

Crestron **SIMPL Windows**

Primer



CRESTRON

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Crestron SIMPL Windows

Overview

About this Primer

The intent of this primer is to introduce programmers to SIMPL Windows programming techniques and how they apply to Crestron control systems. This includes an understanding of how control systems use touchpanels and button panels as user interfaces. Through these interfaces, a user might send a signal that is processed by the control system (manipulated by logic symbols) and outputted to eventually control a device.

Simplified Control System



The control process is more complex than this and has many more variables. However, this is the basic concept of programming Crestron control systems. Users of this information should have a basic understanding of the following:

Microsoft Windows

- Knowledge of basic Windows commands
- Familiarity with Windows features and functions

Audio/Visual

- Knowledge of different control formats (serial, IR, relays)
- Familiarity with A/V equipment
- Ability to read and understand control and wiring diagrams

SIMPL Windows provides a wide variety of symbols that are constantly being expanded to support virtually every possible application. As you become proficient at using SIMPL Windows it will become obvious that there are many ways to solve the same control problem. This allows for programming creativity and independent flexibility.

Crestron Development Software

SIMPL Windows

Crestron SIMPL Windows provides all the tools necessary to configure, program, test and debug an integrated control system application. Combining the familiar drag-and-drop functionality of Microsoft Windows with the programming power of SIMPL (Symbol **I**ntensive **M**aster **P**rogramming **L**anguage), SIMPL Windows provides the link between Crestron systems hardware, user interfaces, and the world of equipment to be controlled.

The **configuration** aspect of SIMPL Windows allows you to select the control system, user interfaces, network devices and controlled equipment required for the installation. To these hardware components you can assign port addresses, Network IDs and IP addresses, set communication parameters and specify which device is connected to which card or network control module. You can also specify what VisionTools™ Pro-e touchpanel projects are required for the system.

The **programming** aspect allows you to select the logic symbols the system will require, assign signals to those symbols and connect the signals to other symbols or devices as determined by the program logic. SIMPL Windows includes a wide variety of symbols that are constantly being expanded to support virtually every possible application. As you become proficient at using SIMPL Windows it will become obvious that there are many ways to solve the same control problem. This allows for programming creativity and independent flexibility.

Finally, the **testing** aspect allows you to test and debug your SIMPL Windows program using powerful diagnostic tools including Test Manager, Network Analyzer, and the Crestron Viewport. You can call these tools directly from SIMPL Windows or launch the tools independently.

For even greater flexibility, the SIMPL Windows installation package includes **SIMPL+™**, a development tool that allows advanced programmers to create and compile custom control modules using a procedural language similar to C. You can add SIMPL+ modules to your SIMPL Windows program or user module much like a logic symbol, to extend functionality or solve a specific control problem.

SIMPL Windows is fully integrated with Crestron's suite of software tools, which include the following:

Crestron VisionTools® Pro-e

VisionTools® Pro-e is Crestron's touchpanel page design software. Using VisionTools Pro-e, programmers can create powerful touchscreen control interfaces that include pop-up subpages for specific device transport controls, multi-mode buttons and sliders with 3D effects, high-resolution graphics, dynamic text, video windows, sound, and more. VisionTools Pro-e uses join numbers to identify button presses, feedback, and other digital, analog and serial signals. These join numbers correspond to inputs and outputs on the touchpanel symbol detail in SIMPL Windows.

DEAL™ for Windows

Crestron's DEAL™ (Device Editor and Learner) for Windows software enables programmers to learn manufacturer's IR signals. When used in conjunction with the Crestron CNXLIR (IR Learner), DEAL allows you to create, modify and test IR driver files, and to save the learned IR files in the User Database where you can add them to your SIMPL Windows program.

Media Manager™ System Builder™

The Media Manager™ System Builder™ offers automatic programming for such residential and commercial applications as audio distribution, home theater, and video conferencing. The System Builder provides a Wizard-like interface that takes you through a series of programming screens. Simply follow the prompts to select the control system, user interfaces, devices and functionality. The System Builder then automatically programs, compiles, and uploads the system, including VisionTools Pro-e touchpanel projects and control system logic.

D3 Pro™

Crestron D3 Pro™ software offers design, development, and documentation for a complete residential lighting system, with additional support for auxiliary devices such as security systems, motion detectors and shades. Like the System Builder, D3 Pro presents a Wizard-like interface. Programming is accomplished through a series of simple but powerful System View screens. After the design is complete, D3 Pro automatically creates, compiles, and uploads the control system program and touchpanel projects.

These are just some of the software tools that Crestron has created to help you accomplish your programming tasks more easily and efficiently. You can download all Crestron software for free from the Software Updates area of the Crestron Web site (requires registration).

Databases

The **Crestron Database** is a large collection of information that is accessed by various Crestron software packages, including SIMPL Windows, D3 Pro, and the System Builder. The bulk of the Database consists of IR driver files that control user devices such as CD players, DVD players, conferencing equipment, and other third-party IR devices the end user interfaces with using the Crestron control system.

In addition to IR driver files, the Crestron Database contains hundreds of Crestron logic modules that control third-party device functions. Modules are self-contained logic programs that have been pre-coded, tested and debugged at Crestron. These dedicated modules can be plugged into a program and used to generate all the proper control codes for a device automatically.

The **User Database** is designed to store IR driver files that are not included in the Crestron Database. Programmers usually generate IR files using the Crestron CNXLIR (IR Learner) in conjunction with DEAL (**D**river **E**ditor and **L**earner) for Windows software. Alternatively, you can obtain user IR files by downloading them from the Crestron Design Center or Crestron FTP site.

In addition to IR driver files, the User Modules directory stores user-created logic modules that are not included in the Crestron Database.

Product Catalog CD

Crestron provides a variety of ways for you to obtain information about Crestron hardware. The most comprehensive resource is the Crestron Web site: **www.crestron.com**. Here you can download the most up-to-date user manuals, reference guides, and CAD drawings for all Crestron control systems, network devices and touchpanels. You can also access the Crestron Design Center, which provides extensive information about user modules that control equipment from I2P partner manufacturers, including help files, sample logic programs, touchpanel projects, cable diagrams, and more.

You can access the Crestron Web site directly from the SIMPL Windows **Online Support** menu. Click **Crestron Online** for the Crestron home page, or click **Crestron Design Center** to open the Dealer/Tech Resources page.

The **Crestron Product Catalog and Technical Reference CD** is another valuable tool that you can use in conjunction with the Crestron Web site, or any time you're not connected to the Internet. The CD is a comprehensive library of Crestron brochures, catalogs, product specification sheets, CAD drawings and user manuals. You can browse the CD independent of any Crestron program, or you can link the CD directly to SIMPL Windows to display documentation for devices you select in the Device Library.

To access user manuals from SIMPL Windows

1. Insert the Product Catalog CD into the CD-ROM drive (you can close the selection screen if it opens automatically).
2. In the SIMPL Windows Device Library, select whichever Crestron control system, network device, touchpanel or control card you want documentation for and press F1.
3. The first time you try to access the Product Catalog CD from SIMPL Windows you will be prompted to browse for the CD-ROM drive or folder where the CD is located. Locate the drive or folder and click **Open**.
4. If documentation is available for the selected device, SIMPL Windows will find the PDF file and open it in Adobe Reader. If no PDF file is available for the device, then the SIMPL Windows help file will display programming help for the device.
5. You can click **Product Catalog CD** on the SIMPL Windows **Help** menu any time you want to open the CD selection screen for documents, brochures, CAD drawings, or utilities.
6. If you do not have the CD inserted and you press F1 on a device in the Device Library, SIMPL Windows will prompt you to insert the CD. You can then either insert the CD or click **Cancel** to view the online help file.

Crestron Control Systems

Why Program Control Systems?

The term **program** refers to the instructions loaded into the control processor that cause it to operate in an intended way. For example, to control a DVD player, you must write a program that tells the control system which port the unit is connected to, what IR codes to send to it, and which buttons on a touchpanel trigger those functions. A typical program may contain hundreds of similar instructions designed to allow control of an entire rack full of audio/visual equipment. All programs are written in the SIMPL programming language. Crestron has created the SIMPL Windows development application expressly for writing in this language.

Elements of a Control System

Main Processor

The Crestron control system processor is the heart of a complete remote control system. Its basic function is to integrate and communicate with equipment made by other manufacturers. To do this the control system's working memory (**RAM**) must be programmed to use the specific instructions, or program, to communicate with the devices being controlled.

In addition to working memory, control systems contain an operating system (OPS). Similar to the operating systems that run personal computers, the OPS is a set of instructions that enables the control system to understand the program that has been loaded into it and to control equipment connected to the system by various input/output devices (an infrared module, for example).

The need to upgrade the OPS will arise if programmers want to take advantage of new programming capabilities, new Crestron hardware devices, or to correct a problem found in a previous version. You can download control system updates from the Crestron Web site. Operating system files on this site have file names such as c2.v3080.cuz, with different extensions depending on the type of processor. Before downloading, make sure the update is compatible with your control system by verifying that the file name matches the OPS version number and the extension corresponds to your control processor model.

2-Series processors use a CUZ file to load the operating system to the control system. 2-Series processors provide 32 MB of DRAM, which is expandable to 4GB for processors that include a Compact Flash slot. The size of the program, and number of analog, digital, and serial signals that can be processed are limited only by the amount of available RAM. In addition to RAM, the processor provides 256KB of NVRAM (non-volatile RAM) that is used to store SIMPL+ variables and variables expressly written to it by some "memory" symbols in SIMPL. These symbols include Analog RAM, Digital RAM, and Analog Non-Volatile Ramp, and are commonly used for lighting or volume presets. Non-volatile RAM retains data written to it when power is turned off. The 256K of NVRAM may also be split to use 64K or 128K as an NVRAM disk.

X-Series processors have a base Monitor in addition to the operating system, as well as separate TCP/IP stacks, all contained in a UPZ file. The separate stacks are for systems that include the CNXENET or CNXENET+ card for Ethernet communication. X-Series processors allow a total of 16373 user-defined digital

signals, and 2048 user-defined analog/serial signals. The processor also provides 256K of NVRAM that is divided in different ways depending on the type of Ethernet card being used.

“Legacy” control processors such as the ST-CP and CN-Series processors allow a total of 4085 user-defined digital signals and 512 analog/serial user-defined signals.

Processor	Maximum number of signals
2-Series	Depends on available RAM
X-Series	16373 digital 2048 analog/serial
ST-CP and CN-Series	4085 digital 512 analog/serial

Network Control Modules

Network control modules are devices connected to the Cresnet or Ethernet network that extend the functionality of the control system and allow it to control third-party equipment. Crestron provides an impressive variety of network control modules, including audio receivers, mixers, distribution switchers, surround sound processors, video processors, camera controllers and room solution boxes.

Any 2-Series processor is also capable of operating in “slave” mode, meaning that it can be controlled by another 2-Series processor, in order to operate as a powerful network control module.

Network control modules are located in the SIMPL Windows Device Library as **Cresnet Control Modules** and **Ethernet Control Modules**. Lighting control modules are located in the **Lighting** folder.

Plug-in Control Cards

Crestron plug-in control cards are circuit boards that can be easily installed in the expansion slots of a processor and allow it to communicate with equipment. Plug-in control cards include network interface cards that connect the 2-Series or X-Series control system to the Ethernet network. Control cards are represented in the SIMPL Windows Device Library as **Plug-in Control Cards**. Once installed and configured the control cards allow the system to control virtually any number and variety of devices.

Many control devices such as serial ports are available as either Plug-in Control Cards or Network Control Modules.

Cards are usually less expensive since they don’t require housing or power regulation. Of course, control cards are limited to the number of expansion slots in the control processor.

User Interfaces

User interfaces are the controls that the user will use to request an action. Crestron manufacturers a large variety of user interfaces, ranging from simple and inexpensive handheld remotes and keypads to top-of-the-line touchpanels.

Touchpanels

Crestron touchpanels are the most common user interface of any control system. Touchpanels are available in Cresnet, Ethernet, and wireless versions with either gray scale or color displays.

Programmers develop touchpanel screen layouts with VisionTools Pro-e software. Buttons are assigned numbers that link them to the specific operation that it represents in the SIMPL Windows program. These links are called **join numbers** and will be describe in more detail later.

Wired Keypads

Wired keypads have a simple design and operate on the Cresnet network. Their push-button operation offers classic styling. Many models offer a choice of button configurations and panel finishes.

Wireless Remotes

Crestron wireless touchpanels and remotes communicate with the control system using Crestron gateway receivers (e.g. CNRFGWA, CNIRGWA, or CNRFGWX). The gateway is connected to the control system via Cresnet. Wireless IR/RF transmitters are one-way devices; they do not receive, but only transmit IR or RF signals. Likewise, the Crestron CNIRGW is a one-way remote IR receiver and the CNRFGWA is a one-way remote RF receiver.

User devices

User devices are the audio/visual equipment, such as CD players, TVs, and VCRs that will be controlled by the Crestron control system. The User Devices folder contains hundreds of driver files for these devices, organized by manufacturer or device type.

Control Methods

When working with and programming Crestron control systems, it is important to have a good understanding of how devices can be controlled. In general, any device that has an electrical interface of some sort can be controlled by a Crestron control system. The most common control methods are listed below:

- Relay closures (mechanical or solid-state)
- Serial communications
- Analog voltages
- Custom Crestron interfaces

Relay closures

Many devices employ internal electronics that allow functions to be triggered through a simple electrical contact. In the world of control systems, this is accomplished using relays. Devices such as screens and drapes, or third-party lighting control systems tend to use this type of interface. In addition, some not-dimmed lighting circuits can be switched on and off using relays. Crestron manufactures relays of many different flavors: low-power relays for use with devices that do not draw a lot of current or require high voltages, and high-power relays for

direct control of motors and lighting circuits. In addition, relays can either be mechanical or solid-state. If you are unsure about what type of relay is needed for a given application, you can call Crestron technical support for assistance.

Serial Communications

Many devices today can be controlled using various types of serial communication. Typically serial-controlled devices use one of the following types of serial communication: Infrared, RS-232, RS-422, RS-485, MIDI, and "custom serial". In the next few paragraphs we will discuss the differences between these formats.

What does "serial" mean?

The term **serial** describes a communications format in which one piece of information is transmitted and/or received after the next. As an analogy, think of a telephone where you hear one word after word until a sentence is constructed. This is different from **parallel** communications in which multiple pieces of information are transmitted and received simultaneously.

Serial communication encompasses a wide variety of popular formats, many of which are supported directly with Crestron control systems. The sections below describe the most common formats in more detail.

IR (Infrared)

For many years infrared remote control has been very popular, and today it remains among the most common forms of serial control. As the name implies, infrared control consists of serial data transmitted via pulses of infrared light. In addition, IR signals are usually modulated by a carrier signal. In most cases this carrier signal has a frequency of approximately 40kHz, though some can go as high as 1MHz.

In the Crestron world there are two applications of IR control. Crestron wireless user interfaces may use IR for communication with the control system. In this case the IR is transmitted/received by Crestron equipment in a proprietary format.

Crestron IR wireless interface

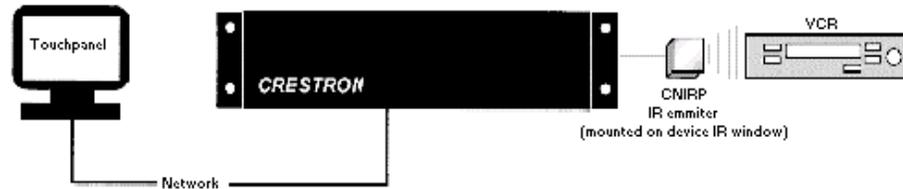


The other application of IR control is IR signals that the system generates to control other manufacturer's devices (e.g. to mimic Sony or Panasonic). The system can generate the functions that were available on the device's remote control.

Since IR is a one-way communication, there is no feedback from the equipment being controlled. That is, data is transmitted to the device to be controlled, but no data is returned from the device to the control system. This means that when using IR control, you have no true feedback from the device telling you that your command was accepted, for example. This is one inherent disadvantage with this type of control. Another disadvantage of IR is that it depends upon a line-of-sight between the control system and the device to be controlled. To counter this problem, Crestron can provide an IR probe, which provides a wired connection from the

control system to the IR receiver on the controlled device. Care must be taken to ensure that the IR emitter on the IR probe is properly located next to the receiver.

Remote IR Equipment



Manufacturers do not normally publish the exact nature of the data that is being sent via their IR remote controls. Therefore in order to generate the proper signal out of the Crestron IR card, the remote must be learned through the use of a special device called an IR Learner. The device, when attached to a PC and used in conjunction with Crestron's IR learning software (DEAL for Windows), will generate a driver file that can be inserted into your programs. Once the program is finished and loaded into the control system, the control system's IR card can convert the information in the driver file into the proper electrical signal.

Crestron IR Equipment

IR Probes (CNXIRP and STIRP)

The IR probe (CNXIRP or STIRP) is a very small, wired IR emitter that Crestron developed to be installed externally over a device's IR window. The probe is wired from the control system and emits IR signals directly into the device's IR window. Since the IR Probe can be mounted externally on equipment, it eliminates the need to open other manufacturer's equipment in order to rewire or alter the IR window. In addition, by installing the probe directly on the device being controlled, the interference caused by direct sunlight and high efficiency fluorescent lighting can be eliminated.

IR Sprayer

The IR sprayer is an IR emitter that can "spray" IR signals 90 degrees. It eliminates the need for the IR probe and can be positioned in a central location to reach all devices. It is designed to handle several IR codes so only one sprayer is needed for many devices.

IR Device Modules/Control Cards

IR device modules, such as the C2IR-8 or the IR ports built into some control systems, provide control of IR or some serial controlled devices. The C2IR-8 and the built in IR ports require the IR probe (CNXIRP) when using IR communication.

See Serial IR for information on using IR ports for serial communication.

IR Learner (CNXLIR)

Crestron Electronics CNXLIR is used to "learn" the codes (pulses of infrared light) that a device's remote sends to control a piece of equipment. By learning these codes programmers can create custom IR device drivers. DEAL for Windows software allows programmers to create, modify, and test driver files. Programmers can then store the learned .IR files in the User Database for use in their SIMPL Windows programs.

Crestron Database

As described earlier, the Crestron Database contains hundreds of pre-coded IR driver files for programmers to utilize. This database covers most of the IR controlled devices on the market today. In fact, the database supports all current control formats, including relay control, analog voltages, and TCP/IP. Programmers can search the database by manufacturer or device type.

Custom Serial

The term **custom serial** is used here to describe a communications protocol that is similar to IR, but is carried out over a wire rather than light pulses, and there is no carrier frequency. It is called custom because currently a number of manufacturers employ this method, but there is no true standard. Sony Control-S and Marantz RC-5 are examples of custom serial formats in use today.

In terms of usage, this form of serial communications differs from IR only in that a specially made wired cable must be used in place of an IR probe to connect from the control system to the controlled device. Because the data format is normally identical to a corresponding IR remote, serial drivers are created first by learning the remote to generate an IR driver, then by passing the file through a special filter that removes the carrier frequency. Just like with IR, custom serial signals are generated using an IR card such as the C2IR-8.

Crestron Custom Serial Equipment

CNSP-109

The CNS-109 is an Electrahome/Vidikron Cable for use with C2IR-8 or (1) serial output port.

CNSP-110

The CNSP-110 is a Sony VO 5000, 7000, 9000 serial Umatic cable for use with C2IR-8 port.

CNSP-112

The CNSP-112 is a Sony Control-S cable for use with (1) C2IR-8 port.

RS-232, RS-422, and RS-485

The terms **RS-232**, **RS-422**, and **RS-485** all refer to physical standards for serial communication developed by the Electronic Industries Association (EIA). The standards specify the electrical interface between equipment. These standards have been developed to allow various pieces of equipment to communicate with one another without concern for special hardware; any device that conforms to one of the standards above should be able to communicate with any other device conforming to the same standard. Of the three formats, RS-232 is by far the most popular for use in control systems. For the remainder of this section, the term RS-232 will be used to describe any of the three protocols, except where noted.

Unlike the IR or custom serial formats, RS-232 control does not use ready-to-go driver files. Instead, the data format, or **protocol**, that a controlled device is expecting will be described in the unit's manual. This protocol includes the data that the device expects to receive and transmit, the speed at which it communicates (baud rate), the error checking (parity), the number of data bits and the number of stop bits. In addition, a given device may require hardware (RTS/CTS) or software (XON/XOFF) handshaking, which controls the flow of data between two devices. All of these elements are adjusted in the control program to match the manufacturer's specification.

Because of the absence of a driver file, RS-232 control is generally considered more difficult to program than IR or custom serial. This is because each time an RS-232 device is to be programmed, the programmer must look up the protocol in the manual, and then write the necessary logic into his program to send this data. To counter this, many devices have dedicated modules written for them. These modules can be plugged into a program and used to generate all the proper control codes automatically.

The differences between RS-232, RS-422, and RS-485 are physical in nature, and do not affect the programmer, except that they must make sure that the Crestron product being used to send the data supports the format, and has been configured properly. RS-232 uses one wire to transmit data, and one wire to receive it. It is generally valid for sending data up to 50 feet, but this distance can depend on many factors, such as cable quality, baud rate, and the ambient electrical noise. The RS-422 format uses a balanced pair of wires for transmission, and another pair for reception. The balanced pair allows the data to be less susceptible to noise, and RS-422 signals can be sent up to 2000 feet. The final standard, RS-485, is similar to RS-422 except that a single pair of conductors is used for both transmitting and receiving data. This makes RS-485 very attractive for network applications, where data is being shared between more than 2 devices. A typical application might be an HVAC system that communicates to various thermostats and to a control system over an RS-485 LAN.

The Crestron C2IR-8 plug-in control card can only transmit RS-232 one-way. The C2COM-2 plug-in control card is capable of generating RS-232, RS-422 or RS-485 two-way signals. The ST-COM network device can generate RS-232, RS-422, or RS-485 two-way communication data.

Crestron RS-232, RS-422, and RS-485 Equipment

C2IR-8

The C2-IR8 includes eight serial ports for one-way RS-232.

C2COM-2

The C2COM-2 is a Cresnet plug-in control card. It includes two bi-directional RS-232/RS-422 (DB-9) ports with hardware handshaking.

CAUTION: The DB9 pin-outs on the C2COM-2 control card are not standard RS-232. Connecting a straight-through serial cable may damage equipment. Refer to the Crestron Cable database or contact Crestron for serial cable pin-out specifications.

ST-COM

The ST-COM network device can generate either RS-232, RS-422, or RS-485 data.

Limitations

RS-232 is limited to a wire length of 50ft (15 m) and a minimum of three conductors (RXD, TXD, and Ground).

Each piece of equipment requires a specific (protocol) format for the data it is expecting.

Programmer needs to be familiar with binary, hex, and/or ASCII in order to generate the correct strings.

MIDI (Musical Instrument Digital Interface)

MIDI stands for Musical Instrument Digital Interface and is yet another serial communications standard. As its name implies, MIDI is used most commonly for allowing musical instruments to talk to one another. However, certain audio mixers,

which sometimes find their way into control system applications, use MIDI control. From a programmer's viewpoint, MIDI does not differ from RS-232, RS-422, or RS-485. From a hardware standpoint, the CNX-MIDI card is required to generate the proper control signals.

Crestron MIDI Equipment

CNX-MIDI

The CNX-MIDI interface card is a MIDI IN, OUT and THRU interface. It is used with mixers and lighting equipment.

Analog Voltages

Certain devices, typically units such as camera pan-tilt heads, lighting control systems, or voltage-controlled attenuators (VCAs) can be controlled with an analog voltage. Programmable analog voltages can be generated using the CNXAO-8 card or C2I-IO8. The latter card contains 8 Versiports capable of being programmed for digital input/output or analog output.

Custom Crestron Interfaces

Certain devices have control interfaces that do not fall neatly into one control method or category. In these instances Crestron has developed custom modules (either plug-in control cards or network modules) to offer control. Examples of these include:

- Line-level audio attenuation (volume control)
- Pan/Tilt and Zoom/Focus control
- Slide projector control
- Keyboard/Mouse interface
- Lighting (dimmed and non-dimmed) and motor control modules

For detailed information regarding the above, see the Crestron Catalog for exact model names, and reference the User Guide for each module.

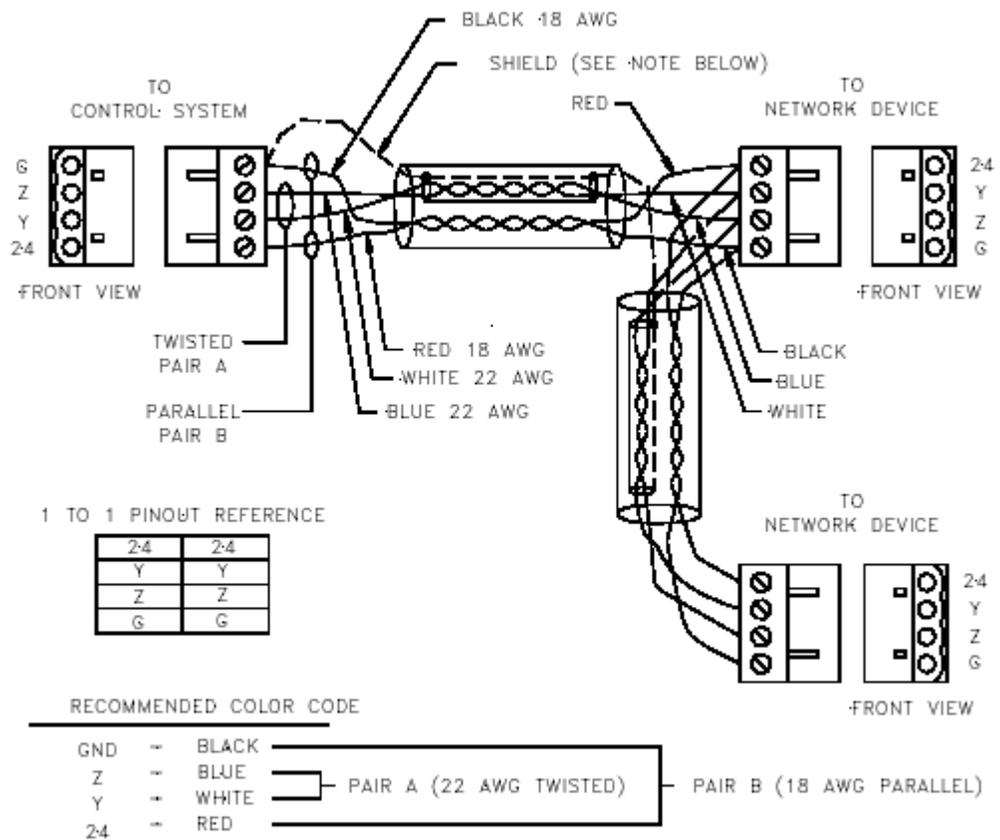
Cresnet

The Crestron network, or **Cresnet**, refers to the network topology that is used by Crestron. The RS-485 bus is used to connect the control system to Crestron 'network' devices such as a CNECI-4A (electric control interface for AC powered devices) or a CNSC-1A (slide projector interface). The RS-485 bus should be used to locate devices remotely when the limitations of IR and RS 232 restrict the installation plans. For example, IR must have line-of-sight to the device being controlled. Serial communications (RS-232) is limited to 50ft. The Cresnet RS-485 is a proprietary cable connection that can be connected to devices with up to 5,000 feet of cable.

Cresnet cable consists of:

- **Pair A** #22 AWG, twisted pair with shield for data lines
- **Pair B** #18 AWG, twisted pair for power and ground
- PVC jacket

Cresnet - Network Interconnect Specifications



CAUTION: POSSIBLE EQUIPMENT DAMAGE IF MISWIRED.

Do not power up system until all wiring is verified. Care should be taken to ensure data (Y, Z) and power (24, G) connections are not crossed.

Ground shield at control system end only.

Model CNTBLOCK network terminal block is recommended for testing purposes and convenience of wiring.

SIMPL Windows Programming

Introduction to SIMPL

Crestron engineers are dedicated to the development of our products and the interface with other manufacturer's equipment. However, control systems need individual programming in order to be customized for each installation. Crestron control systems are programmed using **SIMPL** (Symbol Intensive Master Programming Language).

SIMPL is an object oriented programming language designed for easy implementation of your control system requirements. The objects that are used in SIMPL are called **symbols**. Each symbol has a specific set of operations that it will perform. The lines that connect symbols are called **signals**. The collection of SIMPL symbols and their interconnection to one another is the **program**. Therefore, the program is actually a picture created with objects (symbols) and lines (signals). This type of picture is also referred to as a block diagram or flow diagram in other applications. When planning an A/V installation, a block diagram indicating how all of the system equipment is connected is essential to the installer. SIMPL allows the programmer to develop a control program in a similar fashion. The collection of all the symbols being used and the signals that connect them create a picture similar to a block diagram. The development of a SIMPL program is intimately tied to the block diagram of the A/V installation.

Symbol Categories

Writing a program in SIMPL is similar to wiring a circuit: you have to choose the right components, and you have to wire them together properly. As just described, in SIMPL the components are called symbols and the wires are called signals. Just like in real-world electronics there are a multitude of symbols to choose from to accomplish your goal, as you program more and more systems you will likely find a subset of symbols that you use for most situations.

Symbols in SIMPL can be divided into two broad categories: **device symbols** and **logic symbols**.

Device Symbols

Device symbols represent Crestron network control devices that can be included in a program. They can be placed into or deleted from the program in the Configuration Manager section of SIMPL Windows only. The Program Manager allows device

symbols to be connected, but not added or deleted. Device symbols are located in the Device Library of the Configuration Manager.

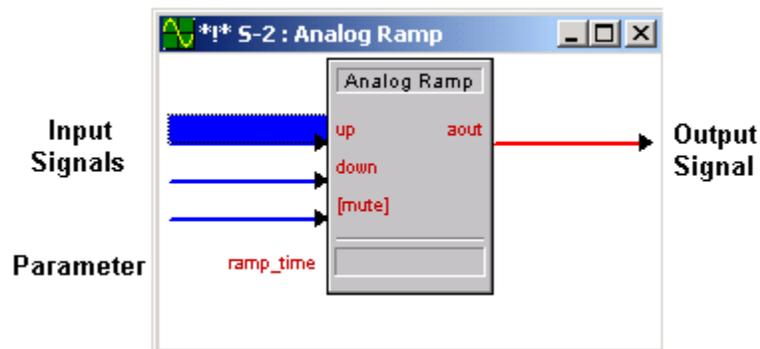
Logic Symbols

While device symbols allow you to communicate with the outside world, logic symbols allow you to make your program perform exactly the way you want. Logic symbols can range from the very basic ones such as the AND, OR, or NOT symbols, to those designed for very special applications. A more in-depth discussion of logic symbols can be found in the Programming with Symbols section.

Symbol Properties

Although each symbol serves a special purpose, all symbols share some basic properties. These are inputs, outputs, and parameters.

Example: Analog Ramp symbol



Inputs

Symbol inputs allow signals to be connected from other parts of the program. Depending upon the symbol type, the current **state** of the input signal(s) may affect one or more output signal(s). Some symbols have a fixed number of inputs, while others can have a variable number of inputs, determined by the programmer based upon need.

Outputs

Except for a few special cases, the ultimate purpose of a symbol is to modify the states of its outputs. These outputs states will depend upon the symbol type, the current or past states of the input signals, and the values of the parameters. Because the symbol alone determines the states of its output signal(s), the symbol is considered the **driving source** for the output signals. Depending on the nature of signal, some outputs can have more than one driving source.

Similar to symbol inputs, the number of symbol outputs is fixed for some symbols, or can be variable based on need for other symbols.

Parameters

Some symbols also have parameters, which are constant values that help determine how the symbol behaves. For example, a symbol that delays an action for a specified period of time would have a parameter determining how long the delay should be for. The exact function of a parameter depends solely on the symbol type itself.

For convenience, parameters may be expressed in a variety of formats (all of which are directly related to one another). Although a parameter will default to one format based upon the symbol type, you can alter the format by changing **the format specifier** at the end of the value.

Listed below are the valid formats, where the character in parentheses represents the format identifier.

- (d)ecimal
- (h)exadecimal
- (%) percentage of 65535
- (s)econds
- (t)icks – 1 tick = 1/100 seconds (2-Series); or 1/112.5 seconds (X-Series)
- (')character(') (single byte)

To set a parameter to a specific format, add the identifier after the value, i.e., 25%; if the parameter is a single byte, place single quotes before and after the ASCII character.

Parameters can also specify the time of day. Here the time of day is expressed in military time followed by the “seconds” format specifier, as follows:

- HH.MM.SS.HSs
- MM.SS.HSs
- SS.HSs
- SSs
- .HSs

Where HH = hours; MM = minutes; SS = seconds; and HS = hundredths of a second.

For example, the parameter 20.03.05s signifies a time value of 20 minutes, 3 seconds, and 5 hundredths of a second. When using this notation you can leave out the larger units if you are not using them, thus "3.00.00s" would mean 3 minutes, 0 seconds, and 0 hundredths of a second (it would NOT mean 3 hours).

Depending on the function of a symbol, a parameter can be signed or unsigned. Signed values range from–32768 to +32767; unsigned values range from 0 to 65535. Percentages can also be expressed as negatives, i.e., -25% = 25% of 65536, or 16384. (-16384 = 49152d). Thus a parameter of -25% is the same as 49152d. Refer to the SIMPL Windows help file for further information on valid parameter values.

NOTE: Parameters are constants whose value must be known at compile time. The value of the parameter cannot be changed while the program is running (e.g. a signal cannot be assigned to a parameter). To change a parameter, the program must be changed and recompiled.

Signal Types

The concept of the signal has already been broached. Signals are the elements used in your program to interconnect the various device and logic symbols that comprise your program. However the discussion of signals does not end there. For starters, signals can be one of three types: **digital**, **analog**, or **serial**. For any given signal, the signal type is determined by the driving source. If the symbol that drives the signal

has an analog output, then the signal connected there will by definition become an analog signal. The three signal types are defined in more detail below:

Digital Signals

Digital signals are the most common in the SIMPL language, and a typical program will be comprised of between 95% and 100% digital signals. This type of signal can have only two states, often referred to as on/off. Other common descriptors are high/low, active/inactive, or 1/0. This transition is called the **rising edge**, or positive edge. Generally speaking, actions in SIMPL program are triggered by a digital signal going from the low to the high state. Although most actions are **edge-triggered**, others can be **level-triggered** (based upon current state, not just last transition). For example, a Toggle symbol is edge-triggered; it drives its digital output high and low with each rising edge of its input. In contrast, the Buffer symbol is level-triggered; its 'enable' digital input signal must remain high for signals to flow.

When looking through the symbol library reference, take note as to which symbols are edge-triggered, and which are level-triggered. You can find this information by selecting the symbol and pressing F1, which will open the context-sensitive help window for the symbol.

As stated previously, the type of signal is determined by its driving source. In many applications there are signals that have multiple driving sources. Such signals are said to be **jammed**. As a general rule, digital signals should not be jammed; that is, they should have only one driving source. But there are two important and common exceptions: system inputs (such as button presses), and the outputs of Buffer symbols. These exceptions can be very useful in applications where functionality must be shared across several user interfaces. For example, a DVD player can be controlled by a touchpanel as well as by a remote control transmitter.

In SIMPL Windows, digital signals are represented by a blue line.

Analog Signals

Analog signals are represented with 16-bit numbers, and thus can have values between 0 and 65535 ($2^{16} - 1$). This means that unlike digital signals, analog signals can vary continuously in value, in the same manner as a parameter such as volume or temperature. This property makes analog signals useful for controlling devices that do not have discrete on/off settings, such as volume controllers, pan/tilt head controllers, and lighting dimmers.

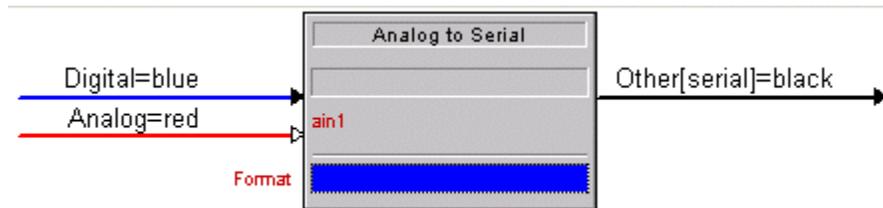
Unlike digital signals, analog signals by their very nature may have multiple driving sources. Thus analog signals are said to be jammable. In practice, whenever more than one symbol is driving the same analog signal, the symbol that lasts changes the signal's value takes precedence. Typical applications for analog signals are volume, lighting, and temperature levels, as well as advanced string manipulation.

In SIMPL Windows, analog signals are represented by a red line.

Serial Signals

Serial signals facilitate the transmission of serial data (i.e. strings of characters). These signals can be generated by incoming data on a COM port or by a symbol that has a serial output. Similar to analog signals, serial signals are jammable; thus multiple symbols can be used to generate strings on a single signal. By default, serial signals are **transient**, meaning that the data on a serial signal is only valid for the **logic wave** in which it was created (logic waves are described below). Symbols such as the Make String Permanent symbol allow serial strings to be retained in memory.

In SIMPL Windows, serial signals are represented by a black line.

Example Signal Colors

Some signals are ambiguous, meaning that the signal type is determined by the driving source. For example, the inputs and outputs of a Serial Buffer symbol can be either serial or analog. The ambiguous signal is resolved when the signal is connected to an analog or serial symbol. Ambiguous signals should be resolved before the program is finalized; otherwise a compiler error will be generated.

In SIMPL Windows, ambiguous signals are represented by a green line. Once they are resolved, the line color changes to blue (digital), red (analog) or black (serial).

Special Signals '0' and '1'

The special signals '0' and '1' are used to force a value on a signal. '1' is a digital-only signal whose value is always logic high. A digital signal named '0' will always be logic low. A '0' on an analog signal forces the signal to a constant value of zero. On a serial signal, a '0' will result in no string being transmitted.

Logic Waves and Logic Solutions

A **logic wave** is a processor unit of measurement defined as the elapsed time between the moment a signal's state changes and the moment that all symbols connected to that signal have been evaluated. This is analogous to the term "propagation delay" used when describing digital hardware. Although logic waves are not expressed in real-world time units (i.e., milliseconds) due to the fact that the actual time is indeterminate at compile time, SIMPL guarantees that all symbols have a propagation delay of exactly one logic wave.

Note that some symbols do not always conform to this rule. Examples are time-based symbols such as Delay and One-Shot. While the propagation delay of the Delay symbol is determined solely by its parameter values, a One-Shot will propagate in a single logic wave when its trigger input goes high. However, the falling edge of the input has no effect, and the symbol's output will go low only after the specified time has expired.

One or more logic waves make up a **logic solution**.

A logic solution is defined as the time it takes, starting with an external impetus, for the SIMPL logic processor to evaluate all symbols to the point at which all signals in the program have reached a "steady state" that is, the time required for all signals to settle to stable, unchanging states. The length of a logic solution can vary at runtime, and can be expressed in logic waves, i.e., "when this button is pressed, the subsequent logic solution should take 6 logic waves".

It is important to realize that time-based (scheduled) events do not occur during a logic solution, except to serve as the impetus to initiate one. Thus using an Oscillator symbol would not cause an endless logic solution. Instead, each time the output signal of the Oscillator changes, it triggers a new logic solution that runs until all affected signals arrive at their final states. On the other hand, endless logic solutions can be created by connecting logic incorrectly (i.e., routing the output of a NOR symbol back into its input). This situation should obviously be avoided.

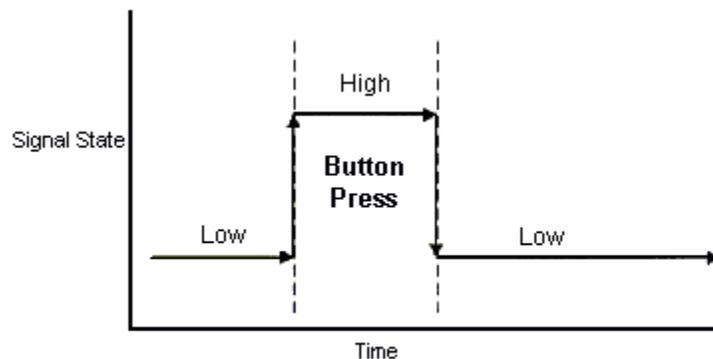
Programming with User Interfaces

The heart of any well-designed control system is the user-interface. This is the link between the end-user and the control system itself. Regardless of how cleverly programmed, or technically savvy a given system is, if it lacks a quality user-interface it is unlikely that the system will be appreciated, or used to its full potential. Crestron control systems offer an impressive array of user interface options, from the top-of-the-line Isys TPS touchpanels, to cost-effective and simple wired button panels. No matter what type of interface(s) you are using in your system, this section will help explain how to use them in your program.

Button Presses

In a program button presses (whether from a touchpanel, wired or wireless button panel, or other interface) are associated with signals. Since for a given device not all buttons may be used, unused buttons are not given signal names. When a button is pressed, the corresponding signal is asserted in the control system program. When the button is released, that same signal is de-asserted. See the signal-state diagram below for a graphical representation of this.

Simplified Button-Press



Low = Inactive = 0

High = Active = 1

Note that in this case the button alone determines the state of the signal. That is, when the button is pressed, the signal is high, and when the button is not pressed, the signal is low. Because of this the button is the **driving source** for that signal. Since a button can have only two states, high or low, the signal that it drives can only have two states, thus this signal is a **digital signal**.

In most cases digital signals are limited to one driving source. That is, it is illegal to have two different symbols driving the same digital signal. However, there are two important exceptions to this rule. One concerns the Buffer symbol, which will be described later. Button presses are another exception, in that a single signal may be driven from multiple buttons. This can be very convenient, especially in cases where you want to share functionality across several user interfaces. For example, the same volume up and volume down controls may be accessible from a touchpanel as well as from a wireless remote. Instead of having to create different signal names for each case, and then using an OR symbol to combine the functionality, it is legal (and desirable) to use the same signal names in both cases.

Button Feedback

User-interfaces that support 2-way communication (any interface except for 1-way wireless transmitters) also support button feedback. This term is used to describe the button's active appearance. For button panels, feedback is usually indicated with a LED located inside the button housing. For touchpanels, feedback can vary, and often includes changing the frame and text color, along with a simulated 3D appearance.

Visual Button Feedback

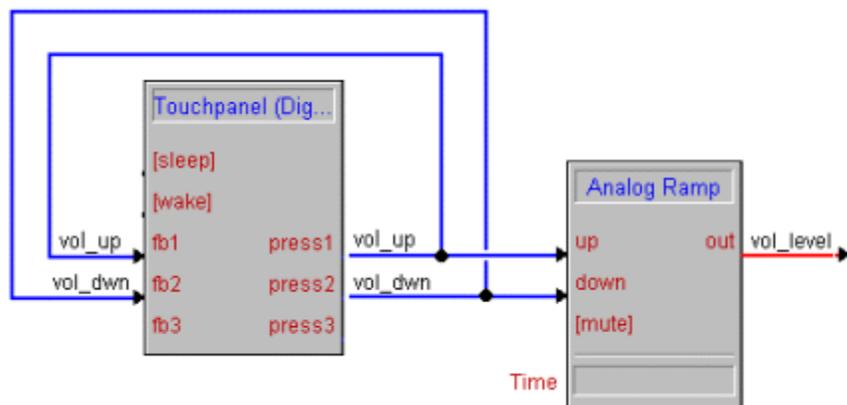


Feedback is vitally important to a good user interface design. For one thing, feedback lets the user know that a button press has registered with the system. This is especially important for touchpanels, where the user cannot tell from feel alone whether they pressed in the right spot. Another purpose feedback serves is to provide information to the user about the current state of the system (that the VCR is currently in PLAY mode, for example). In this case, care should be taken to make the feedback be as accurate as possible, as inaccurate or vague feedback will only serve to confuse the user.

Whether a button is pressed or not is determined by the user (or the user's finger to be exact!) but it is a signal that decides whether a button is shown in its feedback state or not. Therefore, the signal is the driving force for the button feedback. Where the signal comes from depends upon what type of feedback is needed. The most basic type of feedback is called **momentary** feedback. Momentary feedback causes the button to display in its feedback state only when the button itself is pressed. This type of feedback makes sense for functions that occur only while the button is pressed. For example, volume up and volume down buttons typically receive momentary feedback because the volume level only changes (goes up or down) while the corresponding button is pressed.

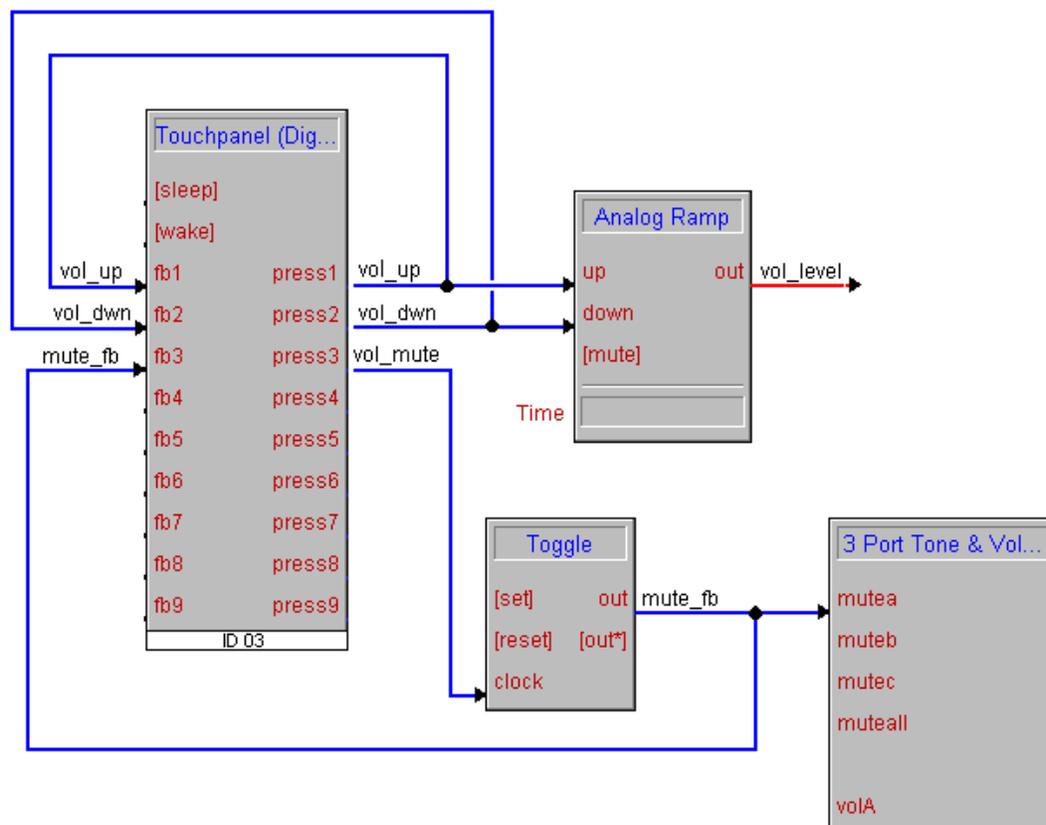
Momentary feedback can be achieved simply by connecting the button press signal name to the feedback signal for the same button, as shown in the diagram below.

Volume Momentary Feedback



Certain buttons may call for more complex feedback. For example, a volume mute button may alternately turn the mute on and off. To indicate this with feedback, the button should display in the feedback state when the mute function is on, and turn off when mute turns off. Clearly, momentary feedback will not do the trick here, so we must use logic symbols to generate the desired behavior. This example shows how to do this using the Toggle symbol.

Volume Mute – Toggle Feedback



An even more elaborate form of feedback is possible when there is 2-way communications between the control system and a device being controlled. In this case it is sometimes possible (and desirable) to show feedback based solely upon information received from the device (NOTE: this information is also called feedback. Don't confuse this with button feedback). For example, suppose you are controlling a switcher, which allows you to choose one of 4 video sources. If the switcher itself sent information back to the control system detailing which source was currently selected, your program could use that information to highlight the button representing the selected source. This would guarantee that the feedback was always correct, even if a user performed the switch from the switcher itself, and not via the control system.

Subpages (touchpanels only)

Subpages are powerful objects available for touchpanels only. Subpages are in many ways similar to standard touchpanel pages, in that they may contain buttons, text, graphics, etc. However, subpages ordinarily do not take up the entire display screen area. Instead, a subpage often defines a small area with buttons serving a specific function, such as VCR control buttons. A given subpage can then be designed to

appear on top of a standard page at any time and then disappear when no longer needed, similar to a dialog box in Windows or Macintosh computers.

In order to make the implementation of subpages as flexible as possible, they are controlled (i.e. shown or hidden) via touchpanel feedback signals. That is, whenever a subpage is needed, a subpage reference is created at the exact location where it is to appear. This subpage reference is simply a link to the subpage object that was created previously. Each subpage reference is then be assigned a join number, and the feedback signal for that join number will determine whether or not the subpage appears. As long as the signal is high, the subpage will appear, and will disappear as soon as the signal goes low. The example below shows the logic necessary to control a volume subpage from a single button, allowing the subpage to be toggled on or off as necessary.

Analog displays (touchpanels only)

VisionTools Pro-e provides a number of objects for different types of analog displays. For example, if you want to create a bargraph, you can go to the VisionTools Pro-e toolbar, select the Gauge (bargraph) object and scale it to the size you want. You would then assign an analog feedback join number to the gauge that represents the analog channel that the gauge will display the value of.

VisionTools Pro-e provides several analog objects:

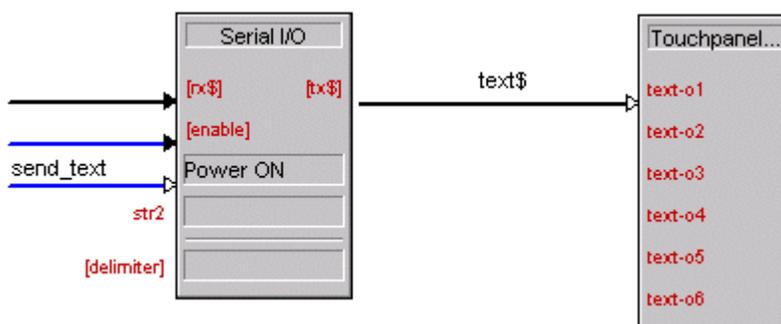
1. Gauges (bargraphs)
2. Sliders (bargraphs that also can be moved via touch)
3. Digital gauges (display an analog signal in number format)
4. Percentages (display analog signals in %)
5. Time (display analog signals in time format: HH:MM:SS)

Indirect text (touchpanels only)

Indirect text is a feature where the particular text string that appears on a touchpanel button can change, depending on the signal state. For example, when the user touches a button it might read “Power ON”, and when touched again it might read “Power OFF”.

In SIMPL Windows, touchpanel definitions have built-in serial feedback signals for defined for indirect text fields. These text fields accept serial data signals directly.

Serial Send to touchpanel text fields



Building a Program with SIMPL Windows

Programming Process

Identify the equipment that is going to be controlled.

Programmers should prepare documentation that lists all the equipment that is to be controlled.

Determine how the equipment is going to be controlled.

Knowing how the various pieces of equipment are going to be controlled is very important. This will let the programmer know what control devices (Network Module, Control Card, or other) will be necessary to control the equipment.

For example: IR control devices require a C2-IR8 plug-in card.

Configure the system in SIMPL Windows

Configure the system by building it in the Configuration Manager. Locate the control system in the Device Library. Drag and drop the control system into the System Views window. Complete the system configuration by adding interfaces, network modules, control cards, and other devices. All the necessary Crestron hardware should be included in your configuration.

Program the system in SIMPL Windows

After the system is built by adding all the necessary Crestron hardware, begin programming the system by working in the Programming Manager. Program each button function from touchpanels and other user interfaces. Begin by naming the output signals from the user interface. Select the symbol(s) needed for the program in the Symbol Library. Drag and drop the symbols into the Program View window. Assign signal names to symbol inputs and outputs in the Detail View window.

Basic Programming Rules

1. Symbols can be either device symbols or logic symbols.
2. Logic symbols perform an operation that manipulates signals.
3. Logic symbols only change states of output signals.
4. Signals connect symbols.
5. Digital signals should have only one driving source. Only one symbol in the program should list the signal as an output.

NOTE: There are some exceptions to digital signals having only one driving source. The exceptions are button presses and buffer outputs.

Build a System

The SIMPL Windows Configuration Manager allows you to do the following:

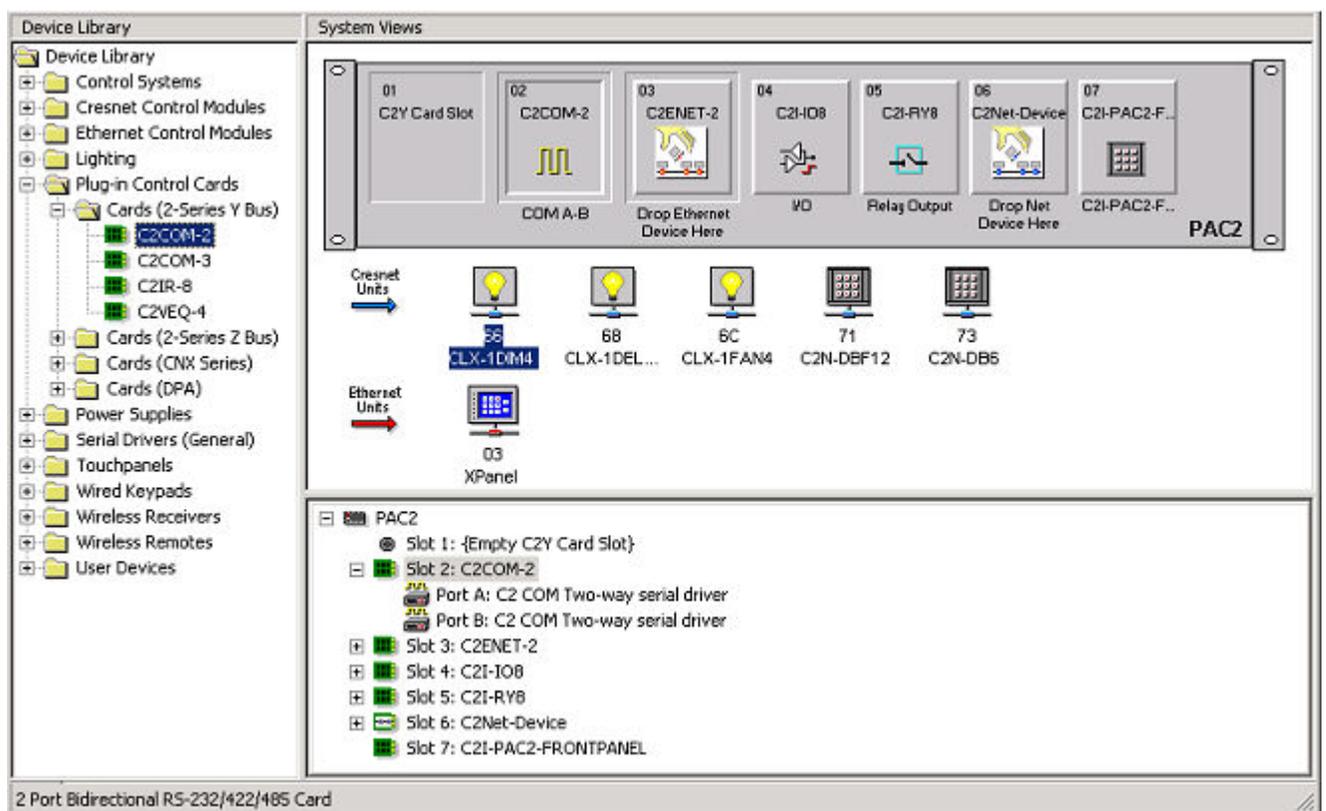
- Select the control system.
- Select additional Crestron hardware required for the installation. This can include plug-in control cards, network control modules, touchpanels, and wireless remotes.

- Select user devices made by third-party manufacturers. These are usually the devices being controlled and can include CD players, DVD players, TVs and any other equipment the end user interfaces with using the control system.
- Configure the devices by specifying which units are connected to which control cards or network modules. Assign ports, network addresses and IP information, specify communication settings and document the system with connection/installation notes.
- Specify what VisionTools Pro-e projects are required for the system.

The Configuration Manager screen consists of three panes: a **Device Library** and two **System Views**.

The Device Library is a tree with folders for all Crestron and third-party hardware, including Crestron control systems, Cresnet and Ethernet control modules, plug-in control cards, touchpanels, and user devices. You can view hardware by opening and closing the folders in the tree. As you select devices the SIMPL Windows status bar will display a description of the device.

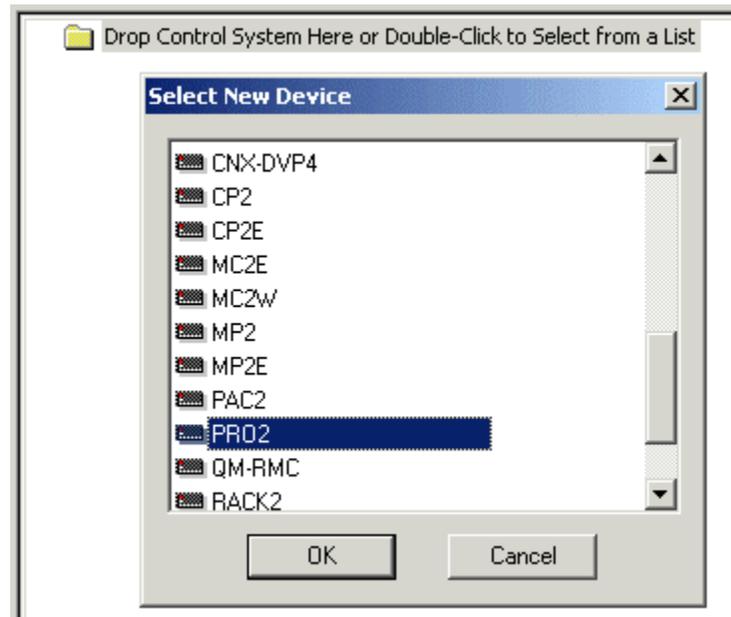
The top System View pane is a "picture view" of the control system and any Cresnet or Ethernet devices you add to the program. The lower System View is a tree of the control system with numbered slots that you can open and close to view the network addresses and configure each item.



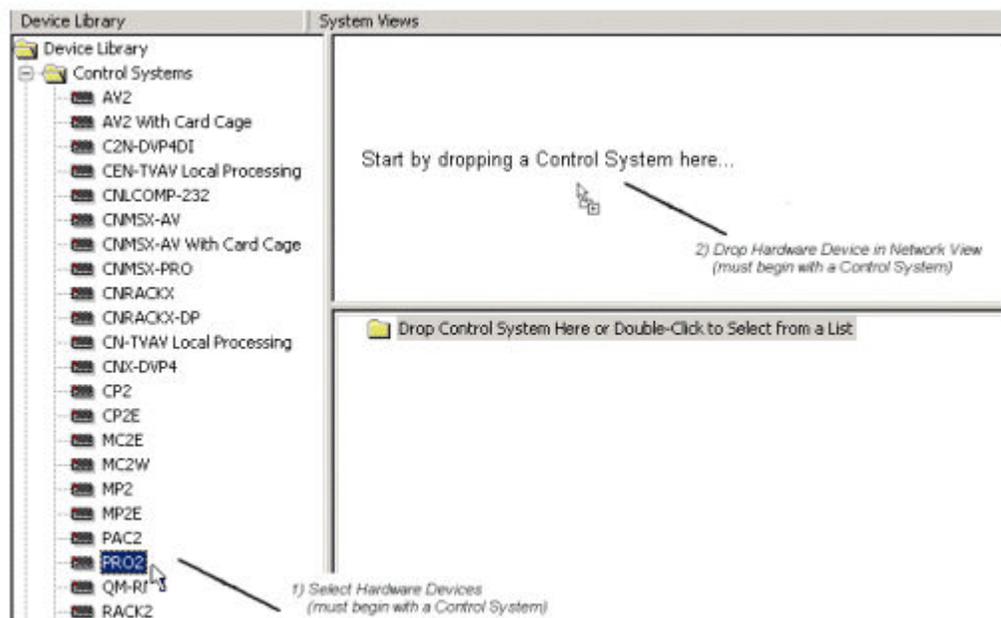
Control Systems

The first step in building a system with SIMPL Windows is to select the control processor. The Device Library includes all current Cresnet and Ethernet control systems, including 2-Series, QM, and X-Series models.

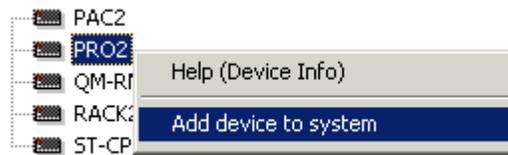
You can quickly add a control system by double-clicking the empty folder that is displayed in the lower System View and selecting the control system from the list.



You can also drag the control system to either of the System Views.



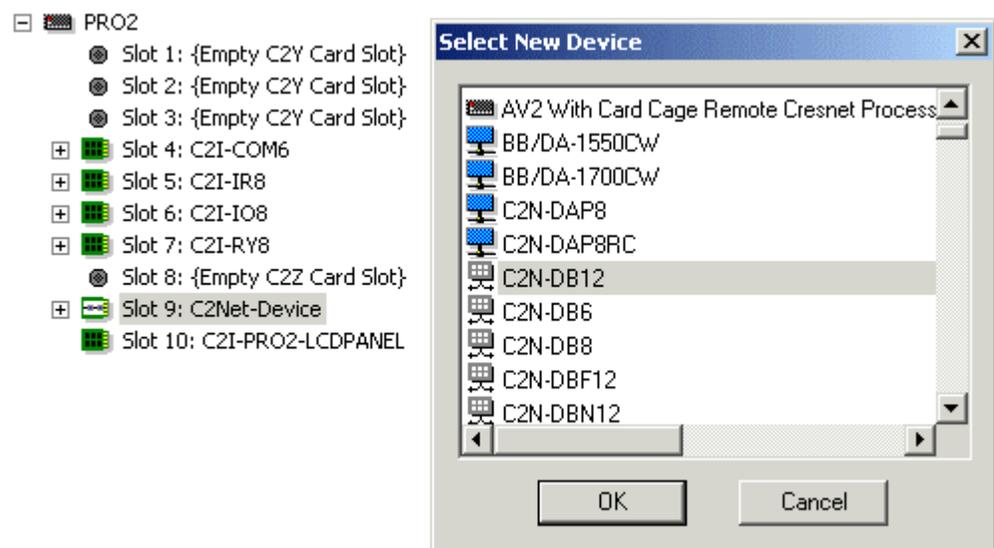
Another method is to right-click the control system in the Device Library and choose **Add Device to System** from the submenu.



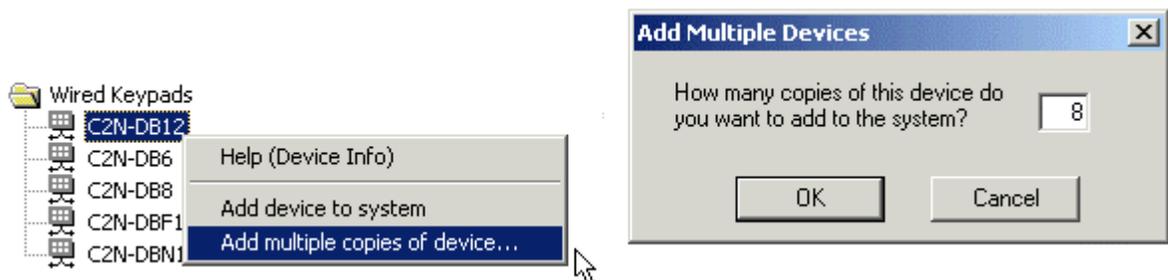
Network Hardware

Once you add the control system, the next step is to add the other devices that comprise the system, including network control modules, touchpanels and other interfaces, additional plug-in cards, and user devices from the Crestron Databases.

The quickest and most efficient way to add Crestron hardware is to double-click the card slot or Network ID in the tree view. This will open a selection list of Crestron devices that are compatible with that slot. For example, if you want to add a Cresnet device you can double-click the Net Device slot. Then scroll down the list to locate the device.



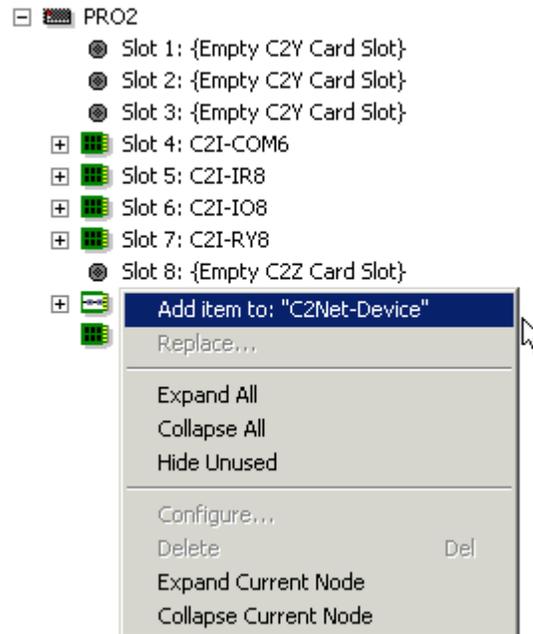
To quickly add multiple copies of a Crestron device, right-click the unit in the Device Library and select **Add multiple copies** from the submenu. Then enter the number of devices you want to add and click **OK**.



If you add a Crestron device to a control card slot, SIMPL Windows will auto-assign the network address, first by the default factory ID and then sequentially.

To add a Crestron device to a specific network address expand the slot and double-click the network address. This will open the device selection list and add the device to the selected ID.

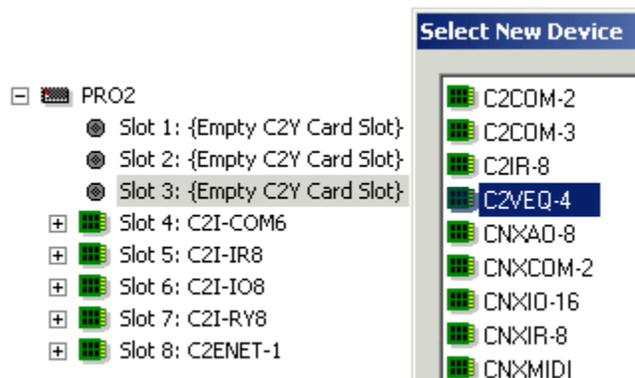
Another way to open the device selection list is to right-click the slot or network address and select **Add item** from the submenu.



Plug-in Control Cards

Crestron plug-in control cards are circuit boards that can be easily installed in the expansion slots of the control system. Plug-in cards serve many purposes, from providing additional ports for IR or serial control, to adding audio mixing capabilities to a processor, to connecting the control system to the Ethernet network. You can select cards from the Plug-in Control Cards folder of the Device Library.

You can quickly determine which plug-in cards are compatible with which slots by double-clicking the empty card slot in the control system tree. This will display a list of all available cards.



Serial Devices

Crestron processors control serial devices using physical standards such as RS-232, RS-422, and RS-485. Unlike IR, RS-232 control does not use ready-to-go driver files. Instead, the data format, or protocol, that the device is expecting will be provided by the manufacturer in the unit's documentation.

Most Crestron control systems provide built-in COM cards and IR cards that enable 1-way and 2-way serial control. In addition, Crestron manufactures a variety of plug-in COM cards, plug-in IR cards, and standalone network devices that enable serial control. For example, the C2COM-2 plug-in control card is capable of generating RS-232, RS-422 or RS-485 two-way signals. The ST-COM is a standalone Cresnet device that also generates two-way communication data. The C2-IR8 card provides eight IR/serial ports that support one-way RS-232 signals.

Crestron's COM cards have internal serial drivers ready to be configured for 2-way communication. Once you know the protocol for a serial device you can "add" the device by configuring the communication settings of the serial driver. You can view the serial ports by expanding the COM card or COM device in the control system tree.



Double-click the serial driver to display its Device Settings. Click the **Serial Settings** tab and configure the device according to the manufacturer's specification. This is described in detail in the Configure Device section.

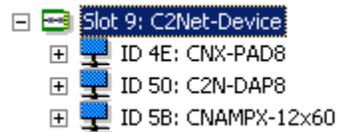
User Devices

You can locate third-party user devices in the Device Library by Manufacturer or Device Type. To add a user device, right-click the unit and select **Add device to system**. As shown below, you also have the option to add multiple copies of the device.



You can also use the standard Windows drag-and-drop method to drag a device to the card slot or port address in the tree view.

To hide unused slots from the tree view, right-click any item in the tree and select **Hide Unused** from the submenu. This will make only the connected network addresses visible and simplify the tree view.



Network IDs

A **Network ID** is a two-digit hexadecimal value that uniquely identifies each Crestron device on the control system network. Every programmable Crestron device, including network control modules, remote processors, touchpanels, remotes and Ethernet devices, must be assigned a unique network address to enable communication with the control system. The type of ID a device is assigned depends on the communication format.

Cresnet devices receive a Cresnet ID, also called a NET ID. The control system's Net-Device slot in SIMPL Windows provides 252 NET IDs for connecting Cresnet devices, although the physical network would require the use of a network expander if more than 30 Cresnet devices are connected. NET IDs range from 03 to FE.

Ethernet devices receive an IP ID, in addition to a unique IP address or host name. The Ethernet card slot in SIMPL Windows provides 252 IP IDs for connecting Ethernet devices. IP IDs range from 03 to FE.

Wireless panels and remotes must communicate with a Cresnet gateway receiver and are assigned an IR ID or RF ID. The number of available IDs differs depending on the gateway. Crestron's two-way wireless gateways such as the CNRFGWX provide 15 RF IDs (01 to 0F) for connecting wireless panels. Other gateways, such as the CNIRGW, provide up to 254 IR IDs (01 to FF).

The Network ID you assign to a device in SIMPL Windows must be the same as the device's hardware ID, which is the internal ID set at the factory. You generally have to change the hardware IDs of Crestron devices so that they match the IDs assigned in the software. The procedure for changing the hardware ID differs depending on the device, and is described in each unit's documentation.

You can set or change the assigned Network ID of a Crestron device when you add it your program. You can drop a device directly on a network address. You can also drag the device from one network address to another.

Finally, you can edit the Network ID of a device when you double-click it to open its Device Settings. This is described in the next section.

Configure Devices

Once you have added all your Crestron and third-party hardware to your system, you can configure these network devices by double-clicking the device in either of the System Views. You can also right-click the device and select **Configure**. This will display the Device Settings dialog box. The available configuration options differ depending on the device.

Cresnet Devices

Device Name: You can use this tab to change the default name of the device and enter a device location. The new name will appear in the System Views and Program

View, as well as in the title bar of the device's symbol. The device name and location will be included in the Device by Location report. It's a good idea to provide descriptive names and specific locations for all network devices, as this can aid in debugging. Devices that draw power from the Cresnet network will also display the power consumption in watts.

The screenshot shows the 'Device Info' tab of a configuration window. It contains three input fields: 'Device Name' with the value 'C2N-DAP8', 'Device Location' with the value 'Living Room', and 'Power Consumption' with the value '14.0'.

Net ID: You can change the Cresnet ID of the device by selecting from the list.

The screenshot shows the 'Net ID' dropdown menu open. The current selection is '40'. The list of options includes 40, 41, 42, 43, 44, 45, 46, and 47.

Connection Sheet: You can use these free text fields to enter information and program notes about connected equipment, installation requirements, functionality, and other points you want to document. This information will be included in SIMPL Windows reports such as the Connection Sheet, Devices by Location, or any User Report that you generate.

The screenshot shows the 'Connection Sheet' tab. It features three main sections: 'Function' with the text 'Video Switch', 'Equipment' with the text 'MP2', and a 'Notes' text area containing '3x2 composite/S-video switch and 4x2 RGBHV crosspoint' and 'Conference room installation.' There is also a 'Copy Previous...' button.

Device Info: This tab provides "read-only" program information about each device.

Device Name | Net ID | Connection Sheet | **Device Info**

Type: Driver File:

Mfg: Logic File:

Model: Control ID:

Control ID has multiple dvcs

Crestron DB User DB Project DB

Ethernet Devices

IP Net Address: You can change the IP ID of an Ethernet device or Ethernet remote processor by selecting from the list. In addition to the IP ID, you have to assign a unique IP address. If the device or remote processor has a static IP address, click **Use IP Address** and enter the IP address in the text fields.

Device Name | **IP Net Address** | Connection Sheet | Device Info

IP ID

Default Address
 . . . Use IP Address
 Use Host Name

Port
 TCP
 UDP

If the device or remote processor is enabled for DHCP or else has been assigned a host name by the system administrator, then click **Use Host Name** and enter the fully qualified domain name.

Device Name | **IP Net Address** | Connection Sheet | Device Info

IP ID

Default Address
 . . . Use IP Address
 Use Host Name

Port
 TCP
 UDP

Serial Devices

Serial Settings: Set the device's serial protocol according to the manufacturer's specification. The protocol you set here includes the communication standard (e.g., RS-232), the speed of data transmission (baud rate), error checking (parity), the number of data bits, and the number of stop bits. In addition, a given device may require hardware (RTS/CTS) or software (XON/XOFF) handshaking, which controls the flow of data between two devices. Finally, some devices require line pacing, or pauses between characters during transmission.

Device Name		Port Assignment		
Serial Settings		Connection Sheet		Device Info
Baud Rate:	Data Bits:	Stop Bits:	Parity:	Pacing (ms):
9600	8	1	N	
Comm. Std:	Handshaking			
(RS232)	HW:	(None)	SW:	(None)

Touchpanels

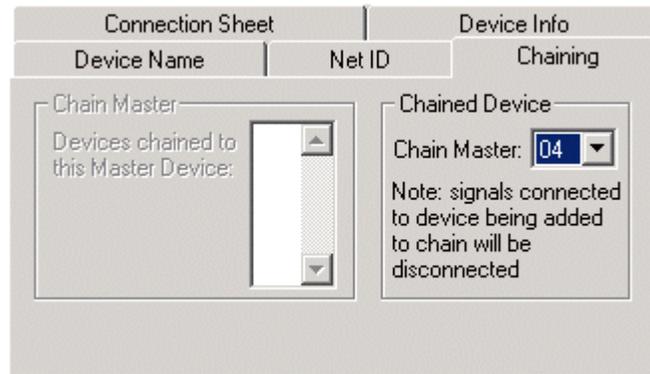
UI Project: Each touchpanel in a SIMPL Windows program has an associated VisionTools Pro-e project that defines join numbers for every digital, analog, and serial signal that the touchpanel sends to the control system or receives as feedback. You have to map the joins in the VT Pro-e touchpanel project to input and output signals on the touchpanel symbol detail. To facilitate this you can import the touchpanel project into SIMPL Windows. The imported project will be included if you create an archive.

To import the touchpanel project click **Browse** to locate the project file. You can select the **Create signals** check box to automatically define digital and analog signals on the touchpanel definition. Here serial joins, sound joins, Web control and analog state joins will NOT be imported and will need to be defined manually. Signal names will have the format: *Page name_button text*. Note that this operation will not overwrite or erase existing signals on the touchpanel symbol.

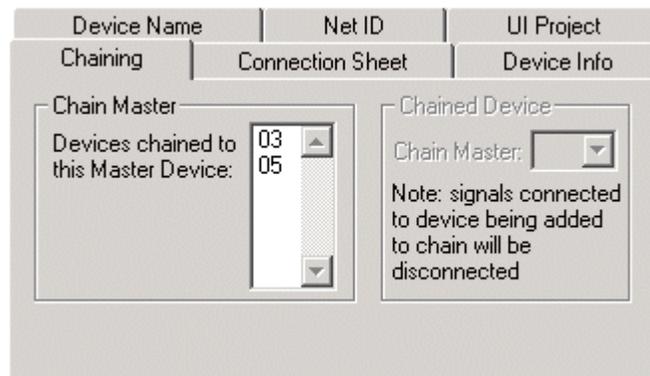
Device Name		IP Net Address	
UI Project		Connection Sheet	
Device Info			
Project			
C:\Crestron\WtPro-e\Projects\TPS-6000.vtp		Browse...	
<input checked="" type="checkbox"/> Create signals on panel for each Join in .vtp project			

Chaining: (Cresnet only): If you have multiple touchpanels of the same type that will be used for exactly the same functions, you can chain them together so that they will be programmed identically. Here the Chain Master is the touchpanel that determines the characteristics of the rest of the chain. To chain a touchpanel to a Chain Master, select the Net ID of the Chain Master from the drop-down list. In the example below, the touchpanel will be chained to the Chain Master located at Net ID

04. The chained device will share the master device's definition, and it will be displayed in the top System View as a **Chained**  icon.



The Chain Master panel will automatically display the Net IDs of all touchpanels that have been chained to it. In the following example, the Chain Master has two chained touchpanels located at Net IDs 03 and 05. As indicated below, the chained panel will lose any signals that were previously defined.



Connecting Signals

After you build the system by adding all the necessary Crestron hardware in Configuration Manager, begin programming the system by working in the Programming Manager. Program each button function from the system touchpanels or other user interface devices. Begin by naming the output signals from the user interface (output signals will already have assigned names if a VT Pro-e project has been brought in when configuring a touchpanel in Configuration Manager).

Select the symbol(s) needed for the program in the Symbol Library. Drag and drop the symbols into the Program View window. Assign signal names to symbol inputs and outputs in the Detail View window.

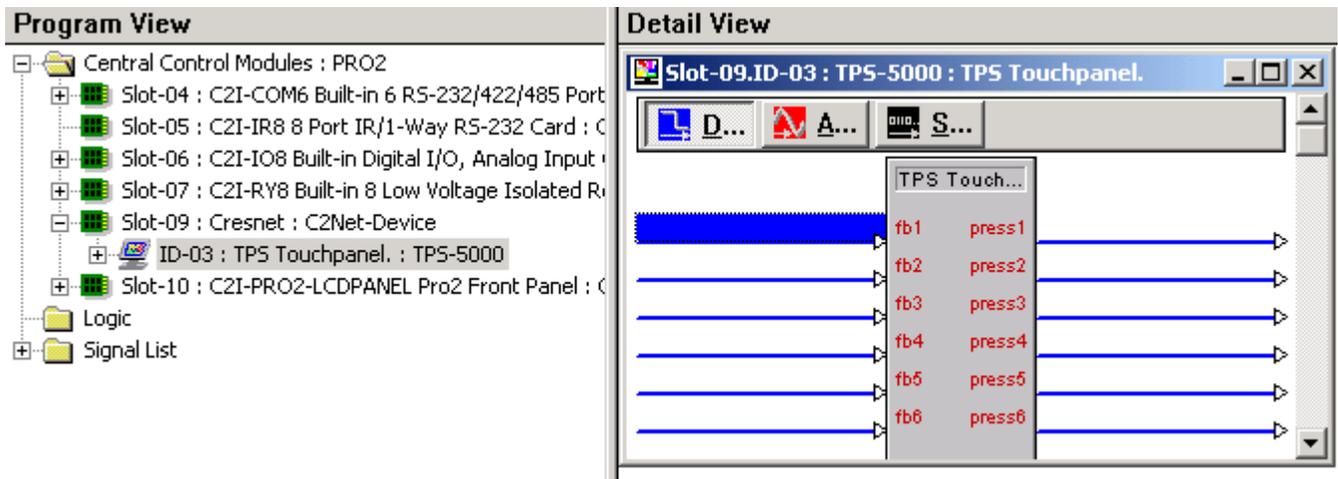
Define Signals from User Interface

User interfaces are usually the most convenient place to begin programming. In a program, button presses (whether from a touchpanel, wired or wireless button panel, keypad, or other interface) are associated with signals. When a button is pressed, the corresponding signal name is asserted in the control system program. When the button is released, that same signal is un-asserted.

The button press is the end user’s request for a specific action; therefore, the output signals of the user interface have to be named, or “defined”. This way, each signal can be identified and routed properly.

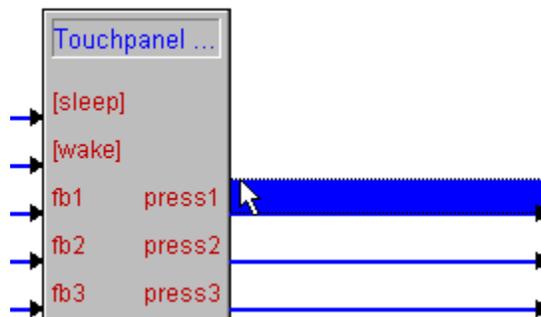
To program a user interface, locate it in Program View by expanding the appropriate slot or folder. Then drag the interface to Detail View or double-click it. This will display the touchpanel definition in Detail View.

User Interface (Touchpanel) Symbol



Click each signal you want to name. Signals should be given descriptive names such as “Power_On”, “Screen_Up” or “DVD_Play”, for example.

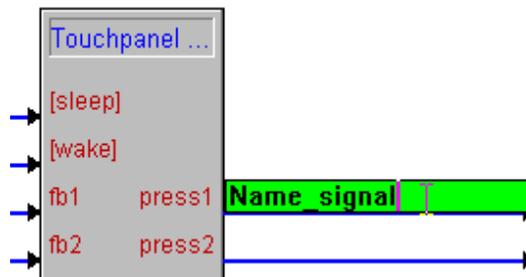
Selected Signal



The signal must be selected or highlighted before text can be entered. By default, the top input signal (top left) is automatically selected when a signal is first displayed. Use the pointer or arrow keys to navigate around the symbol.

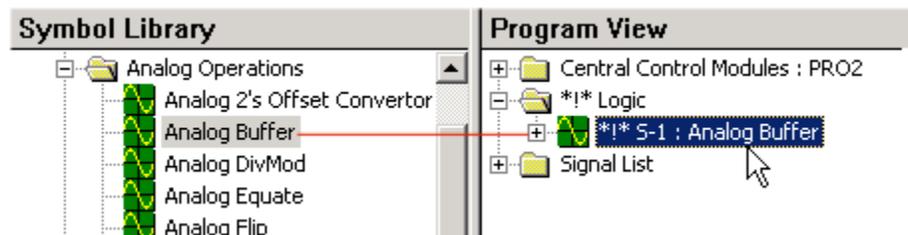
NOTE: Signals whose symbol label appears in [brackets] are optional and are not necessary for the symbol to operate.

You can enter the signal name when the signal is highlighted.

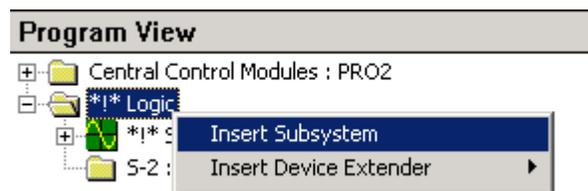
Entering Signal Name**Using Logic Symbols**

Programmers will typically use many symbols when programming in SIMPL Windows. Logic symbols allow programmers independent flexibility by offering many different ways to solve a control problem. Logic symbols can range from the very basic ones such as the AND, OR, or NOT symbols, to symbols designed for very special applications.

You can bring logic symbols into the program by selecting them in the Symbol Library and dragging them into Program View. Note that if you drop a symbol directly into Detail View, it will not be placed in the Logic folder.



SIMPL Windows allows you to create Subsystems, which are subfolders within the Logic folder. In this way you can organize symbols according to logic functions. To create a subsystem, select the Logic folder and choose **Insert Subsystem** from the right mouse menu.



When you create the new folder, you can right-click it to rename the folder to something meaningful, and you can drag symbols from the Symbol Library directly into the new folder.

Programming with Logic Symbols

Introduction

In the last chapter we saw how a program could be written simply using device symbols and connecting them via signals. This type of program uses "direct functionality." That is, button presses (or any other type of system input) are connected directly to control functions, such as the PLAY command on an IR driver. When the button is pressed, the PLAY command is sent out the IR port, and it stops as soon as the button is released. This type of programming is simple, but as control systems get more complex, you will find that you require more control over what goes on inside the program. This is handled through the use of *logic symbols*.

In general terms each logic symbol can be thought of as a very specialized processor. A logic symbol will evaluate the state of the signals connected to its input terminals, and generate appropriate signal values onto the signals connected to its output terminals. The values of the output signals will depend on the nature of the logic symbol itself, and on the values of the symbol's parameters, where appropriate.

Types of Logic Symbols

Currently there are over one hundred logic symbols available for use by SIMPL programmers. These symbols range from simple digital logic gates to complex serial data generators. In order to make it easier to find the symbol or symbols needed for a particular application, the entire logic symbol collection has been categorized as follows:

Analog Operations – Symbols that are used to perform analog functions such as ramping operations for lighting or volume presets.

Conditional – Logic gates that assert their outputs depending on whether some condition is true or false.

Counters – Binary and decimal counters.

Debugging – Symbols that track signals during run time, or force signals to analog, digital or serial types.

Device Interface – Mouse and keyboard simulators.

e-Control Software – Symbols that are used by Crestron e-mail power applications.

Memory – Symbols that write and read to NVRAM. That is, they retain data in memory even if power is shut off.

Program Formatting – Symbols that help to organize and arrange program information.

Sequencing Operations – Symbols that assert outputs according to a sequence.

Serial – Symbols that generate, parse, and process serial string data.

System Control – Symbols that affect the logic processor and allow it to communicate with remote systems and send data directly to the console.

Time/Date – Symbols that process timing data, including astronomical clocks, calendars, and the processor's internal clock.

Timers – Symbols that remember their previous states and trigger functions at specified times or after specified delays.

Touchpanel Interface – Symbols for broadcasting serial data to network touchpanels.

The rest of this section will show examples incorporating the most commonly used symbols. After reading this section, you can refer to the SIMPL Windows help file, which includes individual help topics for every logic symbol available in the SIMPL language.

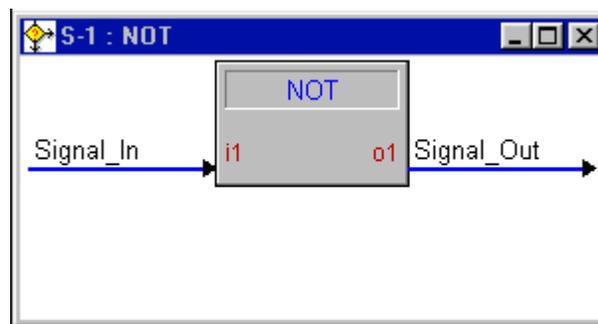
Basic Logic

The term basic logic is used here to describe the most elemental logic elements in SIMPL. If you have some experience working with digital logic, then you will be familiar with these symbols. Even if you do not have any prior knowledge of digital logic, this section should teach you all you will need to know to program successfully in SIMPL.

NOT Symbol

The NOT symbol, also known as an inverter, simply inverts the input signal onto the output. That is, whenever the input is high, the output will be low, and vice-versa.

NOT Symbol



Instead of describing the symbol's operation this way, we can use a truth table, which shows the logical relationship between the symbol inputs and outputs.

Signal_In	Signal_Out
Low	High
High	Low

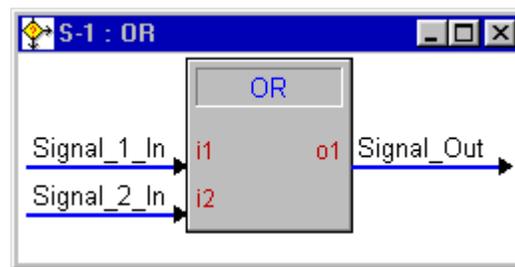
NOT Symbol Example: Automatic Camera Control

Sometimes a device provides the opposite signal than you want. For example, say your control system is set up to receive contact closures from an automatic microphone mixer, indicating which microphone has just been spoken into. In a video conferencing application, these closures might be used to point the camera directly at the speaker. However, suppose that instead of supplying a *closure* each time a microphone was spoken into, the relays were normally all closed and that it supplied an *open contact* to signify a microphone trigger. You could pass each incoming signal into a NOT symbol to first invert its level. The output signals could then be used to trigger camera presets somewhere else in your logic.

OR Symbol

The OR symbol will drive its output signal high whenever any of its inputs are high. Looking at the figure below, you could say that 'signal_out' is high whenever 'signal_1_in' OR 'signal_2_in' are high.

OR Symbol



The truth table for a 2-input OR symbol is shown below.

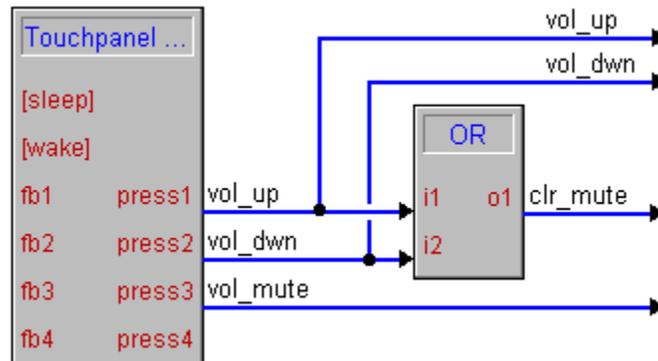
Signal_In 1	Signal_In 2	Signal_Out
Low	Low	Low
High	Low	High
Low	High	High
High	High	High

Note from the truth table that when *both* of the input signals are high, the output is still high. If you need an operation where the output is high when only one of the inputs are high; you can use an Exclusive OR (XOR) symbol.

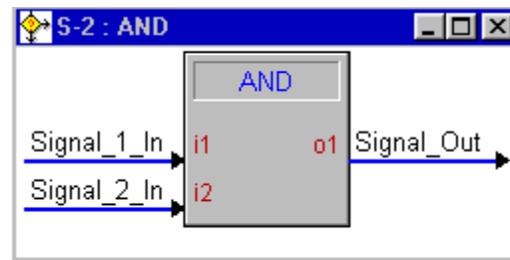
Note that the OR symbol has an arbitrary number of inputs (determined by the specific application), and a single output. That is, a 20-input OR symbol will have a high output whenever any of the 20 input signals are high.

OR Symbol Example: Volume Un-mute

As an example, consider volume control, which typically consists of up, down, and mute buttons. When the audio has been muted, you may want to un-mute it automatically if the volume up or down buttons were pressed. To accomplish this you could use an OR symbol like the one shown. Note that additional logic is needed to finish this example, and this will be covered in a later section.

OR Symbol Example**AND Symbol**

The AND symbol will drive its output signal high whenever all of its inputs are high. Looking at the figure below, you could say that 'signal_out' is high whenever 'signal_1_in' AND 'signal_2_in' are high.

AND Symbol

Alternatively, we can describe the behavior of the AND symbol using the truth table shown below.

Signal_In 1	Signal_In 2	Signal_Out
Low	Low	Low
High	Low	Low
Low	High	Low
High	High	High

NOTE: Similar to the OR symbol, the AND symbol can have arbitrary number of inputs, but always a single output.

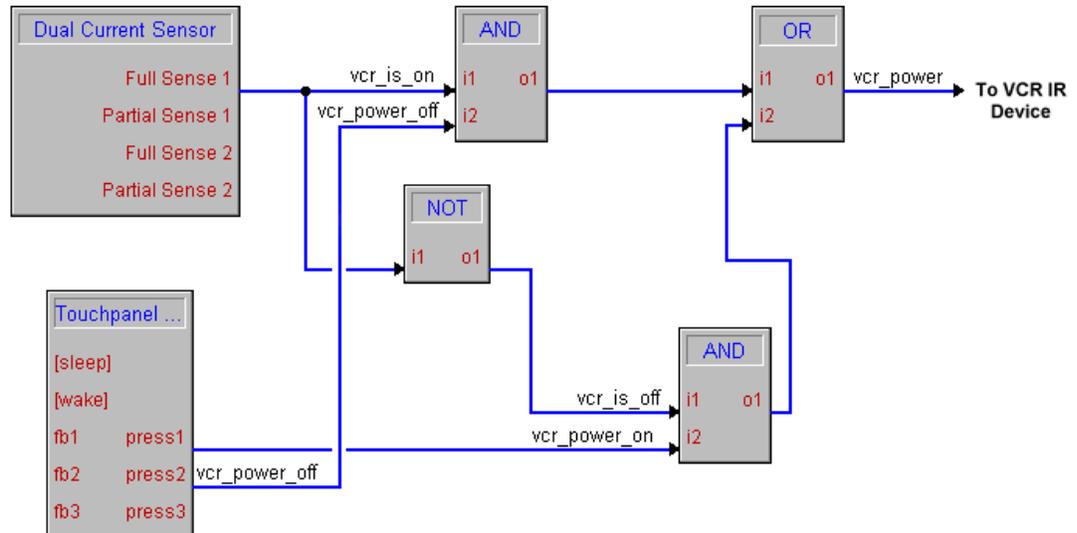
AND Symbol Example: discrete power on/off

Because the output to an AND symbol will go high only when **all** of its inputs are high, you would not ordinarily route multiple button presses directly into an AND. This would mean that both buttons would have to be pressed simultaneously. Instead, one or more inputs to the AND are usually latched signals, often used to determine the current state of something in the system.

For example, assume that we want discrete power on and off control of an IR-controlled VCR that only provides a toggling power function (on/off). Through the

use of a current sensing device, we have generated a digital signal that represents whether a VCR is currently turned on or not. That is, when the signal 'vcr_is_on' is high, the VCR is on. Using AND symbols, we can ensure that when the VCR is on, and the 'vcr_power_off' button is pressed, we send the power command to the VCR. If the VCR is off and the 'power_off' button is pressed, we do not want to send the power command because this would cause the VCR to turn on. We use similar logic to handle the case where the 'vcr_power_on' button is pressed. See the AND Example for a logic diagram of a complete current sensing program.

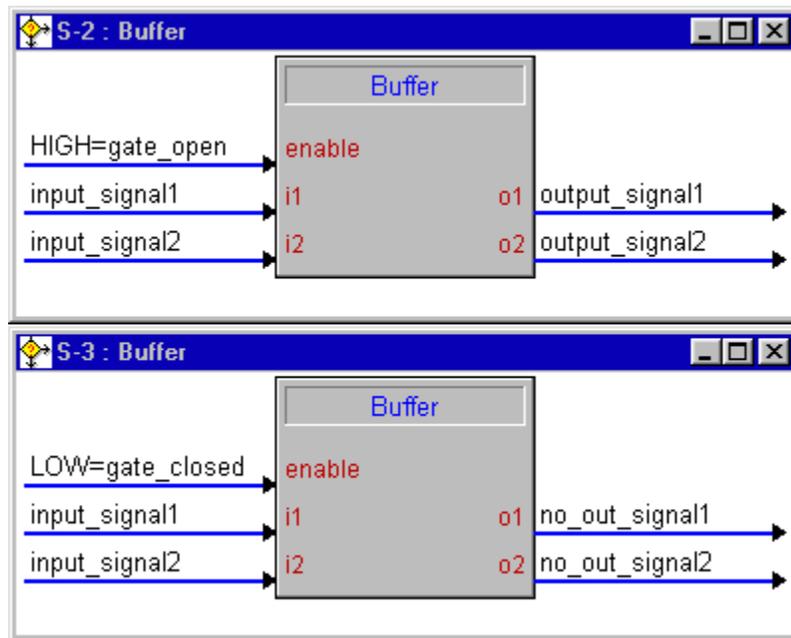
AND Example



Buffer Symbol

The *Buffer* symbol can be thought of as a gate that can be opened or closed, thus controlling the flow of data. When the gate is open, digital signals are allowed to flow unaltered from the inputs to the corresponding outputs. When the gate is closed, all output signals are set to logic low and the input signals have no effect on them.

Opening and closing the 'gate' is handled by the *enable* input terminal. When the signal connected to this terminal is high, the *Buffer* is enabled (the gate is open), and when this signal is low, the symbol is disabled (the gate is closed).

BUFFER Symbol- High/Low

This symbol differs from the other symbols discussed to this point in that not only does it allow an arbitrary number of inputs (in addition to the enable), but each input has a corresponding output. This is unlike the NOT, OR, and AND symbols, which have just a single output. Realize that each input/output pair in the *Buffer* is independent of the other input/output pairs. That is, a given input signal can affect the state of its corresponding output (when the symbol is enabled), but will not affect any other output. It is because of this that the *Buffer* is sometimes referred to a *compound AND* symbol, where each input is AND-ed with the enable input to determine the state of each output.

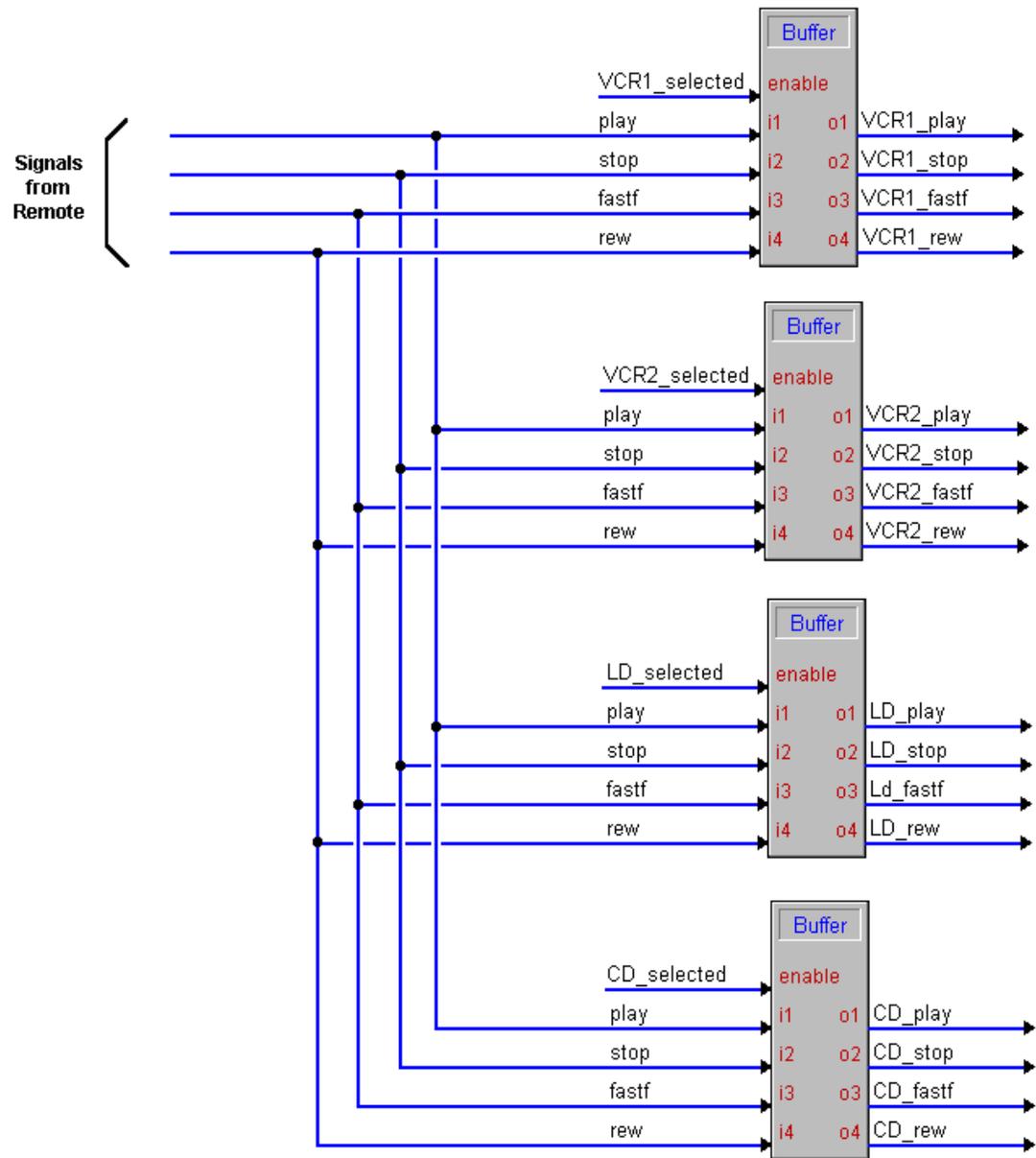
One interesting and very useful property of the *Buffer* symbol is the nature of its output signals. Previously we described digital signals and cautioned that each digital signal could have only one driving source, though there were some exceptions to this 'rule.' We also learned that system inputs like button presses were one such exception. Outputs of the *Buffer* symbol are another exception. This means that a signal being driven by a *Buffer* may also be driven by another *Buffer*, or by a button press (or other system input). This characteristic has far-reaching consequences that will be discussed in detail later in this manual.

Buffer Example: multi-device control

A common application for the *Buffer* symbol is to allow control of many devices using a shared set of buttons. This is useful when programming hand-held remote transmitters, which have a limited set of buttons. A typical layout for such a remote is to have one set of transport buttons, with different source select buttons to determine which device the transport buttons will control.

Because a *Buffer* works like a compound AND symbol, we often need to generate 'state' signals. That is, signals whose value denotes the state of something in the system. In this example we will need signals for each source which tell us whether that source is currently selected or not. In the following chapter we will see how to generate these signals, but for now, we will simply assume that we have them. See the sample program.

Buffer Example



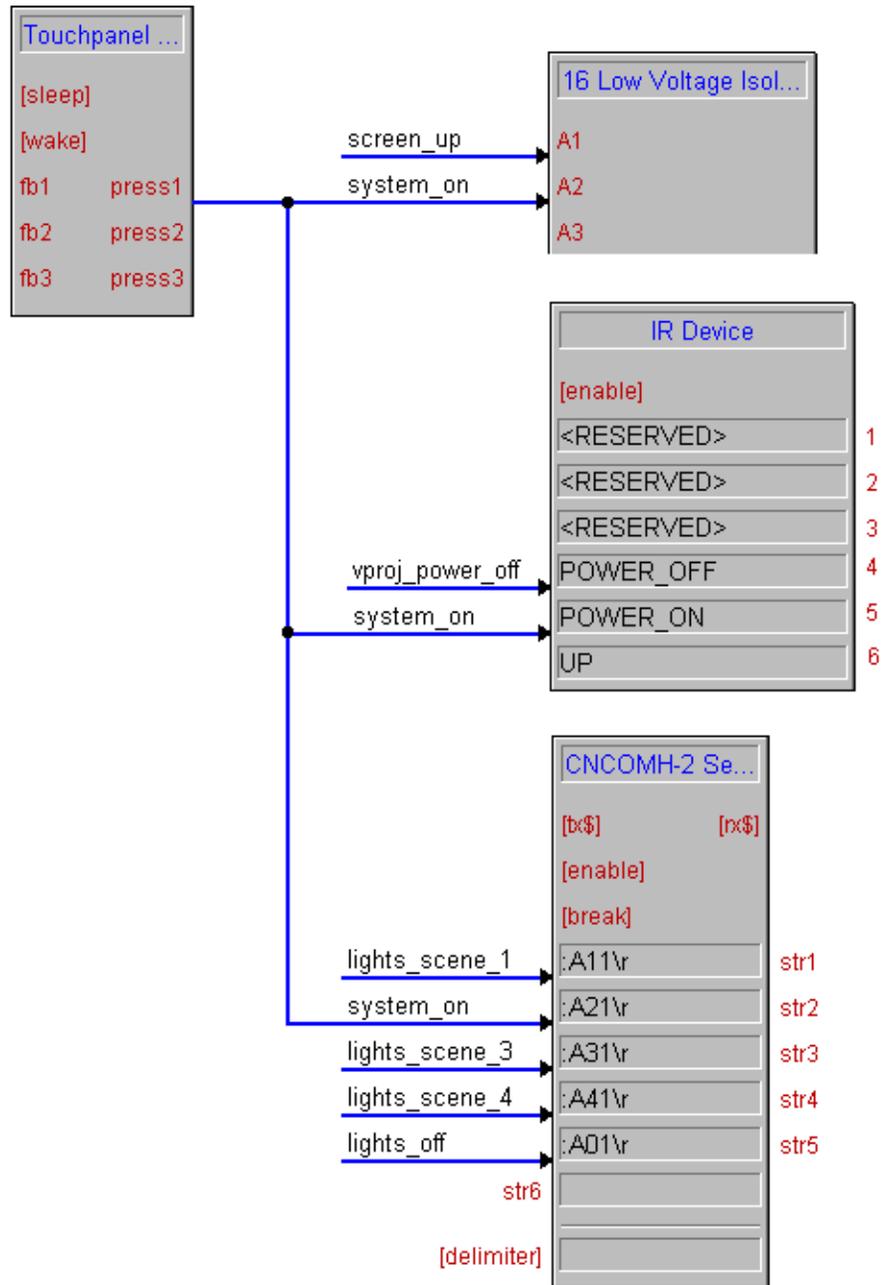
Note from the example that only one *Buffer* should be enabled at any given time. If two *Buffers* were enabled at once, pressing the PLAY button would cause multiple commands to be issued, which is not what we want in this example. To ensure that this does not happen, we can force only one of the state signals to be high at any time. This will be covered later in this chapter.

Buffer Example: triggering multiple events

The power of a custom-programmed control system such as the Crestron is that you can provide users with automated functionality to meet their exact needs. A well-designed control system will allow the user to do what they need with as little user-interaction as possible. This requires that in many cases a single button press will trigger multiple events.

The nature of the SIMPL language makes it relatively easy to cause multiple events to occur off of a single button press (or any event for that matter). For example, if a button labeled 'system on' were designed to lower the screen, turn on the video projector, and select a certain lighting preset, this could be accomplished by connecting the button's output signal to a relay to lower the screen, to the 'Power_On' command on the projector's IR driver, and to a string literal on the RS-232 driver for the lighting system. Without any logic programming we have accomplished our goal. This is the program shown.

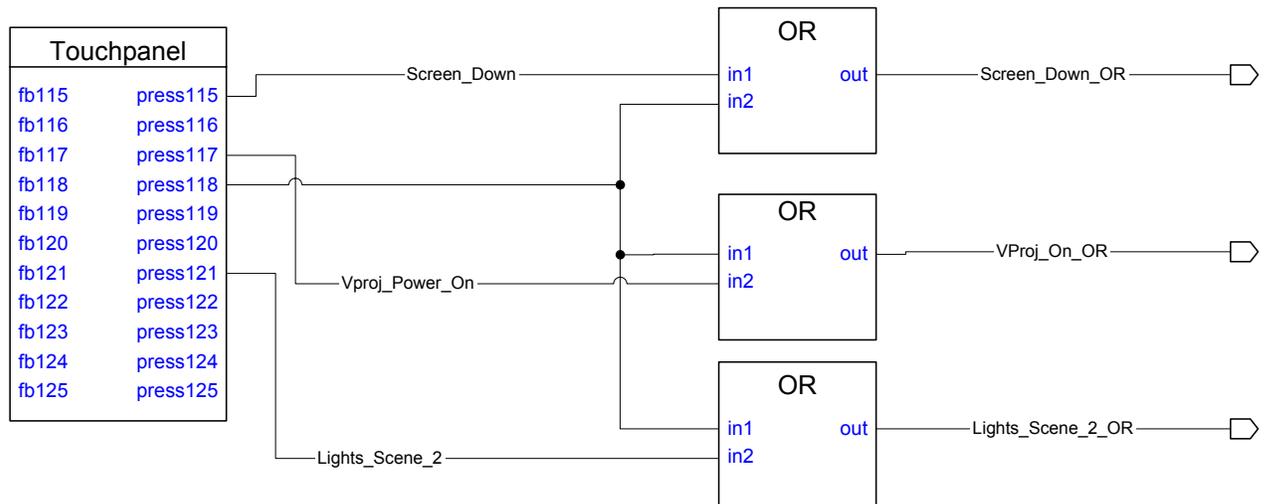
Single Button Press Example



However there are some drawbacks to this method. First, programs written in this matter can be difficult to read, in that you must trace the signal completely to determine what events it triggers. This is made easier by the ‘Show Routings’ command in SIMPL Windows. The second drawback is more serious: what if you wanted to provide individual control of the screen, the projector power, and the lighting presets? With the example shown above, these three functions are tied together and can never be controlled independently. Even if you think that this type of control is not needed, it may be needed in the future, requiring you to make significant changes to your program.

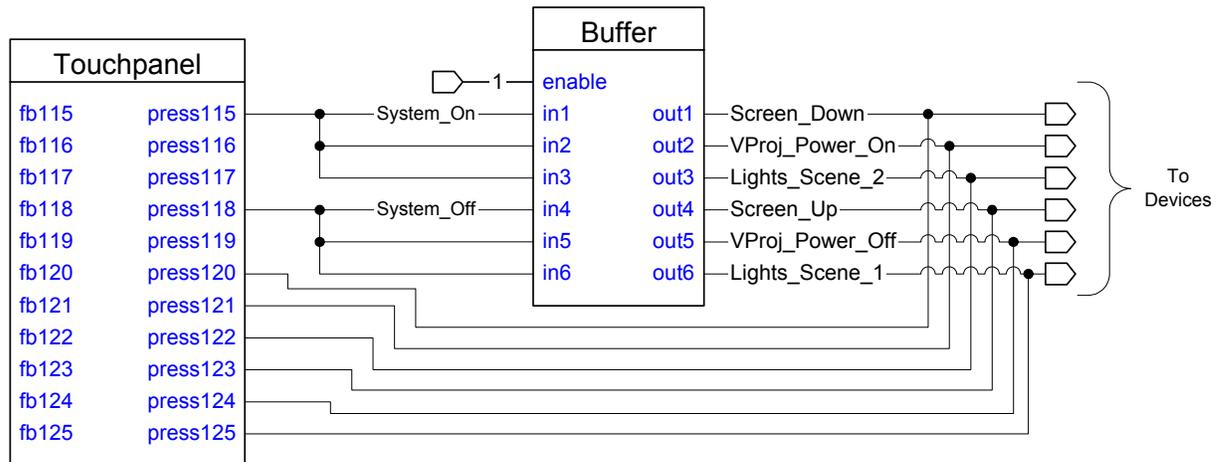
To avoid this limitation, we can add logic to the program. An intuitive solution uses OR symbols to gather all the events used to trigger a single event. For example, if we want to lower the screen on the ‘system on’ button press, *or* when the ‘screen down’ button is pressed, we use an OR to accomplish this. The figure below shows an equivalent program to the one above, now using OR symbols, thus allowing for independent control of each function.

Multiple OR symbols for discrete control



This example is more flexible, but also has drawbacks. First, like the previous example, programs will be hard to follow, especially as they get larger; for each function you must trace back through an OR symbol to determine which events trigger it. Second, as your program grows there may arise other occasions where you need to trigger a function. For example, perhaps you want to lower the screen automatically every time a source is selected. This can be handled by simply increasing the number of inputs to the appropriate OR symbol, but ultimately this leads to a ‘messy’ and hard to debug program.

This now leads us back to the *Buffer* symbol. Remember that the output signals on a *Buffer* may be tied to existing signals that are driven by system inputs or by other *Buffers*. This enables us to create an elegant program that uses one or more *Buffers* to handle all the multi-event triggering. Shown below is a program that performs more functions than the OR symbol example above, yet uses only a single symbol.

Buffer

You will notice two interesting features about this example. First, the enable input has a signal called '1' connected to it. Earlier in the manual we described this special signal as a digital signal that always has a value of logic high. In this case, this will cause the *Buffer* to be permanently enabled. This is useful when you are using the *Buffer* not to control the flow of signals, but to 'map' one signal name into many others, as we have done here. The second unique feature of this example is the fact that we have used the same signal name multiple times in the input side of the *Buffer*. This allows multiple output signals to be driven high when a single input signal goes high. Finally, notice that because the input/output pairs of the *Buffer* are independent of one another, we have used a single symbol to generate the system on and system off sequences. However, for clarity we could have just as correctly used two separate symbols.

State Logic

The previous section discussed some of the most commonly used basic logic elements. This section will cover commonly used symbols that contain state information. That is, the symbols described here provide the most basic form of memory in a SIMPL program. Realize however that this memory is volatile, and any stored information will be lost if the program is reset or the control system is powered off.

The fundamental difference between the symbols in this section and those in the previous section, are that the states of the output signals cannot be determined by evaluating the current state of the input signals. Instead, it is something that happened in the past that has caused the outputs to attain their current states. This is where the concept of memory comes from. In addition, the input signals for these symbols are considered "edge-triggered," meaning that the output signal states depend on input signal transitions. In most cases, symbols are positive edge-triggered, in that an input changing from low to high will cause an output change. In some cases, however, inputs can be negative edge-triggered, and thus a transition from high to low will affect the outputs. Symbols discussed in the last section are

considered “level triggered” in that the current input values always determine the states of the outputs.

Set/Reset Latch symbol

This symbol implements the most basic memory element, also known as a set/reset flip-flop. The symbol has two possible states, referred to (oddly enough) as set and reset. When set, the signal connected to the ‘out’ terminal will be high. When reset, ‘out’ will be low. The ‘out*’ output provides the complement of ‘out,’ that is, whenever ‘out’ is high, ‘out*’ is low and vice-versa. At startup (when the program resets) the value of ‘out’ will be low (and thus ‘out*’ will be high).

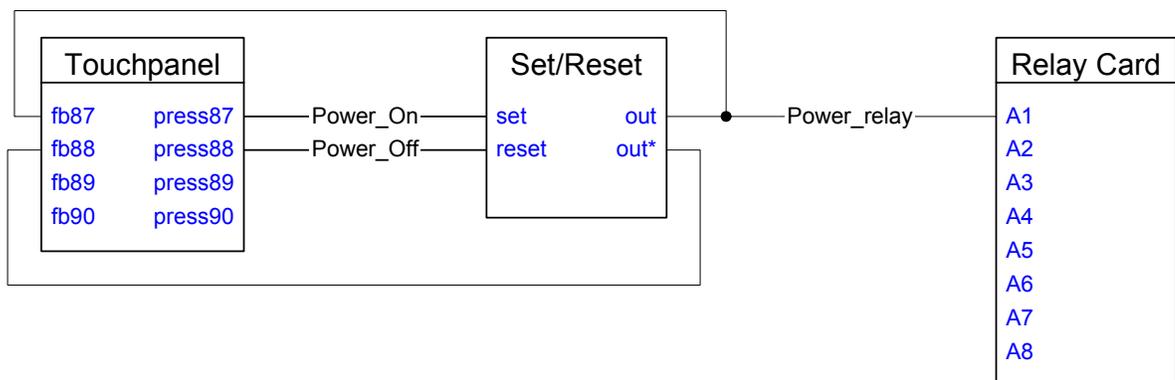
A positive edge on the ‘set’ input will cause ‘out’ to go high. Once this transition is seen on the ‘set’ input, the output will not change even after ‘set’ goes low. We say that the output has ‘latched.’ In order for ‘out’ to go low again (and thus ‘out*’ go high), there must be a positive edge seen on the ‘reset’ input.

Set/Reset Latch Example: System Power Relay

Suppose you are using an AC power controller to switch power on and off to the equipment rack. Often such a power controller will have a low-voltage contact closure interface: close the contact and the power switches on, open the contact and it switches off. Clearly in this case we need a latching signal that we can connect to a low-voltage relay in the Cresnet system (on a CNRY-8/16 for example).

A *Set/Reset Latch* symbol will work perfectly for this application. Simply connect the signal from the ‘power on’ to the ‘set’ input, and the signal for ‘power off’ to the reset input. Lastly, connect the output marked ‘out’ from the *SR Latch* to the relay itself. When the *SR Latch* is set, the signal connected to ‘out’ will be high, thus closing the relay and turning on the power. Remember that this output signal will remain high until the symbol is reset.

Set/Reset Latch Example: system power relay



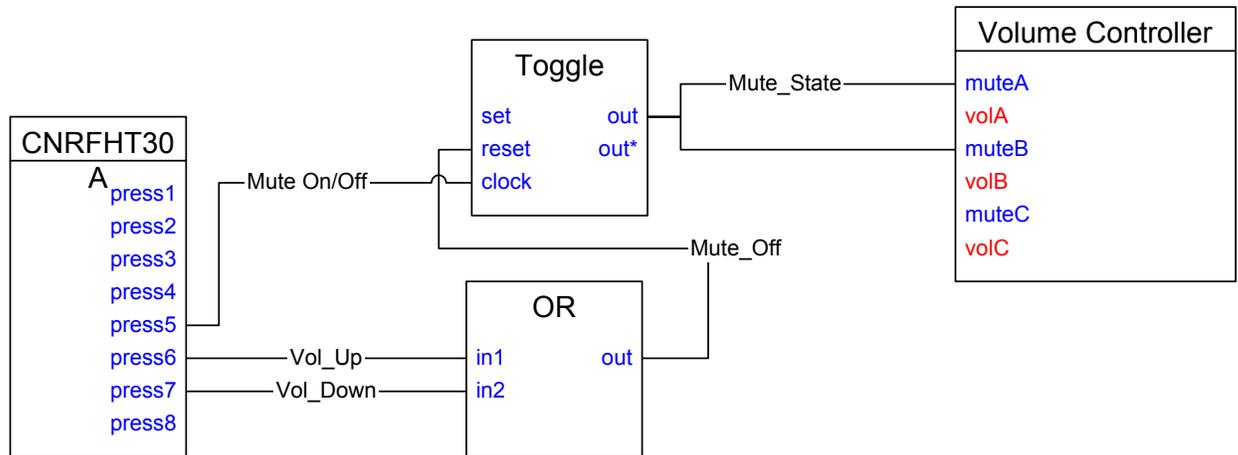
Toggle Symbol

The *Toggle* symbol has a lot in common with the *Set/Reset Latch*. In fact, the *Toggle* actually is an *SR Latch* with an additional input added on. This input is labeled ‘clock,’ and each positive edge on this input will cause the symbol’s state to alternate between set and reset. The ‘set’ and ‘reset’ inputs are still provided to serve as overrides to force the symbol to a specific state.

Toggle Example: Volume Mute

A *Toggle* symbol provides an easy way to implement a single-button volume mute. Shown is a mute button being connected to the 'clock' input. Each press of this button will cause the signal 'Mute_On' to alternate between logic high and low. Typically this output signal would be routed to a muting relay inside of a volume controller such as the ST-VC. Also note the use of the 'reset' input, which forces the volume to unmute any time the user presses the volume up or down buttons.

Toggle Example: volume mute

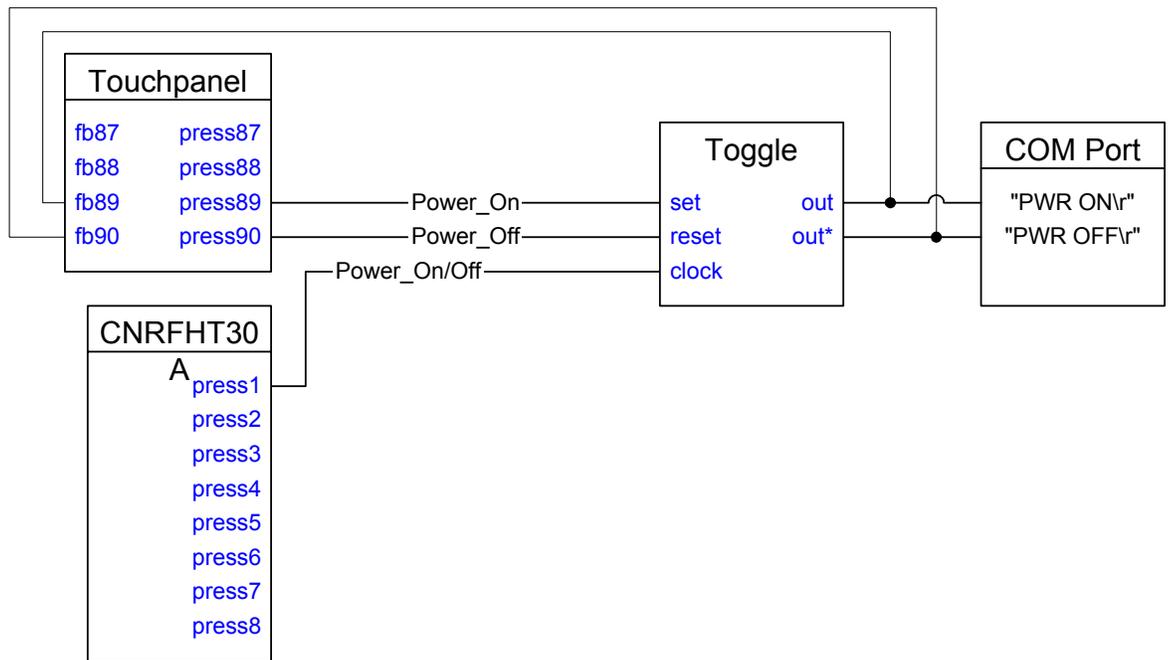


One word of caution: using a Toggle symbol in this manner would not be recommended when controlling a device that itself provides only a toggling mute function. For example, if you were controlling an AV Receiver via IR, it may have a mute function that will Toggle between mute and unmute each time the command is sent. In this case, you would not want a latching on/off signal, but instead you should connect the mute button signal directly to the IR command. You might then be tempted to use the Toggle symbol to provide realistic feedback on a Touchpanel, showing the user what state the receiver was in. Be careful here as well, because it is generally not recommended to provide state feedback unless you can be sure that it is correct. Thus if you suspect that the feedback and the actual state of the receiver can become 'out of sync' with one another, it may be best to provide momentary feedback.

Toggle Example: Device Power On/Off

The last example used only the 'out' output signal from the *Toggle* to control mute status. Sometimes both the 'out' and 'out*' outputs are required. Take for example an RS-232 controlled video projector. Often such devices will have separate commands for power on and power off. The program shown uses both outputs of the *Toggle* to drive these commands. On each successive rising-edge of the 'proj_power' signal, one of the power commands will be sent. Note of course that the *Toggle* outputs are latching, but because RS-232 commands are only sent on the rising-edge of the driving signal, this does not present a problem. However, if the video projector were IR controlled, we would not want to program like this, since the corresponding IR command would be sent continuously to the device. Instead, we could add additional logic to create a short pulse from the *Toggle* outputs. This will be covered later on in this manual.

Toggle Example: device power on/off



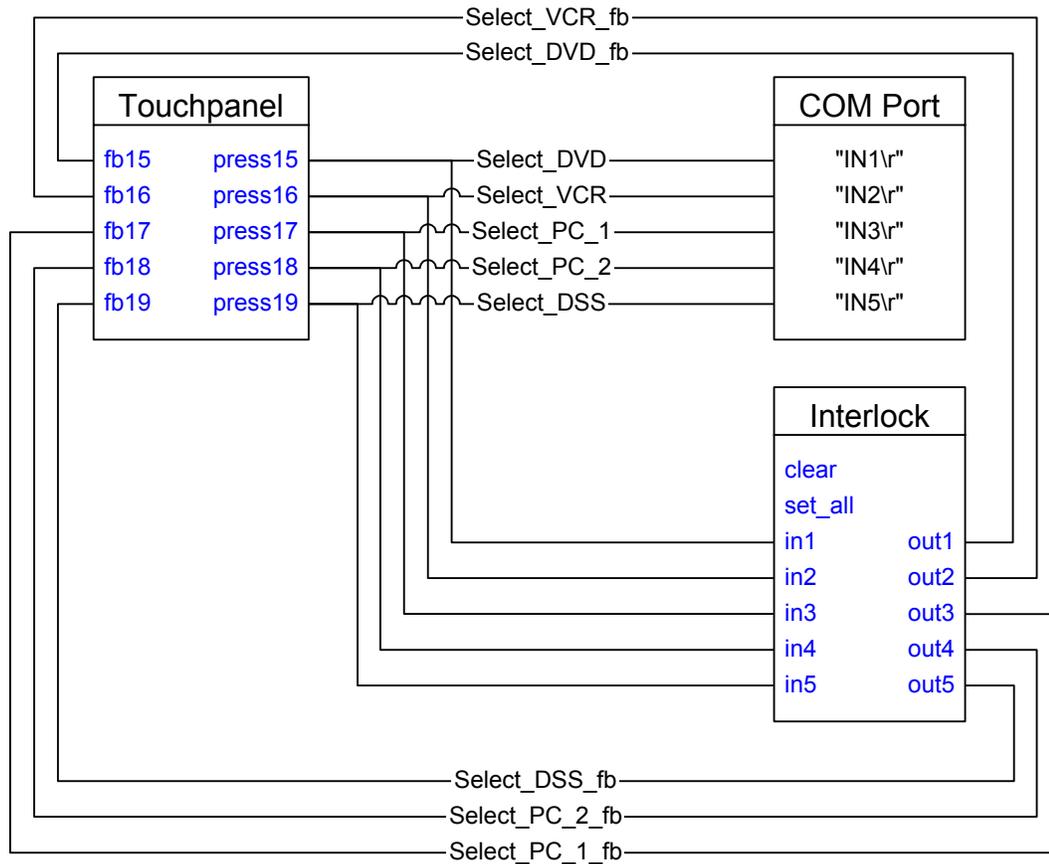
Interlock Symbol

The *Interlock* symbol will latch an output high on the rising-edge of its corresponding input. In addition, any other output signal that was previously high will be latched off, thus this symbol will have at most one output high at any given time (the exception here is the ‘set all’ input, discussed below). This property is called **break before make**. In essence, this symbol will remember which input was last driven high, making it very handy when the user has to select from a number of choices.

The *Interlock* also has 2 special input terminals, ‘clear’ and ‘set all.’ ‘Clear’ will cause any output that was previously high to go low. ‘Set all’ will cause all the outputs to go high at the same time, the only time that more than one output can be high simultaneously. This is useful in some specific applications involving non-volatile memory.

Interlock Example: Source Selection Feedback

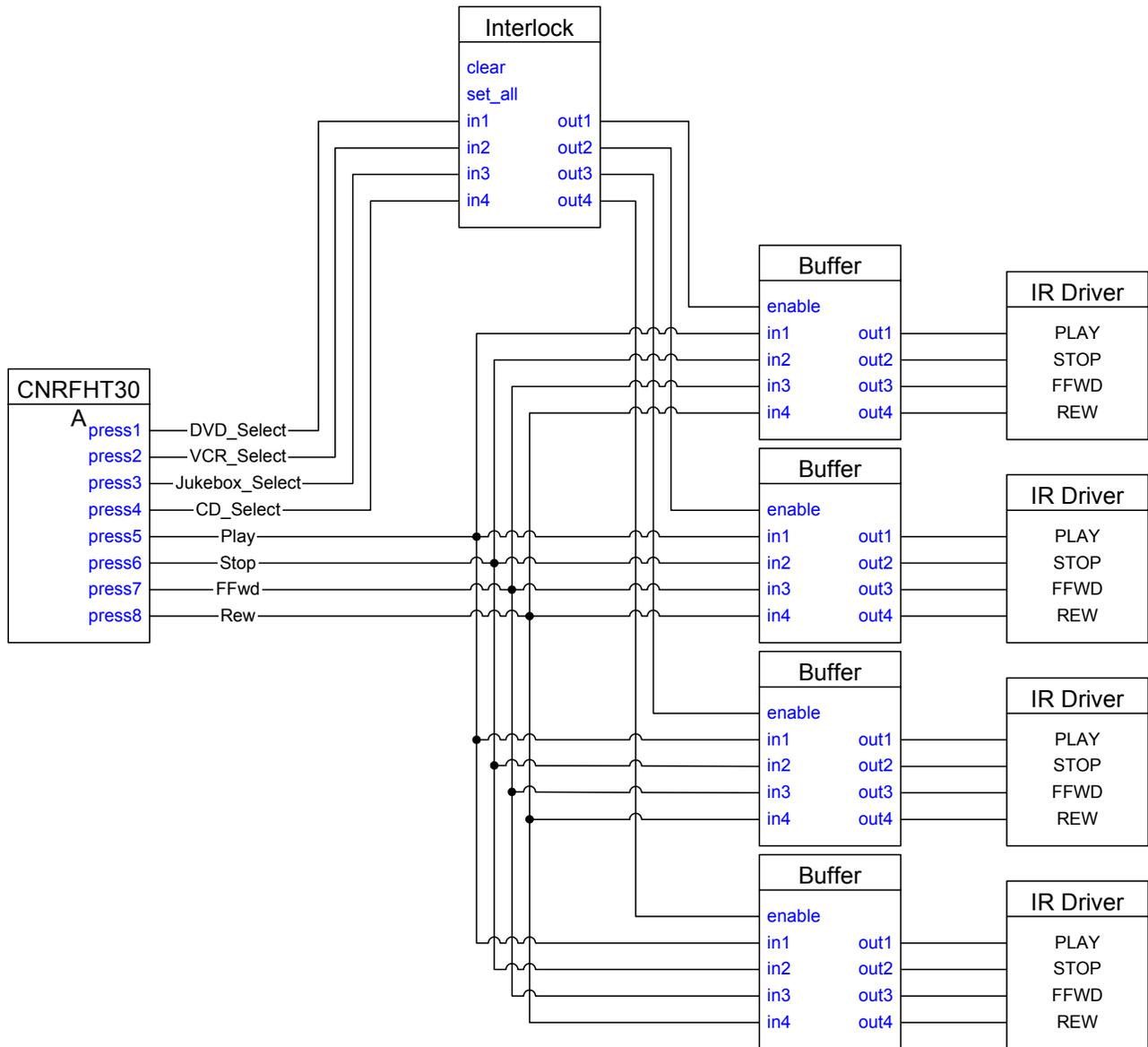
Many audio video systems consist of some sort of source selection. That is, the user can select between a number of sources for viewing and/or listening. A typical example in a conference room application might be VCR, laser disc, slide projector, or computer, which may be selected by sending commands to a switcher or a video projector. Shown below is an *Interlock* symbol that is implemented to provide feedback to the user by showing which source is currently selected.

Interlock Example: source selection feedback

Note that the output signals in this example are being used for feedback only, and are not being routed to the switcher to select the source. This is because the outputs of the *Interlock* are latched, and it is generally considered poor programming to drive momentary functions (such as an RS-232 command) with a latching signal, even though in some cases it may work correctly. Since we have momentary signals already on the input side of the symbol, it is 'cleaner' to use these to drive the switcher.

There is one other reason to use the input signals of the *Interlock* to drive the switcher, as opposed to the outputs. If we were to use the output signals, and for some reason the same source had to be reselected (if for example, someone manually changed the switcher), this would not work unless another source was selected first and then the desired source reselected. This is because the RS-232 driver will send data on the rising edge of the driving signals, and once an output of an *Interlock* has gone high, it will not provide a positive-edge unless it is first turned off (by selecting another input) and then turned back on again.

Interlock Example: multi-device control (part 2) - Each IR Driver symbol represents a different .IR file to control a different device



Earlier in the chapter we discussed controlling multiple devices with a common set of buttons using *Buffer* symbols. At the time, we simply accepted that appropriate signals were generated to enable or disable the *Buffers*, thus ensuring that only one of them was enabled at any given time. Now that we have introduced the *Interlock* symbol, we can complete this example as shown above.

Time-based Logic

All of the logic that we have seen up to now is strictly event-driven; when an event (a positive-edge transition, for example) occurs the symbol drives its output signals to the appropriate levels. Sometimes this is not sufficient, however, and you need to control when things will happen. The symbols discussed in this section all allow some form of control based on time.

One Shot Family

Thus far we have seen how symbols drive their output signals to different values (high or low), but as a programmer, you do not have any control over the duration of time that those signals maintain their levels. The One Shot family of symbols allows this type of control.

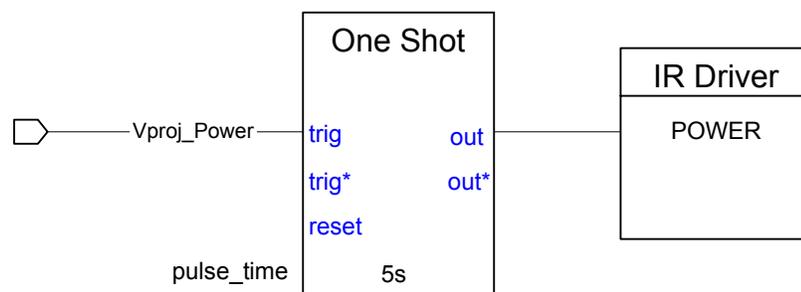
One Shot

The most fundamental symbol in this family is simply called One Shot. It responds to a positive-edge on the 'trigger' input by driving the output signal (connected to 'out') high for the duration specified by the double-precision 'time' parameter. The output signal will remain high only for this duration, regardless of what is happening on the 'trigger' input. Once 'out' has gone low, the symbol may be re-triggered by another positive-edge. The output 'out*' is simply the complement of 'out' just as we saw with the *Set/Reset Latch* and *Toggle* symbols.

One Shot also has a 'trigger*' input, which causes the symbol to trigger on the negative-edge of a signal. Thus a negative-edge seen on 'trigger*' will have the identical effect as a positive-edge on 'trigger.' Also notice the 'reset' input. This input allows you to cancel a one-shot operation that is already in progress. That is, once a positive-edge is seen by the trigger input, the signal connected to 'out' will go high for the amount of time specified by the 'pulse_time' parameter. Once this output pulse has started, the only way to cancel it before the full pulse_time has elapsed is by driving the reset input high. The trig and trig* inputs are ignored for as long as reset is held high.

All symbols in the One-Shot family provide a reset input (with the exception of the Multiple One-Shots symbol) that works in the same manner.

One Shot Example: video projector power on



Some brands of video projectors require that you hold down the 'power on' button on their IR remotes for a lengthy period before the projector turns on. This is to prevent you from switching it on (or off) accidentally while handling the remote. In a

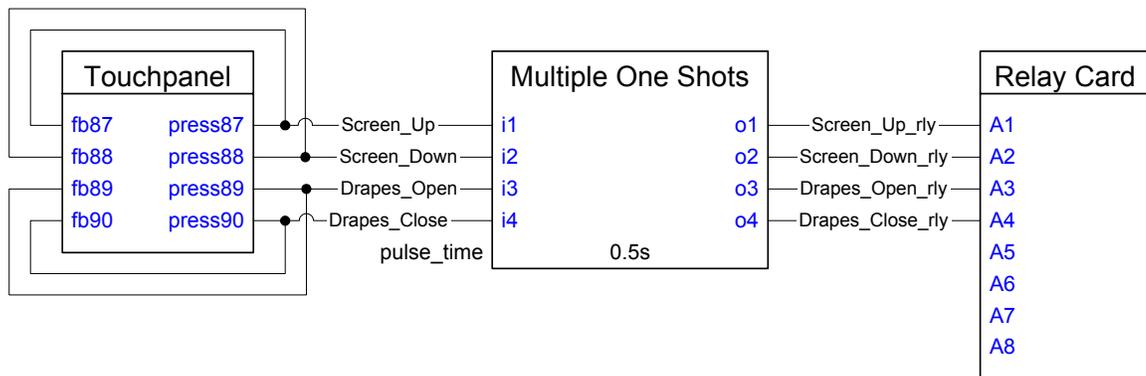
custom control system you would normally want to handle this internally, thus the user can simply tap a button and the projector would turn on as expected. Shown above is a One Shot symbol that is triggered off a button press and generates a 4-second output pulse to drive the IR command. Conveniently, if the video projector power on function was part of a power up sequence programmed using *Buffers*, any time the signal ‘vproj_power_on’ is driven high, the One Shot will ensure that a 4 second pulse is delivered to the IR driver.

Multiple One Shot

Many times you will find that when you need to use a One Shot to create a fixed-pulse-length signal, you will need to do the same to other related signals. This can be accomplished with many One Shot symbols, but because it is so commonplace there is a special symbol available called the Multiple One Shot.

The Multiple One Shot symbol is essentially a bunch of independent One Shots grouped into a single symbol. However, notice that each input/output pair represent the ‘trigger’ and ‘out’ of a One Shot symbol; there is no ‘trigger*’ inputs or ‘out*’ outputs on the Multiple One Shot. In addition, all input/output pairs, though independent of one another, share a common pulse length, specified by the double-precision ‘time’ parameter.

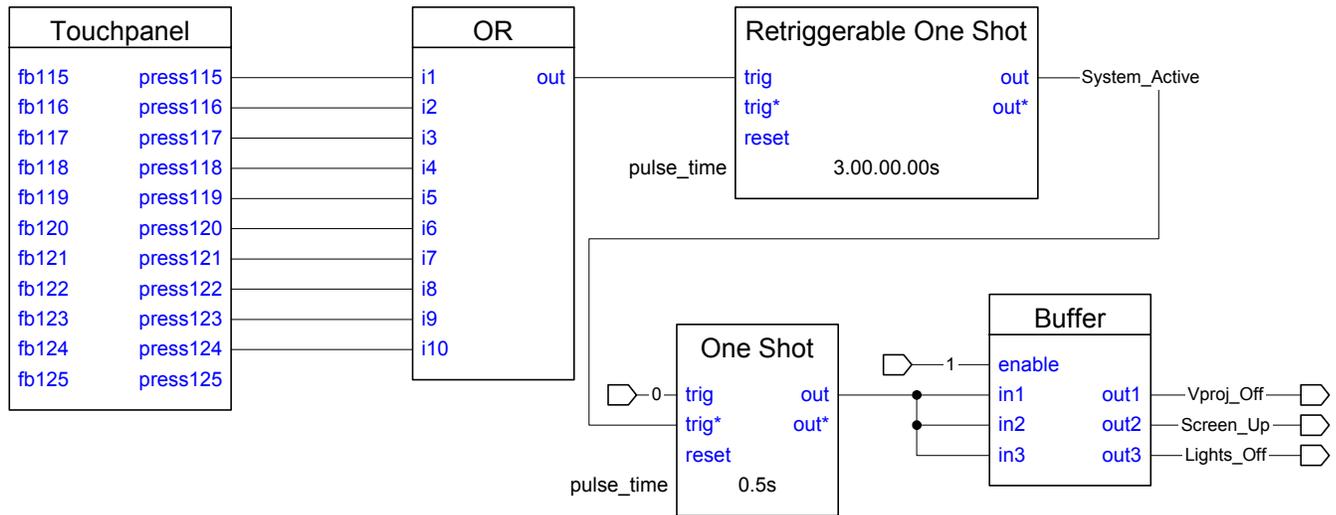
Multiple One Shot Example: screen and drape relays



When controlling motorized screens and drapes via low-voltage relays, care must be taken to ensure that the relay closes long enough for the screen or drape manufacturer’s interface to recognize it. In most cases such interfaces require only about a half-second closure, but you cannot be sure that the user will press the button for a full half-second. To account for this, a Multiple One Shot symbol can be used as shown above.

Retriggerable One Shot

Another form of one shot is the Retriggerable One Shot, which is almost functionally identical to the One Shot. The only difference is that the One Shot symbol will ignore any changes on ‘trigger’ or ‘trigger*’ until ‘out’ goes low. The Retriggerable One Shot will recognize a rising-edge on the ‘trigger’ input (or falling-edge on ‘trigger*’) even while ‘out’ is high, causing it to ‘re-trigger’ and start the count all over again. ‘Out’ will not go low until the full duration specified by the double precision ‘time’ parameter has elapsed since the last trigger.

Retriggerable One Shot Example: automatic power down

You can program a system to detect inactivity and power down the equipment automatically after a specified period of time has elapsed. The figure shown above is a program to do just this.

Recall from the SIMPL Windows Programming chapter that time parameters can be expressed in the HH.MM.SS.XXs format, where: HH = hours, MM = minutes, SS = seconds, and XX = hundredths of a second. Thus in the above example the 'pulse_time' parameter of "3.00.00.00s" means 3 hours, 0 minutes, 0 seconds, and 0 hundredths of a second. When using this notation you can leave out the larger units if you are not using them, thus "3.00.00s" would mean 3 minutes, 0 seconds, and 0 hundredths of a second (it would NOT mean 3 hours).

Note that an OR symbol is used to detect when a relevant button has been pressed, and each press will cause the Retriggerable One Shot symbol to be retriggered, thus starting the countdown over again. When 3 hours have passed with no buttons being pressed, 'system_active' will go low. The 'system_active' output is routed into the 'trig*' input of a One Shot symbol, which will detect the falling edge of the signal and activate its output accordingly.

The "0" signal on the 'trig' input of the One Shot symbol is required whenever you only want to use 'trig*', due to the fact that the 'trig' input is a required (i.e., not optional) input. Placing a 0 here tells the symbol to ignore this input at all times.

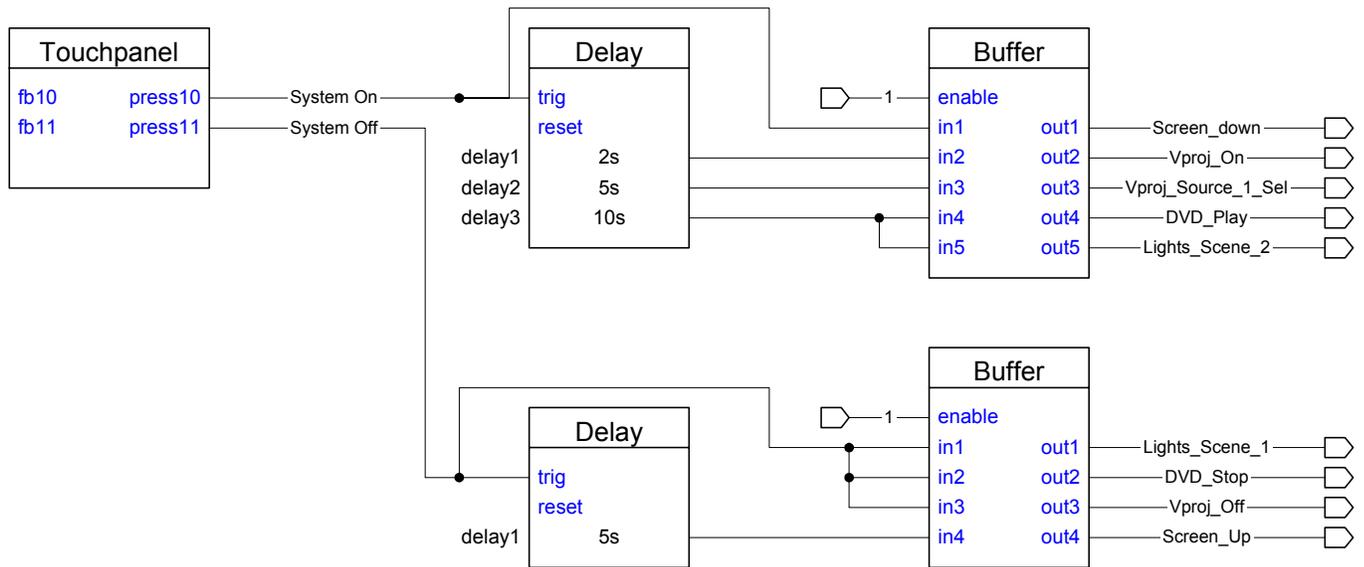
Delay Symbol

The Delay symbol is used to postpone an event for a given amount of time. Basically the output signals will be exact replicas of the inputs (in terms of positive and negative transitions), but delayed by the appropriate amount of time. The Delay symbol also has a 'reset' input, which cancels any impending output events.

At first glance you might think that the Delay symbol presents an easier way of building the auto-power-down example shown in the previous section using the Retriggerable One Shot symbol. However, two factors prevent you from using the Delay symbol in this application. First, the Delay is not retriggerable, but instead it

simply passes all input transitions through to the output(s). Thus, you would need some elaborate logic to reset the Delay each time a button was pressed. Second, the Delay symbol is a single-precision symbol, meaning that the values of the ‘time’ parameters can only range from 0 to 583 seconds. This makes it impossible to create a 3-hour wait time.

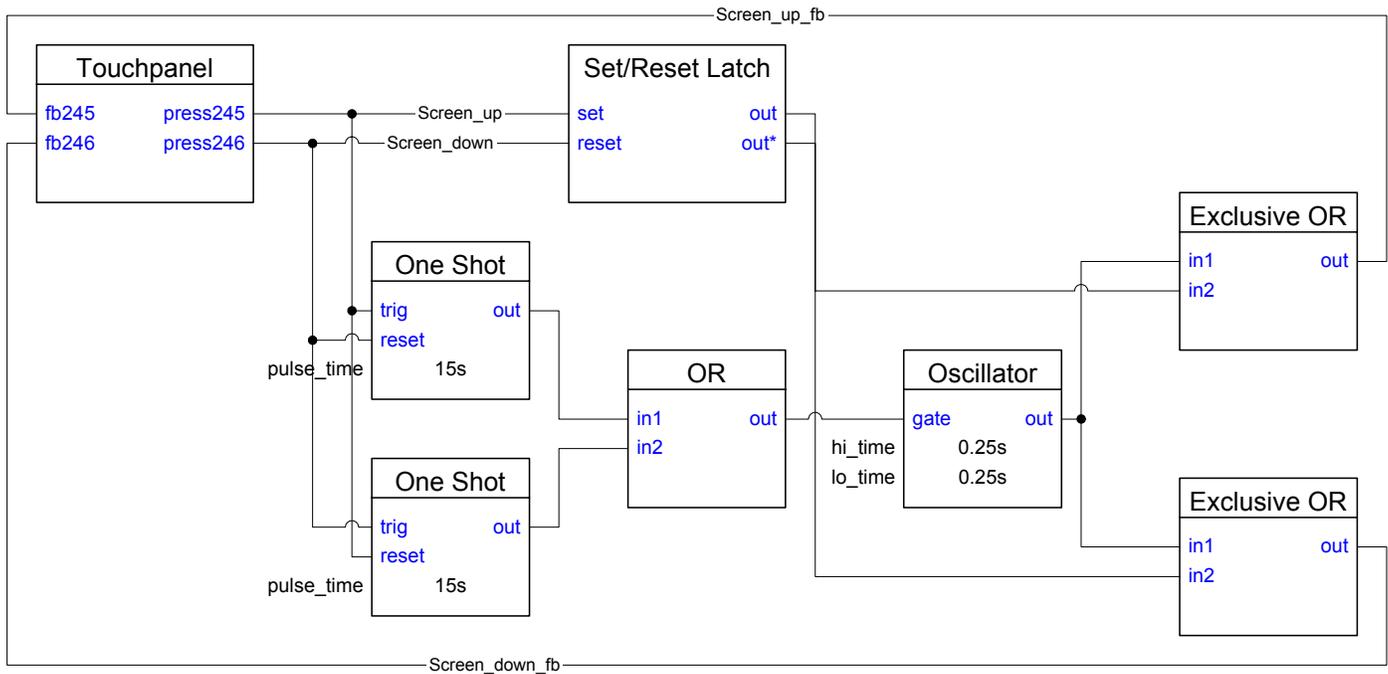
Delay Example: system power sequencing



Earlier in this chapter we saw an example using Buffer symbols that allowed us to generate multiple events from a single signal. This example provided an easy and elegant way to create system power on/off events. One limitation of that first example was that we had no control over when each event occurred. That is, once the input to the Buffer was triggered, all of the outputs triggered immediately, and this is not always acceptable. For example, during a ‘power on’ sequence you want the projector lift to lower first, then turn on the projector, then switch to a certain source only after the projector had ample time to turn on. The figure shows how to program such a sequence using a Delay and a Buffer. Note that the Delay outputs are passed through the Buffer in order to trigger the desired event. This is done so that the signal names may be driven by other system inputs or other Buffers, as described in that first example. Finally, notice that the signal ‘system_power_off’ is routed into the ‘reset’ input of the Delay symbol. This will prevent problems when the system on and off buttons are pressed within a few seconds of one another (because the user changed his mind, for example). Without resetting the Delay, a ‘system on’ function that had yet to be processed would occur during the ‘system off’ process, causing an undesirable situation.

Oscillator Symbol

An Oscillator symbol allows you to create a constantly alternating signal, useful for tasks such as polling an RS-232 device for status information or blinking a feedback indicator on a user interface. The output will only oscillate for as long as the ‘gate’ input is high, thus allowing you to turn the symbol on or off. The time that the output signal is high and low is governed by the ‘hi_time’ and ‘lo_time’ parameters.

Oscillator Example: blinking feedback

In order to indicate to the user that a certain event is processing, you can use an Oscillator to cause a button's feedback to blink. For example, when the user presses the 'Screen down' button, instead of simply latching the feedback high with a symbol like an *SR Latch*, you could blink the feedback until the screen was all the way up (or down) and then keep the feedback solid. The program in the figure above accomplishes this.

Analog Logic

The last section introduced you to the most basic set of symbols in the SIMPL language. With a good understanding of these symbols, you can write complex and powerful programs. You might have noticed, however, that all of the symbols discussed up until now have dealt exclusively with digital signals. From our discussion in previous chapters we know that in addition to digital signals our programs can contain analog and serial signals as well. This chapter deals with symbols that can generate and manipulate analog signals.

Before we get into dealing with specific signals, let's make sure that we understand why analog signals are important. Basically, each analog signal contains 16-bits of information, unlike a digital signal which only contains 1 bit (on or off). This 16-bit property means that analog signals can have values that range from 0 to 65,535 ($2^{16} - 1$). It is this large range of values that make analog signals useful for controlling devices that do not have discrete on/off controls. For example, a relay has an opened and a closed state, each IR function on an IR driver is either being transmitted or not. These all lend themselves to control via digital signals. However, when you consider devices such as volume controllers, pan/tilt head controllers, and lighting dimmers, you see examples where digital signals are not sufficient: enter analogs.

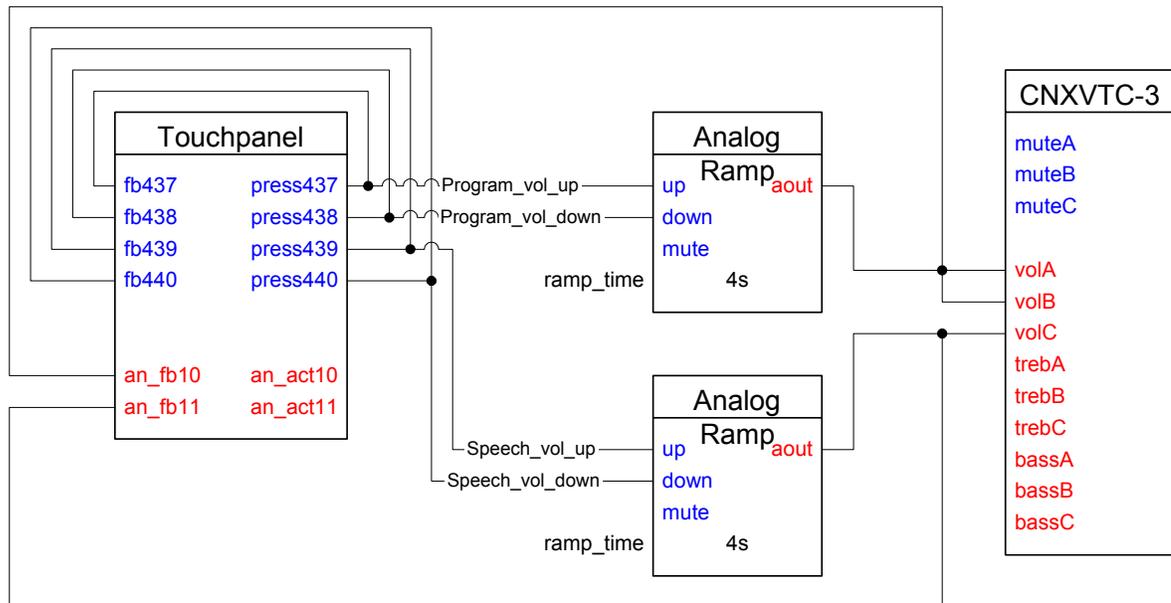
As we saw in the last chapter, each digital signal should only have one driving source, except in certain cases where this is allowed, such as system inputs (like button presses) and the outputs of Buffers. Analog signals have no such restrictions, thus each signal can have as many driving sources as you deem necessary. This may seem unnatural, and that there would be conflicting values for each signal. This is not the case, as each signal assumes a value based on the symbol which last changes it.

When a symbol modifies the value of one of its analog outputs, the signal connected to that output will hold the new value and retain it until that symbol or another symbol changes the value. In the case where a signal has more than one driving source, the value on the signal will be based on the symbol that changed its value last.

Analog Ramp Symbol

The Analog Ramp symbol generates an analog signal which changes linearly whenever the 'up' or 'down' inputs are high. The 'time' parameter sets the amount of time it takes for the output to go from 0 to 100% (or vice versa). This symbol also has a 'mute' input, which forces the output signal to 0% on the positive-edge, and returns it to its previous value on the negative edge, thus this input is commonly driven by a *Toggle* symbol.

Each Analog Ramp symbol is ideally suited to providing volume control, as long as the controlling device can accept an analog signal, as is the case with the CNXVTC-3. As shown in the following example, channels A and B of the CNXVTC-3 are being driven by the first Ramp, providing stereo volume control, and the second Ramp controls channel C.

Analog Ramp Example: volume control via CNXVTC-3

Analog Initialize

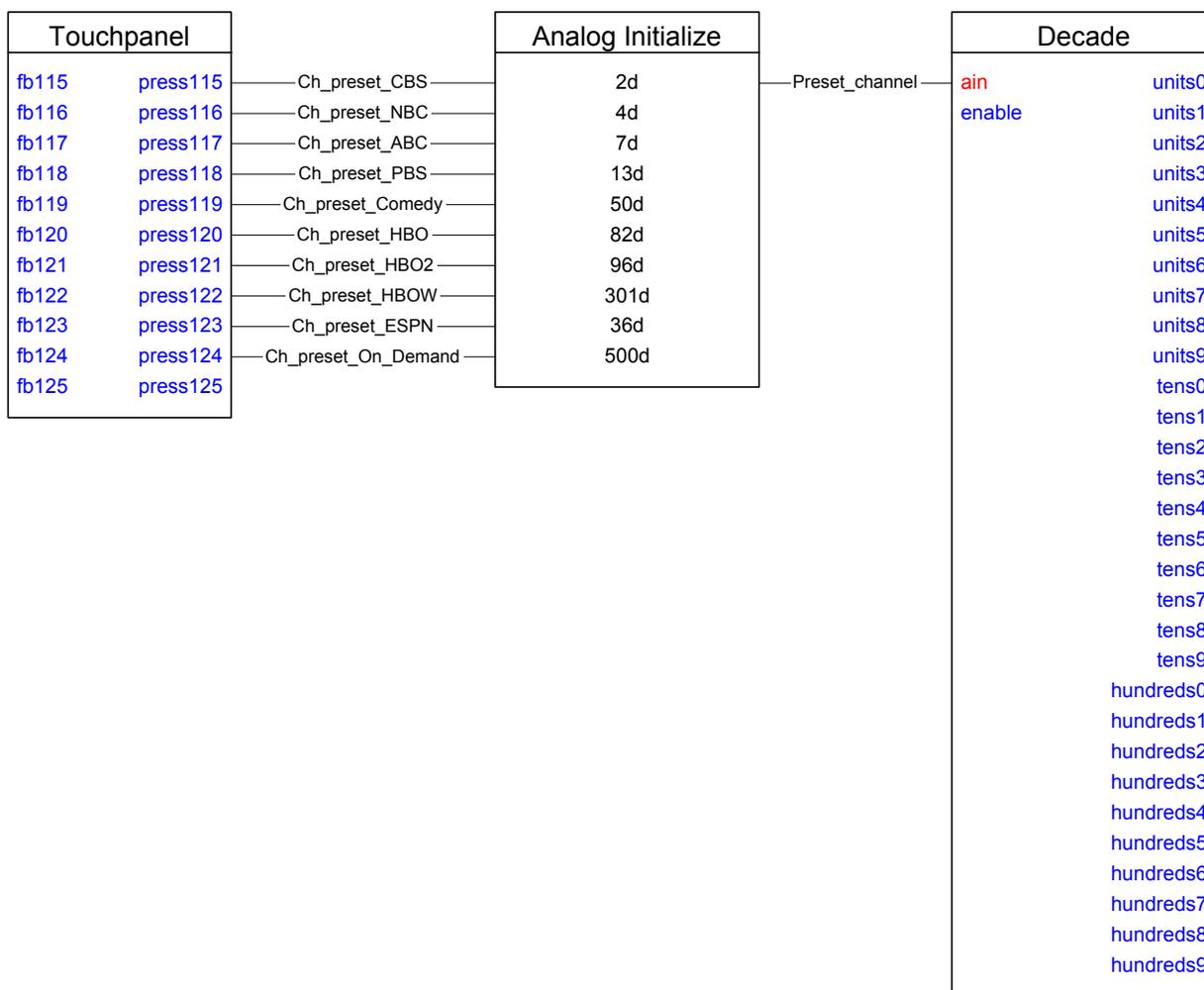
The Analog Initialize symbol allows you to set the current state of an analog signal to a specified value. The symbol behaves in two distinct ways, based on how you configure it.

Single-Output Form:

In this configuration the symbol has multiple digital inputs and a single analog output. Each input has a corresponding parameter. When a digital input goes high (that is, on the rising-edge) the analog output will take on the value specified by the parameter corresponding to that digital input. Due to the nature of analog signals in general, the analog output will maintain this value until this symbol or another symbol explicitly changes its value.

This form of the Analog Initialize is very useful to allow an analog signal to take on different values throughout the course of a running program. As an example, let's say that we want to create a number of TV channel preset buttons, where each button is responsible for changing the tuner to a specific channel. One way to accomplish this would be to use an Analog Initialize symbol with a digital input for each preset channel you want. In the example shown below, we are introducing an additional symbol, called the Decade, which is handy for decoding an analog value into its hundreds, tens, and units digits. This is especially useful when dealing with an IR-controlled device that expects individual keypad commands, as we are assuming in this example. For more information on the Decade symbol, please consult the SIMPL Windows help file.

Analog Initialize – the outputs of the Decade symbol must be connected to additional logic, not shown in the example below



Single-Input Form:

The second form of the Analog Initialize symbol is corollary to the first, in that now there is only a single digital input, and multiple analog outputs. Aside from this difference, the behavior of the symbol is essentially the same, except that on the rising-edge of the digital input, each analog output is assigned the value specified by its corresponding parameter.

This form of the Analog Initialize is useful if you have more than one analog signal to assign values to. Of course in this case you will need one Analog Initialize symbol for each set of values you wish to assign. If, for example, we wanted to modify the example presented above so that instead of changing one TV's channel, we wanted to change five TV's, each to a *different* channel (for, say, a sports bar), we could add one Analog Initialize symbol with a single input and five analog outputs, and then copy that symbol as many times as necessary (once for each desired preset), changing the digital input and parameter values on each one, but leaving the five analog outputs the same.

In addition, this form of the Analog Initialize is often used to initialize a number of analog signals that never need to change as the program runs. This is useful when

used in conjunction with other symbols that require analog signals as inputs (e.g. Analog Sum). In this case you can simply place a "1" on the digital input, and thus on startup all output signals will be set to the values specified by the corresponding parameters.

Analog Preset Symbol

The *Analog Preset* symbol allows you to force an analog signal to a specific value, and to have it assume that value by smoothly ramping from its current value to the new value over the time specified by the 'time' parameter. Note that the actual speed that the analog signal changes is based upon this parameter and the total distance it must travel.

This symbol has a single digital input, but an arbitrary number of analog outputs, each output having a corresponding destination value. On the rising edge of 'input', the output signals will start ramping to their destination values. This one-input, multiple-output property makes each Preset symbol useful for creating a 'scene,' where the analog outputs could represent lighting zones, volume levels, etc.

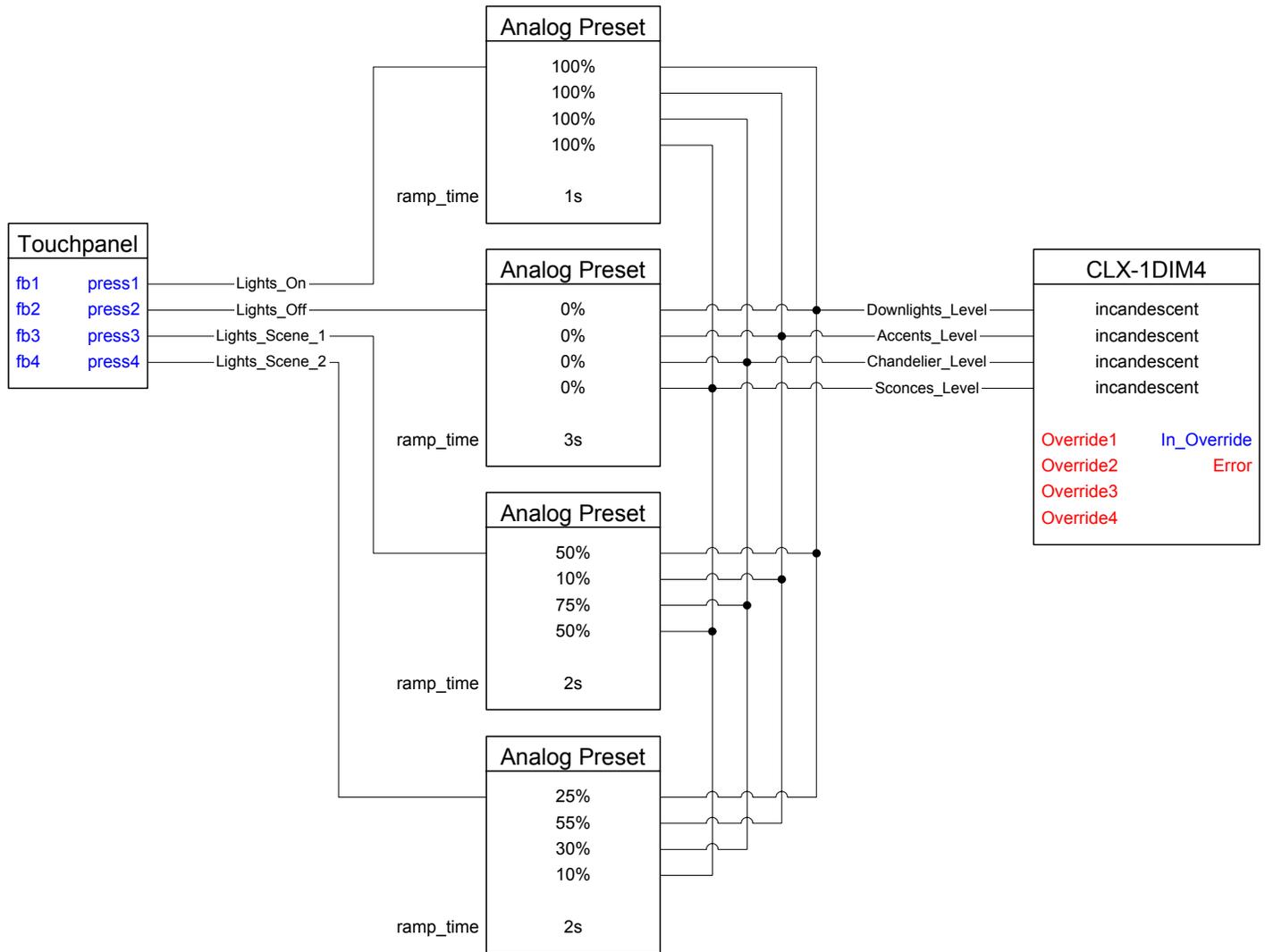
The Analog Preset symbol is very similar in operation to the "Single-Input Form" of the Analog Initialize symbol, described above. While the Analog Initialize symbol can be used for any application where analog signals are needed, such as volume and lighting control, it is not always the most appropriate option.

The problem with using the Analog Initialize symbol in certain cases is that when the symbol is triggered by a rising- edge, the analog signals on the outputs immediately change to the values specified by their parameters. In situations where you want a smooth transition instead of a jump, use the Analog Preset symbol.

The only difference between the Analog Preset symbol and the Single-Input Form of the Analog Initialize symbol is the addition of the "ramp_time" parameter. This parameter specifies how long it takes from the moment the digital input goes high to the moment that the analog outputs achieve their desired values. During that time the analog outputs will fade linearly.

The following example shows how you can use the Analog Preset symbol to create lighting scenes.

Analog Preset Example: preset volume levels



Note that this implementation does not allow for user-adjustable lighting scenes; instead the light levels are "hard-coded" into the program and changing these presets would require editing and recompiling the program. To add support for presets that can be adjusted at run-time without requiring editing the program, you could use a combination of the Analog RAM and Analog Variable Preset symbols, which are not discussed in this primer. Please see the SIMPL Windows help file for more information on these two symbols.

Serial/Analog One-Shot

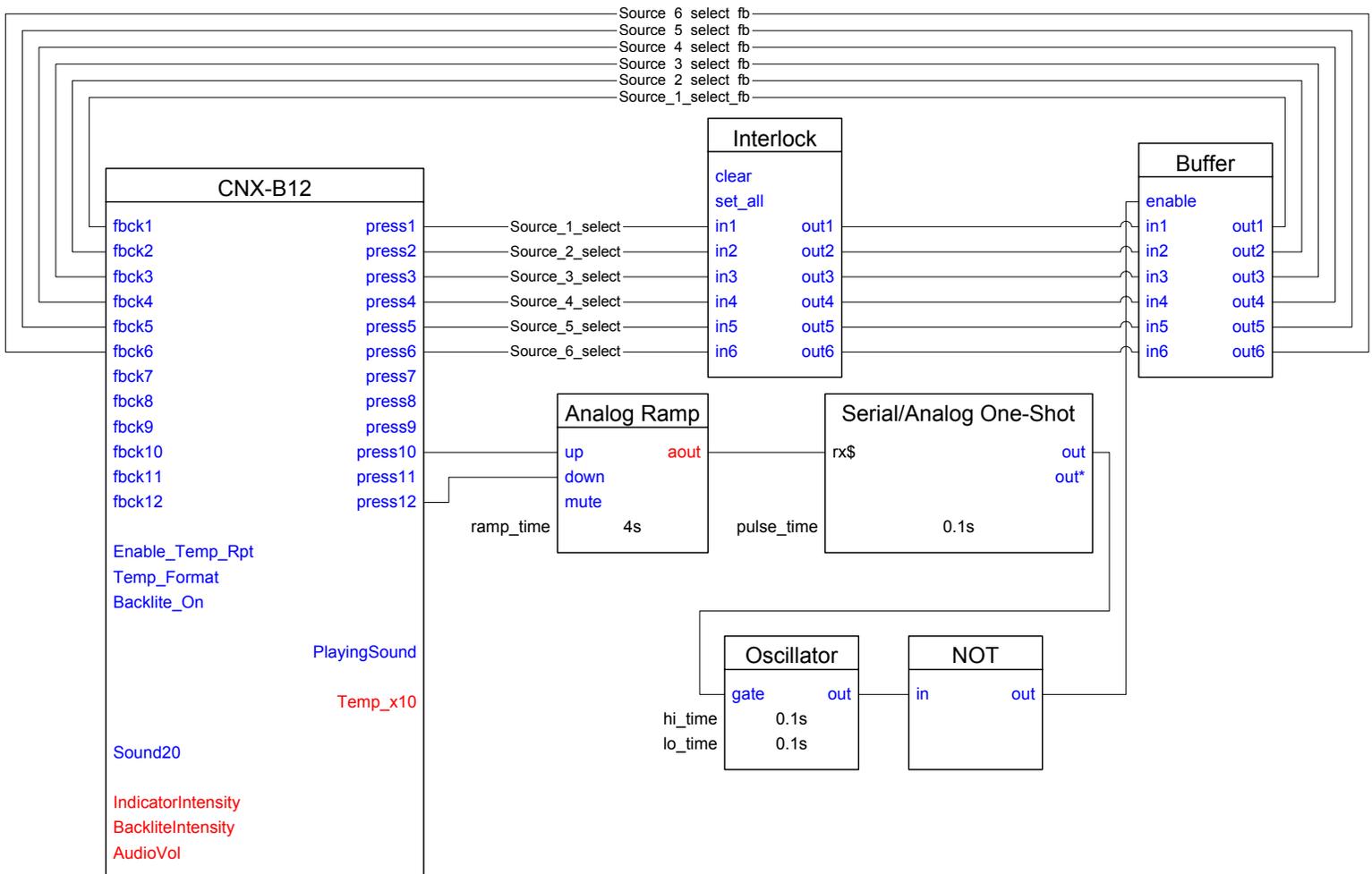
Sometimes it is helpful not only to know the value of an analog signal, but to know whenever it changes value. This is the job of the Serial/Analog One-Shot. This symbol is similar in nature to the One-Shot family of symbols discussed in the Digital Logic chapter, except that instead of relying on a digital signal to trigger the

symbol, it is triggered by any change on the analog or serial signal connected to its "rx\$" input.

When a change is detected on the input, the symbol will drive its digital output "out" high for the amount of time specified in the "pulse_time" parameter. The symbol is also retriggerable in the sense that if the input signal changes again while the symbol's output is still high, the timer restarts. Thus the output signal will remain high until the input stops changing long enough for "pulse_time" to expire. When the input is an analog signal, any change in value on that signal is enough to trigger the symbol. When the input signal is a serial signal, the symbol will trigger any time new data is placed on that signal.

As an example, we can use the Serial/Analog One-Shot symbol to implement feedback that will blink whenever the volume is changing. Here we must be sure not to make the pulse_time parameter too short, or the symbol's output may go low for a short time even while the volume is being adjusted.

Serial/Analog One-Shot Example



Modules

SIMPL Windows provides programmers with a number of Crestron modules as well as a predefined directory to store user created modules.

Crestron modules are prepackaged logic programs. A Crestron module is a set of pre-written and debugged logic used for controlling a particular device or performing a function. The use of modules saves programming and debugging time since a large portion of the symbol – signal functionality already exists inside the module. Thus even beginning programmers can control very complex equipment by using the correct Crestron module.

It is important to remember that modules (unlike symbols) do not have optional inputs or outputs. Because of this, all input and output signals must be defined. Module input signals that are not used can be given a 0 (zero) as a signal name. This will force the signal LOW and will not affect the module. Output signals are different and should be given unique names such as “no_connect1, no_connect2...” Do not force unused output signals states with 1 or 0, this may affect how the module operates internally.

Programmers can create their own modules and store them in the User Modules directory. Alternatively, programmers can use an existing Crestron module as a starting point, and edit them to match their specific needs.

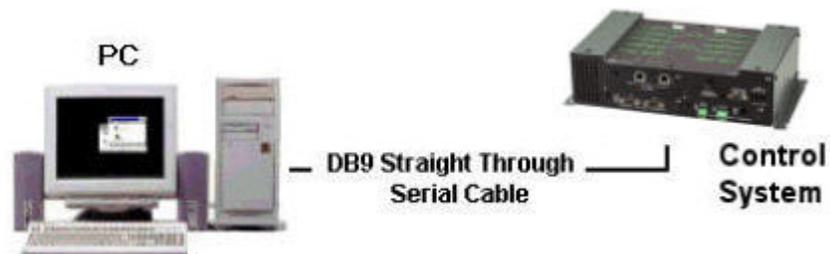
For detailed information about Crestron and user modules, refer to the SIMPL Windows help file.

Communication Settings

You must establish a valid connection between the control system and the PC before you can upload programs or otherwise communicate with the processor. This is accomplished using either a serial (RS-232) or TCP/IP connection. If you are connecting to the control system for the first time, you must use RS-232. You can then configure the IP settings of the control system for subsequent connections over Ethernet.

For RS-232 communication, use a DB9 straight-through serial cable to connect the COMPUTER port on the control system to one of the COM ports on the PC.

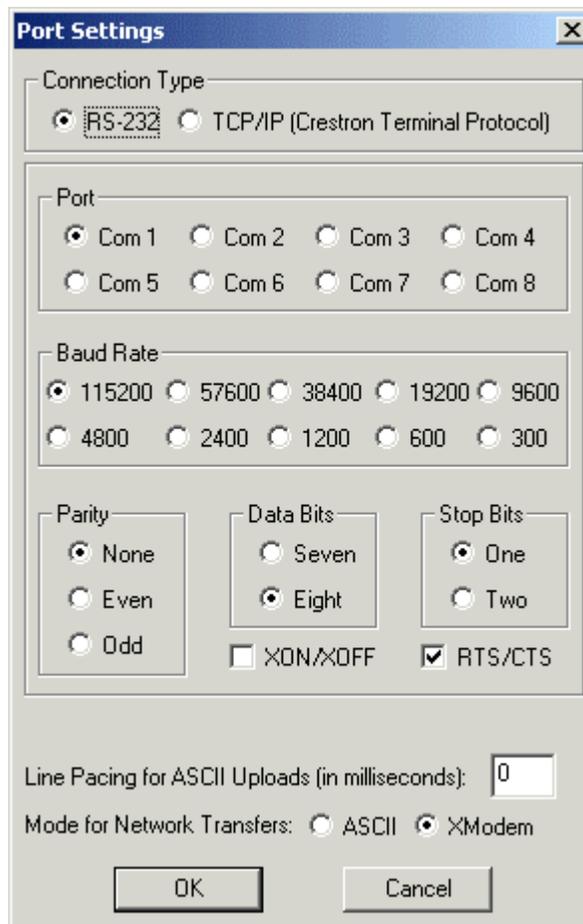
RS-232 connection



Click **Communications** on the **Edit** menu and select the connection type: **RS-232**. Then use the following settings to make the COM port settings of the PC match those of the control system:

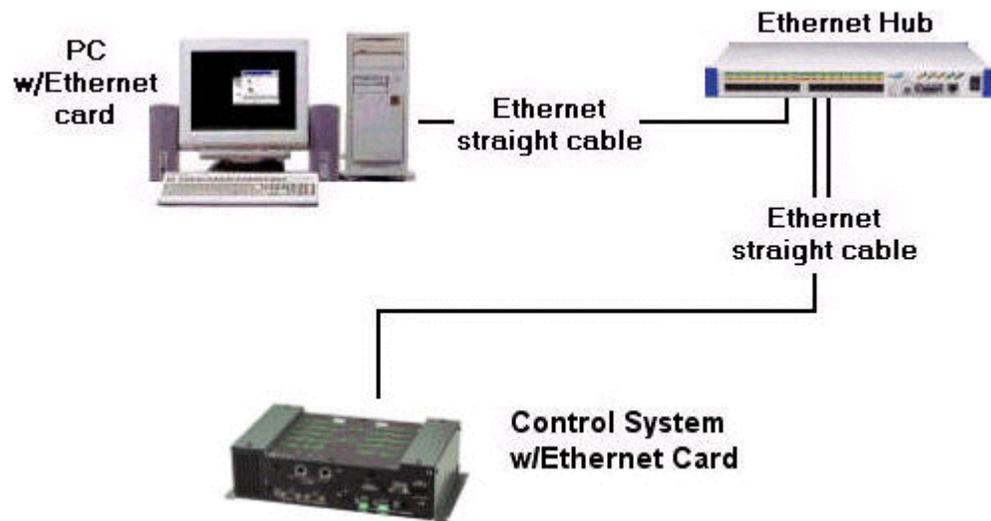
- Port = COM 1. Select the correct COM port on the PC (COM 1 through COM 8).
- Baud rate = 115200 for 2-Series control systems; 57600 for X-Series; 38400 for the ST-CP
- Parity = None
- Number of data bits = 8
- Number of stop bits = 1
- Hardware handshaking (RTS/CTS) enabled (2-Series only)
- Software handshaking (XON/XOFF) not enabled

Communication settings for a 2-Series processor



For a TCP/IP connection, use Ethernet straight-through cables to connect the PC and control system to the Ethernet network.

TCP/IP connection



Set IP Information

If you intend to communicate with the control processor via Ethernet you have to configure the processor's IP information.

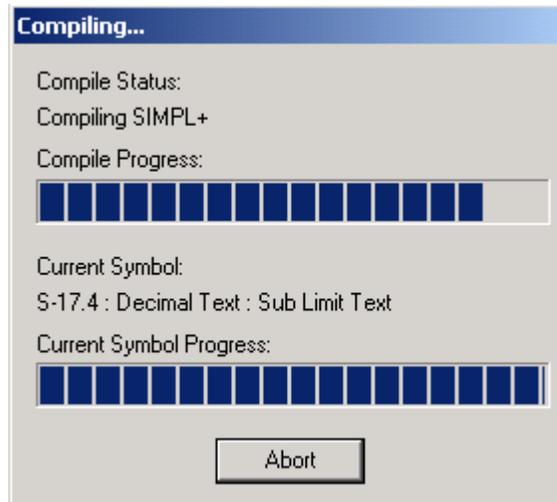
1. Set up an RS-232 connection to the control system, as described earlier.
2. Click **Viewport** on the **Tools** menu to start the Crestron Viewport.
3. Click **Set IP Information** on the Viewport **Communications** menu. The Ethernet settings you specify here include the control system's IP address or host name, IP mask and default router address. The exact IP information will differ depending on the application—for example, if you enable DHCP or SSL. In most cases you will obtain the IP values from a system administrator.
4. Enter the IP information and click **OK** to reboot the control system. Exit the Crestron Viewport.

Now that you have configured the control system's IP settings, you can connect to the control system via Ethernet. Click **Communications** on the SIMPL Windows **Edit** menu and select **TCP/IP** as the connection type. Enter the IP address or host name of the control system. Alternatively, you can click **Prompt on Connect** to be prompted for the IP information at program upload.

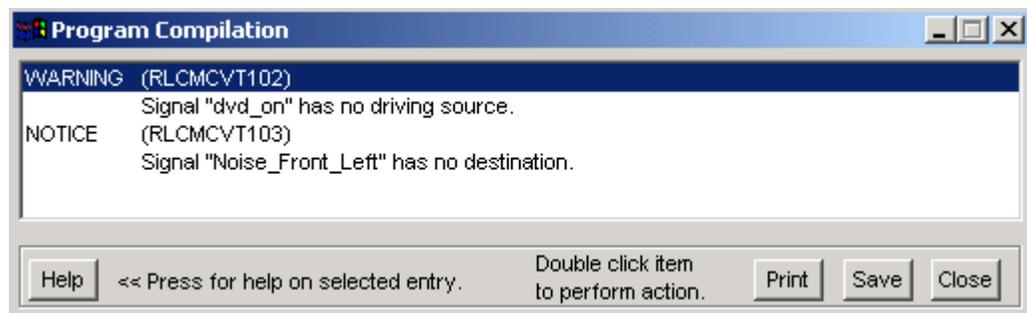
Compiling and Uploading Programs

Once you have completed your logic program you can compile the program and upload it to the control processor.

To compile the program click the **Convert/Compile**  button. If you have not already saved the program you will be prompted to do so. The Compiling screen will show a progress bar with information about the program as it is converted and compiled.

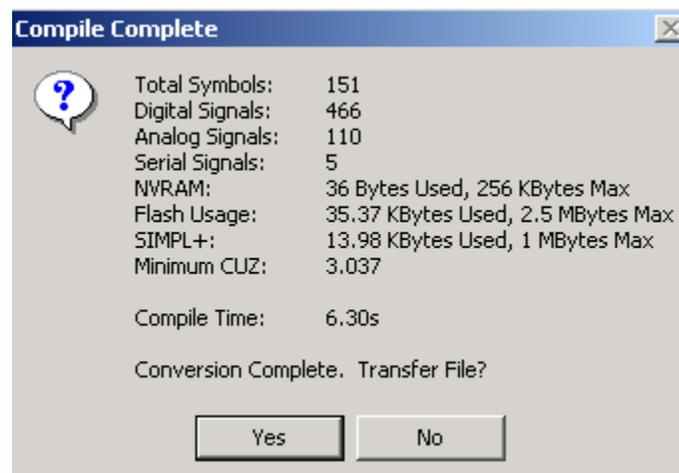
Convert/Compile Operation Information

If any errors or warnings are generated during the compile operation, they will be shown in the Program Compilation list. You can click **Help** for further information about the error, or double-click the error to locate the signal that generated the error. For further information about compiler errors, refer to the SIMPL Windows help file.



The Compile dialog box will display information about the program, including the number of symbols, signals, memory usage, and compile time.

To upload the program to the control processor, first establish a connection to the processor if you have not already done so. Click **Yes** to transfer the file.



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