PACIFIC
SCIENTIFIC
AUTOMATION TECHNOLOGY GROUP

MOTION TECHNOLOGY DIVISION

110 Fordham Road
Wilmington, MA 01887
(978) 988-9800
Fax (978) 988-9940

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5240/5220

Stepper/Motor Indexer/Driver

Programming Reference Manual

Rev C

Table of Contents

1 Introduction to 5240 Programming

In this Chapter

This chapter contains informations necessary to become familiar with the 5240 programming environment. Topics covered are:

- RS-232 serial port
- Modes of operation
- Abort commands
- 5240 Start up

1.1 RS-232 Serial Port

The 5240 indexer/driver may be interfaced to the RS232 port of a terminal or PC. Baud rates of 300 through 9600 are selectable by asserting combinations of plug-in jumpers.

Jumpers E16, E17, and E18 are used to set baud rates as shown in the table below. The cover must be removed for access. Refer to Section 2.6 of your Installation and Hardware Manual for the location of these jumpers and instructions for removing the cover.

Baud Rate	**E16**	**E17**	**E18**
9600	L-C	L-C	L-C
4800	H-C	L-C	L-C
2400	L-C	H-C	L-C
1800	H-C	H-C	L-C
1200	L-C	L-C	H-C
600	H-C	L-C	H-C
300	L-C	H-C	H-C
Illegal	H-C	H-C	H-C

Notes: *1. The factory default setting is 9600 baud.*

2. The 5240 tests the state of these jumpers at power-up. Therefore, they have no effect until power is cycled.

Procedure

Connect the 5240 to your terminal or host computer as shown in Section 2.5.3, “J2 Serial Port Connection”, of the 5240 Installation and Hardware Reference portion of this manual.

If you are using a PC or compatible, use the PACCOM disk supplied with your 5240 to emulate a terminal.

1. Insert the PACCOM diskette into the PC and select that drive (usually A: or B:).
2. Type “PACCOM<ENTER>” to start PACCOM.
3. On PACCOM’s main menu, use the arrow keys to highlight “Select Hardware” and press <ENTER>.
4. Select “5220/5240 Series” and press <ENTER>.
5. Press <Esc> to return to the main menu. Now select “Terminal Emulator” and press <ENTER>.

Note: *The PC is now acting as a “dumb” terminal.*

To verify communication with your 5240, apply power to the 5240 and press the space bar twice. You should see the message:

```
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```

If you do not get this message, remove power from the 5240 and:

1. Check all the cabling.
2. Check that:
   a. The terminal and baud rates are the same.
   b. The correct COM port is selected.
   c. The following parameters are met:

      Parity: None

      Stop Bits: One

      Data Bits: Eight

Note: *The terminal's serial port parameters can be set using PACCOM's "Init Serial Port" function.*

1.2 Modes of Operation

The 5240 Indexer/Driver can be operated in three modes:

- Immediate
- Program execution
- Edit

1.2.1 Immediate Mode

In the immediate mode, commands are loaded via the RS-232 port and executed upon receipt of a carriage return. [1] When AC power is applied, the 5240 will enter the immediate mode after:

1. Receiving an Esc character. The 5240 will then send the # character, followed by a carriage-return/line-feed to the terminal.

or

2. Receiving two space characters. The 5240 will then send the sign-on message described in Section 1.1 "RS-232 Serial Port."

Note: *This is true unless the "Remote Start" Input (J1-9) is pulsed or held low which would force the 5240 to enter the program execution mode.*

For example, the following sequence will cause the 5240 to perform a 1000 step incremental move in the clockwise direction:

1. Apply power to the 5240.
2. Press the Esc key on the terminal. The 5240 will enter the immediate mode and send the # character, followed by carriage-return/line-feed to the terminal.

[1] Multiple 5240s can be daisy chained so that a single terminal can be used to communicate with several axes. The command format is slightly different than the single axis format described here and is covered in Section 1.5.2 and Appendix F.

3. Type the following:

   +1000<ENTER>

The 5240 will initiate a 1000 step incremental move. Parameters such as ramp rate and speed will be at the power-on default values set at the factory unless you have changed them using the "P" command described later.

Immediate mode guidelines

- A command can be changed prior to entry by using the Backspace key.
- Command lines may be up to 11 characters long, including the carriage-return. Only one command can be included on the line.
- Spaces are optional between command characters and the first number. Commands with two numbers require at least one space between numbers.
- Command characters may be either upper case or lower case.
- The 5240 echoes characters until a carriage-return is received.[2] When a carriage return is received (signaling the end of a command) the 5240 normally sends a carriage-return/line-feed as soon as action is taken on the command[3] unless the command is a request for data. If the command is a request for data (such as query), the 5240 sends the requested data followed by a carriage-return/line-feed.
- If a non-motion command (such as setting an output discreet) is sent to the controller while a motion command (such as an

[2] If more than 11 characters are received before a carriage-return, then the 5240 sends the character #, followed by a carriage-return/line-feed indicating too long a line.

[3] The carriage-return/line-feed does not mean execution of the command is complete, only that execution of the command has begun. For example, for a long incremental move, carriage-return/line-feed is sent as soon as the move starts.

index move) is being executed, the non-motion command will be executed as soon as it is received.

- If a second motion command is sent to the controller while another is in process, the first will run to completion before the second is executed. The 5240 will not send a carriage-return/line-feed following the receipt of the second command until the first is complete because no action is taken on the second command until then. No additional commands can be sent to the 5240 until it sends the carriage-return/line-feed.

The 5240 will not respond to immediate commands if either the Jog+ or Jog- inputs are active prior to the sending of the first character of a command line. Conversely, once the first character of a command line is transmitted to the 5240, the Jog+ and Jog-inputs are ignored.

1.2.2 Program Execution Mode and Edit Mode

In program execution mode, commands stored in non-volatile (NV) memory are executed sequentially. Jump and looping instructions, which can be conditional on the state of the inputs, allow complex motion profiles.

A program is created by typing “Enn”<ENTER> while in the immediate mode. This exits the immediate mode and enters the edit mode at line nn. For example, typing “E0” <ENTER> allows entering line 0 of the program.

Pressing <ENTER> stores the command line. The 5240 will then send the line number for the next command to the terminal and the next command can be typed.

The edit mode is terminated, and the immediate mode entered by typing “E”<ENTER> or by pressing the Esc key. Typing “E”<ENTER> causes the 5240 to put and “End” symbol after the last line so that program execution will terminate after that line.

Pressing <Esc> will exit the edit mode without the “End” symbol. Therefore, to modify a line of a program already in memory, enter the edit mode by typing “Enn” where nn is the desired line number, retype the line followed by <ENTER>, and exit the edit mode by pressing <Esc>.

A program can be run by typing “Gnn”<ENTER> while in the immediate mode where nn is the first line number of your program.

Program execution mode and edit mode guidelines

Below are some specific guidelines to be followed while in the program execution mode and edit mode.

- One command can be entered per program line.
- If a program begins at line 0 (using E00), it can be started by typing “G”<ENTER> or by pulling the Remote Start input (J1-9) low.
- Program execution as well as motor motion can always be stopped by pressing the <Esc> key.
- Several non-overlapping programs can reside in memory at the same time, each starting at different line numbers.
- Program memory can be read using the list from Address Command (L).
- The TRACE feature displays the instruction being executed while a program is running which is useful for program debugging. See the “G aa b” Command for more information.

1.3 Abort Commands

The following commands abort an operation in process:

- ESCape
- “S”
- Remote stop

1.3.1 ESCape

Sending the ESC character (CHR$(27)) to the indexer over the RS-232 port results in the following actions:

Mode	**Resulting Action**
Immediate	Clears input buffer and terminates all motion. Step output is terminated immediately (no ramping).
Edit	Exit edit mode and return to immediate mode without inserting "END" in program.
Program Execution	Aborts program execution and terminates all motion. Step output is terminated immediately (no ramping). Indexer returns to immediate mode.

Note: *If more than one process is active when an ESCape command is issued, ALL processes are aborted.*

1.3.2 "S" or "s"

Sending "S" (a following carriage-return is required when indexer is in immediate mode) to the indexer over the RS-232 port results in the following actions:

Mode	**Resulting Action**
Immediate	Terminates motion. Speed ramped to zero at deceleration rate.
Edit	Enters "S" in program line. No effect on any motion in progress.
Program Execution	Aborts program execution and terminates all motion. Speed ramped to zero at deceleration rate. Indexer returns to immediate mode.

Note: *1. Sending "S"<CR> does not terminate motion properly in the immediate mode when one motion command is in process and another has already been commanded. In this case, ESC should be used to terminate motion.*

2.“S” can be used as an instruction in a program. When used in a program, motion is terminated as described here. However, program execution is ***not*** *terminated.*

1.3.3 Remote Stop

Forcing the Remote Stop Input (J1-8) low results in the following actions:

Mode	**Resulting Action**
Immediate	Terminates motion. Speed ramped to zero at deceleration rate.
Edit	Terminates motion. Indexer remains in edit mode.
Program Execution	Aborts program execution and terminates all motion. Speed ramped to zero at deceleration rate. Indexer returns to immediate mode.

Note: *If in the immediate mode and one motion command is in process and another has already been commanded, the Remote Stop Input* must *be held low until motion stops to insure proper operation.*

1.4 Jog Inputs

The motor can be made to jog at constant speed in the clockwise direction by pulling the + Jog Input (J1-25 low and in the counter clockwise direction by pulling the -Jog Input (J1-24) low.

Note: *If both the + and - Jog inputs are pulled low, rotation will be in the positive or clockwise direction.*

High jog speed is selected by pulling the Jog Hi/Lo Input (J1-10) low. Leaving (J1-10) disconnected or by pulling it high selects the low jog speed. Both the low and high jog speeds are programmed using the ^11 hh command (see the command descriptions later in this manual). Speed will be ramped up and down at the accel/decel rate.

Note: The jog inputs have no effect if:

1. A program is executing.

2. Any character has been entered to start the command line while in the immediate mode.

3. A <u>positioning</u> move is in process while in immediate mode. (A ramp to Velocity command <u>will be</u> overridden by a jog command.).

1.5 5240 Start Up

This section explains the two kinds of 5240 start up. These are:

- Single-axis
- Multi-axis

1.5.1 Single-Axis Start Up

The start up sequence for single axis units consists of two consecutive space characters. The result is a pre-defined sign on message:

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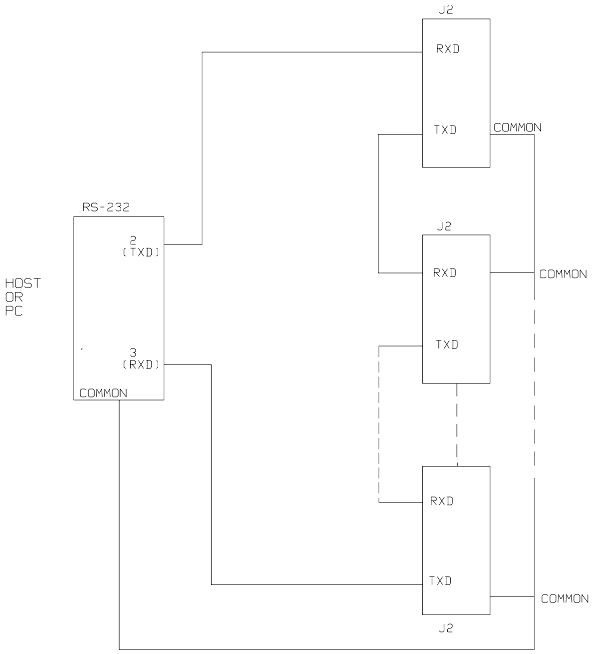
The 5240 Indexer/Driver is now in the immediate mode.

1.5.2 Multi-Axis Start Up

Multiple 5240 indexer/drivers can be interconnected directly (daisy-chained) as shown below.



Note: *All 5240 baud settings must be the same.*

Connection diagram

Procedure

The start up sequence for multi-axis operation requires transmitting the Line Feed Character (^J) to the first axis followed by a valid “Name” character that must be a, b, ...z or A, B, ...Z (names are case sensitive).

The first axis adopts this character as its name and sends the next highest ASCII character to the next axis and so on. Thus, if the host sends ^J “A” to the first axis after power-up, the first axis will adopt the name A, the second B, the third C, etc.

Once this start up sequence is complete, each axis echoes received characters to the next axis in the daisy chain. A command can be sent from the host to a particular axis by sending the command:

    Name Command ^J

If the third axis in the string has the name C, sending the command:

    C R 1000^J

results in the third axis ramping up to 1000 steps/sec.

The ESCape command does not need a prefix and will abort motion and programs in all axes.

Notes:

1. *Once the recognized sequence is received, the 5240 will assume the name until a hardware reset is made.*
2. *In multi-axis configuration, sign-on messages will not be generated.*
3. *Refer to Appendix F, “Daisy Chain Input Commands” for additional information on multi-axis execution.*

2 Quick Reference

In this Chapter

This section contains an alphabetized list of 5240 programming commands including a brief description and the operating modes where they apply. Detailed descriptions of each command is given on the page indicated in Chapter 3.

Command	Description	Mode	Page #
A 1 and A	All clear/restore	Immediate	3-2
B	Not used		
C n	Current enable	Immediate/Program	3-3
D	Not used		
E aa	Edit from address	Immediate	3-5
F nn	Start/Stop velocity	Immediate/Program	3-6
G aa b	Go from address/trace	Immediate/Program	3-8
Hs d	Home	Immediate/Program	3-10
I	Not used		
J aa n	Jump to address	Program	3-12
K	Read input port	Immediate/program	3-13
L aa	List from address	Immediate	3-16
M n	Accel/Decel slope	Immediate/Program	3-17
N	Not used		
O p	Distance event	Immediate/Program	3-19
P	Parameters store	Immediate	3-21
Q n	Query	Immediate	3-22
R nn	Ramp to velocity	Immediate/Program	3-24
S	Stop	Immediate/Program	3-26
T	Not used		
U aa k	Loop on input port	Program	3-27

Table (cont'd)

Command	Description	Mode	Page #
V nn	Velocity	Immediate/Program	3-29
W nn	Wait	Program	3-30
X	Not used		
Y n	Set output port	Immediate/Program	3-31
Z p	Set position counter	Immediate/Program	3-33
.	Hold and wait	Immediate/Program	3-34
+ nn	Positive incremental move	Immediate/Program	3-36
- nn	Negative incremental move	Immediate/Program	3-37
@ p	Absolute move	Immediate/Program	3-38
^ 11 hh	Jog velocity	Immediate	3-39
\ n	Divide	Immediate/Program	3-40
ESC	Abort	Immediate	3-41

A1 and A

All Clear / Restore

Immediate

Purpose

These commands initialize the 5240. The command A1<ENTER> clears all programs and restores the variables M, F, and V to their factory default values. The factory default values can not be altered by the user and are:

M = 5	Acceleration/Deceleration Slope
F = 400	Start/stop speed
V = 5009	Final velocity

A <ENTER> sets the values of M, F, and V to the values stored in non-volatile memory (which can be altered using the "P" command). Nothing in non-volatile memory is altered by A <ENTER>.

Syntax

A1 <ENTER>

A <ENTER>

Note: *Frequent use of the A1 command should be avoided because lifetime of the non-volatile memory will be reduced. For additional information, refer to Appendix C, "Non-Volatile Memory."*

Programming guidelines

To find the active values for M, F, and V, simply type "Q" <ENTER>. The terminal will display:

```
Q M = mmm(ssss) F= fff, V= vvvv
```

where mmm is the value of M, ssss is the corresponding number of steps to reach the final velocity, fff is the value of F, and vvvv is the value of V.

C n

Current Enable

Immediate/Program

Purpose This command enables and disables the driver section of the 5240.

Syntax C n <ENTER>

C0 Disables driver so no current is applied to the motor windings. DISABLE red LED will illuminate.

Caution

Care should be practiced when using this command since the motor shaft will have no holding torque.

C1 Enables driver. C1 forces DISABLE red LED to be turned OFF.

Default C1

Note: *The user may change the default value by using the "P" command.*

Programming guidelines On receipt of any "Move" command, motor phases are enabled automatically and are energized while stepping. When stepping is completed a settling time of 255 steps at the initial velocity is provided before the motor phases (Enable) are automatically de-energized.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 V 1000	Set final velocity to 1000 sps
8 + 5000	Index 5000 steps in the positive direction
11 W 100	Wait 0.1 second
14 C 0	Disable the driver
E	End of program block terminator

Eaa

Edit from Address

Immediate

Purpose

This command is used to enter or edit a program.

Syntax

E aa <ENTER>

Range

aa = 0 to 255

Programming guidelines

If “aa” is left blank, the editing will start from address 0.

Existing programs can be modified by specifying starting address.

ESCape will cause a return to the Immediate mode without inserting an end of program terminator.

Entering a second “E” command will terminate the program mode and will insert a program terminator in the stored program followed by a return to the immediate mode.

Instructions are stored directly in the non-volatile memory after each line is entered.

Program segment

Program line	Explanation
E0	Enter the edit mode at address 0
0 M 5	Set ramp factor to 5
2 F 400	Set start/stop speed to 400 sps
5 V 1200	Set the velocity to 1200 sps
8 - 2500	Index 2500 steps in the negative direction
E	End of program block terminator

Note: *For additional information, refer to Appendix B, “Terminal Program Example”, and Appendix C, “Non-Volatile Memory.”*

F nn

Start/Stop Velocity

Immediate/Program

Purpose

This parameter sets the start/stop velocity (initial velocity) in steps per second. This is the lowest velocity commanded when ramping the speed up during acceleration and ramping the speed down during deceleration.

Syntax F nn <ENTER>

Default 400 steps/sec

Note: *The user may change the default value by using the ”P” command.*

Value nn = 14 to 2003

Programming guidelines

As with all velocity parameters, the start/stop speed is divided by the divide command (\n).

The Query “Q” command can be used to examine and display the updated velocities.

The start/stop velocity applies to:

- All positioning commands. (+, -, @p)
- Ramp to velocity command. (R)
- Software stop (S) and hardware stop input.
- Final phase in homing sequence if home speed is above start/stop speed.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set Start/stop speed to 300 sps
5 V 1200	Set velocity to 1200 sps
8 - 5000	Index 5000 steps in the negative direction
E	End of program block terminator

Note: *For additional information, refer to Appendix D, “High Speed Considerations”, and Appendix E, “Ramp Algorithm and Lookup Table”.*

G aa b

Go from Address, Trace

Immediate/Program

Purpose

This command will execute the programmed sequence starting at location "aa".

Most programs will begin at "0". However, the user may wish to start at another address. The address must begin at a stored instruction address.

Syntax

G aa b <ENTER>

If b = 1, the trace mode is turned on. A display of the current step being executed is produced while the program is running.

Programming guidelines

The format of the displayed program lines is the same as that of the "L" command.

The Trace mode will be in effect until the program ends or is aborted.

The Trace mode is useful in developing or debugging programs.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 \ 5	Set divide factor to 5
2 M 50	Set ramp factor to 50
4 F 1000	Set start/stop speed to 1000 sps
7 V 10000	Set velocity to 10000
10 + 10000	Index 10000 steps in the positive direction
13 S	Stop
14 G 40 1	Go to address 40 and turn trace mode on
E	End of program block terminator

E40	Enter the program block starting at address 40
40 \ 1	Set divide factor to 1
42 M 5	Set ramp factor to 5
44 F 350	Set start/stop speed to 350 sps
47 V 1500	Set velocity to 1500 sps
50 - 5000	Index 5000 steps in the negative direction
53 S	Stop
E	End of program block terminator

Note: *For additional information, please refer to Appendix B, "Terminal Program Example".*

Hs d

Home

Immediate/Program

Purpose

This command initiates a search for the home position. Home position is defined by the home input (J1-13) transitioning from low to high. The search algorithm insures that the transition is sensed with the motor turning in the same direction to eliminate affects of backlash.

Syntax

Hs d <ENTER>

s specifies the speed while searching for the home switch while d specifies the initial search direction as described below.

Value

s = 1 to 255

Step rate equals ten times s (10 - 2550 steps per second)

d = 0 or 1

d = 0:

If the home input is high, initial rotation will be counter-clockwise at the speed specified by parameter s. When the home input goes low, the motor will stop, then reverse direction and rotate clockwise at the start speed until the home input goes high. This transition defines the home position and rotation stops.

d = 1:

If the home input is high, initial rotation will be clockwise at the speed specified by parameter s. When the home input goes low, the motor will stop, then reverse direction and rotate counterclockwise at the start speed until the home input goes high. This transition defines the home position and rotation stops.

Programming guidelines

As with all velocity parameters, the home search speed is divided by the divide command (\n).

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 V 100	Set velocity to 100 sps
8 H 50 1	Initiate home routine
10 Z 0	Set position counter to 0
E	End of program block terminator

Jaa n

Jump to Address aa, n times

Program

Purpose

Executes a program segment n + 1 times.

Syntax

aa Start of program segment

.
.
.

bb J aa n

The above lines cause the program segment starting at line aa to be executed n + 1 times (once before the jump is executed and n more times due to the n jumps).

Values

aa must be a valid program number

n = 0 to 255

Programming guidelines

This instruction cannot be nested because there is only one jump counter available for use at a given time.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set the ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 V 1000	Set the velocity to 1000 sps
8 + 200	Index 200 steps in the positive direction
11 W 500	Wait 0.5 seconds
14 J 8 9	Jump to address 8, 9 times (index 200 steps 10 times)
E	End of program block terminator

K

Read I/O Status

Immediate/Program

Purpose

This command returns a decimal number corresponding to the I/O Status. The number returned is formed as follows:

N = I/O(1) + 2 * I/O(2) + 4 * I/O(3) + 8 * I/O(4) + 16 * I/O(5) + 32 * M + 64 * T + 128 * CCW

where

I/O(1) - I/O(5) correspond to the state of the corresponding programmable input/output ports. I/O(n) is equal to 0 if the port n is high and the port n output is set equal to 0. I/O(n) is equal to 1 if the port n input is pulled low or the port n output is set equal to 1.

M equals 1 if the Moving port (J1-22) is low (steps being generated). Otherwise, M equals 0.

T equals 1 if the Trip output (J1-11) is low and 0 if the Trip output is high. The Trip output toggles every time the position crosses the value of the Distance Event parameter (See the O p instruction description).

CCW equals 1 if the active or most recent motion is in the counterclockwise direction, otherwise CCW equals 0.

Example:

All outputs set to 0

Input 1 is low (1)

Input 2 is high (0)

Input 3 is low (1)

Input 4 is high (0)

Input 5 is low (1)

Moving is 1

T is 0

CCW is 1

The number returned by the K command is:

1 + 0 + 4 + 0 + 16 + 32 + 0 + 128 = 181

Syntax K <ENTER>

Value returned 0 to 255

Programming guidelines

This command is only used to return I/O port status to the host terminal since the 5240 has no commands which can use the information provided.

At hardware reset, all ports (Inputs/Outputs) are high.

Caution

Ports are bi-directional. To avoid confusion it is recommended that each port be used as an input or an output but not both.

Note: *The K and the Y129 commands are equivalent. Both commands can be used interchangeably to read and display the ports (inputs/outputs). Refer to the "Y" command for additional information.*

Program segment

Program line	Explanation
E60	Enter the program block at address 60
60 M 5	Set ramp factor to 5
62 F 450	Set start/stop speed to 450 sps
65 V 1500	Set velocity to 1500
68 O- 1000	Set distance event at 1000 steps counterclockwise
71 Z 0	Set the position to 0
74 - 5000	Index 5000 steps in the negative direction
77 K	Return the ports status
E	End of program block terminator

Executing the above program segment returns the data 192 to the terminal. The value 192 indicates that distance event has passed and motion is in the negative direction (64 + 128).

Program segment

Program line	Explanation
E80	Enter the program block at address 80
80 M 5	Set ramp factor to 5
82 F 450	Set start/stop speed to 450 sps
85 V 1200	Set velocity to 1200 sps
88 Z 0	Set the position counter to 0
91 + 1100	Index 1100 steps in the positive direction
94 Z 0	Set the position counter to 0
97 0 -1000	Set distance event at 1000 steps counterclockwise
100 - 5000	Index 5000 steps in the negative direction
103 Y 129	Return the port status
105 + 5000	Index 5000 steps in the positive direction
108 O 0	Disable the distance event
111 S	Stop
E	End of the program block terminator

Executing the above program returns the data 192 back to the terminal. The value 192 indicates that distance event has passed and motion is in the negative direction (64 + 128).

Laa

List from Address

Immediate

Purpose

This command lists programs stored in non-volatile memory using the following format:

```
Address     Instruction          Value1  Value2
```

Note: *Values will be displayed only if applicable to the particular instruction type.*

Syntax

L aa <ENTER>

Programming guidelines

A maximum of twenty instructions are displayed (listed) at any time.

Programs will be listed until the “E” (end of program) character is encountered. To list a program starting at a higher address, issue another “L” command specifying the starting address of the new program.

To verify program:

Enter:

```
Laa<ENTER>
```

where

“aa” is the start address of the program block

The terminal will display the instructions and addresses that reside in non-volatile memory.

Note: *For additional information, please refer to Appendix B, “Terminal Program Example.”*

M n

Acceleration/Deceleration Slope

Immediate/Program

Purpose

This command sets the acceleration and deceleration rates. A predefined lookup table of step rates as well as the parameter “M” defines the acceleration/deceleration profile. “M” defined how many steps are generated at each step rate.

Note: *Please see Appendix E, “Ramp Algorithm & Lookup Table”, for a detailed descrition of the ramping algorithm.*

Syntax

M n <ENTER>

Range

n = 0 to 254

N = 0 will eliminate any ramping

Default

n = 5

Note: *The user may change the default value by using the “P” command.*

Programming guidelines

Larger values of “n” increase the length of the acceleration ramp.

Program segment

Program line	Explanation
E0	Enter the program block at address 0
0 \ 5	Set the divide factor to 5
2 M 50	Set the ramp factor to 50
4 F 1000	Set start/stop speed to 1000 sps
7 V 10000	Set velocity to 10000 sps
10 + 10000	Index 10000 steps in the positive direction
13 S	Stop
14 \ 1	Set the divide factor to 1
16 M 5	Set the ramp factor to 5
18 F 350	Set start/stop speed to 350 sps
21 V 1500	Set the velocity to 1500 sps
24 - 5000	Index 5000 steps in the negative direction
27 S	Stop
E	End of program block terminator

Note: *Refer to Appendix D, "High Speed Considerations", and Appendix E "Ramp Algorithm and Lookup Table."*

O p

Distance Event

Immediate/Program

Purpose

This command is used to set the distance event. During moves, the current position (position counter) is compared to the distance event position at each step.

The distance event output will be toggled (alternated) each time the Position Counter reaches or passes the Distance Event Value. If a program is running, a jump to line 200 occurs at this time.

Syntax

O p <ENTER>

p = 0, disable the distance event

p = -0, sets the distance event position to 0

Range

p = -32,767 to +32,767

Default

p = 0(Off)

Programming guidelines

If in the programming Run mode, a user program located at address 200 will be automatically executed(called).

The distance event can be displayed using the "Q" (Query) command.

The distance event may be reset to a logic high by use of Y64 command.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set the ramp factor to 5
2 F 350	Set start/stop speed to 350 sps
5 V 1250	Set velocity to 1250 sps
8 Z 0	Set position counter
11 O 1000	Set distance event to 1000 steps in the clockwise direction
14 + 2000	Index 2000 steps in the positive direction
17 S	Stop
18 Z 0	Set position counter
21 @ 1000	Index 1000 steps clockwise from position 0
24 S	Stop
25 O 0	Disable the distance event
E	End of program block terminator
E200	Enter the program starting at address 200
200 Y 31	Turn all outputs On
202 W 500	Wait 0.5 seconds
205 Y 0	Turn all outputs Off
207 W 500	Wait 0.5 seconds
210 J 200 4	Jump to address 200, 4 times (turn outputs ON/OFF 5 times)
213 S	Stop
E	End of program block terminator

Note: *For additional information, refer to Appendix D, “High Speed Considerations.”*

P

Parameters Store

Immediate

Purpose

The following parameters are saved in the non-volatile memory and will be recalled as defaults during power-on reset.

F(nn)	Start/Stop Speed
M(n)	Acceleration/Deceleration Slope
V(nn)	Velocity
O(p)	Distance Event
\n	Divide
^ 11 hh	Jog Velocity
C0	Current Enable

These default values will be overridden by an A1 command which restores the factory default values.

Programming guidelines

Frequent use of “P” and “A1” commands should be avoided, as memory longevity may be affected.

Note: *For additional information, refer to Appendix C, “Non-Volatile Memory.”*

Q(n)

Query

Immediate

Purpose This command can be used to examine various parameter settings.

Syntax Qn <ENTER>

Programming guidelines The display is as follows:

Q Command	Explanation
Q	Returns M, F, V, and O values **Note:** The number in parentheses after the value displayed for M represents the total number of steps required to reach full speed.
Q1	Returns position counter value.
Q2	Displays status of various inputs and parameter settings. The value returned is defined by: N = 2 * D + 32 * H + 64 * L+ + 128 * L- where the values of D, H, L+ and L- are defined as follows: D = 1 if current is disabled (by C0 command) D = 0 if current is enabled (power-on default or after C1 command) H = 1 if the Home input (J1-13) is low H = 0 if the Home input is high. L+ = 1 if the Limit+ input (J1-120) is low L+ = 0 if the Limit+ input is high L- = 1 if the Limit- input (J1-23) is low L- = 0 if the Limit- input is high. ***Note:*** D is not affected by the Disable input (J1-21).

Q Command	Explanation
Q3	Returns status of move in progress. The value returned is defined by: $N = P + 2 * V + 8 * H$ where P, V, and H are defined as follows: P = 1 if a Positioning move is in progress. This includes + and - incremental moves and absolute moves. Otherwise P = 0. V = 1 if a Velocity move is in progress. This includes moves resulting from the R command (ramp to velocity) as well as homing moves. Otherwise, V = 0. H = 1 if Homing is in progress. Otherwise, H = 0. **Note:** The value returned during a homing move will be 10 since both H = 1 and V = 1.

R nn

Ramp to Velocity

Immediate/Program

Purpose

This command causes the motor to ramp up or down to a constant velocity of nn steps/sec.

Note: *The velocity will be divided by the \n value. See the \n command*

Syntax

R [-]nn <ENTER>

Programming guidelines

Motion will continue at the given speed until a new (R nn) velocity is entered, or motion is terminated as described below.

Ramp parameters may be modified prior to each velocity command allowing different ramp slopes.

The direction is specified by the sign preceding the velocity nn (no sign is interpreted as positive).

Motion can be terminated by:

- The R0 command
- The software stop command “S” or hardware remote stop
- The ESCape key

A distance move cannot be executed directly from an R nn command unless the R nn command is R0.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 R 1000	Ramp up to a constant speed of 1000 sps
8 W 3000	Wait for 3 seconds
11 R 0	Ramp down to 0 sps
E	End of program block terminator

Note: *For additional information, refer to Appendix D, “High Speed Considerations”, and Appendix E, “Ramp Algorithms and Lookup Table.”*

S

Stop

Immediate/Program

Purpose

This command causes the motor to ramp to a stop using the ramp parameter.

Syntax

S <ENTER>

Programming guidelines

If a program is running when this command is entered, the move will terminate after deceleration, but the program will continue executing.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 R 1500	Ramp up to constant sped of 1500 sps
8 W 3000	Wait 3.0 seconds
11 S	Stop motion
12 Y 0	Set all outputs OFF
14 W 1000	Wait 1.0 second
17 Y 128	Increment outputs in binary fashion
19 J 14 30	Jump to address 14, 30 times
25 Y 0	Set all outputs Off
E	End of program block terminator

U aa k

Loop on Input Port

Program

Purpose

This command will test the specified input port for the required condition.

If the port is not at the stated level, the program will jump to the specified address. Otherwise, the program will continue at the next instruction.

If the specified address is for a previous instruction, the program will loop until the input reaches the specified level. The program then continues to the next step.

Syntax

U aa k <ENTER>

where aa is the address specified and k is the port condition

Port conditions are:

Port	Test for Input Low	Test for Input High
K1	k = 0	k = 1
K2	k = 2	k = 3
K3	k = 4	k = 5
K4	k = 6	k = 7
K5	k = 8	k = 9

Programming guidelines

The examples below will clarify the use of the U command.

U 40 0	Jump to address 40 if K1 is high
U 50 1	Jump to address 50 if K1 is low
U 60 2	Jump to address 60 if K2 is high
U 120 8	Jump to address 120 if K5 is high
U 130 9	Jump to address 130 if K5 is low

Program segment

Program line	Explanation
E0	Enter the program block at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set the start/stop speed to 300 sps
5 Y 0	Turn Off all outputs
7 U 40 1	Jump to address 40 if K1 is low
10 U 60 3	Jump to address 60 if K2 is low
13 S	Stop all motion
14 G 7 0	Go to address 7 (Trace mode is Off)
E	End program block terminator
E40	Enter the program block at address 40
40 U 40 5	Loop until K3 = 5(input port 3 is low)
43 V 1000	Set velocity to 1000 sps
46 + 1000	Index 100 steps in the positive direction
49 Y 16	Turn output 5 On
51 W 500	Wait 0.5 second
54 G 5 0	Go to address 5(Trace mode is Off)
E	End program block terminator
E60	Enter the program block at address 40
60 U 60 7	Loop until K4 = 7(input port 4 is low)
63 R -2000	Ramp to 2000 sps in the negative direction
66 Y 16	Turn output 5 On
68 W 2000	Wait 2.0 seconds
71 G 5 0	Go to address 5(Trace mode is Off)
E	End program block terminator

V nn

Velocity

Immediate/Program

Purpose This command sets the final velocity (steps per second) whenever an absolute or an incremental move is commanded or required.

Syntax V nn <ENTER>

Range nn = 14 to 10,000

Default nn = 5,009

Note: *The user may change the default value by using the "P" command.*

Programming guidelines The final output velocity is divided by the value of the divide (\n) command.

This value is independent of ramp to velocity, jog or home speeds.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 V 1000	Set velocity to 1000
8 + 10000	Index 10000 steps in the positive direction
E	End program block terminator

Note: *For additional information, refer to Appendix D, "High Speed considerations", and Appendix E, "Ramp Algorithms and Lookup Table."*

W nn

Wait

Program

Purpose

This command produces a delay of ”nn” milliseconds. The controller will remain in an idle state for the specified time. The program will then continue in the Ramp to Velocity mode.

Syntax

W nn <ENTER>

Value

nn = 1 to 65,535

Programming guidelines

High speed operation during wait time commands will increase delay time by as much as 14 times the normal value.

The wait command will not start timing if issued while indexing, until the motion has been completed.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 R 1000	Ramp up to velocity of 1000 sps
8 W 3000	Wait for 3.0 seconds
11 Y 1	Turn only output 1 On
13 W 1000	Wait 1.0 second
16 Y 2	Turn only output 2 On
18 W 1000	Wait 1.0 second
21 Y 0	Turn Off all outputs
23 S	Stop motion
E	End of program block terminator

Yn

Set Output Port

Immediate/Program

Purpose This command controls the state of output ports 1 through 5 (J1-3, J1-15, J1-2, J1-14, J1-1).

Syntax Yn <ENTER>

Value n ranges from 0 to 31 (except for special cases described below).

n is selected as follows:

n = Out(1) + 2 * Out(2) + 4 * Out(3) + 8 * Out(4) + 16 * Out(5)

where Out(n) is 1 to force output port n on (low) and Out(n) is 0 to set output port n off (high).

Examples:

- Y0 sets all output ports off (high)
- Y1 sets output port 1 on (low)
- Y3 sets output ports 1 and 2 on (low)
- Y31 sets all output on (low)

Special cases

Y128 will cause output ports 1 through 5 to increment in a binary fashion. For example, if the outputs are all off (zero), then the command Y128 results in output port 1 switching on (low). Another Y128 results in output port 1 switching off and output port 2 switching on.

Y129 reads I/O status. Y129 is equivalent to the K instruction. See “K” for additional information.

Programming guidelines

At power-up, all output ports are turned off (high).

Because the I/O ports are bi-directional, the following precautions should be taken:

1. If a port is to be used for input, be sure that any Y instruction writes “0” to the corresponding output. For example, if I/O port 1 is to be used for input, the argument n for any Yn instruction must be even.
2. If a port is to be used for output, be sure that the corresponding input pin is left open and <u>not</u> pulled low. For example, if I/O port 1 is to be used for output, be sure that pin J1-1 is left disconnected.

Caution

To avoid confusion, it is recommended that each port be used as an input or an output but not both.

Z p

Set Position Counter

Immediate/Program

Purpose

This command sets the position to the value “p”.

Syntax

Z p <ENTER>

Range

p = -32,768 to 32,767

Programming guidelines

The value of the position counter can be examined using Q1.

The position counter is set to 0 at power-up (hardware reset).

This command is typically used in conjunction with the home, H(nn, b), and the absolute move (@p) commands.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set the ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 Z 0	Set position counter to 0
8 W 1000	Wait 1.0 second
11 Q 1	Return the value of the position counter
13 W 100	Wait 0.1 second
16 + 2000	Index 200 steps in the positive direction
19 Q 1	Return the value of the position counter
21 @ 0	Go to position zero
24 Q 1	Return the value of the position counter
E	End program block terminator

.

Hold and Wait

Immediate/Program

Purpose

Instruction or commands that have the “period” command will wait until a low trigger level is input to Port 1. Input K1 (J1-5) or Output Y1 (J1-3) only.

Entering a period (.) will generate a software trigger which is DC level sensitive.

Syntax

command. <ENTER>

Example:

+1000.

This command will begin a 1000 step incremental move after input port 1 is pulled low.

Programming guidelines

Consecutive instructions with the “period” command will execute as long as the port is held low, due to either a signal input or a previous set output on Port 1 (K1 or Y1).

The instructions, in both program and immediate modes, will not be executed, but put on hold until Port 1 (K1 or Y1) goes low.

When listing a program using the “L” command, instructions are listed with a period (.) immediately after the instruction letter.

Caution

If the Hold and wait instruction is used to trigger on Input 1, be sure that any Y command only writes 0 to Output 1.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 350	Set start/stop speed to 350 sps
5 V 1250	Set velocity to 1250 sps
8 + 5000	Index 5000 steps in the positive direction
11 - 5000	Index 5000 steps in the negative direction
14 W 500	Wait 0.5 second
17 J 8 4	Jump to address 8, 4 times (Alt. moves 5 times)
20 V 1000	Set velocity to 1000 sps
23 + 1000	Index 1000 steps in the positive direction
26 - 4000**.**	Wait for port 1 to go low, then index 4000 steps in the negative direction
E	End of program block terminator

Note: *For additional information, refer to Appendix B, “Terminal Program Example.”*

+ nn

Incremental Move, Positive

Immediate/Program

Purpose

This command will step the motor “nn” steps in the positive direction.

Syntax

+ nn <ENTER>

Range

nn = 0 to 65,535

Programming guidelines

The motion profile for this move is defined per the previously set values for M(nn), F(nn), and V(nn) parameters.

The position counter will overflow at 32,767. However, this will not affect operation of the + nn command.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set the ramp factor to 5
2 F 300	Set the Start/Stop speed to 300 sps
5 V 1000	Set the velocity to 1000 sps
8 + 1000	Index 1000 steps in the positive direction
11 Y 1	Turn Output 1 On
E	End of block terminator

- nn

Incremental Move, Negative

Immediate/Program

Purpose This command will step the motor “nn” steps in the negative direction.

Syntax - nn <ENTER>

Range nn = 0 to 65,535

Programming guidelines

The motion profile for this move is defined per the previously set M(nn), F(nn), and V(nn) parameters.

The position counter will overflow at -32,768. However, this will not affect operation of the -nn machine.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set ramp factor to 5
2 F 300	Set start/stop speed to 300 sps
5 V 1000	Set the velocity to 1000 sps
8 - 1000	Index 1000 steps in the negative direction
11 Y 2	Turn output 2 On
E	End program block terminator

@p

Absolute Move

Immediate/Program

Purpose

This command will step the motor until the position counter value equals the value “p”.

Syntax

@ p <ENTER>

Range

p = -32,768 to 32,767

Programming guidelines

The move profile is defined by M(nn), F(nn), and V(nn) previously set parameters and is relative to the position counter value (”Z” command).

The position counter can be initialized using the ”Zp” command. Usually this is done after searching for the Home switch using the ”H” command.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 M 5	Set the ramp factor to 5
2 F 300	Set the start/stop speed to 300 sps
5 V 1000	Set velocity to 1000 sps
8 Z 0	Set the position counter to zero
11 @ 2000	Index 2000 negative steps from zero position
14 W 1500	Wait 1.5 seconds
17 Y 1	Turn output 1 On
19 @ 0	Go to position zero
22 W 1500	Wait 1.5 seconds
25 Y 0	Turn all outputs Off
E	End of program block terminator

^11 hh

Set Jog Velocity

Immediate

Purpose

This command sets the low and high jog speeds.

Syntax

^11 hh <ENTER>

where 11 defines the low jog speed and hh defines the high jog speed. The values for 11 and hh are multiplied by ten to determine the jog speeds in steps/sec.

Example:

^10 100

sets the low jog speed to 100 steps/sec and the high jog speed to 1000 steps/sec.

Value

11: 0 to 255

hh: 0 to 255

Default

11 = 3 (30 steps/sec)

hh = 20 (200 steps/sec)

Note: *The user may change the power-on default values using the ”P” command.. However, the A0 command will always return the power-up default values back to the factory settings.*

Programming guidelines

Speeds are divided by the (\n) command.

Note: *For additional information, refer to Appendix C, “Non-Volatile Memory”.*

\ N

Divide

Immediate\ Program

Purpose

This command causes all speeds during ramping and constant velocity to be divided by the value of “n”.

Syntax \n <ENTER>

Range n = 1 to 255

Programming guidelines

Speeds as low as 3 steps per minute may be obtained.

As “n” is increased, other parameters such as M(nn), F(nn), and V(nn) should be increased to obtain the desired output.

This command is used to produce smoother acceleration at low speeds.

This command should not be changed while moving.

Program segment

Program line	Explanation
E0	Enter the program block starting at address 0
0 \ 5	Set the divide factor to 5
2 M 50	Set the ramp factor to 50
4 F 1000	Set the start/stop speed to 1000 sps
7 V 10000	Set the velocity to 10000 sps
10 + 10000	Index 10000 steps in the positive direction
E	End of program block terminator

Note: *For additional information, refer to Appendix C, “Non-Volatile Memory”, Appendix D, “High Speed Considerations”, and Appendix E, “Ramp Algorithm and Lookup Table”.*

ESC

Abort

Immediate

Purpose

This command terminates motion and stops any program. The indexer will be in the immediate mode after the ESC command.

Programming guidelines

Current enable or ports are not affected.

Stepping and position counter update will cease immediately without deceleration. The lack of deceleration can cause mechanical overshoot.

Appendix A ASCII Codes

ASCII Code Result			ASCII Code Result		ASCII Code Result		ASCII Code Result	
0	^@	NUL	32		64	@	96	‘
1	^A	SOH	33	!	65	A	97	a
2	^B	STX	34	\	66	B	98	b
3	^C	ETX	35	#	67	C	99	c
4	^D	EOT	36	$	68	D	100	d
5	^E	ENQ	37	%	69	E	101	e
6	^F	ACK	38	&	70	F	102	f
7	^G	BEL	39	‘	71	G	103	g
8	^H	BS	40	(	72	H	104	h
9	^I	HT	41	)	73	I	105	i
10	^J	LF	42	*	74	J	106	j
11	^K	VT	43	+	75	K	107	k
12	^L	FF	44	,	76	L	108	l
13	^M	CR	45	-	77	M	109	m
14	^N	SO	46	.	78	N	110	n
15	^O	SI	47	/	79	O	111	o
16	^P	DLE	48	0	80	P	112	p
17	^Q	DC1	49	1	81	Q	113	q
18	^R	DC2	50	2	82	R	114	r
19	^S	DC3	51	3	83	S	115	s
20	^T	DC4	52	4	84	T	116	t
21	^U	NAK	53	5	85	U	117	u
22	^V	SYN	54	6	86	V	118	v
23	^W	ETB	55	7	87	W	119	w
24	^X	CAN	56	8	88	X	120	x
25	^Y	EM	57	9	89	Y	121	y
26	^Z	SUB	58	:	90	Z	122	z
27	^[	ESC	59	;	91	[	123	{
28	^\	FS	60	<	92	\	124	|
29	^]	GS	61	=	93	]	125	}
30	^^	RS	62	>	94	^	126	~
31	^_	US	63	?	95	_	127	

Appendix B Terminal Program Example

The following example illustrates how to create, edit and execute programs through a serial port.

Entry	Remark
E0<ENTER>	Place in edit mode, insert instructions at address 0

Note: *Start inserting instructions. the address is displayed during entry.*

Entered Address	Instruction	Remark
(0)	\ 5 <ENTER>	Set divide factor to 5
(2)	M 50 <ENTER>	Set ramp factor to 50
(4)	F 1000 <ENTER>	Set start/stop speed to 300 steps/sec
(7)	V 10000	Set velocity to 10000 sps
(10)	+ 10000 <ENTER>	Index 10000 steps in the positive direction
(13)	S <ENTER>	Stop motion
(14)	\ 1 <ENTER>	Set divide factor to 1
(16)	M 5 <ENTER>	Set ramp factor to 5
(18)	F 350 <ENTER>	Set start/stop speed to 350 steps/sec
(21)	V 1500 <ENTER>	Set velocity to 1500 sps
(24)	- 5000 (.)	Wait for port 1 to go low then index 5000 steps in the negative direction.
(27)	S <ENTER>	Stop motion

Note: *Addresses in parentheses are supplied by the 5240.*

Terminate editing

Type E<ENTER>

The 5240 will respond with a carriage-return/line-feed. The program now resides in non-volatile memory.

Verify and list program

Type L0<ENTER> or L <ENTER>

The terminal will display the program (both addresses and instructions)

Example

```
0  \           5
2  M          50
4  F        1000
7  V       10000
10 +       10000
13 S
14 \           1
16 M           5
18 F         350
21 V        1500
24 -        5000
27 S
```

Execute

If the user wishes to display the commands as they are executed, the TRACE mode should be turned ON.

Type G 01 <ENTER>

The 5240 will begin executing the pre-programmed instructions beginning with address 0. Because the TRACE option is in effect, the display will list each instruction prior to execution.

The user may terminate program execution at any time by entering <ESCape>.

Edit program

The user may want to change one or more instructions.

Example

For example, to change the instructions at address 4 to 1100 steps/sec and instructions at address 24 to 7500 steps in the negative direction, perform the following.

```
E4 <ENTER>
F 1100 <ENTER>
ESC
E24 <ENTER>
- 7500
ESC
```

The edit is complete.

Type

```
L <ENTER>
```

The program will be listed:

```
0 \          5
2 M         50
4 F       1100
7 V      10000
10 +     10000
13S
14 \         1
16 M         5
18 F       350
21 V      1500
24 -      7500
27 S
```

Appendix C Non-Volatile Memory

The non-volatile memory allows storage of power up default values and user programs even when AC power is removed from the indexer/driver.

Stored parameters

Parameters are stored in both volatile memory (RAM) and non-volatile memory (EEPROM). The values stored in RAM are used during execution of motion commands. Upon power up, or when the RESTORE (A) command is issued, parameters are transferred from EEPROM to RAM. When a parameter is changed, using the commands listed below, the value in RAM is changed but not the value in EEPROM. Values stored in RAM are transferred to EEPROM when the STORE (P) command is issued. Finally, the ALL CLEAR (A1) command restores the values of M, F, and V stored in both EEPROM and RAM to their default values.

Command	Description	Command	Description
^11 hh	Jog speeds	M	Ramp slope
\n	Divide	O	Distance event
Fnn	Initial velocity	V	Final velocity
C0	Current disable		

Program

All program entries or changes, using the edit mode, are made directly in EEPROM.

Write cycles

The 5240 is designed using a non-volatile EEPROM for storage of programs and parameters. This device is rated to retain data for over 100 years.

As with all EEPROMs, there is a limit to the number of times it may be re-programmed. Each time a cell is written to a small number of electrons are trapped in the dielectric.

After numerous write cycles, the dielectric becomes less effective and the cell cannot retain its charge.

In order to extend the life of the EEPROM in your controller, eliminate any unnecessary commands that write directly to the EEPROM. These include the ALL CLEAR command “A1” and the STORE command “P”.

Use the STORE command “P” sparingly. If possible, let the host download the parameters into RAM as needed and do not store them in EEPROM.

If a host is to initiate several different stored motion sequences, program each as a separate program starting at different addresses and initiate each using the GO FROM ADDRESS command. This is much faster than downloading a motion sequence each time and avoids constant writing into EEPROM.

Appendix D High Speed Considerations

Because motion control is of the highest priority, processing received information may be delayed if commands are sent while stepping at very fast rates. This condition will only occur at internal/external step rates exceeding 10,000 steps per second at a baud rate 9600.

In serial applications where commands at high baud rates are sent while motion is active, the user should insure a small delay between characters.

Note: *The internal rate is defined as the output step rate times the divide factor.*

The 5240 indexer/driver is designed to control the step rate with a high degree of accuracy. Therefore, step control is given priority over other processes. At high step rates, this will manifest itself as a slight latency. Execution time increases when a high step rate is active during command cycles.

For example, reading positions while moving at high rates will usually have little effect when step rates are below 10,000 steps/sec. But, when speeds approach the maximum step rate, latency effects may have to be taken into consideration.

The distance event output is activated for the exact position specified. When running a program (“G” command) several “fetches” from the non-volatile memory are required (along with service time). Latency may allow several motor steps to occur by the time address 200 is reached.

“Loop on port” may exhibit similar latency effects at high speeds. The port will require a longer “true” condition to be recognized. A faster method to implement the “wait for port” condition is to use the Hold and Wait command (“.”).

Appendix E Ramp Algorithm & Lookup Table

Introduction

The 5240 Indexer/Driver uses a lookup table to determine the number of steps in the velocity ramp that occur from the initial (start/stop speed) velocity to the final velocity. The lookup table contents are included at the end of this appendix.

The velocity profile is a quantized linear ramp with discrete velocities stored in a lookup table. The velocity commands are in pulses per second.

The algorithm begins at the exact start/stop velocity entered, then runs at the next highest velocity in the lookup table. The velocity increments until it reaches the value immediately before the final velocity entered. The next velocity will be the final velocity.

The number of pulses output at each velocity is determined by the **M**(slope) command. The **M** value sets the number of pulses at each velocity.

For example:

```
M5
F300
V3000
```

The start/stop velocity and table velocities are:

300	1776	2656
721	1973	2810
1054	2158	2954
1324	2333	3000
1562	2498	

Five pulses will be generated at each of these rates as set by the M 5 command. The total ramp time from initial to final velocity is given by the sum of the times at each velocity during ramp up.

$$\text{Ramp time} = M * \sum_{V = \text{start/stop velocity}}^{V = \text{Last table entry below final velocity}} 1/V$$

For example, ramp time for the above is:

$$\text{Ramp time} = 5 * [\frac{1}{300} + \frac{1}{721} + \frac{1}{1054} + \frac{1}{1324} + \frac{1}{1562} +$$

$$\frac{1}{1776} + \frac{1}{1973} + \frac{1}{2158} + \frac{1}{2333} + \frac{1}{2498} + \frac{1}{2656} + \frac{1}{2810} + \frac{1}{2954}]$$

Divide command

The divide command (\n) can be used to modify the ramp profile. The divide command allows you to add more points to the velocity ramp, resulting in smaller velocity increments and smoother ramping.

All commanded velocities are divided by the (\n) command. When using the (\2) command with the previous example, the actual output pulse rate would be divided by 2. The initial velocity (Fnn) will be 150 pulses per second and the final velocity (Vnn) will be 1500 pulses per second. The new, modified ramp time will be :

$$\text{Ramp time} = 5 * 2 [\frac{1}{300} + \frac{1}{721} + \frac{1}{1054} + \frac{1}{1324} + \frac{1}{1562} +$$

$$\frac{1}{1776} + \frac{1}{1973} + \frac{1}{2158} + \frac{1}{2333} + \frac{1}{2498} + \frac{1}{2656} + \frac{1}{2810} + \frac{1}{2954}]$$

To run between the same start and final velocities as the original example (300 to 3000) with (\2) command, the program parameters will be:

```
\ 2
M 5
F 600
V 6000
```

Velocities are found from the lookup table:

300	2810	4228	5389
721	2954	4347	5486
1054	3103	4452	5585
1324	3245	4562	5689
1562	3376	4678	5760
1776	3504	4775	5870
1973	3628	4876	5946
2158	3762	4982	6000
2333	3889	5092	
2498	4007	5207	
2656	4114	5297	

The velocity ramp now consists of 41 points compared to the initial 14 without the (\2) command.

$$\text{Ramp time} = 5 * [\ \frac{1}{300} + \frac{1}{721} + \frac{1}{1054} + \langle + \frac{1}{5946}\ ]$$

Note: *If the final velocity is <u>below</u> 721 sps (the second speed in the lookup table) there will be **<u>NO</u>** ramping associated with that move. Instead, the move is completed in one step.*

Ramp lookup table

75	4678	7089	8948	10593
721	4775	7144	9035	10716
1054	4876	7257	9125	10716
1324	4982	7314	9216	10842
1562	5092	7373	9216	10842
1776	5207	7493	9309	10971
1973	5297	7554	9404	10971
2158	5389	7617	9501	10971
2333	5486	7680	9501	11104
2498	5585	7745	9600	11104
2656	5689	7877	9600	11239
2810	5760	7945	9701	11239
2954	5870	8014	9804	11378
3103	5946	8084	9804	11378
3245	6063	8156	9910	11378
3376	6144	8229	9910	11520
3504	6227	8303	10017	11520
3628	6312	8378	10127	11520
3762	6400	8455	10127	11666
3889	6490	8533	10240	11666
4007	6583	8613	10240	11815
4114	6678	8613	10355	11815
4228	6727	8694	10355	11815
4347	6827	8777	10473	11969
4452	6929	8862	10473	11969
4562	6982	8948	10593	11969

Appendix F Daisy-Chain Input Commands

This appendix contains a few guidelines for multi-axis operation using 5240 units.

As with the single-axis mode, the 5240 echoes all characters received.

The first character of a command MUST be the “name” character assigned to the appropriate axis. The command line terminator MUST be a line feed character (LF = ^J).

”name” command (^J)

The line feed “clears” the command buffer for all units. The controller tests the character immediately following the line feed. If the character matches the assigned “name”, the 5240 will interpret the remaining characters (up to 11 characters) as an input command. If the controller does not detect a proper name and command, the data is simply echoed to the next controller in the chain.

The designated controller re-issues the line feed after processing the command. If the command is of the type that results in a data output (i.e. Q1), the data (result) will be inserted before the line feed. The line feed does not indicate that a move or other time consuming command is completed, but only that it is initiated.

The ESCape command does not require the use of, and will not be qualified by, a “name” prefix. All controllers in the daisy chain will respond.

Program entry and editing, though possible, are difficult in multi-axis mode. It is recommended that programs be entered into each controller separately, using single-axis mode and then the controllers connected in a daisy chain. If editing must be done thorough the daisy chain, enter the edit mode with the line:

```
“name” E ^J
```

Then enter each program line preceded by “name” and terminated by ^J.

Note: *Unlike editing in single-axis mode, line numbers are not displayed while editing a program in multi-axis configuration mode. Also, the List command does not display a complete copy of the program.*

Examples

Assuming two controllers are serially connected with name assignments of “A” and “B”,. the characters in parentheses are echoed back to the host after passing through all the controllers.

Input from host	Response from controller
A+1000 (line feed)	A +1000 (line feed)
B-500 (line feed)	B -500 (line feed)
A Q (line feed)	A xxx (line feed)

1. xxx is the data required (the motion parameters of axis A).
2. The Q command , in the multi-axis mode, will return and display the data in the following format:

   mm nnn fff vvv ooo (line feed)

   A slight delay may be encountered which is determined by the baud rate.

Note: *The labels that identify the data in the single-axis configuration are omitted in the daisy chain configuration.*

Result data

The result output is similar in format to the format for single-axis mode operation. The ASCII numbers are followed by a line feed character. The spaces act as delimits for multiple number responses. Below are a few examples of data output:

```
A Q1 (LF)
B Q1 (CR, LF)
AQ1     ppp (LF)
BQ1     (CR) ppp (LF)
```

“ppp” represents the position counter value requested by Q1.

(CR) represents the carriage return character (^M).

(LF) represents the line feed character (^J).

Appendix G Command Summary

Command	Description	Modes	Refer to Note
A 1	Clear and reset controller	Immediate	1
C n	Current enable	Immediate, program	1
E aa	Edit from address	Immediate	1
F nn	Start/stop speed	Immediate, program	1
G aa b	Go from address, mode	Immediate	1
H nn b	Seek home	Immediate	1
J aa n	Jump to address n+1 times	Program	
K	Read input port	Immediate, program	
L aa	List from address	Immediate	
M n	Accel/Decel slope	Immediate, program	2
O p	Distance event	Immediate, program	
P	Parameter store	Immediate	1
Q n	Query	Immediate	
R nn	Ramp to velocity	Immediate, program	
S	Stop	Immediate, program	
U aa k	Loop on input port	Program	
V nn	Velocity	Immediate, program	
W nn	Wait	Program	
Y nn	Set output port	Immediate, program	
Z p	Set position counter	Immediate, program	
.	Hold and wait	Immediate, program	
+nn	Positive incremental move	Immediate, program	1

Command	**Description**	**Modes**	**Refer to Note**
-nn	Negative incremental move	Immediate, program	1
@ p	Absolute move	Immediate, program	1
^ 11 hh	Jog velocity	Immediate	1
\ n	Divide	Immediate, program	1
ESCape	Abort	Immediate	3

1 Command should not be executed with motion in progress.

2 Slope can be changed during ramp to velocity moves.

3 May be executed at any time.

5240 Programming Reference Index