Control Technology Corporation

Installation Guide

MultiPro+™ MC Automation Controller

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

You program the MultiPro+ MC 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.

This guide is divided into the following sections:

This document is current as of the following revision levels:
- Controller Firmware - 2.12
- Controller Hardware - A

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# Dimensions and Mounting Instructions for the MultiPro+ MC

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
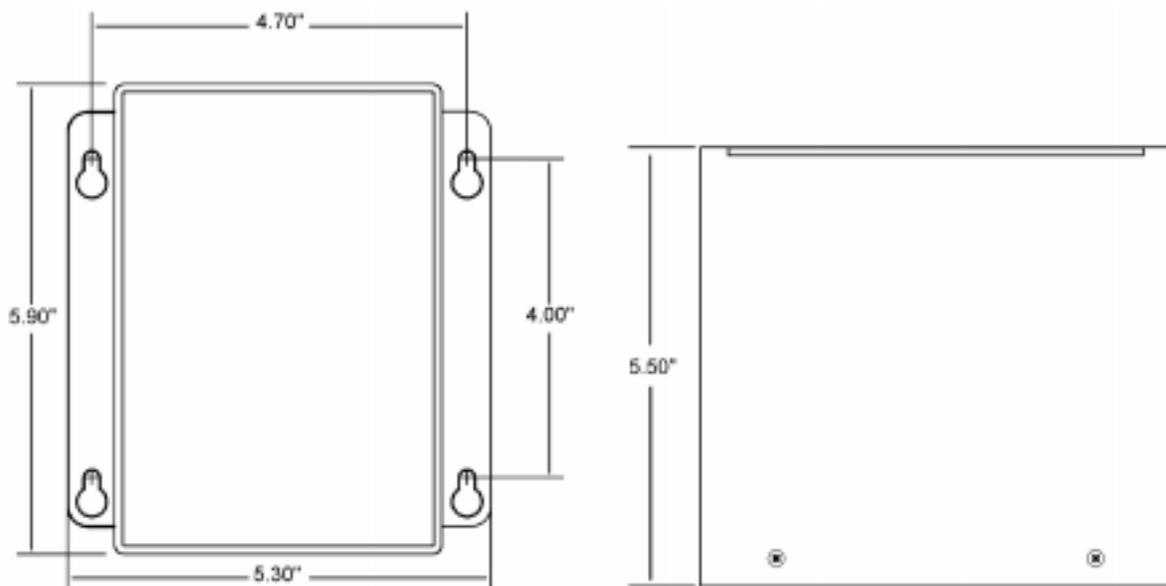
Controller Description and Connections

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

Dedicated digital output connector: Provides access to the digital outputs. The dedicated digital outpus are mapped one-to one with the analog inputs.

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

Power connector: Provides 24 VDC to the controller.

Power indicator: These lights are lit when the power is applied to the controller. The +5 volt supply is derived from the 24 volt supply.

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

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

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

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 16 of the controllers 24 outputs. The outputs are numbered 1 thought 16.

Analog input/output connector: Provides access to the analog inputs and outputs.

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

Digital Input Connector Wiring

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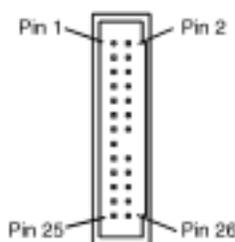
Digital Outputs 1-16 Connector Wiring

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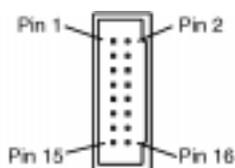
Dedicated Digital Outputs 1-8 Connector Wiring

Pin No.	Signal	Pin No.	Signal
1	D output 1	2	D output 2
3	D output 3	4	D output 4
5	D output 5	6	D output 6
7	D output 7	8	D output 8
9	Return	10	Return
11	Return	12	Return
13	+24 VDC	14	+24 VDC
15	+24 VDC	16	+24 VDC
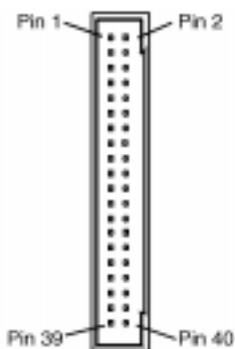
Analog Input/Output Connector Wiring

Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin No.	Signal
1	10 V ref	2	10 V ref	21	A input 6+	22	A input 6-
3	Return	4	Return	23	A input 7+	24	A input 7-
5	A input 1+	6	A input 1-	25	Return	26	Return
7	Return	8	Return	27	A input 8+	28	A input 8-
9	A input 2+	10	A input 2-	29	Return	30	Return
11	A input 3+	12	A input 3-	31	A output 1	32	A output 2
13	Return	14	Return	33	A output 3	34	A output 4
15	A input 4+	16	A input 4-	35	A output 5	36	A output 6
17	A input 5+	18	A input 5-	37	A output 7	38	A output 8
19	Return	20	Return	39	Return	40	Return

MultiPro+ MC 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

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

Analog Input/Output Specifications

Absolute Maximum Ratings	Min	Max	
Maximum analog input voltage	±15		VDC
Minimum analog output load resistance	2.0		kΩ
Maximum output current			
Precision 10 volt reference output		25	mA
Digital outputs (per output		500	mA
Analog isolation - voltage withstand (one minute duration max.)		1500	volts

Analog Output Specifications	Min	Typ	Max	
Output voltage range	-10.000		10.000	VDC
Output resolution		2.44		mV
Output settling time				
-10.000 to +10.000 V		.2		ms
0 to 5.000 V		.1		ms

Analog Input/Output Specifications (cond.)

Analog Input Specifications	Min	Typ	Max	
Differential input range	-10.000000		+10.000000	VDC
Common mode voltage range	-10		+10	VDC
Input resistance		10		MW
Input resolution (15 bit)		.00305		%FS
Input accuracy (25 °C, 8-sample filtering)		.00305		%FS
Input conversion time (asynchronous)		2.083		ms
Input filter settings (default = 1 sample)	2.083		533.248	ms
Threshold triggering response (Analog input to digital output response)		2.25		ms

Dedicated Digital Output Specifications	Typ	Max		
On voltage (I_o = 500 mA)		.6	1.2	VDC
Off leakage (applied V = 24 VDC)		1	100	µA DC
Maximum output current*			500	mA DC

*All digital outputs are short circuit and over-current protected.

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 (Io = 500 mA)		0.8	1.8	VDC
Output off leakage (applied V = 24 V)[3]		0.01	0.75	µA

Digital Input Specifications	Min	Typ	Max	
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 (Vi = 8 V typ)		-1.0	-1.85	mA
Input off current (typ leakage current allowable)			-250	µA

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.

4. All Power Requirements are worst-case, with all inputs and/or outputs activated.

5. 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	V DC
RS-232 Receivers	3		12	V DC
EtherNet Transceivers (10 Megabit/sec)			1.5	AC PP

Network Performance Specifications	Max	
Host Communications		
Single register transaction from controller[2]	8	ms
16 register read from controller[2]	9 - 12	ms
50 register read from controller[2]	10 - 13	ms
Peer-to-Peer Communications[2]		
Single register transaction from controller	8	ms

Notes:

1. Specifications shown above are at 25° C, unless otherwise noted.

2. With high communications priority active or one task running.

MultiPro+ MC Power Connections

Connecting DC Power

The MultiPro+ MC contains an internal power supply which provides a +5 VDC isolated voltage 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.
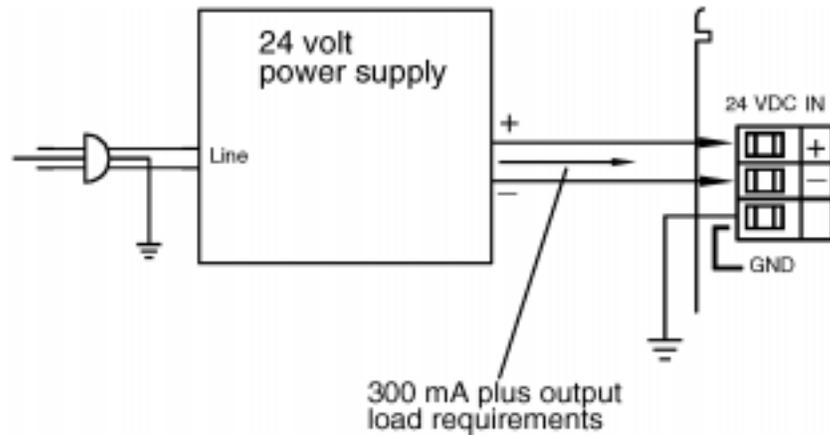
The Importance of Proper Grounding

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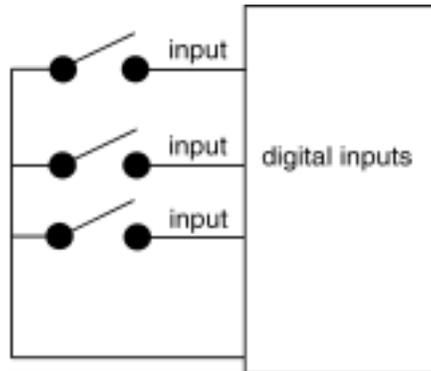
The controller senses when any of the inputs have been pulled down to return by a switch closure, and a Monitor instruction or any other programmed instruction referring to a general-purpose input can use this information.

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.
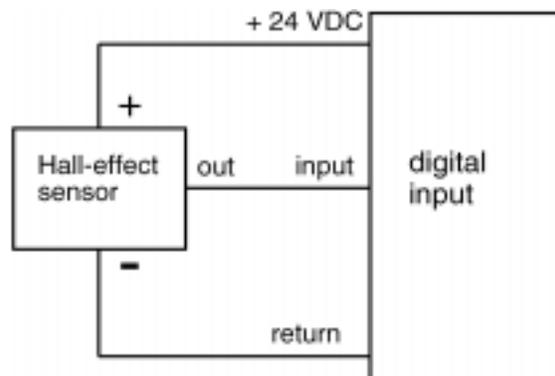
Connecting Digital Outputs

Using Open-collector Outputs

The MultiPro+ MC provides 24 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.
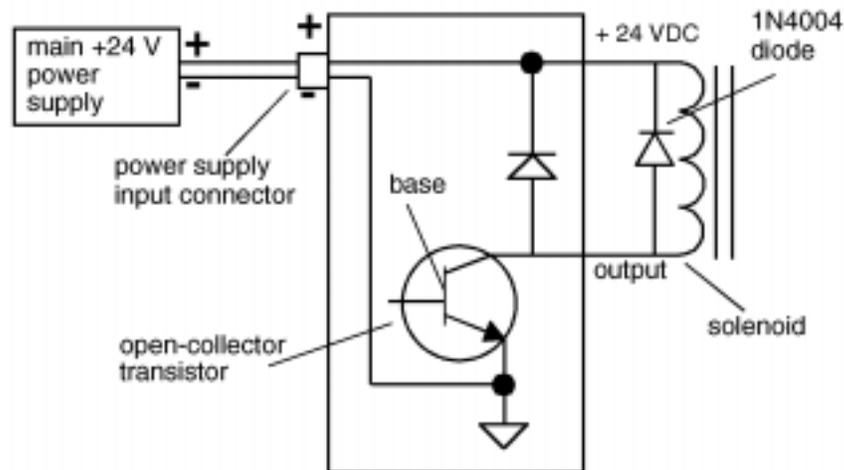
When the output is turned on, current is allowed to flow through the transistor, just as though a switch contact had been closed. The controlled device turns on in response to the flow of current.

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 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.
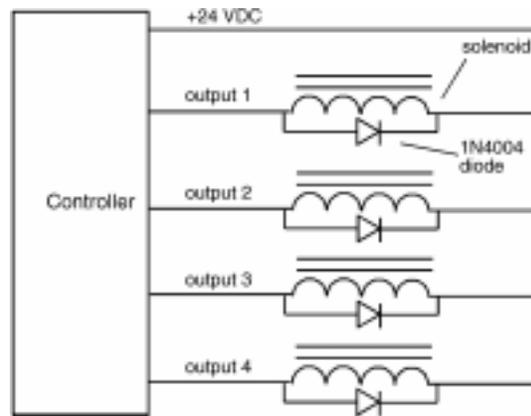

Connecting to a Second External Power Supply

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 to 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.
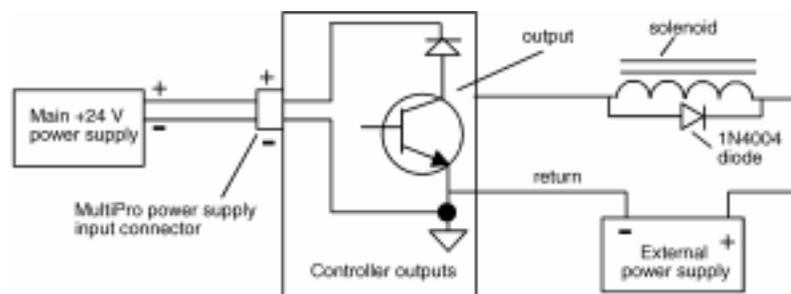
WARNING: Each output has a protection diode with its cathode connected to the + 24 VDC power supply at the input connector. This diode prevents damage to the output when connected to an inductive load. If a separate power supply is used for the external devices, as shown above, a current path exists 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.
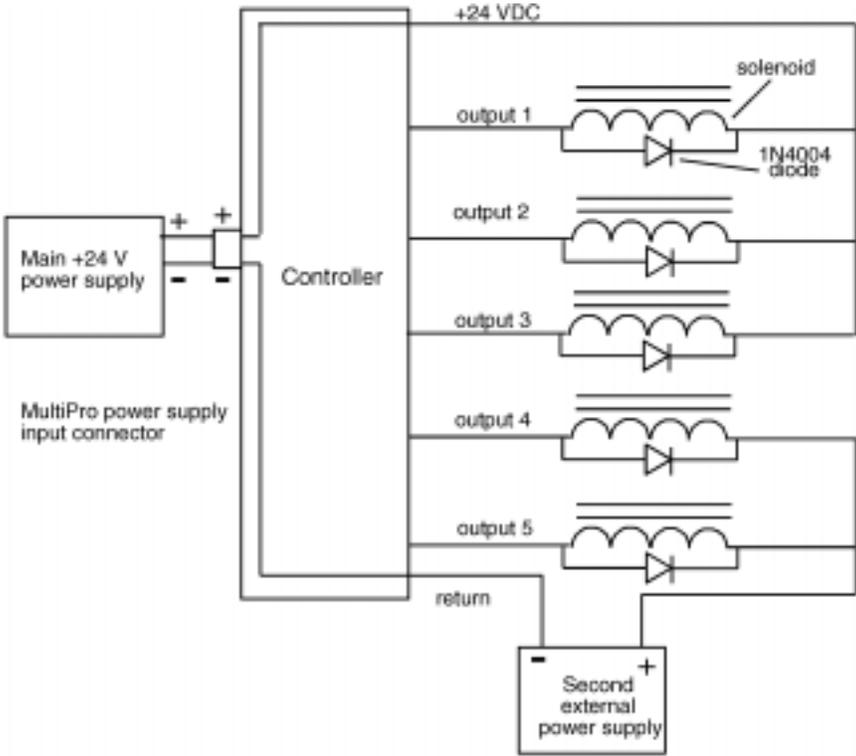
IMPORTANT! Do not use an external power supply with an output voltage greater than the output voltage rating of the outputs.

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.

Connecting and Programming Analog Inputs

Connecting Analog Inputs

All analog inputs are optically-isolated from the controller CPU logic to reduce ground-looping and increase noise immunity. These illustrations show wiring configurations for the following connections:

- A differential signal
- A single-ended signal
- A potentiometer

Connecting a Differential Signal
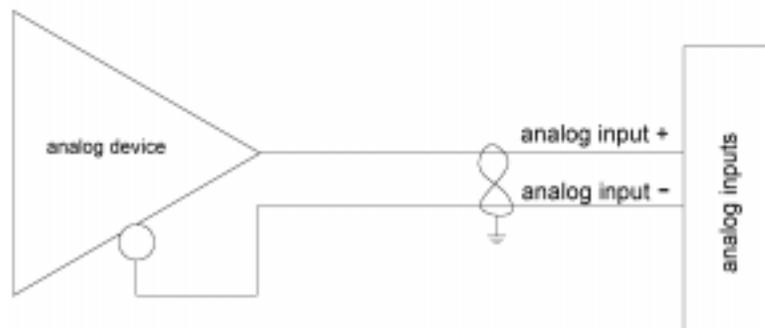
NOTE: All shields are located on the controller side and run to ground.

Connecting a Single-ended Signal
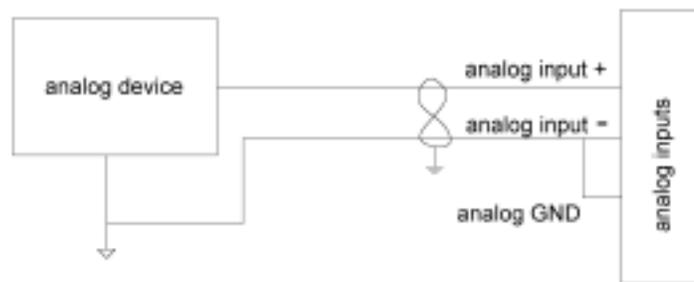
Connecting to a Potentiometer
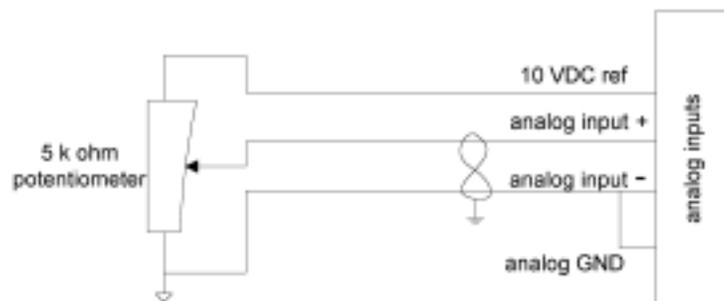
Specifying Digital Filter Length

Registers 18501 - 18508 allow you to specify the digital filter length for the analog inputs on the MultiPro. The value entered in the register specifies the total number of samples taken. The samples are continuously averaged for use in your program. The default value is one, meaning unfiltered. A single sample period for an analog conversion is 2.0833 ms. Control Tech's recommended filter length value is eight (2.0833 * 8 = 16.67 ms or a 60 Hz rate). A digital filter value of 8 or a multiple of 8 helps reject any 60 Hz noise that may be present on your system.

NOTE: The analog inputs perform their operations asynchronously. Larger filter lengths will not effect controller response to other activities.

Setting Up Input Thresholds

Each analog input can be configured to control an associated digital output based on reaching pre-defined setpoints. The digital outputs are mapped one-to-one with the analog inputs. When an analog input reaches a predefined setpoint value, the controller turns the associated digital output on or off.

The setpoints may be dynamically adjusted from the controllers Quickstep program, using CTCMON, or via an operator interface. The dedicated digital outputs are open collector digital outputs and are available for driving DC loads. Each output can handle up to .5 amp load and provides over-current and short circuit protection.

Registers 19001 - 19008 and 19501 - 19508 set the threshold set points for the dedicated digital outputs. The manner in which you use these registers depends on the way you want control the output. For example:

In the following illustration, the first output on the analog module is Off and remains Off until the voltage level on analog input 1 meets or exceeds 6.000 VDC. If the voltage goes lower than 4.000 VDC the output turns back Off. Here the hysteresis area is between 4.000 VDC and 6.000 VDC is to prevent unwanted toggling of the output when the voltage is on the edge of the set point.
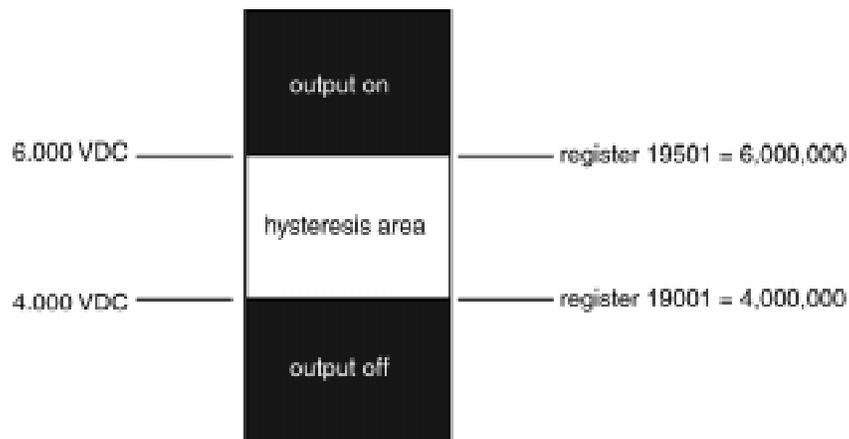
In this example, the first output on the analog module will be OFF and remain off until the voltage level on analog input#1 meets or exceeds 6.000 VDC. If the voltage then lowers to less than 4.000VDC the output will turn back OFF. Here the hysteresis area is between 4.000VDC and 6.000VDC to prevent unwanted toggling of the output when the voltage is on the edge of the set point.
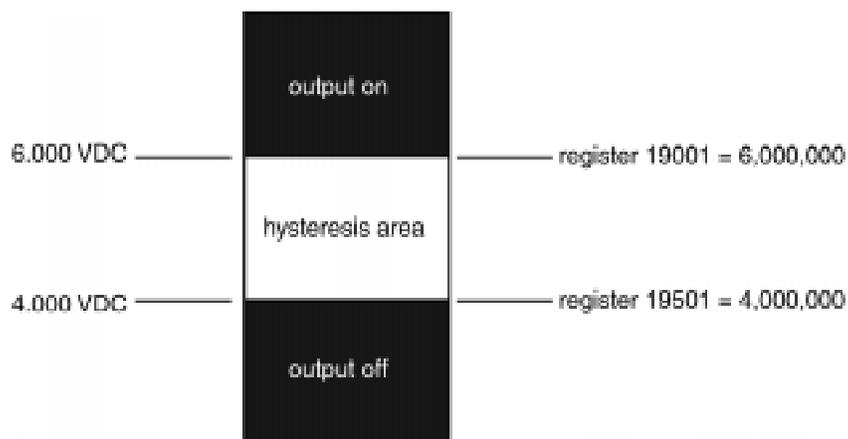
The following example configures analog input 1. When the value exceeds 3.000000 VDC, digital output 1 turns on. When the analog input value falls below 2.500000 VDC, the output turns off. Since the analog inputs have their own CPU, this process is handled locally and is not subject to the Quickstep program's execution time.

```
[10] DIGITAL_OUTPUT_THRESHOLDS
     ;;;
     ;;; Register 19001 sets the minimum threshold for analog
     ;;; input 1 as 2.500000. Register 19501 sets the maximum
     ;;; threshold for analog input 1 as 3.000000.
     ;;;
     ─────────────────────────────────────────────────
     <NO CHANGE IN DIGITAL OUTPUTS>
     ─────────────────────────────────────────────────
     store 2500000 to Reg_19001
     store 3000000 to Reg_19501
     goto next
```

Your Quickstep program can check the status of the output at any time. Registers 18001 - 18008 give you access to the dedicated outputs. These registers are both read and write accessable. A value of zero indicates that the output is off, and a one indicates that it is on. You can use an IF instruction to see when an output is on or off. You can also turn the output on or off by storing a zero or one to the approriate register.

The following example, goes to the next step when dedicated output 1 is on.

```
[56] CHECK_DEDICATED_OUTPUT
     ;;;
     ─────────────────────────────────────────────────
     <NO CHANGE IN DIGITAL OUTPUTS>
     ─────────────────────────────────────────────────
     if Reg_18001=1 goto next
```

The following example turns on dedicated output 3 and turns off output 8.

```
[446] CHANGE_DEDICATED_OUTPUTS
    ;;;
    _____-
    <NO CHANGE IN DIGITAL OUTPUTS>
    _____-
    store 1 to Reg_18004
    store 0 to Reg_18008
    goto next
```

Disabling the Thresholding Feature

To disable the tresholding feature, store a number greater than 10,000,000 to register 19501 (for analog input 1) to register 19508 (for analog input 8) and store a number less than -10,000,000 to register 19001 (for analog input 1) to register 19008 (for analog input 8).

Alternate Access to Analog Inputs

Registers 8501-8508 provide alternate access to the analog inputs. All values are expressed in millivolts and can range from -10,000,000 to +10,000,000 (-10 to +10 VDC). The following example checks the value on an analog input and proceeds to the next step if the value is greater than 9.150000 VDC:

```
if Reg_8504>9150000 goto next
```

Connecting and Programming Analog Outputs

Connecting Analog Outputs

The MultiPro has eight bipolar (±10 volts) analog outputs with a resolution of 13 bits. The following illustration shows the wiring configurations for an analog output:
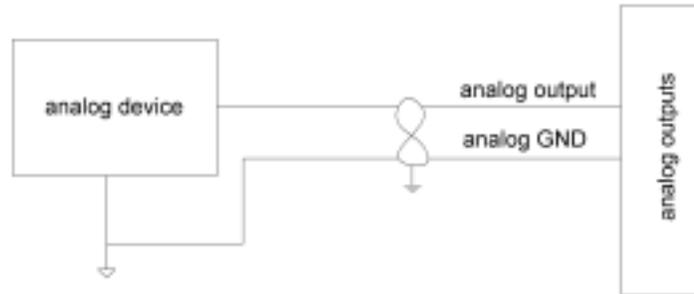
NOTE: All shields are located on the controller side and run to ground.

Alternate Access to Analog Outputs

Registers 8001-8008 provide alternate access to the analog outputs. The following examples check the value on an analog output and change the value of an output. All values are expressed in millivolts.

The following example checks the value of analog output 1 and proceeds to the next step when the value is reached:

```
if Reg_8001 > 1259 goto TURN_OFF_VALVE
```

This example has the controller send 4.500 VDC out analog output 6.

```
store 4500 to Reg_8006
```

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.
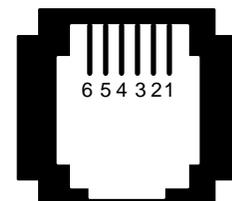
1 – +5*

2 – TxD outbound

3 – Common

4 – Common

**5 – RxD inbound**

6 – +5 return*

*COMM 1 only

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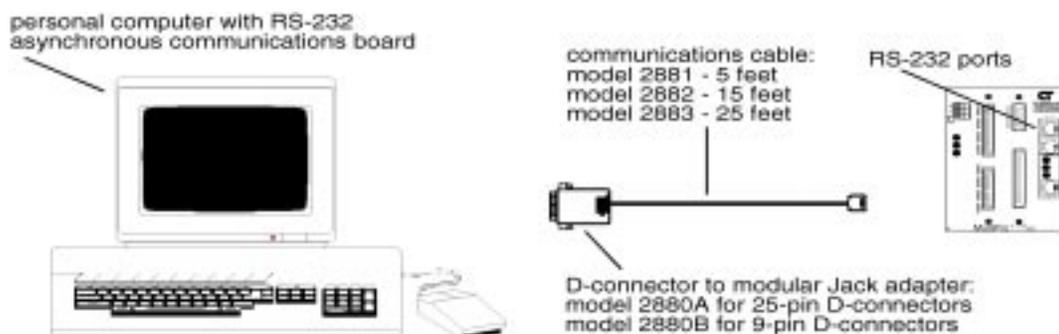
Control tech has adapters available that connect directly to a male 25-pin (Model 2880A) or 9-pin (2880B) D connector. These adapters provide a modular jack wired for compatibility with the COMM port. To be fully compatible when using this adapter, the computer's communications port should be wired as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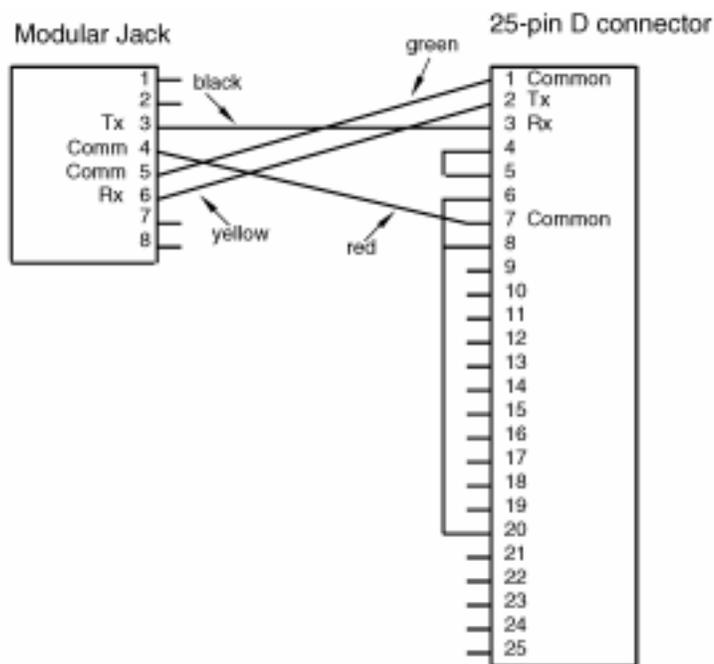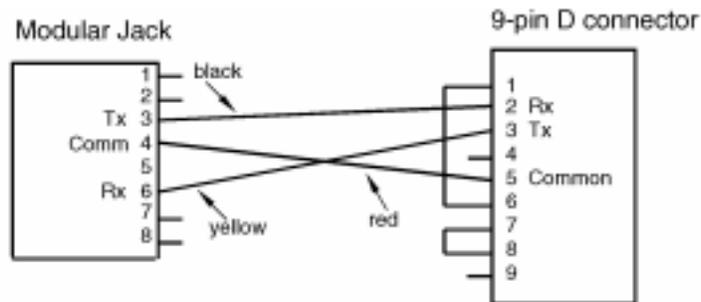
Setting-up Ethernet Controller Communications

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:
    - — Global and group broadcasting
    - — Individual controller read/write capability
    - — Downloading/uploading Quickstep programs
    - — Access to all controller resources
- Peer-to-peer communications offering indirect node access
- Built-in controller security from network
- 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