executes set point 0



Note: *All Set Point values are stored in non-volatile memory and should not be updated frequently. Use Manual mode controls for dynamic positioning (See below).*

Reading the Set point

The set point request is communicated from the serial port to the HOST by inputting:

:10<CR>

To verify set point 0 for motor 1

:10xxx,yyy,zzz<CR>

is the controller response where **xxx** is the set point value, **yyy** is the velocity and **zzz** is the acceleration value.

Setting the Motor Position Manually

The motor position can be set manually using the following commands:

- :1a50000<CR>** Sets Acceleration value to 50,000 for motor 1.
- :1v50000<CR>** Sets Velocity (max speed) value to 50,000 for motor 1.
- :1p250000<CR>** Sets motor 1 absolute position to 250,000 using the parameters above.
- :1p0<CR>** Sets motor 1 absolute position to 0 using the parameters above.

Reading the Motor Position

The command below reports the position of motor 1

:1p<CR>

The controller then responds with the motor position using the format:

:1pxxxx<CR> *xxxx is absolute position from -2.147B to +2.147B*

RS485 Command Set

The RS485 command set uses “Set and Get” commands to read and write control registers on the 9x and 85 Series Motors. See the command reference listed in Appendices A and B.

Get Commands

The command structure for GET commands is:

`:xy<CR>`

Where

x = Device Address in ASCII Hex

y = Register Address in ASCII HEX

To read position, for example:

`:1p<CR>`

The controller will respond with:

`:1p12800<CR>` indicating the position is 12800 ('p' is ASCII 70hex).

Set Commands

The structure for Set Commands are similar to Get, except that all commands must be followed by a number.

`:xyzzzz<CR>`

For example, to set position:

`:1p12800<CR>`

This instructs the motor to move to position 12800 using the global velocity and acceleration.

Set Points

Set points, for RS485 devices, are assigned to each motor independently, but can be executed by all motors simultaneously by issuing a “Global” command. Each axis has 10 set points stored in non-volatile memory. In addition, devices configured for RS485 communications do not support multi-axis recipe commands.

Global Commands

Global commands affect all motors simultaneously and are accessed by using the 0 (zero address).

For example:

:0D<RETURN>

This command will query the motor address, allowing the user to set a new address.



Note: *Only one motor can be connected to the bus to utilize this global command.*

Other Global commands include:

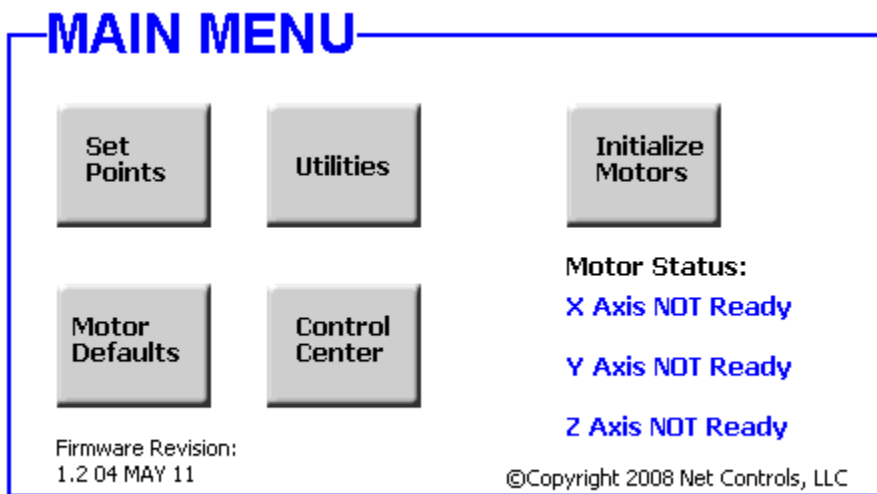
63hex	'c'	Home to Command
64hex	'd'	Execute Set Point Number
68hex	'h'	Halt, Soft or Hard
69hex	'l'	Initialize/Enable Drivers

Touchscreen Operation

9X SERIES Controllers equipped with a touchscreen interface can be configured and operated completely independent of a host computer. Note that default configuration, set point configuration, and recipe configuration use the same concepts as the serial port interface.

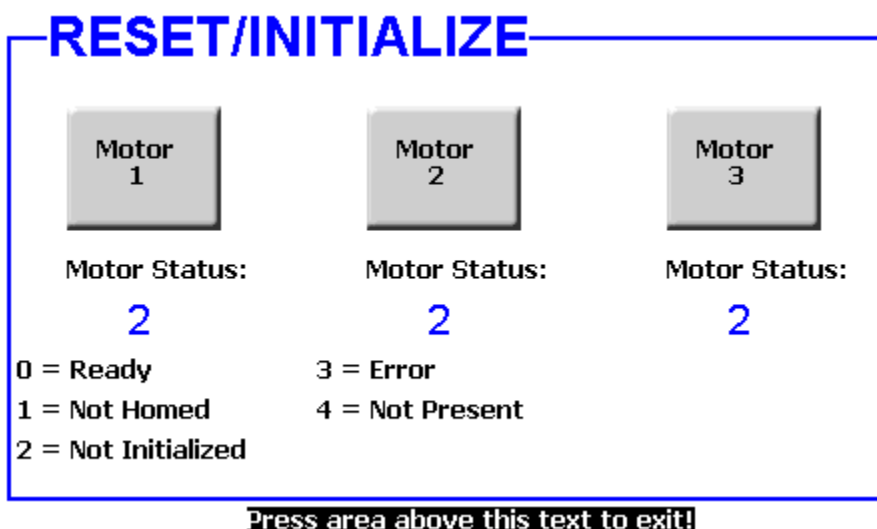
Main Menu/Initialization

The Main Menu is the starting point for all operations.



The Main Menu allows the user to jump to various configuration and control menus, as well as providing the user a status of each axis. Also, it is from the Main Menu that the motors are initialized.

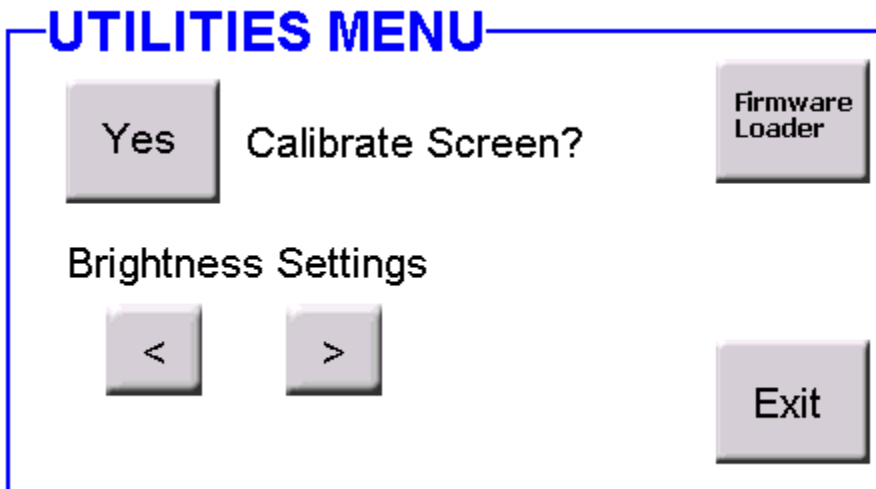
To initialize the motor(s), press the **Initialize Motors** button. The RESET/INITIALIZE screen is activated and the status of each motor is displayed. The motor(s) will operate in state 0 or 1 only.



To initialize the motor(s), simply press the button representing the motor you wish to initialize. Please note that this is also the method used to reset a motor after an error has occurred. Press any area in the lower part of the screen to exit to the Main Menu.

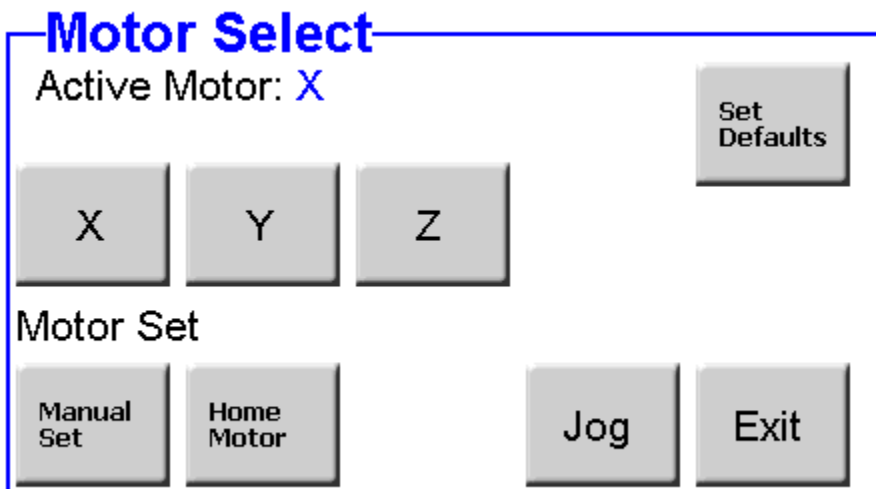
Utilities Menu

The Utilities Menu provides the user with an interface to adjust the screen settings and calibrate the touchscreen if needed. Brightness settings are saved and need not be configured on each power up.



Motor Defaults

The Motor Defaults Menu is used to change/view the various motor parameters used for operation. All of the default parameters listed in table 4.1 can be modified. From the Main Menu, press the **Motor Defaults** button. A preliminary menu will be displayed to allow for the selection of the motor.



Once the active motor is selected, press the **Set Defaults** Button. The Default Parameters screen is displayed so the user can view all of the current defaults for the active motor.

Default Parameters

Run I:	Hold I:	Enc CPR:	Accel:	Velocity:
80	10	800	1000	10000
CW/CCW:	Load Error:	Init Error:	Microsteps:	Decay Mode:
1	65535	128	16	1
			Global Accel:	1000
			Global Velocity:	10000
Active Motor: X				

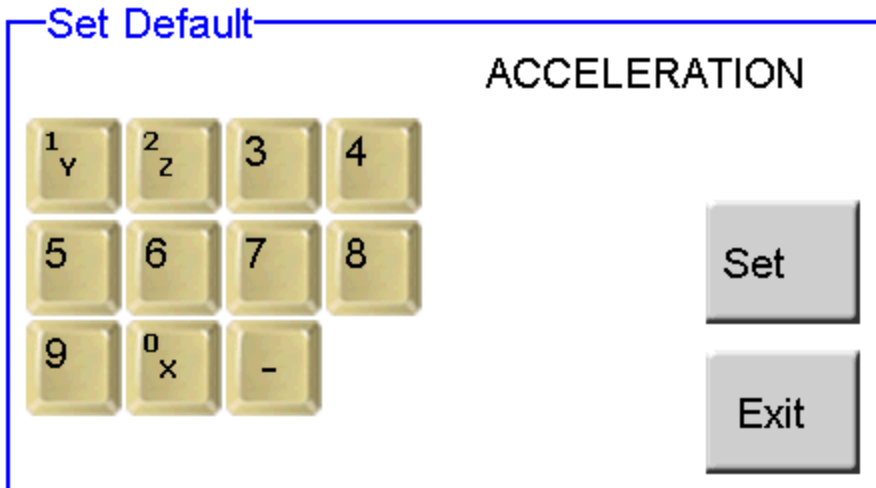
Press area above this text to exit!

Pressing any area above the flashing text will display the Defaults screen and allow any of the default parameters to be modified. Press Exit button to go/return to the control center.

Defaults

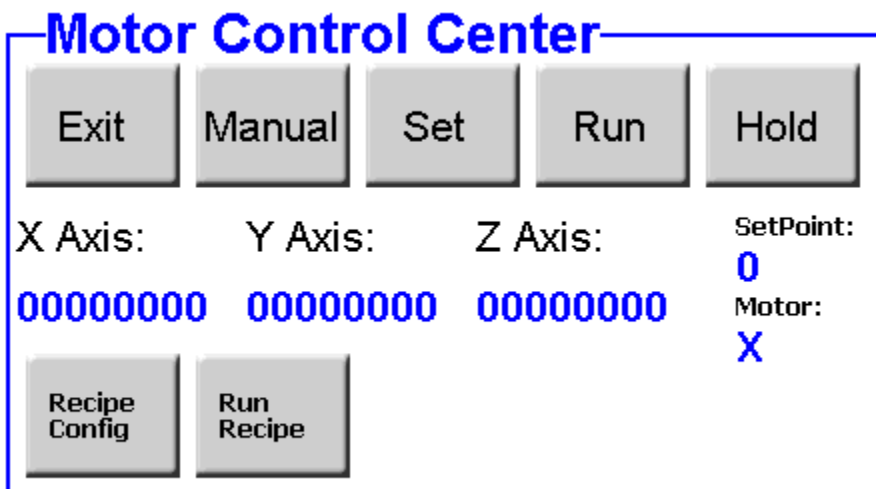
Run Current	Hold Current	Encoder CPR	Default Accel	Default Velocity
CW CCW	Load Error	Init Error	Micro Steps	Decay Mode
Global Accel	Global Velocity			Exit

To set/modify a parameter, simply press the appropriate button and use the keypad to set. The parameter to be set will be displayed in the upper right of the screen. Pressing the **Set** button will save the new parameter value in non-volatile memory and need not be set again. Pressing the Exit button will take the user back to the Defaults screen where another parameter can be selected or the user can exit the default setup screens.



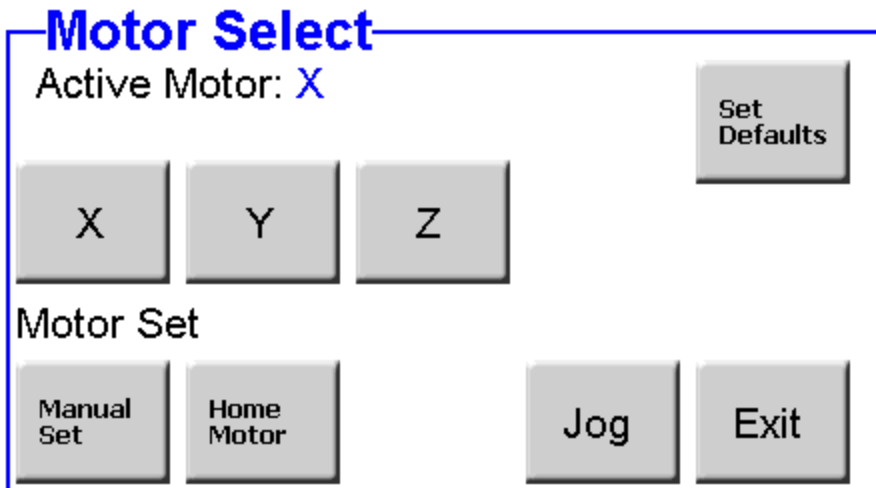
Motor Control Center

The Motor Control Center is used to display motor positions, move motors manually, move motors automatically via set points, or to select and run recipes. Also, the **Hold** button is available to stop all motors and kill the recipe task if running.

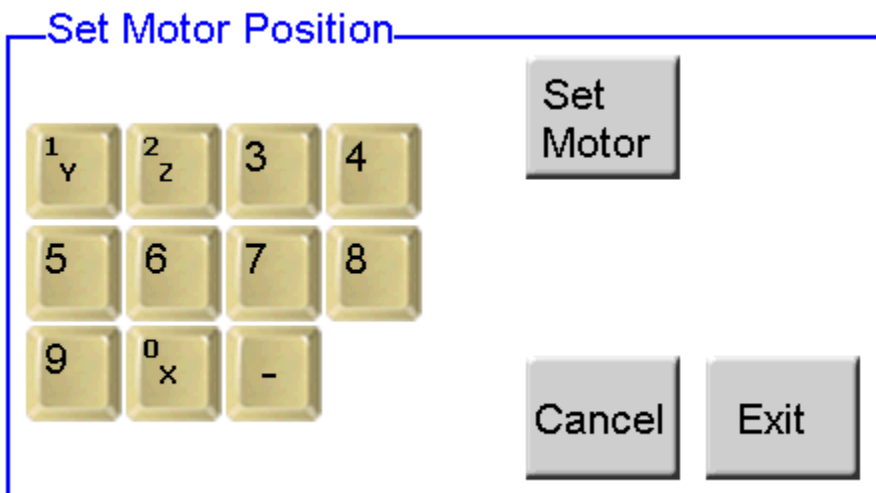


Manual Motor Operation

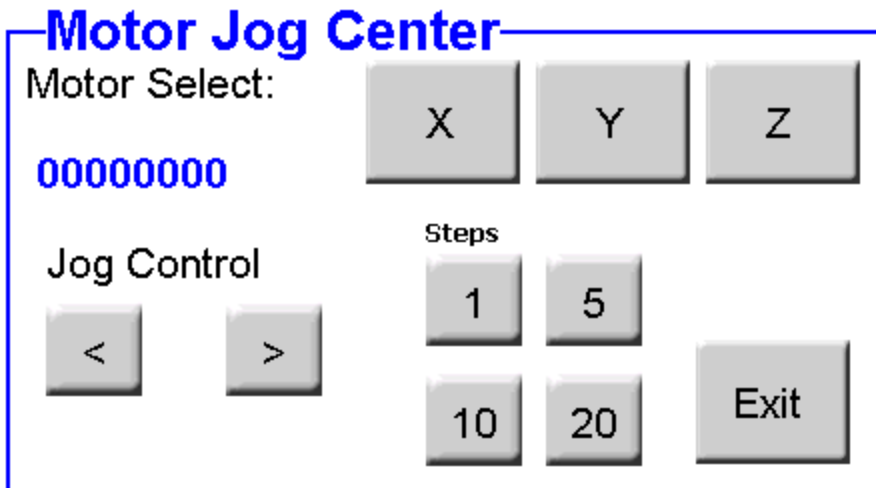
To move the motor(s) manually, press the **Manual** button from the Motor Control Center menu. The Motor Select screen will be displayed. Select the motor to move and/or verify it is the Active Motor. Press the **Manual Set** button to display the keypad.



Once the keypad is displayed, enter an absolute position to the desired value and press the **Set Motor** button. The motor will begin to move immediately.

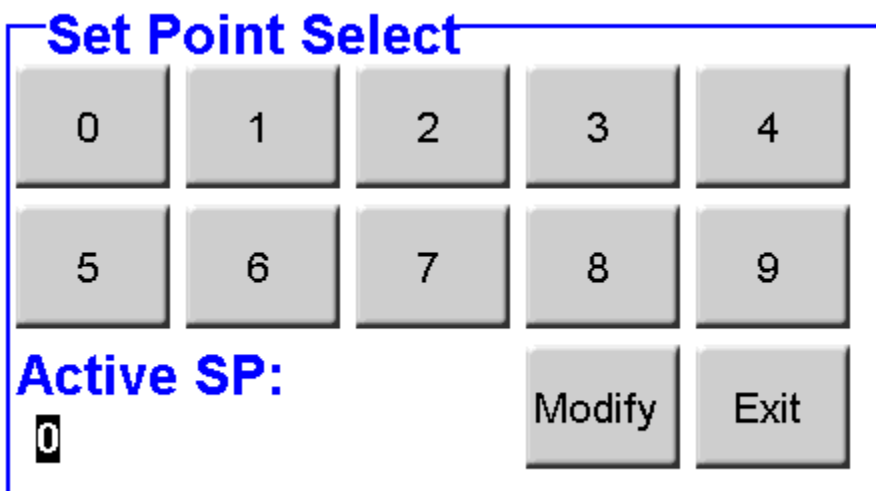


Alternatively, the motor(s) can be jogged to a relative position by selecting the Jog button from the Motor Select screen. Once selected, the Motor Jog Center screen is displayed and each motor can be moved in a positive or negative direction in 1, 5, 10, or 20 step increments. Please note that the absolute position of the active motor is displayed in the upper left of the screen in blue text.



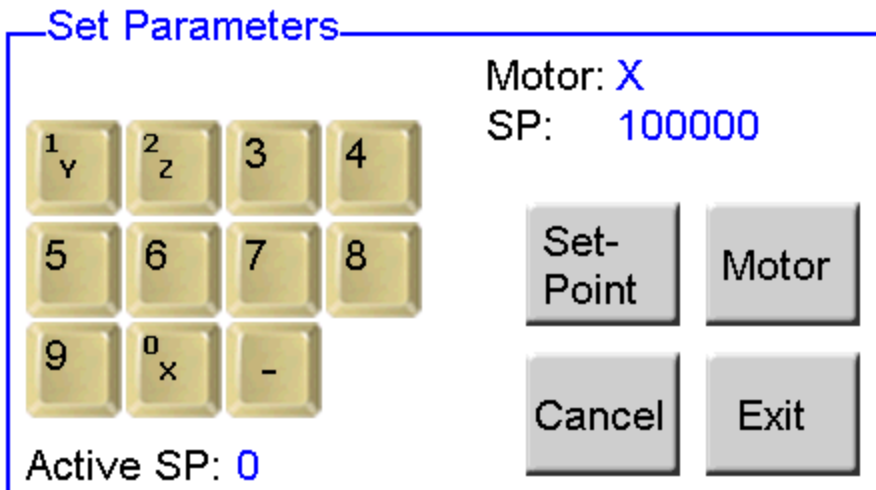
Set Points

Set points are used to position a motor to a particular position without the need to re-enter the absolute position each time a move is desired. To configure the set points, the user can enter the set point select menu from either the Main Menu screen or the Motor Control Center Screen. From the Motor Control Center screen, press the **Set** button to enter the Set Point Select menu. From the Main Menu screen, press the **Set Points** button.



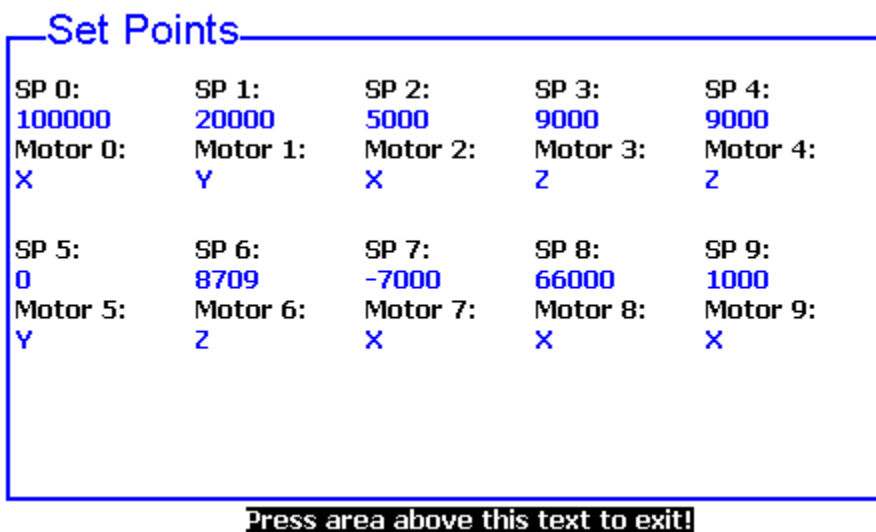
To select the active set point, press the appropriate button (0-9). The active set point will be displayed in the lower left of the screen and will be highlighted. To view or modify the active set point, press the **Modify** button to display the Set Parameters screen.

If no modifications are necessary, simply press the Exit button to return to the Set Point Select screen, then exit to the Motor Control Center screen by pressing the **Exit** button again.



To modify a set point, select the motor first by selecting the 0, 1, 2 keys (x, y, and z respectively) and press the **Motor** button. Then, enter the set point value to apply to the selected motor and press the **Set Point** button. The set point will be saved in non-volatile memory and need not be set again.

If entering the set points menu from the Main Menu screen, all of the currently configured set points will be displayed so the user can obtain an overview of all the set points.



Exit this page to return/display the Set Point Select screen to modify and/or exit the set points menus.

To execute a set point, select the **Run** button from the Motor Control Center screen. The current active set point will be executed.

Recipe Configuration

To configure a recipe, first configure the absolute motor position(s) using the set points. From the Motor Control Center, press the **Recipe Config** button to display the Recipe Configuration screen. This screen contains online instructions for configuring a recipe.

Recipe Configuration

Configure the Receptie:

1. Select step number
2. Set Axis Number
0 = X, 1 = Y, 2 = Z
3. Set setpoint pointer (0-9)
4. Set Wait time

Step Number: 0
Axis Number: Y
SP Pointer: 0
Wait Time: 0

SP Pointer Wait Time
Step Number Axis Number
Exit

The user starts by selecting the step number. This is the step in the overall recipe sequence, from 0-9. The axis is then selected to map an absolute position. Third, a pointer is entered to map the motor to a set point, 0-9. Lastly, a wait time is entered to define a wait period in between each step of the recipe sequence. Press the **Exit** button to return to the Motor Control Center.

To run the recipe, select the **Run Recipe** button from the Motor Control Center screen. The user will be prompted to select the number of step to run, 0-9. Enter the number of steps. The recipe begins immediately.

Motor Homing

To home the motor(s), use the Manual button from the Motor Control Center screen. Select the active motor to home and press the **Home Motor** button to display the Homing Center screen. Using the buttons on the screen, the user can home the motor(s) using various scenarios listed in section 4. Please note that I/O's must be present and fully configured to home a motor, unless the **Load Error** button is used. In this case, an encoder must be present and configured correctly. In addition, homing to an error requires a mechanical hard stop. Also note that I/O's need to be configured via the serial interface.

Motors need not be homed to work properly. Homing simply provides an absolute reference for positioning applications.

Homing Center

Encoder Index	Input 1	Input 2
Input 3	Input 4	Load Error

Encoder & Inputs must be configured
Prior to Homing

Exit

APPENDIX A: ASCII COMMAND REFERENCE

“Set” Commands:

Command	Address (hex)	ASCII Printable Equivalent	Remarks
Acceleration	0x61	a	:abxxx where: a = Address b = 'a' xxx = Acceleration in steps/sec ²
Home	0x63	c	:abxxx where: a = Address b = 'c' x = Home To Point
Execute Set Point	0x64	d	:abxxx where: a = Address b = 'd' x = Setpoint Number
Halt	0x68	h	:abxxx where: a = Address b = 'h' x = 1 = Hard Stop x = 2 = Soft Stop
Initialize/Enable	0x69	i	:abxxx where: a = Address b = 'i' x = 1
Jog	0x6A	j	:abxxx where: a = Address b = 'j' xxx = Number of steps to jog (can be -)
Set Output 2	0x6E	n	:abxxx where: a = Address b = 'n' x = 1 = On x = 0 = Off
Set Output 1	0x6F	o	:abxxx where: a = Address b = 'o' x = 1 = On x = 0 = Off
Go to Position	0x70	p	:abxxx where: a = Address b = 'p' xxx = Position

Set Speed	0x73	s	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 's' <i>xxxx</i> = Speed in steps/sec
Velocity	0x76	v	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'v' <i>xxxx</i> = Max Velocity in steps/sec
Go to Absolute Position	0x78	x	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'x' <i>xxxx</i> = Absolute Position 0-360.0 in degrees
Set Point 0	0x30	0	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '0' <i>xxxx</i> = Position assigned to setpoint 0
Set Point 1	0x31	1	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '1' <i>xxxx</i> = Position assigned to setpoint 1
Set Point 2	0x32	2	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '2' <i>xxxx</i> = Position assigned to setpoint 2
Set Point 3	0x33	3	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '3' <i>xxxx</i> = Position assigned to setpoint 3
Set Point 4	0x34	4	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '4' <i>xxxx</i> = Position assigned to setpoint 4
Set Point 5	0x35	5	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '5' <i>xxxx</i> = Position assigned to setpoint 5
Set Point 6	0x36	6	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '6' <i>xxxx</i> = Position assigned to setpoint 6
Set Point 7	0x37	7	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '7' <i>xxxx</i> = Position assigned to setpoint 7

Set Point 8	0x38	8	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '8' <i>xxxx</i> = Position assigned to setpoint 8
Set Point 9	0x39	9	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '9' <i>xxxx</i> = Position assigned to setpoint 9
NV Acceleration	0x41	A	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'A' <i>xxxx</i> = Acceleration in steps/sec ² Non-volatile
Baud	0x42	B	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'B' <i>x</i> = 1 = 9600 <i>x</i> = 2 = 19200 <i>x</i> = 3 = 38400 <i>x</i> = 4 = 57600 <i>x</i> = 5 = 115200
Direction	0x43	C	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'C' <i>x</i> = 1 = CCW <i>x</i> = 0 = CW
Address	0x44	D	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'D' <i>xxxx</i> = Device address 0-F (hex)
Encoder CPR	0x45	E	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'E' <i>xxxx</i> = Encoder CPR or PPS x4
Set Zero	0x46	F	: <i>ab</i> where: <i>a</i> = Address <i>b</i> = 'F' sets current absolute position to 0
Holding Current	0x48	H	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'H' <i>x</i> = 0-31 (31 = 2A/Phase)
Initialization Load Error	0x49	I	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'I' <i>xxx</i> = Allowable Error before hard stop is detected

Out 1 Configuration	0X4A	J	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'J' <i>x</i> = Config Parameter
Out 2 Configuration	0x4B	K	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'K' <i>x</i> = Config Parameter
Load Error	0x4C	L	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'L' <i>xxxx</i> = Allowable Following Error before faulting
Microsteps/Step	0x4D	M	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'M' <i>xxx</i> = 2-256
Current Range Select	0x4F	O	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'O' <i>x</i> = 0 = High Range (2A) <i>x</i> = 1 = Low Range (1A)
Run Current	0x52	R	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'R' <i>x</i> = 0-31 (31 = 2A/Phase)
NV Speed	0x53	S	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'S' <i>xxxx</i> = Max Speed in Steps/Sec Non-volatile
Input 1 Configuration	0x54	T	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'T' <i>x</i> = Config Parameter
Input 2 Configuration	0x55	U	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'U' <i>x</i> = Config Parameter
Input 3 Configuration	0x56	V	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'V' <i>x</i> = Config Parameter
Input 4 Configuration	0x57	W	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'W' <i>x</i> = Config Parameter

Input 5 Configuration	0x58	X	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'X' <i>x</i> = Config Parameter
Input 6 Configuration	0x59	Y	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'Y' <i>x</i> = Config Parameter
Index Configuration	0x5A	Z	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'Z' <i>x</i> = Config Parameter

APPENDIX B: ASCII REQUEST AND RESPONSE REFERENCE

“Get” Requests:

Command	Address (hex)	ASCII Printable Equivalent	Remarks
Acceleration	0x61	a	Returns : <i>abx</i> where: <i>a</i> = Address <i>b</i> = 'a' <i>x</i> = Acceleration in steps/sec ²
Following Error	0x62	b	Returns : <i>abx</i> where: <i>a</i> = Address <i>b</i> = 'b' <i>x</i> = Following Error expressed as micro-steps relative to the encoder count (ratio)
Status	0x66	f	Returns : <i>abxy</i> where: <i>a</i> = Address <i>b</i> = 'f' <i>x</i> = System Status <i>y</i> = Current active Set Point
Motor Status	0x67	g	Returns : <i>abxy</i> where: <i>a</i> = Address <i>b</i> = 'g' <i>x</i> = 1 = Motor Running <i>x</i> = 0 = Motor Stopped/finished <i>y</i> = Motor Status: 0 = Motor Ready 1 = Motor Not Homed 2 = Motor Not Initialized 3 = Motor Error
Initialize/Enable	0x6C	l	Returns status of all inputs 4 + Index 1 = High 0 = Low i.e. : <i>ab00001</i> indicates Index is High
Output 2 Status	0x6E	n	Returns : <i>abx</i> where: <i>a</i> = Address <i>b</i> = 'n' <i>x</i> = 1 = On <i>x</i> = 0 = Off
Output 1 Status	0x6F	o	Returns : <i>abx</i> where: <i>a</i> = Address <i>b</i> = 'o' <i>x</i> = 1 = On <i>x</i> = 0 = Off

Position	0x70	p	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'p' <i>xxxx</i> = Position
Current Speed	0x73	s	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 's' <i>xxxx</i> = Current Speed in steps/sec
RPM	0x75	u	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'u' <i>xxxx</i> = RPM (float) XX.XX
Global Velocity	0x76	v	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'v' <i>xxxx</i> = Max Velocity in steps/sec
Absolute Position	0x78	x	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'x' <i>xxxx</i> = Absolute Position 0-360.0 in degrees
Encoder Position	0x79	y	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'y' <i>xxxx</i> = Encoder Counts (Can be negative)
Software Revision	0x7A	z	Returns : <i>abxyz</i> where: <i>a</i> = Address <i>b</i> = 'z' <i>xyz</i> = Series Revision-Date
Set Point 0	0x30	0	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '0' <i>xxxx</i> = Position assigned to setpoint 0
Set Point 1	0x31	1	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '1' <i>xxxx</i> = Position assigned to setpoint 1
Set Point 2	0x32	2	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '2' <i>xxxx</i> = Position assigned to setpoint 2
Set Point 3	0x33	3	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '3' <i>xxxx</i> = Position assigned to setpoint 3

Set Point 4	0x34	4	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '4' <i>xxxx</i> = Position assigned to setpoint 4
Set Point 5	0x35	5	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '5' <i>xxxx</i> = Position assigned to setpoint 5
Set Point 6	0x36	6	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '6' <i>xxxx</i> = Position assigned to setpoint 6
Set Point 7	0x37	7	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '7' <i>xxxx</i> = Position assigned to setpoint 7
Set Point 8	0x38	8	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '8' <i>xxxx</i> = Position assigned to setpoint 8
Set Point 9	0x39	9	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = '9' <i>xxxx</i> = Position assigned to setpoint 9
NV Acceleration	0x41	A	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'A' <i>xxxx</i> = Acceleration in steps/sec ² Non-volatile
Baud	0x42	B	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'B' <i>x</i> = 1 = 9600 <i>x</i> = 2 = 19200 <i>x</i> = 3 = 38400 <i>x</i> = 4 = 57600 <i>x</i> = 5 = 115200
Direction	0x43	C	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'C' <i>x</i> = 1 = CCW <i>x</i> = 0 = CW
Address	0x44	D	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'D' <i>xxxx</i> = Device address 0-F (hex)

Encoder CPR	0x45	E	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'E' <i>xxxx</i> = Encoder CPR or PPS x4
Holding Current	0x48	H	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'H' <i>x</i> = 0-31 (31 = 2A/Phase)
Initialization Load Error	0x49	I	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'I' <i>xxx</i> = Allowable Error before hard stop is detected
Out 1 Configuration	0x4A	J	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'J' <i>x</i> = Config Parameter
Out 2 Configuration	0x4B	K	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'K' <i>x</i> = Config Parameter
Load Error	0x4C	L	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'L' <i>xxxx</i> = Allowable Following Error before faulting
Microsteps/Step	0x4D	M	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'M' <i>xxx</i> = 2-256
Current Range Select	0x4F	O	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'O' <i>x</i> = 0 = High Range (2A) <i>x</i> = 1 = Low Range (1A)
Run Current	0x52	R	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'R' <i>x</i> = 0-31 (31 = 2A/Phase)
NV Speed	0x53	S	: <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'S' <i>xxxx</i> = Max Speed in Steps/Sec Non-volatile
Input 1 Configuration	0x54	T	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'T' <i>x</i> = Config Parameter

Input 2 Configuration	0x55	U	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'U' <i>x</i> = Config Parameter
Input 3 Configuration	0x56	V	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'V' <i>x</i> = Config Parameter
Input 4 Configuration	0x57	W	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'W' <i>x</i> = Config Parameter
Input 5 Configuration	0x58	X	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'X' <i>x</i> = Config Parameter
Input 6 Configuration	0x59	Y	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'Y' <i>x</i> = Config Parameter
Index Configuration	0x5A	Z	Returns : <i>abxxxx</i> where: <i>a</i> = Address <i>b</i> = 'Z' <i>x</i> = Config Parameter

APPENDIX C: WARRANTY

Net Controls, LLC Warranty

Each product sold by Net Controls, LLC (Net Controls) is warranted to be free from the manufacturing defects that adversely affect the normal functioning thereof during the eighteen (12) month period immediately following delivery thereof by NET CONTROLS (or in the case of products or components of any product purchased by NET CONTROLS from another for any lesser period of time that such manufacturer warrants said product or component to NET CONTROLS), provided that the same is properly operated under conditions of normal use and that regular, periodic maintenance and service is performed or replacements made, in accordance with the instructions provided by NET CONTROLS. The foregoing warranty shall not apply to any product or component that has been repaired or altered by anyone other than an authorized NET CONTROLS representative or that has been subject to improper installation or abuse, misuse, negligence or accident. NET CONTROLS shall not be liable for any damage, loss, or expense, whether consequential, special, incidental, direct or otherwise, caused by, arising out of or connected with the manufacture, delivery (including any delay in or failure to deliver), packaging, storage or use of any product sold or delivered by NET CONTROLS shall fail to conform to the foregoing warranty or to the description thereof contained herein, the purchaser thereof, as its exclusive remedy, shall upon prompt notice to NET CONTROLS of any such defect or failure and upon the return of the product, part or component in question to NET CONTROLS at its factory, with transportation charges prepaid, and upon NET CONTROLS's inspection confirming the existence of any defect inconsistent with said warranty of any such failure, be entitled to have such defect or failure cured at the NET CONTROLS factory and at no charge therefore, by replacement or repair of said product, as NET CONTROLS may elect. NET CONTROLS MAKES NO WARRANTY OR REPRESENTATION OF ANY KIND, EXPRESS OR IMPLIED, (INCLUDING NO WARRANTY OR MERCHANTABILITY), EXCEPT FOR THE FOREGOING WARRANTY AND THE WARRANTY THAT EACH PRODUCT SHALL CONFORM TO THE DESCRIPTION THEREOF CONTAINED HEREIN, and no warranty shall be implied by law.