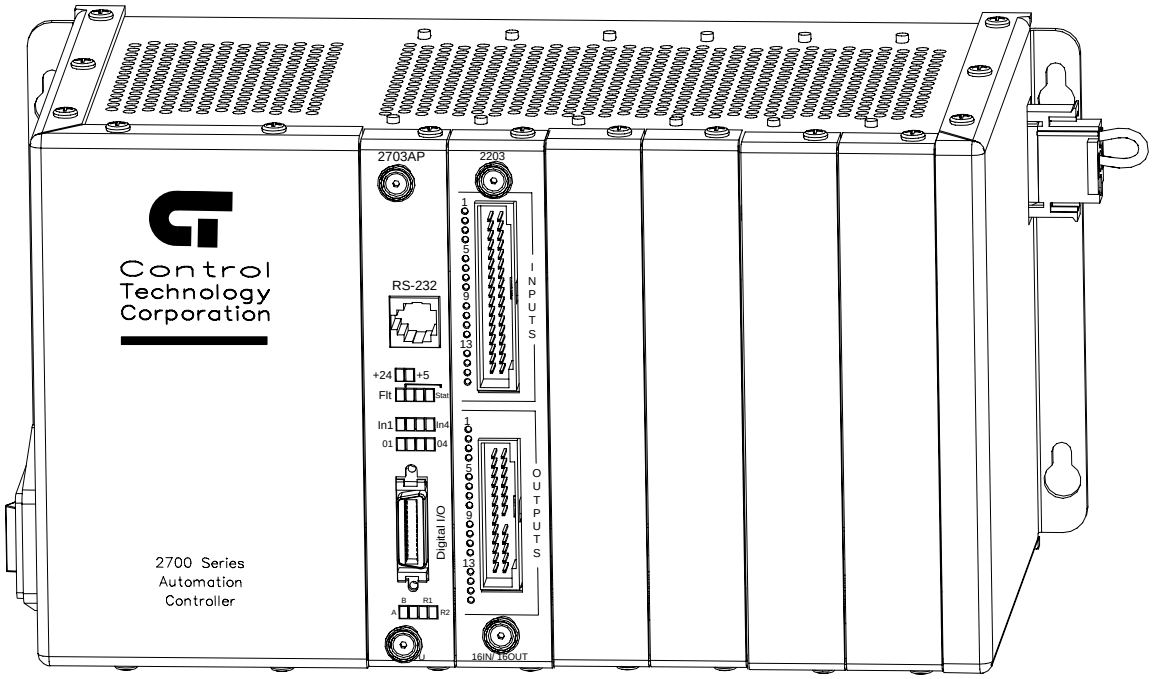
Model 2700AP Automation Controller Installation Guide



Doc. No. 2700APIG
Revision B
June 2008

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Notes to Readers

The *Model 2700AP Installation Guide* provides the following information:

- System Overview – describes the various 2700AP configurations.
- Dimensions and Mounting Considerations – mounting dimensions and precautions on mounting the 2700AP.
- 2703AP 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 2700AP.
- Board Handling Precautions-- contains general guidelines on handling printed circuit boards with ESD devices.
- Module Installation – how to install modules in the 2700AP controller.
- Power Connections – connecting power to the controller.
- Status Lights – how the status light functions.
- Computer – Controller Communications – describes the controller's RS-232 port and how it functions; how to add a second port with the 2886 adapter; Ethernet connections.
- Application Notes – how to use the real-time clock (RTC); sample Quickstep programs.

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

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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.

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System Overview

The Model 2700AP has a flexible plug-in architecture that supports a variety of modules and comes in three sizes:

Model #	Description
2700AP-5	contains slots for 5 modules and a plug-in CPU
2700AP-10	contains slots for 10 modules and a plug-in CPU
2700AP-16	contains slots for 16 modules and a plug-in CPU

Program the 2700AP controller using 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.

Dimensions and Mounting Considerations

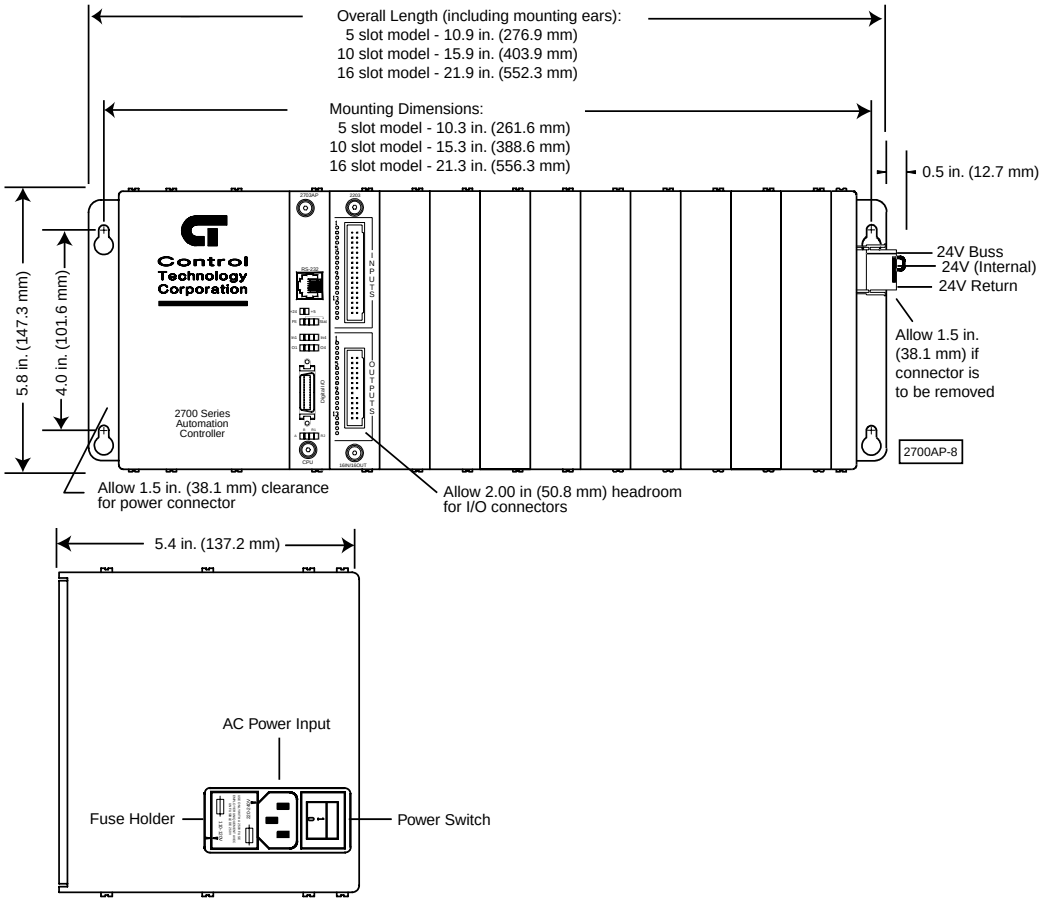
The Model 2700AP Automation Controller has mounting ears that allow easy mounting to flat surfaces such as a NEMA-rated electrical enclosure. Figure 1 shows the controller's dimensions.

Mounting Considerations

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

- Avoid flying metal chips that may result from installation or subsequent machine construction. Avoid conductive dusts, liquids, or condensing humidity. If any of these conditions exist, mount the 2700AP in a NEMA 4 or NEMA 12 rated enclosure.
- Do not mount the 2700AP 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. 2700AP Dimensions



Model 2703AP CPU Description

This section describes the Model 2703AP CPU faceplate and the Model 2346 distribution board.

Figure 1. Model 2703AP CPU Faceplate

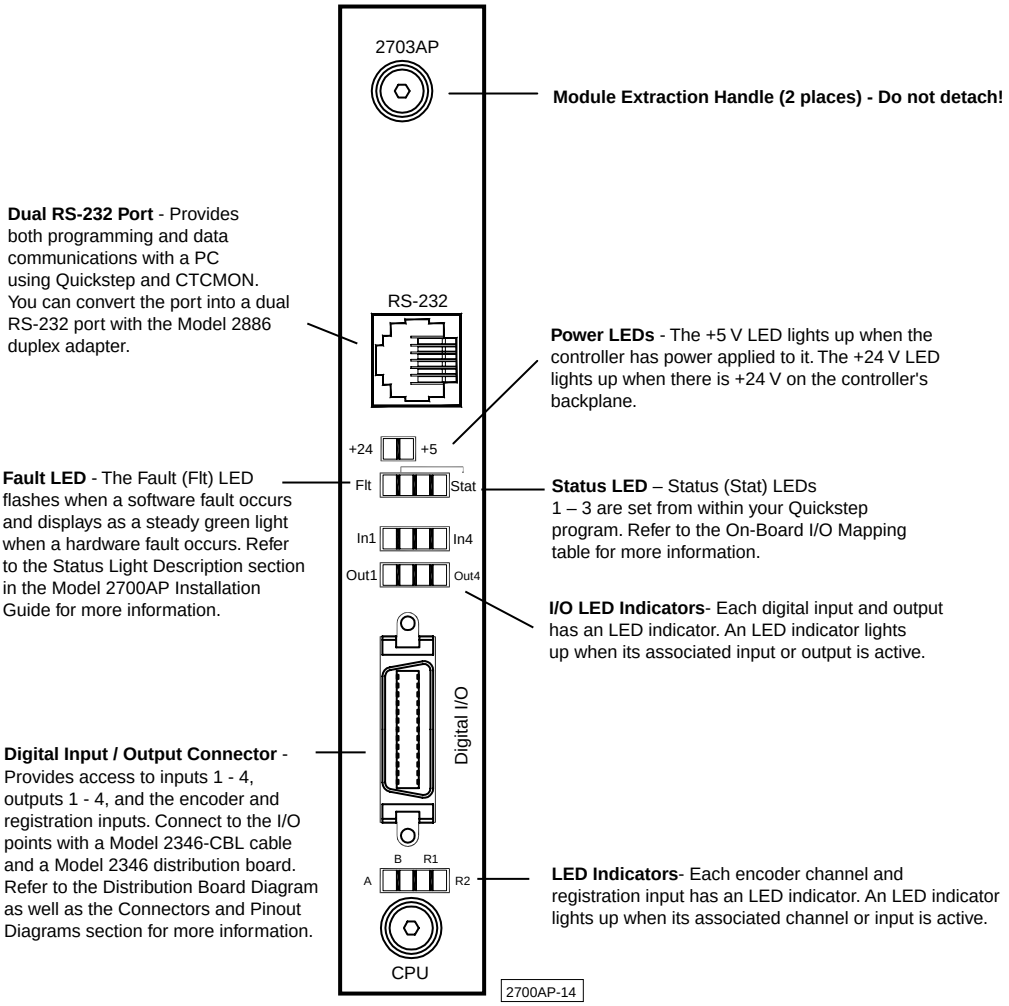


Figure 2. Model 2346 Distribution Board Description

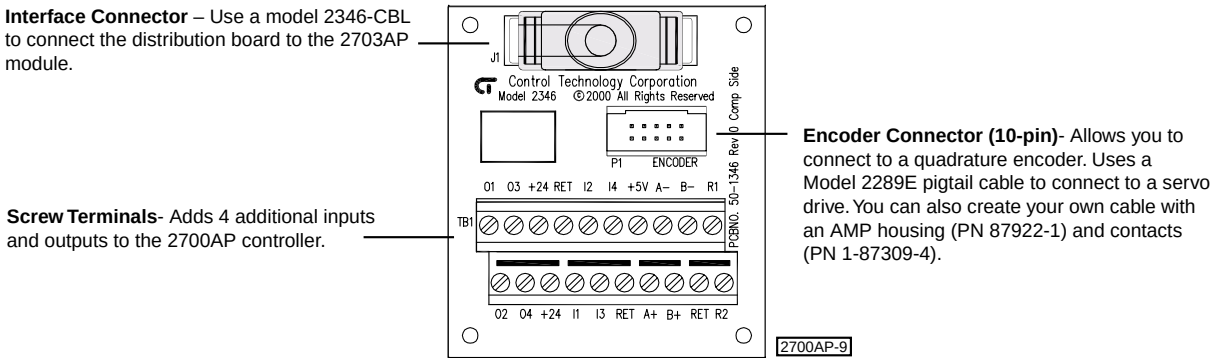
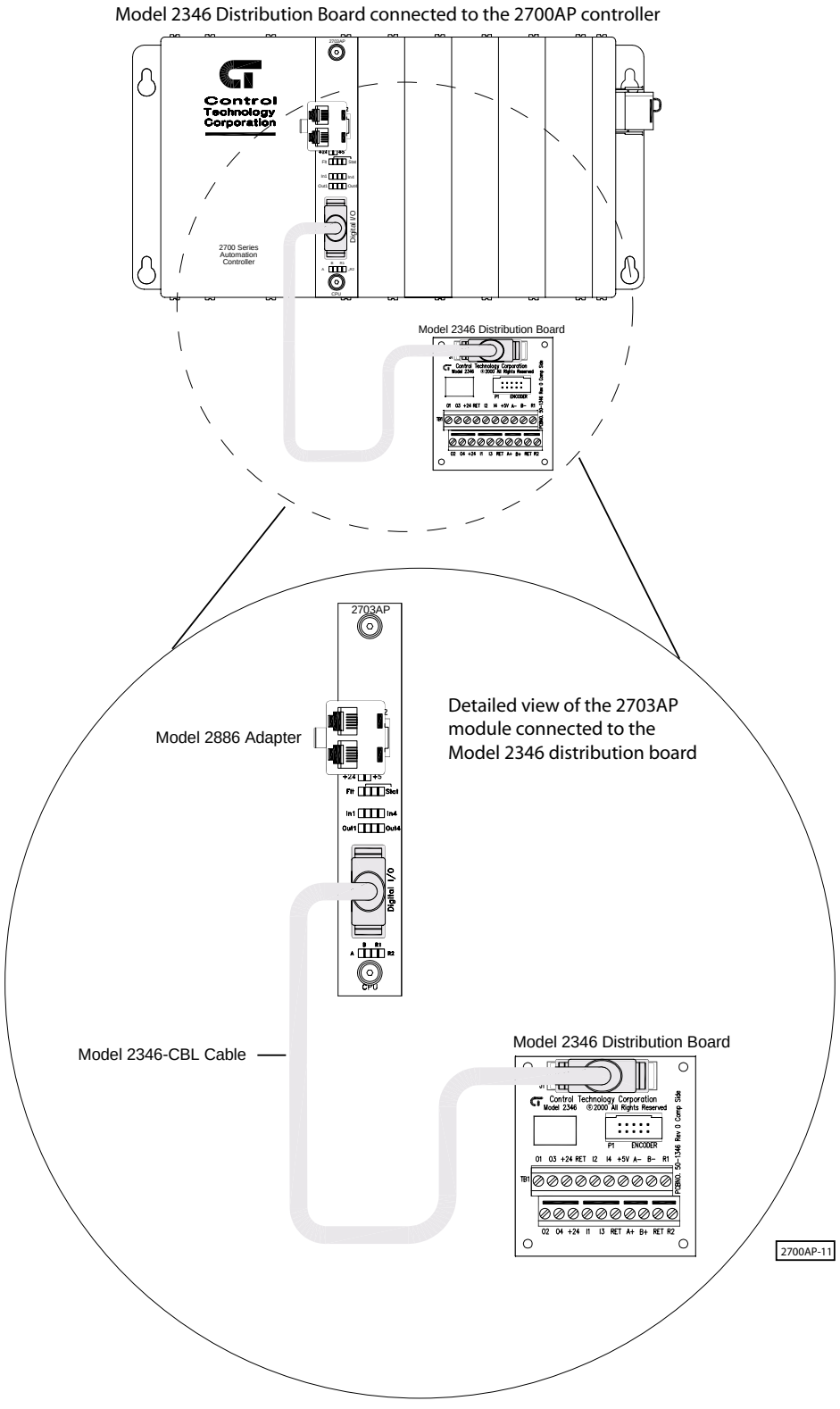


Figure 3. Model 2346 Distribution Board Connection Diagram



Wiring Diagrams

Table 1. I/O Connector

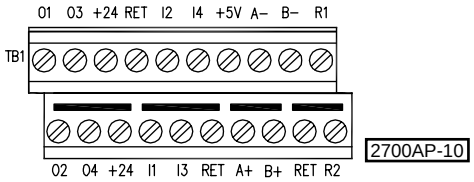
I/O Connector Distribution Contacts (located on Model 2346 distribution board)	Pin #	Signal	Pin #	Signal
	1	Output 1	11	Output 2
	2	Output 3	12	Output 4
	3	+24 V	13	+24 V
	4	Return	14	Input 1
	5	Input 2	15	Input 3
	6	Input 4	16	Return
	7	+5 V	17	Phase A+
	8	Phase A-	18	Phase B+
	9	Phase B-	19	Return
	10	Registration Input 1	20	Registration Input 2

Table 2. Interface Connector

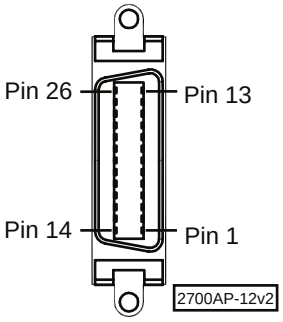
Interface Connector (located on 2703AP module and 2346 distribution board)	Pin #	Signal	Pin #	Signal
	1	+5VE	14	RET
	2	Phase B+	15	Phase B-
	3	Phase A+	16	Phase A-
	4	RET	17	RET
	5	REG1	18	REG2
	6	IN3	19	IN4
	7	IN1	20	IN2
	8	+24V	21	+24V
	9	OUT4	22	OUT4
	10	OUT3	23	OUT3
	11	OUT2	24	OUT2
	12	OUT1	25	OUT1
	13	+24V	26	+24V

Table 3. Encoder Connector

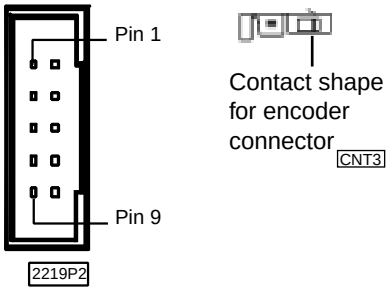
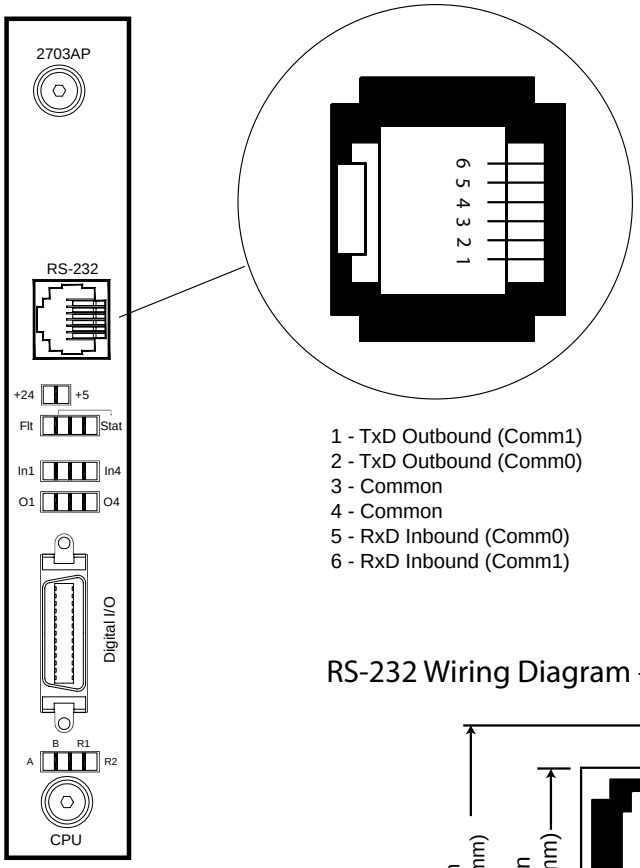
Encoder Connector (located on the Model 2346 distribution board)	Pin #	Signal	Pin #	Signal
	1	Phase A (+)	6	5 Volt Return
	2	Phase A (-)	7	+5 VDC (for encoder)
	3	NC	8	Phase B (+)
	4	NC	9	Phase B (-)
	5	Index (-)	10	Index (+)

Table 4. On-Board I/O Mapping in Quickstep

2703AP Input	QS Resource	2703AP Output	QS Resource
1	Input 993	1	Output 993
2	Input 994	2	Output 994
3	Input 995	3	Output 995
4	Input 996	4	Output 996
	Input 998	Status LED 1	Output 998
Registration Input 1	Input 999	Status LED 2	Output 999
Registration Input 2	Input 1000	Status LED 3	Output 1000

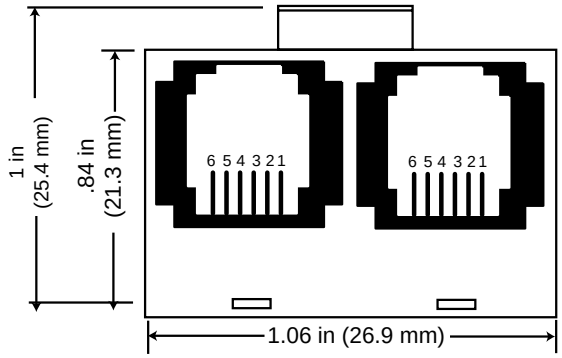
Figure 4. RS-232 Wiring Diagrams

RS-232 Wiring Diagram – Single Port

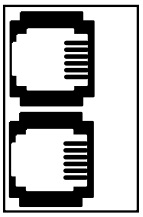


1 - TxD Outbound (Comm1)
2 - TxD Outbound (Comm0)
3 - Common
4 - Common
5 - RxD Inbound (Comm0)
6 - RxD Inbound (Comm1)

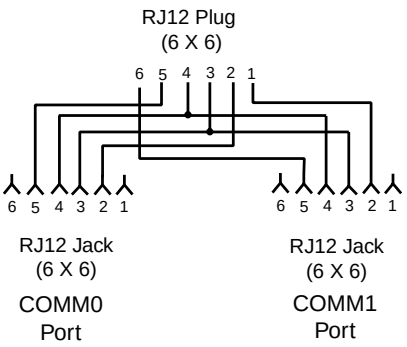
RS-232 Wiring Diagram – Dual Port with the Model 2886 Adapter



Orientation of connector when plugged into 2703AP



Wiring Diagram



2700AP-2

Specifications

Table 5. General Specifications

Description	Min.	Typical	Max.	Units
Absolute Maximum Ratings				
Ambient Temperature				
Operating	0		+50	°C
Storage	-20		+80	°C
Controller Characteristics				
AC voltage range				
120 V mode (50/60 Hz)	100.0	120.0	132.0	VAC
240 V mode (50/60 Hz)	200.0	240.0	264.0	VAC
Current requirements				
120 V mode	0.9	1.5		A
240 V mode	0.45	0.75		A
User memory capacity (4 years unpowered lithium-cell RAM)		128K		Bytes
The main CPU is an Hitachi SH2 processor running at 24.576 MHz.				
Power Supply Capacities				
+24 V I/O supply			1.5	A
+5 V logic supply			5.0	A
Common mode voltage range	-10		+10	VDC
Encoder power supply capacity (+5 V)			250.0	mA
CPU power requirement (5 V)		0.4	0.6	A
Communications Characteristics				
RS-232 transmitters		± 5	± 12	VDC
RS-232 receivers		± 5	± 12	VDC

1. Controller capacities are not mutually inclusive. You cannot operate resources at full capacity at the same time.
2. These inputs and outputs require a Model 2346 distribution board (Figures 2 and 3).
3. The second communications port requires a Model 2886 adapter (Figure 4).
4. Specifications are at 25°C unless otherwise specified.

Table 5. General Specifications (Continued)

Description	Min.	Typical	Max.	Units
Controller Resource Summary				
Multi-tasking (tasks)			84	
Volatile registers (32-bit)			500	
Non-volatile registers (32-bit)			4500	
Data table elements (16-bit, non-volatile)			16000	
Input-linkable counters			8	
Flags			32	
Program steps			4096	
Controller Capacities [1]	**2700AP-5**	**2700AP-10**	**2700AP-16**	
Module slot capacity	5	10	16	
Digital inputs	160	320	512	
Digital outputs	160	320	512	
Analog inputs	80	128	256	
Analog outputs	40	128	256	
Stepping motor axes (2206 only)	10	16	16	
Servo motor axes	10	16	16	
Relay outputs	40	80	128	
RS-232 channels	12	13	13	
CPU Module On-Board I/O				
Digital inputs [2]	4	4	4	
Digital outputs [2]	4	4	4	
Encoder inputs [2]	1	1	1	
Registration inputs [2]	2	2	2	
RS-232 ports [3]	2	2	2	

1. Controller capacities are not mutually inclusive. You cannot operate resources at full capacity at the same time.
2. These inputs and outputs require a Model 2346 distribution board (Figures 2 and 3).
3. The second communications port requires a Model 2886 adapter (Figure 4).
4. Specifications are at 25°C unless otherwise specified.

Table 6. Electrical Specifications

Description	Min.	Typical	Max.	Units
Absolute Maximum Ratings				
Applied input voltage	0		27.0	VDC
Applied output voltage	0		24.0	VDC
Operating Characteristics				
Differential encoder inputs				
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 counting rate [1]			3.0	MHz
Counting range	-2,147,483,648		+2,147,483,647	Counts
Output on voltage (I_o = 500 mA) [2]		1.0	1.5	VDC
Output off leakage (applied voltage = 24V) [3]		1.0	100.0	µA
Input off voltage (I_i = 0 mA)		24.0	26.4	VDC
Input on current (V_i = 0 V) [4]		-4.4	-5.0	mA
Input on current threshold (V_i = 6 V typical)		-3.2	-3.5	mA
Input off current (typical leakage current allowable)			-250	µA

1. This value assumes a 50% duty cycle, which means that the ON time = OFF time.
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. Under normal operation, no external input voltage is applied. Inputs should be externally switched to the input common.
5. Specifications are at 25°C unless otherwise specified.

Table 7. Hardware / Firmware Revision Levels

Model Numbers	Hardware Revision Level	Firmware Revision Level [1] [2]
2700AP-5, -10, -16	A or greater	N/A
2703AP	A or greater	3.05

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 3.05 translates to:

   Major Revision Level 3
   Minor Revision Level 05

   If this value changes to 3.10, it translates to:

   Major Revision Level 3
   Minor Revision Level 10 (not revision level 1)

Board Handling Precautions

The module's printed circuit board contains electrostatic discharge sensitive (ESD) devices. Improper board handling could result in damage to the board. The following precautions are recommended when handling the board or before inserting it into the controller:

- Make sure you are grounded electrically by using a wrist strap connected to an electrically grounded workstation or by physically touching the controller case or something electrically connected to the controller case.
- Avoid touching the leads or contacts of the circuit board and handle the board by its edges only.
- Transport circuit boards in protective, anti-static bags, bins, or totes. Do not insert boards into materials such as plastic, polystyrene foam, clear plastic bags, bubble wrap, or plastic trays.

Installing Modules into the Controller

The controller accepts a variety of plug-in modules. The plug-in CPU has its own slot and is not counted as part of the total number of slots in the controller. The module fits into one of the slots of the automation controller (Figure 5). Insert any combination of modules into the controller (subject to system limits) and install them in any order. This is possible because the controller's CPU dynamically assigns such times as motor numbers, input numbers, and output numbers each time power is re-applied to the controller. These numbers are assigned from left-to-right across the controller (from slot 1 to slot 10 in a model 2700AP-10).

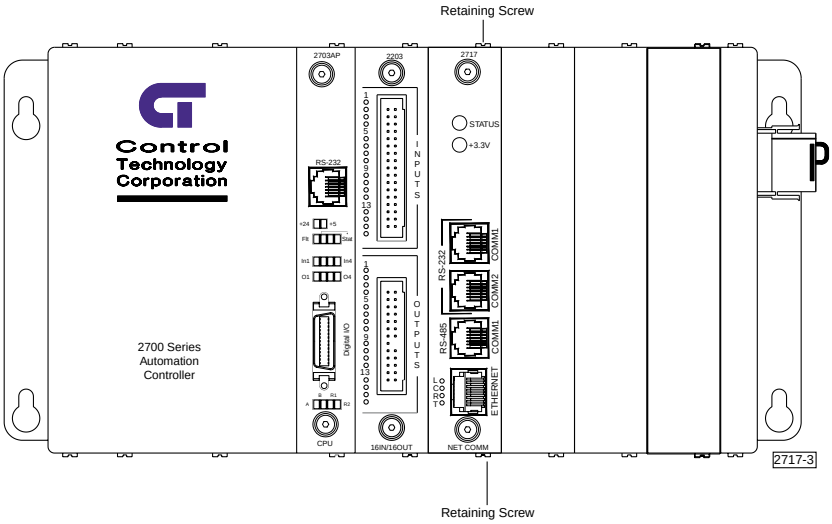
To install a module into the automation controller:

Note

Retain all hardware removed during this procedure.

1. Remove all AC and DC power, including any external supplies connected to the controller.
2. Locate an unused slot and remove two retaining screws from the top and bottom of its cover plate.
3. Slide the module into the slot and make sure that the circuit board slides into the nylon guides at the top and bottom of the controller case. Make sure that the card is oriented properly so that its labels are right-side-up.
4. Press the module firmly into the controller. Make sure that the module's faceplate is flush with the adjacent sheet metal surface.
5. Re-install two retaining screws in the top and bottom of the new module.
6. Wire the module according to the instructions in its installation guide.

Figure 5. 2700AP Series Controller with a 2717 module installed in the right-hand slot.



Some modules provide one or more connectors on their faceplates. To keep their wires from becoming accidently unplugged and from tangling together, CTC manufactures a bracket to hold the wires. The Model 2699 bracket attaches to the controller as shown in Figure 6. Once the bracket is installed, attach the connector wires.

1. Remove the retaining screws from the top of the module. Save these screws to secure the bracket.

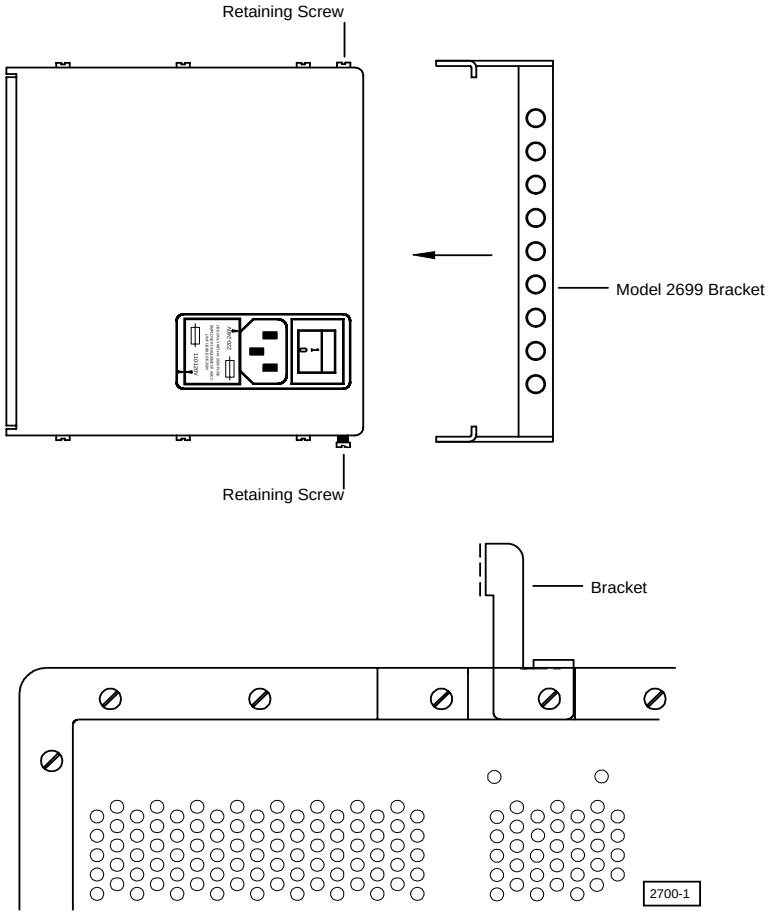
2. Place the bracket on the controller and align the holes on the bracket with the holes for the retaining screws.

3. Re-install the retaining screws.

4. Wire the module according to the instructions in its installation guide.

5. Use ty-wraps to fasten the wires to the holes in the bracket.

Figure 6. Attaching the Model 2699 bracket



The Model 2699 bracket requires an additional 2 inches of clearance for the front of the controller.

Connecting AC Power

The Model 2700AP contains an internal power supply which provides two mutually-isolated voltages (+5 VDC and +24 VDC) for the operation of the controller. Three LED indicators are located on the CPU: two for these voltages (I/O Supply and Logic Supply) and one to indicate if the controller is turned ON (Status).

The controller's power supply requires AC power (either 120 VDC or 240 VAC nominal) for proper operation. Power is applied to the controller with a standard IEC-type power connector on the side of the controller. A US-standard three-prong power cord is provided with the controller for this purpose.

The supply voltage required is determined by a voltage selector switch on the side of the unit (Figure 7). A fuse of the appropriate rating must also be installed in the fuse holder integral to the IEC-type connector (Table 8).

Table 8. Fuse Ratings

Voltage	Range	Fuse
120 VAC	100 - 132	2 A
240 VAC	200 - 264	1 A

Figures 7 and 8 show the location of the voltage selector/fuse holder. The voltage selector/fuse holder is in a removable cartridge. To remove the voltage selector/fuse holder:

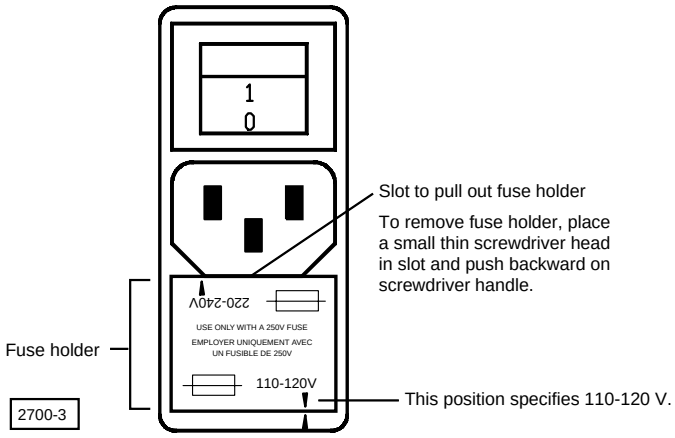
1. Insert a small flat head screwdriver into the slot and push the cartridge out.

2. Remove the voltage selector/fuse holder from the controller to change the voltage selection and to insert a fuse. The fuse holders are located along the side of the cartridge.

Caution

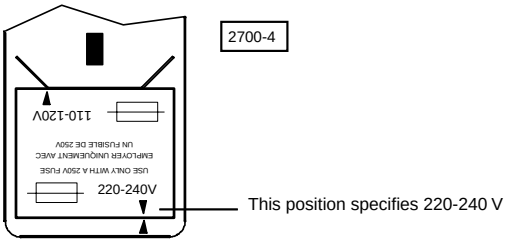
Do not connect an external supply with a voltage rating other than +24 V to this connector as potential incompatibilities may exist with other installed modules. Consult CTC for further information.

Figure 7. Voltage Selector Switch



Specify the voltage by inserting the voltage selector in the controller as shown in Figure 7 and Figure 8. In Figure 7, the voltage selected is 110-120 V and in Figure 8, the voltage selected is 220-240 V.

Figure 8. Position label (magnified)



Using Step-down or Isolation Transformers

When using a step-down or isolation transformer to supply power to the controller, make note of the following:

- Step-down transformers typically derive 120 VAC from much higher voltage lines that also supply power to heavy equipment. Often, when motors are first energized in heavy equipment, the stall currents that result can cause the voltage supplied to the step-down transformer to drop by as much as 50%. Because step-down transformers are ratio-metric devices, the voltage supplied to the controller drops proportionately, causing a potential system malfunction.

- The relatively light load imposed by the controller on the transformer secondary may result in excessive voltage and represents a potential hazard to the system.

- Neither type of transformer represents ideal protection against electrical noise. Inter-winding capacitances can result in noise transference among windings and differential noise may still be electromagnetically coupled to the secondary.

- Adequate grounding of the controller is still critical to its proper performance. For more information, refer to *The Importance of Proper Grounding*.

These issues often point to the use of an independent power feed (120 or 240 VAC) for the controller and associated components. The resulting additional stability and design integrity are often well worth the slight additional cost.

The Importance of Proper Grounding

The controller is outfitted with an integral line filter to protect against electrical noise carried on the AC power line. This line filter, along with the shielding provided by the controller enclosure itself, depend on the presence of a good ground connection for effectiveness. This is normally accomplished by connecting the controller's power cord to a well-grounded outlet.

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.

In instances where step-down or isolation transformers are being used to power the controller, the ground connection should still be made directly to the controller.

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 provides 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** – available with a current capacity of up to 1.5 Amps (maximum). It supplies power to external control devices such as solenoid valves, relays and sensors. This power supply may also be used with some modules, supplying power to circuitry on the outbound side of any on-board isolation. For more information on 24 VDC usage, refer to a module's data sheet.

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

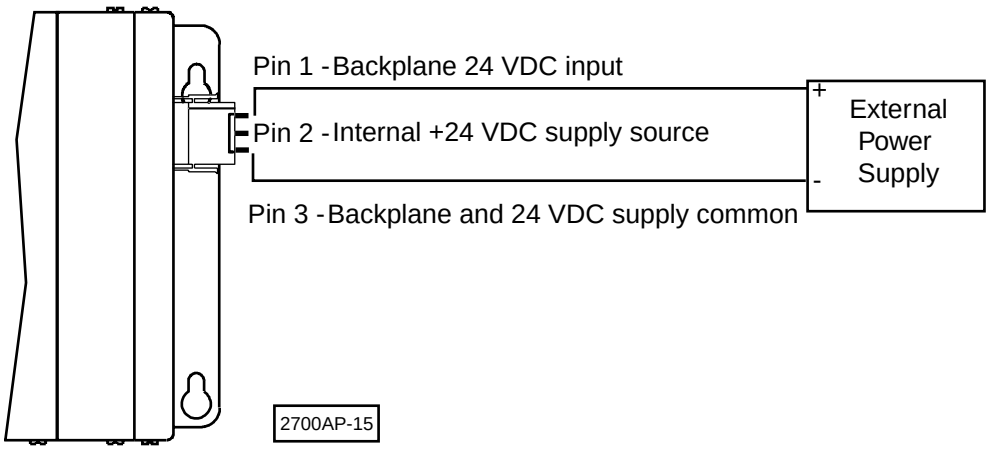
Note

Do not make any external connections to either the +5 V power supply or its common as an increased susceptibility to electrical noise may result.

Using External Power Supplies

Many of the modules available for this series of controllers allow the use of an external power supply for supplying power to actuators and other devices in place of using the controllers +24 V supply. The individual installation guides for these modules provide additional details.

Figure 9. External VDC Connector



It is possible to connect an external +24 V power supply (with a capacity not in excess of 10 Amps) to the controller's backplane, which takes the place of the controller's internal +24 V supply. A nylon, 3-pin connector is provided on the side of the controller for this purpose. This connector (as supplied by CTC) is fitted with a mating plug that is wired with a jumper. The jumper carries +24 V from the internal power supply to the I/O power bus extending across the controller's backplane.

Remove the jumper plug and use the connector to attach an external power supply to the I/O power bus and to the I/O common, pins 1 and 3. An extra mating connector with pins is included with each controller. You can also order a plug with a pigtail wires (Model 2885) from CTC for this purpose.

Status Light Description

The status light on the Model 2700AP is used to indicate a software or hardware fault (Figure 10). These faults are described below.

Note

After the controller is turned ON, the light is steady and green 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 2703AP 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 2703AP is idle and all resources that can be set (outputs, etc.) remain in the state they were in before the fault occurred.

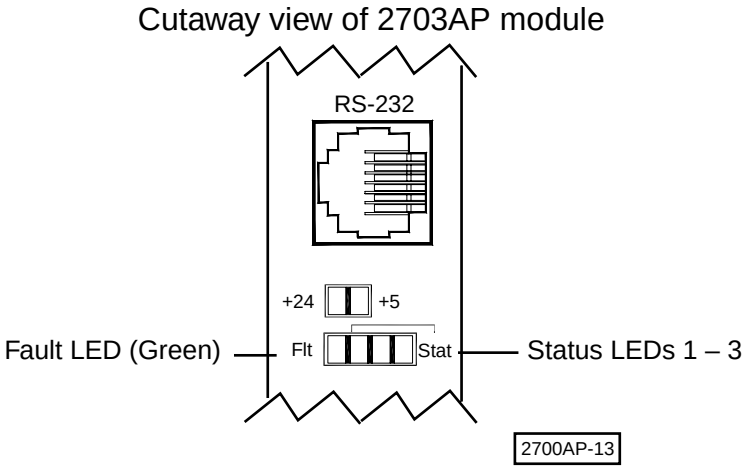
Note

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.

Figure 10. Fault LED Location on 2703AP Faceplate



Computer – Controller Communications

The controller can communicate with a computer or with other controllers through an RS-232 port or on an Ethernet network.

RS-232 Communications

The controller's RS-232 port allows 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 2700AP 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 (Single Port)

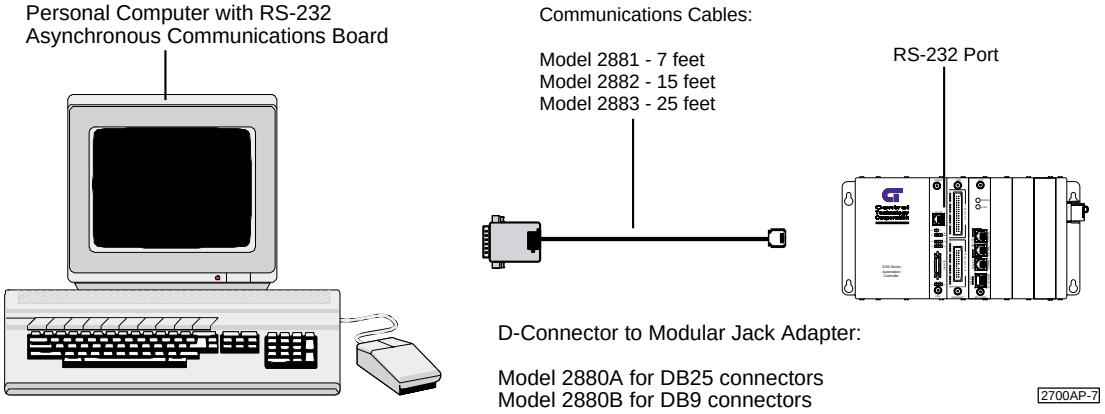
Connections to the controller's RS-232 port are made through a modular jack on the controller (labelled COMM). This jack carries the receive signal, two commons (ground), and the transmit signal for the communications channel. The pin connection diagram (Figure 4) illustrates the wiring of the jack. Only the center four connectors of a six or eight conductor jack are used.

RS-232 Connections (Dual Ports)

The 2700AP can operate with dual RS-232 ports by adding the Model 2886 duplex adapter. Connect through one of the adapter's modular jacks (labeled COMM1 and COMM0). These jacks carry receive and transmit signals for both ports as well as two commons (ground). Refer to Figure 4 for connection information.

Standard Control Technology cables are available for connecting to this jack (Figure 11). As an alternative, many commonly available telephone cables may be substituted.

Figure 11. 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 port. 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 2700AP to a telephone line.

Figures 12 and 13 show computer-controller connections using an RS-232 connection and DB25 and DB9 connectors.

Figure 12. DB9 Connections

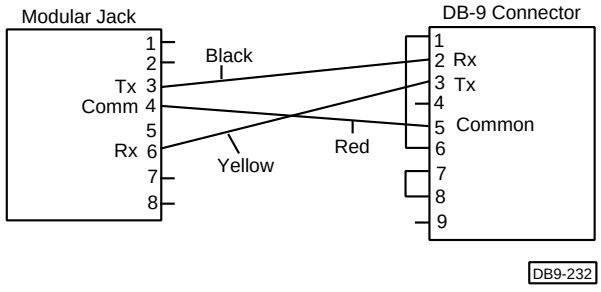
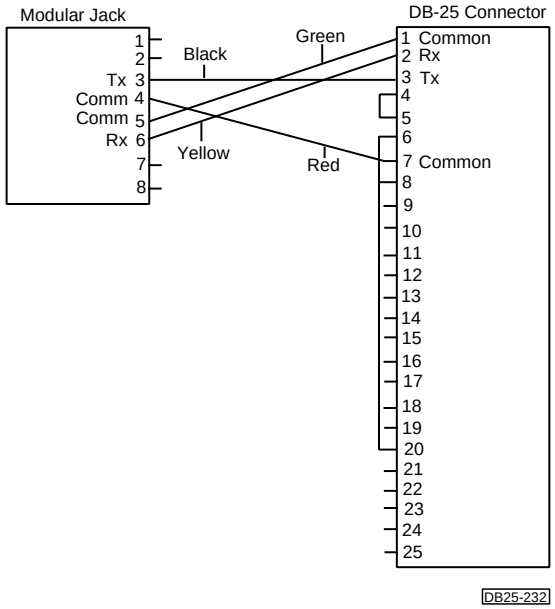


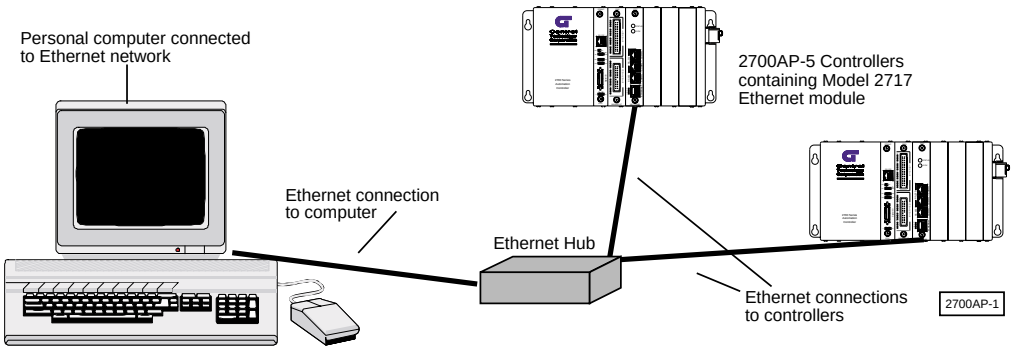
Figure 13. DB25 Connections



Using Ethernet for Controller Communications

The 2700AP controller can access an Ethernet network (Figure 14) for controller-computer communications using a Model 2717 Ethernet Module. The 2717 module has an Ethernet port that allows it to communicate over an Ethernet network using 10Base-T or 100Base-T connections that adhere to the IEEE 802.3 standard.

Figure 14. Ethernet Connections



Refer to the *Model 2717 Installation Guide* in the Customer Support area of our web site at www.ctc-control.com for detailed connection information.

Application Notes – Using the Real-Time Clock

The Model 2700AP Controller includes a real-time clock (RTC) feature. The clock is preset at the factory to Eastern Standard Time. The registers listed below are used to read the current time or set the clock to local time:

- **Register 13014** - seconds
- **Register 13015** - minutes
- **Register 13016** - hours (24 hour clock)
- **Register 13017** - day of month
- **Register 13018** - month of year (1-12)
- **Register 13019** - year (two fields)
- **Register 13020** - day of week (1-7, where Sunday=1)

Note

All registers are read/write.

Examples

In this example, when the RTC reaches five minutes past the hour, the program goes to the next step.

```
[10] Clock_Test
    ;;;
    ————————————————————-
    <No Change in Digital Outputs>
    ————————————————————-
    if Minutes = 5 goto next
```

In this example, the program goes to the next step at 12:59:59 p.m. on December 31, 1999.

```
[20] Clock_Test
    ————————————————————-
    <No Change in Digital Outputs>
    ————————————————————-
    if Seconds <> 59 goto CLOCK_TEST
    if Minutes <> 59 goto CLOCK_TEST
    if Hours <> 23 goto CLOCK_TEST
    if Day <>31 goto CLOCK_TEST
    if Month <>12 goto CLOCK_TEST
    if Year <> 99 goto CLOCK_TEST
    goto HAPPY_MILLENIUM
```

In this example, when a specific event occurs it activates an input and the controller moves to the next step.

```
[50] Time_Stamp
    ————————————————————-
    <No Change in Digital Outputs>
    ————————————————————-
    monitor Event_Trap goto next
[51] Save_Data
    ————————————————————-
    <No Change in Digital Outputs>
    ————————————————————-
    store Seconds to Saved_Seconds
    store Minutes to Saved_Minutes
    store Hours to Saved_Hours
    store Day to Saved_Day
    store Month to Saved_Month
    store Year to Saved_Year
```

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