MiCOM Px4x

Advanced User Programmable Curve Tool

Px4x/EN AUPCT/A11

Software Version P14x (V46 and later) and P24x (V55 and later)

Advanced Guide

Schneider Electric

Note

The technical manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

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1 INTRODUCTION TO THE CURVE TOOL

1.1 What is the User Programmable Curve Tool?

The User Programmable Curve Tool (UPCT) allows you to create user-defined curves and to download and upload these curves to and from the MiCOM Px4x range of relays. You can use this tool to create programmable overcurrent and overfluxing operating and reset curves. The user-friendly Graphical User Interface (GUI) lets you easily create and visualize curves either by entering formulae or data points.

Although at some point in the future, the functionality may be incorporated into the MiCOM S1 suite, it is currently being provided as a stand-alone application.

1.2 Supported Devices

The following range of devices are currently supported

- P14x series of Feeder Protection relays with Software Version 46 and above
- P24x series of Motor Protection relays with Software Version 55 and above

1.3 Features

- Allows the user to create new configuration curve files or edit existing curve files
- Allows the user to enter a defined number of curve points or a user-defined formula
- Allows the user to create and save multiple formulae
- Allows the user-defined curve to be associated with a predefined curve Px4x template
- Allows interpolation between curve points
- Allows the user to save curve formulae in XML format and configured curve points in CSV format, enabling easy data exchange
- Allows the user to save configured curve data in CRV format, suitable for download into the relay
- Enables easy upload of the curve data from a relay
- Allows the user to input constants with user-defined values
- Graphically displays curves with zoom, pan, and point-on-curve facilities
- Color coding of multiple curves enables effective comparison
- Allows the user to print curves or save curves in a range of standard image formats

2 INSTALLATION AND SETUP

2.1 System Requirements

Minimum	Recommended
Processor: 1 GHz minimum	Processor: 2 GHz
Memory: 256 MB minimum	Memory: 1 GB
Operating systems: Windows 2000	Operating systems: Windows XP
Screen Resolution: 800 x 600	Screen Resolution: 1024 x 768

Table 1 - System requirements

2.2 Installation

Open the User Programmable Curve Tool installation folder and click on **setup.exe** to start the InstallShield wizard.

Follow the onscreen instructions, selecting whichever language you require. You should carry out a complete installation and to install all the templates, by ensuring the relevant options are selected (These are the default installation settings).

After successful installation the application can be accessed by clicking the shortcut on the desktop or shortcut in the Windows programs menu:

Start > Programs > Schneider Electric > User Programmable Curve Tool > User Curve Tool.

3 USER INTERFACE

Before starting, make sure that the RS-232 serial cable is connected to the RS-232 serial port on the front panel of the relay.

To start the User Programmable Curve Tool, double click on the icon installed on the desktop or select **Start** > **Programs** > **Schneider Electric** > **User Programmable Curve Tool**.

The Curve Tool splash screen appears followed by the main screen (see Figure 1.

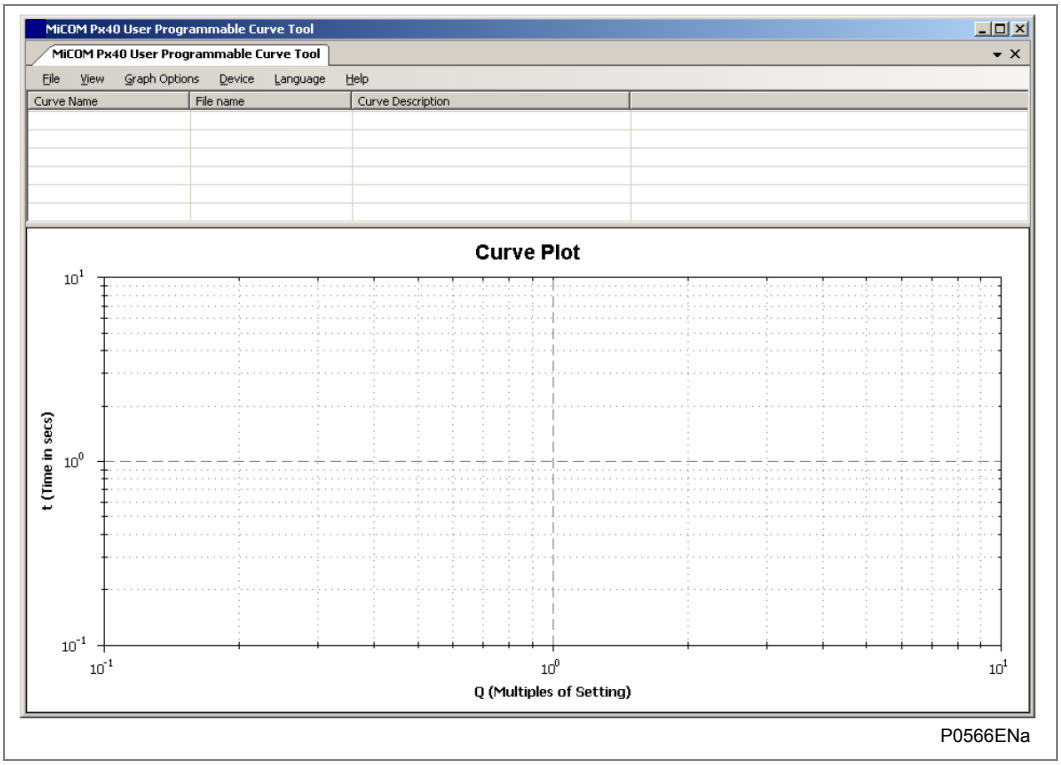


Figure 1 - Curve Tool User Interface

The main screen consists of:

- The main menu bar
- The curve selection table
- The Curve Plot area

These separate items are dealt with in the following sections.

3.1 Summary of Menu Items

3.1.1 File

Menu item	Description
File > New > Formula	Opens up a new formula or new input table
File > New > Input Table	Opens up a new input table
File > Open Curve	Opens up existing curve
File > Close Curve	Closes curve
File > Save > Input Table View	Saves curve file in CSV format
File > Save > Product View	Saves curve file in CRV format
File > Save As > Input Table View	Saves new file in CSV format
File > Save As > Product View	Saves new file in CRV format
File > Save As > Dcc File	Saves new file in CSV format (for Omicron)

Table 2 - File menu

3.1.2 View

Menu item	Description
View > Show Curve Details	Opens up the Curve Details dialog
View > Show Formula Editor	Opens up the Formula Editor dialog

Table 3 - View menu

3.1.3 Graph Options

Menu item	Description
Graph Options > X-Axis Scale > Linear	Selects linear x-axis scale
Graph Options > X-Axis Scale > Logarithmic	Selects logarithmic x-access scale
Graph Options > Y-Axis Scale > Linear	Selects linear y-axis scale
Graph Options > Grid Lines > Logarithmic	Selects logarithmic y-access scale
Graph Options > Grid Lines > Major Grid Lines	Shows grid lines in a course scale
Graph Options > Grid Lines > Minor Grid Lines	Shows grid lines in a fine scale

Table 4 - Graph Options menu

3.1.4 Device

Menu item	Description
Device > Connection Configuration	Configure the communications interface
Device > Send Curve	Send a curve to a relay
Device > Extract Curve	Extract a curve from a relay

Table 5 - Device menu

3.1.5 Language

Menu item	Description
Language > Deutsch	German
Language > English	English
Language > Español	Spanish
Language > Français	French
Language > Deutsch	German
Language > Русский	Russian
Language > 中文	Chinese* * You must ensure your PC is configured for this language

Table 6 - Language menu

3.1.6 Help

Menu item	Description
Help > Help Content	Invokes HTML help system
Help > About	Displays information on software name and version

Table 7 - Help menu

3.2 Curve Selection

The Curve selection pane contains a list of available curves. As you import or create more curves, they will appear as row items in this table. The curves are plotted on the graph if their relevant checkbox is checked.

You select a curve for upload or download by clicking on the curve name, whereby it will become highlighted.

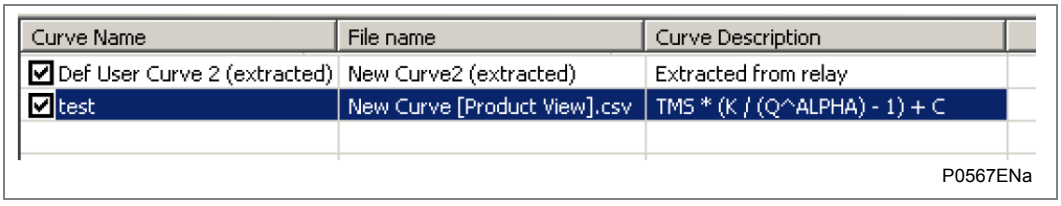


Figure 2 - Curve selection

3.3 Curve Plot

The **Curve Plot** area is used to display the curves. It displays the time on the y-axis versus Q (multiples of nominal current) on the x-axis. This is the standard method of defining protection relay configuration curves.

You can carry out a range of flexible operations on the curves from the context sensitive menu, invoked by clicking the right mouse button anywhere in the plot area. Operations include copying and saving the image, zooming, panning and printing. These are summarized in Table 8.

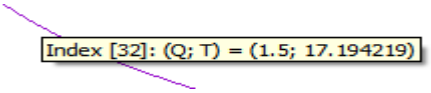
Menu item	
Copy	Copy image to clipboard
Save Image As…	Save image in one of the formats: PNG, GIF, JPEG, TIFF, BMP
Page Setup…	Set up the page for printing
Print Preview	View the page as it will be printed
Print…	Print the page
Show Point Values	This shows the data point (Q & T) on any point of the graph according to where your mouse cursor is positioned. For example: 
Un-Zoom	Un-zooms, last zoom action
Undo All Zoom/Pan	Reverts to original view.
Set Scale to Default	Sets the scale to the default value

Table 8 - Curve Plot operations

3.3.1 Zooming and Panning

To zoom in, click and hold the left mouse button and drag to define the area of interest. To pan, click and hold the left mouse button whilst holding the shift key and move the mouse in the relevant direction.

To un-zoom or un-pan, right-click on the Curve Plot to invoke the context sensitive menu and select the relevant menu item.

3.3.2 Scales

You can set the scale of each axis to either logarithmic or linear. You do this from the Graph Options menu.

3.3.3 Grid lines

You can show or hide grid lines using the Graph Options menu.

3.4 Curve Details Pane

You can bring up further details about the curves by selecting **View** > **Show Curve Detail**.

The **Curves Points Details** window appears and occupies the left-hand-side of the Curve Plot screen, condensing the Curve Plot screen into the right-hand-side of the screen. You can alter the width of the two areas by positioning the mouse curser on the vertical border between the two areas and dragging. The Curve Detail dialog can be closed at any time by clicking the cross in the right-hand corner. You can also auto-hide the Curve detail by clicking the icon next to the cross. This will allow you to view the plot in full size, and only show the curve detail when you position the cursor in the marked area in the left-hand margin. Figure 3 shows the User Interface with the Curve Detail displayed.

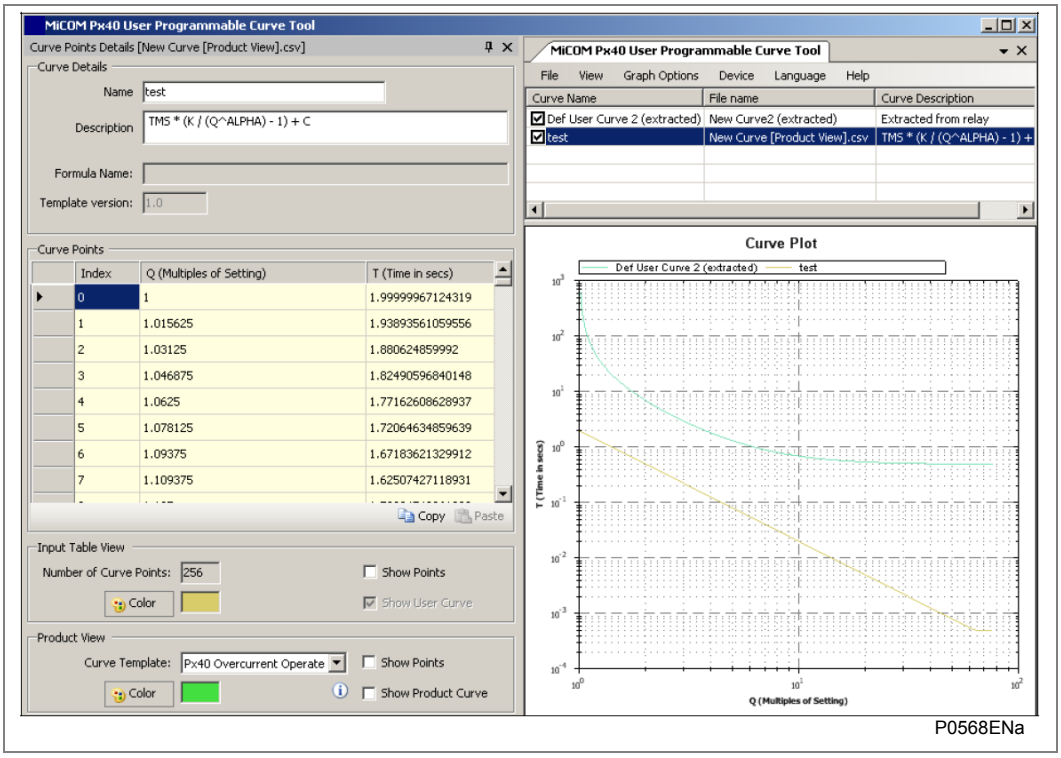


Figure 3 - Curve Tool desktop with Curve Detail displayed

The **Curves Points Details** area consists of four panes, which will now be described.

- Curve Details
- Curve Points
- Input Table View
- Product View

In the **Curve Details** pane you can define the name and description of the user curve. You can enter a string up to 16 standard ASCII characters**.** If you do not enter a name, the default name **New Curve** will be used.

The formula name and template version are also displayed if applicable.

3.5 Curve Points Pane

The **Curve Points** pane displays consists of three columns as described in Table 9.

Column	Description
Index	Each curve point has a unique index number associated with it, starting at 0, incrementing by 1 and ending with the last curve point.
Q (multiples of setting)	Q, in this context stands for Quantity. It is the secondary current I_s expressed in multiples of the nominal current I_n.
T (Time in secs)	T is the imposed delay time, expressed in seconds.

Table 9 - Curve Points Pane

3.5.1 Entering Values into the table

You can input values for Q and T to define a table. You do this by selecting **File** > **New** > **Input Table**. You insert the values for Q and T accordingly. You can insert up to a maximum of 256 curve points (index 0 to 255). If fewer points are inserted, the tool automatically interpolates points using a linear interpolation method.

The tool instantaneously updates the graph view as points are entered.

You can also copy and paste an entire table from Excel or other compatible table formats. You do this by copying the table to the clipboard, positioning the cursor in the top left-hand Q cell and pasting.

3.6 Input Table View Pane

In this pane, you can elect to show the user curve and/or its associated points or not. It also allows you to choose the color of the plotted user curve.

3.7 Product View Pane

In this pane, you can select a curve template from the Px40 product range. You can also choose whether to plot the product curve and/or its points or not. It also allows you to choose the color of the plotted product curve. Curve template definition is described in section 3.9.

3.8 Formula Editor

You open up the Formula Editor by selecting View > Show Formula Editor.

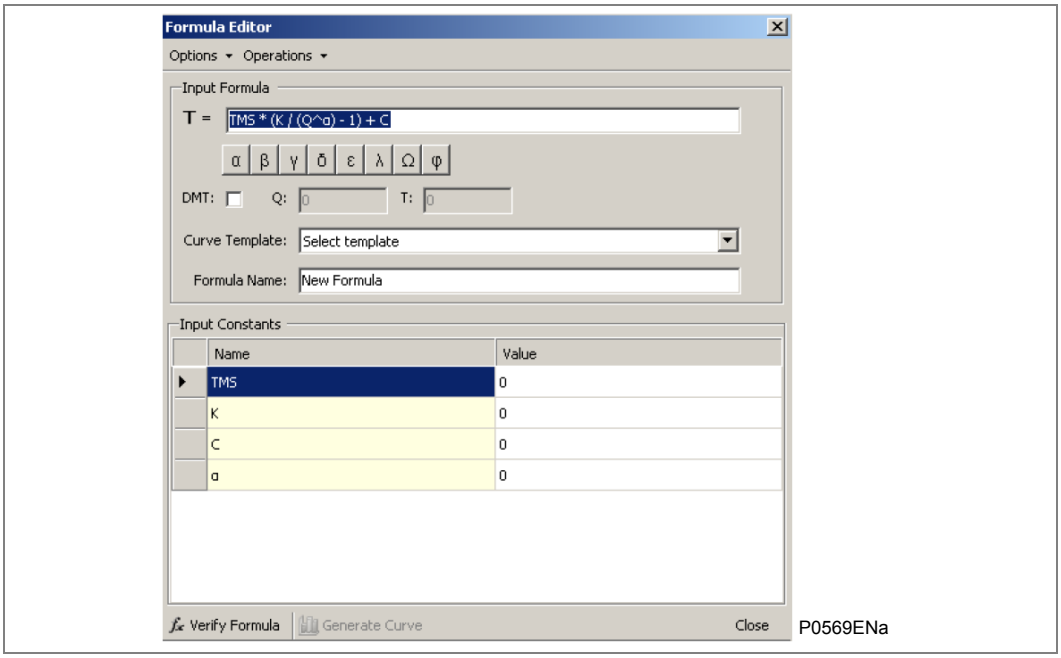


Figure 4 - Formula Editor

The **Formula Editor** dialog allows you to define your own formula. You enter the formula into the **T=** field. The operators available to you are described in Table 10. The formula is case sensitive. You may use only upper-case letters.

The curve you are creating with the formula must be associated with a predefined template, which must match the template of one of the four curves stored in the relay. You select the required template from the **Curve Template** dropdown box. The template defines a curve of with a specific spread of points which can be downloaded to the protection relay. This aspect is described in section 3.9.

You enter the formula name into the **Formula Name** field. This can be any combination of standard ASCII characters up to 32 characters.

If you require a Definite Time characteristic check DMT (Definite Minimum Time) checkbox. This enables the Q and T value entry fields, into which you can enter fixed values for the tripping current and the delay time.

You can enter whatever constants you like into the formula. For your convenience, the first eight letters of the Greek alphabet have been included on the formula editor as buttons. Click on a button to enter the character in the formula field.

The allowed operators are summarized in Table 10.

Operators	Description
+	Plus
-	Minus
*	Multiply
/	Divide
^	Raise to the power of
sqrt()	Square Root
ln()	Natural logarithm

Operators	Description
Sin	Sin function
Cos	Cos function
Tan	Tan function

Table 10 - Allowed Operators

To validate the formula, click the **Verify Formula** button at the bottom left corner of the screen. The names of the constants used in the formula are displayed in the **Input Constants** table. The formula verifier checks that the operators are valid, but does not check that the formula itself is valid or whether the results will be out of range.

3.8.1 Entering the Constants

You input the formula constants in the **Value** column.

3.8.2 Saving the Formula

To save the formula, select the **Options** tab then click **Save As…**

Choose a file name. The file is saved in XML format. You can enter up to 16 standard ASCII characters**.**

3.8.3 Generating the Curve

Once the constants have been entered and the file has been saved, the **Generate Curve** button (next to the **Verify Formula** button) becomes enabled. Click this button to generate a curve.

The curve is generated in the **Curve Plot** window.

3.8.4 Operations Tab

The Operations tab provides exactly the same functionality as the **Verify Formula** button and the **Generate Curve** button.

3.9 Curve Template Definitions

Many protection relay functions have a characteristic to define their Operate and Reset operation in the form of inverse curves, with current on the x-axis and time on the y-axis. Each curve is made up of 256 points, which defines its characteristic. Figure 5 shows an example of some typical inverse curves. Please note that the curves here are shown purely to provide an idea of the characteristic shape, and are not specific to the products described in this manual.

In the Phasor tool, the curves created with the formula or points table must match the templates of their respective curves stored in the relay. Each curve is defined by 256 points with a specific spread of the points in different areas of the curve.

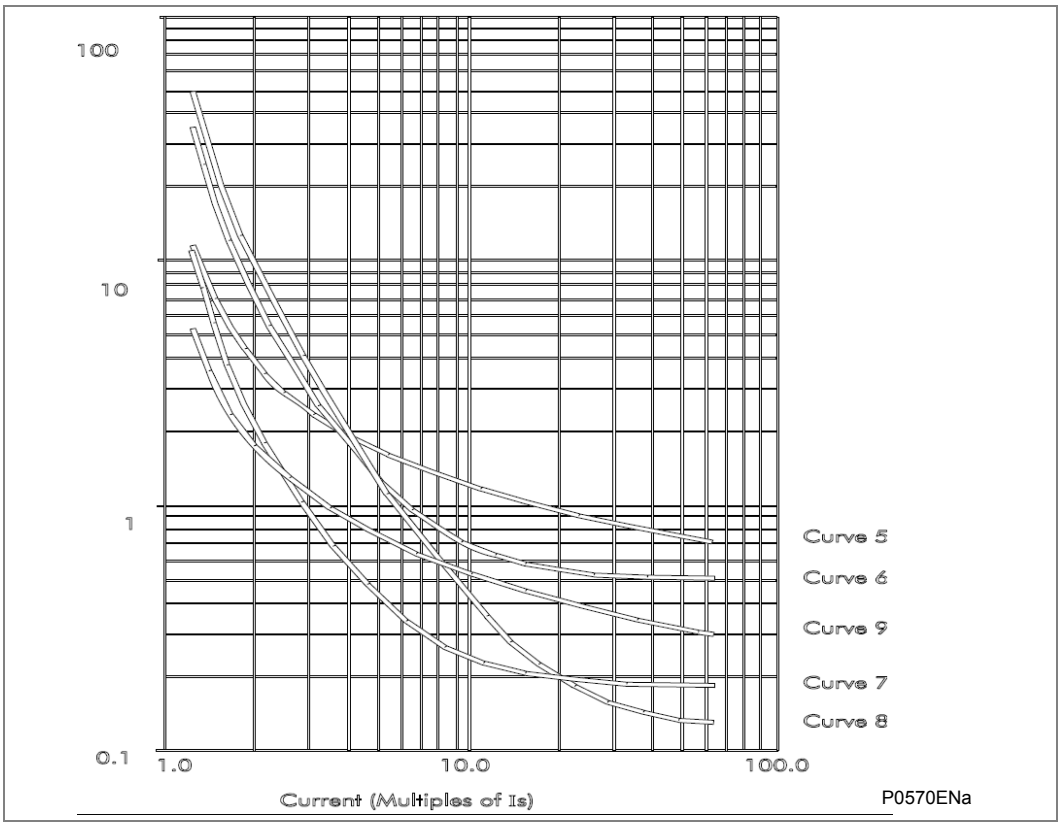


Figure 5 - Example Curves

The UPCT currently supports templates for the P24x series only, so only these curves are described here.

Curve	Template	Description
Curve 1	Px40 Overcurrent Operate	Overcurrent protection IDMT operate curve
Curve 2	Px40 Overcurrent Reset	Overcurrent protection IDMT reset curve
Curve 3	P24x Thermal Overload Operate	Thermal overload protection operate (heating) curve
Curve 4	P24x Thermal Overload Reset	Thermal overload protection reset (cooling) curve

Table 11 - Curve tool curve templates

The curve templates have a clearly defined number of graphical points to define certain portions of the curve. The following tables summarize these template definitions.

Range	Number of points
Range 1: 1x to 3x setting	128
Range 2: 3x to 32x setting	116
Range 3: 32x to 76x setting	12
Overall range	256

Table 12 - P24x Overcurrent operate

Range	Number of points
Range 1: 1x to 0.96x setting	116
Range 2: 0.96x to 0.7x setting	128
Range 3: 0.7x to 0x setting	12
Overall range	256

Table 13 - P24x Overcurrent reset

Range	Number of points
Range 1: 1x to 4x setting	150
Range 2: 4x to 5x setting	68
Range 3: 5x to 10x setting	32
Range 3: 10x to 32x setting	6
Overall range	256

Table 14 - P24xThermal overload operate

Range	Number of points
Range 1: 1x to 0.96x setting	116
Range 2: 0.96x to 0.7x setting	128
Range 3: 0.7x to 0x setting	12
Overall range	256

Table 15 - P24x Thermal overload reset

3.10 Connection Configuration

The UPCT is currently a stand-alone application therefore it must be possible to set up communication independent of the MiCOM S1 software. For this reason, the UPCT provides its own connection configuration facility.

The **Connection Configuration** dialog is invoked by selecting **Device** > **Connection Configuration**. This screen is used to define the communication settings for downloading and uploading the curves to and from the relay. The Px40 series of relays have a front serial RS232 port, a rear serial RS485 port, and another rear port that can be either an additional RS485 serial port or an Ethernet port (but not both). The supported ports are summarized in Table 16.

Port	Interface	Typical use
Front serial port	RS232	Local setup (temporary)
Rear Serial port	RS485	Multi-drop SCADA
Ethernet port	10/100Mbps Ethernet	Network SCADA

Table 16 - Supported communications

The **Edit Connection** dialog will depend on the port used. You select which port you wish to configure from the **Scheme** dropdown box. Figure 6 shows the screen, which appears if either of the serial ports is selected and Figure 7 shows the **Ethernet** screen. Figure 8 shows the Transactions Values screen, which appears when you click on the **Transaction Values** tab.

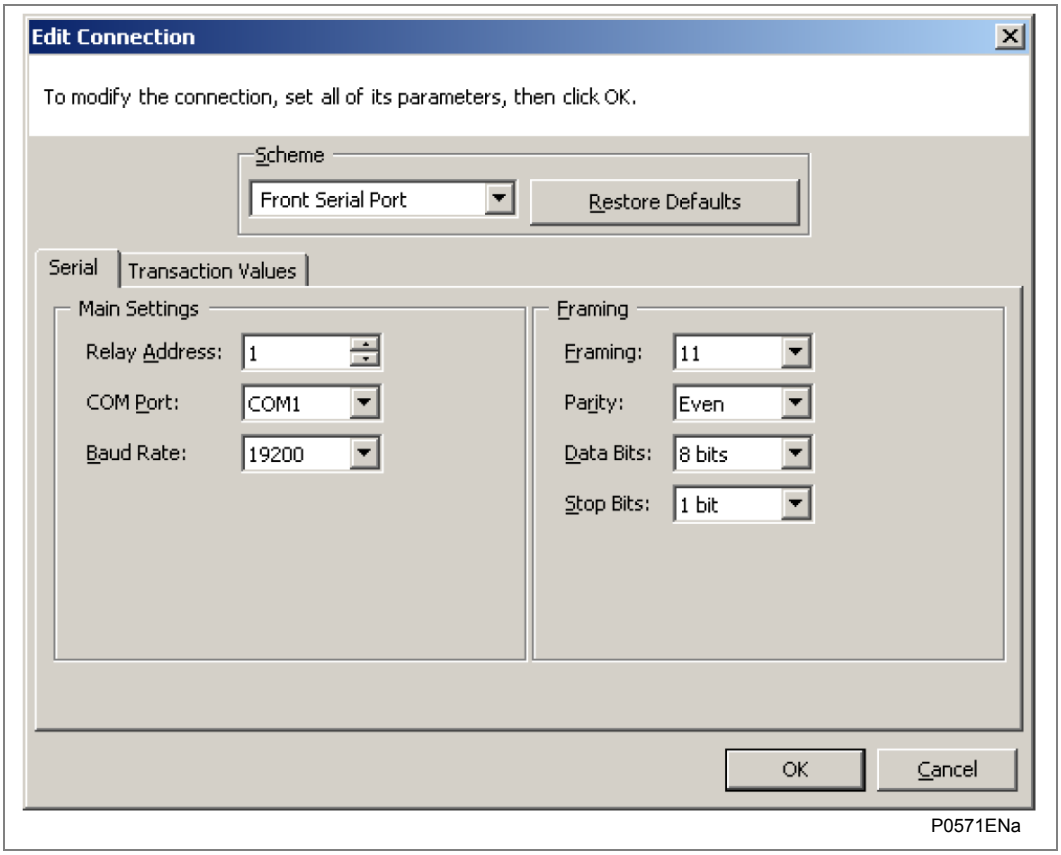


Figure 6 - Serial communication settings

The **Serial** tab allows you to enter the serial communication parameters. The fields are already populated with the default settings.

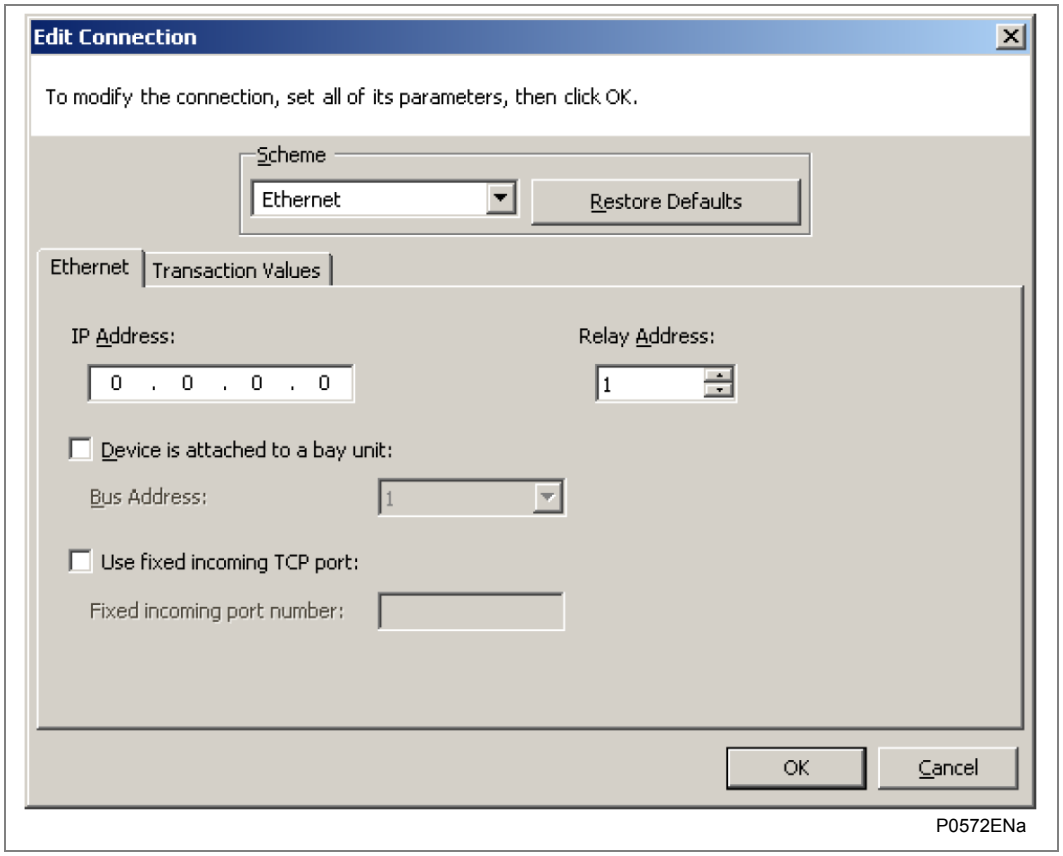


Figure 7 - Ethernet communication settings

Some devices support Ethernet connectivity. The UPCT allows you to enter the IP address and TCP port parameters.

There is no DHCP support, so the IP address must be known and entered manually for Ethernet configuration.

The TCP port may be chosen either dynamically or statically. If you require a static TCP port, you must check the **Use fixed incoming TCP port** checkbox and enter the port number.

If the device is attached to a bay unit, the bus address must be specified. You select this from the dropdown box, which becomes enabled once you have checked the **Device is attached to a bay unit:** checkbox.

The Courier address of the relay must be specified. This is simply an integer, which can be entered into the **Relay Address** field either manually or with the up and down arrows.

3.10.1 Transaction Configuration

Schneider Electric has a proprietary protocol called Courier, which is used for the SCADA communications between relays. This protocol has a set of transaction parameters associated with it, which must be defined. The values will vary depending on the type of communication interface used.

The **Transaction Value** screen is shown in Figure 8. The screen is the same for the other two supported interfaces, but the actual values are different depending on which port is selected. The screenshot shown shows the default values for the Front serial port.

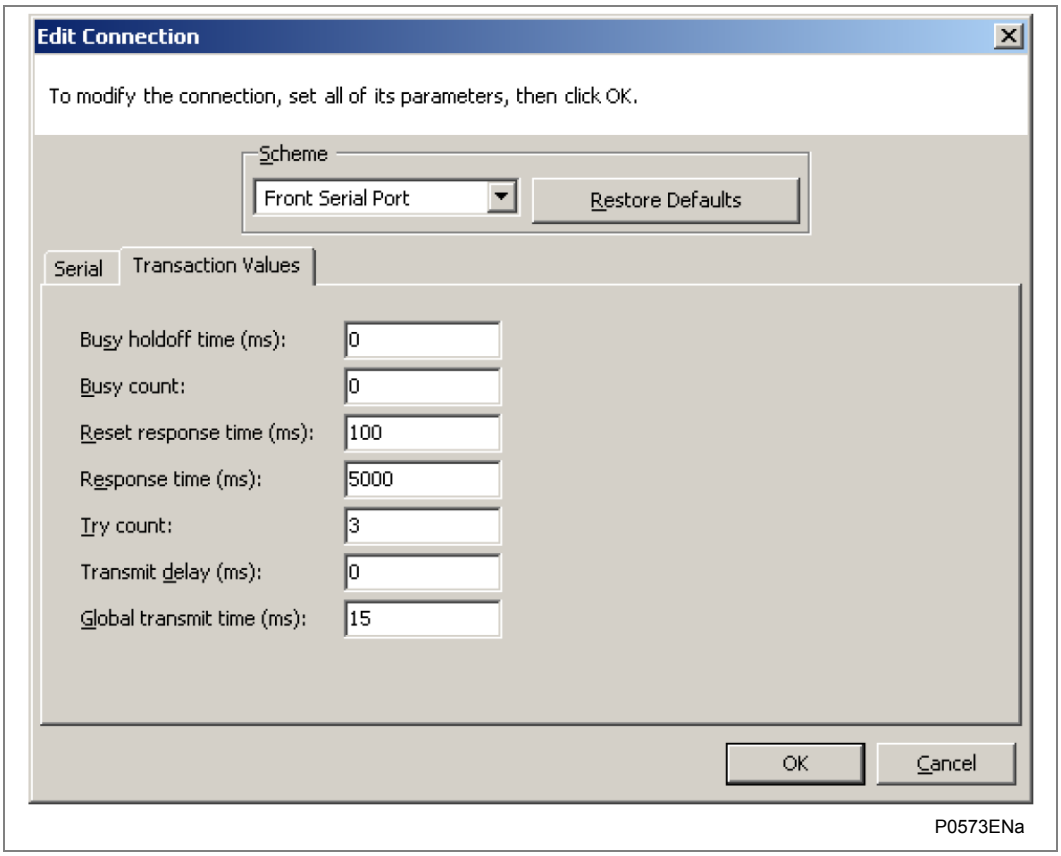


Figure 8 - Transaction Values

The default Transaction Values are entered automatically for each of the three types of communication. These can be changed if necessary. The parameters are described in Table 17, and the default values are shown in Table 18.

Transaction Value	
Busy Hold-off Time (ms)	The time interval used by Courier between receiving a BUSY response and sending a subsequent POLL BUFFER commands.
Busy Count	The maximum number of BUSY responses that will be accepted for a single Courier transaction before aborting the transaction. In order to cope with abnormal situations where a device is not replying correctly to requests, a limit is placed on the number of BUSY responses that should be accepted. Without this limit the link to the device would get stuck in a loop.
Reset Response Time (ms)	The maximum time from a sending the last byte of a Courier Reset Remote Link message to receiving the first byte of a response. When that time has elapsed the request is aborted.
Response Time (ms)	The maximum time from a sending the last byte of a Courier message to receiving the first byte of a response. When that time has elapsed the request is aborted. The Response Time parameter is used for all messages except Courier Reset Remote Link messages.
Try Count	The number of tries to be used before aborting the request.

Transaction Value	
Transmit Delay Time (ms)	The minimum delay that is put between receiving a response and transmitting the next request. Transmit delay is normally set to zero. Transmit delay may be set to a few milliseconds when using half duplex communication to provide time for the other end of the link to change its mode of operation from transmitting to receiving.
Global Transmit Time (ms)	The minimum delay that is put between transmitting a global message and the next transmission.

Table 17 - Transaction Values – description

Transaction Value	Front port	Rear port	Ethernet
Busy Hold-off Time (ms)	0	50	0
Busy Count	0	100	0
Reset Response Time (ms)	100	100	100
Response Time (ms)	20000	100	20000
Try Count	2	3	2
Transmit Delay Time (ms)	0	5	0
Global Transmit Time (ms)	15	15	15

Table 18 - Transaction Values – default values

If you change the settings, you can revert to the default settings by clicking on the **Restore Defaults** button.

3.11 Send a Curve to a Relay

Select the curve to be downloaded by clicking in the relevant row. It will become highlighted in blue.

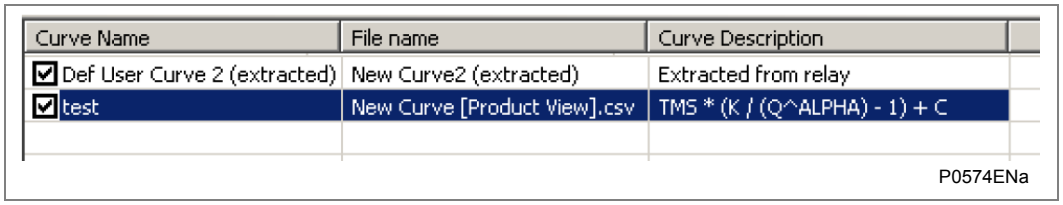


Figure 9 - Curve Listing

Click the **Device** tab and select **Send Curve**. The Send Curve Form appears.

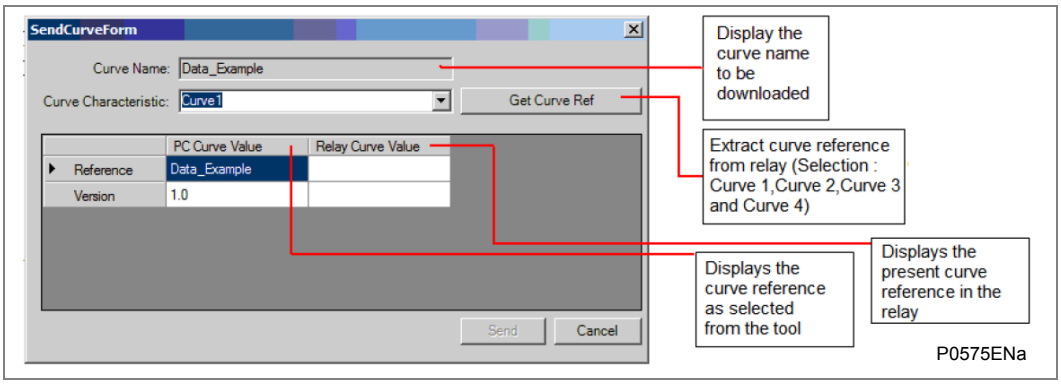


Figure 10 - Send Curve Form

The relay stores four curve characteristics as summarised in Table 19. Select which curve you wish to overwrite from the **Curve Characteristic** dropdown box.

Curve	Description
Curve 1	Px40 Overcurrent Operate
Curve 2	P24x Thermal Overload Operate
Curve 3	Px40 Overcurrent Reset
Curve 4	P24x Thermal Overload Reset

Table 19 - Curves stored in relay

Click Send to download the curve to the relay.

Click **Get Curve Ref** for verification.

If the download was successful, the PC Curve Value will be the same as the Relay Curve Value, because it will have overwritten the existing Relay curve value, as shown in Figure 11.

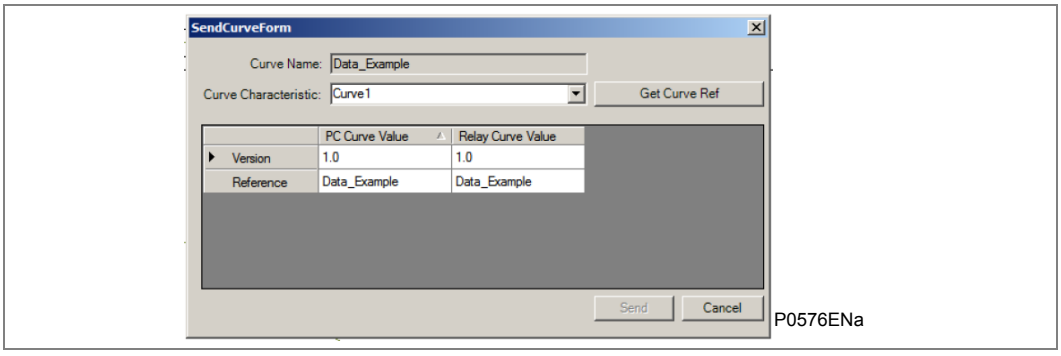


Figure 11 - Get Curve Ref

Extract curve from relay and save it on computer in CSV format or CRV format.

4 GLOSSARY OF TERMS

Symbol	Description
ASCII	American Standard Code for Information Interchange
BMP	BitMaP – a file format for a computer graphic
CRV	Curve
CSV	Comma Separated Values (a file format for database information)
Courier	Schneider Electric's proprietary SCADA communications protocol
DCC	Omicron compatible format
DHCP	Dynamic Host Configuration Protocol
DMT	Definite Minimum Time
EIA	Electronic Industries Alliance
GIF	Graphic Interchange Format – a file format for a computer graphic
GUI	Graphical User Interface
HTML	Hypertext Markup Language
I_n	Nominal Current
JPEG	Joint Photographic Experts Group – a file format for a computer graphic
ln	Natural logarithm
I_s	Secondary Current
PNG	Portable Networks Graphic – a file format for a computer graphic
Q	Quantity defined as per unit value
RS232	A common serial communications standard defined by the EIA
SCADA	Supervisory Control and Data Acquisition
SQRT	Square Root
T	Time
TCP	Transmission Control Protocol
TIFF	Tagged Image File Format – a file format for a computer graphic
UPCT	User Programmable Curve Tool
XML	Extensible Markup Language

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