Model 2654 MultiPro™ 32 I/O Quad Stepper Installation Guide

Contents

Notes to Readers

The *Model 2654 MultiPro 32 I/O Quad Stepper Installation Guide* provides the following information:

- Mounting the MultiPro controller -- mounting dimensions and precautions.

- MultiPro Description and Connections -- an overview of the MultiPro's basic functions; pinout diagrams for all connectors.

- MultiPro Specifications -- general, stepper, and digital I/O specifications.

- Power Connections -- connecting power to the MultiPro.

- Status Lights -- how the status light functions.

- I/O Connections -- connecting digital inputs and outputs.

- Controller Communications -- describes the MultiPro's RS-232 port and its function.

- Stepper Application Notes -- programming a stepper, hardware considerations, and sample Quickstep programs.

- Special Purpose Registers -- how to use the special purpose registers.

Related Documents

The following documents contain additional information:

- For information on Quickstep, refer to the *Quickstep*™ *Language and Programming Guide* or the *Quickstep*™ *User Guide*.

- For information on the registers in your controller, refer to the *Register Reference Guide* (available at www.ctc-control.com).

- For information on Microsoft Windows or your PC, refer to the manuals provided by the vendor.

Formatting Conventions

The following conventions are used in this book:

ALL CAPS BOLDFACE	Identifies DOS, Windows, installation program file names.
Boldface	Indicates information you must enter, an action you must perform, or a selection you can make on a dialog box or menu.
Italics	Indicates a word requiring an appropriate substitution. For example, replace *filename* with an actual file name.
Text_Connected_With_Underlines	Indicates symbolic names used in Quickstep programs. Step Names are ALL_CAPITALS. Other symbolic names can be Initial_Capitals or lower_case.
SMALL CAPS	Identifies the names of Quickstep instructions in text.
Courier font	Identifies step names, comments, output changes, and Quickstep instructions appearing in the Quickstep editor.
Art Code 2217P1	Identifies the file name of a particular graphic image.

How to Contact Control Technology Corporation

Control Technology Corporation is located in Massachusetts, and we are open from 8:30 a.m. to 5:00 p.m. eastern time. Contact us at 1-508-435-9595 and 1-800-282-5008 or FAX 1-508-435-2373.

See us on the World Wide Web at www.ctc-control.com.

Your Comments

We welcome your suggestions and comments about this or any other Control Tech document. Comment forms are in the file called **BUGRPT.WRI**, which was installed in the **QSWIN21** directory during your Quickstep installation. You can also email comments to techpubs@control.com.

Getting Started

Contents

Dimensions and Mounting Instructions

All MultiPro controllers have mounting ears (shown below) that allow easy mounting to flat surfaces such as a NEMA-rated electrical enclosure.

Mounting Considerations

Select a mounting location that protects against the environmental hazards listed below:

- Avoid flying metal chips that may result from installation or subsequent machine construction. You should also avoid conductive dusts, liquids, or condensing humidity. If any of these conditions exist, mount the MultiPro in a NEMA 4 or NEMA 12 rated enclosure.

- Do not mount the MultiPro in an environment that requires explosion proof practices.

- Avoid mounting locations that are in close proximity to devices that produce electromagnetic interference (EMI) or radio frequency interference (RFI). Devices such as motor starters, relays, large power transformers, and ultrasonic welding apparatus fall into this category

Dimensions
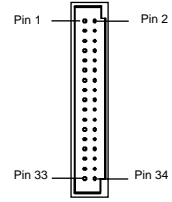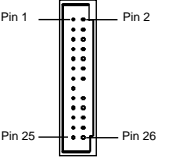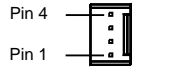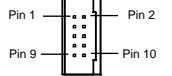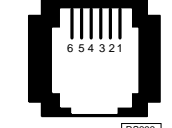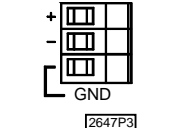
The MultiPro's dimensions are illustrated below.

Mounting Ear Detailed View
(use 4 mounting bolts)

Power Connector - Provides 24 VDC to the controller.

Digital Input Connector - Provides access to inputs 1-16.

Power Indicators - Light when the power is on and indicate that the logic supply is present.

Status Light - Indicates software or hardware faults. Refer to *Status Light Description* for more information.

Led Indicators - Each digital input and output has an LED indicator. An LED indicator lights up when its associated input or output is active.

Control Technology Corporation

24 VDC IN

GND

+24V

+5V

STAT

INPUTS

COMM RS-232

OUTPUTS

HOM FLIM RLIM SLIM JCW JCC — INPUTS 1

HOM FLIM RLIM SLIM JCW JCC — INPUTS 2

HOM FLIM RLIM SLIM JCW JCC — INPUTS 3

HOM FLIM RLIM SLIM JCW JCC — INPUTS 4

1 +5V DIR GND PLS

2 +5V DIR GND PLS

3 +5V DIR GND PLS

4 +5V DIR GND PLS

MultiPro ™ 32 I/O Quad Stepper

2654F1

Dedicated Input Connector - Provides access to the servo dedicated inputs.

External Drive Connector - Provides pulse and direction signals to the stepping motor drive.

RS-232 Port - Provides both programming and data communications with a PC using Quickstep and CTCMON. Refer to *Setting Up RS-232 Controller Communications* for more information.

Digital Output Connector - Provides access to outputs 1-16.

Connectors and Pin Diagrams

Input Connector	Pin #	Signal	Pin #	Signal	Pin #	Signal	Pin #	Signal
Pin 1 — Pin 2 ... Pin 33 — Pin 34 2647P1	1	Input 1	9	Input 5	17	Input 9	25	Input 13
	2	Return	10	Return	18	Return	26	Return
	3	Input 2	11	Input 6	19	Input 10	27	Input 14
	4	Return	12	Return	20	Return	28	Return
	5	Input 3	13	Input 7	21	Input 11	29	Input 15
	6	Return	14	Return	22	Return	30	Return
	7	Input 4	15	Input 8	23	Input 12	31	Input 16
	8	Return	16	Return	24	Return	32	Return
							33	+24 VDC
							34	Return

Output Connector	Pin #	Signal	Pin #	Signal	Pin #	Signal	Pin #	Signal
Pin 1 — Pin 2 ... Pin 25 — Pin 26 2647P2	1	Output 1	7	Output 4	13	Output 7	19	Output 10
	2	Output 14	8	Return	14	Return	20	+24 VDC
	3	Output 2	9	Output 5	15	Output 8	21	Output 11
	4	Output 15	10	Return	16	No Pin	22	+24 VDC
	5	Output 3	11	Output 6	17	Output 9	23	Output 12
	6	Output 16	12	Return	18	+24 VDC	24	+24 VDC
							25	Output 13
							26	NC

External Drive Connector	Pin #	Signal	Dedicated Input Connector	Pin #	Signal	Pin #	Signal
Pin 4 ... Pin 1 2206P2	4	+5 VDC	Pin 1 — Pin 2 ... Pin 9 — Pin 10 2206P1	1	Home	6	Jog CCW
	3	Direction		2	Forward Limit	7	+24 V Return
	2	Return		3	Reverse Limit	8	+24 V Return
	1	Pulse		4	Soft Limit	9	+24 VDC
				5	Jog CW	10	+24 VDC

RS-232 Connector	Pin #	Signal	Power Connector	Pin #	Signal
6 5 4 3 2 1 RS232	1	NC	+ − GND 2647P3	1	+24 VDC
	2	TxD Outbound		2	+ 24 V Return
	3	Common		3	Ground
	4	Common			
	5	RxD Inbound			
	6	NC			

Specifications

General Specifications

Description	Min.	Typical	Max.	Units
Controller Characteristics				
Ambient Temperature				
Operating	0		+50	°C
Storage	-20		+80	°C
Voltage Range	22.0	24.0	27.0	VDC
Current Requirements at 24 VDC		.45	.6	A
User Memory Capacity		24K		Bytes
(11 yr. Lithium-cell RAM)				
Controller Performance Specifications[2]				
Controller CPU Clock Speed		12.288		MHz
Stepper CPU Clock Speed		12		MHz
Sense Input, Jump to New Step, Change Output		0.7		ms
Perform Multiplication (between volatile registers)		0.6		ms
Time Delay Duration, 10 ms programmed		10.5		ms
Time Delay Duration, 1 s programmed		1.001		s
Internal Count Rate				
Up to 3 inputs being counted		500 Hz		
4 to 6 inputs being counted		250 Hz		
7 to 9 inputs being counted		166 Hz		
Communications Characteristics				
RS-232 Transmitter		± 9	± 12	VDC
RS-232 Receiver	± 3		± 12	VDC
Controller Resource Summary				
Multi-tasking (Tasks)			28	
Volatile Registers (32-bit)			490	
Non-volatile Registers (32-bit)			500	
Data Table Elements (16-bit, non-volatile)			8000	
Input-linkable Counters			8	
Flags			32	
Program Steps			1024	

Notes:

1. The specifications listed above are at 25°C, unless otherwise specified.
2. The specifications shown are with one task running. RS-232 communications may degrade the count by up to 10 %.

Stepper Specifications

Description	Min.	Typical	Max.	Units
Absolute Maximum Ratings				
Current Draw from On-Board +5 VDC Power Supply[1] (for powering external drive inputs)			96	mA DC
Electrical Specifications				
Pulse and Directional Output				
Low V_{OL} (I_{OL} = 24 mA)	0.36		0.44	VDC
High V_{OH} (I_{OH} = 24 mA)	4.44		5.25	VDC
Pulse Width (Jumper-configurable)				
For Microstepping Motor Drives		1.3		ms
For Half-Step and Full-Step Motor Drives		34		ms
Axis Control Inputs				
Off Voltage[2] (I_1 = 0 mA)		24.0	26.4	VDC
On Current (V_1 = 0 V)		2.1	2.5	mA
Threshold				
Low-to-High		8.5		VDC
High-to-Low		7.5		VDC
Performance Specifications				
Maximum Velocity Setting	1		250,000	Steps/sec
Resolution of Maximum Velocity Setting		3.9		Steps/sec
Acceleration and Deceleration Settings			130,000,000	Steps/sec^2
Resolution of Acceleration and Deceleration Settings		15.3		Steps/sec^2
Position Range	-2,147,483,648		2,147,483,647	Steps
Relative Motion Command Range	-2,147,483,648		2,147,483,647	Steps

Notes:

1. This is powered by the controller's 24V supply.
2. This value is dependent on the controller's auxiliary supply voltage (24V is typical).

Digital I/O Specifications

Description	Min.	Typical	Max.	Units
Absolute Maximum Ratings				
Applied Input Voltage[1]	0		27.0	VDC
Applied Output Voltage[2]	0		24.0	VDC
Output Current				
Single Output			500	mA DC
Per Output Connector (2649, 2655)			5	A
Total Limit (2649, 2655)			10	A
Total Limit (All other MultiPro models)			5	A
Operating Characteristics				
Output On Voltage (Io = 500 mA)		0.8	1.8	VDC
Output Off Leakage[3]		0.01	0.75	μA
(applied voltage = 24V)				
Input Off Voltage (Ii = 0 mA)		24.0	26.4	VDC
Input On Current (Vi = 0 V)		-2.10	-2.85	mA
Input on Current Threshold		-1.0	-1.85	mA
(Vi = 8 V typical)				
Input Off Current			-250	μA
(typical leakage current allowable)				

Notes:

1. Under normal operation, no external input voltage is applied. Inputs should be externally switched to the input common.

2. An on-board protection diode returns to +24 V from each output.

3. In the off state, unconnected outputs are internally pulled to +5 V through a diode and an LED indicator.

Hardware/Firmware Revision Levels

Model Numbers	Hardware Revision Level	Firmware Revision Level[2]
All	0	2.18

NOTES:

1. You can confirm firmware revision levels by doing a register read in Quickstep's monitor program. Use register 13490 for this operation.

2. Firmware revision levels are not equivalent to standard decimal numbers. For example, firmware revision level 2.18 translates to:

Major Revision Level 2
Minor Revision Level 18

If this value changes to 2.20, it translates to:

Major Revision Level 2
Minor Revision Level 20 (not revision level 2)

Power Connections

Connecting DC Power

The MultiPro requires an externally supplied voltage of +24VDC for proper operation. Power is connected through the connector located on top of the MultiPro.

+24VDC powers all the I/O circuitry and also supplies power to a DC/DC converter. This conversion circuit creates an isolated +5VDC supply that powers the MultiPro's logic circuitry.
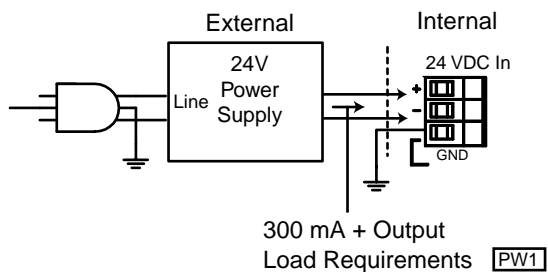
The Importance of Proper Grounding

The MultiPro's ground should follow a direct, low-impedance path to the plant's power source that is not shared by any machinery that injects a large amount of electrical noise onto the line.

NOTE: For more information on noise protection, refer to CTC Technical Note No. 26, *Reducing Noise Susceptibility*. This document is available at no charge from your distributor, directly from CTC, or from our Web site at www.ctc-control.com.

Status Light Description

The status light (STAT) is located on the MultiPro's front left panel and is used to indicate a software or hardware fault. These faults are described below.

NOTE: After the MultiPro is turned ON, the light is steady and red during the first second of operation.

Software Fault

Quickstep programs may produce software faults that are indicated by a periodic flashing light. These faults occur when the MultiPro is unable to execute because an application problem exists within the Quickstep program. You can view the fault type by viewing the program status in Quickstep's monitoring utility, CTCMon. Once a software fault occurs, the MultiPro is idle and all resources that can be set (outputs, etc.) remain in the state they were in before the fault occurred.

NOTES: CTCMon is integrated into Quickstep version 3.0x. For earlier versions of Quickstep, it is a separate monitoring utility.

You can program register 13009 to turn off a specific output when a software fault occurs. Refer to the *Quick Reference Register Guide* at www.ctc-control.com for more information.

Hardware Fault

Hardware faults are displayed as a steady red light and indicate that the internal watch dog timer has disabled the MultiPro's CPU. When this occurs, the MultiPro's outputs are also disabled.

Try clearing a hardware fault by cycling the power and/or downloading the same Quickstep program. If the fault doesn't clear, your MultiPro may require repair. Contact our Technical Support representative for assistance.

Connecting Digital Inputs

The MultiPro has 16 digital inputs that you can activate with a switch closure to **Return**, which is the common for the MultiPro's 24 V supply. Each input is opto-isolated from the MultiPro's logic circuitry and is internally self-powered by the 24 V supply through a current-limiting resistor.
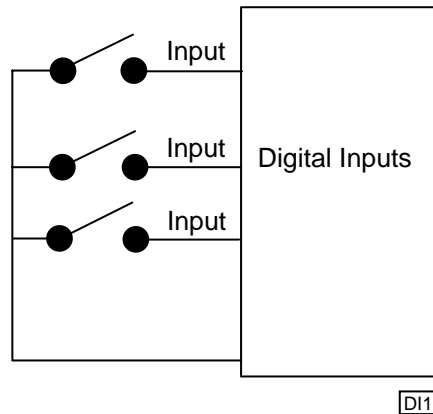
The MultiPro senses when an input is pulled down to **Return** by a switch closure. A `Monitor` instruction or any other programmed instruction referring to a general purpose input can use this information.

Using Solid-State Sensors

You can connect many types of electronic sensors such as three-wire Hall-effect sensors, proximity sensors, and phototransistors to the inputs without any additional circuitry. These devices must have sinking type open-collector outputs (NPN) and must be able to withstand at least +24 volts on their output terminals when they are in the OFF state. The sensor must also be able to sink the required input current (i.e.- 2.1 mA) when ON.

NOTE: Do not use two-wire, solid-state sensors.

Electronic sensors have internal circuitry that generally requires an external power source. The illustration below shows how to connect a solid-state sensor.
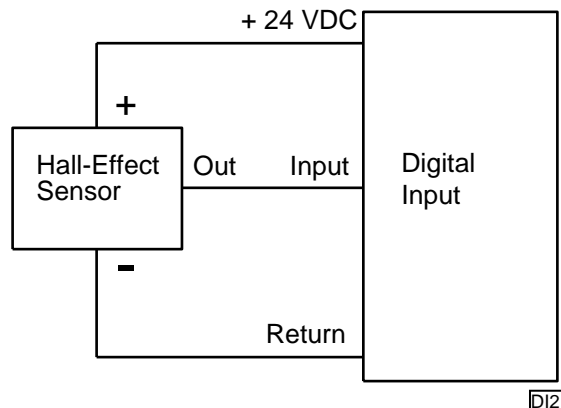
Connecting Digital Outputs

Using Open-Collector Outputs

The MultiPro has 16 outputs for driving external loads such as solenoid valves, indicators, solid-state relays and other low-power DC loads. These outputs are configured as open-collector transistors that can switch loads up to 0.5 Amps DC. Open-collector outputs are transistors whose collector terminal is left unconnected to allow greater flexibility in its use.

An open-collector output, which is shown in the schematic below, performs roughly the same function as a switch contact with one side of the switch connected to ground. When the output is turned OFF, no current can flow through the transistor. This is equivalent to an open switch contact, because the device being controlled is turned OFF.
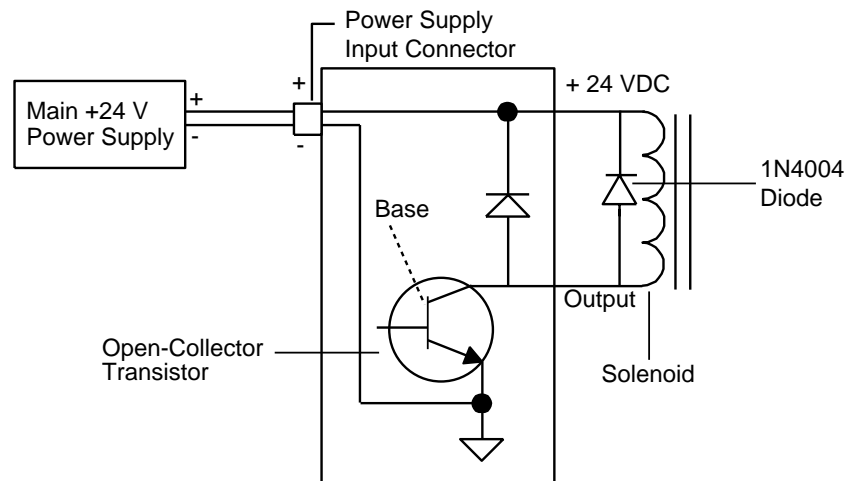
When the output is turned on, current flows through the transistor, which is equivalent to a closed switch contact. The controlled device turns on in response to the flow of current.

Connect a device to an open-collector output by connecting one of the device's terminals to the output and the other terminal to the positive side of the power supply. If the device is polarized, connect its negative [-] terminal to the output.

NOTE: Control Tech recommends that you place a suppression diode across inductive loads. Use a 1N4004 diode or its equivalent. Locate the diode as close to the load as possible. Refer to the illustration on the previous page for more information.

CAUTION: Do not exceed the rated current of the power supply in use. When you calculate your system's current requirements, you need to consider the maximum number of output devices that will be turned on simultaneously. Include 0.45 A for the MultiPro in your calculation.

Connecting Multiple Devices

It is possible to supply power to multiple devices from the same power source. One lead of each device is attached to an independent output and the other lead is connected to the positive [+] terminal of the power source. The illustration below shows four solenoid valves that are controlled by Outputs 1-4. Power is supplied to each output from the controller's power supply.
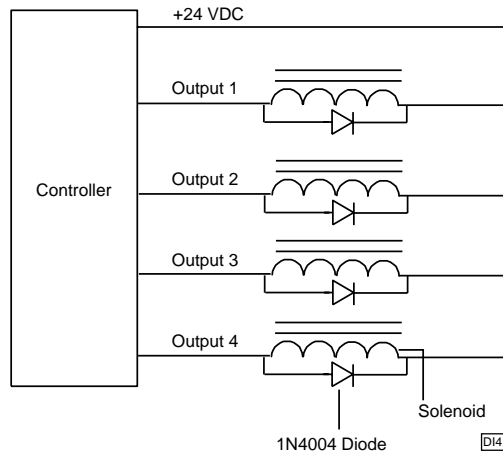
Connecting to a Second External Power Supply

Multiple devices can also derive their power source from a secondary external power supply. Some devices use this external supply while others use the controller's power supply. If you use this option, connect each device to the positive [+] terminal of the appropriate power supply. The diagram below illustrates this setup.

NOTE: If you decide to use an external power supply, do not tie the positive terminals of the two supplies together by direct means or indirect means.
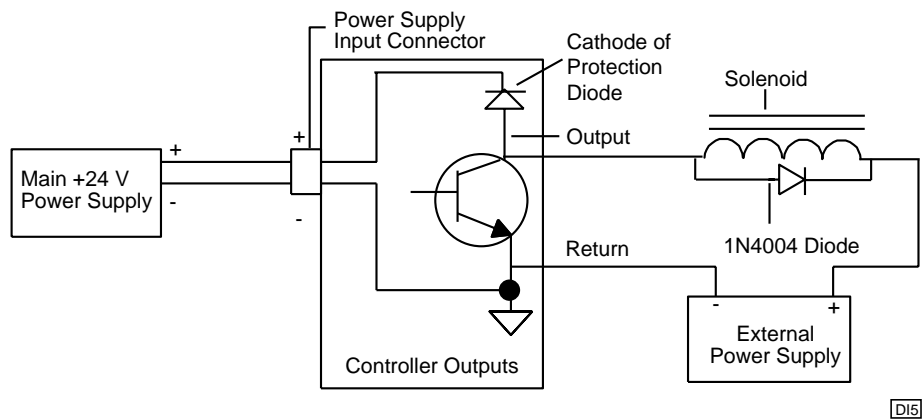
CAUTION:

⚠️

Each output has a protection diode with its cathode connected to the +24 VDC power supply through the input connector. This diode prevents damage to the output when it is connected to an inductive load. If you use an external supply as shown in the previous illustration, a current path exists between the two supplies through the devices being controlled. Under normal circumstances, this practice is acceptable. However, some power supplies offer low impedance with respect to the power supply return when you turn them OFF. For example, in the previous illustration, the main supply is turned OFF and the external supply is ON. Current from the external supply can energize the device connected to the output and turn it ON.To prevent this situation, make sure that both supplies are turned ON and OFF at the same time.
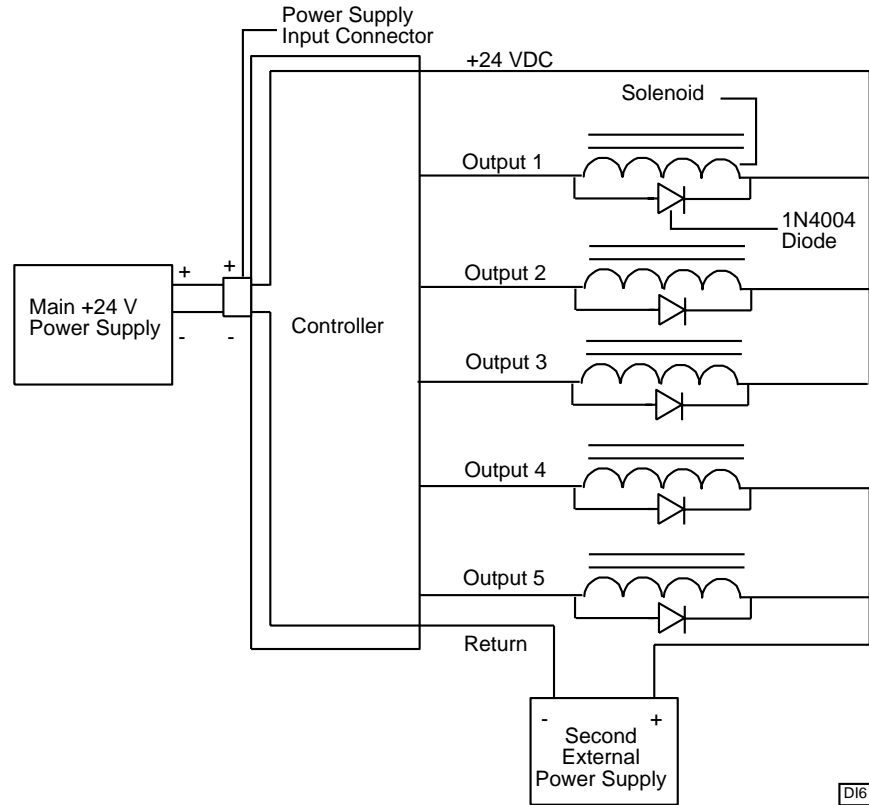
NOTE: Do not use an external power supply with an output voltage that exceeds the voltage rating of the MultiPro's outputs.

CAUTION:

⚠️

Do not connect the positive [+] terminals of the power supplies together! Damage to one of the supplies may result. The illustration above shows the connection between the external supply's negative terminal and the output connector's return terminal. This provides a complete path for the current traveling through the device being controlled.

Setting Up Computer – Controller Connections

The MultiPro's RS-232 port provides a means for downloading Quickstep programs and supports data communications.

RS-232 Protocols

The MultiPro is equipped with built-in protocols that allow direct computer communications with its RS-232 port. This means that an external PC can directly interact with many of the MultiPro's resources such as registers, inputs and outputs, and flags without modifying the MultiPro's program. You can also use the RS-232 port to monitor the MultiPro with CTCMON.

NOTE: These protocols are described in the *CTC 32-Bit Data Communications Functions Reference Guide,* which is available in the Customer Support area of our web site at www.ctc-control.com.

You can connect to the RS-232 port through the modular jack (labeled COMM) on the MultiPro's front left panel. This jack carries the receive and transmit signals and two commons (ground). The pin diagram on the right illustrates the wiring of the jack.

Standard Control Technology cables are available for connecting to this jack (see the diagram on the following page). As an alternative, many commonly available telephone cables may be substituted.

Connecting to a D-Connector

RS-232 ports on computers are usually configured through 25-pin (DB25) or 9-pin (DB9) D-type connectors. There is a standard for wiring such connectors that is followed by most PC manufacturers.

6 5 4 3 2 1
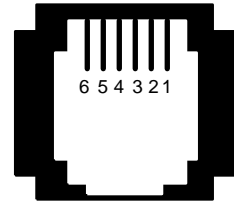
1 - NC
2 - TxD Outbound
3 - Common
4 - Common
5 - RxD Inbound
6 - NC

RS232MP

Control Technology has adapters available that connect directly to a male DB25 (Model 2880A) or DB9 (Model 2880B) connector. These adapters provide a modular jack wired for compatibility with the COMM port. To ensure full compatibility with these adapters, you should wire the computer's communications port as a DTE (Data Terminating Equipment) device as follows:

- Pin 2 = TxD
- Pin 3 = RxD
- Pin 7 = Ground

NOTE: Do not connect the MultiPro to a telephone line.

The following illustrations show computer-controller connections using an RS-232 connection and list the part numbers for DB25 and DB9 connectors.

Personal Computer with RS-232
Asynchronous Communications Board

Communications Cables:

Model 2881 - 7 feet
Model 2882 - 15 feet
Model 2883 - 25 feet

RS-232 Port

Control Technology Corporation

MultiPro™ 32 I/O Quad Stepper

D-Connector to Modular Jack Adapter:

Model 2880A for DB25 connectors
Model 2880B for DB9 connectors

2654COM

Modular Jack

1	
2	Black
Tx 3	
Comm 4	
5	
Rx 6	Red
7	Yellow
8	

DB-9 Connector

1	
2	Rx
3	Tx
4	
5	Common
6	
7	
8	
9	

DB9-232

Modular Jack

DB-25 Connector

```
          1                 Green          1  Common
          2     Black                      2  Rx
    Tx    3                                 3  Tx
  Comm    4                                 4
  Comm    5                                 5
    Rx    6     Yellow        Red           6
          7                                 7  Common
          8                                 8
                                            9
                                           10
                                           11
                                           12
                                           13
                                           14
                                           15
                                           16
                                           17
                                           18
                                           19
                                           20
                                           21
                                           22
                                           23
                                           24
                                           25
```

DB25-232

Stepper Application Notes

Contents

Programming a Stepping Motor

This section describes how to program your MultiPro. When you program a stepping motor, use the following Quickstep servo instructions:

- Profile Servo
- Turn Servo
- Monitor Servo
- Zero Servo
- Search and Zero Servo
- Stop Servo
- If Servo
- Store Servo

NOTE: The registers mentioned in this chapter only apply to Axis 1. Refer to *Chapter 3, Special Registers*, for more information on other special registers.

Setting Up Stepping Motor Operating Parameters

The MultiPro must have a set of operating parameters before it can turn a stepping motor. You must specify these parameters with the PROFILE SERVO instruction. The stepping motor operating parameters are as follows:

- **Max Speed** — Establishes the maximum speed of the motor.

- **Accel** — Specifies the acceleration rate of the motor. The deceleration rate is the same as the acceleration rate. Refer to *Setting Acceleration and Deceleration Values* for information on setting a different deceleration rate.

NOTES: 1. The **Max Speed** and **Accel** parameters are the only PROFILE SERVO parameters that work with your MultiPro. The controller ignores the other parameters.

2. The maximum speed is expressed in units of steps-per-second (steps/sec). Your programmed maximum speed has a resolution of 1 step/sec. Acceleration and deceleration are expressed in units of steps-per-second-per-second (steps/sec^2) with a granularity of 1 step/sec^2.

3. The PROFILE SERVO instruction must appear before the first TURN SERVO instruction in your Quickstep program. If it is not executed before the first TURN SERVO instruction, a software fault stating, "Servo not ready," results. Additional PROFILE SERVO instructions are only necessary when you want to change the motor's operating parameters.

4. Re-profiling on-the-fly, which allows the stepping motor to take on new settings during a motor motion, is possible. To re-profile the motor, program another PROFILE SERVO instruction with a new maximum speed or acceleration value. You do not have to re-specify a value that does not change.

5. Adjustments to the ramping (acceleration and deceleration) parameters while the motor is accelerating or decelerating causes an instantaneous change in the ramp that may be undesirable. To avoid this, make changes to the ramping parameters when the motor is stopped or is turning at maximum speed. You can view the status of the motor by checking the appropriate special registers. For example, check register number 14301 for the current status of the first motor. Refer to *Chapter 3*, *Special Registers*, for more information.

Setting Acceleration and Deceleration Values

The PROFILE SERVO instruction acceleration parameter sets both the acceleration and deceleration values. If you want the acceleration and deceleration values to be different, use one of the special purpose registers after the profile instruction to set a different deceleration value. For example:

```
profile axis_1 max=50000 accel=100000
store 20000 to reg_15006 (axis No. 1 deceleration register)
```

sets the acceleration equal to 100,000 steps/sec^2 and the deceleration equal to 20,000 steps/sec^2. Refer to *Chapter 3, Special Registers*, for the appropriate register number for each axis.

NOTE: If you specify a new acceleration rate, it overwrites the existing deceleration rate stored in Register 15006. Therefore, you must a new deceleration rate.

Searching for Home

Each stepping motor axis has a dedicated home input. This input is used in conjunction with the SEARCH AND ZERO SERVO instruction to set a zero or home position for the axis. This instruction starts the motor turning at the speed and acceleration specified in the PROFILE SERVO instruction. The motor turns counterclockwise if the home input's contacts are open and continues to turn in this direction until the contacts close (change state). Conversely, the motor turns clockwise if the home input's contacts are closed and continues to turn in this direction until the contacts open (change state). In either case, the home input is checked every millisecond, which offers very good repeatability. Once the MultiPro senses a contact transition on its home limit switch input (dedicated input), the motor then stops and the current position is set to zero.

NOTES: 1. Make sure the motor's maximum speed is low enough to stop the motor instantly. If the speed is set too high, the motor may overrun its intended position.

2. SEARCH AND ZERO SERVO the motor once at a relatively high speed to consistently put the motor in the home position. Then, SEARCH AND ZERO SERVO the motor again at a slow speed.

The following example shows how to SEARCH AND ZERO SERVO a motor:

```
[1]   COARSE_HOME
      ;;;Commence initial home sequence for motor axis 1.
      _____
          <NO CHANGE IN DIGITAL OUTPUTS>
      _____
      profile axis_1 maxspeed=2000 accel=2000
      search and zero axis_1
      monitor axis_1 stopped goto next

[2]   MOVE_OFF_HOME
     ;;;Move motor off home switch
      _____
          <NO CHANGE IN DIGITAL OUTPUTS>
      _____
      turn axis_1 cw 500 steps
      monitor axis_1 stopped goto next
```

```
[3]  FIND_HOME
     ;;;Re-profile for slower homing speed, then
```

Turning a Motor

There are three modes of turning the motor:

1. **Absolute Positioning** – In this mode, the MultiPro's stepper board always references the home (or zero) position in a turn instruction and moves a specified distance from the home position. For example, the following instruction

   ```
   turn axis_2 to 50000
   ```

   causes the motor to position itself 50,000 steps from home. The motor automatically turns in the correct direction to reach the new position.

2. **Relative Positioning** – In this mode, the direction of the turn (clockwise or counterclockwise) is specified in the turn instruction along with a defined number of steps to turn. For example, the following instruction

   ```
   turn axis_1 cw 12340 steps
   ```

   turns the motor 12,340 steps clockwise from its current position.

3. **Velocity Control** – In this mode, you establish a direction and begin continuous operation. The maximum speed and acceleration are based on the current profile instruction and can be changed. For example, the following instruction

   ```
   turn axis_1 cw
   ```

   starts the motor turning clockwise at its current maximum speed and acceleration. The motor continues to turn until the MultiPro issues a STOP SERVO instruction or until a Limit or Stop input is activated.

Once a motor is in motion, do not initiate another turn or zero instruction until the motion is complete or the "servo not ready" software fault occurs. Use the MONITOR SERVO instruction to check the current status (running/stopped) of the motor.

The MultiPro's stepper board tracks the position of the motor with all three modes and allows you to use all three types of positioning and control in the same program.

NOTE: Quickstep instructions specifying clockwise or counterclockwise operation assume that the motor is wired according to the manufacturer's recommendations and that the logical sense of the direction output of the MultiPro's stepper board agrees with the logical sense expected by the motor's drive.

Stopping the Motor

There are two instructions that terminate the motion of a motor already in motion:

- STOP (SOFT) SERVO causes the motor to stop at the deceleration rate specified in the last profile instruction.

- STOP (HARD) SERVO causes the MultiPro's stepper board to try to stop the motor instantly. However, because of momentum, the motor may not stop instantly and could lose its absolute position.

In either case, you should use a MONITOR SERVO STOPPED instruction before issuing another turn instruction.

Monitoring and Changing Other Motor Parameters

There are various special purpose registers that allow you to monitor and change the motor parameters. For more information, refer to *Chapter 3, Special Registers*.

Using Dedicated Inputs

Monitoring Dedicated Inputs

Registers 15007 and 15017 can return a bit pattern that indicates if any of the dedicated inputs are active. A binary representation of the dedicated input number is stored in the register. Each input has a unique binary value.
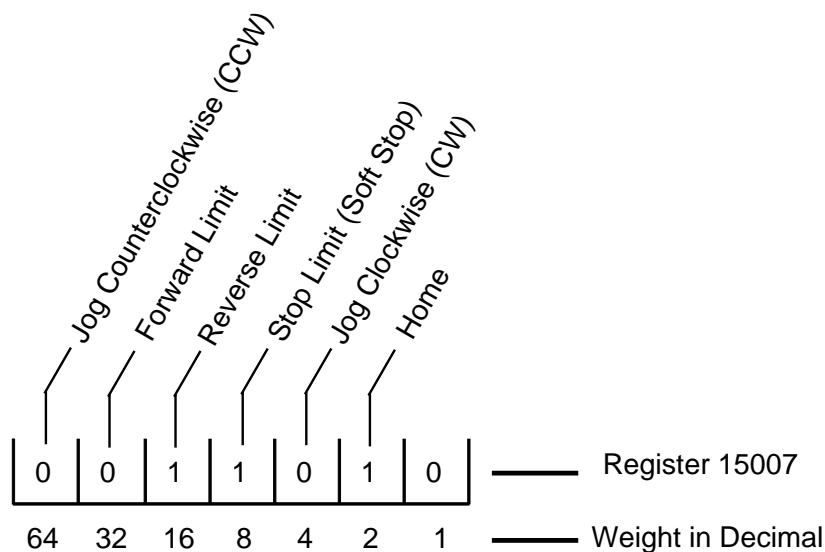
The illustration above shows that the home, reverse limit, and soft stop inputs are active. Register 15007 (for Axis 1) returns a value of 26 because the respective weights of the inputs are 2, 8 and 16. To test any individual input, use the bitwise AND instruction to apply a mask to the register. The following instruction applies a bit mask that tests to see if the Home input is active:

```
[1]   TEST_FOR_HOME_AXIS1
      ;;; Home = 2
      _____

           <NO CHANGE IN DIGITAL OUTPUTS>

      _____

      store reg_15007 and 2 to reg_10
      if reg_10 = 2 goto FOUND_HOME
      goto TEST_FOR_HOME_AXIS1
```

Connecting Dedicated Inputs

The MultiPro has six dedicated inputs that you can activate with a switch closure to **Return**, which is the common for the MultiPro's 24 V supply. Each input is opto-isolated from the MultiPro's logic circuitry and is internally self-powered by the 24 V supply through a current-limiting resistor. The following illustration shows the switch closure for the dedicated inputs.

Switch Closure for Dedicated Inputs

Input   HOM
          FLIM
          RLIM
          SLIM
Return   JCW
          JCC

+24 V

Hall-Effect Sensor   Out   Input   HOM
                                        FLIM
                                        RLIM
                                        SLIM
                                        JCW
                              Return   JCC

Solid-State Sensor Connection

ST2
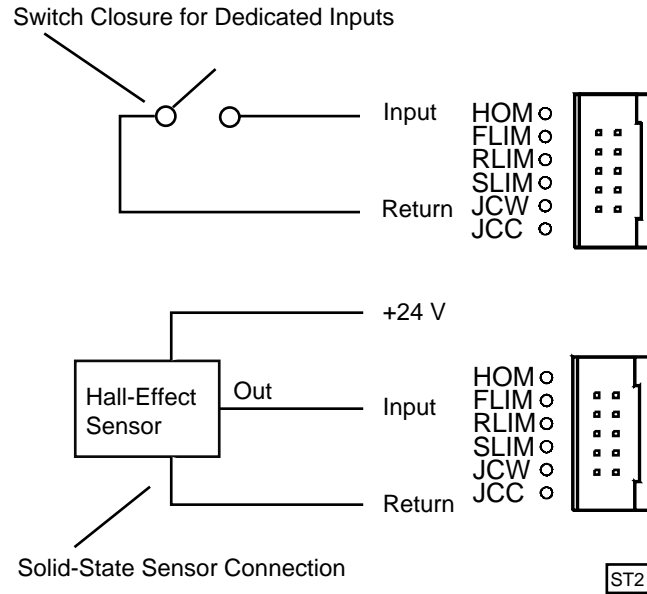
Stepper Hardware Considerations

Dedicated Inputs

The dedicated inputs are internally pulled up to 24 VDC and are actuated by a contact closure to the 24 V Return. You can supply this closure with a mechanical switch or with certain types of solid-state, open-collector outputs. The dedicated inputs are:

- **Forward Limit** – If the motor is moving clockwise, this input disables all clockwise movement and attempts to stop the motor instantaneously. This may cause the motor to lose its home position. If this occurs, you need to re-home the motor.

- **Reverse Limit** – If the motor is moving counterclockwise, this input disables all counterclockwise movement and attempts to stop the motor instantaneously. This may cause the motor to lose its home position. If this occurs, you need to re-home the motor.

- **Soft Limit** – This input stops the motor with the deceleration rate programmed in the PROFILE SERVO instruction.

- **Jog Clockwise** – This input starts the motor turning clockwise at the acceleration rate programmed in the PROFILE SERVO instruction. The motor reaches velocity and continues to turn until this input is turned OFF. It then decelerates to a stop at the programmed deceleration rate.

- **Jog Counterclockwise** – This input starts the motor turning counterclockwise at the acceleration rate programmed in the PROFILE SERVO instruction. The motor reaches velocity and continues to turn until this input is turned OFF. The motor then decelerates to a stop at the programmed deceleration rate.

- **Home** – Refer to *Searching for Home* for more information on this input.

NOTES:

1. **Start Input** (*Optional*): If you choose the Start input option in your Quickstep program, it replaces the **Jog Clockwise** dedicated input. To use the Start dedicated input, you must program your TURN SERVO instruction with the ON START parameter. The MultiPro checks the On Start input every millisecond, which improves the repeatability of the start motion. The motion does not begin until the Start switch is activated. To choose this option, store the number 1 in register 13801 for the first axis and 13802 for the second axis. Once you store the number 1 to these registers, you do not have to store it again in your program.

2. If a motor has been stopped by any of the above stop inputs, the programmed instruction MONITOR SERVO STOPPED becomes true and your program proceeds to the specified step.

The dedicated inputs are not all active at the same time. The following list describes when the dedicated inputs are active and inactive.

- **Forward Limit Input** – This input is active only when the motor is moving in the clockwise direction. This allows the motor to back off of a limit switch because you can still move counterclockwise. For example, if the Forward Limit input is connected to a limit switch for a linear table and the table hits the limit switch, the table is able to move counterclockwise and return to the home position.

- **Reverse Limit Input** – This input is active only when the motor is moving in the counterclockwise direction.

Model 2654 MultiPro™ 32 I/O Quad Stepper Installation Guide

- **Soft Stop Input** – This input is inactive when the motor is searching for home or when it is jogging under control of the jog inputs. It can also access the position where the input signal occurred through a special purpose register such as 13701. You can take advantage of this feature in applications where soft stop is used to synchronize a repetitive motor motion with some external event such as sensing a registration mark on a continuous web of material.

NOTE: The soft stop input does not always stop the motor and should not be used with any limit switch that prevents damage to a machine.

- **Jog CW/CCW Inputs** – These inputs are only active when the motor is stopped. Once a PROFILE SERVO instruction has occurred, the motor starts turning in either a clockwise or counterclockwise direction (depending on the input).

    If both these inputs are applied simultaneously, the first one sensed by the MultiPro prevails and the other is ignored. When the jog input signal is removed, the motor decelerates to a stop at the profiled deceleration rate.

    Jog inputs are inactive in the following situations:

    – Once motion is triggered by another source, applying and/or removing a jog input has no effect.

    – Jog CW is inactive when the Forward Limit input is active. However, Jog CCW remains active.

    – Jog CCW is inactive when the Reverse Limit input is active. However, Jog CW remains active.

    – Both jog inputs are inactive when the Soft Dtop input is active.

- **Home Input** – This input is only active when the MultiPro is searching for home. Otherwise, it remains inactive.


Stepper Application Notes

Connecting Stepping Motor Drives

Connecting the MultiPro to a Stepping MotorDrive

The illustrations on the following pages show how to connect your MultiPro to these stepping motor drives:

- **Applied Motion Products (AMP)** – 235 drive series, 335 drive series, and 556 drive series stepping motors

- **Compumotor** – OEM 350 and OEM 650 stepping motors

- **Centent** – CNO 142 and CNO 143 stepping motors

- **Intelligent Motion Systems (IMS)** – IM483 stepping motors

Connecting to an Applied Motion Products Stepping Motor Drive
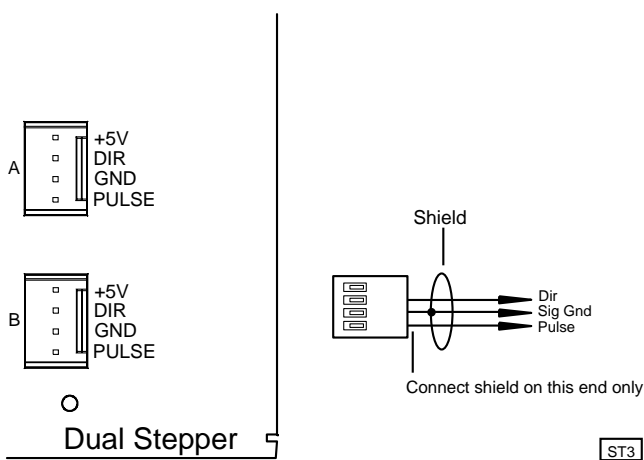
Note: The Model 2654 is a quad stepper.

Connecting to a Compumotor Stepping Motor Drive
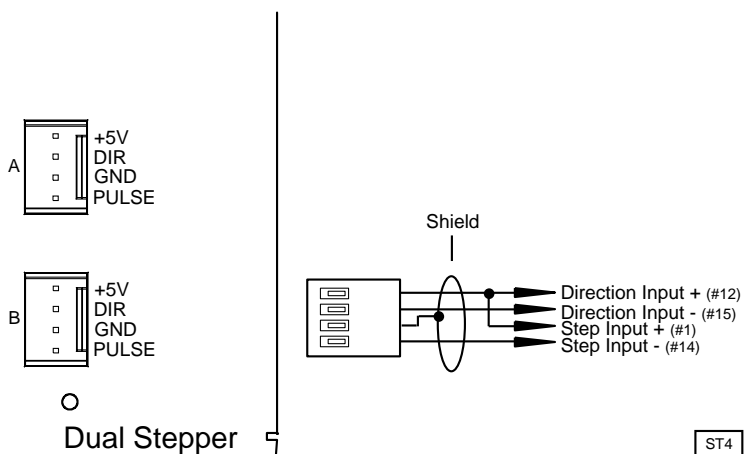
Note: The Model 2654 is a quad stepper.

Connecting to a Content Stepping Motor Drive

Note: The Model 2654 is a quad stepper.

Connecting to an Intelligent Motion Systems (IMS) Stepping Motor Drive

Note: The Model 2654 is a quad stepper.
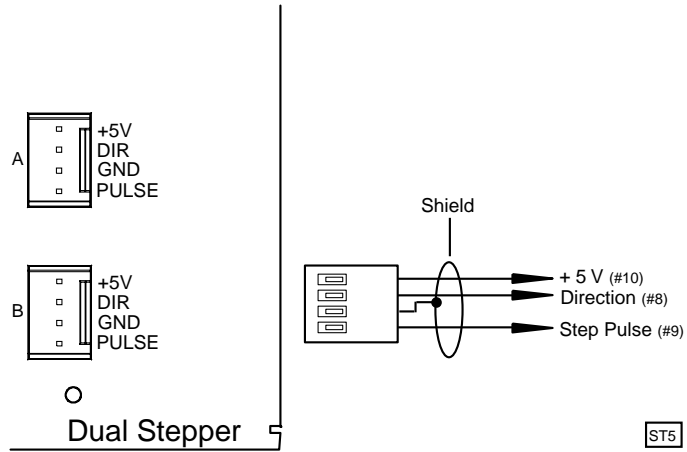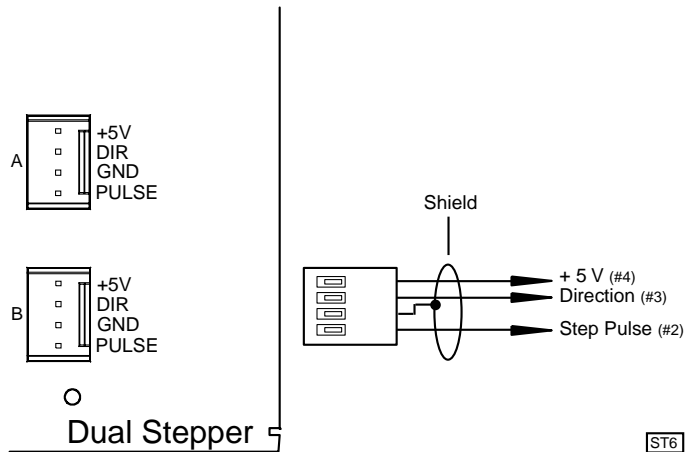
Sample Quickstep Programs

The following pages contain sample Quickstep programs.

NOTE: Maxspeed units are in steps/sec. Acceleration units are in steps/sec^2.

Example 1 – Absolute Move of One Stepping Motor

This example shows a stepping motor moving 100,000 steps from its home position. The `monitor Axis_1:stopped` instruction causes the MultiPro's program to remain in this step until the motor completes the move.

```
[1] ONE_AXIS_ABSOLUTE_MOVE
    ;;; This program will commence an absolute move on axis
    ;;; one based on the parameters in the profile
    ;;; instruction.
    _____
    <NO CHANGE IN DIGITAL OUTPUTS>
    _____
    profile Axis_1 maxspeed=50000 accel=100000
    turn Axis_1 to 100000
    monitor Axis_1:stopped goto next
```

Example 2 – Relative Move of One Stepping Motor

This example shows a stepping motor moving clockwise 100,000 steps from its current position. The `monitor Axis_1:stopped` instruction causes the MultiPro's program to remain in this step until the motor completes the move.

```
[1] ONE_AXIS_RELATIVE_MOVE
    ;;; This program will commence a relative move on axis
    ;;; one based on the parameters in the profile
    ;;; instruction.
    _____
    <NO CHANGE IN DIGITAL OUTPUTS>
    _____
    profile Axis_1 maxspeed=50000 accel=100000
    turn Axis_1 cw 100000 steps
    monitor Axis_1:stopped goto next
```

Example 3 – Velocity Move of One Stepping Motor

This example shows a stepping motor moving clockwise from its current position. The motor turns until it receives a STOP SERVO instruction or until a stop input is activated. The `monitor Axis_1:stopped` instruction causes the MultiPro's program to remain in this step until the motor completes the move.

```
[1] ONE_AXIS_VELOCITY_MOVE
    ;;; This program will commence a velocity move on axis one
    ;;; based on the parameters in the profile instruction.
    _____
    <NO CHANGE IN DIGITAL OUTPUTS
    _____
    profile Axis_1 maxspeed=50000 accel=100000
    turn Axis_1 cw
    monitor Axis_1:stopped goto next
```

Example 4 – Absolute Move of Two Stepping Motors

This example shows two stepping motors. The motor connected to the first axis moves 100,000 steps from its home position and the motor connected to the second axis moves 50,000 steps from its home position. The

instruction causes the MultiPro's program to remain in this step until both motors complete their moves.

Any ratio between multiple axes can be achieved by applying the following formula:

- Velocity = Acceleration * Time
- Acceleration = Velocity / Time

In this example, we are running a 2:1 ratio between the two axes. The motion on each axis will ramp up and down simultaneously.

You can re-profile either motor at any time to establish a new velocity.

If you want to start two axes simultaneously, you can program the TURN SERVO instructions using the ON START parameter. The motion of each motor will begin once the start input located on each axis is triggered. This will start all motion within one millisecond. Refer to *Dedicated Inputs* for information on using the ON START parameter and the start dedicated input.

Example 5 – Staggering the Motion of Two Stepping Motors

This example shows two stepping motors. The motor connected to the first axis moves 100,000 steps from its home position and the motor connected to the second axis moves 25,000 steps from its home position.

The first motor starts turning. When its position reaches half the travel distance, the program moves on to the next step and the second motor starts turning. The

instruction causes the MultiPro's program to remain in the second step until both motors complete their moves.

Any ratio between multiple axes can be achieved by applying the following formula:

- Velocity = Acceleration * Time
- Acceleration = Velocity / Time

In this example, we are running a 2:1 ratio between the two axes. The motion on each axis will ramp up and down simultaneously.

Example 6 – Velocity Move of Two Stepping Motors

This example shows two stepping motors moving clockwise from their current positions. The motors will turn until they receive a STOP SERVO instruction or until a stop input is activated. The `monitor (and Axis_1:stopped Axis_2:stopped)` instruction causes the MultiPro's program to remain in this step until both motors complete their moves.

Any ratio between multiple axes can be achieved by applying the following formula:

- Velocity = Acceleration * Time

- Acceleration = Velocity / Time

In this example, we are running a 2:1 ratio between the two axes. The motion on each axis will ramp up and down simultaneously.

You can re-profile either motor at any time to establish a new velocity.

If you want to start two axes simultaneously, you can program the TURN SERVO instructions using the ON START parameter. The motion of each motor will begin once the start input located on each axis is triggered. This will start all motion within one millisecond. Refer to *Dedicated Inputs* for information on using the ON START parameter and the start dedicated input.

```
[1] TWO_AXIS_VELOCITY_MOVE
    ;;; This program will commence a velocity move on two motor
    ;;; axes based on the parameters in the profile instructions.
    _____
    <NO CHANGE IN DIGITAL OUTPUTS>
    _____
    profile Axis_1 maxspeed=50000 accel=100000
    profile Axis_2 maxspeed=25000 accel=50000
    turn Axis_1 cw
    turn Axis_2 cw
    monitor (and Axis_1:stopped Axis_2:stopped)
    goto next
```

Example 7 – Changing the Velocity of a Stepping Motor During Motion

This sample program positions a stepping motor and generates various velocity profiles throughout the move. After the initial parameters are set, the motor motion is started. When the position reaches 50,000 steps, the program continues to the next step. Each subsequent step changes the velocity and specifies the stepper position where the program moves to the next step.

```
[1] COMPLEX_PROFILE
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=10000 accel=200000
    turn Axis_1 to 500000
    if Axis_1:position >= 50000 goto next

[2] SECOND_PROFILE
    ;;; Re-profile the motor for the a new velocity.
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=20000
    if Axis_1:position >= 70000 goto next

[3] THIRD_PROFILE
     ;;; Re-profile the stepper for a new velocity.
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=50000
    if Axis_1:position >= 110000 goto next

[4] FOURTH_PROFILE
    ;;; Re-profile the stepper for a new velocity.
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=100000
    if Axis_1:position >= 300000 goto next

[5] FIFTH_PROFILE
    ;;; Re-profile the stepper for the next velocity.
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=80000
    if Axis_1:position >= 420000 goto next

[6] SIXTH_PROFILE
    ;;; Re-profile the stepper for the final velocity and wait
    ;;; for the move to complete.
    ─────────────────────────────────────
    <NO CHANGE IN DIGITAL OUTPUTS>
    ─────────────────────────────────────
    profile Axis_1 maxspeed=30000
    monitor Axis_1:stopped goto PROFILE_COMPLETE

    monitor (and Axis_1:stopped Axis_2:stopped)
    goto next
```

Special Registers

Contents

Special Purpose Registers for Steppers

The special registers are the same as the ones in the 2600/2700 series controllers and are set up for 4 axes of motion. For the MultiPro, use the first four registers. For example, register 14001 contains the current position of servo axis 1, register 14002 contains the current position of servo axis 2, and so forth.

Group access special purpose registers display the same parameters for all axes in sequence. Individual access special purpose registers display all the parameters for a single axis.

NOTE: R indicates that the controller can read the register and W indicates that the controller can write to the register.

Group Access Registers

Registers 13701 - 13704	Stores Soft Stop position
Registers 13801 - 13804	Specifies Start option
Registers 14001 - 14004	Current position
Registers 14201 - 14204	Current velocity in steps/sec
Registers 14301 - 14304	Status

        0 = Uninitialized
        1 = Stopped
        2 = Waiting for Start
        3 = Accelerating
        4 = At Speed
        5 = Decelerating to new maximum speed
        6 = Decelerating to stop
        7 = Soft Stop (Transition mode to initiate deceleration)

Registers 14601 - 14616	Deceleration value in steps/sec^2

Individual Access Registers

NOTE: All axes function the same as Axis #1.

Axis 1

Register 15000	Current position
Register 15002	Current velocity
Register 15003	Current status (same as above)
Register 15006	Deceleration value steps/sec2
Register 15007	Monitoring Dedicated Inputs (using a bit map)*

    Home   = 2
    Jog CCW   = 4
    Soft Limit   = 8 (for soft stop)
    Reverse Limit = 16
    Forward Limit = 32
    Jog CW   = 64

All Other Axes

Axis No. 2	Register 15010 - 15017
Axis No. 3	Register 15020 - 15027
Axis No. 4	Register 15030 - 15037