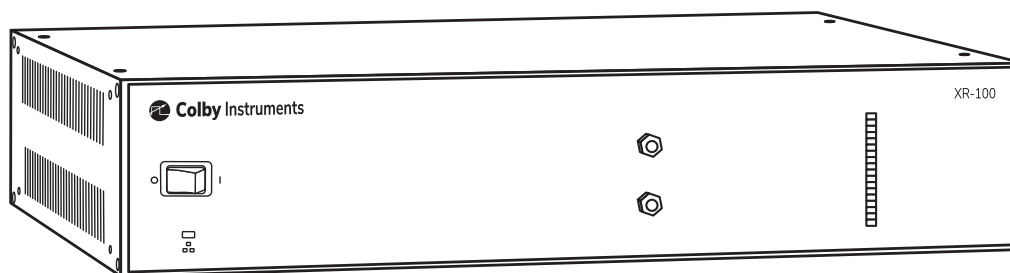


Operating and Programming Manual  
Version 1.0

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# XR-100



# Certification and Warranty

## **Certification**

Colby Instruments certifies that the XR-100 programmable delay line instrument meets all published specifications at the time the instrument is shipped from the manufacturer. SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTIFICATION.

## **Warranty**

The product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Colby Instruments will at its option, either repair or replace the product or item which proves to be defective. Replacement products may be either new or like-new.

EXCESSIVE WEAR OF CONNECTORS, THE TROMBONE UNIT, THE COAXIAL RELAYS, AND OTHER RELAYS CARRYING THE SIGNAL, ARE NOT COVERED BY THE WARRANTY. THE FOREGOING WARRANTY SHALL NOT APPLY TO DEFECTS RESULTING FROM IMPROPER CARE OR USE OF THE INSTRUMENT BY THE BUYER. THIS SHALL APPLY TO ALL COMPONENTS DELIVERED TO THE BUYER.

For warranty service or repair, this product must be returned to Colby Instruments. The Buyer shall prepay all shipping charges for the shipment of item to Colby Instruments. Colby Instruments shall pay the shipping charges to return the product to the Buyer. However, the Buyer shall be responsible for ALL shipping charges, duties and taxes for product returned to Colby Instruments from outside the United States of America.

BUYER MUST OBTAIN A RETURN MATERIAL AUTHORIZATION NUMBER (RMA #) FROM COLBY INSTRUMENTS PRIOR TO THE SHIPMENT OF ANY ITEM TO COLBY INSTRUMENTS. SHIP TO:

## **Colby Instruments**

**Attn: RMA # \_\_\_\_\_**

**15375 SE 30th Place, Suite 320**

**Bellevue, Washington 98007**

**USA**

No other warranty is expressed or implied. Colby Instruments specifically disclaims the implied warranties or merchantability and fitness for a particular purpose. The remedies provided herein are the Buyer's sole and exclusive remedies. Colby Instruments shall not be liable for any direct or special, incidental or consequential damages, whether based on contract, tort, or any other legal theory.

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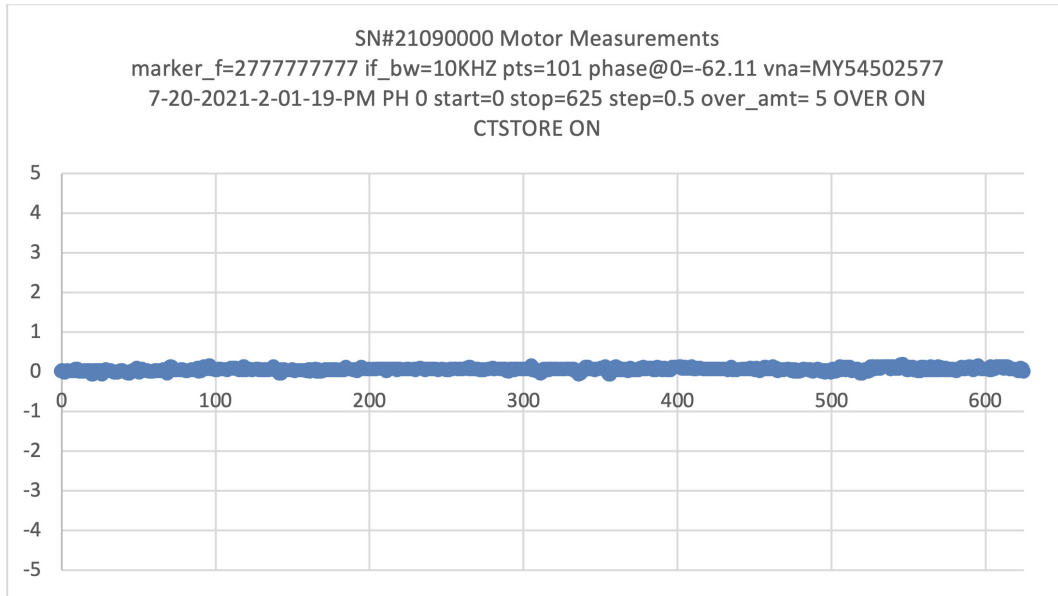
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## XR-100 Technical Specifications

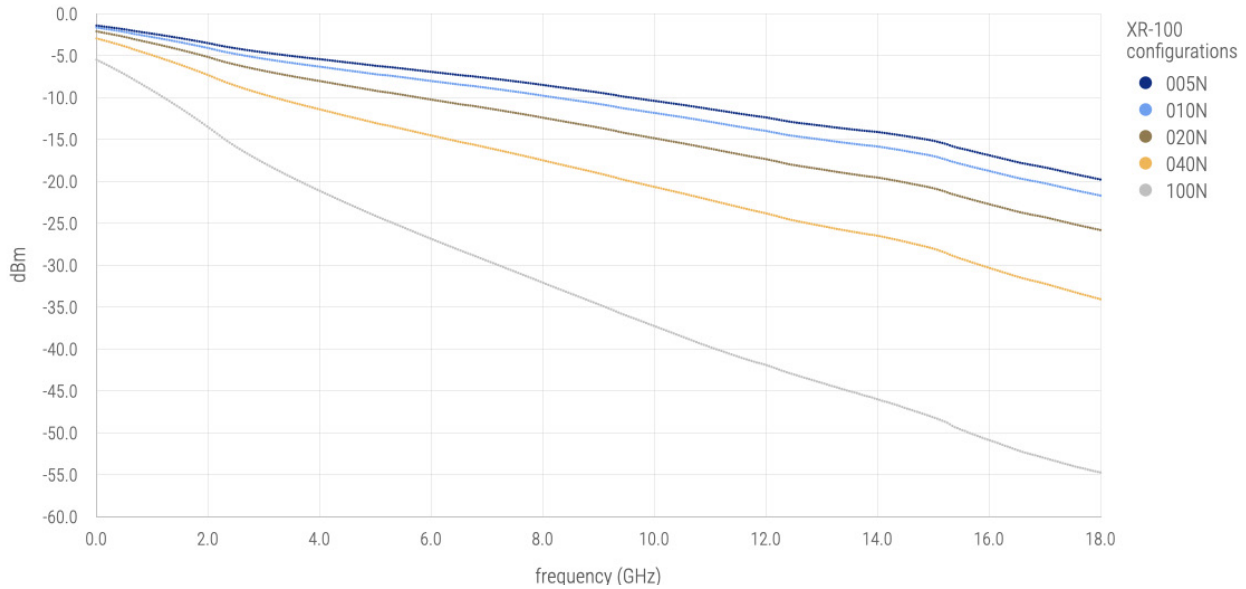
<b>Model</b>	XR-100
<b>Serial Number</b>	21090000
<b>Firmware Version</b>	1.00
<b>Signal Input Range</b>	0 - 18 GHz
<b>Minimum Step Resolution</b>	5 ps, 10 ps, or 1 ns
<b>Maximum Delay Range</b>	up to 50.95 ns, 101.91 ns, or 200.0 ns
<b>Nominal Delay</b>	1.451 ns
<b>Accuracy of Delay</b>	to 0.10%, +/- 2 ps per binary step
<b>Phase Shift Step Resolution</b>	1.8°, 3.60°, and 360° per 1 GHz
<b>Total Phase Shift at 1 GHz</b>	n/a
<b>Total Phase Shift at 5 GHz</b>	n/a
<b>Switching Speed*</b>	< 100 ms
<b>External Trigger</b>	no
<b>Ethernet TCP/IP</b>	yes
<b>Serial RS-232</b>	yes
<b>MT-100A</b>	optional
<b>Web Browser UI</b>	yes
<b>Microwave Relays Rated</b>	5m MTBF
<b>Recommended Service Interval</b>	1 year
<b>Min. frequency for 360° phase shift coverage</b>	n/a
<b>Power Handling Capability</b>	10W CW, 50W peak *Operating at sustained high power levels while changing delay settings or “hot switching” will significantly reduce operational lifetime of instrument.
<b>AC Supply</b>	85 to 240 VAC, 50-60 Hz
<b>Operating Temperature</b>	10 to 30 deg. C
<b>Physical Dimensions</b>	12" L x 16 3/4" W x 3 1/2" H (2U)
<b>Weight</b>	5.6 kg (12.5 lbs.) to 6.1 kg (13.5 lbs.)

\*depending on network latency

# XR-100 Trombone Measurements



# S21 Insertion Return Loss Report



# XR-100 Hostname and MAC-ID

<b>Hostname</b>	COLBY_21090000
<b>MAC-ID</b>	00:00:00:00:00:00

# Chapter 1.0

## Description of the XR-100 programmable delay line instrument

### 1.1 Introduction

The XR-100 Programmable Delay Line Instrument offers precision programmable delay through an in-series network of Aerospace grade microwave relays and precision cut semi-rigid coaxial cable. Total delay range and step resolution is customer specified to a maximum of 200 ns range, 5 ps minimum step, and 16 delay sections.

The XR-100 can be operated locally via Web Browser UI over an Ethernet interface or optionally via MT-100A MicroTerminal over a RS-232 serial port interface. Delay can be set or entered manually or automated via program control. Remote control via Ethernet TCP/IP, RS-232 Serial interface, or Web Browser UI and SCPI command interface is supported.

All signal input and output connections are easily accessible at the front panel and are terminated with female SMA (50  $\Omega$ ) connectors.

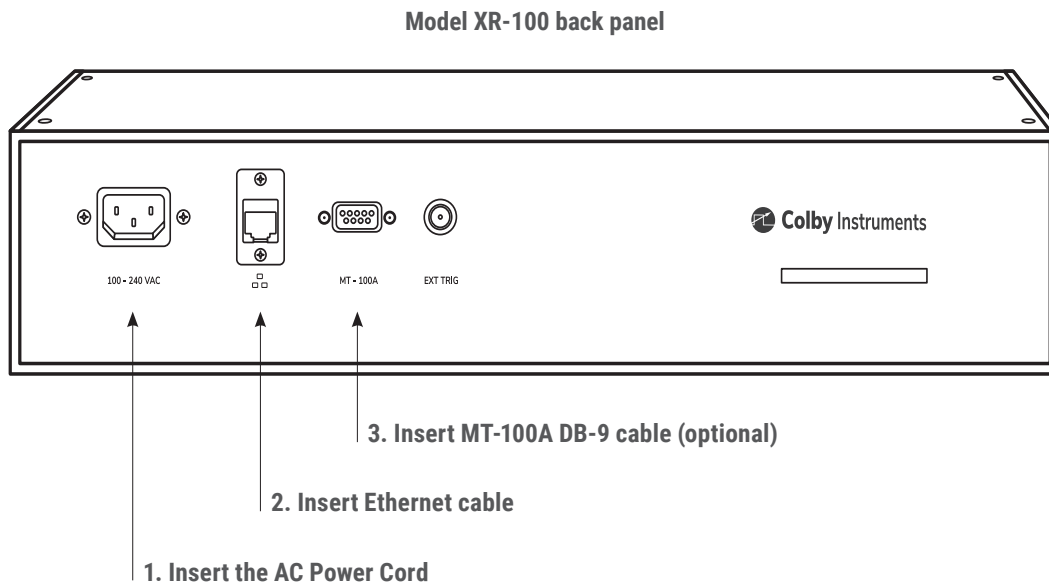
An embedded CPU microcontroller processes commands from any of the attached hardware interfaces: Ethernet (Web Browser UI, TCP/IP) or RS-232 Serial (optional MT-100A Microterminal, or Terminal Emulator program). Commands are processed to turn ON or OFF any one of the binary step sized delay sections to comprise the total delay in the signal path.

# Chapter 2.0

## Getting Started

### 2.1 Using the XR-100 for the First Time

After unpacking the instrument, carefully inspect it for any shipping damage. Remove all standard accessories from the shipping carton.



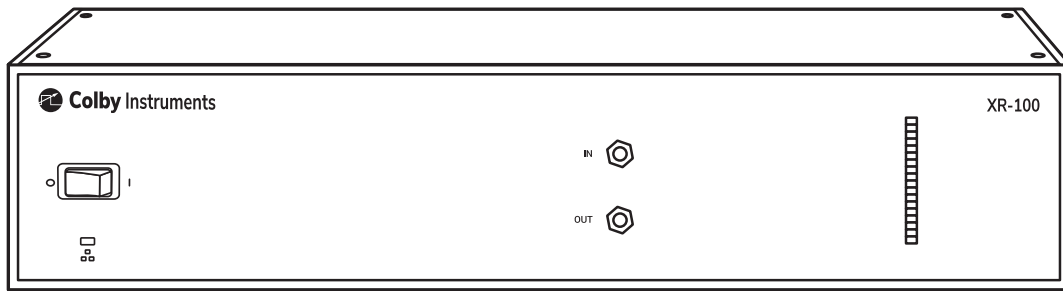
#### 2.1.1 Connecting cables to the XR-100

1. Plug in the XR-100 to a power source by inserting the AC power cord into the 85 to 240 VAC power entry module located on the back panel.
2. If you have an RJ-45 Ethernet cable, connect the cable into the Ethernet Port connector.
3. If you have the (optional) MT-100A MicroTerminal, connect the mated cable to the XR-100 and to the MT-100A MicroTerminal.



## 2.1.2 Turning power ON to the XR-100

Model XR-100 front panel



\*Push the flat rocker switch on the front panel to turn on the XR-100 System Unit.

## 2.2 Self-Test After Power Up

The XR-100 utilizes an embedded microprocessor to perform all necessary tasks. Upon power-up, the XR-100 will initialize and perform an initial self-test.

The XR-100 will now power cycle to OFF, ON, and then back to the OFF position of all the installed relays. The delay is reset to its zero delay (0.0 ps) position and the unit is ready to accept commands.

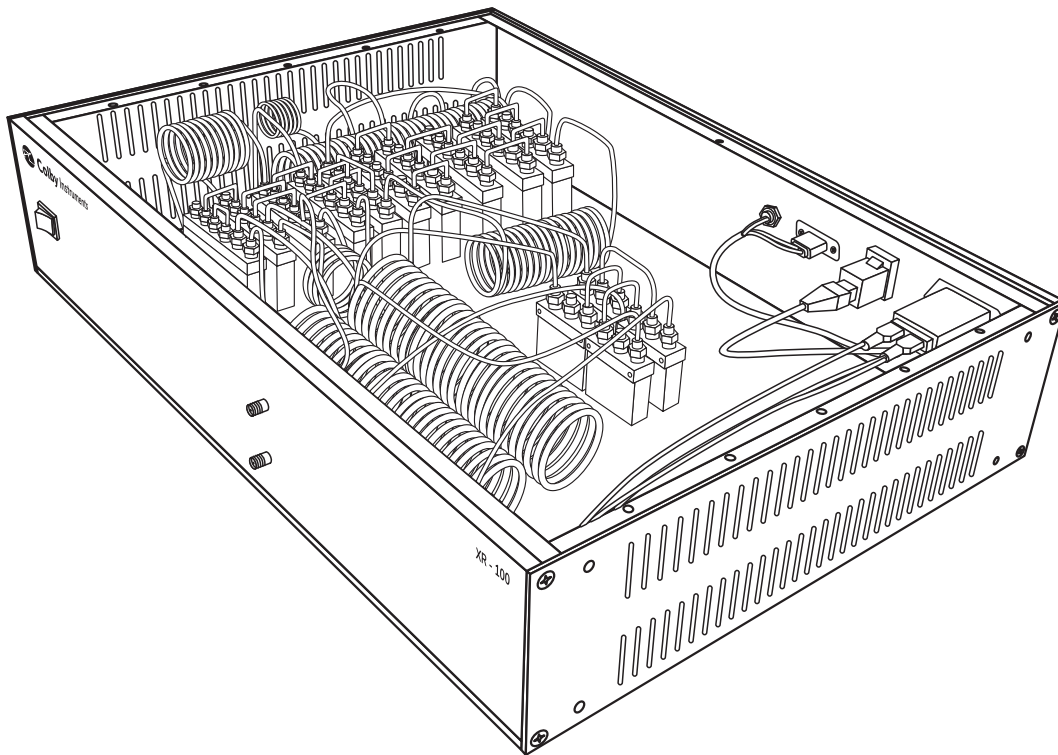
# Chapter 3.0

## Using the Front Panel Connections

### 3.1 Overview of the Front Panel Connections

The **IN** connector begins the signal path and continues through the in-series network of aerospace grade microwave relays and precision cut semi-rigid coaxial cable. The **OUT** connector is the end of this path.

**Model XR-100**



### 3.2 Model XR-100 Typical Delay/Relay Section Values

Delay/Relay Section #	XR-100-100N-005P-15	XR-100-100N-010P-14	XR-100-050N-010P-13	XR-100-200N-001N-8
1	5	10	10	1000
2	10	20	20	2000
3	20	40	40	4000
4	40	80	80	8000
5	80	160	160	16000
6	160	320	320	32000
7	320	640	640	64000
8	640	1280	1280	73000
9	1280	2560	2560	
10	2560	5120	5120	
11	5120	10240	10240	
12	10240	20480	20480	
13	20480	40960	9050	
14	40960	18090		
15	18095			
16				
TOTAL	100000	100000	50000	200000

# Chapter 4.0

## Connecting to XR-100 to Set Delay

There are two general methods to connect to the XR-100 to set the delay:

### Local

Locally via Web Browser UI via Ethernet interface or via the MT-100A Microterminal

### Remote

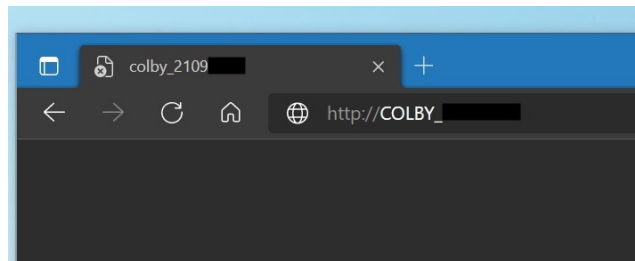
Remotely via the Ethernet TCP/IP (socket) interface or via the Serial Port RS-232 interface

### 4.1 About the default IP address and DHCP

The IP address for each instrument is determined by a DHCP Server on your network since DHCP is turned ON by default. The default hostname of your instrument is COLBY\_YYMMNNNN where YYMMNNNN is the serial number of your instrument. The instrument serial number, default hostname, and MAC:ID is provided with each instrument produced. This information is provided on the front page of this manual and located on the Backpanel of your instrument.

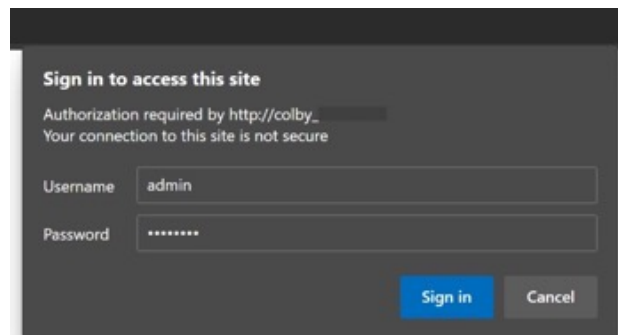
### 4.2 Working with Web Browser UI

From your Web Browser enter [http://COLBY\\_YYMMNNNN](http://COLBY_YYMMNNNN) into the search URL:



### 4.3 About the default Username and Password

The default Username is admin and Password is password. You will need to enter these values to sign-in to the XR-100 web server page.



## 4.4 About the XR-100 Web Server Control Page



control | info | configure | contact us

### Instrument Control XR-100

Channel 1 Delay:	0.00 ps <input type="text"/> ps <input type="button" value="Set Delay"/>
Increment Delay:	Step Size: <input type="text" value="10.0"/> ps <input type="button" value="+"/> <input type="button" value="-"/> Apply to: <input checked="" type="checkbox"/> CH 1
Relays:	$16$ 0000--0000--0000--0000 $1$ 14 Relay Sections
Relay # (1-16):	<input type="text"/> <input type="button" value="Toggle Relay(s)"/>
# of Cycles (1-100):	<input type="text"/> <input type="button" value="Exercise Relays"/>
Commands:	<input type="text" value="Perform Self-Test"/> <input type="button" value="Execute"/>
Message:	

Instrument control is located on this home page. You can set the delay in each channel by entering the desired delay and selecting the Set Delay button.

A step size value can be specified, and a delay channel selected to apply the change to. Select the + or - button to apply the step size amount of delay.

In the Commands section, a Self-Test or Reset can be performed after selecting the desired item and applying the Execute button.

## 4.5 About the XR-100 Web Server Information Page



[control](#) | [info](#) | [configure](#) | [contact us](#)

### Information

Instrument Model:	XR-100
Manufacturer:	Colby Instruments
Serial Number:	21090104
Description:	XR-100 Programmable Delay Line Instrument
# of Channels:	1
Delay Range:	100.00 ns
Step Size:	0 ns
Hostname:	<input type="text" value="COLBY_21090102"/> <input type="button" value="Set Hostname"/>
MAC Address:	00:C0:33:12:D9:55
TCP/IP Address:	192.168.8.29
Firmware Version:	V1.00
Message:	

Specific information regarding your instrument is displayed on this page.

The Hostname can be changed or set from this page.

## 4.6 About the XR-100 Web Server Configure Page



[control](#) | [info](#) | [configure](#) | [contact us](#)

### Configure XR-100

Description:	<input type="text" value="XR-100 Programmable Delay Line Instrument"/>
Password:	<input type="text" value="password"/>
DHCP:	<input checked="" type="radio"/> on <input type="radio"/> off
IP Address:	<input type="text" value="192.168.8.29"/>
Netmask:	<input type="text" value="255.255.255.0"/>
Gateway:	<input type="text" value="192.168.100.1"/>
Port #:	<input type="text" value="5025"/>
Hostname:	<input type="text" value="COLBY_21090102"/>
Terminal Mode:	<input checked="" type="radio"/> MT-100A <input type="radio"/> Serial Port
<input type="button" value="Revert"/> <input type="button" value="Defaults"/> <input type="button" value="Save"/>	

The XR-100 instrument IP address (static or dynamic), socket port number, password, network mask, and gateway address can be set here. NOTE: any of these changes may result in an instrument RESET and loss of connection to your existing web browser session.

## 4.7 Working via Remote Interfaces

There are two different ways to connect remotely:

- Ethernet TCP/IP**
- RS-232 Serial Port**

## 4.8 Communicating over Ethernet TCP/IP

TCP/IP Socket Protocol sends data packets to individual IP addresses over a unique and pre-specified port. The XR-100 supports fixed (static) and dynamic IP addresses and accepts sockets through a specified port number.

Network Addresses including IP address, Gateway IP, Netmask, DHCP, and Port Number can be specified or changed by sending commands to the XR-100 using the TCP/IP, or RS-232 interfaces.

To change the network addresses using a command interface, see Chapter 5.0 APIs and Commands (NET, NET? and NETM? commands).

## 4.9 Default Network Addresses

	Value
IP Address	0.0.0.0 (determined by DHCP) default
Gateway Address	192.168.100.1
Netmask	255.255.0.0
DHCP	ON
Port Number	5025
Hostname	COLBY_YYMMXXXX
MAC-ID	XX-XX-XX-XX-XX-XX

These default network addresses are stored internally in non-volatile storage. If you are unable to communicate with the XR-100 over Ethernet after changing a network address and want to restore the default address settings, follow these instructions:

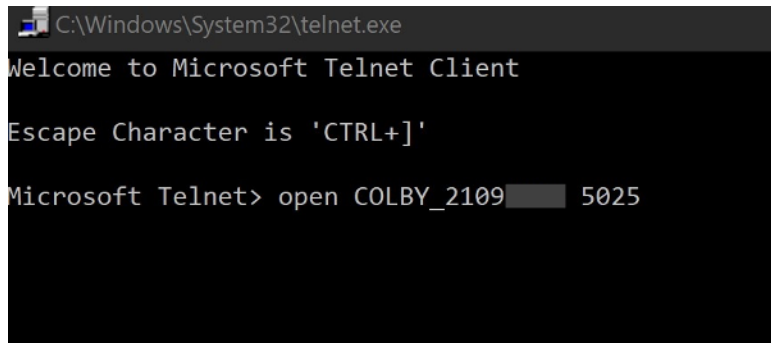
## 4.10 Restoring to Factory Default Settings

1. Turn off the XR-100
2. Remove the top cover of the instrument.
3. On the Channel 1 Trombone Unit (left most trombone when facing the instrument from the front), locate the center pin hole opening on the Trombone top cover.
4. Insert a needle point into the center hole to depress the Restore To Factory Default Button.
5. While keeping the button depressed, turn ON the XR-100 and keep the button depressed for at least 3 seconds and until the front panel lights flash 3x times ON-OFF,ON-OFF,ON-OFF and then fully OFF to acknowledge reverting to factory default settings.
6. Replace the top cover of the instrument.



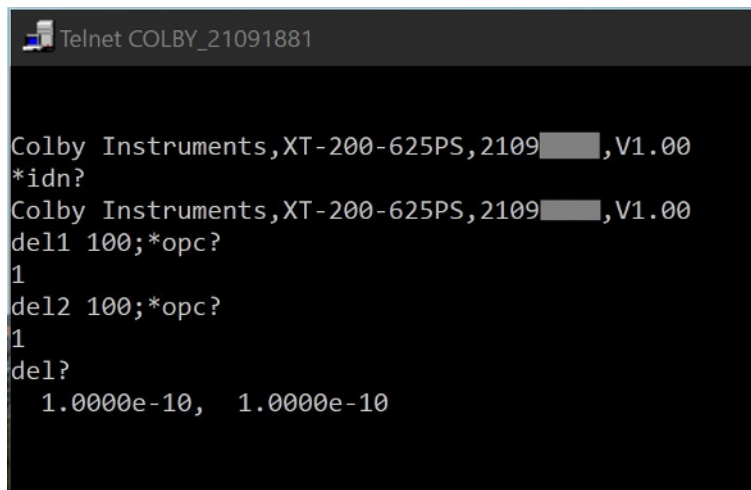
## 4.11 About Connecting via Telnet to the XR-100

You can access the XR-100 via an Ethernet Socket connection using the Telnet (or equivalent) utility. The default port # is 5025. A telnet session can be opened with using the hostname or the IP address of the XR-100.



```
C:\Windows\System32\telnet.exe
Welcome to Microsoft Telnet Client
Escape Character is 'CTRL+]'
Microsoft Telnet> open COLBY_2109 5025
```

After a connection is established, enter SCPI commands to communicate to the XR-100.



```
Telnet COLBY_21091881
Colby Instruments,XT-200-625PS,2109, V1.00
*idn?
Colby Instruments,XT-200-625PS,2109, V1.00
del1 100;*opc?
1
del2 100;*opc?
1
del?
1.0000e-10, 1.0000e-10
```

## 4.12 Setting the delay over RS-232 Serial Port and PC

The RS-232 Serial Port is located on the back panel of the XR-100 System Unit and is used to connect to either the MT-100A Microterminal (with the supplied DB-9 male to female cable) or to a PC (with a null model DB-9 female-to-male cable). Port speed is 9600 baud, 8 data bits, and 2 stop bits.

The XR-100 system unit can operate (send command prompts and receive command data) in either Terminal Mode or in MT-100A Mode. You must specify the correct mode prior to attaching either the MT-100A Microterminal or the PC else command prompts will be displayed incorrectly. Default is MT-100A Mode with the Microterminal attached when the XR-100 is first powered-on.

### 4.13 Attaching the MT-100A Microterminal to the RS-232 port

Ensure the MT-100A Mode is set by sending the command:

command/query	response	description
mode term on		enable MT-100A terminal mode on

to the XR-100. This command can be sent via TCP/IP or via RS-232. If the MT-100A is already connected, you can set the MT-100A Mode **ON** by pressing:

**SETUP** **3** **ENTER** on the MT-100A.

**Note: if the MT-100A Mode is OFF, command prompts from the XR-100 will be displayed incorrectly.**

Use the supplied DB-9 mated cable (supplied with MT-100A) to connect the MT-100A Microterminal to the XR-100 System Unit.

### 4.14 Attaching the PC to the RS-232 port

Ensure the MT-100A Mode is set by sending the command:

command/query	response	description
mode term off		set MT-100A terminal mode off

to the XR-100. This command can be sent via TCP/IP or via RS-232. If the MT-100A is already connected, you can set the MT-100A Mode **OFF** by pressing:

**SETUP** **3** **ENTER** on the MT-100A.

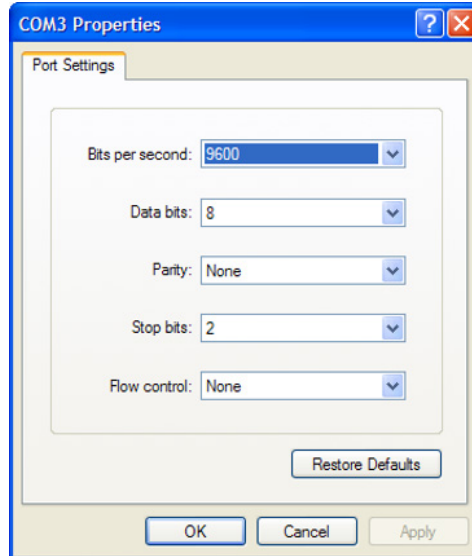
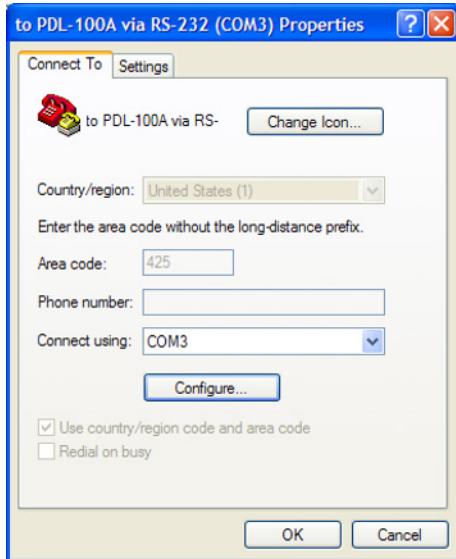
You must use a "null modem" cable when connecting the PC to the XR-100 System Unit. The null modem cable should have a male DB-9 connector to the XR-100 and a female DB-9 connector to the PC.

RS-232 Port speed is 9600 baud, 8 data bits, and 2 stop bits.

## 4.15 Using HyperTerminal and RS-232 connection

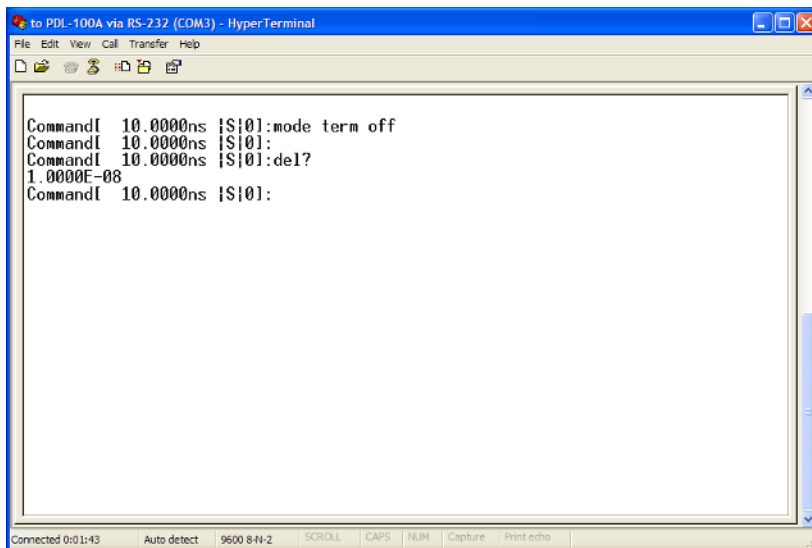
From Windows Desktop, click on the Windows Start button, click on All Programs, click on Accessories, click on Communications, and click on HyperTerminal to start the HyperTerminal application.

Click on File, and click on Properties:



1. Click on the Settings Tab to set the Port Settings.
2. Select 9600 bits per second to connect to the XR-100.
3. Select 2 Stop bits.
4. Select None for Flow Control

Press OK button to continue.



*HyperTerminal Session*

# Chapter 5.0

## Programming the XR-100

The XR-100 can be programmed remotely via a set of Application Programming Interface (API) Commands and Queries using a Standard Commands for Programmable Instruments (SCPI) naming convention and syntax.

### 5.1 About Programming the XR-100

The XR-100 accepts command over the Ethernet or RS-232 Serial port interface. The commands are specified in SCPI format. Commands and Queries are used to automate the operation of the instrument.

#### 5.1.1 Instrument ID

Each XR-100 has a unique Serial # identification.

Use the \*IDN? to query the instrument for its identification string.

query	response
<b>*idn?</b>	Colby Instruments,XR-100-625P,21091234,V1.00

#### 5.1.2 Setting the Delay using del1 or del2 commands

The delay in each channel can be specified using the **DEL1** or **DEL2** command.

command	description
<b>del 200 ps</b>	set delay to 200 ps
<b>del 200 ns</b>	set delay to 12.50 ns

#### 5.1.3 Querying the current delay setting

To query the current delay.

query	response	description
<b>del?</b>	1.0000e-08	delay setting

#### 5.1.4 Setting the delay using a numeric value only

The delay setting can be specified with a numeric value only. Use the UNITS command to set the current default units (either ps or ns) used when units are not specified

command	response	description
<b>100</b>		set delay to 100 (units are determined by units command)
<b>12.50 ns</b>		set delay to 12.50 ns

### 5.1.5 Determine if the operation has completed

After commanding the instrument to set a delay, e.g., sending a DEL command, use the \*OPC? query to determine when the operation has completed. A return value of "1" signifies the new delay setting has taken effect.

command	response	description
<b>del 100 ps</b>		set delay to 100 ps
<b>*opc?</b>	1	operation completed

### 5.1.6 Check the error code

After sending any command, use the \*ERR? or the ERR? query to determine the error code if any.

command	response	description
<b>del 100 ps</b>		set delay to 100 ps
<b>*err?</b>	0	no error

### 5.1.7 Determine the network address and settings

Use the NET? query to determine what the IP address, gateway address, DHCP status, and network settings.

command	response
<b>net?</b>	IP=192.168.8.27,NM=255.255.0.0,GW=192.168.100.1,PORT=5025,DHCP=ON,AD=ON

### 5.1.8 About the UNITS command

The UNITS command sets the default units (ps or ns) to be used when specifying a numeric delay value only (no DEL command).

command/query	response	description
<b>units ps</b>		sets default units to ps
<b>100</b>		set delay to 100 ps
<b>del?</b>	1.0000e-10	query delay
<b>units ns</b>		sets default units to ns
<b>100</b>		set delay to 100 ns
<b>del?</b>	1.0000e-07	query delay

### 5.1.9 Setting a STEP size and using the INC and DEC commands

Delay settings in each channel can be incremented or decremented by a pre-determined step size amount. Use the STEP command to set the step size amount and the INC (increment) or DEC (decrement) command to set the new delay setting.

command/query	response	description
<b>step 25 ps</b>		set step size
<b>step?</b>	2.5000e-11	query the step size
<b>del?</b>	1.000000e-10	
<b>inc</b>		increment
<b>*opc?</b>	1	operation complete
<b>del?</b>	1.250000e-10	
<b>dec</b>		decrement

## 5.2 About Relays in the XR-100

The XR-100 offers delay via an in-series Aerospace-grade microwave relays and precision-cut semi-rigid coaxial cable. Each delay section (relay pair) is a binary step sized multiple of the base step. The base step is the first delay section and is typically 10 ps or 1.0 ns. The actual total delay range and base step size is customer specified.

Typical instrument models:

Delay/Relay Section #	XR-100-100N-005P-15	XR-100-100N-010P-14	XR-100-050N-010P-13	XR-100-200N-001N-8
1	5	10	10	1000
2	10	20	20	2000
3	20	40	40	4000
4	40	80	80	8000
5	80	160	160	16000
6	160	320	320	32000
7	320	640	640	64000
8	640	1280	1280	73000
9	1280	2560	2560	
10	2560	5120	5120	
11	5120	10240	10240	
12	10240	20480	20480	
13	20480	40960	9050	
14	40960	18090		
15	18095			
16				
TOTAL	100000	100000	50000	200000

\*all values are ps units

With the binary step sized in-series path of delay/relay sections, any multiple of the base step size of delay can be achieved up to the total full range of the instrument. With a desired delay setting command, e.g., "DEL 25 NS", the XR-100 automatically determines which combination of delay/relay sections to turn ON or OFF to comprise the desired delay result.

Delay/relays sections can be commanded to turn on or off individually by using the REL command. If relays are not used over a long period of time, they may need to be cycled **off-on-off** or exercised in-order to overcome any stiction force that may be present from inactivity or storage over a long period of time. Use the RELC to cycle the relays from 1 to 100 cycles.

After specifying a DEL command and delay setting value, the XR-100 will switch the required relays and position the trombone motor. Use the \*OPC? query to check when the operation has completed before continuing with additional delay settings or commands.

# Chapter 6.0

## Application Programming Interfaces (API) and Commands

The following commands are specific to the XR-100 instrument:

Setting Delay Commands and Queries	
<b>DEL arg1 [ ps   ns ]</b>	Delay command set delay in active channel
<b>DEL?</b>	Delay query both channels
<b>ERR? or *ERR?</b>	Error query error status code

Relay Commands for Models XT-100-001N thru XT-100-100N	
<b>REL arg1 [ on   off ]</b>	Relay command set
<b>REL?</b>	Relay query
<b>RELC arg1</b>	Relay exercise cycles

System Commands	
<b>DEC</b>	Decrement step command
<b>INC</b>	Increment step command
<b>UNITS ns</b>	set units mode to ns for numeric values
<b>UNITS ps</b>	set units mode to ps for numeric values
<b>UNITS?</b>	returns current units mode for numeric values
<b>STEP arg1 [ ps   ns ]</b>	Step command set step size
<b>STEP?</b>	Step query step size

Networking Settings	
<b>NET IP arg1</b>	Set network IP address
<b>NET GW</b>	Set network gateway address
<b>NET NM</b>	Set network netmask
<b>NET PORT</b>	Set network port #
<b>NET DHCP</b>	Set DHCP to dynamic or static
<b>NET AD</b>	Set network autodrop connection
<b>NET HOSTNAME arg1</b>	Set network hostname
<b>NET?</b>	Query network settings
<b>NET? HOSTNAME</b>	Query network hostname
<b>NETM?</b>	Query network MAC-ID

<b>Common Commands</b>	
<b>*CLS</b>	Clears the instrument settings
<b>*IDN?</b>	Identification String (model and serial number)
<b>*RST</b>	Reset instrument
<b>*TST?</b>	Self-Test Trombone and Return Status
<b>*OPC</b>	Set Operation Complete Bit
<b>*OPC?</b>	Query the Operation Complete Bit



## 6.1 Setting Delay Commands and Queries

Common Commands	
<b>DEL arg1 [ ps   ns ]</b>	Delay command set delay in active channel
<b>DEL?</b>	Delay query both channels
<b>ERR? or *ERR?</b>	Error query error status code

DEL arg1	Set Delay (QUERY)						
<b>Description</b>	<p>The del command sets the delay to the value specified in arg1. The desired delay must be within the total delay range of the device.</p> <p>Delay can be specified in either picosecond (ps) or nanosecond (ns) units if the corresponding ps or ns is indicated. Default is picosecond units if not specified. The instrument will round <b>DOWN</b> to the nearest step size resolution if unable to provide exact delay as entered.</p>						
<b>Syntax</b>	<p><b>DEL arg1 [ ps   ns ]</b></p> <table border="1"> <tbody> <tr> <td><b>arg1</b></td> <td>desired delay setting value</td> </tr> <tr> <td><b>ps</b></td> <td>picosecond units</td> </tr> <tr> <td><b>ns</b></td> <td>nanosecond units</td> </tr> </tbody> </table> <p>Note: Picoseconds is the default units used if no units are specified in the command line.</p>	<b>arg1</b>	desired delay setting value	<b>ps</b>	picosecond units	<b>ns</b>	nanosecond units
<b>arg1</b>	desired delay setting value						
<b>ps</b>	picosecond units						
<b>ns</b>	nanosecond units						
<b>Example</b>	<p><b>del 312.50 ps</b></p> <p><b>del 100</b></p>						
<b>Returns</b>	None. Check error code.						

DEL?	Delay Setting? (QUERY)
<b>Description</b>	Returns the current delay settings for Channel 1 and Channel 2
<b>Syntax</b>	<p>&lt;x.xxxx-yy&gt;&lt;n &gt;</p> <p>(xxxx) is a 4 digit mantissa and (yy) a two digit exponent.</p>

ERR? or *ERR?	Error code query (QUERY)												
<b>Description</b>	Returns the error status												
<b>Returns</b>	<table border="1"> <tbody> <tr> <td><b>0</b></td> <td>No Error</td> </tr> <tr> <td><b>1</b></td> <td>Invalid Command</td> </tr> <tr> <td><b>2</b></td> <td>Invalid Argument</td> </tr> <tr> <td><b>3</b></td> <td>No calibration</td> </tr> <tr> <td><b>4</b></td> <td>Delay setting limit (out of range)</td> </tr> <tr> <td><b>5</b></td> <td>Delay not set</td> </tr> </tbody> </table>	<b>0</b>	No Error	<b>1</b>	Invalid Command	<b>2</b>	Invalid Argument	<b>3</b>	No calibration	<b>4</b>	Delay setting limit (out of range)	<b>5</b>	Delay not set
<b>0</b>	No Error												
<b>1</b>	Invalid Command												
<b>2</b>	Invalid Argument												
<b>3</b>	No calibration												
<b>4</b>	Delay setting limit (out of range)												
<b>5</b>	Delay not set												

## 6.2 Relay Commands for Models XT-100-001N thru XT-100-100N

<b>Relay Commands for Models XT-100-001N thru XT-100-100N</b>	
<b>REL arg1 [ on   off ]</b>	Relay command set
<b>REL?</b>	Relay query
<b>RELC arg1</b>	Relay exercise cycles

<b>REL arg1 [ on   off ]</b>	<b>Relay (COMMAND)</b>	
<b>Description</b>	Turns on or off the specified relay number arg1. The value 0 selects ALL relays.	
<b>Syntax</b>	<b>rel 1 on</b>	turn on relay #1
	<b>rel 0 off</b>	turn off all relays
<b>Returns</b>	None. Check error code.	

<b>REL?</b>	<b>Relay (COMMAND)</b>	
<b>Description</b>	Returns the current state of relays numbered left (#16) to right (#1)	
<b>Syntax</b>	rel?	
<b>Returns</b>	0000000000000101	

<b>RELC arg1</b>	<b>Exercise Relay Cycles (COMMAND)</b>	
<b>Description</b>	Exercise the relays by cycling the relays (OFF-ON-OFF) for the arg1 specified # of cycles in the range (1 to 100).	
<b>Syntax</b>	relc 50	
<b>Returns</b>	None. Check error code.	

## 6.3 System Commands

System Commands	
<b>DEC</b>	Decrement step command
<b>INC</b>	Increment step command
<b>UNITS ns</b>	set units mode to ns for numeric values
<b>UNITS ps</b>	set units mode to ps for numeric values
<b>UNITS?</b>	returns current units mode for numeric values
<b>STEP arg1 [ ps   ns ]</b>	Step command set step size
<b>STEP?</b>	Step query step size

<b>DEC</b>	<b>Decrement step (QUERY)</b>
<b>Description</b>	Decrement the delay setting by the step size amount.
<b>Returns</b>	None

<b>INC</b>	<b>Increment step (QUERY)</b>
<b>Description</b>	Increments the current delay setting by the step size amount.
<b>Returns</b>	None. Check error code.

<b>STEP arg1 [ ps   ns ]</b>	<b>Step command set step size</b>						
<b>Description</b>	Specifies the step size amount when using the INC or DEC command. Use INC (increment) or DEC (decrement) commands to change delay setting by the step size amount.						
<b>Syntax</b>	<p><b>step arg1 [ ps   ns ]</b></p> <table border="1"> <tbody> <tr> <td><b>arg1</b></td> <td>delay step size</td> </tr> <tr> <td><b>ps</b></td> <td>picoseconds</td> </tr> <tr> <td><b>ns</b></td> <td>nanoseconds</td> </tr> </tbody> </table>	<b>arg1</b>	delay step size	<b>ps</b>	picoseconds	<b>ns</b>	nanoseconds
<b>arg1</b>	delay step size						
<b>ps</b>	picoseconds						
<b>ns</b>	nanoseconds						
<b>Example</b>	step 100 ps						
<b>Returns</b>	None. Check error code.						

<b>STEP?</b>	<b>Step query (QUERY)</b>
<b>Description</b>	The <b>step?</b> query command is used return the current delay setting step size.
<b>Syntax</b>	<x.xxxxe-yy><nl> (xxxx) is a 4 digit mantissa and (yy) a two digit exponent.
<b>Returns</b>	5.0000e-12

<b>UNITS</b>	<b>Sets the default units (COMMAND)</b>	
<b>Description</b>	Sets the default units mode when specifying numeric delay setting values only, e.g., "123.50" (without the DEL command) and for display on MT-100A MicroTerminal.	
<b>Syntax</b>	<b>units [ ns   ps ]</b>	
	<b>ps</b>	picoseconds
	<b>ns</b>	nanoseconds
<b>Returns</b>	None. Check error code.	

<b>UNITS?</b>	<b>MODE active channel query (QUERY)</b>	
<b>Description</b>	Returns the current units for specifying values of delay directly	
<b>Returns</b>	<b>ps</b>	picoseconds
	<b>ns</b>	nanoseconds

## 6.4 Networking Settings

<b>NET IP arg1</b>	Set network IP address
<b>NET GW</b>	Set network gateway address
<b>NET NM</b>	Set network netmask
<b>NET PORT</b>	Set network port #
<b>NET DHCP</b>	Set DHCP to dynamic or static
<b>NET AD</b>	Set network autodrop connection
<b>NET HOSTNAME arg1</b>	Set network hostname
<b>NET?</b>	Query network settings
<b>NET? HOSTNAME</b>	Query network hostname
<b>NETM?</b>	Query network MAC-ID

<b>NET</b>	<b>Network Settings (COMMAND)</b>		
<b>Description</b>	The NET command sets the network addresses and other network settings for the instrument. Addresses are stored in non-volatile memory.		
<b>Syntax</b>	<b>NET [ IP   GW   NM   PORT   DHCP   AD ] [ON   OFF   arg1 ]</b>		
	<b>command</b>	<b>arg1</b>	<b>description</b>
	ip	XXX.YYY.ZZZ.AAA	set ip address
	gw	XXX.YYY.ZZZ.AAA	set gateway address
	nm	XXX.YYY.ZZZ.AAA	set network mask
	port	XXXX	port number
	dhcp	ON   OFF	DHCP
	ad	ON   OFF	autodrop
<b>Example</b>	<b>net ip 192.168.100.10</b> <b>net nm 255.255.0.0</b> <b>net port 5678</b> <b>net dhcp off</b>		
<b>Returns</b>	None. Check error code.		

<b>NET ip arg1</b>	<b>Network ip address set (COMMAND)</b>
<b>Description</b>	Sets the network ip address to arg1 (xxx.yyy.zzz.aaa)
<b>Returns</b>	None. Check error code.

<b>NET gw arg1</b>	<b>Network gateway address set (COMMAND)</b>
<b>Description</b>	Sets the gateway ip address to arg1 (xxx.yyy.zzz.aaa)
<b>Returns</b>	None. Check error code.

<b>NET nm arg1</b>	<b>Network socket port address set (COMMAND)</b>
<b>Description</b>	Sets the network socket address to arg1
<b>Returns</b>	None. Check error code.

<b>NET port arg1</b>	<b>Network netmask set (COMMAND)</b>
<b>Description</b>	Sets the network netmask to arg1 (xxx.yyy.zzz.aaa)
<b>Returns</b>	None. Check error code.

<b>NET ip arg1</b>	<b>Network ip address set (COMMAND)</b>
<b>Description</b>	Sets the network ip address to arg1 (xxx.yyy.zzz.aaa)
<b>Returns</b>	None. Check error code.

<b>NET dhcp on   off</b>	<b>Network dhcp enable set (COMMAND)</b>
<b>Description</b>	Sets the DHCP enable for dynamic IP address (on) or static IP address (off).
<b>Returns</b>	None. Check error code.

<b>NET ad on   off</b>	<b>Network autodrop socket connections (COMMAND)</b>
<b>Description</b>	Sets the network autodrop old socket connections to (on) or (off).
<b>Returns</b>	None. Check error code.

<b>NET hostname arg1</b>	<b>Network set new hostname (COMMAND)</b>
<b>Description</b>	Sets the network hostname to arg1.
<b>Returns</b>	None. Check error code.

<b>NET?</b>	<b>Network (QUERY)</b>
<b>Description</b>	The <b>net?</b> query retrieves the values for the <b>currently set</b> network addresses. Note: if no network cable is connected, the IP address returned is invalid (e.g., 0.0.0.0).
<b>Returns</b>	<b>IP=192.168.100.8,NM=255.255.255.0,GW=192.168.100.1, PORT=1234,DHCP=OFF,AD=ON</b>

<b>NET? hostname</b>	<b>Network query hostname (QUERY)</b>
<b>Description</b>	Returns the hostname network address.
<b>Returns</b>	<b>COLBY_YYMMNNNN</b>

<b>NETM?</b>	<b>Network MAC-ID query (QUERY)</b>
<b>Description</b>	The NETM? query returns the network MAC-ID address.
<b>Returns</b>	<b>MAC_ID=0000-0000-0000</b>

## 6.5 Common Commands

<b>*CLS</b>	Clears the instrument settings
<b>*IDN?</b>	Identification String (model and serial number)
<b>*RST</b>	Reset instrument
<b>*TST?</b>	Self-Test Trombone and Return Status
<b>*OPC</b>	Set Operation Complete Bit
<b>*OPC?</b>	Query the Operation Complete Bit

<b>*CLS</b>	<b>Clear Status (QUERY)</b>
<b>Description</b>	Clears the instrument and resets any pending errors codes.
<b>Returns</b>	None

<b>*IDN?</b>	<b>Instrument Identification Information (QUERY)</b>
<b>Description</b>	Returns the Instrument identification information.
<b>Returns</b>	<b>Colby Instruments,XR-100-625P,11111234,V1.00</b>

<b>*RST</b>	<b>Reset instrument (QUERY)</b>
<b>Description</b>	Performs an instrument device reset to its initial power-on state. Delay is set to zero delay setting in all channels. Network IP addresses (if previously changed) will take effect
<b>Returns</b>	None

<b>*TST?</b>	<b>Calibration Self-Test Check (QUERY)</b>				
<b>Description</b>	Performs an internal self-test by moving the electromechanical trombones to the maximum range limit, testing the optical sensor detection, returning to zero delay position, and re-initializing all internal variables.				
<b>Returns</b>	<table border="1"> <tr> <td>0</td> <td>Internal self-test passed.</td> </tr> <tr> <td>1</td> <td>Internal self-test failed.</td> </tr> </table>	0	Internal self-test passed.	1	Internal self-test failed.
0	Internal self-test passed.				
1	Internal self-test failed.				

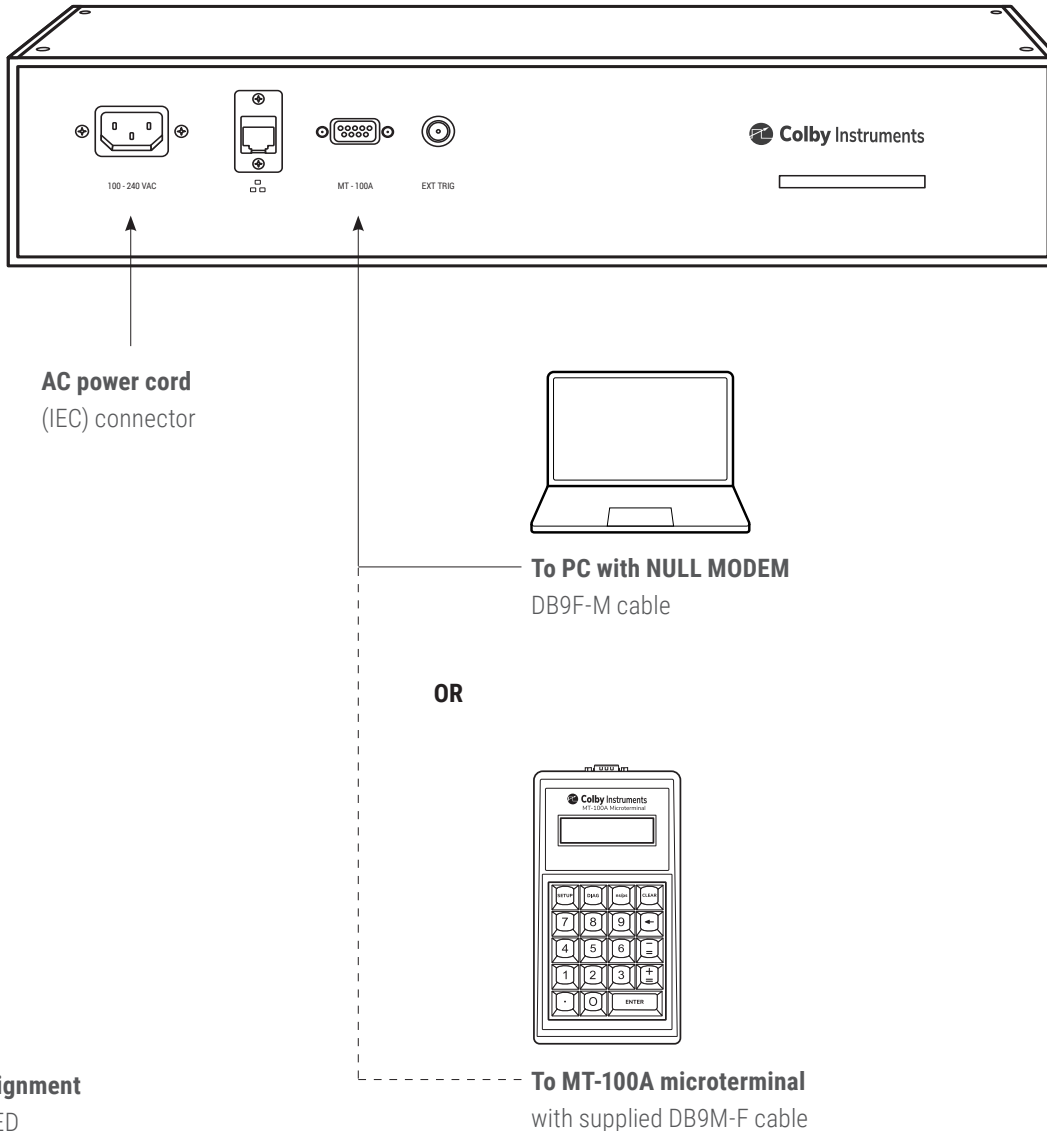
*OPC	Operation Complete Status Bit Set (COMMAND)
<b>Description</b>	Sets the Operation Complete Status bit when all pending device operations have finished. This is the default behavior for all command operations. <b>NOTE:</b> The <b>XR-100</b> blocks (i.e., does not return if queried using *OPC?) until all operations have completed. Use this query and return value to synchronize with automation application.
<b>Returns</b>	None

*OPC?	Operation Complete? (QUERY)				
<b>Description</b>	Returns the status of the Operation Complete Status bit. For all delay setting commands, the Operation Complete Status bit is <b>set</b> after the operation has completed (trombone motor movement has completed). *OPC? query should be used to synchronize setting the delay and waiting until the operation has completed.				
<b>Returns</b>	<table border="1"> <tbody> <tr> <td>0</td> <td>operation has not started yet</td> </tr> <tr> <td>1</td> <td>previous operation has completed</td> </tr> </tbody> </table>	0	operation has not started yet	1	previous operation has completed
0	operation has not started yet				
1	previous operation has completed				



# Chapter 7.0

## Instrument Backpanel



### DB-9 Pin Assignment

- PIN 1 UNUSED
- PIN 2 RXD TO X SERIES INSTRUMENT
- PIN 3 TXD FROM X SERIES INSTRUMENT
- PIN 4 UNUSED
- PIN 5 GND
- PIN 6 UNUSED
- PIN 7 UNUSED
- PIN 8 UNUSED
- PIN 9 +5V (FOR MT-100A)\*

\* DO NOT USE WHEN CONNECTING WITH PC VIA NULL MODEM CABLE

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