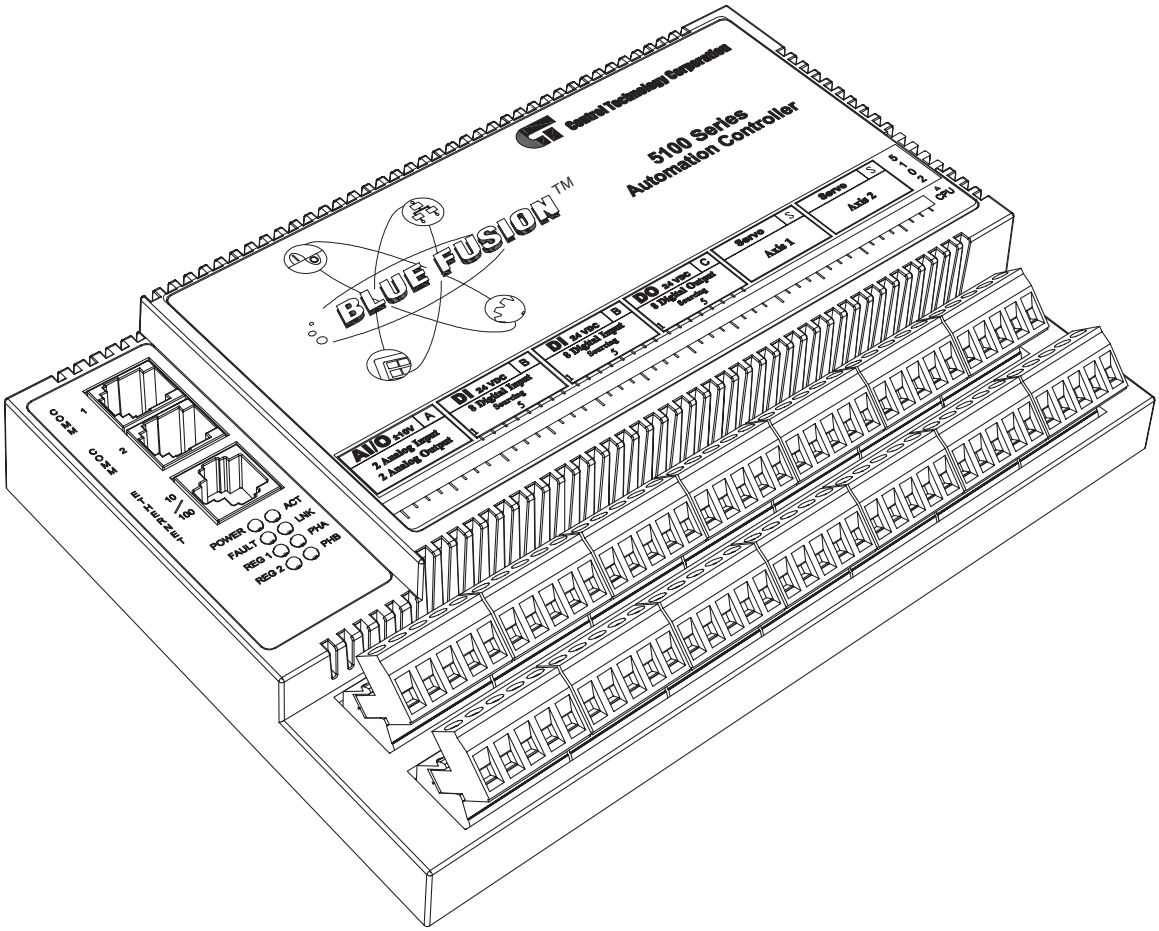
# Model 5100 Series Automation Controller Installation Guide




Doc. No. 5100IG
Revision C
April 2002

The following are trademarks of Control Technology Corporation:

- Quickstep
- CTC Monitor
- CTC Utilities

Windows is a trademark of Microsoft Corporation.

# Contents


Notes to Readers ..... 1
- Related Documents ..... 2
- Formatting Conventions ..... 2
- Contacting Control Technology Corporation ..... 3
- Your Comments ..... 3

System Overview ..... 5
- Easy Installation ..... 5
- Ethernet Connectivity ..... 5
- I/O, Motion Control, and UI Integration ..... 5

Dimensions and Mounting Considerations ..... 6

Model 5100 Description ..... 9

Wiring Diagrams ..... 10

Specifications ..... 12

Connecting Power to the Controller ..... 16
- The Importance of Proper Grounding ..... 16
- The Controller's Power System ..... 16
- Using External Power Supplies ..... 16

Status Light Description ..... 17
- Software Fault ..... 17
- Hardware Fault ..... 17

Computer – Controller Communications ..... 18
- RS-232 Communications ..... 18
- RS-232 Connections ..... 18
- Connecting to a D Connector ..... 19
- Using Ethernet for Controller Communications ..... 20
- Ethernet Protocol ..... 20
  - 10Base-T ..... 20
  - 100Base-T (Fast Ethernet) ..... 20
  - Network Specifications ..... 20
  - Host Communications ..... 21

This page is intentionally left blank.

# Notes to Readers

The *Model 5100 Installation Guide* provides the following information:

- System Overview – describes the various 5100 configurations.
- Dimensions and Mounting Considerations – mounting dimensions and precautions on mounting the 5100.
- CPU Description – provides details on the faceplate and describes the distribution board and how it connects to the CPU.
- Wiring Diagrams – pinout diagrams for the various connectors residing on the distribution board and on the CPU; on-board I/O mapping information.
- Specifications – general and electrical specifications; hardware and firmware revisions for the 5100.
- Power Connections – connecting power to the controller.
- Status Lights – how the status lights function.
- Computer – Controller Connections – describes the controller's RS-232 ports and Ethernet port.

## 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 controller registers, refer to the *Register Reference Guide* (available at www.ctc-control.com).
- For information on Microsoft Windows or the 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, and installation program names. |
| **Boldface** | Indicates information to be entered, an action to be performed, or a selection to be made 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 name of Quickstep instructions in text. |
| `Courier font` | Identifies step names, comments, output changes, and Quickstep instructions appearing in the Quickstep editor. |
| Art Code 2217F1 | Identifies the file name of a particular graphic image. |

## Contacting Control Technology Corporation

Control Technology Corporation is located in Massachusetts. Our business hours are 8:30 AM to 5:00 PM. EST (Eastern Standard Time).

| Contact Method | Address or Number |
|---|---|
| **E-Mail:** | |
| Technical Support: | help@ctc-control.com |
| Technical Publications: | techpubs@ctc-control.com |
| **Website:** | www.ctc-control.com |
| **Telephone:** | 508.435.9595 and 800.282.5008 |
| **FAX:** | 508.435.2373 |
| **Mail:** | Control Technology Corporation<br>25 South Street<br>Hopkinton, MA 01748 |

## Errata Sheets

Refer to the Support area of Control Technology's web site (www.ctc-control.com) for any errata information on this product.

## Your Comments

Suggestions and comments about this or any other Control Tech document can be e-mailed to the Technical Publications Group at techpubs@ctc-control.com.

This page is intentionally left blank.

# System Overview

The Model 5100 Series is part of Control Technology Corporation's Blue Fusion family of automation controllers and is available in multiple configurations. Its flexible architecture can accommodate up to 6 modules in its internal module bays. Analog and digital I/O modules fit into a single bay and motion control modules require two bays.

**Note**

Modules are only installed during the controller fabrication process and are not configurable in the field.

## Easy Installation

The 5100's compact footprint (8.3" x 5.7") allows it to easily fit into cramped system designs. You can snap it onto a DIN rail or use optional mounting ears to install it on a flat surface such as a NEMA-rated electrical enclosure. Pluggable terminal blocks ease repetitive wiring duties by providing a quick disconnect.

## Ethernet Connectivity

A built-in 10/100Base-T Ethernet connector supports various network protocols (TCP/IP, UDP, CTNET, and ModBus TCP) and puts your devices on the Web over secure connections. Refer to *Wiring Diagrams* for information on how this connector is wired.

## I/O, Motion Control, and UI Integration

The 5100 can integrate digital and analog I/O points and up to 6.5 axes of servo or stepper control. Its two serial ports are available for HMIs (human-machine interfaces), programming interfaces, or other serial devices.

Program the 5100 controller with CTC's state programming language, Quickstep™ for Windows™. You can run all programming and diagnostic functions for the controller from your PC with an RS-232 interface or Ethernet communications.

The 2-axis servo motion controller provides precise control of two servo motors by adding a high-performance motion coprocessor in each module. Servo position loop rates are maintained at 250 µs per axis with encoder feedback rates up to 6 MHz without impacting other controller operations. Each module also contains two high-speed inputs that latch encoder position within 1 encoder count for precise registration. Axes can operate independently or can be electronically geared to other axes or the master encoder within the 5100 controller. The servo motion controller also interfaces directly with velocity or torque drives through 16-bit ± 10 V commands.

# Dimensions and Mounting Considerations

The Model 5100 Automation Controller can be mounted by snapping it onto a DIN rail or by using the mounting ears to install it on a flat surface such as a NEMA-rated electrical enclosure. Figures 1 and 2 show the controller's dimensions. 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. Avoid conductive dusts, liquids, or condensing humidity. If any of these conditions exist, mount the 5100 in a NEMA 4 or NEMA 12 rated enclosure.
- Do not mount the 5100 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.

**Figure 1. 5100 Dimensions (1 of 2)**

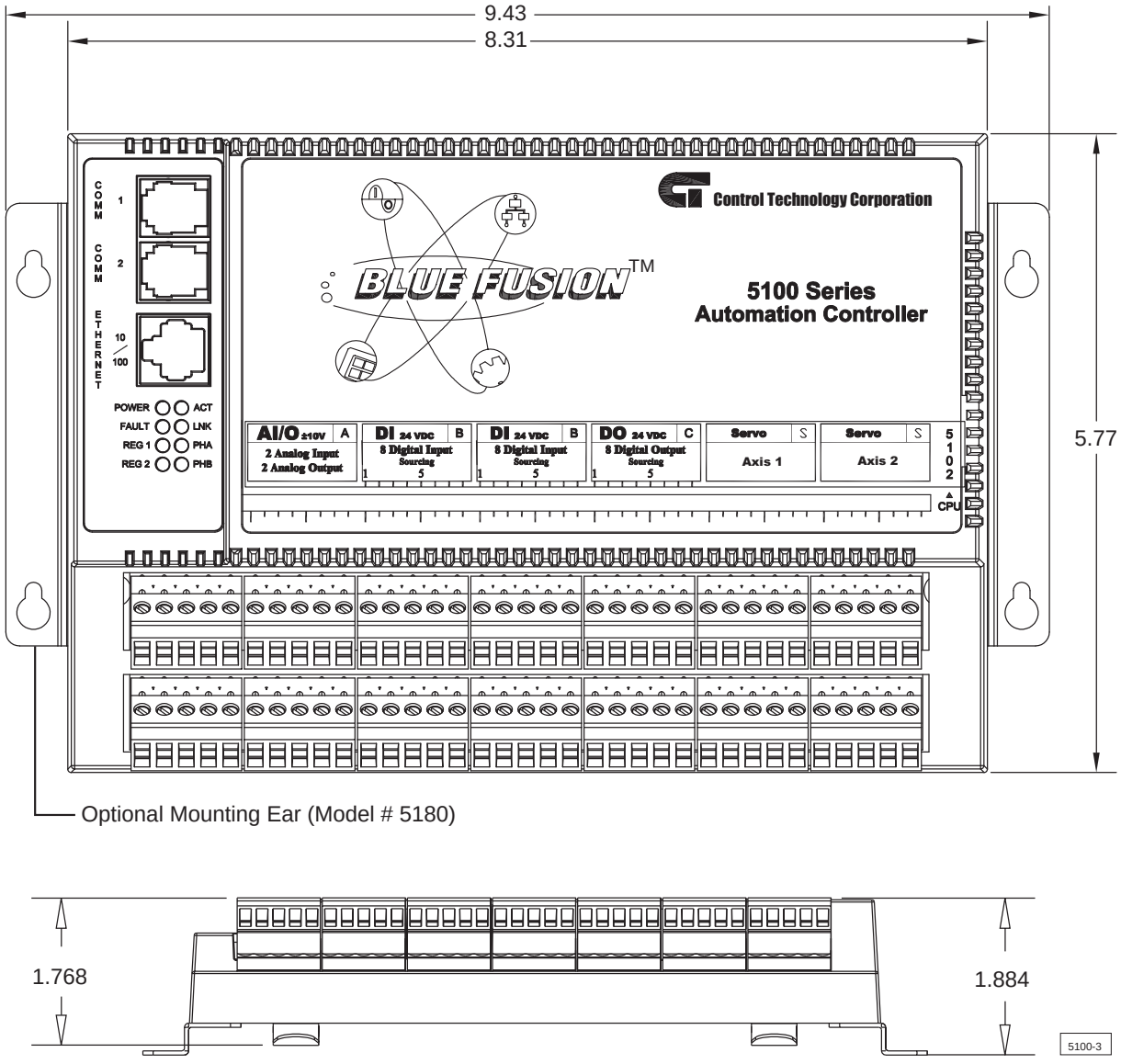
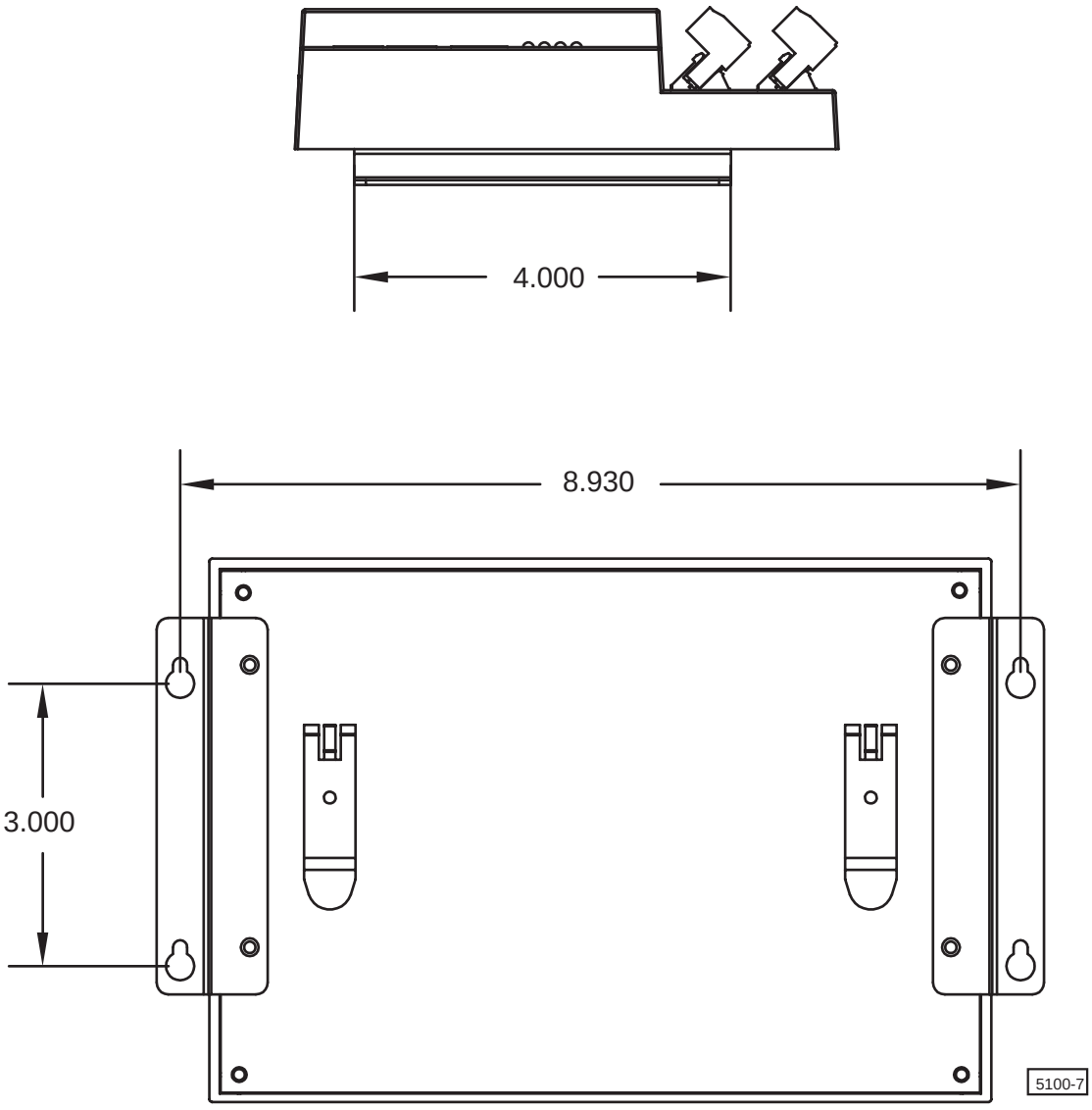
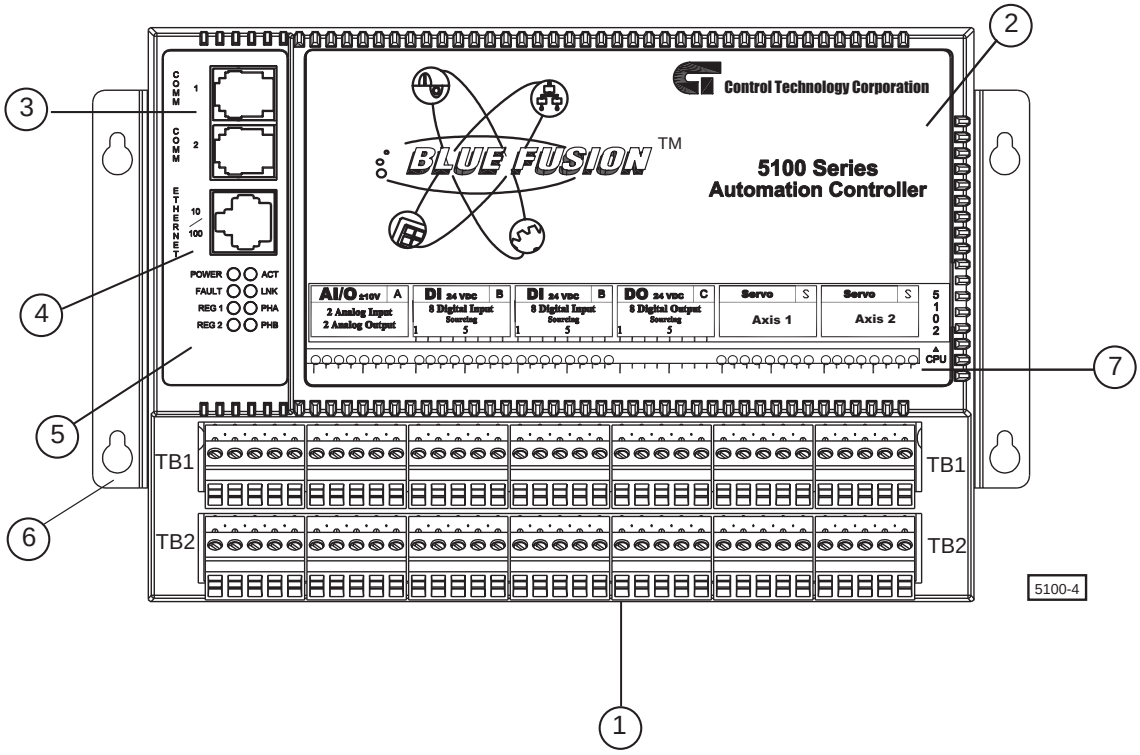


**Figure 2. 5100 Dimensions (2 of 2)**



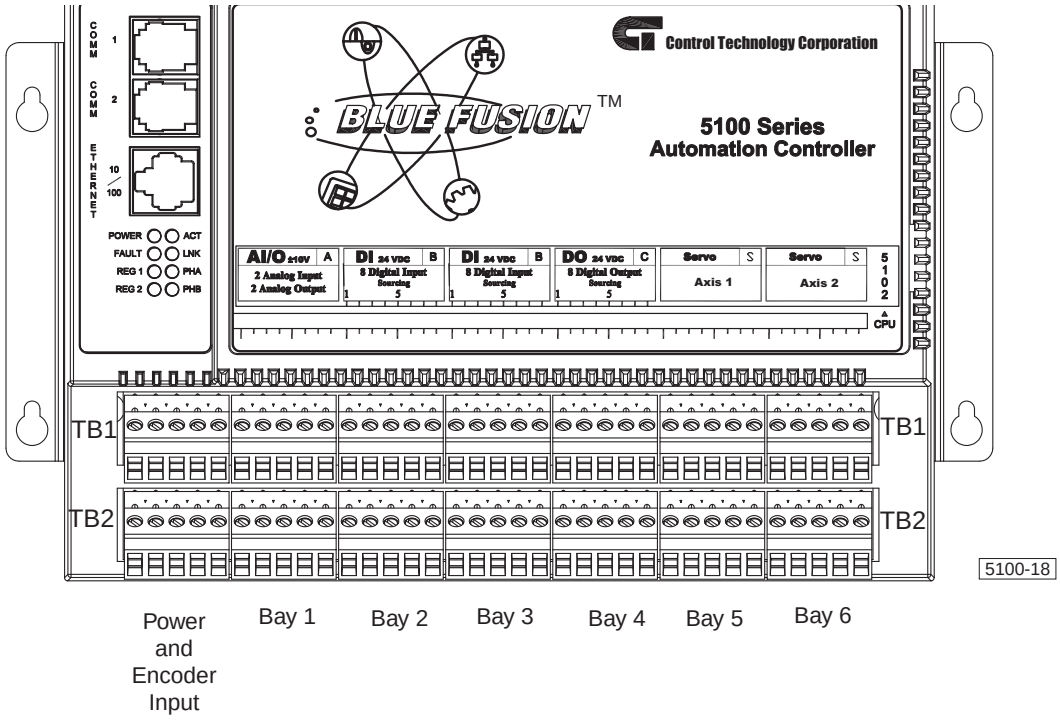
# Model 5100 Description

**Figure 3. Model 5100 Faceplate**

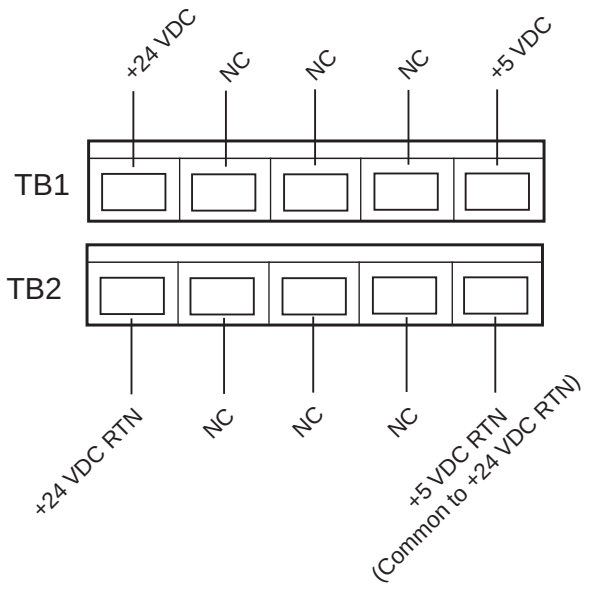



| Callout Number | Description |
|---|---|
| 1 | **Terminal block interface**: Removable terminal blocks connect to the controller's internal module bays and eliminate the need for cables and breakout blocks. The top terminal block is TB1 and the bottom block is TB2 for each location. |
| 2 | **Internal module bays**: There are 6 internal module bays that can hold any combination of I/O and Motion Control modules. I/O modules occupy 1 bay and Motion Control modules occupy 2 bays. |
| 3 | **Dual RS-232 ports**: Provides both programming and data communications with a PC by using Quickstep and CTCMON; compatible with CTC's 2881-2883 communications cables and with the cable supplied with Quickstep. Refer to the RS-232 pinout diagram in *Wiring Diagrams* for more information. |
| 4 | **10/100Base-T connector**: Provides Ethernet communications and contains auto-sensing circuitry that automatically detects the speed of an Ethernet network when a cable is plugged into it. |
| 5 | **CPU status LEDs**: Provide quick diagnostics for the master encoder, Ethernet, and high-speed inputs; indicate when power is applied to the controller; display a hardware or software fault. |
| 6 | **Optional Mounting Ear (Model # 5180):** Alternative method of mounting the controller that allows you to install the controller on a flat surface such as a NEMA-rated enclosure. |
| 7 | **Module I/O status LEDs**: Provide visual I/O indicators at each connection point. |

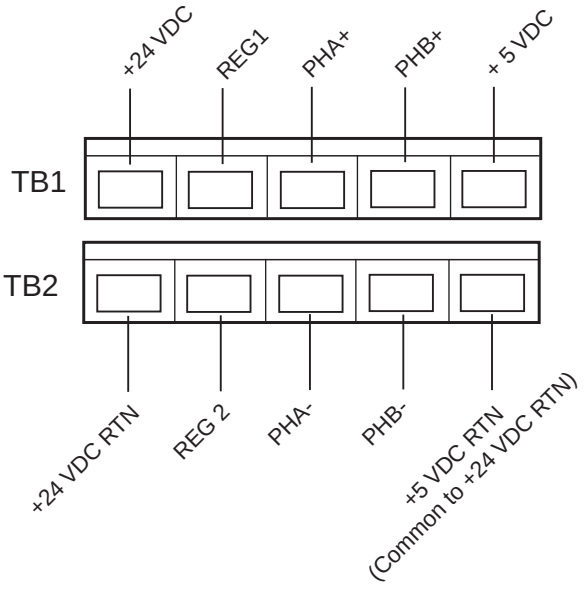
# Wiring Diagrams




Power Input Connector (Model 5101)




Power Input / Encoder Connector (Model 5102)



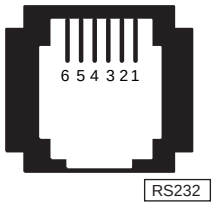
## Table 1. Power Input Connections (Model 5101)

| Signal Name | LED Name | Terminal Block # | Signal Name | LED Name | Terminal Block # |
|---|---|---|---|---|---|
| +24 VDC | | TB1-1 | NC | | TB2-3 |
| +24 VDC Return | | TB2-1 | NC | | TB1-4 |
| NC | | TB1-2 | NC | | TB2-4 |
| NC | | TB2-2 | NC | | TB1-5 |
| NC | | TB1-3 | NC | | TB2-5 |

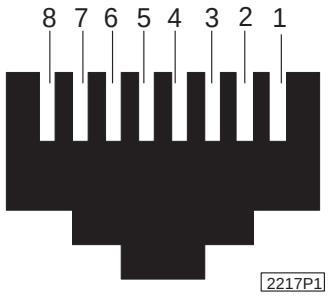
## Power Input / Encoder Connections (Model 5102)

| Signal Name | LED Name | Terminal Block # | Signal Name | LED Name | Terminal Block # |
|---|---|---|---|---|---|
| +24 VDC | | TB1-1 | PHA- | PHA | TB2-3 |
| +24 VDC Return | | TB2-1 | PHB+ | PHB | TB1-4 |
| REG1 | REG 1 | TB1-2 | PHB- | PHB | TB2-4 |
| REG2 | REG 2 | TB2-2 | +5 VDC | | TB1-5 |
| PHA+ | PHA | TB1-3 | +5 VDC Return | | TB2-5 |

## Table 2. RS-232 Connector

| RS-232 Drawing | Pin # | Signal |
|---|---|---|
|   | 1 | Not Used |
| | 2 | TxD Outbound |
| | 3 | Common |
| | 4 | Common |
| | 5 | RxD Outbound |
| | 6 | Common |

## Table 3. Ethernet Connector

| 10/100Base-T Connector | Pin # | Signal |
|---|---|---|
|   | 1 | TX0+ |
| | 2 | TX0- |
| | 3 | RX1+ |
| | 4 | NC |
| | 5 | NC |
| | 6 | RX1- |
| | 7 | NC |
| | 8 | NC |

# Specifications

**Note**

All specifications are at 25°C unless otherwise specified.

## Table 4. Controller Specifications

| Description | Min. | Typical | Max. | Units |
|---|---|---|---|---|
| **Absolute Maximum Ratings** | | | | |
| Ambient Temperature | | | | |
| Operating | 0 | | +50 | °C |
| Storage | -20 | | +80 | °C |
| Applied input voltage | 18.0 | 24.0 | 27.0 | VDC |
| Applied output voltage | 0 | | 24.0 | VDC |
| Current requirement (5 V) | | 0.4 | 0.6 | A |
| **Digital Input Specifications** | | | | |
| Input off voltage ($I_i$ = 0 mA) | 0 | | | VDC |
| Input on current ($V_i$ = 24 V) [1] | | 1.2 | 1.5 | mA DC |
| Input on current threshold ($V_i$ = 16 V typical) | | .8 | .9 | mA DC |
| Input off current (typical leakage current allowable) | | | 250 | µA DC |
| **Digital Output Specifications** | | | | |
| Output on voltage ($I_o$ = 350 mA) [2] | | 22.8 | 23.0 | VDC |
| Output current | | | 350 | mA DC |
| Total limit per controller | | | 3 | A DC |
| Output off leakage (applied voltage = 24 VDC) [3] | | 1.0 | 100.0 | µA DC |
| **Analog Input Specifications** | | | | |
| Differential input range (full scale) | -10.000 | | +10.000 | VDC |
| Common mode voltage range | -10 | | +10 | VDC |
| Input resistance | 10 | | | MΩ |
| Input resolution (14-bit) | | .0061 | .012 | %FS |
| Input accuracy (25°C, 8-sample filtering) | | .0061 | .012 | %FS |

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.

## Table 4. Controller Specifications (Continued)

| Description | Min. | Typical | Max. | Units |
|---|---|---|---|---|
| Input settling time | | | | |
| 1 least significant bit | | 1.64 | | ms |
| -10 V to +10 V | | | 52.5 | ms |
| **Analog Output Specifications** | | | | |
| Output voltage range | -10.000 | | +10.000 | VDC |
| Output resolution | | 2.44 | | mV |
| Output settling time | | | | |
| -10.000 to +10.000 V | | | 3.28 | ms |
| 0 to +5.000 V | | | 1.64 | ms |
| **Controller Characteristics** | | | | |
| User memory capacity<br>(4 years unpowered lithium-cell RAM)<br><br>*The main CPU is an Hitachi SH2 processor running at 24.576 MHz.* | | 128K | | Bytes |
| **Communications Characteristics** | | | | |
| RS-232 transmitters | | ± 5 | ± 10 | VDC |
| RS-232 receivers | ± 3 | | ± 10 | VDC |
| Common mode voltage range | -10 | | +10 | VDC |
| Ethernet Transceivers (10/100 Megabits/sec) [4] | | | 1.5 | VAC PP |
| **Encoder Specifications** | | | | |
| Encoder supply voltage | 0.0 | 5.0 | 5.25 | VDC |
| Encoder supply output current | | | 150 | mA |
| Differential encoder input | | | | |
| Nominal input range | 0.0 | 5.0 | | VDC |
| Open circuit voltage ($I_i$ = 0 mA) | | 5.0 | 5.38 | VDC |
| Logic low current ($V_i$ = 0 V) | | 1.1 | 1.2 | mA |
| Maximum on-board data rate | | | 3 | MHz |

4. This conforms to IEEE Standard 802.3.

## Table 4. Controller Specifications (Continued)

| Description | Min. | Typical | Max. | Units |
|---|---|---|---|---|
| **Registration Input Specifications** | | | | |
| Off voltage ($I_i$ = 0 mA) | | 24.0 | 26.4 | VDC |
| On current ($V_i$ = 0 V) | | 1.2 | | mA |
| Threshold | | | | |
| low-to-high | | 16 | | VDC |
| high-to-low | | 15 | | VDC |
| **Servo Specifications** [5] | | | | |
| Command outputs | | | | |
| Nominal voltage range | -10 | | +10.0 | VDC |
| Resolution (16-bit) | | 305 | | µV |
| Maximum velocity setting | 1 | | 6,000,000 | pulses/s |
| Resolution of maximum velocity | 1 | | | pulses/s |
| Acceleration and deceleration settings | 1 | | 130,000,000 | pulses/s$^2$ |
| Resolution of acceleration and deceleration settings | 1 | | | pulses/s$^2$ |
| Position range (absolute mode) | -2,147,483,648 | | 2,147,483,647 | steps |
| Relative motion command range | -2,147,483,648 | | 2,147,483,647 | steps |
| **Controller Resource Summary** | | | | |
| Multi-tasking (tasks) | | | 84 | |
| Volatile registers (32-bit) | | | 500 | |
| Non-volatile registers (32-bit) | | | 4000 | |
| Data table elements (16-bit, non-volatile) | | | 16000 | |
| Input-linkable counters | | | 8 | |
| Flags | | | 32 | |
| Program steps | | | 4096 | |

5. The term *step* refers to one edge transition on either encoder input for that axis.

## Table 4. Controller Specifications (Continued)

| Description | Min. | Typical | Max. | Units |
|---|---|---|---|---|
| **Controller Capacities (5101)** [6] | | | | |
| Module slot capacity | | | 6 | |
| Digital inputs | | | 48 | |
| Digital outputs | | | 48 | |
| Analog inputs | | | 12 | |
| Analog outputs | | | 12 | |
| Servo motor axes | | | 6 | |
| Ethernet ports | | | 1 | |
| RS-232 channels | | | 2 | |
| Master encoders | | | 0 | |
| **Controller Capacities (5102)** [6] | | | | |
| Module slot capacity | | | 6 | |
| Digital inputs | | | 50 | |
| Digital outputs | | | 48 | |
| Analog inputs | | | 12 | |
| Analog outputs | | | 12 | |
| Servo motor axes | | | 6.5 | |
| Ethernet ports | | | 1 | |
| RS-232 channels | | | 2 | |
| Master encoders | | | 1 | |

6. Controller capacities are not mutually inclusive. You cannot operate resources at full capacity at the same time.

## Table 5. Hardware / Firmware Revision Levels

| Model Numbers | Hardware Revision Level | Firmware Revision Level [1] [2] |
|---|---|---|
| 5100 | 0 or greater | 4.0 |

1. You can confirm firmware revision levels by doing a register read in Quickstep's monitor program. Use register 13003 to confirm the firmware revision in a MultiPro controller.
2. Firmware revision levels are not equivalent to standard decimal numbers. For example, firmware revision level 2.10 translates to:

   Major Revision Level 2
   Minor Revision Level 10

   If this value changes to 2.20, it translates to:

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

# Connecting Power to the Controller

This section provides general guidelines on connecting power to the 5100 controller.

## 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 *Technical Note No. 26, Reducing Noise Susceptibility,* which is available in the Customer Support area of our web site at www.ctc-control.com.

## The Controller's Power System

The controller's power system has two operating voltages that are electrically isolated from one another:

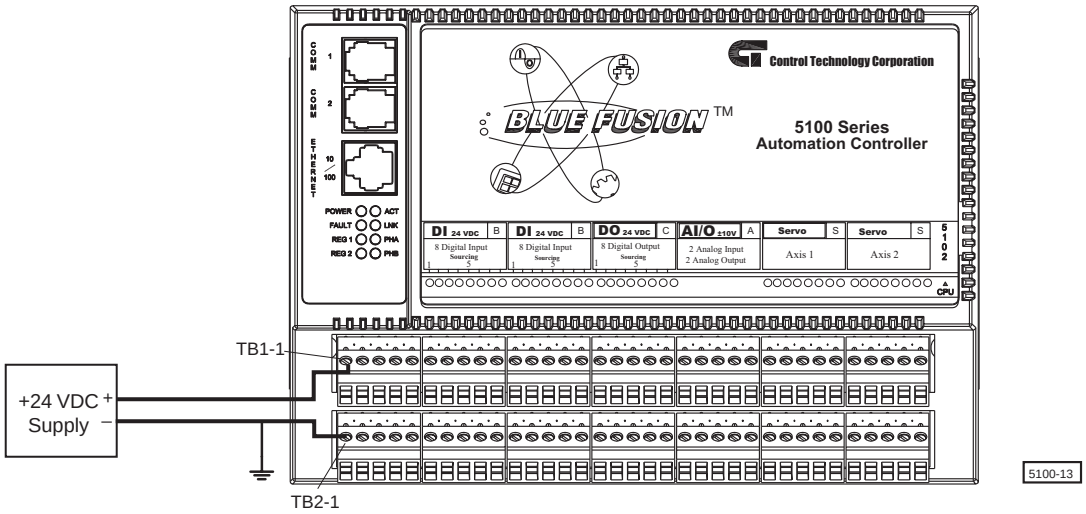
- **+5 VDC** – supplies power to the controller's internal circuitry, the CPU, and the logic-level circuitry on the various modules.
- **+24 VDC** – supplies power to circuitry on the outbound side of any on-board isolation.

The +5 V supply is not usually available at any of the module connectors.

## Using External Power Supplies

Figure 4 shows how to connect an external power supply to the 5100 controller.

**Figure 4. External Power Supply**



# Status Light Description

The status light on the Model 5100 is used to indicate a software or hardware fault (Figure 5). These faults are described below.

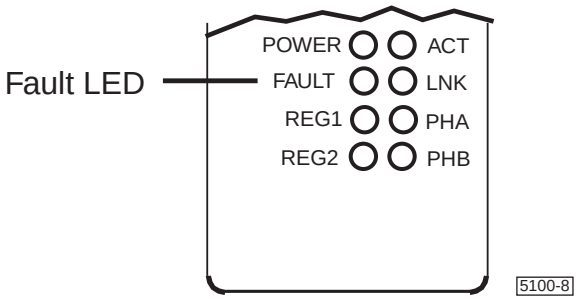
**Note**

After the controller 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 CPU 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.

**Figure 5. Fault LED Location on Faceplate**




**Note**

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 green light and indicate that the internal watchdog timer has disabled the controller's CPU. When this occurs, the controller's outputs are also disabled. Try clearing a hardware fault by cycling the power and/or downloading the same Quickstep program. If the fault continues, your controller may require repair. Contact our Technical Support representative for assistance.

# Computer – Controller Communications

The controller can communicate with a computer or with other controllers through one of its RS-232 ports or through its Ethernet connector.

## RS-232 Communications

The controller's RS-232 ports allow the following activities:

- **Direct communications between a PC and the controller** - This feature enables you to directly interact with many of the controller's resources such as registers, inputs, outputs, and flags without modifying the controller's program.
- **Monitoring** - You can monitor a controller's activity through an RS-232 port with CTCMON.
- **Host configuration** - The 5100 is configurable as a host that can support communications with other external peripherals such as operator interface terminals, bar-code readers, printers, and other controllers. Refer to *Technote No. 30, ASCII Message Transmitting with CTC Controllers*, which is available in the Support section of our web site at www.ctc-control.com.

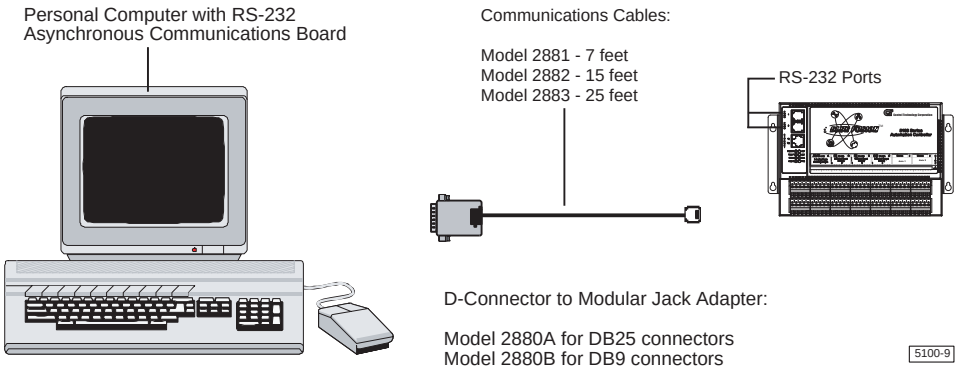
### Note

For more information on data communications and the DLL functions required to communicate with the controller, refer to the *CTC 32-Bit Data Communications Functions Reference Guide,* which is available in the Support area of our web site at www.ctc-control.com.

## RS-232 Connections

Connect to the RS-232 ports through one of the modular jacks on the controller (labeled COMM1 and COMM2). These jacks carry the receive signal, two commons (ground), and the transmit signal for the communications channel. The pin connection diagram in Table 2 illustrates the wiring of the jack. Standard Control Technology cables are available for connecting to this jack (Figure 6). As an alternative, many commonly available telephone cables may be substituted.

**Figure 6. Communications and Cable Connections**



## Connecting to a D Connector

RS-232 ports on computers are usually configured through 25-pin (DB25) or 9-pin (DB9) D-type connectors. Most PC manufacturers use standard wiring on these connector types. Control Technology has adapters available that connect directly to a male DB25 (Model 2880A) or DB9 (Model 2880B) connector. These adapters have a modular jack that is wired for compatibility with the COMM ports. To ensure full compatibility with these adapters, you should wire the computer's communications port as a DTE (Data Terminating Equipment) device.

### Note

Do not connect the 5100 to a telephone line.

Figures 7 and 8 show computer-controller connections using an RS-232 connection and DB25 and DB9 connectors.

**Figure 7. DB9 Connections**

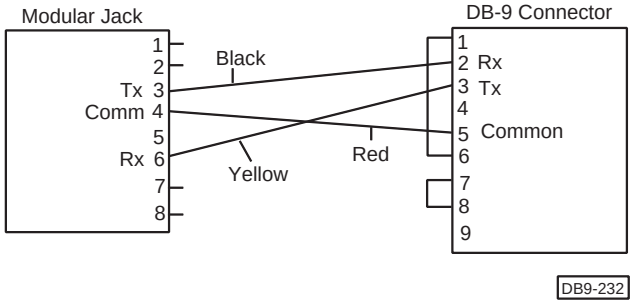
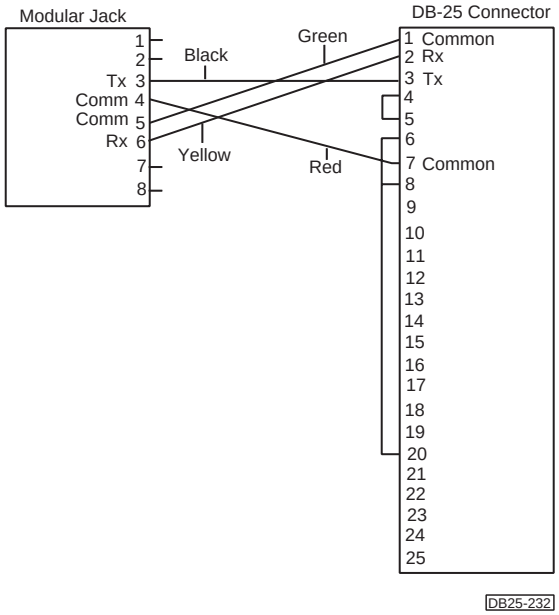



**Figure 8. DB25 Connections**



## Using Ethernet for Controller Communications

The 5100 has a 10/100Base-T connector that conforms to IEEE standard 802.3. This section discusses the Ethernet protocol and illustrates a typical network configuration. Wiring information for the Ethernet connector is listed in Table 3 and performance specifications are listed in Table 4.

## Ethernet Protocol

Ethernet is defined by the IEEE 802.3 standard and is the most widely used local area network (LAN) access method. Data packets are transmitted over twisted pair cable using the carrier sense multiple access with collision detection (CSMA/CD) algorithm until they arrive at their destination without any collisions. Ethernet nodes on a segment share the bandwidth, which is 10 MBps (Ethernet), 100 MBps (Fast Ethernet), or 1000 MBps (Gigabit Ethernet). The 5100 module has an Ethernet port that allows it to communicate over an Ethernet network using 10Base-T or 100Base-T connections. Auto-sensing circuitry automatically detects the transmission rate on the network when a cable is plugged into the port.

### 10Base-T

This connection type uses unshielded twisted pair (UTP) cabling and standard RJ-45 connectors. 10Base-T uses Category 3 (or higher) cables. Higher category numbers provide greater protection from outside electrical interference. CTC recommends using Category 5 UTP cable.

### 100Base-T (Fast Ethernet)

Fast Ethernet (IEEE 802.3u) is traditional CSMA/CD at 100 MBps over UTP cables. Because its design is based on the 10Base-T standard, it can be easily incorporated into existing networks. Three media types are supported:

- **100Base-TX** - 2 pairs of Category 5 UTP cable and an RJ-45 connector.
- **100Base-T4** - 4 pairs of Category 3-5 UTP cable.
- **100Base-FX** - multimode fiber-optic cable; primarily used on backbones.

Because 100Base-TX resembles 10Base-T so closely, it is the most popular type of Fast Ethernet connection.

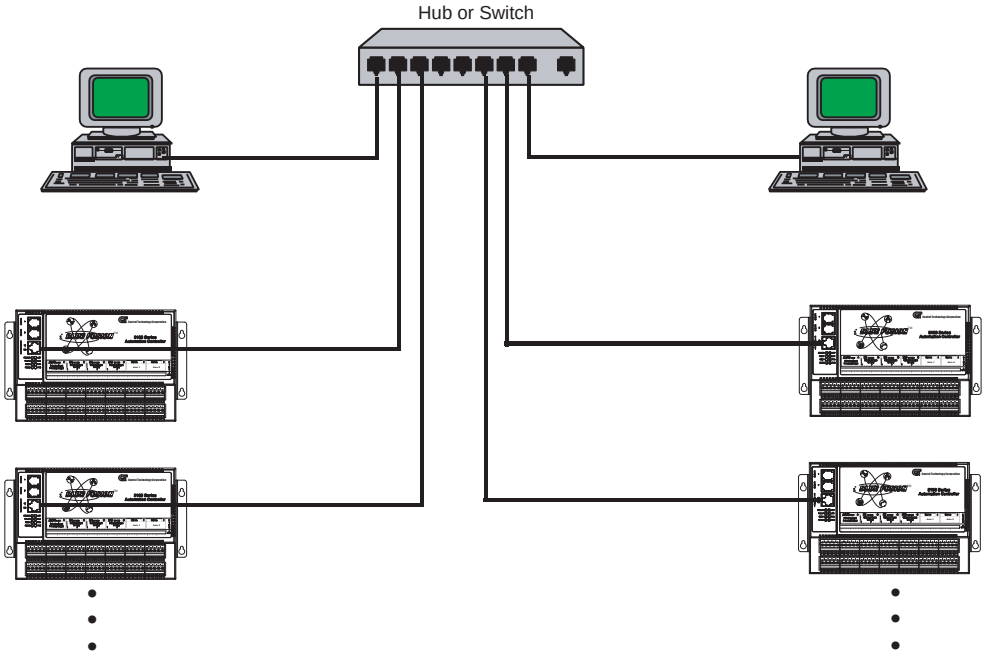
### Network Specifications

Node and cable specifications for 10Base-T and 100Base-T connections are listed below. Termination for 10/100Base-T is provided by a hub. The total nodes per hub are determined by the hub size.

| | |
|---|---|
| **Total number of nodes supported**: | 32767 |
| **Maximum number of nodes per segment**: | 1024 |
| **Maximum cable length per segment**: | 100 meters |
| **Maximum cable length per network**: | 500 meters (10Base-T)<br>200-250 meters (100Base-T) |

Figure 9 shows computer-controller connections using an Ethernet network. It represents one segment out of 5 possible segments on the network. The total cable length between all devices and the hub must not exceed 100 meters.

**Figure 9. Ethernet Connections**




## Host Communications

The 5100's networking capabilities includes host communications, peer-to-peer communications offering indirect node access, built-in error checking, and network access from any controller's RS-232 port. A host computer can interrogate the area network continuously while local computers or operator interface terminals can access the network port using conventional communications protocols from any controller's RS-232 port. For fast data retrieval, the controller supports both block area transfer from a single command request both locally and over the network.

This page is intentionally left blank.