



Installation Guide

MultiPro+™ Dual Stepper Automation Controller

This guide contains installation and applications information for the MultiPro+™ Dual Stepper Automation Controller.

You program the MultiPro+ Dual Stepper controller using CTC's state programming language, Quickstep™ for Windows™. Using either an RS-232 interface or Ethernet communications, you can run all programming and diagnostic functions for the controller from your PC, as well as using them as a computer communications port.

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This document is current as of the following revision levels:

- Controller Firmware - 2.12
- Controller Hardware - A

Dimensions and Mounting Instructions for the MultiPro+ Dual Stepper

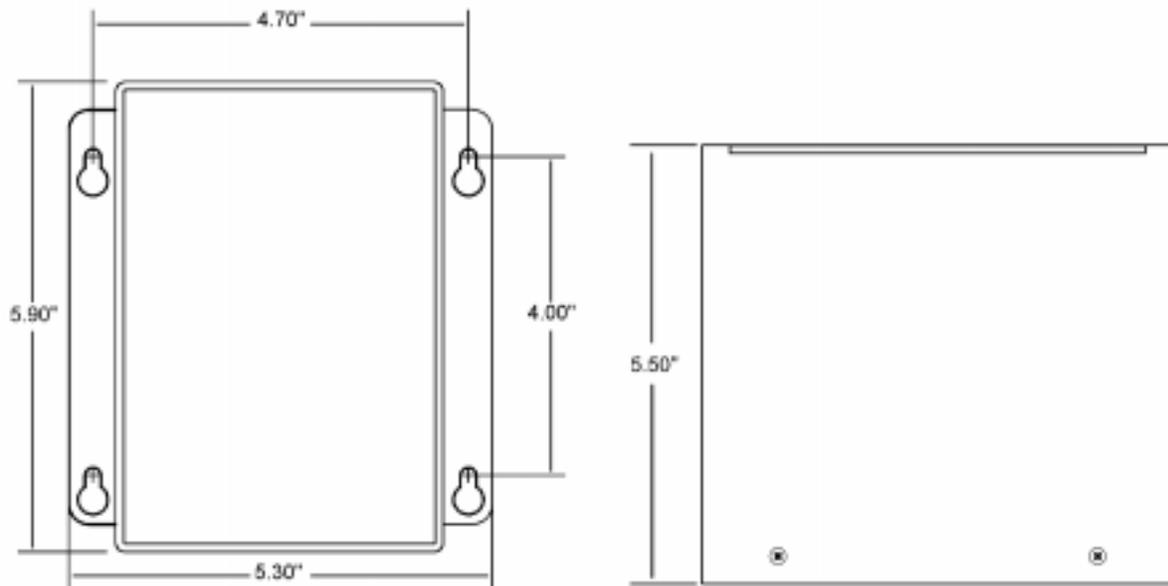
The MultiPro has mounting ears, allowing it to be easily mounted to a flat surface (for example, an NEMA-rated electrical enclosure) with four mounting bolts. You should follow the guidelines described in this installation guide to ensure a successful design.

Mounting Considerations

When selecting a mounting location for the controller, care should be taken to provide protection against various environmental factors:

- The controller should not be exposed to flying metal chips (be careful during installation and subsequent machine construction work.), conductive dusts, liquids or condensing humidity. In environments where these hazards may be present, the controller should be housed in an NEMA 4 or NEMA 12 rated enclosure, as appropriate.
- The controller is not intended for mounting in an environment requiring explosion proof practices.
- If possible, the controller should be mounted physically distant from devices producing electromagnetic interference (EMI) or radio frequency interference (RFI). This includes motor starters, relays, large power transformers, ultrasonic welding apparatus, etc.

The following illustration shows the dimensions of your MultiPro controller



Controller Description and Connections

Digital input connector: Provides access to the 16 inputs. Inputs are numbered 1 through 16.

Led indicators: Each dedicated input has an LED indicator. An LED indicator lights up when its associated input is active.

Dedicated Input Connectors: Provides access to the 6 dedicated inputs (per axis), as well as providing +24 for powering external sensors.

Power connector: Provides 24 VDC to the controller.

Power indicator: This light is lit when the power is on whether or not the controller is in operation. It also indicates that the logic supply is present.

Status light: Indicates software or hardware faults. Refer to the section *Status Light Description* for additional 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.

Digital output connector: Provides access to the controllers outputs. The outputs are numbered 1 through 16.

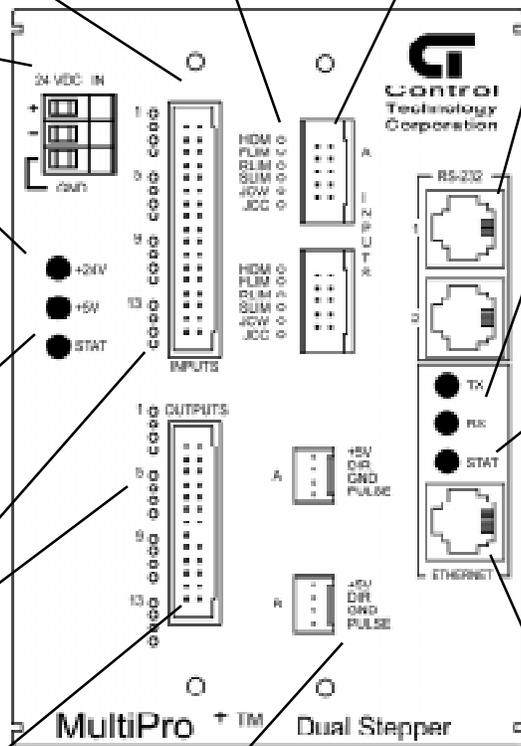
External drive connector: Provides pulse and direction signals to the stepping motor drive.

RS-232 channels: Provides both programming and data communications via a personal computer using Quickstep and CTCMON. Refer to the section, *Setting up RS-232 Controller Communications* for more information

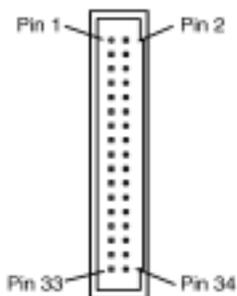
Transmit/Receive lights: Indicates when the controller is transmitting or receiving data or communications.

Ethernet status light: indicates that Ethernet communications are working correctly. The light goes on briefly at power up and then shuts off.

Ethernet Port: Provides programming, data communications, and peer-to-peer communications. Refer to the section, *Setting up Ethernet Communications* for more information.

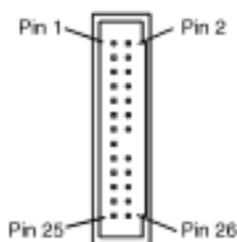


Controller Description and Connections



Digital Input Connector Wiring

Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin No.	Signal
1	Input 1	2	Return	19	Input 10	20	Return
3	Input 2	4	Return	21	Input 11	22	Return
5	Input 3	6	Return	23	Input 12	24	Return
7	Input 4	8	Return	25	Input 13	26	Return
9	Input 5	10	Return	27	Input 14	28	Return
11	Input 6	12	Return	29	Input 15	30	Return
13	Input 7	14	Return	31	Input 16	32	Return
15	Input 8	16	Return	33	+24 VDC	34	Return
17	Input 9	18	Return				



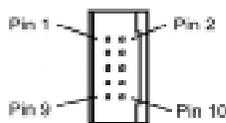
Digital Output 1-16 Connector Wiring

Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin No.	Signal
1	Output 1	2	Output 14	15	Output 8	16	No pin
3	Output 2	4	Output 15	17	Output 9	18	+24 VDC
5	Output 3	6	Output 16	19	Output 10	20	+24 VDC
7	Output 4	8	Return	21	Output 11	22	+24 VDC
9	Output 5	10	Return	23	Output 12	24	+24 VDC
11	Output 6	12	Return	25	Output 13	26	N/C
13	Output 7	14	Return				



Stepping Motor External Drive Connector Wiring

Pin No.	Connection
1	+ 5 VDC
2	Direction
3	Return
4	Pulse



Stepping Motor Dedicated Input Connector Wiring

Pin No.	Connection
1	Home
2	Forward limit
3	Reverse limit
4	Stop limit
5	Jog left
6	Jog right
7	+24 V return
8	+24 V return
9	+24 VDC
10	+24 VDC

MultiPro+ Dual Stepper Specifications

CPU Specifications

CPU Characteristics	Min	Typ	Max	
Ambient Temperature				
operating	0		50	°C
storage	-20		80	°C
Voltage Range	22	24	27	VDC
Current Requirement@ 24VDC		.2	.3	Amp
CPU Power Requirements (5V)		0.2	0.25	Amp
User Memory Capacity (11 yr. Lithium-cell RAM)		24K		Bytes

These controllers use a 80C196 processor running at 18.432 MHz

CPU Typical Performance Specifications

	Typ
Sense input, jump to new step, change output	1 ms
Perform multiplication (between volatile registers)	1 ms
Time delay duration, 10 ms programmed	11.0 ms
Time delay duration, 1 . programmed	1.002 sec
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

Note: Performance specifications shown are with one task running. RS-232 communications may degrade count by up to 10%.

Controller Resource Summary

Multi-Tasking (number of tasks)	28
Volatile Registers (32-bit)	488
Non-Volatile Registers (32-bit)	500
Data Table Elements (16-bit, Nonvolatile)	8000
Input-linkable Counters	8
Flags	32
Program Steps	1024

Stepping Motor Specifications

Performanace Specifications	Min	Typ	Max	
Maximum Velocity Setting	4		250,000	steps/sec
Resolution of Maximum Velocity		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

Specifications	Min	Typ	Max	
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

MultiPro+ Dual Stepper Specifications

Stepping Motor Specifications (cond.)	Min	Typ	Max	
Dedicated Inputs				
Off Voltage ² ($I_1 = 0$ mA)		24.0	26.4	VDC
On Current ($I_1 = 0$ V)		2.1	2.5	mA
Threshold				
low-to-high		8.5		VDC
high-to-low		7.5		VDC

Digital Input/Output Specifications

Input/Output Absolute Maximum ratings	Min	Typ	Max	
Applied input voltage	0		27.0	VDC
Applied output voltage	0		24.0	VDC
Output Current				
Single output			500	mA DC
Total limit			5	Amp DC

Digital Output Specifications (Outputs 1 -16)	Typ	Max	
Output on voltage ($I_o = 500$ mA)	0.8	1.8	VDC
Output off leakage (applied V = 24 V) - Note 3	0.01	0.75	μ A

Digital Input Specifications	Min	Typ	Max	
Input off voltage ($I_i = 0$ mA)		24.0	26.4	VDC
Input on current ($V_i = 0$ V)		-2.10	-2.85	mA
Input on current threshold ($V_i = 8$ V typ)		-1.0	-1.85	mA
Input off current (typ leakage current allowable)			-250	μ A

Notes:

- Under normal operation, no external input voltage is applied – inputs should be externally switched to the input common.
- An on-board protection diode returns to +24 V from each output.
- In the off state, unconnected outputs are internally pulled to +5 V through a diode and an LED indicator.
- All Power Requirements are worst-case, with all inputs and/or outputs activated.
- Specifications shown above are at 25° C., unless otherwise noted.

RS-232 and Ethernet Specifications

Absolute Maximum Ratings	Min	Max	
Current draw from on-board +5 V supply		110	mA (DC)
Operating Characteristics	Min	Typ	Max
RS-232 Transmitters		9	12
RS-232 Receivers	3		12
EtherNet Transceivers (10 Megabit/sec)			1.5
Power Requirements (from controller)			
+5 VDC		630	750
+24 VDC		53	170

CTNET Network Performance Specifications	Typ	
Host Communications		
Single register transaction from 2217	2	ms
Single register transaction from 2600 (Note 2)	2	ms
16 register read from 2600 (Note 2)	12-15	ms
50 register read from 2600 (Note 2)	13-16	ms
Peer-to-Peer Communications (Note 2)		
Single register transaction from 2217	9-11	ms
Single register transaction from 2600	10-13	ms

Notes:

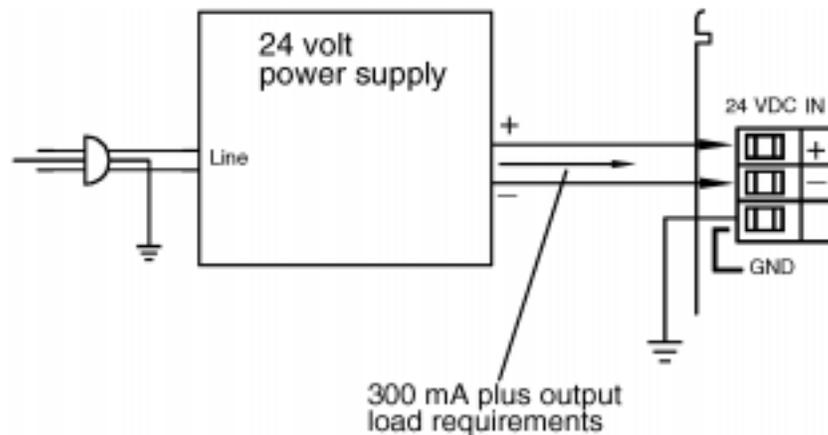
1. Specifications shown above are at 25° C., unless otherwise noted.
2. With high communications priority active or one task running.

MultiPro+ Dual Stepper Power Connections

Connecting DC Power

The MultiPro+ Dual Stepper contains an internal power supply which provides two mutually-isolated voltages (+5 VDC and +24 VDC) for the operation of the controller.

The controller's power supply requires 24 VDC for proper operation. Power is applied to the controller via the power connector on the top of the controller. The controller's power system derives its operating voltage from the external 24 volt supply.



The Importance of Proper Grounding

As with any electronic equipment, the controller's ground should follow a direct, low-impedance path to the plant's power source. If possible, this path should not be shared by any machinery which injects a large amount of electrical noise into the ground.

For further consideration regarding noise protection, refer to the Application Note, *Reducing Noise Susceptibility*. Application notes may be obtained at no charge from your distributor or directly from CTC.

Status Light Description

The status light on the MultiPro can indicate one of the following conditions:

- **Software fault:** A periodic flashing light on the MultiPro indicates a program software fault. This means the controller was unable to execute due to an application problem within the program. To determine what type of software fault has occurred, you can view the program status using Quickstep for Windows' program monitoring utility, CTCMON.

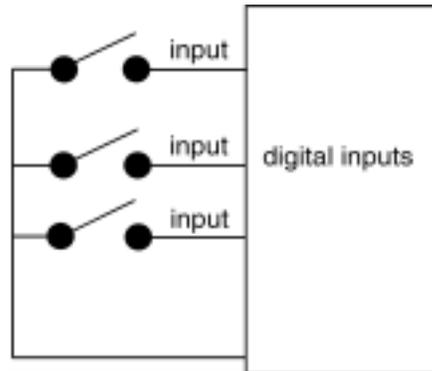
If a program software fault occurs, the controller is idle and all settable resources, such as outputs, registers or flags, are left in the state they were in prior to the software fault. You can program register 13009 to turn off a specific output in the event of a software fault. Refer to the list of special purpose registers for more information.

- **Hardware fault:** A steady red light indicates that the internal watch dog timer has disabled the controller's CPU. If this occurs, the controller's outputs are also disabled. Try cycling the power, re-downloading your Quickstep program, or both. If the fault continues, your controller may have to be returned to Control Technology Corp. for repair. For further details, contact our Technical Support department before returning your controller.

When powering-up the controller, the status light is a steady red light during the first second of operation.

Connecting Digital Inputs

The 16 digital inputs require only a switch closure to the **Return** (the common for the controller's 24 Volt supply) to actuate. Each input is internally self-powered from the 24 Volt power supply through a current limiting resistor, and is optoisolated from the controller's logic.



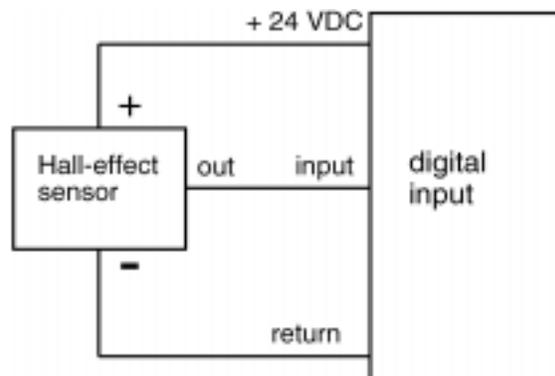
The controller senses when any of the inputs have been pulled down to return by a switch closure, and a Monitor instruction or any other programmed instruction referring to a general-purpose input can use this information.

Using Solid State Sensors

You can connect many types of electronic sensors to the inputs. You can connect three wire Hall-effect sensors, proximity sensors, and phototransistors without any additional circuitry. These devices should be specified as having sinking-type open-collector outputs (NPN) and must be capable of withstanding at least +24 volts on their output terminals when 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 typically require an external power source for powering their internal circuitry. The following illustration shows how to connect a solid state sensor.



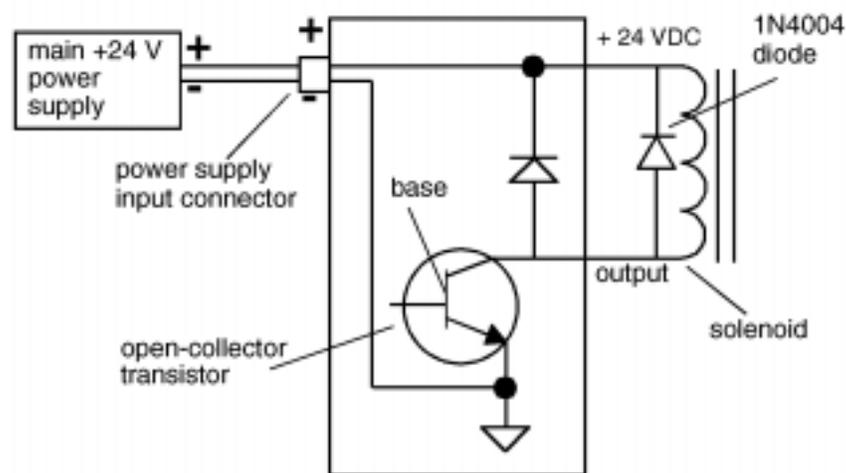
Connecting Digital Outputs

Using Open-collector Outputs

The MultiPro+ Dual Stepper provides 16 outputs for driving external loads, such as solenoid valves, indicators, solid-state relays and other low-power DC loads. These outputs are in the form of open-collector transistors capable of switching loads up to 0.5 Amp DC

This type of output gets its name from the fact that the collector terminal of the output transistor is left open, or unconnected, to allow greater flexibility in its use.

An open-collector output, shown schematically 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 the equivalent of the switch contact being open, because the device being controlled is turned off.



When the output is turned on, current is allowed to flow through the transistor, just as though a switch contact had been closed. The controlled device turns on in response to the flow of current.

To connect a device to an open-collector output, one terminal of the device is connected to the open-collector output (if the device is polarized, the negative [-] terminal is connected to the output). The remaining terminal of the device is connected to the positive side of the power supply.

IMPORTANT! Control Tech recommends that you place a suppression diode across inductive loads. Use a 1N4004 diode or equivalent. The diode should go as close to the load as possible, as shown in the illustrations.

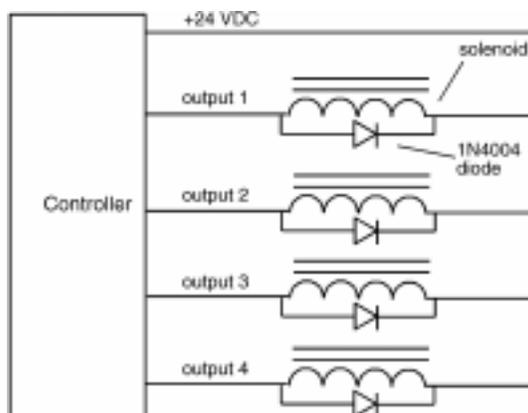
Care should be taken not to exceed the rated current of the power supply being used. When calculating the current requirements of your system, you only need to consider the maximum number of output devices to be turned on simultaneously plus .3 AMPs for the

Connecting Digital Outputs

MultiPro+ in your calculation.

Connecting Multiple devices

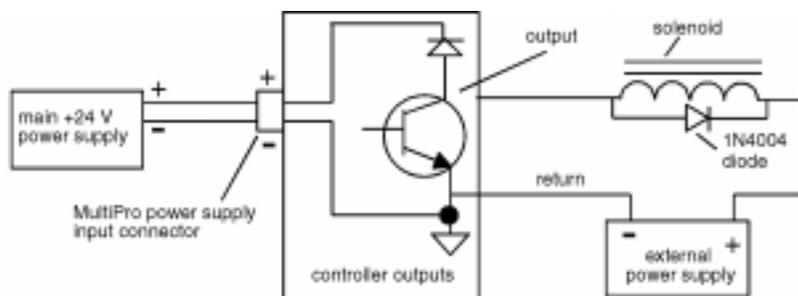
When powering multiple devices from the same power source, each device is connected with one of its leads attached to an independent output, and the other lead connected to the positive terminal of the power source. The following diagram shows four solenoid valves being controlled by outputs 1 through 4. All outputs are powered by the power supply which is powering the controller.



Connecting to a Second External Power Supply

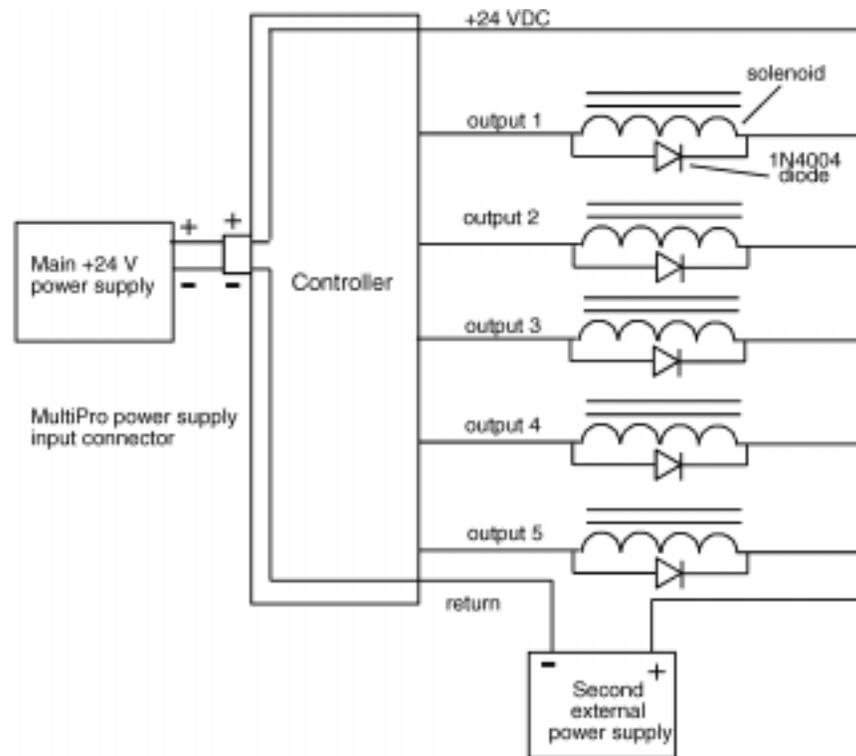
It is also possible to power some of the devices from a second external power supply, while powering others from the supply powering the controller. To do this, you must connect each device being controlled to the positive terminal of the appropriate power supply. Refer to the diagram on the next page. When connecting to an external power supply, do not connect the positive terminals of the two supplies together, either directly or indirectly.

IMPORTANT! Control Tech recommends that you place a diode across inductive loads. Use an IN4004 diode or equivalent. The diode should go as close to the load as possible, as shown in the illustrations.



WARNING: Each output has a protection diode with its cathode connected to the + 24 VDC power supply at the input connector. This diode prevents damage to the output when connected to an inductive load. If a separate power supply is used for the external devices, as shown above, a current path exists between the two supplies through the devices being

controlled. Under normal operation this practice is okay. However some power supplies when powered down, tend to offer a low impedance with respect to power supply return. If in the above configuration, the main power supply is powered down and the external one is not, the current from the external supply can energize the device connected to the output, turning it on. To prevent this, make sure that both supplies are powered up and down together.



IMPORTANT! Do not use an external power supply with an output voltage greater than the output voltage rating of the outputs.

Do not connect the positive [+] terminals of the power supplies together! Damage to one of the supplies may result.

Notice, in the diagram above, the connection between the negative [-] terminal of the external power supply and the return terminal on the controller's output connector. This is necessary to provide a complete circuit for the current travelling through the device being controlled.

Setting-up RS-232 Controller Communications

Using the RS-232 Port for Controller Communications

The RS-232 port on your MultiPro provides a means for both programming and data communications via a personal computer using Quickstep. The MultiPro is also equipped with a built-in protocol allowing direct computer communications with the controller's RS-232 port. This protocol is described in the *Guide to CTC Serial Data Communications*. It allows an external computer to directly interact with many of the controller's resources such as, counters, registers, I/O, flags, without modifying the controller's program.

You can also use RS-232 communications when monitoring a controller using CTCMON.

RS-232 Connections

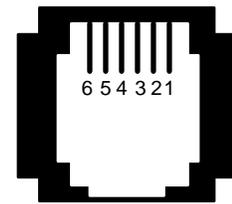
Connections to the MultiPro's RS-232 port is made via a modular jack on the controller (labelled COMM). This jack carries the receive signal, two commons (ground), and the transmit signal for the communications channel. The pin connection diagram illustrates the wiring of the jack. Only the center four connectors of a six- or eight-conductor jack are used.

A series of standard CTC cables are available for making connections to this jack. See the illustrations below and on the following page. As an alternative, many commonly-available telephone cables may be substituted.

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

Connecting to a D Connector

RS-232 ports on computers are frequently brought out through 25- or 9-pin D type connectors. There is a standard for wiring such connectors followed by most PC manufacturers.



- 1 – +5*
 - 2 – TxD outbound
 - 3 – Common
 - 4 – Common
 - 5 – RxD inbound
 - 6 – +5 return*
- *COMM 1 only

personal computer with RS-232 asynchronous communications board

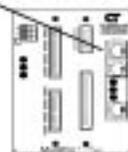


communications cable:
model 2881 - 5 feet
model 2882 - 15 feet
model 2883 - 25 feet

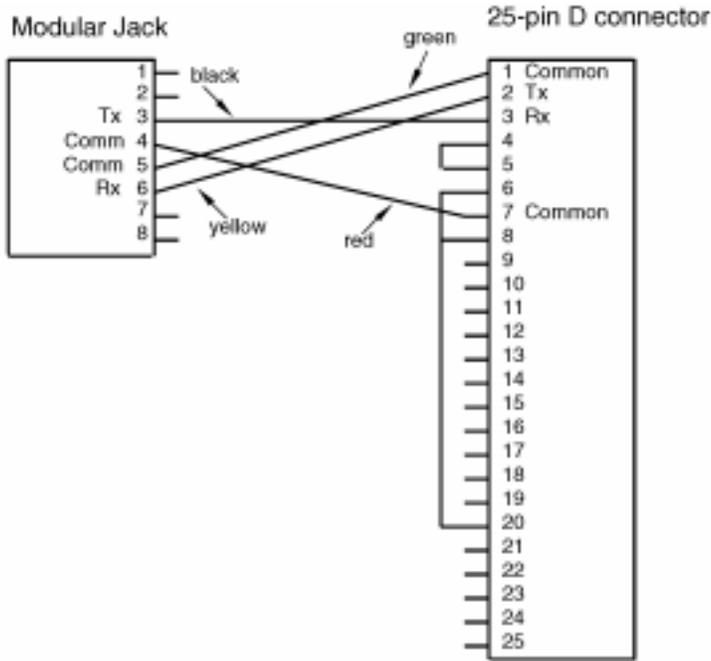
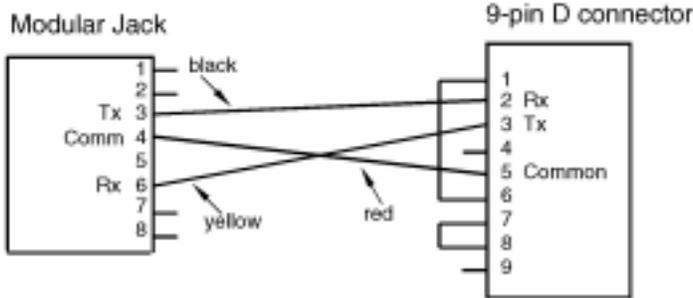


D-connector to modular Jack adapter:
model 2880A for 25-pin D-connectors
model 2880B for 9-pin D-connectors

RS-232 ports



Control tech has adapters available that connect directly to a male 25-pin (Model 2880A) or 9-pin (2880B) D connector. These adapters provide a modular jack wired for compatibility with the COMM port. To be fully compatible when using this adapter, the computer's communications port should be wired as a DTE device.



Setting-up Ethernet Controller Communications

Using Ethernet for Controller Communications

Your MultiPro controller can access an ethernet network for controller-computer communications using 10BaseT connections. The connections to the controller Ethernet port uses Ethernet IEEE 802.3 standard connections. Control Tech recommends using category 5 cables and connectors, as well as category 5 wiring techniques.

MultiPro network capabilities are as follows:

- Ethernet IEEE 802.3 standard 10BaseT connections
- Data rates of 10 Mbps
- Host communications with:
 - Individual controller read/write capability
 - Downloading/uploading Quickstep programs
 - Access to all controller resources
- Peer-to-peer communications offering indirect node access
- Built-in error checking
- Network access from any controller RS-232 port

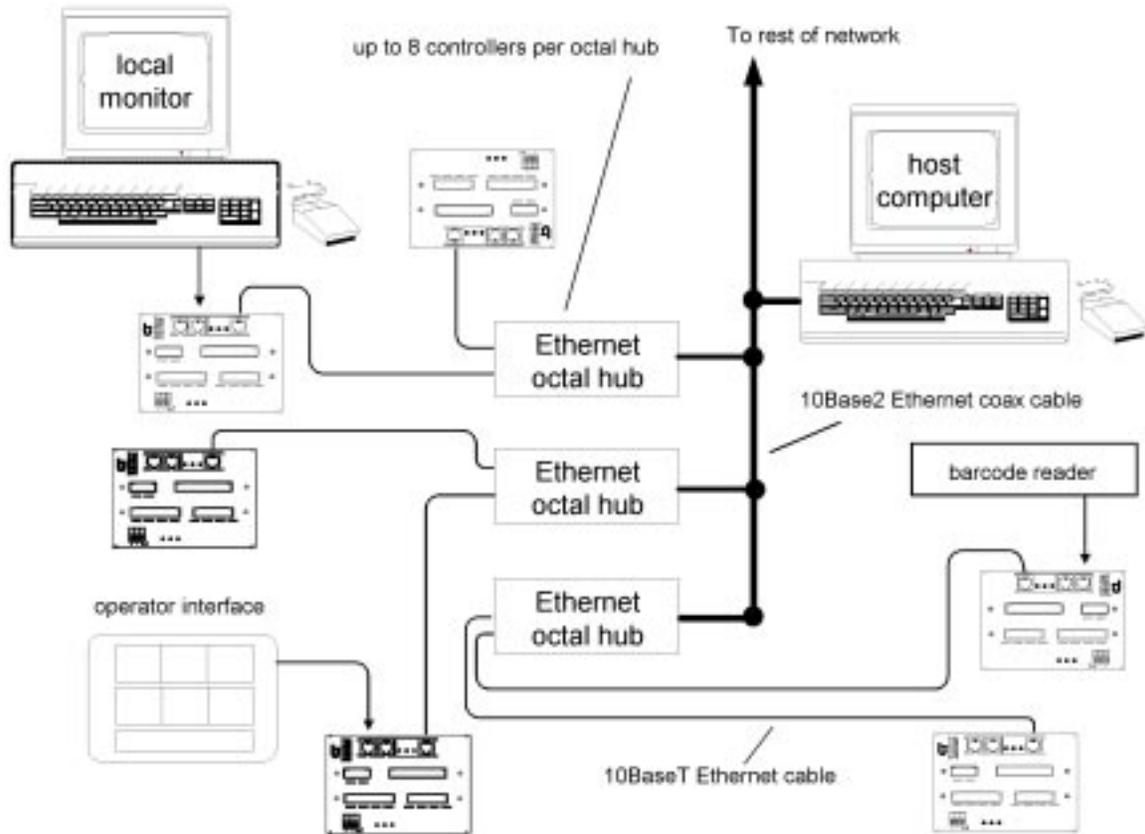
A host computer can interrogate the network area continuously, while at the same time local computers or operator interface terminal can access the network port using or conventional communications protocols from any controller's RS-232 port. For fast data retrieval, the controller supports block area transfer from a single command request both locally and over the network.

Other network specifications include:

- Maximum cable length per segment is 100 meters.
- Maximum cable length per network is 925 meters
- Total number of nodes supported is 999

The illustration on the following page shows computer-controller connections using an Ethernet network.

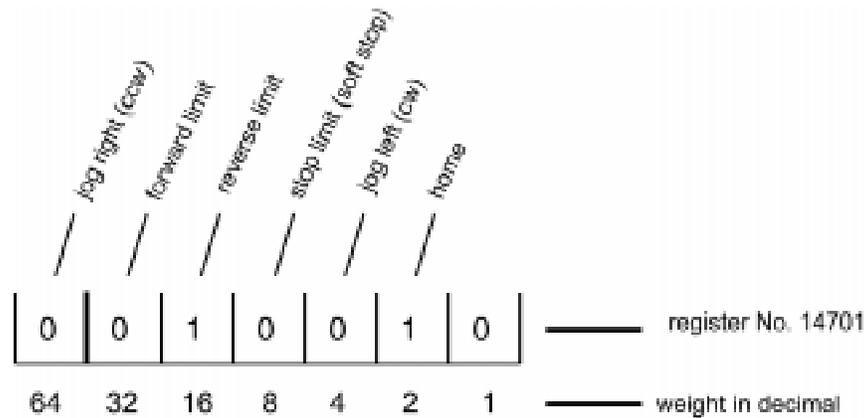
Sample Ethernet Network



Using Dedicated Inputs

Monitoring Dedicated Inputs

Registers 15007 and 15017 can return a bit pattern that indicates which, if any, of the dedicated inputs are activated. The number of the dedicated input is stored as a binary representation (of the input number) in the register. Each input has its own binary value.

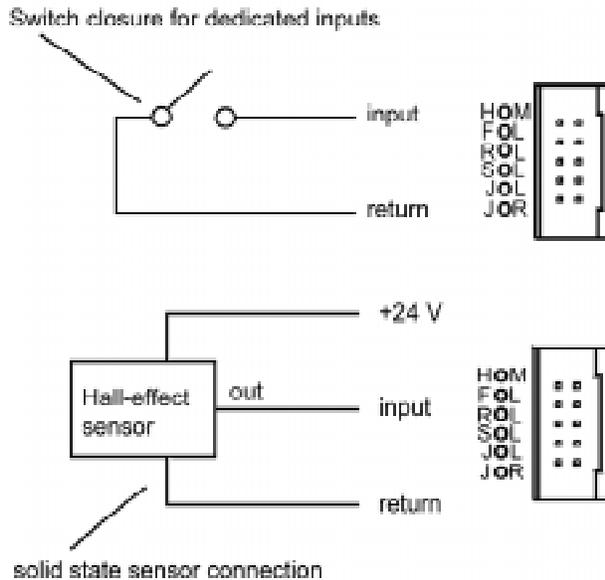


In the illustration above, the home, reverse limit, and soft stop inputs are shown as active. Register 15007 (for axis No. 1) would return a value of 26, because the respective weights of the inputs are 2, 8, and 16. To test any individual input, the bitwise AND instruction may be used to apply a mask to the register. The following instruction applies a bit mask that test 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 six dedicated inputs on the MultiPro+ Dual Stepper require only a switch closure to return (the common for the controller's 24 volt supply) to be actuated. Each input is internally self-powered from the controller's 24 volt power supply through a current limiting resistor and is opto-isolated from the controller's logic. The following illustration is an example of the switch closure for the dedicated inputs.



Using Solid State Sensors

You can connect many types of electronic sensors to the dedicated inputs, such as three-wire Hall-effect sensors, proximity sensors, and phototransistors, with out any additional circuitry. These devices should be specified as having sinking-type open-collector outputs (NPN) and must be capable of withstanding at least +24 volts on their output terminals when in the off state. The sensor must also be able to sink the required input current, i.e., 2.4 mA, when on.

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

Electronic sensors typically require an external power source for powering their internal circuitry. If the sensor chosen requires a power supply voltage equal to the controller's built-in auxiliary supply (24 volts), it can be powered directly by the controller, eliminating the need for an additional external supply.

Programming a Stepping Motor

The following section describes how to program your MultiPro+ Dual Stepper. When programming the stepping motor, use the Quickstep instructions for Servos:

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

Setting Up Stepping Motor Operating Parameters

Before the controller can turn your stepping motor, it must have a set of operating parameters. These parameters must be specified using the PROFILE SERVO instruction. Operating parameters for the motor are as follows:

- Max Speed – Establishes the maximum speed of the motor.
- Accel Rate – Specifies the acceleration rate of the motor. The deceleration rate is the same as the acceleration rate. See the section on *Setting Acceleration and Deceleration Parameters* for information on setting a different deceleration rate.

NOTE: You can use only the Max and Accel parameters of the Profile Servo instruction with the 2206 module. The controller ignores the other parameters.

The maximum speed is expressed in units of steps-per-second (steps/sec). Your programmed maximum speed has a resolution of about 4 steps/sec. The acceleration and deceleration is expressed in units of steps-per-second-per-second (steps/sec²) with a granularity of about 16 steps/sec².

The PROFILE SERVO instruction must appear before the first TURN SERVO instruction in your Quickstep program. If it is not executed prior to 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.

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 stepping 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.

NOTE: 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 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.

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 a special purpose register after the profile instruction to set a different value for the deceleration value. For example:

```
profile axis_1 max=50000 accel=100000
store 20000 to reg_15006 (motor axis 1 deceleration register)
```

Result:

Acceleration = 100000 steps/sec²
Deceleration = 20000 steps/sec²

NOTE: If you specify a new acceleration rate, the deceleration rate in register 15006 is overwritten by the new acceleration rate. You must respecify the deceleration rate.

Searching for Home

Each stepping motor axis has a dedicated home input. This is most often used in conjunction with the **SEARCH AND ZERO** instruction to set a home position for the axis. When the controller executes the **SEARCH AND ZERO** instruction, the following occurs:

- If the home input does not have a switch closure, the motor turns in a counterclockwise (ccw) direction until the switch closes (changes state). If the home input has a switch closure on it, the motor turns in a clockwise (cw) direction until the switch opens (changes state). In either case, the Home input is checked every millisecond, which offers very good repeatability. The motion will be at the profiled maximum speed and acceleration values.
- When home is sensed, the motor stops and the position is set to zero.

HINT 1: Make sure the maximum speed of the motor is low enough that the motor can stop instantly or the motor may overrun its intended position.

HINT 2: To get the motor in the home position consistently, **SEARCH AND ZERO** the motor once at a relatively high speed. Then **SEARCH AND ZERO** the motor again at a slow speed. The following example shows how to **SEARCH AND ZERO** 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
    ;;re-home motor
    -----
    <NO CHANGE IN DIGITAL OUTPUTS>
    -----
    profile axis_1 maxspeed=500 accel=500
    search and zero axis_1
    monitor axis_1 stopped goto next
```

Turning a Motor

There are three modes of turning the motor:

1. Absolute Positioning – In Absolute Positioning the MultiPro+ Dual Stepper always references the home (or zero) position in a turn instruction and moves a specified distance from home position. For example, the following instruction

```
turn axis_2 to 50000
```

causes the motor to position itself 50000 steps from home. The motor automatically turns in the correct direction to reach the new position.

2. Relative Positioning – In Relative Positioning, the direction of the turn, either cw or ccw, 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 12340 steps clockwise from its current position.

3. Velocity Control – In this case, 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 will continue to turn until the controller 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 instruction until the motion is complete, or a software fault, “servo not ready,” results. Use the MONITOR SERVO instruction to check the current status (running/stopped) of the motor.

The MultiPro+ Dual Stepper tracks the position of the motor through all three types of instructions, allowing you to use all three types of positioning and control in the same program.

NOTE: Quickstep instructions specifying cw or ccw operations assume the following:

- The stepping motor is wired according to manufacturer’s recommendations.
- The logical sense of the direction output of the MultiPro+ Dual Stepper 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+ Dual Stepper to try to stop the motor instantly. However, because of momentum, the motor does not stop instantly and consequently the absolute position may be lost.

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

Monitoring and Changing Other Motor Parameters

There are a number of special purpose registers available that allow you to monitor and change the motor parameters. For more information, refer to the list of special purpose registers for the MultiPro+ Dual Stepper and your automation controller.

Hardware Considerations for Stepping Motors

Dedicated Inputs

All dedicated inputs on the MultiPro+ Dual Stepper are internally pulled-up to 24 VDC, requiring a contact closure to 24V Return to actuate. The contact closure can be supplied by a mechanical switch or by certain types of solid state open-collector outputs.

- Forward limit – If the motor is moving cw, disables all cw movement, attempting to stop the motor instantaneously. The home position of the motor may be lost, requiring you to re-home it.
- Reverse limit – If the motor is moving ccw, disables all ccw movement, attempting to stop the motor instantaneously. The position of the motor may be lost, requiring you to re-home it.
- Stop limit (soft stop) – Stops the motor using the deceleration rate programmed in the PROFILE SERVO instruction, terminating the motion.
- Jog Left (cw) – Starts the motor turning clockwise at the acceleration rate programmed in the PROFILE SERVO instruction. The motor reaches velocity and continues to turn until the jcw input is turned off. The motor then decelerates to a stop at the programmed deceleration rate.
- Jog Right (ccw) – Starts the motor turning counterclockwise at the acceleration rate programmed in the PROFILE SERVO instruction. The motor reaches velocity and continues to turn until the jccw input is turned off. The motor then decelerates to a stop at the programmed deceleration rate.
- Home – Refer to *Searching for Home*.

If you have chosen the Start option, it replaces the jog cw dedicated input with an Start input and jog cw is not available. To use the Start dedicated input you must program your TURN SERVO instruction using the ON START parameter. The MultiPro checks the On Start input every millisecond, which improves the repeatability of the start motion. The motion will not commence until the Start switch is activated.

To choose this option store the number 1 in register 13801 for the first axis 1 and store 13802 for the second axis. Once you store the number 1 to this register, you do not have to store it again in your program.

NOTE: 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 step specified.

Not all of the dedicated inputs are 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 cw direction. This allows the motor to be backed off a limit switch, because you can still move ccw.
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 can still move ccw and return to the home position.
- Reverse limit input – This input is active only when the motor is moving in the ccw direction.
- Soft stop input – This input is not active when searching for home or when jogging under control of the jog inputs. Because there are some instances where the soft stop input does not stop motion, you should not use this input for any limit switch intended to prevent damage to a machine.

Hardware Considerations

The Soft stop input has the additional advantage of storing the position at which the input signal occurred. The position is accessible via a special purpose register, 13701 for the first axis and 13702 for the second axis. You can take advantage of this feature in applications where soft stop is used to synchronize a repetitive motor motion to some external event, such as, a registration mark being sensed on a continuous web of material.

- Jog cw and jog ccw inputs – The jog inputs are active only when the motor is stopped. Following a PROFILE SERVO instruction, a jog input will commence a cw or ccw motion, depending on the input.

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

The following list describes when the jog inputs are inactive:

- Once a motion is triggered by other means, applying and/or removing a jog input has no effect.
- The jog cw input is inactive when the Forward limit switch is active. However, the jog ccw input is active.
- The jog ccw input is inactive when the Reverse limit switch is active. However, the jog cw input is active.
- Both jog inputs are inactive when the soft stop input is active.
- Home input – The home input is only active when the MultiPro+ Dual Stepper is searching for home. Otherwise, it does nothing at all.

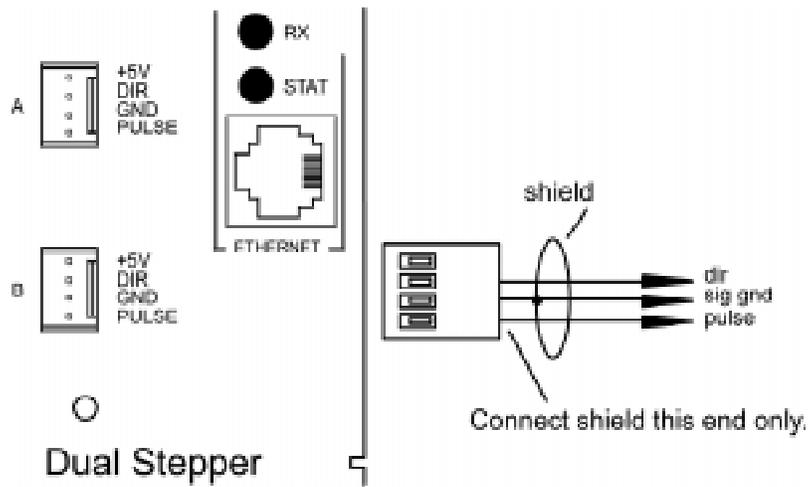
Connecting Stepping Motor Drives

Connecting the MultiPro+ Dual Stepper to a Stepping Motor Drive

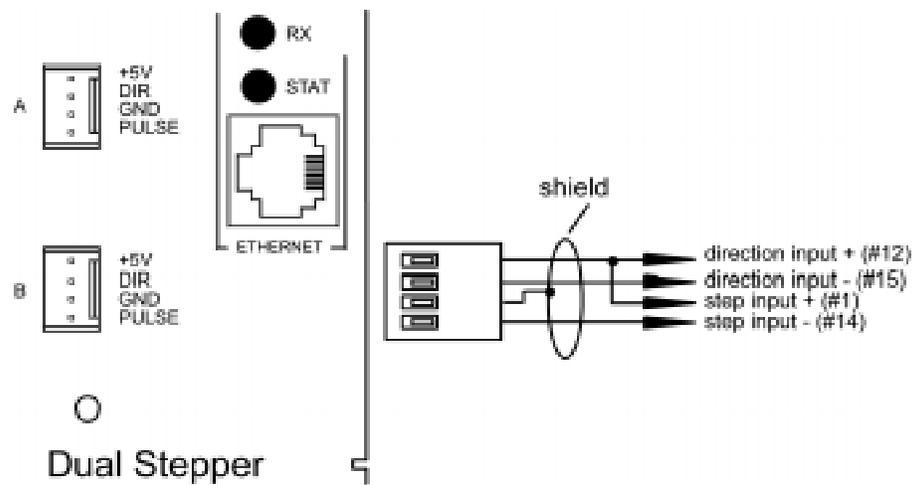
The illustrations on the following pages show how to connect your MultiPro+ Dual Stepper to these stepping motor drives:

- 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

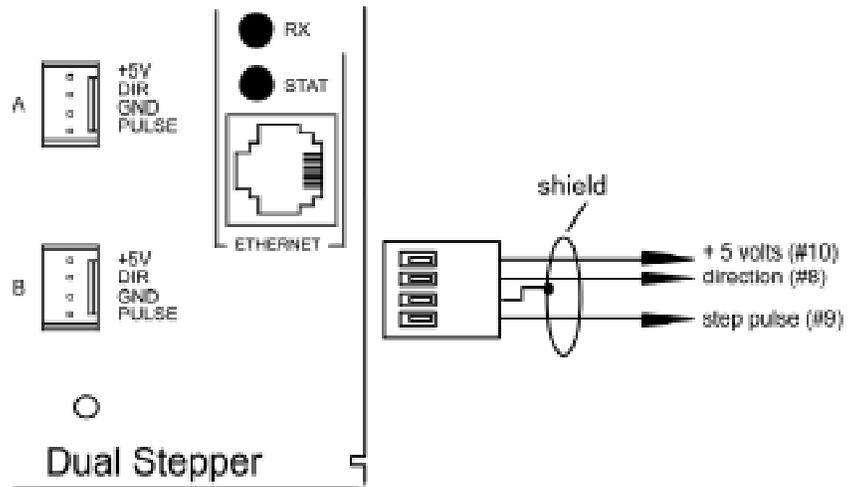


Connecting to a Compumotor Stepping Motor Drive

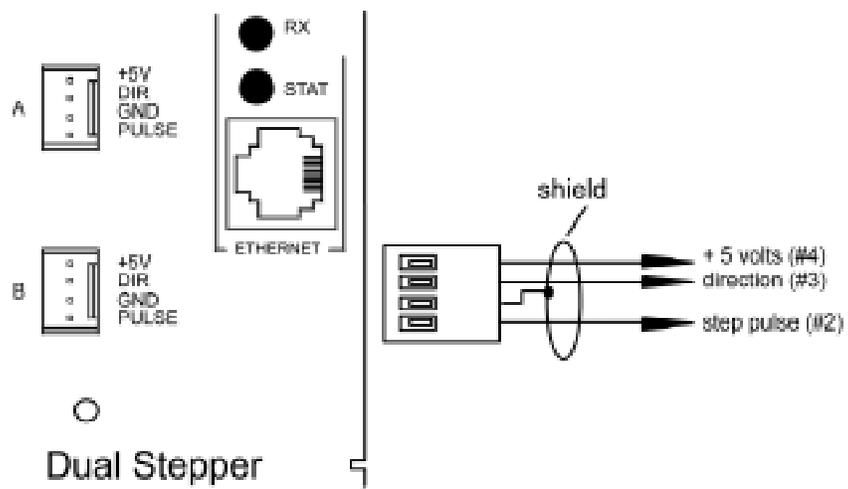


Connecting Stepping Motor Drives

Connecting to a Centent Stepping Motor Drive



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



Sample Quickstep Programs for Stepping Motors

The following pages contain sample quickstep programs.

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 controller's program to remain in this step until the motor completes the move.

Maxspeed units are in steps per second. Acceleration units are in steps per second².

```
[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 controller's program to remain in this step until the motor completes the move.

Maxspeed units are in steps per second. Acceleration units are in steps per second².

```
[1]      ONE_AXIS_RELATIVE_MOVE
      ;;; This program will commence an 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 will turn until it receives a `STOP SERVO` instruction or until a stop input is activated. The `monitor Axis_1:stopped` instruction causes the controller's program to remain in this step until the motor completes the move.

Maxspeed units are in steps per second. Acceleration units are in steps per second².

```
[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 following instruction:

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

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

Maxspeed units are in steps per second. Acceleration units are in steps per second². So, any ratio between multiple axes may be achieved by applying the following formula:

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

In this example, we are running a 2 to 1 ratio between the two axes. These motions 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 or more axes simultaneously, you can program the `TURN SERVO` instructions using the `ON START SWITCH` parameter. The motors' motion will begin once the start input located on each axis is triggered. This will start all motions within one millisecond. Refer to *Hardware Considerations, Dedicated Inputs* for information and instructions on using the On Start Switch parameter and the Start dedicated input.

```
[1]      TWO_AXIS_ABSOLUTE_MOVE
      ;;; This program will commence an absolute move
      ;;; on two motor axes based on the parameters in
      ;;; the profile instructions.
      ;;;
      ;;; Maxspeed units are in steps per second.
      ;;; Acceleration units are in steps per second
      ;;; per second.
      ;;; So, any ratio between multiple axes may
      ;;; achieved by applying the following formula:
      ;;; Velocity = Acceleration * Time
      ;;; Acceleration = Velocity / Time

      <NO CHANGE IN DIGITAL OUTPUTS>

      profile Axis_1 maxspeed=50000 accel=100000
      profile Axis_2 maxspeed=25000 accel=50000
      turn Axis_1 to 100000
      turn Axis_2 to 50000
      monitor (and Axis_1:stopped Axis_2:stopped) goto next
```

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 is put in motion. When the position of the first motor reaches half the travel distance, the program moves on to the next step and begins the motion of the second motor. The following instruction:

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

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

Maxspeed units are in steps per second. Acceleration units are in steps per second². So, any ratio between multiple axes may achieved by applying the following formula:

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

In this example, we are running a 2 to 1 ratio between the two axes. These motions will ramp up and down simultaneously.

```
[1]      TWO_AXIS_STAGGERED_MOVE
      ;;; This program will commence an absolute 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 to 100000
if Axis_1:position >= 50000 goto next

[2]      TRIGGER_SECOND_AXIS
      ;;; Turn the second axis and wait for both axes
      ;;; to be complete before moving on the next part
      ;;; of the program.
      _____
      <NO CHANGE IN DIGITAL OUTPUTS>
      _____

turn Axis_2 to 25000
monitor (and Axis_1:stopped Axis_2:stopped) goto next
```

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 it receives a STOP SERVO instruction or until a stop input is activated. The following instruction:

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

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

Maxspeed units are in steps per second. Acceleration units are in steps per second². So, any ratio between multiple axes may achieved by applying the following formula:

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

In this example, we are running a 2 to 1 ratio between the two axes. These motions 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 or more axes simultaneously, you can program the TURN SERVO instructions using the ON START SWITCH parameter. The motors' motion will begin once the start input located on each axis is triggered. This will start all motions within one millisecond. Refer to *Hardware Considerations, Dedicated Inputs* for information and instructions on using the On Start Switch parameter and the Start dedicated input.

Sample Quickstep Programs

```
[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 while generating various velocity profiles throughout the move.

After the initial parameters are set, the motor motion is started. When the position reaches 50000 steps, the program continues to next step.

Maxspeed units are in steps per second. Acceleration units are in steps per second².

```
[1]      COMPLEX_PROFILE
      _____
      <NO CHANGE IN DIGITAL OUTPUTS>
      _____
      profile Axis_1 maxspeed=10000 accel=200000
      turn Axis_1 to 50000
      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 servo 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 servo for a new velocity.
      _____
      <NO CHANGE IN DIGITAL OUTPUTS>
      _____

[4]      FIFTH_PROFILE
      profile Axis_1 maxspeed=100000
      if Axis_1:position >= 300000 goto next
      ;;; Re-profile the servo 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 servo 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
```

Special Purpose Registers for Stepping Motors

Group Access:

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

These registers are for axes 1 - 16. For the MultiPro+ Dual Servo, use the first two registers, for example register 14001 contains the current position of motor axis 1, and 14002 contains the current position of motor axis 2.

Registers 13701 - 13702	Stores Soft Stop position
Registers 13801 - 13802	Specifies Start option
Registers 14001 - 14002	Current position
Registers 14201 - 14216	Current velocity in steps/sec
Registers 14301 - 14316	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:

These registers are for axes 1 - 16. For the MultiPro+ Dual Servo, use the first two registers, for example register 15002 contains the current velocity of motor axis 1, and 15012 contains the current velocity of motor axis 2.

Axis No. 1

Register 15000	Current position
Register 15002	Current velocity
Register 15003	Current status (same as above)
Register 15006	Deceleration value steps/sec ²
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

Axis No. 2	Register 15010 - 15017
Axis No. 3	Register 15020 - 15027
Axis No. 4	Register 15030 - 15037
Axis No. 5	Register 15040 - 15047
Axis No. 6	Register 15050 - 15057
Axis No. 7	Register 15060 - 15067
Axis No. 8	Register 15070 - 15077
Axis No. 9	Register 15080 - 15087
Axis No. 10	Register 15090 - 15097
Axis No. 11	Register 15100 - 15107
Axis No. 12	Register 15110 - 15117
Axis No. 13	Register 15120 - 15127
Axis No. 14	Register 15130 - 15137
Axis No. 15	Register 15140 - 15147
Axis No. 16	Register 15150 - 15157