

# *pREX*

## Programmable Relay Expander

by

# *CircuitWerkes*



## Technical Manual

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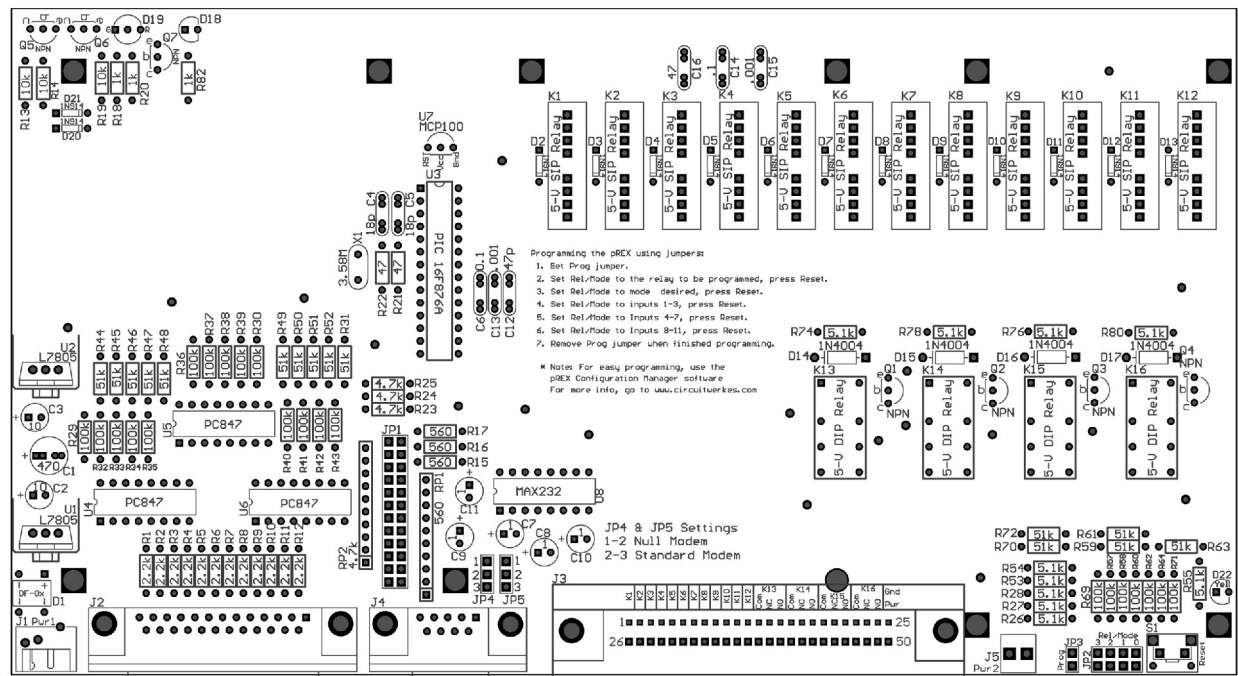
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# The CircuitWerkes pREX Programmable Relay Expander

## Description

The CircuitWerkes pREX, or Programmable Relay Expander, is a highly-flexible relay multiplier that can be used for a variety of applications, such as mapping one contact closure input to 16 contact closure outputs. The pREX contains 12 microprocessor-controlled SPST relays and 4 microprocessor-controlled DPDT relays, each of which can be independently configured to operate in a variety of modes. The pREX accepts 12 optically-isolated inputs, ranging from 4 to 24 volts, from the DB-25 connector located on the back of the board. These may be operated in active-low mode(ground-level) by setting the jumpers on JP1, eliminating the need for an external power source (see “Operational Overview”). All relay contacts are brought out on the 50-pin RJ-21 connector, which can be connected to a standard Telco punch block, making it easy to interface the pREX to your equipment.

Because each relay can be individually programmed, the pREX can be configured in almost any way imaginable. Each relay can be triggered by any number of inputs, combined together using basic logic functions. For instance, if you would like Relay 1 to operate in a pulse-stretching fashion only when Inputs 1, 2, and 3 are all active, the pREX can easily be programmed to do this using either the CircuitWerkes pREX Configuration Manager software, the jumpers located on the back of the board, or even a simple terminal program running on a host PC. This can be done by connecting the pREX to the PC's serial port using the DB-9 connector located next to the DB-25. The operation and configuration of the pREX will be discussed in greater detail later.

On the front of the enclosure are two LEDs. The right LED is a power indicator which is green if both power supplies are working, red if one of the supplies fails, and off if the board is not receiving power. The left LED is the yellow “Relay Active” indicator. This LED is on when any of the relays are active and off otherwise. While programming the device, this LED is used as a progress indicator, telling the user where in the programming process the pREX is. This is essential when programming the device with the on-board jumpers.

Figure 1. Layout of the pREX

## Operational Overview / Installation

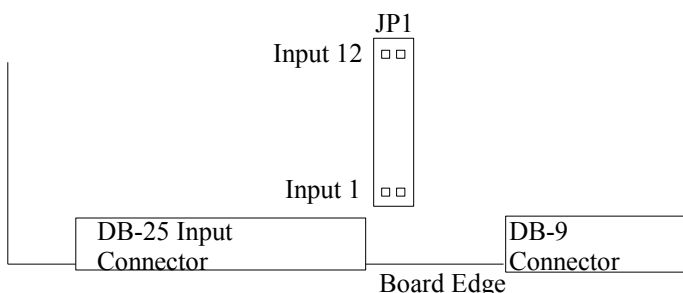
### Powering the pREX

The pREX can be powered with the included wall transformer, or any 12-18 Volt AC or DC supply capable of delivering 400 mA. If your pREX shipped with a power adapter with a barrel connector, then you should plug the connector into J1, located next to the DB-25 connector. If, however, you received a power adapter with split-leads, then you should screw the leads into terminal block J5 - polarity is unimportant. Also, the power may be daisy-chained to other pREX and/or REX Relay Expanders by connecting the terminal block J5 of the first device to the input power connector J1 of the next device. Please note that in order to daisy-chain the power, your transformer must be able to deliver 400 mA for each pREX in the chain. CircuitWerkes does not recommend connecting more than 5 pREX devices (or REX devices) in one chain.

### Setting up the inputs

Inputs are connected to the pREX through the DB-25 connector located next to the power jack. You have

the option of allowing your equipment to source or sink current. To source current to the pREX's inputs, remove the corresponding jumpers from JP1 (see Figure 2 for layout of JP1) and tie all of the negative leads on the DB-25 connector to your equipment's ground. Connect each of the positive leads of the DB-25 to your equipment's outputs. With the jumpers removed, your equipment must supply the power needed to activate the inputs. Figure 3 shows the layout of the DB-25 input connector, as seen from the back of the pREX. When set up to be sourced to, a positive voltage from 4 to 24 V, applied across an input's pins on the DB-25 connector, will activate the input.

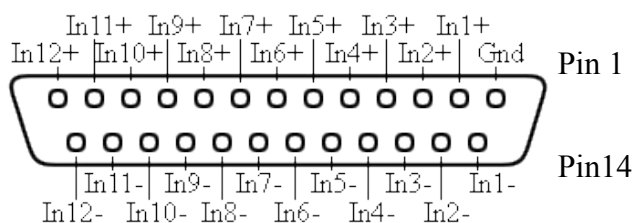


If not using dry contact closures to ground for operating the pREX, please see Note below regarding JP1 jumper setting.

Figure 2. Layout of Input Source/Sink Select jumper JP1

By default, the pREX comes from the factory with all inputs set up for your equipment to sink current. That is, every jumper on JP1 is in place. With the jumpers in place, it is unnecessary to use your equipment's power supply. Simply connect the ground on the DB-25 to your equipment's ground. To activate an input, your equipment will need to pull the negative lead on the DB-25 to ground. The positive lead should be left unconnected. To use the pREX in this mode, remove the jumpers from JP1 and connect the positive output of your equipment to the positive lead on the DB-25 connector, as seen in Figure 3.

**Warning:** Any sourced inputs must have the corresponding jumper on JP1 removed.



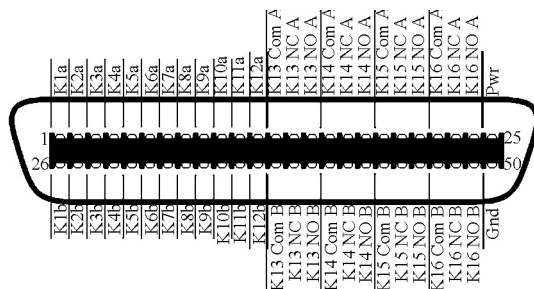
**Note:** The default configuration of the pREX is for all inputs internally pulled high. To operate in the factory default configuration, you need only provide a dry contact closure from any minus (-) input to the pREX ground terminal. Do not ground the + inputs or provide a Voltage source to the + input without removing the associated jumper from JP1 first.

Figure 3. Input Connections on the Female DB-25 Connector

### Connecting the relay outputs

The relay contacts are brought out of the device on the 50-pin RJ-21 connector located next to the 2-pin terminal block. This connector provides an easy interface to a standard Telco punch block, which can be purchased through CircuitWerkes, or a wide variety of electrical and telecommunications vendors. Figure 4 shows the pinout of the RJ-21 connector, which is also screen printed on the top-side of the board. Table A-1 on page 12, in the Appendix, shows how the relays are brought out onto a standard Telco punchblock.

Figure 4. Contact Connections of the Male RJ-21 Connector



the pREX manual show a different pinout for the RJ-21. Figure 4 (at left) is the correct pinout for all production versions of the pREX.

### Theory of Operation

#### Overview

The microprocessor inside the pREX constantly monitors the state of each input, mapping those inputs to the various relays which they're programmed to control. The microprocessor is also keeping track of when to open and close each relay based on the user configuration. Each relay can be operated in a number of different modes, both timed (Leading-Edge, Trailing-Edge, Pulse-Stretch, etc.) and untimed (Momentary, Latching, and Toggle), and

can be activated by any of the inputs, or any combination of inputs. A full listing of the relay modes and input modes are given in Tables 1 and 2. The following examples may help to clarify how to use the various modes to achieve your desired results. They also provide some typical applications where the pREX may be used, although it is by no means limited to these applications.

#### Example #1: Basic pREX Operation

A simple function that the pREX can perform is that of a relay multiplier. This can be used to distribute control signals to various places in a studio or industrial environment. For instance, it may be desired that, upon receiving a contact closure from a satellite feed, two separate pieces of equipment should begin recording that feed for a period of one hour. This is easily accomplished by connecting one of the pREX inputs to the satellite feed's contact closure. Two of the pREX's relays should be configured for Leading-Edge mode (see "Programming the pREX" section) with a closure time of one hour, triggered by the input connected to the contact closure. Since only one input is being used with these relays, the input mode could be set for OR, AND, XOR, or Interlocked (IL), but to make things easier, we'll just keep it in the OR mode. Any of these modes would work, however, because the logical combination of only one input is equivalent to that input alone. The two relays will be connected to the two pieces of equipment that record the feed. In this configuration, the contact closure from the satellite feed will give a pulse on the specified input. Upon seeing the leading edge of the pulse, the microprocessor inside the pREX will close both of the specified relays. These relays will remain closed until the programmed time of one hour has expired, at which time the processor will open the relays signaling to the recording equipment to cease recording.

#### Example #2: Multiple Inputs, Multiple Relays

To take Example #1 a little further, it may be desired that three different feeds can cause the recording equipment to begin recording. The first step is to connect the contact closures to the inputs of the pREX. Next, both of the relays should be configured for Leading-Edge mode, triggered by the three inputs ORed together. When any of the three inputs are activated (contact closures), both relays will close for one hour. If during the course of that hour any of the inputs change state, the relays will remain closed. The relays will open when the time has expired, regardless of the state of the inputs.

#### Example #3: Interlocked Groups

As a final example, we will describe how to set the pREX up as an audio or video switcher. To do this, several relays will be configured to operate in the Latching mode. In this mode, a relay closes upon a leading edge of its' latching input and opens upon a leading edge of its' unlatching input. Please note that the latching input and unlatching input can be configured as combinations of inputs on the board (i.e. Input 1 AND Input 2 AND Input 3).

For the purposes of this example, suppose relays K1, K2, and K3 are to be set up in an Interlocked group, where Input 1 closes K1, Input 2 closes K2, Input 3 closes K3, and Input 4 opens all of the relays. In an Interlocked group, no more than one relay can be closed at any given time. If K1 is closed and Input 2 is activated, then K1 will be opened and K2 closed. To configure the pREX, relays K1, K2, and K3 should each be programmed for Latching operation. The latching inputs should be set to Input 1, Input 2, and Input 3, respectively. The unlatching inputs for each relay should be set to OR the three inputs which are not used in the relay's latching input. For example, K2 will have Input 2 as its latching input, and Inputs 1, 3, and 4 ORed together as its unlatching input.

Upon powering up the pREX, all of the relays will be open. When input 1 is activated, K1 will receive an active latching input and close. Since the other relays are already open, they will not change states. When input 2 is activated, K1 will receive an active unlatching input, so it will open. K2 will get an active latching input and will, therefore, close. When Input 4 is activated, all three of the relays will receive an active unlatching input, so whichever relay is currently closed will open. The other relays will remain open.

#### Things to think about

It's important, when planning the use of the pREX, to think of each relay as a separate entity. Each relay has a corresponding relay input, which does not necessarily correspond to a single board input (the board inputs are brought out on the DB-25 connector). By this, it is meant that a relay input may be configured as a logical combination of board inputs, and any other relay may use those very same board inputs, in any combination desired. The relay input is really just an abstraction of the combination of board inputs. With this in mind, programming the pREX to achieve the desired result should be easy and, in some cases, fun.

Furthermore, the designers at CircuitWerkes encourage the users to utilize this flexibility, and get creative with its configuration. For instance, interesting results can be achieved by chaining a relay's output to another relay's inputs. Also, a form of sequencing can be achieved by tying a relay's output to its own input, if the relay is in a timed mode (Leading-Edge, Pulse-Stretch, etc.). For example, if Relay K1 is configured to operate in a 1-second Leading-Edge mode, with Input 1 as its only input, an interesting result will occur. To set this up, tie one of K1's outputs to Power, and tie the other output to Input 1. Also, pull Input 1 to ground through a 560-ohm resistor. Additionally, put Relay K13 into Toggle mode, with Input 1 as its input. Now, when the device is powered up, you

will here K13 continuously toggling once every second. With a little bit of planning and creativity, you may find that the pREX can achieve the same results as far more expensive and complicated devices.

## Programming the pREX

To give the user as much flexibility in using the pREX as possible, the designers at CircuitWerkes made every relay independently controlled by the microprocessor. Each relay may be set to function in one of several operating modes, which are listed in Table 1 on the following page. In addition to the relay operating modes, the pREX also allows the user to specify which inputs activate each relay. Each relay may be controlled by any number of inputs, which can be combined using basic logic functions, as seen in Table 2. Also, each input or input function may control any number of relays, so relays can be grouped together for use as a relay expander. The ability to program the relay modes and input modes gives you the power to configure your pREX in almost any way imaginable. If you can come up with any more programming possibilities that can't be achieved currently, let us know, it may end up in a future revision.

<b>pREX Relay Operating Modes</b>	
Mode	Description
Momentary	Relay closes when input is active and opens when input is inactive
Toggle	Relay toggles (changes states) on leading-edge (inactive-to-active) of input
Leading-Edge (timed)	Upon leading-edge of input, relay closes for a user-specified amount of time
Trailing-Edge (timed)	Upon trailing-edge of input, relay closes for a user-specified amount of time
Either-Edge (timed)	Upon leading- or trailing-edge of input, relay closes for a user-specified amount of time
Pulse-Stretch (timed)	Relay closes upon leading-edge of input, relay opens a user-specified amount of time after trailing-edge
Min-Time (timed)	Relay closes upon leading-edge of input and remains closed for at least the user-specified amount of time. If the input remains active for longer than the set time, then the relay opens upon a trailing-edge of the input.
Max-Time (timed)	Relay closes upon leading-edge of input for no longer than the amount of time specified. If a trailing-edge is encountered before the time has expired, the relay opens with the edge. Otherwise, the relay opens when time expires.
Debounce (timed)	The relay closes only after the input has been active for a specified amount of time. Once this time has been reached, the relay closes for the duration of the active input.
Latching	The relay closes upon a leading-edge of its' latching input. The relay remains closed until a leading-edge on its unlatching input occurs. This mode can be used to configure interlocked groups of relays.

Table 1. Programmable Relay Operating Modes of pREX

<b>pREX Input Modes</b>	
Mode	Description
OR	Relay input is active if any of the specified inputs are active. Relay input is inactive if <u>all</u> of the specified inputs are inactive.
AND	Relay input is active only if <u>all</u> of the specified inputs are active. Relay input is inactive if any of the specified inputs are inactive.
XOR	Relay input is active if an odd number of specified inputs are active. Relay input is inactive if an even number of specified inputs are active.
Interlocked (IL)	Relay input is active if exactly one of the specified inputs is active. Relay input is inactive if any more or less than one of the specified inputs is active.
NOR (Not OR)	Relay input is active only if <u>all</u> of the specified inputs are inactive. Relay input is inactive if any of the specified inputs are active.
NAND	Relay input is active if any of the specified inputs are inactive. Relay input is inactive if <u>all</u> of the specified inputs are active.
NXOR	Relay input is active if an even number of inputs are active. Relay input is inactive if an odd number of inputs are active.
NIL	Relay input is active if any more or less than one of the specified inputs is active. Relay input is inactive if exactly one of the specified inputs is active.

Table 2. Programmable Input Modes of pREX

### **pREX Configuration Manager software**

The pREX can be programmed in a variety of different ways. The first way, which CircuitWerkes recommends for its ease-of-use and speed at which programming can be performed, is through the use of the CircuitWerkes pREX Configuration Manager software, which comes bundled with the pREX (it can also be downloaded from the website at [www.circuitwerkes.com](http://www.circuitwerkes.com), check often for updates). To use the software, simply start the application on your PC and connect the serial port to the DB-9 connector on the back of the pREX.

### **Installation**

pREX Configuration Manager runs on a variety of Windows operating systems, including Windows XP, Windows 98, Windows ME, Windows NT, and Windows 2000, but not on Windows 95. To begin installation, simply place the CD in your CD-ROM drive (usually <D:\>) and run Setup.exe. The software relies on the Microsoft .NET Framework to operate, so this will need to be installed before the program is installed. If the framework is not already installed on your computer, the Setup program will realize this and ask if you would like to install the .NET framework. Select “Yes” and then follow any additional prompts to continue the installation. Once installation is complete, a shortcut to the software may be found in the “Programs” directory (in the “Start” menu) under “CircuitWerkes\pREX\pREX Configuration Manager”.

### **Connecting the pREX**

To connect the pREX to the host PC, a standard male-to-female serial cable should be connected from the PC's serial port to the DB-9 connector on the pREX. A serial cable can be obtained from any electronics or computer store. It is also possible to connect the pREX to the PC using a null modem serial cable. This requires changing jumpers JP4 and JP5, located on the board next to the DB-9 connector. By default, the pREX is shipped ready to use with a standard serial cable. For this setup, JP4 is jumpered across pins 2 and 3 and JP5 is jumpered across pins 1 and 2. For a null modem cable, the jumpers are reversed (JP4 = 1-2 and JP5 = 2-3). Note that the PCB silk-screen incorrectly says that JP4 & 5 should be set the same depending upon the type of cable used. If you set both pREX jumpers to 2-3 or 1-2, you won't hurt your pREX, but neither will it communicate with your PC. Serial communication will also not work if these jumpers are removed completely. In most cases, the factory setting for a standard serial cable is the desired setting.



Figure 5. Screenshot of pREX Configuration Manager

### Operation

pREX Configuration Manager allows you to load any possible configuration onto the pREX quickly and easily, read the current configuration from the device, load and save presets, and view helpful information (logic diagrams, board layout, contact info, etc.). Upon starting, Configuration Manager will attempt to read the current configuration from the pREX. If a pREX is not connected to the PC's serial port on COM1, or if it is not powered up, a message will appear in the status box stating that communication with the pREX was not possible. Please note that you may still use the software even if a pREX is not connected. This allows you to create and save custom presets, which you may upload to the pREX at a later time. Also, you may make as many changes to the current setup as you want without affecting the actual configuration of the pREX. Your changes will take effect only after you press a "Program" button. The software provides many possibilities to set up your pREX.

#### Setting up the relay mode:

Once the program is loaded, you will be presented with the main screen, as shown in Figure 5. The first step is to navigate to the specific relay you would like to program by either using the drop-down box labelled "Relay number", or by left-clicking the image labelled "Relay X" ("X" is the number of the currently selected relay) until you reach the desired relay. Next you should choose the mode to operate the relay in by selecting the drop-down box labelled "Relay mode".

If you select a timed mode, then the sliders in the "Closure Time" group will be enabled. This will allow you to change the number of hours, minutes, and seconds that the specified mode takes effect. Keep in mind that this time does not apply to the same thing for each relay mode. For instance, in Leading-Edge mode, the specified time designates how long the relay will remain closed once an active input is detected. However, in Debounce mode, the time corresponds to how long an input must remain active before a relay is closed. It is important to consider this for each relay mode, so that you can select the mode which best fits your desired outcome.

#### Setting up the inputs:

The next step in configuring the pREX is to choose the inputs that you would like to affect this relay. This is done by left-clicking the input buttons, organized in a column in the center of the window. A dark blue button indicates that the input is not activated for this relay, and a teal button indicates that the input is active. You will also need to select the input mode. To operate a relay by only one board input, simply select the desired input and choose the OR mode. The input mode describes how to combine the board inputs to get the relay input. As an example, if you would like Relay 1 to be activated only if both Input 1 and Input 2 are active, then the AND mode would be selected, as well as Inputs 1 and 2. The opposite of this mode would be NAND, where the relay input will be inactive if both inputs are active. A full explanation of the input modes is given in Table 2, and a very basic understanding of Boolean logic may help to clarify how to use the input modes to your advantage.

#### Programming the pREX:

The final step is to either program the pREX, or set up the next relay. This can be done by pressing either the "Program Relay" or "Program All" button, or by selecting the "Edit" menu, then choosing "Program" and selecting the desired relay. It is recommended that you save your configuration first (by choosing "File", "Save As") to prevent any potential loss of data. If you wish to program only the selected relay, then pressing the "Program Relay" button will do this, without overwriting the configuration of the other relays. On the other hand, if you'd like to program every relay according to the current setup, then you can press the "Program All" button. A

progress bar, located below the program buttons, will display the progress of the reprogramming. To minimize the amount of time spent programming the pREX, you can save your common configurations on your PC. Then, when you want to reprogram the pREX, open the configuration file (choose “File”, “Open”) and press “Program All”. Please note that in order to program the pREX using a PC, the “Prog” jumper JP3 on the back of the board must be removed.

Reading the current configuration:

At any point in the configuration process, you can read the current configuration of the pREX by pressing the “Read Relay” or “Read All” buttons. You may also read a relay by choosing “Edit”, “Read”, and the desired relay number. Please keep in mind that if you read a relay's configuration, the setup for that relay will be updated in the Configuration Manager, overwriting the previous setup. Therefore, if you read all relays, the entire configuration will be overwritten. For this reason, it is recommended that you save your work if you'd like to come back to it later.

PC-Control:

The last point to mention is the issue of PC-Control. In addition to programmability, any of the relays can be controlled from your PC, as well. That is, just by clicking a button on the Configuration Manager window, you can open and close any of the relays. To do this, first read the current configuration from the pREX as described above. Next, select the relay you would like to control with the computer and, if it is not already checked, left-click the check box labeled “PC-Control”. This places the specified relay into PC-Control mode. In this mode, the relay will not respond to inputs, it will only respond to PC commands. Other relays that aren't in PC-Control mode, however, will still respond to their specified inputs. Once the “PC-Control” check box is selected, the “Momentary input” and “Latching input” buttons will be enabled. When one of these buttons are pressed, an active input command is sent to the specified relay, and the relay acts according to it's current configuration. Pressing the “Momentary input” button sends a 10 ms pulse to the relay input. The “Latching input” button simply toggles the relay's current input value.

As an example, consider that Relay 1 is in the Momentary mode. Sending a Momentary input will cause the relay to close for the duration of that input, which is 10 ms. In most cases, that is not long enough. Sending a Latching input, however, will cause the relay to close until another Latching input is sent. This is probably more desirable. Now consider the relay is in the Leading-Edge mode, with a closure time of 1 second. If a Momentary input is sent, the relay will close for 1 second, during which time sending another Momentary input will have no effect. Once the time period has expired, another Momentary input will cause the relay to close again. If a Latching input is sent, the relay will again close for 1 second. The relay input is now active. In order to get the relay to close again. Two more Latching inputs must be sent – one to deactivate the relay input, and another to reactivate it. Therefore, for the Leading-Edge mode, a Momentary input probably makes more sense. You are encouraged to play around with this feature to see just how it works. Also, keep an eye out in the future for software updates and additional features as they become available. These can be found on our website ([www.circuitwerkes.com](http://www.circuitwerkes.com)).

### **Terminal program**

If, for some reason, the Configuration Manager software is not available, or you would prefer not to use it, the pREX may also be programmed with a host PC's serial port using a terminal application, like HyperTerminal™, which comes bundled with Microsoft® Windows®. The pREX communicates with the PC at 57600 bps using 8-bit words, no parity bits, and 1 stop bit. Once a connection is made, simply press <Enter> to let the pREX know that you are there. You will be presented with the main menu requesting input regarding the desired action to perform.

To begin, press <P> to start the programming process. Other functions may be accessed as well by pressing the corresponding key as displayed in the main menu. After pressing <P>, you will be presented with a series of prompts related to the configuration of the device, such as the relay number to be programmed, the operating mode, inputs and their mode, and timing information. This allows full programming of the pREX in a very straightforward manner. If at any point in the process you enter incorrect information, or you decide not to program the relay, you may press the Escape key <Esc> to cancel programming.

The first prompt asks for the relay number to be programmed. This is a number 1 through 16 that corresponds to the number screenprinted next to each relay on the circuit board. Relays 1 through 12 are SPST relays, and Relays 13 through 16 are DPDT relays. Type the relay number you'd like to program, then press <Enter>. Next, the pREX will request that you enter the relay mode number to put the relay in. Table 3 provides the mode numbers and the corresponding relay mode. Enter the desired mode's number, followed by the Enter key.

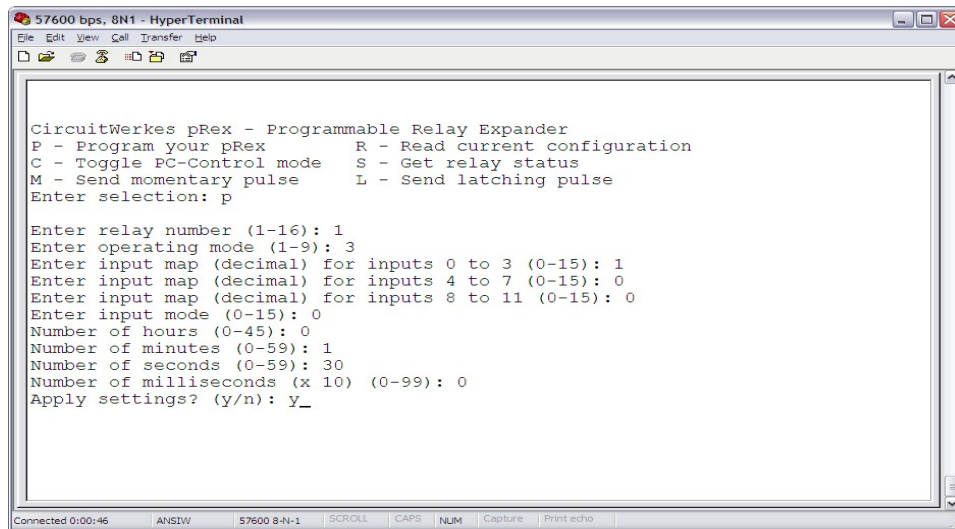


Figure 6. A Typical pREX HyperTerminal Session

The next step is a little more difficult to grasp. The next three prompts are related to the inputs which will affect the relay. These prompts ask for a decimal number corresponding to four inputs (1 to 4, then 5 to 8, followed by 9 to 12). This number comes from the binary representation of the input map for the four specified inputs. For those who don't know binary arithmetic, Table 4 gives a mapping of the inputs to the number that should be entered.

Relay Mode Number	Relay Mode
1	Momentary
2	Toggle
3	Leading-Edge
4	Trailing-Edge
5	Either-Edge
6	Pulse-Stretch
7	Min-Time
8	Max-Time
9	Debounce
10	Latching

Table 3. Relay Mode Numbers and Corresponding Mode Names

Just to clarify a little bit, let's consider how to program Inputs 1 through 4 for a relay. We'll look at a few different scenarios to provide a good understanding of how this works. The input number corresponds to that inputs place in a binary number, where a 0 means that the input does not affect the relay, and a 1 means that it does. So, if we want Input 4 to be in the relay's input map, but not Inputs 1, 2, and 3, then the binary number corresponding to this mapping would be 1000. In decimal, this number would be  $(1*8) + (0*4) + (0*2) + (0*1) = 8$ . This is the number to enter after the pREX prompts for Inputs 1 to 4. Now suppose we would like all four of those inputs to be in the input map. Then the appropriate decimal number would be  $(1*8) + (1*4) + (1*2) + (1*1) = 15$ . So, "15" should be typed after the prompt, followed by <Enter>. Notice that the multipliers (8, 4, 2, and 1) remain constant, only the multiplicands (0 or 1) change. In case you didn't realize you would have to do math problems in order to set the pREX up, the following table can be used to determine the number to enter.

Decimal Map Number	Inputs 4, 8, and 12 active?	Inputs 3, 7, and 11 active?	Inputs 2, 6, and 10 active?	Inputs 1, 5, and 9 active?
0	No	No	No	No
1	No	No	No	Yes
2	No	No	Yes	No
3	No	No	Yes	Yes
4	No	Yes	No	No
5	No	Yes	No	Yes
6	No	Yes	Yes	No
7	No	Yes	Yes	Yes
8	Yes	No	No	No
9	Yes	No	No	Yes
10	Yes	No	Yes	No
11	Yes	No	Yes	Yes
12	Yes	Yes	No	No
13	Yes	Yes	No	Yes
14	Yes	Yes	Yes	No
15	Yes	Yes	Yes	Yes

Table 4. Decimal Numbers to Enter for Input Map Selection

After entering the input map numbers for all 12 inputs, you will be asked to enter the input mode number. This number corresponds to the method you would like to use to combine the inputs, such as OR, AND, XOR, NOR, etc. Table 5 provides the number you will need to enter at this prompt for the various input modes. Please note that the numbers jump from 3 to 8. Numbers not included in Table 5 should not be entered, as they will not program the device correctly.

Input Mode Number	Input Mode
0	OR
1	AND
2	XOR
3	IL
8	NOR
9	NAND
10	NXOR
11	NIL

Table 5. Input Mode Numbers and Corresponding Mode Names

Once the input mode is selected, the following prompt will vary, depending on which relay mode you selected. If you chose either Momentary or Toggle modes, you will be asked to confirm the entered configuration. This is your last chance to cancel the programming for this relay. To cancel either press <N> or <Esc>. As soon as you press <Y>, the specified relay configuration will be stored in the microprocessor's permanent storage, and the previous configuration will be overwritten.

If, however, you have chosen any of the timed relay modes (Relay Modes 3 through 9), following the input mode, you will be presented with four more prompts asking for the desired time in hours, minutes, seconds and milliseconds. Type in the desired amount of time for each prompt, followed by the Enter key. Keep in mind that the number you enter for milliseconds is multiplied by 10. So, if you enter "10", this will correspond to 100 ms. The pREX timed modes allow for a minimum of 10 ms (by typing 0, <Enter>, 0, <Enter>, 0, <Enter>, 1, <Enter>) and a maximum of 45 hrs., 59 mins., 59 secs. And 990 ms (by typing 45, <Enter>, 59, <Enter>, 59, <Enter>, 99, <Enter>). Once all of the timing information has been entered, you will be presented with the confirmation prompt. Press <Y> to program the relay.

The last possibility is if the Latching mode (Relay Mode 10) was chosen. The first group of input information requested corresponds to the Latching input. After entering this information, you will be presented with the same four prompts related to the input map and input mode. The second time around, these prompts correspond to the Unlatching input, that is, the input which will open the specified relay once it has been closed by the Latching input. You should follow the same method as you did to enter the Latching input map to enter the Unlatching. You can either use Table 4 to get the decimal number needed, or you can arrive at the correct number through calculation, as demonstrated previously. After entering the Unlatching input map and mode, you will be prompted to confirm the changes. Type <Y> to to program the relay.

### **On-Board Jumpers**

Another method which can be used, although it is by no means the easiest, is by using the right-angle programming jumpers located on the back of the board. This method can be fairly time consuming, and is, therefore, only recommended if a PC is not available and the pREX must be programmed immediately. Another downside to programming the pREX using the jumpers is that the relays may not be programmed for any of the timed modes using this method, the relays may only be programmed for Momentary and Toggle modes. If you need to program the pREX using the jumpers, however, first jumper the “Prog” header, JP3. This puts the device into programming mode. A series of steps must then be performed to enter numerical information into the device. This is done by setting the “Rel/Mode” jumpers, JP2, to the desired number (in binary, which will be discussed further) and pressing the “Reset” button, S1. Once enough information is entered to program the specified relay, the information is stored in the microprocessor’s permanent memory, or EEPROM. If at any point, the user enters incorrect information, or they decide to change a certain value, the “Reset” button can be held for approximately 1.5 seconds to go back to the beginning of the programming process. This does not, however, revert relay configurations that were already stored back to their previous states. It only prevents the current relay configuration from being stored.

The “Rel/Mode” jumpers JP2 are labelled 0 through 3, which corresponds to the position that each jumper represents in a binary number. To represent a 1 in that position, the jumper should be set, and 0 is represented by removing the jumper. Table 6 gives a mapping of the decimal number represented by the various “Rel/Mode” jumper settings. Following the table is a list of steps required to program each relay.

	Jumper JP2 Postions			
Decimal Value	3	2	1	0
0	Off	Off	Off	Off
1	Off	Off	Off	On
2	Off	Off	On	Off
3	Off	Off	On	On
4	Off	On	Off	Off
5	Off	On	Off	On
6	Off	On	On	Off
7	Off	On	On	On
8	On	Off	Off	Off
9	On	Off	Off	On
10	On	Off	On	Off
11	On	Off	On	On
12	On	On	Off	Off
13	On	On	Off	On
14	On	On	On	Off
15	On	On	On	On

Table 6. Decimal Value Represented by Various Jumper Settings

Steps to program the pREX using the on-board jumpers:

1. Jumper “Prog” pin, JP3. (Yellow LED should begin flash constantly)
2. Set “Rel/Mode” jumpers to the relay number minus 1. (i.e. A “0” corresponds to Relay 1)
3. Press and hold “Reset” button for about half a second. (LED should flash one more time, then turn off)
4. Set “Rel/Mode” jumpers to the relay mode number (according to Table 3) minus 1. Remember: only the Momentary and Toggle modes can be programmed using the jumpers.

5. Press and hold “Reset” button for about half a second. (LED should flash twice, then turn off)
6. Set “Rel/Mode” jumpers to the input map for inputs 1 to 4. (see Table 4)
7. Press and hold “Reset” button for about half a second. (LED should flash three times, then turn off)
8. Set “Rel/Mode” jumpers to the input map for inputs 5 to 8.
9. Press and hold “Reset” button for about half a second. (LED should flash four times, then turn off)
10. Set “Rel/Mode” jumpers to the input map for inputs 9 to 12.
11. Press and hold “Reset” button for about half a second. (LED should flash five times, then turn off)
12. Set “Rel/Mode” jumpers to the input mode number. (see Table 5)
13. Press and hold “Reset” button for about half a second. (LED should continuously flash, indicating that the relay has been programmed and the pREX is ready to program another relay)
14. If you would like to program another relay, repeat steps 2 through 13 for each additional relay. Otherwise, remove the jumper from the “Prog” header.

As you can see from the directions above, quite a few steps are needed to program the pREX's relays using the on-board jumpers. For this reason, the jumper programming method is provided as an emergency backup only, and should generally be avoided, if possible. It is highly recommended that you use the pREX Configuration Manager software to program and control your pREX's relays, as this is the easiest and quickest way to do so.

## Appendix

Table A-1. Relay outputs and Telco Punchblock layout

<b>pREX Wiring Description</b>			
<b>Relay No.</b>	<b>50-Pin (RJ-21) Connector Pin No.</b>	<b>Standard Wire Color</b>	<b>Telco Block Wire Pair No.</b>
K1-SPST	1	Blue/White	Pair 1
	26	Blue	
K2-SPST	2	Orange/White	Pair 2
	27	Orange	
K3-SPST	3	Green/White	Pair 3
	28	Green	
K4-SPST	4	Brown/White	Pair 4
	29	Brown	
K5-SPST	5	Slate/White	Pair 5
	30	Slate	
K6-SPST	6	Blue/Red	Pair 6
	31	Blue	
K7-SPST	7	Orange/Red	Pair 7
	32	Orange	
K8-SPST	8	Green/Red	Pair 8
	33	Green	
K9-SPST	9	Brown/Red	Pair 9
	34	Brown	
K10-SPST	10	Slate/Red	Pair 10
	35	Slate	
K11-SPST	11	Blue/Black	Pair 11
	36	Blue	
K12-SPST	12	Orange/Black	Pair 12
	37	Orange	
K13 Com	13	Green/Black	Pair 13
	38	Green	
K13 NC	14	Brown/Black	Pair 14
	39	Brown	
K13 NO	15	Slate/Black	Pair 15
	40	Slate	
K14 Com	16	Blue/Yellow	Pair 16
	41	Blue	
K14 NC	17	Orange/Yellow	Pair 17
	42	Orange	
K14 NO	18	Green/Yellow	Pair 18
	43	Green	
K15 Com	19	Brown/Yellow	Pair 19
	44	Brown	
K15 NC	20	Slate/Yellow	Pair 20
	45	Slate	
K15 NO	21	Blue/Violet	Pair 21
	46	Blue	
K16 Com	22	Orange/Violet	Pair 22
	47	Orange	
K16 NC	23	Green/Violet	Pair 23
	48	Green	
K16 NO	24	Brown/Violet	Pair 24
	49	Brown	
Power	25	Slate/Violet	Pair 25
Ground	50	Slate	

## Technical Specifications

Relays: on	16 microprocessor-controlled relays operate in a variety of modes (See section “Programming the pREX”): 12 SPST relays – 20-VDC, 0.5-A 4 DPDT relays – 30-VDC, 1-A Output connector – Male 50-pin Centronics (RJ-21) connector
Inputs:	12 opto-isolated inputs accept +5 to 24 V signals in active-high mode and 0V in active-low mode (see “Operational Overview”). Inputs can be grouped based on a number of input modes. Input connector – Female DB-25 connector
User Interface:	PC interface connector – Female DB-9 GUI - CircuitWerkes pREX Configuration Manager software (included) is used to program the device and control the relays. Configuration Manager runs on a host Windows PC, which communicates with the pREX over an RS-232 connection.  A standard terminal application, like HyperTerminal (included with Windows), may also be used to program/control the pREX.  If a PC with RS-232 capabilities is not available the pREX may also be programmed using the on-board jumpers, JP2 and JP3 (see “Programming the pREX”).
Indicators:	Yellow (leftmost) LED indicates when any relay changes state. Power indicator (rightmost LED) provides the status of the power supplies (Green = both supplies are okay, Red = one supply has failed)
Power requirements:	12 -18 Volt AC/DC, 400 ma., 14Vdc 500 ma. wall transformer supplied
Physical Dimensions:	W 11” x D 5 1/4” x H 1 1/2”
Weight:	
Mounting Options:	RM-01 (1 Rack Unit Height)

## Repair or Service Information

In the event of the need for service or repair, call CircuitWerkes at (352) 335-6555 for a Return Merchandise Authorization number (RMA). Then carefully package the unit along with a note of the problem and send it to the address below. Be sure to include your contact information (address - not PO Box - telephone numbers) and best time to call.

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