Chapter 6: Program GPI/O and Serial Input/Output

General Purpose Inputs (GPI)

The ESP has 8 GPI that can be expanded to 16 GPI with the addition of a GPIO expansion card. GPI are used to connect external hardware such as potentiometers (to control levels or gains) and switches (to select a parameter set or preset). You assign functions to the external control in the GPI control panel in ControlSpace Designer software.

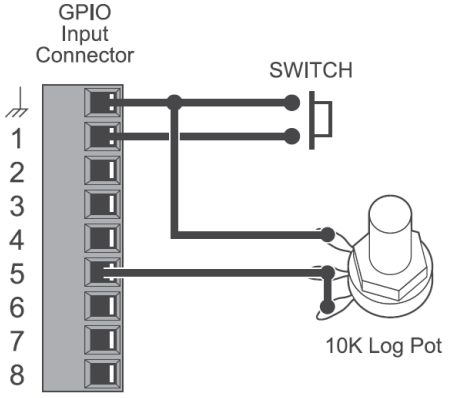

Figure 6.1 - Example GPI connections with a switch above and potentiometer below

To open the GPI control panel, double-click on the GPI block in the **ESP-88** window.

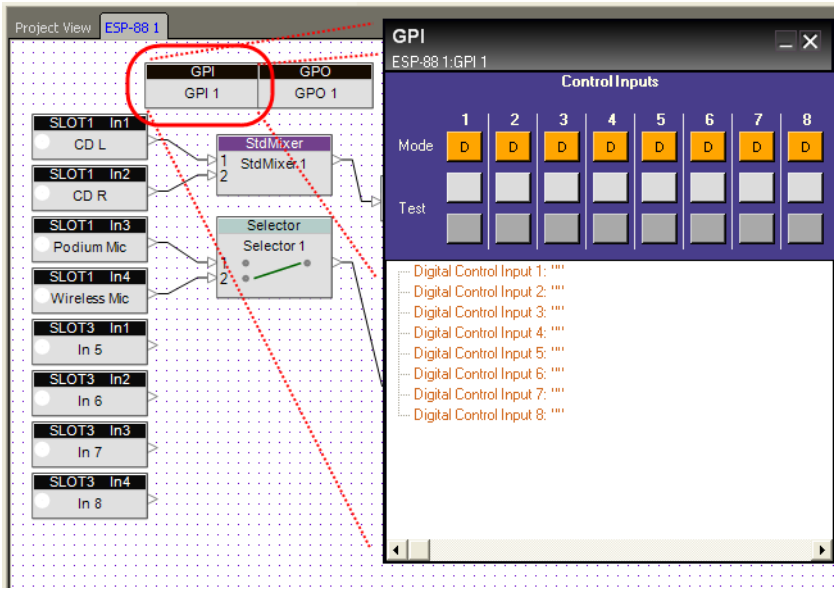

Figure 6.2 - Open the GPI control panel

Use the programming tree in the bottom half of the GPI control panel to assign functions that are invoked by the eight General Purpose Inputs. You can drag and drop signal processing blocks, parameter sets, groups, or presets onto the text lines. The top half of the GPI control panel contains **Mode** buttons to switch between operating modes, and **Test** buttons to simulate the behavior of an assigned function.

Operating modes

General Purpose Inputs can be configured to operate in one of three modes: digital, up/down, and analog. Use the **Mode** buttons in the GPI control panel to switch a GPI to a different mode.

Operating Mode	Description
Digital 	Typically used when connecting a switch or push button, this mode expects a normally open switch for operation. Both “on” and “off” actions are supported
Up/Down 	Up/Down mode uses two adjacent GPI, and is intended to support two push buttons for use as volume up and down. Normally open switches are expected.
Analog 	Analog mode is intended for a 10K linear type potentiometer that can be linked to a gain control or grouped gains. When the potentiometer is at the 10 KOhm position the gain is set to minimum, and when the pot is at the 0 KOhm position, the gain is set to the maximum level.

Programming GPI

To program a GPI, drag and drop from the ESP-88 window onto a text line in the programming tree of the GPI control Panel. For example, to program a potentiometer on GPI 1 to control the wireless mic gain, first switch the GPI to analog mode, then drag the wireless mic input block onto “Analog Control Input 1:”

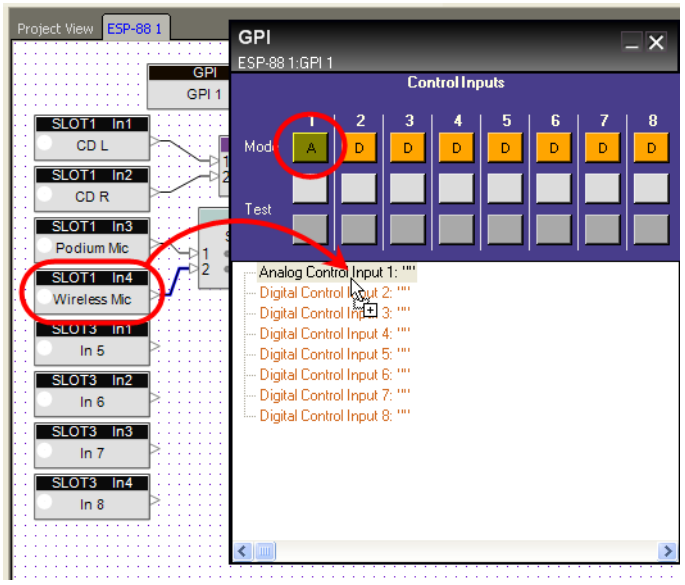

Figure 6.3 - Assign the Wireless Mic input to a GPI

Invoking signal processing blocks using a GPI

You can use a switch or button connected to a GPI to recall a snapshot of blocks in your system. When the external switch or button is pushed, the block's settings are returned to the pre-defined state. For example, you could use an external button to switch a Selector block to a certain input. To do this, first set the Selector block to the desired state. Then drag the signal processing block into the appropriate GPI. This action takes a snapshot of the signal processing block and saves it to the GPI programming. The GPI should be in digital mode to invoke a signal processing block, so set the mode button to digital.

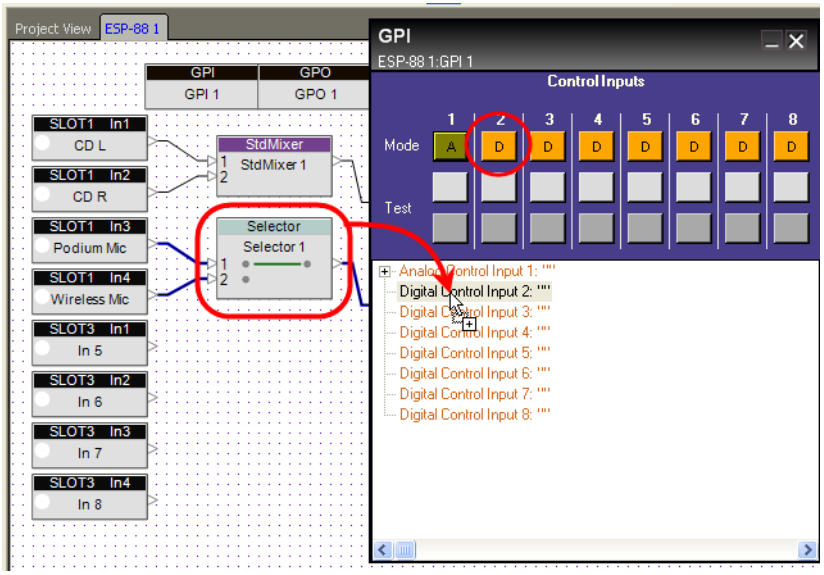

Figure 6.4 - Assign a Selector block to a digital GPI

When you assign a signal processing block to a digital GPI, the **Set Mode** window opens. This window is used to designate whether the snapshot of the signal processing block is recalled when the external switch is closed (ON) or open (OFF).

*Figure 6.5 - **Set Mode** window*

If there is only one action that is invoked by the external controller, then choose ON or OFF based on which state should invoke the signal processing block -- going active “ON”, or going active “OFF”. You do not have to program both states. If there are two actions that are invoked by the external controller, you can program both ON and OFF states. Drag the block onto the same GPI but this time select the OFF state. Both states will be programmed to the GPI.

Note: **One scenario in which you might program both ON and OFF states is the case of a “push-to-talk” button for a microphone. You could program the system to mix in the microphone when the button is pushed, and to remove the mic from the mix when the button is released.**

Open the GPI tree structure to verify what has been programmed.

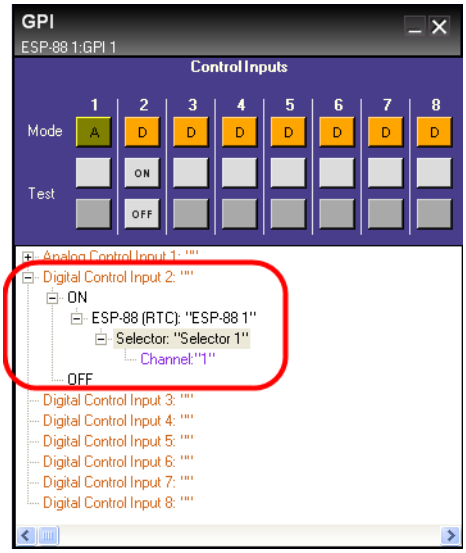

Figure 6.6 - Open the tree structure to view what is programmed

All signal processing blocks (except meters) can be invoked by an external switch in this “snapshot” manner using a GPI in digital mode. You can also invoke multiple blocks with an external switch in this manner by dragging multiple blocks into one GPI programming tree.

Invoking a parameter set

Parameter sets can be invoked by an external controller using a GPI in digital mode. Drag the parameter set into the GPI control panel and drop it into the desired control input. Drag multiple parameter sets into the GPI to invoke multiple parameter sets with the same external switch or button. After dragging the parameter sets into the GPI, choose the appropriate ON/OFF mode in the **Set Mode** window.

Invoking a preset

A preset can only be invoked using a timer or a GPI. To invoke a preset using a GPI, select digital mode, and then drag the preset into the GPI control panel and drop it into the desired control input.

Controlling a group

Grouped gains can be controlled by GPIs in analog mode, digital mode, or up/down mode. Drag a group of gain controls into a GPI according to the following logic:

- Digital mode - The external button or switch will control the Mute status only
- Analog mode - The external potentiometer will control Level only
- Up/Down mode - The external buttons will control Level only

Discrete mode

When using an external switch or button to control a group in digital mode, ControlSpace supports a discrete, or 1:1 connection between the control and the Mute status. This discrete connection can be set to one of three different modes. You are prompted to choose a mode when you drag and drop the group into the GPI control input.

Figure 6.7 - Choose a discrete mode

- **Active Hi.** - Grouped state is invoked when the external control is activated (normally open switch = closed).
- **Active Lo.** - Grouped state is invoked when the external control is deactivated (closed switch = open).
- **Toggle** - Grouped state is toggled as the external control is toggled.

Discrete mode is only supported for groups, not for individual gain blocks. If you want to control an individual gain block with GPI in discrete mode, you will need to create a group and drag the gain block into the group, then assign the group to a GPI.

Using a potentiometer

Use a GPI in Analog mode when connecting an external potentiometer control. A potentiometer can be used to control a gain block, or a group of gains. For example, your system might only require a main volume knob mounted to the wall. Drag the gain block or group into an Analog input in the GPI control panel.

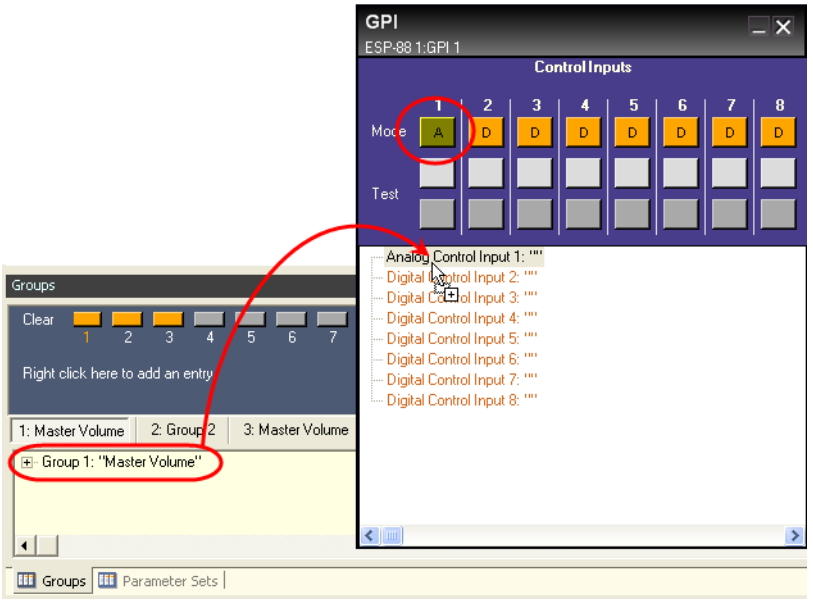

Figure 6.8 - Drag a group onto a GPI set to analog mode

You can adjust the maximum, minimum and step size for the analog control. Right click on **Property** in the GPI tree structure and choose **Edit Volume Property**. The **Volume Property** dialog box opens.

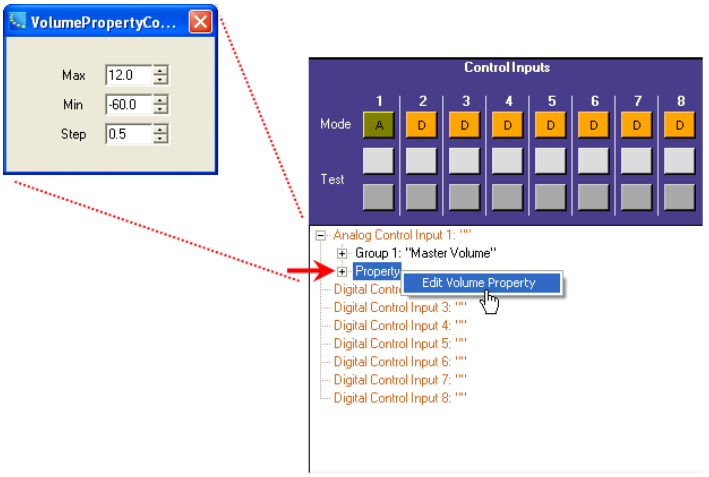

Figure 6.9 - Open the Volume Property dialog box

Set the minimum and maximum volume levels and step size in decibels.

Using up and down buttons for volume control

Use a GPI Digital Up/Down input to control a volume level using two buttons. Up/down buttons can be used to control a gain block, or a group of gains. Drag the gain block or group into a Digital Up/Down input in the GPI control panel.

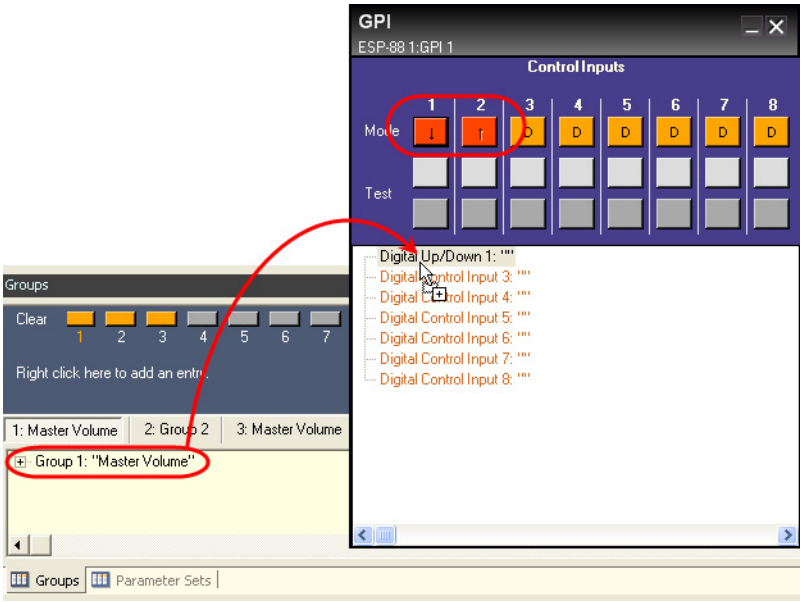

Figure 6.10 - Drag a group onto a GPI set to up/down mode

You can adjust the maximum, minimum and step size for the Digital Up/Down control. Right click on **Property** in the GPI tree structure and choose **Edit Volume Property**. The **Volume Property** dialog box opens. Set the minimum and maximum volume levels and step size in decibels.

Testing GPI

Use the Test buttons in the GPI control panel to simulate the operation of a GPI. In analog mode, such as when a potentiometer is attached, pressing the test button will pop up a fader control. In digital mode, the test buttons will simulate ON and Off states.

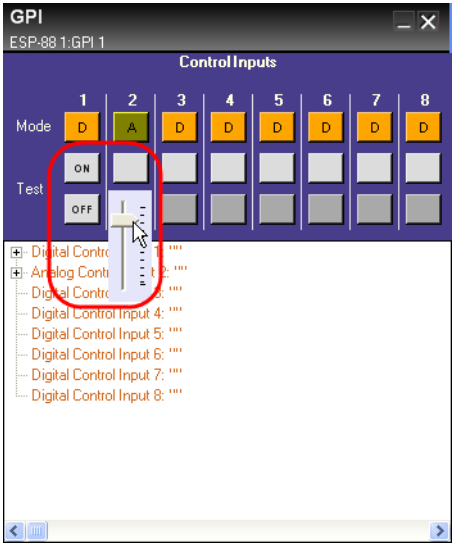

Figure 6.11 - Digital and analog test buttons

General Purpose Outputs (GPO)

The ESP-88 has 8 GPO that can be expanded to 16 GPO with the addition of a GPIO expansion card. GPO are often used as indicators that are activated when the system is in a certain state. For example, you might use GPO to signal an external device, like a video switcher, when a certain parameter set is chosen. Or, you could attach an LED to a GPO and program it to illuminate when a parameter set is invoked.

Note: GPO can only be controlled by a timer, or by invoking a parameter set.

To open the GPO control panel, double-click on the GPO block in the **ESP-88** window.

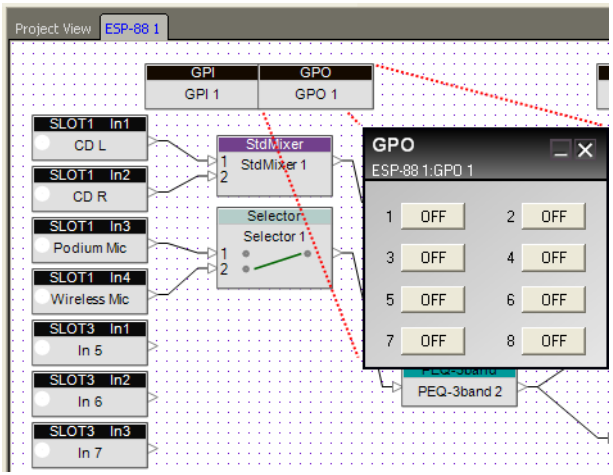

Figure 6.12 - Open the GPO control panel

Set the state of a specific GPO channel by clicking on the **ON**/**OFF** button.

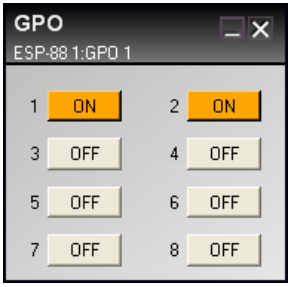

Figure 6.13 - Click a button to set the GPO state

Programming GPO

The process for programming a GPO is different than that of a GPI. There are two ways to program a GPO. The first method is to use the Project Directory. After setting the state of the GPO to **ON** or **OFF**, find the GPO in the **Project Directory** window, and drag it into a parameter set, or timer. When the parameter set is invoked or the timer expires, the GPO will change to the programmed state (**ON** or **OFF**).

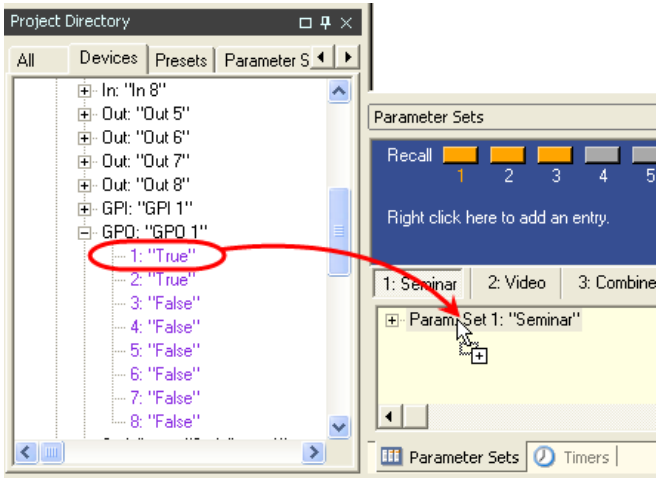

Figure 6.14 - Drag a GPO from the Project Directory to a parameter set or timer

The second method is to use the Parameter Set Nodes List (this only applies to parameter sets). To program a GPO to be activated by a parameter set, open the Parameter Set Nodes List by right clicking on the parameter set name, and place a checkmark next to the desired GPO.

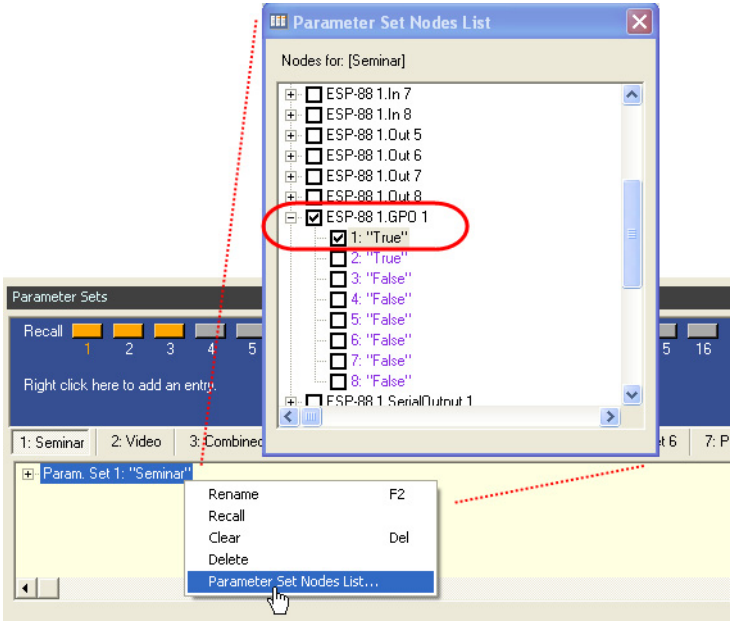

Figure 6.15 - Use the Parameter Set Nodes List to program a GPO

Serial Inputs

The ESP-88 has a serial port that can be used to send and receive serial strings or commands. The serial port is located on the back of the ESP-88, and is configured for 38,400 baud, no parity, 8 bits, 1 stop bit, and no flow control. To open the Serial Input control panel, double-click on the **SerialInput** block in the **ESP-88** window.

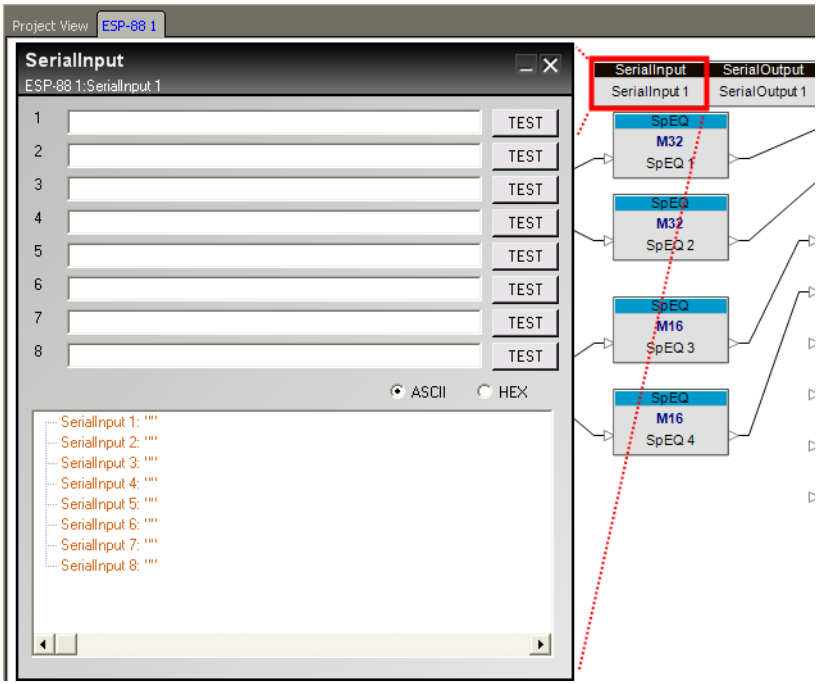

Figure 6.16 - Open the Serial Input control panel

You can program your ControlSpace ESP-88 system to recall a snapshot of a block, or invoke a parameter set when the ESP-88 receives a serial string. To program a Serial Input, drag and drop one or more blocks or parameter sets onto a text line in the programming tree of the control panel. Enter the serial string that is to be recognized by the system in the corresponding field in the upper half of the control panel. When the incoming serial string matches any of the eight strings entered, the block or parameter set programmed for that string is invoked. For example, you might receive the ASCII string “S2” from an external system indicating that “scene 2” has been selected, and ControlSpace should invoke the programmed signal processing block or parameter set.

Note: **The ESP-88 automatically assumes that each input string is terminated with one carriage return (CR). You must program the equipment sending the serial string to the ESP-88 to terminate the serial string with one CR at the end of each command. You do not need to enter this CR in the Serial Input entry windows.**

Note: **You must use hex when designating a control character like CR or LF. To designate a hex character, use backslash 0, then the hex value of the character (0-F).**

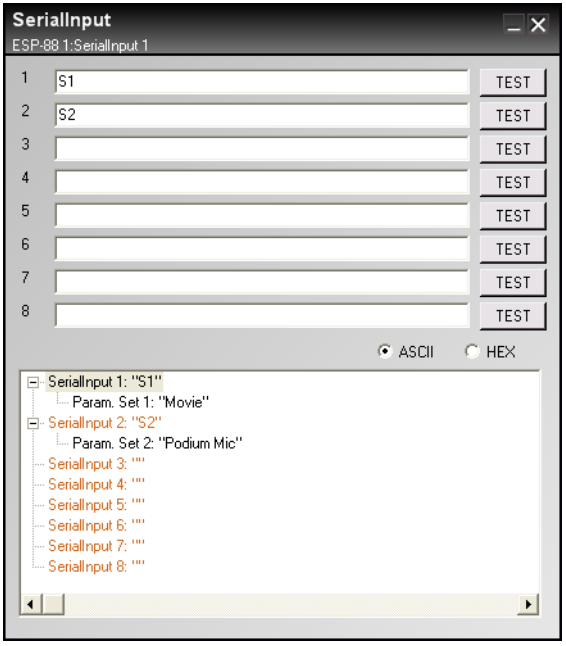

Figure 6.17 - The input strings “S1” and “S2” invoke a parameter sets

Use the **Test** buttons on the Serial Input control panel to simulate the incoming serial string.

Serial Outputs

The serial output device is used to send a serial string when a parameter set is invoked, or when a timer expires. To open the Serial Output control panel, double-click on the **SerialOutput** block in the **ESP-88** window.

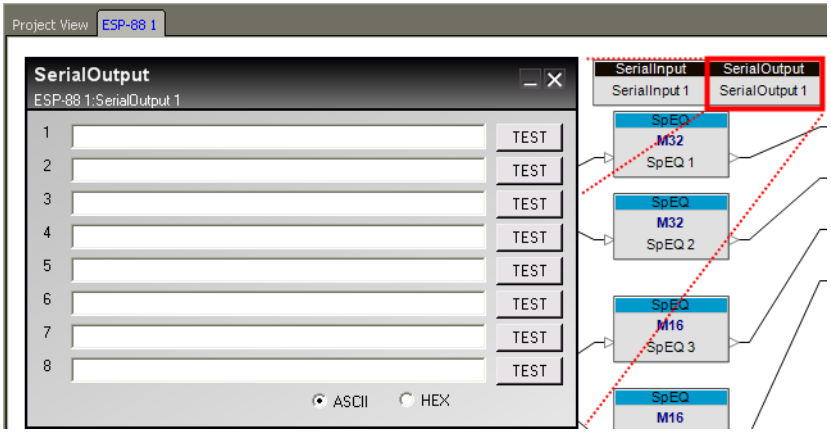

Figure 6.18 - Open the Serial Output control panel

There are two ways to program a Serial Output which are similar to programming a GPO. There are two ways to program a Serial Output. After typing the serial string or command into the Serial Output control panel, find the Serial Output in the Project Directory, and drag it into a parameter set or timer. When the parameter set is invoked, or the timer expires, the Serial string is sent out the Serial port on the ESP-88. For example, you could send a signal to a video switcher when a parameter set is invoked or a timer expires.

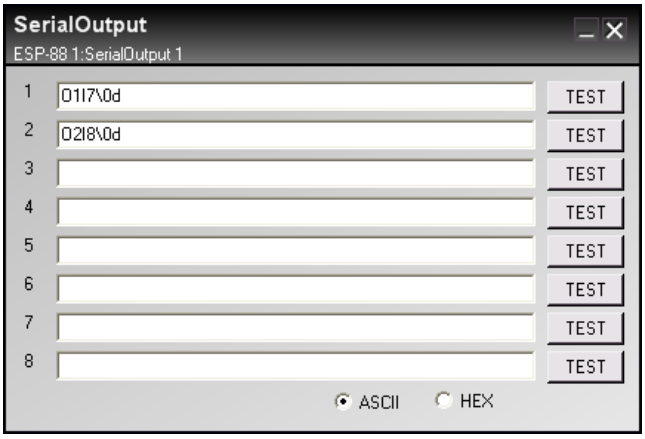

Figure 6.19 - Serial output strings to be sent by the ESP-88

You can also use the Parameter Set Nodes List to program a Serial Output to be activated by a parameter set, . Open the Parameter Set Nodes List by right clicking on the parameter set name, and place a checkmark next to the desired Serial Output.

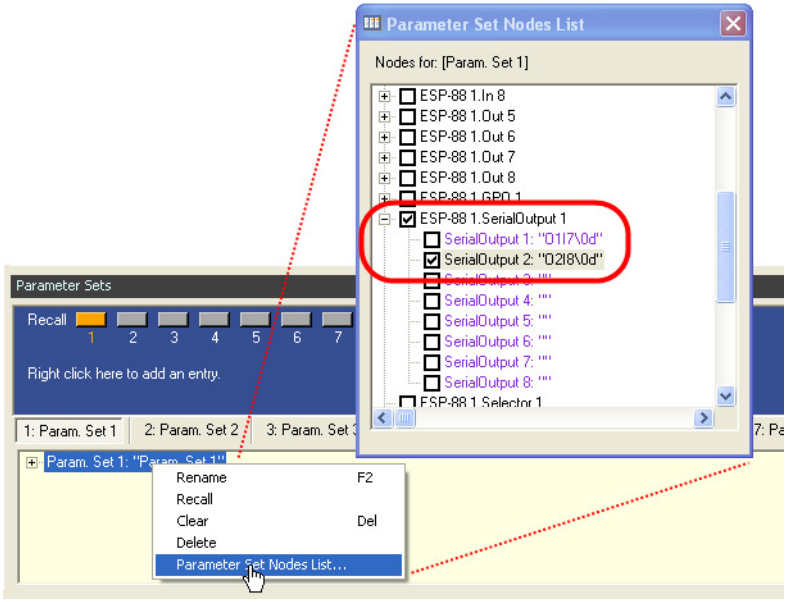

Figure 6.20 - Use the Parameter Set Nodes List to program a Serial Output

Using the Project Directory

The **Project Directory** window contains all objects in your system design in a tree structure format. To open the Project Directory window, go to **Window** > **Project Directory**.

*Figure 6.21 - **Project Directory** window*

The **Project Directory** window is a master directory of your system design. All devices, signal processing blocks, and programming are displayed in the tree structure. To see a particular object in your design, expand the appropriate tree structure. For example, to view the settings for an input block, click on **Devices** > **ESP-88**, and then click on the input.

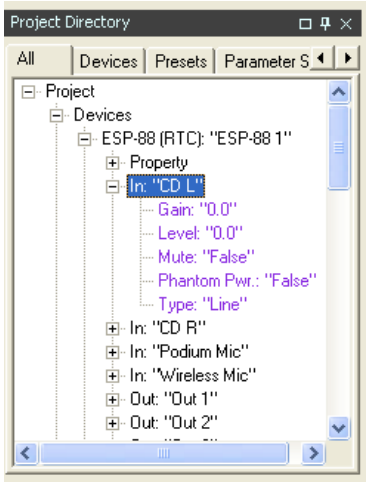

Figure 6.22 - Viewing input block settings

By default, the **All** tab is selected at the top of the **Project Directory** window to display all objects in your design. You can select a different tab to view a sub category of objects. For example, select the **Parameter Sets** tab to view all parameter sets.

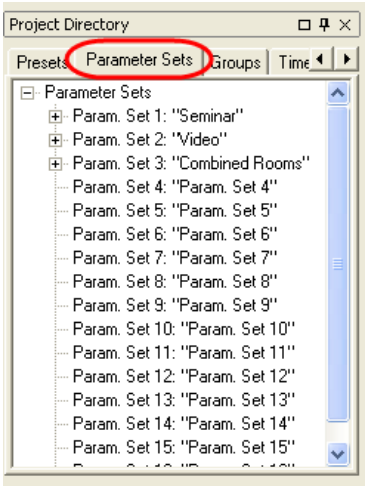

*Figure 6.23 - **Parameter Sets** tab*

You can use the Project Directory to program user controls without opening the Smart Simulators or GPI control panels. For example, to access the CC-64 controls, select the **Devices** tab in the **Project Directory** window, then click on the **CC-64** > **Standard**.

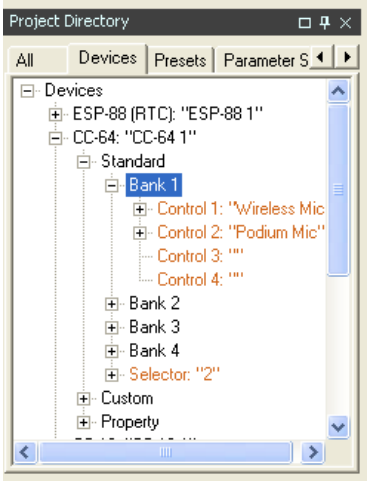

*Figure 6.24 - Access CC-64 controls in the **Project Directory** window*

You can drag and drop into the banked controls, Selector, and Custom controls just as you would with the CC-64 Smart Simulator. In the same manner, you can assign functions to a CC-16 buttons using the **Project Directory** window.

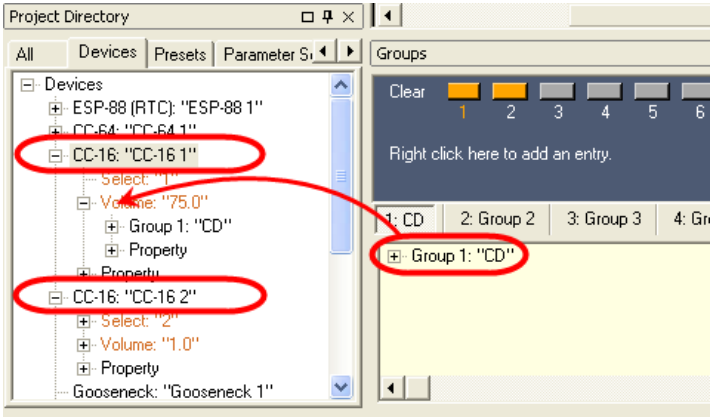

*Figure 6.25 - Assign CC-16 controls in the **Project Directory** window*

Drag and drop into the select and volume control buttons to assign functions.