

***SymNet***<sup>™</sup>  
**Audio Matrix**

**SymNet Designer**  
**User's Guide**

**Application Revision 2.0 - August 2002**

## Contents

Introduction	2	MIXERS / MATRIXES	51
<b>Introducing SymNet™</b>	<b>2</b>	AUTOMIXERS	52
<b>Glossary</b>	<b>3</b>	COMBINERS (ROOM COMBINERS)	55
<b>Architects and Engineers Specifications</b>	<b>4</b>	FILTERS & EQS	57
<b>(SymNet 8x8)</b>	<b>4</b>	DYNAMICS	60
<b>Factory Contact Information</b>	<b>5</b>	SPL COMPUTER	64
<b>Release Highlights</b>	<b>7</b>	DELAYS	65
<b>Copyright, Trademarks, Notices</b>	<b>8</b>	ROUTERS	65
Hardware	9	SIGNAL GENERATORS	66
<b>Hardware Overview</b>	<b>9</b>	METERS & ANALYZERS	67
<b>Limitations</b>	<b>9</b>	SUPERMODULES	67
<b>8x8, 8in, 8out</b>	<b>9</b>	SYMLINK BUS SENDS & RETURNS	67
<b>CobraLink Overview</b>	<b>16</b>	SETTINGS	69
<b>BreakIn12, BreakOut12 Overview</b>	<b>22</b>	CONTROL SCREEN VIEWER	69
<b>BreakIn12, BreakOut12 Installation</b>	<b>22</b>	PRESET RECALL BUTTON	69
<b>ARC (Adaptive Remote Control)</b>	<b>25</b>	EXTERNAL DEVICES	69
<b>Real Time External Control</b>	<b>29</b>	CONTROL SCREENS	69
SymNet™ Designer	37	CREATING AND CONTROLLING PRESETS FROM SYM- NET DESIGNER	69
<b>Host Computer Requirements</b>	<b>37</b>	Appendix	72
<b>Software Installation</b>	<b>37</b>	<b>Bibliography</b>	<b>72</b>
<b>Wire Logic</b>	<b>37</b>	<b>Delay</b>	<b>72</b>
<b>Menu Bar</b>	<b>40</b>	<b>Equalization</b>	<b>72</b>
<b>The Toolkit</b>	<b>50</b>	<b>Sidechain</b>	<b>73</b>
SETTINGS	50	<b>SymNet™ Technology Overview</b>	<b>73</b>
CONTROL SCREEN VIEWER	50		
EXTERNAL DEVICES	50		
PRESET RECALL BUTTON	50		

## Introduction

### Introducing SymNet™

SymNet is a modular audio mixing, routing, and processing system. This next generation technology is the logical choice for designers who need one DSP solution that can handle a wide variety of applications. From 80,000 seat football stadiums to small houses of worship - if you want to design sound systems of any size, make on-the-fly changes, and specify only as much hardware as your design requires, SymNet is your choice.

SymNet's uniquely powerful "building-block" style architecture allows you to create elegant and efficient designs – saving budget and reducing rack-space. Engineered for modularity, you won't be stuck with dozens of unused inputs or outputs. There are three

different rack-mounted DSP IO modules: an 8X8, an 8 input, and an 8 output module. There are low cost input (BreakIn12) and output (BreakOut12) expansion modules without DSP. There is a CobraNet™ breakout module. All modules can be linked in any combination to create a wide range of system configurations.

SymNet lets you create simple or complex audio signal processing solutions using a simple and intuitive drag-and-drop interface. Download the finished design to the SymNet processor and you're up and running. This modularity extends past the individual processors because you can link multiple processors together and share audio between them.

<b>The Intelligent System Solution</b>	
True modular architecture	Building a multi-unit system is easy because the SymLink audio network interface is standard on all units. Specify only the amount of hardware that your design requires – whether that means many units connected via SymLink, or just one unit.
Intuitive and powerful SymNet Designer control software	CAD style drag-and-drop setup, coupled with a bevy of convenient features, offers quick and easy system configuration and control.
Loaded with advanced processing modules	AGC/Levelers, Voice Processors, SPL Computers, Crossovers, Eqs, Compressors, Limiters, Gates, Delays, and more.
Powerful mixing and routing	Mono, Stereo, and LCR Mixers, Auto-mixers, Matrixes with Cross-point Volume Control.
Great setup tools	Signal Generators, Meters, Input Selectors, Oscilloscope, Test Probe.
All inputs mic/line switchable	phantom power available.
Powered by Sharc floating-point processors.	32-bit floating point processing makes system gain-staging a snap by completely eliminating internal clipping and signal-to-noise ratio hassles.

## Glossary

**CobraLink™.** A core SymNet hardware units which sends or receives audio and control data from a SymNet ring to a distant SymNet ring or other CobraNet device.

**CobraNet™.** A technology for transmitting audio over Ethernet. It is implemented in SymNet systems under license from Peak Audio, a division of Cirrus Logic.

**Configuration.** A particular arrangement of SymNet hardware units and their routings.

**Configuration File.** A single SymNet configuration store in a PC file with the extension \*.cfg.

**Control Screen.** A customized group of specific files used to control SymNet in real time. Control screens may be password protected.

**Settings File.** A file containing multiple user settings for modules and units.

**Site.** A collections of up to eight SymNet configurations.

**Site File.** A collection of eight SymNet configurations stored in a PC file with the extension \*.sym. The site file can also be archived to non-volatile memory in the SymNet hardware.

**Super-module.** A collection of SymNet modules configured to do a particular task. The Super-module wraps a set of modules into a 'magic box' that has input and output terminals. Super-modules may be copied and repeated throughout a system.

**SymLink™.** The 64 channel digital audio and control data bus which connects SymNet hardware units.

**SymNet Audio Matrix™.** An awesome DSP system.

**SymNet Designer.** The Windows application used to design and control the SymNet Audio Matrix.

**SymNet™ Ring.** A local area network of SymNet units interconnected via a SymLink digital audio and control data bus using shielded CAT-5 cable.

**Architects and Engineers Specifications*****SymNet 8x8***

The Audio Matrix shall have eight analog inputs and eight analog outputs. Internal 24-bit A/D & D/A converters shall operate at a sample rate of 48kHz. All internal audio signal processing (with the exception of input and output attenuators) shall be digital (DSP). Electronically balanced inputs and outputs shall be provided on detachable Europlug connectors. Inputs shall be individually programmable to accept either microphone or line level signals.

Means shall be provided to connect digital audio and control data from the 8x8 Audio Matrix to other similar devices over a 64 audio channel bus to form a local area network (LAN).

Each hardware unit shall contain four floating point 66Mhz SHARC DSPs, and a 32-bit host processor.. PC software shall be provided to download compiled DSP modules to each hardware unit. Available system components shall include (but not be limited to) various forms of: mixers, automixers, equalizers, filters, crossovers, dynamics/gain controls, matrixes, delays, level controls, level meters, room combiners and tone generators. RS-232 communications shall be utilized for software downloading, uploading, configuration and control. After initial programming from a Windows PC, systems may be controlled using either RS-232 serial communication from a PC or by third party control systems such as AMXTM and CrestronTM.

Eight analog control inputs shall be provided. These high-impedance inputs shall accept 0-10V positive DC signals. A 10V reference voltage shall be available at the rear panel interface.

Six binary outputs shall be provided. They shall be NPN transistor outputs, wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections shall be provided.

The SPDT output relays shall be provided. Contact ratings shall be: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive.

The Audio Matrix shall be the SymNet 8x8 from Symetrix, Inc.

***SymNet 8in***

The Audio Matrix shall have eight analog inputs. Internal 24-bit A/D converters shall operate at a sample rate of 48kHz. All internal audio signal processing (with the exception of input and output attenuators) shall be digital (DSP). Electronically balanced inputs and outputs shall be provided on detachable Europlug connectors. Inputs shall be individually programmable to accept either microphone or line level signals.

Means shall be provided to connect digital audio and control data from the 8x8 Audio Matrix to other similar devices over a 64 audio channel bus to form a local area network (LAN).

Each hardware unit shall contain two floating point 66Mhz SHARC DSPs, and a 32-bit host processor.. PC software shall be provided to download compiled DSP modules to each hardware unit. Available system components shall include (but not be limited to) various forms of: mixers, automixers, equalizers, filters, crossovers, dynamics/gain controls, matrixes, delays, level controls, level meters, room combiners and tone generators. RS-232 communications shall be utilized for software downloading, uploading, configuration and control. After initial programming from a Windows PC, systems may be controlled using either RS-232 serial communication from a PC or by third party control systems such as AMXTM and CrestronTM.

Eight analog control inputs shall be provided. These high-impedance inputs shall accept 0-10V positive DC signals. A 10V reference voltage shall be available at the rear panel interface.

Six binary outputs shall be provided. They shall be NPN transistor outputs, wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections shall be provided.

The SPDT output relays shall be provided. Contact ratings shall be: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive.

The Audio Matrix shall be the SymNet 8in from Symetrix, Inc.

***SymNet 8out***

The Audio Matrix shall have eight analog outputs. Internal 24-bit D/A converters shall operate at a sample rate of 48kHz. All internal audio signal processing (with the exception of input and output attenuators) shall be digital (DSP). Electronically balanced inputs and outputs shall be provided on detachable Europlug connectors.

Means shall be provided to connect digital audio and control data from the 8x8 Audio Matrix to other similar devices over a 64 audio channel bus to form a local area network (LAN).

Each hardware unit shall contain two floating point 66Mhz SHARC DSPs, and a 32-bit host processor.. PC software shall be provided to download compiled DSP modules to each hardware unit. Available system components shall include (but not be limited to) various forms of: mixers, automixers, equalizers, filters, crossovers, dynamics/gain controls, matrixes, delays, level controls, level meters, room combiners and tone generators. RS-232 communications shall be utilized for software downloading, uploading, configuration and control. After initial programming from a Windows PC, systems may be controlled using either RS-232 serial communication from a PC or by third party control systems such as AMXTM and CrestronTM.

Eight analog control inputs shall be provided. These high-impedance inputs shall accept 0-10V positive DC signals. A 10V reference voltage shall be available at the rear panel interface.

Six binary outputs shall be provided. They shall be NPN transistor outputs, wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections shall be provided.

The SPDT output relays shall be provided. Contact ratings shall be: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive.

The Audio Matrix shall be the SymNet 8out from Symetrix, Inc.

**Factory Contact Information**

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**Release Highlights - SymNet Designer Version 2.0 - 16 August, 2002**

- 6 dB/octave sloped low pass and high pass filters have been added to the Mono and Stereo Filter sub-classes in the Filters & EQs class in the Module View Toolkit.
- SPL Computer™ modules (gap sensing) have been added to the Dynamics class in the Module View Toolkit. Included are mono and stereo SPL computers for controlling the long term volume of a signal based on measuring the ambient room level when the signal is quiet.
- Output selector modules (de multiplexer) with mute have been added to the Input Selectors class (which is now labeled Routers). They include mono and stereo output selectors and output distributors for selectively sending a single source signal to either one of many, or any of many output destinations respectively.
- The sine, sawtooth, triangle and square tone generators now have programmable sweep start and end frequencies, as well as a sweep rate control and the ability to sweep repetitively.
- Parameter Presets. The settings of operator chosen module controls can now be grouped into up to 16 presets which can be downloaded to hardware and triggered by time, external control or a control in the SymNet Designer application.
- Support for BreakIn12 and BreakOut12 boxes. The two new SymNet hardware units, BreakIn12 and BreakOut12, are now supported by SymNet Designer.
- Bug Fixes as required. General improvements to system reliability and usability.
- Mono and Stereo Programmable Filters. Two new sub classes of modules have been added to the Filters & EQs class in the Module View Toolkit. They include mono and stereo programmable low pass, high pass, and band pass filters. These filters allow greater control than standard filters by adding controls for filter type, resonance, and slope.
- Analyze will now work inside super-modules. The Analyze feature has been improved to take into account the contents of super modules.
- An easier to see Download Status window is now available to indicate the current state of communication with hardware, indicating if the current design has changed since the last download to hardware.
- The duplicate feature has been added to the right click menu on items which formerly supported this feature only through the main menu.
- Support for 31 rings and 16 addresses. The SymNet Designer application and hardware firmware has been upgraded to support up to 31 rings of 16 units each for a total of 496 units and a maximum sustained DSP power of 245 GFLOPS (billion floating point operations per second).
- ARC network now unique to each ring. Each Ring of SymNet units can now support a different ARC network of up to 32 ARCs, allowing up to 992 ARC devices to be used.
- Mute control added to Input Selector modules.



**Release Highlights****Release Highlights - SymNet Designer Version 1.2 - 3 June, 2002**

- New linkable Automixer modules with channel priority control.
- New Room Combiner modules to facilitate easy room combining/splitting installations.
- Gain modules include master fader for convenient grouping of multiple signals..
- New matrix modules with 32 inputs.
- GUI speed improvements especially with large mixer modules.
- Ability to resize sheets (working area).
- Ability to add textual notes to objects (units, configurations, modules, etc.).
- Increased DSP efficiency in stereo mixer and stereo parametric EQ modules.

**Release Highlights - SymNet Designer Version 1.1 - 1 March, 2002**

- Supports the CobraLink unit for larger systems and longer distance between units.
- Supports CobraNet to allow interfacing with third party CobraNet equipment (e.g. power amps, mic amps, A/D's, D/A's, etc.).
- Support for SymNet ARC (Adaptive Remote Control), programming, simulation, downloading and uploading.
- Enhanced RS-232 control protocol allows better control via AMX or Crestron units.
- GUI PC can be connected via Ethernet instead of RS-232 when CobraLink hardware is present - faster downloads and screen updates, longer distances between PC and SymNet ring(s).
- Enhanced control over analog control inputs (pots) allows for scaling and inverting.
- New External Control Manager screen shows control of entire site at a glance - combines ARCs, Crestron/AMX devices, and analog control in a single screen.
- Separation of Browser from ToolKit to its own floating window.
- Support for CobraLink (SymLink to CobraNet) hardware unit.
- Calibrate function for analog controls.
- Additional External Devices icons.
- Storage of picture bitmaps in Designer file.
- Storage of all eight configurations in Symnet Designer file, now called "site" files. Configuration menu - Import, Export, Clear, rename.
- Optional confirmation of downloads.
- One button download and upload of entire SymNet Designer site file to hardware.
- Storage of configuration triggers and power on default in site file.
- Redistribution of RS-485 control to all units in site.
- Control of object precedence in Control Screens (Move to front, Move to Back).
- CobraNet Bundle Manager.

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## Hardware

### Hardware Overview

A SymNet™ system is comprised of one or more SymLink™ hardware units connected by a common bus. This bus is known as SymLink. SymLink is a closed ring topology creating what is essentially a local area network (LAN).

Each unit in the ring has two unidirectional SymLink ports. One port is an input port and is intended to connect to an upstream neighbor. The second port is an output port and is intended to connect to the downstream neighbor. The output of the last unit in the chain connects to the input of the first unit. The result is a ring of data flow. SymLink carries both 32-bit digital audio data and control data.

Two or more local area SymNet rings (LANS) may be connected into a wide area network (WAN) using CobraNet™ technology. To create a SymNet WAN each SymNet ring must include a CobraLink unit which can be thought of as a 'CobraNet breakout box'.

As of this writing there are six core hardware units in the SymNet lineup:

- 8x8 - Eight analog audio inputs and outputs, 4 DSP processors, SymLink, control ports.
- 8in - Eight analog audio outputs, 2 DSP processors, SymLink ports, control ports.
- 8 out - Eight analog audio outputs, 2 DSP processors, SymLink ports, control ports.
- CobraLink - SymLink ports, CobraNet ports (primary and secondary).
- BreakIn12 - 12 analog audio inputs, SymLink ports, no DSP, no control ports.
- BreakOut12 - 12 analog audio outputs, SymLink ports, no DSP, no control ports.

### Limitations

- DSP capacity. Each processor module requires a certain amount of DSP power and this requirement is shown as a percentage within the module itself and as a total displayed at the left-hand side of the Status Bar.
- Maximum Number of units in a SymNet ring: eight (8).

- Maximum Number of CobraLink units in a SymNet ring: one (1).
- Maximum Number of SymNet rings connected via CobraNet: eight (8).
- SymLink Cable length: 10 meters, maximum. (shielded Category 5 cable)
- CobraNet Cable length: 100 meters, maximum. (shielded Category 5 cable)

### 8x8, 8in, 8out

There are 3 configurations of rackmounted SymNet DSP/IO units. They may be linked in any combination via the SymLink digital audio and control data bus.

- SymNet 8x8 - 8 inputs, 8 outputs, 4 SHARC floating point DSP's.
- SymNet 8in - 8 inputs, 2 SHARC floating point DSP's.
- SymNet 8out - 8 outputs, 2 SHARC floating point DSP's.

### Audio Performance

SymNet 8x8, 8in, and 8out deliver audio fidelity that will please the most discerning ear. From high-headroom, low-noise audio IO, to the 40-bit floating point processing algorithms, SymNet has been designed for superior sonic performance.

### SHARC® Floating-Point DSP

Hardware units incorporate SHARC floatingpoint DSP. Utilizing 40-bit floating-point algorithms, the 4 on-board SHARCs deliver 528 MFLOPS (million floating point instructions per second). Studio quality 24-bit AD and DA converters provide dynamic range performance in excess of 110 dB.

### Control Inputs and Outputs

All three units have identical control interface features.

- RS-232 - Front and rear panel RS-232 ports for connection to third party serial control devices or a host PC.
- RS-485 - For connections to third party serial control devices or the SymNet ARC (Adaptive Remote Control).

- **Analog Control Inputs** - Eight high-impedance inputs accept 0-10V positive DC signals. 10V reference voltage available at rear panel interface. Use with external potentiometer (10k linear taper) or external voltage source (0-10V).
- **Binary Outputs** - Six NPN transistor outputs, wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections furnished. These outputs can also drive an LED directly. Current limit resistor not needed.
- **Relay Outputs** - Three SPDT relay contacts. Contact rating: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive.

### SymLink

All three units have SymLink TRANSMIT and RECEIVE ports for connecting digital audio and control data to a SymLink local area network.

## 8x8, 8in, 8out installation

### What ships with the 8x8, 8in, and 8out

- The SymNet 8x8, 8in, or 8out hardware unit.
- SymNet Designer CD-ROM (Windows).
- A detachable IEC power cable.
- A printed Quick Start Guide.

*Note: You can complete the product warranty registration online at [www.symetrixaudio.com](http://www.symetrixaudio.com).)*

### What you need to supply

- A Windows PC with 300MHz or higher Pentium and WIN 98SE or WIN 2000 operating system.
- 10MB-15MB free storage space.
- 1024x768 graphics capability.
- 16 bit or higher colors.
- CD ROM drive or Internet connection.
- 64MB RAM (WIN 98SE) or 128MB RAM (WIN

2000).

- A cable to connect the RS-232 serial port of your PC to a SymNet front panel RS-232 input.
- (Optionally:) Two or more shielded CAT5 patch cables if connecting to other SymNet or CobraLink units via the SymLink bus.

## Operator Safety Summary

Follow all warnings and instructions. Install in accordance with the manufacturer's instructions.

**Power Source.** SymNet™ Audio Matrix hardware uses a switching power supply that automatically adjusts to the applied voltage. Ensure that your AC mains voltage is 100-240 VAC, 50-60 Hz.

**Grounding.** This product is intended to operate from a power source that does not apply more than 240 Vrms between the power supply conductors or between either power supply conductor and ground. A protective ground connection, by way of the grounding conductor in the power cord, is

essential for safe operation. The chassis of this product is grounded through the grounding conductor of the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle

before making any connections to the product. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation.

**Fuse.** This product contains no user servicable fuse.

**Danger from Loss of Ground.** If the protective ground connection is lost, all accessible

conductive parts, including knobs and controls that may appear to be insulated, can render an electric shock.

**Proper Power Cord.** Use only the power cord and connector specified for the product and your operating locale. Use only a cord that is in good condition. Protect the power cord from being walked on or pinched, particularly at the plug, convenience receptacle, and the point where the cord exits from the apparatus.

**Operating Location.** Do not operate this equipment under any of the following conditions: explosive atmospheres, in wet locations, in inclement weather,

improper or unknown AC mains voltage, or if improperly fused. Do not install near any heat source such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat. Unplug this apparatus during lightning storms or when unused for long periods of time.

**Stay Out of the Box.** To avoid personal injury (or worse), do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed. Only use accessories specified by the manufacturer. Clean only with a damp cloth.

**User-Serviceable Parts.** There are no user serviceable parts inside the SymNet™ Audio Matrix. There are no adjustments or jumpers to set within the chassis. Settings are stored in non-volatile ram and no backup battery is required. In case of failure, refer all servicing to the factory. Servicing is required when the SymNet™ Audio Matrix has been damaged in any way, such as when liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

### **Equipment Markings**

The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user of the presence of uninsulated “dangerous voltage” within the product’s enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons. The exclamation point within an equilateral triangle is intended to alert the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product (i.e., this quick start).

### **CAUTION**

*To prevent electric shock, do not use the polarized plug supplied with the unit with any extension cord, receptacle, or other outlet unless the prongs can be fully inserted.*

**Hardware Installation and Connections**

Mounting	Discussion	Remarks
Hardware units	1U (WDH: 48.26 cm x 21.59cm x 4.369cm / 19 in x 8.5 in x 1.72 in)	Depth measurement does not include connector and wire allowance.
Space Required	3U	Allow one blank rack space above and below each unit for proper ventilation and cooling.
Electrical	100-240 VAC, 50-60 Hz, 100W maximum.	Power supply automatically adapts to mains voltage and current. No manual voltage switching required.
Ventilation	Internal fan expels warm air at right side of equipment.	Ensure that the left and right equipment venting holes are unobstructed.
Weight	3.0kg/ 6.6 lbs net.	

Connections	Discussion	Remarks
Analog Inputs and Outputs (Audio)	Detachable Euroblock connectors.	Connectors come in 3-pin modules. Connectors included with unit. (Symetrix part number 039003)
Binary Outputs (relay and open collector (OC))	Detachable Euroblock.	Connectors come in 3-pin modules.
Analog Control Inputs	Detachable Euroblock.	Accepts 0-10 VDC analog or binary control voltages.
SymLink	CAT5 shielded network cabling required.	Uses standard 'straight-through' wiring. 10 meter length limit.
RS-232	DB9 female d-sub connector	Same connector used on front panel. You need pins: 2, 3, 5, 7, 8, (wired 'straight-through').
RS-485	Detachable Euroblock.	
AC mains	Standard IEC 320 3-pole male connector.	Opposite end as required for your locale. Cable included with unit.

***Please note the following:***

- Unlike EtherNet which uses a hub and spoke topology making a single connection to each device from the hub, SymLink is a ring network. Each device on a SymLink network has two connections: TRANSMIT and RECEIVE. With SymLink the last unit's TRANSMIT connector must connect to the first unit's RECEIVE connector.
- SymLink cables must be shielded, and are limited to 10 meters length (each).

Analog Inputs and Outputs	Description	Details	Remarks
Analog Inputs (x8)	Balanced-bridging input accepts signal levels from mic (-50dBu nominal) through line (+4dBu nominal). 48V phantom power available. There is 20 dB headroom past the signal level selected. At unity gain (+4dBu setting), the maximum input level is +24dBu.	Input impedance: >6.66k balanced, >3.3k unbalanced. The input topology uses a balanced instrumentation amplifier. Both inputs are identical and symmetrical in terms of impedance and shunt capacitance. Set input level capability, phantom power, and gain via control software.	For unbalanced use, either reference the minus input terminal to the signal source ground (preferred) or ground the minus input to the adjacent ground terminal. Using the second method deprives you of the common mode rejection inherent in a balanced input, even when coming from an unbalanced source.
Analog Outputs (x8)	Balanced line output delivers +24dBu maximum level. Nominal level can be software adjusted for professional or consumer line levels or mic level.	Output source impedance: 204 ohms balanced, 102 ohms unbalanced. The output topology is a chain of inverters, emulating a grounded center-tap transformer secondary.	For unbalanced float (do not connect) the minus output terminal. Note that unbalanced usage results in 6dB lower output level.
Analog Control Inputs (x8)	High-impedance input accepts 0-10V positive DC signals. 10V reference voltage available at rear panel interface.	Use with external potentiometer (10k linear taper) or external voltage source (0-10V). See Rear Panel for connections.	

Binary, Relay and RS-485 I/O	Discussion	Remarks
Binary Outputs (x6)	Six NPN transistor outputs, cleverly wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections furnished. These outputs can also drive an LED directly. Current limit resistor not needed.	2N4401 transistors. Current must be < 50mA, 24V maximum. Control software determines how these are used. If you're driving a relay, be sure to include a reversed biased diode connected across the relay coil. When driving a LED connect the LED from the output to ground.
Relay Outputs (x3)	Three SPDT relay contacts. Contact rating: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive	SymNet Designer determines how these are used. Do not use at 120VAC.
RS-485 I/O (x1)	Connect to RS-485 system.	2 signal lines and ground provided. See <a href="#">SymNet Control Protocol</a> .

Indicators and Switch Settings

Front Panel Indicator	LED Color	Remarks
POWER	Red	Indicates Power ON.
SERIAL COMM	Yellow	Indicates communication with host PC.
SYMLINK ACTIVE	Green	Indicates communication with other SymLink networked device(s).
CLIP	Red	Indicates analog input clipping.
SIGNAL IN	Yellow	Indicates signal present at input.
SIGNAL OUT	Green	Indicates signal present at output.

*Please note the following:*

- An eight-position DIP switch is located in the middle of the rear panel of the SymNet™ hardware. It determines serial port speed, master/slave mode, unit address, and factory firmware enable. The ON setting is to the left as you face the rear of the unit.
- After changing any DIP switch setting, reboot the hardware by disconnecting it from AC power and then reconnecting it.

Switch Number, top to bottom	What does it do?	Remarks
8 - Use Factory Firmware	On = Use Factory OS Off = Use upgraded OS	Set to OFF unless instructed otherwise by SymNet factory Technical Support Group.
3-7 - ADDR (DeviceAddress)	Each unit must have a unique address. These switches set that number, in binary form, using the bit values labeled on the equipment. On = 1, Off = 0. The device address equals the number programmed via SW3-7.	SW3 - 1 SW4 - 2 SW5 - 4 SW6 - 8 SW7 - 16  All switches OFF = device address 0 (zero). All switches are ON = device address 31.
2 - MASTER / SLAVE	Off (right) = MASTER, On (left) = SLAVE	In a SymLink ring that does not include a CobraLink unit, unit with ADDR = 1 must be the MASTER. All other units must be SLAVES.
1 - BAUD	Sets baud rate of front panel RS232 Serial Port.	Off=115200 baud, On=57600 baud. Must match setting in SymNet Designer.



#### RS-232 control via PC

The rear panel DIP switch determines the baud rate (speed) of the front panel RS-232 connector. This setting must match the setting in the SymNet Designer Preferences. (See the discussion of Communications under File Preferences.) After changing the setting of the DIP switch, you must reboot the hardware by removing and restoring AC power to the unit.

The cable connecting to the host PC is a simple DB-9 extension cable, with like pins wired to like pins, with male and female connectors at the ends. You can purchase this at any computer store. Generally all pins are wired, which is permissible. At a minimum, you need pins 2, 3, 7, and 8 wired. Pin 5 (ground) is optional.

Test your RS-232 connection by trying to download to the hardware. The yellow RS-232 LED on the front panel should illuminate.

## CobraLink Overview

### Introduction

A CobraLink unit is a member of the SymNet family of products. It allows extending the distances between SymNet units and/or connecting 3<sup>rd</sup> party CobraNet equipment to a SymNet system. A CobraLink unit allows sending up to 32-channels over audio onto a CobraNet network and receiving up to 32-channels from a CobraNet network. It acts as a router and gateway from a SymLink bus to a CobraNet network. A CobraLink unit also enables you to control a SymNet system using an Ethernet connection in addition to or instead of a PC serial port.

CobraNet is a system for routing high quality uncompressed audio and control over a standard Fast Ethernet network using off-the-shelf networking components and cables. Developed by Peak Audio and licensed by Symetrix, it has become somewhat of a standard in the audio world. Much more information on CobraNet is available at Peak Audio's web site: <http://www.peakaudio.com/CobraNet/>.

### SymNet connections with CobraLink

A CobraLink unit is physically connected to other SymNet DSP units via the SymLink bus. As always, the SymLink bus forms a complete ring. The CobraLink device sits in a SymLink ring just like a SymNet DSP device. It's SymLink Transmit connector is connected to the next "downstream" unit. It's SymLink Receive connector is connected to the next "upstream" unit. The CobraLink unit acts as the master device for the ring. All other SymNet DSP devices in the ring should be set as slaves.

Version 1.1 of SymNet Designer only supports one CobraLink device per SymLink ring. Future versions may allow for more than one CobraLink device per ring. In a system utilizing CobraLink units, there is generally more than one ring each of which has exactly one CobraLink units.

### CobraNet connections with CobraLink

A CobraLink unit is connected to other CobraLink units or 3<sup>rd</sup> party CobraNet devices through an Ethernet network. For a very simple system with just two CobraNet devices, this could be as simple as an Ethernet crossover cable. For very large systems, it might be a complex system of hubs, switches, routers, and media converters. In the most typical small to medium-size systems, it would be a single Ethernet switch to which all CobraNet devices are connected.

In general, networks built around switches are

preferable to those built around repeater hubs.

Switches allow full duplex communications and more efficient bandwidth usage. Please see [http://www.peakaudio.com/CobraNet/Network\\_Design.html](http://www.peakaudio.com/CobraNet/Network_Design.html) for more information on setting up your CobraNet network. A list of approved Ethernet network components for CobraNet may be found at [http://www.peakaudio.com/CobraNet/tested\\_Ethernet.html](http://www.peakaudio.com/CobraNet/tested_Ethernet.html).

Note that although there are two CobraNet Ethernet connections on the back of the SymLink unit, only one can be used simultaneously. The other is provided for redundancy. If you require a redundant network, then make connections from both Ethernet ports to the network. Otherwise, connect only the primary one.

### PC Control Connections

**Serial Connection** - A PC controls a CobraLink system using an RS-232 serial connection just as it does any other SymNet unit. When connecting the host computer to a SymNet system utilizing CobraLink units, the PC is always connected to a CobraLink unit, never a SymNet DSP unit. You may connect the PC to any CobraLink unit in a system and control all of them.

**Ethernet Connection (Internet Protocol or IP)** - It is also possible to control a CobraLink system using an Ethernet connection to your PC. The PC must be connected to the CobraNet Ethernet port either directly or much more typically through an Ethernet switch or hub. Note that for security reasons, you will be required to put the hardware into IP control mode using a serial port connection. This is to prevent unauthorized "hacking" of a SymNet system from the outside over IP.

To enable IP control, you will need to assign an IP address to at least one of the CobraLink units in the system. Currently, only static IP addressing is supported by CobraLink hardware. To assign an IP address, right click on a CobraLink unit and choose Properties. Then click the CobraNet Options button. In the CobraNet Options dialog box, check the "Enable CobraNet Control of this unit" box. Enter a valid IP address for this unit. If you want, you can also enter an Access Code for this device. This acts as a password protection for this system since any computer controlling this unit will need to have a matching access code. You may leave the access code blank if you do not require this type of security. After completing these steps, click Write Settings to Unit.

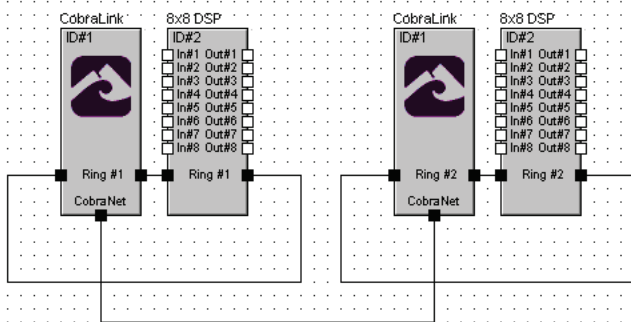
After this is done, go to Preferences and under communications, choose Use CobraNet. Now, you are ready to connect and control the SymNet system over IP. This allows control from any point on the CobraNet LAN or even other LANs and WANs using appropriate

Ethernet routing devices.

Device Addressing

In a multi-ring SymNet system that uses CobraLink, each device is given a two-part ID. The ID consists of a ring number and a unit address. For each ring, the CobraLink unit's DIP switches determine the ring number for all devices on that SymLink ring. The DIP switches on the SymNet unit determine the unit address within that ring. A CobraLink unit implicitly has a unit address of 1.

An example may help clarify this addressing. Consider a system that has two rings, each of which has one CobraLink unit and one SymNet 8x8 DSP unit as shown schematically below. In this case, one of the CobraLink units would be set to address 1 and the other would be set to address 2. Both SymNet DSP units would be set to address 2 and both would be set



as slaves.

Routing Audio over CobraNet SymNet Designer allows very flexible routing of audio over CobraNet. The tools for routing are an extension of the SymLink Bus sends and returns. If you have not already done so, please read the section on the SymLink buses before continuing.

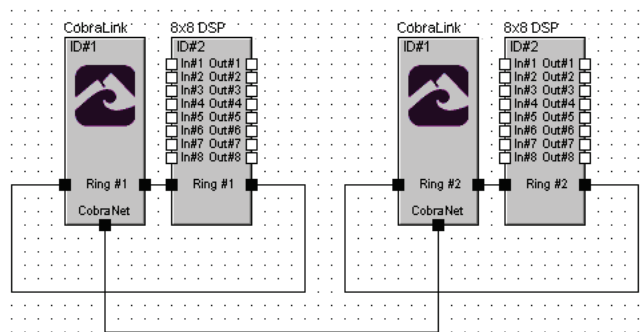
In addition to SymLink bus send and return modules found on all SymNet units, CobraLink units have CobraNet bundle send and return modules. In CobraNet terminology, bundles are groups of up to 8 audio channels that are routed together in a single Ethernet packet. Think of them as groups of audio channels. A bundle must be sent by exactly one device but can be received by many devices.

To route audio from the SymLink bus onto CobraNet, open a CobraLink unit and add a SymLink bus return. Next add a CobraNet bundle send. Finally, wire the desired audio signals from the SymLink return to the CobraNet send. You can set the bundle number of the CobraNet bundle by right clicking on the bundle module and choosing Properties.

To route audio from CobraNet to the SymLink bus, open a CobraLink unit and add a CobraNet bundle return. The bundle number should match the bundle number of the sending device. Next add a CobraNet SymLink bus send. Finally, wire the desired audio signals from the CobraNet return to the SymLink send.

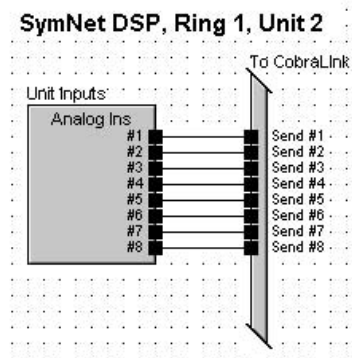
Here is a complete example showing how to route the 8 analog inputs of one SymNet DSP unit to the 8 analog outputs of another SymNet DSP unit in a different ring using CobraNet.

- 1) Create the top level configuration showing the 4



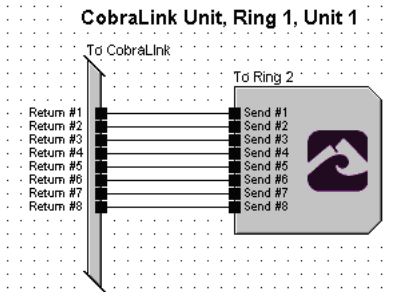
devices, 2 CobraLink and 2 SymNet 8x8 DSP. Note: the wires shown at this level are only for clarity and drawing them in the software is not required for operation. They represent physical connections that must be made to actual hardware.

- 2) Open up the Ring #1 ID#2 8x8 DSP. Add a SymLink bus send and wire it to the Analog Inputs as shown

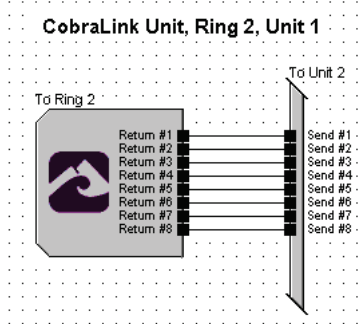


below.

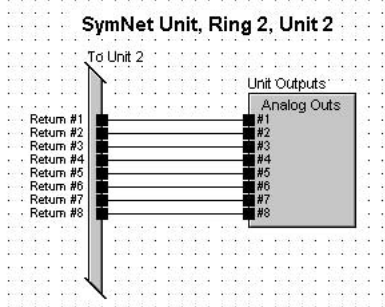
- 3) Open up the Ring #1 ID#1 CobraLink. Add a SymLink bus return that matches the send added above. Add a CobraNet bundle send. Wire them together as shown below.



- 4) Open up the Ring #2 ID#1 CobraLink. Add a CobraNet bundle return that matches the bundle send added above. Add a SymLink bus send. Wire them together as shown below.



- 5) Open up the Ring #2 ID#2 8x8 DSP. Add a SymLink bus return that matches the send added above. Wire it to the analog outputs as shown below.



After downloading, the eight input channels from the SymNet in ring #1 will be sent out the eight output channels in SymNet ring #2.

**Multicast vs. Unicast bundles**

CobraNet supports two different kinds of audio bundles that differ in the way they are routed. They are called multicast and unicast bundles. A multicast bundle supports a one-to-many routing of audio on the network. Because a multicast bundle is sent to every device on the network, it consumes bandwidth

network-wide. Hence use of this delivery service must be rationed on a switched network. In contrast, a unicast bundle supports a one-to-one routing of audio on the network. Because unicast audio is sent only to the devices asking for it, network bandwidth is preserved for other devices. Where network bandwidth is an issue, unicast bundles should be used whenever possible.

In SymNet Designer, you control the bundle type based on the number you assign to the bundle. Bundle numbers 1-255 are multicast bundles. Bundle numbers 256-65279 are unicast bundles. Which type of bundle should you use? In a small system with less than eight bundle sends, multicast bundles can be used safely. For larger systems where more bundle sends are required, unicast bundles should be used whenever audio is intended for only one destination.

Note that if you set up a CobraLink unit to use a unicast bundle, but try to receive the audio from that bundle in two different devices, the CobraLink unit will switch to using multicast mode for that bundle. This ensures that all requesting devices receive this bundle but may use up more bandwidth than you are expecting. Caution is advised.

**Audio level and bit-depth issues**

In version 1.1 of SymNet Designer, CobraLink units always transmit 20-bit audio. In future versions, 24-bit audio may be supported. CobraLink units are capable of receiving 16- 20- or 24-bit audio. The received audio bit depth is dependent on the sending device. Hence, if a CobraLink unit is connected to a third party device which is sending 24-bit audio, 24-bit audio will be received.

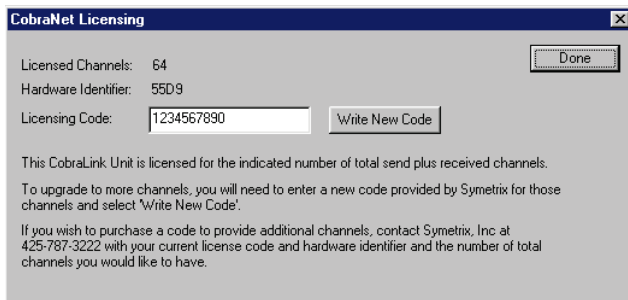
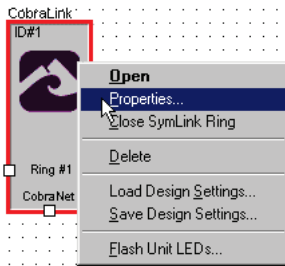
When sending audio over the SymLink bus, a 32-bit floating point format is used. This allows for almost infinite dynamic range, no worries about clipping, and high resolution at any level. However, since CobraNet doesn't support this format, all audio going over CobraNet is converted to fixed point format before sending. This means that care should be taken to ensure that the audio going over CobraNet is not clipping (< 0dBFS) and is of a reasonable signal level, just as if you were sending this audio to an analog output.

**CobraNet Channel Licensing**

Peak Audio charges a royalty fee for every channel sent or received over CobraNet. A CobraLink system allows anywhere from 0 to 64 channels to be utilized. So that users are not paying for more channels than they are using, Symetrix provides a flexible system

where channels are purchased as needed in 8-channel increments.

CobraNet channel licensing is controlled by entering a code into SymNet Designer. The code is specific to a given CobraLink unit using a hardware identifier. (Technically, it is tied to the last four digits of the MAC address of the CobraNet Ethernet port.) To obtain a code to allow additional channels to be used, contact Symetrix. To enter the code, in SymNet Designer add a CobraLink unit, right click on it and choose Properties. Next click CobraNet Licensing button.



In the CobraNet Licensing dialog box, you will see the current number of licensed channels as well as your hardware identifier. To upgrade your channel count, enter the new license code provided by Symetrix into the licensing code box and click Write New Code. Note: when contacting Symetrix to obtain a new code, you will be asked to provide your hardware identifier and current number of licensed channels.

### *CobraLink Hardware Installation*

#### What ships with CobraLink

- The CobraLink hardware unit.
- SymNet Designer CD-ROM (Windows).
- One PS-4 universal input switching power supply (6VDC @ 3.0 amperes).
- A printed Quick Start Guide.

*Note: You can complete the product warranty registration online at [www.symetrixaudio.com](http://www.symetrixaudio.com).)*

#### What you need to supply

- A Windows PC with 300MHz or higher Pentium and WIN 98SE or WIN 2000 operating system.
- 10MB-15MB free storage space.
- 1024x768 graphics capability.
- 16 bit or higher colors.
- CD ROM drive or Internet connection.
- 64MB RAM (WIN 98SE) or 128MB RAM (WIN 2000).
- A cable to connect the RS-232 serial port of your PC to a CobraLink front panel RS-232 input.
- Two CAT5 patch cables to connect the CobraLink hardware to a SymLink bus.
- A CAT5 crossover cable for CobraNet connections to a second CobraLink unit or other third party CobraNet device.

### **Operator Safety Summary**

Follow all warnings and instructions. Install in accordance with the manufacturer's instructions.

**Power Source.** This product is intended to operate from a Symetrix PS-4 power supply only.

**Grounding.** To avoid electric shock, plug the power cord into a properly wired receptacle before making any connections to the product. When the provided plug does not fit your outlet, consult an electrician for replacement of the obsolete outlet.

**Danger from Loss of Ground.** If the protective ground connection is lost, all accessible conductive parts, including knobs and controls that may appear to be insulated, can render an electric shock.

**Proper Power Cord.** Use only the power cord and connector specified for the product and your operating locale. Use only a cord that is in good condition. Protect the power cord from being walked on or pinched, particularly at the plug, convenience receptacle, and the point where the cord exits from the apparatus.

**Operating Location.** Do not operate this equipment under any of the following conditions: explosive atmospheres, in wet locations, in inclement weather, improper or unknown AC mains voltage, or if improperly fused. Do not install near any heat source such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat. Unplug this apparatus during lightning storms or when unused for long periods of time.

**Stay Out of the Box.** To avoid personal injury (or worse), do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed. Only use accessories specified by the manufacturer. Clean only with a damp cloth.

**User Serviceable Parts.** There are no user serviceable parts inside the CobraLink. In case of failure, refer all servicing to the factory. Servicing is required when the CobraLink has been damaged in any way, such as when a power supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

### **CAUTION**

***To prevent electric shock, do not use the polarized plug supplied with the unit with any extension cord, receptacle, or other outlet unless the prongs can be fully inserted.***

Connections, Indicators, and Switch Settings

Front Panel Connection	Connector	Remarks
RS-232	DB-9 (d-sub) Female	Connects to host computer running SymNet Designer version 1.1 or greater. In a SymNet site which includes CobraLink units the PC must be directly connected to Ring 1, Unit 1.
Front Panel Indicator	LED Color	Remarks
POWER	Red	Indicates Power ON
SERIAL COMM	Yellow	Indicates communication with host PC
COBRANET ACTIVE	Green	Indicates communication with other CobraNet device(s).
SYMLINK ACTIVE	Green	Indicates communication with other SymLink networked device(s)
Rear Panel Connection	Connector or Control	Remarks
POWER INPUT	Detachable Euroblock, Pin Jack	Accepts power from Symetrix PS-4 power supply only.
DEVICE CONFIG	8 position DIP switch	<p><u>1 (BAUD)</u> - Sets front panel RS-232 baud rate. Default = UP = 115,200. DOWN = 57,600.</p> <p><u>2 (not used)</u></p> <p><u>3-7 (RING)</u> - Sets the ring number of the SymNet ring. In a system with more than one CobraLink unit, each unit should be given a unique ring number. Exactly one unit must be set as address 1, that is switch 3=DOWN, switches 4-7=UP.</p> <p>In a multi-ring SymNet system that uses CobraLink, each device is given a two-part ID. The ID consists of a ring number and a unit address. For each ring, the CobraLink unit's DIP switches determine the ring number for all devices on that SymLink ring. The DIP switches on the SymNet unit determine the unit address within that ring. A CobraLink unit implicitly has a unit address of 1.</p> <p><u>8 (BOOT MODE)</u> - Default = UP. Set to DOWN only if instructed to do so by a Symetrix factory technician or engineer.</p>
SYMLINK	RJ-45	SymNet units connect via a ring network called SymLink. Each device on the network has two connections: TRANSMIT and RECEIVE. Each unit's TRANSMIT connector must connect to another unit's RECEIVE connector. The order of units does not matter. The last unit's TRANSMIT connector must return to the first unit's RECEIVE connector to complete the ring. Connect using high quality shielded CAT5 patch cables.
RS-232	DB-9 (d-sub) Female	Connects to third party control device such as AMX or Crestron.
RS-485	Detachable Euroblock	Connects to third party control device such as AMX or Crestron.
COBRANET	RJ-45	Connects the SymNet ring to a CobraNet network. Use the connector labelled PRIMARY. The connector labelled SECONDARY is redundant and can be used if the CobraNet device you are connecting to has a SECONDARY port.

More Information on CobraNet

For more information on CobraNet, see Peak Audio's web site at <http://www.peakaudio.com/CobraNet/index.htm>.

## BreakIn12, BreakOut12 Overview

The BreakIn12 and BreakOut12 are low cost input (A/D) and output (D/A) expansion devices which when added to SymNet systems can drastically reduce total system price while greatly increasing input and output capacity.

Unlike SymNet 8x8, 8in, and 8out units the BreakIn12 and BreakOut12 contain no DSP processors, a design feature which accounts for significant cost savings. Because of the tremendous DSP power contained in a single SymNet 8x8 (4 SHARC floating point processors) many designs don't fully utilize the 8x8's DSP potential. The BreakInOut boxes allow you to tap that full potential. For example, by connecting a BreakIn12 and BreakOut12 to a SymNet 8x8 you create a very powerful 20x20 DSP matrix at an extremely competitive price.

The BreakIn12 has 12 analog inputs while the BreakOut12 has 12 analog outputs. Both units exist as nodes with unique addresses in a SymLink ring network. They are set up and controlled over the network from the SymNet Designer application running on a PC connected to the master unit. Mic gain, attenuation, and phantom power are controlled per channel directly from SymNet Designer.

## BreakIn12, BreakOut12 Installation

*(Note: You can complete the product warranty registration online at [www.symetrixaudio.com](http://www.symetrixaudio.com).)*

### What you need to supply

Two or more shielded CAT5 patch cables to connect to other SymNet or CobraLink units via the SymLink bus.

### Operator Safety Summary

Follow all warnings and instructions. Install in accordance with the manufacturer's instructions.

**Power source.** SymNet™ BreakIn12 and BreakOut12 hardware uses a switching power supply that automatically adjusts to the applied voltage. Ensure that your AC mains voltage is 100-240 VAC, 50-60 Hz.

**Grounding.** This product is intended to operate from a power source that does not apply more than 240 Vrms between the power supply conductors or between either power supply conductor and ground. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation. The chassis of this product is grounded through the grounding conductor of the power cord. To avoid

electric shock, plug the power cord into a properly wired receptacle before making any connections to the product. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation.

**Fuse.** This product contains no user serviceable fuse.

**Danger from Loss of Ground.** If the protective ground connection is lost, all accessible conductive parts, including knobs and controls that may appear to be insulated, can render an electric shock.

**Proper Power Cord.** Use only the power cord and connector specified for the product and your operating locale. Use only a cord that is in good condition. Protect the power cord from being walked on or pinched, particularly at the plug, convenience receptacle, and the point where the cord exits from the apparatus.

**Operating Location.** Do not operate this equipment under any of the following conditions: explosive atmospheres, in wet locations, in inclement weather, improper or unknown AC mains voltage, or if improperly fused. Do not install near any heat source such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat. Unplug this apparatus during lightning storms or when unused for long periods of time.

**Stay Out of the Box.** To avoid personal injury (or worse), do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed. Only use accessories specified by the manufacturer. Clean only with a damp cloth.

**User-Serviceable Parts.** There are no user serviceable parts inside the SymNet™ Audio Matrix. There are no adjustments or jumpers to set within the chassis. Settings are stored in non-volatile ram and no backup battery is required. In case of failure, refer all servicing to the factory. Servicing is required when the SymNet™ Audio Matrix has been damaged in any way, such as when liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

### Equipment Markings

The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user of the presence of uninsulated "dangerous voltage" within the



product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons. The exclamation point within an equilateral triangle is intended to alert the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.

**CAUTION**

*To prevent electric shock, do not use the polarized plug supplied with the unit with any extension cord, receptacle, or other outlet unless the prongs can be fully inserted.*

**Hardware Installation and Connections**

**Hardware units.** 1U (WDH: 48.26 cm x 21.59cm x 4.369cm / 19 in x 8.5 in x 1.72 in). Depth measurement does not include connector and wire allowance.

**Space Required.** 3U. Allow one blank rack space above and below each unit for proper ventilation and cooling.

**Electrical.** 100-240 VAC, 50-60 Hz, 100W maximum. Power supply automatically adapts to mains voltage and current. No manual voltage switching required.

**Ventilation.** Internal fan expels warm air at right side of equipment. Ensure that the left and right equipment venting holes are unobstructed.

**Weight.** 3.0kg/ 6.6 lbs net.

**Connections.** The detachable Euroblock connectors come in 3-pin modules. Connectors included with unit. (Symetrix part number 039003)

**SymLink.** CAT5 shielded network cabling required. Uses standard 'straight-through' wiring. 10 meter length limit.

**RS-232.** N/A. This connection is for factory use only. All communications with the BreakIn12 or BreakOut12 are via the SymLink™ bus under the control of a SymNet™ DSP or CobraLink™ master unit.

**AC mains.** Standard IEC 320 3-pole male connector. Opposite end as required for your locale. Cable included with unit.

*Please note the following:*

Unlike EtherNet which uses a hub and spoke topology making a single connection to each device from the hub, SymLink is a ring network. Each device on a

SymLink network has two connections: TRANSMIT and RECEIVE. With SymLink the last unit's TRANSMIT connector must connect to the first unit's RECEIVE connector. SymLink cables *must* be shielded, and are limited to 10 meters length (each).

**Analog Inputs and Output.**

Analog Inputs (BreakIn12). Balanced-bridging input accepts signal levels from mic (-50dBu nominal) through line (+4dBu nominal). 48V phantom power is provided. There is 20 dB headroom past the signal level selected. At unity gain (+4dBu setting), the maximum input level is +24dBu.

Input impedance: >6.66k balanced, >3.3k unbalanced. The input topology uses a balanced instrumentation amplifier. Both inputs are identical and symmetrical in terms of impedance and shunt capacitance. Set input level capability, phantom power, and gain via control software.

For unbalanced use, either reference the minus input terminal to the signal source ground (preferred) or ground the minus input to the adjacent ground terminal. Using the second method deprives you of the common mode rejection inherent in a balanced input, even when coming from an unbalanced source.

Analog Outputs (BreakOut12). Balanced line output delivers +24dBu maximum level. Nominal level can be software adjusted for professional or consumer line levels or mic level.

Output source impedance: 204 ohms balanced, 102 ohms unbalanced. The output topology is a chain of inverters, emulating a grounded center-tap transformer secondary. For unbalanced applications float (do not connect) the minus output terminal. Note that unbalanced usage results in 6dB lower output level.

**Indicators and Switch Settings**

Front Panel Indicator	LED Color	Remarks
POWER	RED	Indicates Power ON
SERIAL COMM	YELLOW	Indicates communication with host PC

SYMLINK ACTIVE	GREEN	Indicates communication with other SymLink networked device(s)
CLIP	RED	Indicates analog input or output clipping
NOMINAL	YELLOW	Indicates average signal level present
PRESENT	GREEN	Indicates signal present (-40dbFS or greater).

Please note the following:

An eight-position DIP switch is located in the middle of the rear panel of the SymNet™ hardware. It determines serial port speed, master/slave mode, unit address, and factory firmware enable. The ON setting is to the left as you face the rear of the unit. After changing any DIP switch setting, reboot the hardware by disconnecting it from AC power and then reconnecting it.

Switch Number, top to bottom	What does it do?	Remarks
1 - BAUD	N/A	1 - BAUD N/A This connection is for factory use only. All communications with the BreakIn12 or BreakOut12 is via the SymLink™ bus under the control of a SymNet™ DSP or CobraLink™ master unit.
2 -RESERVED	N/A	N/A

3-7 - ADDR (Sets Device Address)	Each unit must have a unique address. These switches set that number using the bit value labelled on the equipment. On = 1, Off = 0. The device address equals the number programmed via SW3-7.	SW3 - 1 SW4 - 2 SW5 - 4 SW6 - 8 SW7 - 16  All switches OFF = device address 0 (zero).  All switches are ON = device address 31. A device address of 1 is not valid.
8 - Use Factory Firmware	On = Use Factory OS  Off = Use upgraded OS	Set to OFF unless instructed otherwise by SymNet factory Technical Support Group.

**Interconnecting Multiple Units via SymLink™**

This is relatively straightforward, however the following points are important to keep in mind:

SymLink™ is a ring network unlike Ethernet which uses a hub and spoke topology making a single connection to each device from the hub. Each device on a SymNet™ network has two connections: TRANSMIT and RECEIVE. With SymNet™ the last unit's TRANSMIT connector must connect to the first unit's RECEIVE connector.

SymLink™ cables must be shielded, and are limited to 10 meters length (each).

It is not necessary to follow any particular numeric order when interconnecting units. This may be helpful when units are located in adjacent racks.

Each unit must have a different Unit ID number. The master unit must be Unit ID #1. Remember where this unit is, because the PC running Sym Net™ Designer must be connected to it.



**ARC (Adaptive Remote Control)**

The ARC is an RS-485 device used to remotely control configuration changes or module parameters within a SymNet system. It is designed to be mounted in a single-gang electrical wall outlet, and comes with a plastic wall plate.

Hardware Details

The ARC hardware can be powered in two ways – either using the ARC-PS power supply, or by running 6-15VDC into the device directly. Current requirements at 6V are 300mA, proportionately less as the supply voltage increases.

The RS-485 control signals can be routed to the ARC in two ways – either via the same cable that provides power from the ARC-PS, or from the rear panel RS-485 jack on the master SymNet box directly.

The ARC uses a 3 button interface, and has an 8 digital alphanumeric LED display for display of menu items and parameter values. The brightness of the LED display is controlled from the SymNet Designer application. The 3 buttons are labeled MENU, UP, and DOWN. Pressing the MENU button selects the parameter(s) to be changed. Pressing the UP or DOWN buttons adjusts the selected parameters.

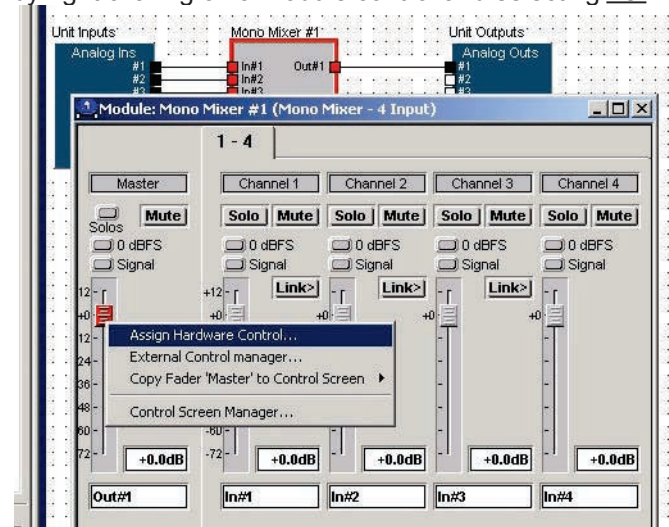
Each individual ARC control panel in a system can be easily locked out for temporary security purposes if so desired. To prevent the use of an ARC panel, continuously press the MENU button for at least 4 seconds and then press the UP button. The ARC will now be locked.

To unlock the ARC panel and return it to normal

operation continuously press the MENU button for at least 4 seconds and then press the DOWN button.

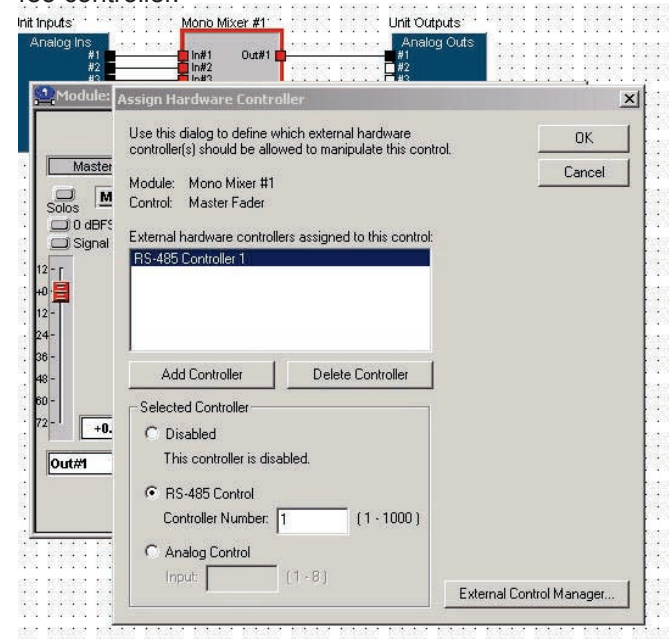
Setting up the ARC for use with SymNet

To set up the ARC to control module parameters, start by right clicking on a module control and selecting As-



Assign Hardware Control....

Then click on Add Controller and proceed to add a RS-485 controller.

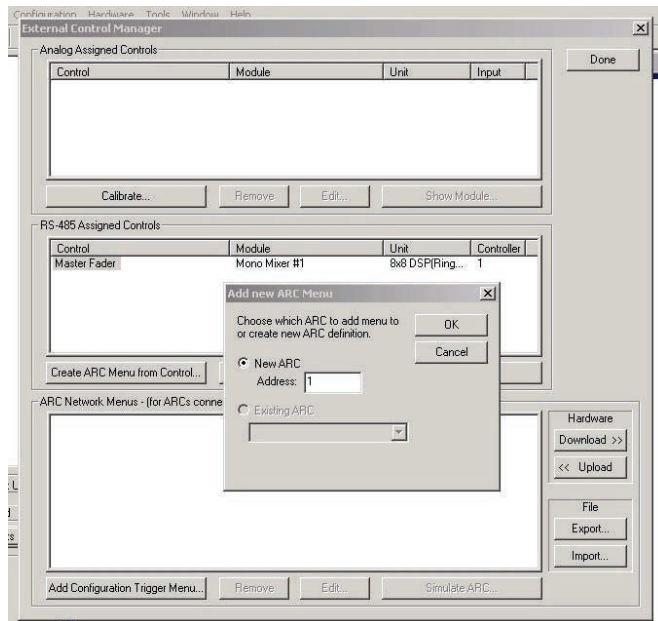


After the ARC has been added to the list of available hardware controllers, you need to set it up so that the parameter you assigned to the ARC shows up on the ARC's menu. The setup procedure for an ARC is done from the External Control Manager screen. You can launch the External Control Manager directly from the Assign Hardware Controller screen or from the Tools Menu.

Using the External Control Manager with an ARC

After opening the External Control Manager, you have the options of changing editing or removing RS-485 controlled parameters from the list in the middle of the screen, or creating and adjusting the ARC's menus, or setting up the ARC to control configuration changes.

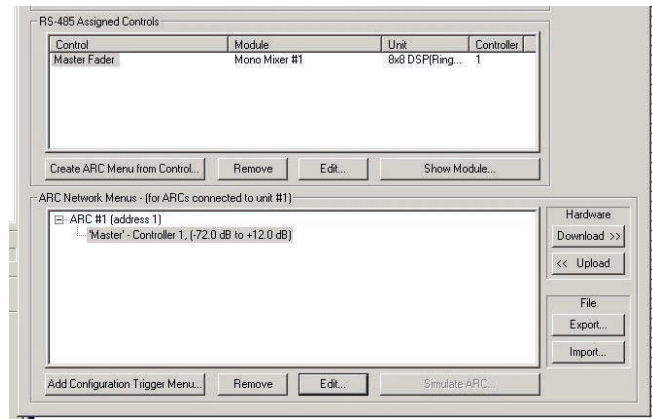
The list of assigned parameters shows up under the RS-485 Assigned Controls section of the External Con-



rol Manager. This is a list of all parameters to which external RS-485 controls have been assigned. By clicking on the name of the control in the list, you can edit the control to which it has been assigned, remove it, or create an ARC menu containing it, using the appropriate buttons.

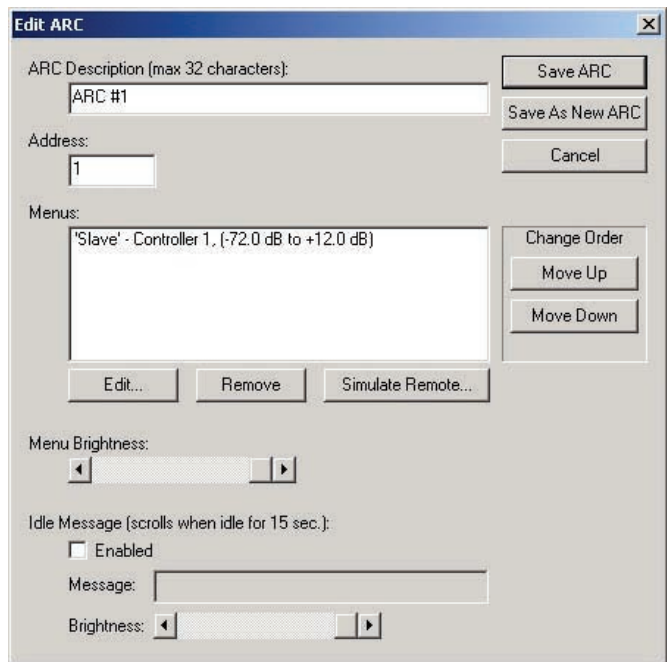
Under RS-485 Assigned Controls select Create ARC Menu from Control.....

Once you have created the ARC Network Menu, you can edit the basic setup parameters of a single ARC by highlighting the ARC device itself (the base of the tree) in the ARC Network Menu list, and hitting the Edit button below. This brings up a screen with various basic ARC functions.



The ARC Description is the name of the ARC as used by SymNet Designer. Edit this so the ARC appears as any name you desire.

Address: defines the physical RS-485 address of the



device to be edited. This should match the 5-pin dip switch on the ARC itself (encoded as binary).

The Menus: list shows the different parameters you have assigned to the ARC. You can edit or remove the menu, or simulate the ARC from the Menu section.

The Menu Brightness appears as a fader, this allows the ARC's display to be adjusted to ambient light conditions, and also saves power, if necessary.

The ARC also provides an option to add an Idle Message, which appears if the ARC buttons have not been pressed for 15 seconds. If the message is greater than 8 characters, it scrolls from left to right across the ARC's display. The brightness of this Idle Message is

separately controllable via a fader, such that the Idle Mode can be discreet, and/or save even more power.

Once all the changes to the ARC's main setup are made, they should be saved using the Save ARC button at the top right of the screen. All saved changes must still be downloaded into the device with the Download button in the External Control Manager screen.

Individual Menu items on each ARC can also be customized. To do this, highlight the appropriate Menu item from the ARC Network Menu list in the External Control Manager, and click Edit at the bottom of the list. This will bring up the Edit Menu dialog box.

From the Edit Menu dialog, several parameter specific changes can be made.

The Menu Name, (parameter name) can be edited, up to 8 characters in length.

The RS-485 Controller number can be edited. This is the actual parameter number, not the address of the ARC.

The menu item defaults to changing the actual control

parameter inside the SymNet with each press of the UP or DOWN button. To force the ARC to only send parameter changes at the end of operation, check the Don't accept changed value until "Select" button pressed option.

The Menu can also wrap around from high to low values (and vice versa) if the Wrap-around menu checkbox is checked. Not advised for gain faders, etc.

The Continuous Menu items have variable resolution, while Enumerated Menus allow specific values to be named and stored as a list of values.

Once all the menu items have been edited, they should be saved with the Save Menu button. This will take you back to the External Control Manager dialog box. At this point you can assign more controls, menus to assigned controls, or hit Download to send the menu information to the ARC.

When Downloading, the ARC will display "Download". This usually lasts a few seconds. Following this, the last state of the ARC will be restored (either Idle Message or the last menu item). At this point, the ARC may be used to control all the parameters assigned to it.

**ARC Power Supply (ARC-PS)**

The ARC-PS is a power supply and control signal patch bay for the ARC. It is a 1RU hardware device designed to allowed connection of multiple ARCs to a single SymNet box and a single power supply.

Power is delivered to the ARC-PS from a 9-15VDC, 2-3A supply. Either euro connector or coaxial power plug can be used, as they are wired in parallel. A rear panel LED indicates power has been applied to the ARC-PS.

RS-485 control connection from SymNet is via the rear panel RS-485 3-pin euro jack. Please wire A to A and B to B on the RS-485 connections.

Power and RS-485 data is sent to the ARCs via the 8 rear panel RJ45 connectors. Power is delivered on one pair of the CAT5 wires, ground return on the other. RS-485 data occupies one pair, with its own ground return. A standard CAT5 cable should be used.

The number of ARCs being powered off each RJ45 jack can vary from 1 to 4. With 1 ARC, the ARC-PS can supply power to ARCs located up to 1000ft (300 meters) away. However, distances decrease to a maximum of 300 feet (90 meters) for the entire chain if 4 are used.

The maximum number of ARCs powered from one ARC-PS depends on the power supply used and the current used by each ARC. This is a complex formula, but under all circumstances, at least 8 can be powered with the supplied power supply. For a macro-enabled spreadsheet, please contact Symetrix Technical Services Group.

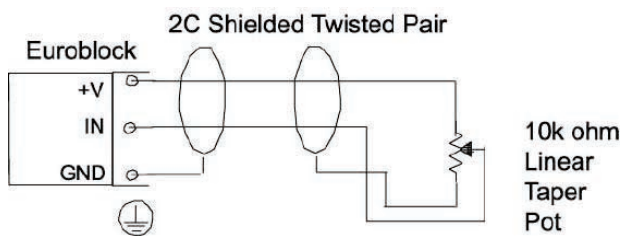
**Real Time External Control**

**Analog Control Inputs**

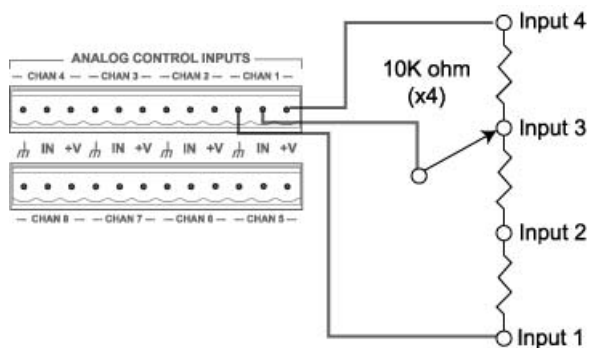
SymNet 8x8, 8in and 8out units have eight analog controllers that respond to 0-10 volts DC. A 10V reference voltage is available on the rear panel. You assign DSP module controls to these controllers by right-clicking the control and choosing Assign Hardware Control from the popup menu.

The external controller can be a pot (10k, linear is preferred), voltage selector switch, or an external DC voltage source that swings from 0 to +10Vdc.

**Typical Control Potentiometer Wiring**



**Typical Control Switch Wiring**



Typical 4 position external input source selector switch wiring using a single pole, four position switch.

**RS-232 & RS-485 (SymNet Control Protocol)**

**Introduction**

The purpose of this document is to provide a technical understanding of the Symetrix SymNet™ Command Protocol. It will define and illustrate the protocol used to communicate with the SymNet™ via a serial RS-232 or RS-485 interface.

SymNet™ 8x8, 8in, 8out and CobraLink™ units can be controlled by RS-232 based controllers such as certain AMX or Crestron models, or any RS-232 equipped device that can be adapted to this protocol. The protocol consists of humanly readable text commands

and responses.

Control is achieved by using the existing controller assignment system in SymNet™ Designer for RS-485 control over most processing parameters. Right-clicking on most faders and buttons of module views will allow assigning the parameter to an RS-485 controller. An appropriate controller number is assigned in the 1-1000 range then the design with the controller assignment is downloaded. At this point, the RS-485 or RS-232 interfaces, referencing the controller number can control the parameter.

Conventions used in this document

A dollar sign (\$) preceding a set of alphanumeric characters denotes a hex value. All other number values should be considered decimal values. **Example:** "\$A0" represents the decimal value of "160".

**General Notes**

Connections

The SymNet™ unit's RS-232 ports must be properly configured to accept the RS-232 Accessory Controller Protocol. See the section **RS-232 Port Configuration** for information on how to properly setup your units. For the sake of clarity the RS-232 port on the front of the SymNet™ will be referred to as the "Host PC Control Port" located on the front of the unit, and the "Accessory Remote Control Port" located on the rear of the unit. These names reflect the manner in which these ports are typically used.

Connect your RS-232 based accessory remote to the front or rear panel RS-232 connector as determined after reading the **RS-232 Port Configuration** section. For experimentation purposes, a terminal emulation program such as *HyperTerminal* included with *Windows* can be run on a PC instead. Typically this connection requires a "straight through" cable, but a null-modem cable may be required depending on the manufacturer. In general, if the sexes of the two connectors you are trying to connect are the same, a "null modem" cable is required. Set up the controller for baud: 38400, start bits: 1, stop bits: 1, parity: NONE. No handshaking or flow control is used.

RS-232 Port Configuration

As previously mentioned, SymNet™ 8x8, 8in, 8out and CobraLink™ units all have two RS-232 DB-9 connectors: one on the front and one on the rear. Typically, the front panel port is used for host PC control and the rear panel is used for accessory remote controller input. Alternatively, the rear panel jack can be used for host PC control in systems requiring a permanent host PC connection where exposed front panel wiring is not acceptable. But in this situation, accessory remote controllers should not be used.

In order to handle this situation and allow the operation of accessory controllers without the host PC, a master SymNet™ unit can be programmed to assign the host PC connection to either the front or rear panel jacks. This is done using the **Set Port** command and is fully described on page 11. This setting is done to non-volatile memory, and will be remembered through power cycles.

Future version of the SymNet™ Designer host PC application may have the ability to set the host PC override state from the PC itself. For now, you must use a terminal emulation program such as *HyperTerminal* or incorporate the code into the accessory controller program.

In addition to the **Set Port** command (see page 11), there are also two commands, **Set Quiet Mode** and **Set Echo** that affect the remote control RS-232 port. The unit's default settings (Quiet Mode ON, Echo OFF) are typical for most applications, so most users will not need to know about these commands. However, they are also documented for reference on page 12.

#### RS-232 Control

The RS-232 protocol is used to simulate the movement of a RS-485 controller by referencing the controller number and a new virtual position. As previously mentioned, controller numbers can be 1-1000. Controller positions are a 16 bit unsigned number providing a range of 0-65535. Try not to get confused! Even though the actual control interface may be over RS-232, what you are controlling is actually an RS-485 control number that has been mapped to a parameter as defined in your SymNet™ Configuration with the SymNet™ Designer program.

#### RS-485 Control

RS-485 control is generally done using one or more of the Symetrix ARC (Adaptive Remote Controller) units. Further discussion of RS-485 and the ARC can be found on the Symetrix web site.

### Parameter Notes

#### Faders

Faders in SymNet™ Designer can be controlled to the limits of their minimum and maximum values shown in the Module View Screens. A controller position of zero (0) will cause the minimum fader position to be realized. A controller position of 65535 will cause the maximum fader position to be realized. Increasing positions will move the fader linearly in dB.

Most volume faders in SymNet™ Designer have a range of -72dB to +12dB. In these cases, the following

formula can be used to convert from RS-485 controller position to dB:

$$\text{Volume dB} = -72 + 84 * (\text{CONTROLLER POSITION} / 65535)$$

If CONTROLLER POSITION = 0, Volume dB = OFF

Note that some faders have a different range than -72 to +12dB and future versions of SymNet™ Designer may allow further scaling and limiting the range of RS-485 controller values. In this case, the formula will depend upon the actual fader range. The more general formula is shown below:

$$\text{Volume dB} = \text{MINIMUM VALUE} + (\text{MAXIMUM VALUE} - \text{MINIMUM VALUE}) * (\text{CONTROLLER POSITION} / 65535)$$

Where MINIMUM VALUE is the fader's lower limit in dB and MAXIMUM VALUE is the fader's upper limit in dB.

#### Buttons

Buttons in SymNet™ Designer such as a mute or bypass can be controlled similarly with controller positions by sending the minimum value (0) to turn the switch off (button not pushed) and sending the maximum value (65535) to turn the switch on (button pushed).

#### Selectors

Controlling selectors can either be done by assigning a controller to the individual input buttons, or to the single input selector slider. It is recommended that the input selector slider be used because it allows reading back the current state whereas the buttons do not. A value of zero (0) will select the first input and a value of (65535) will select the last input. Other values are selected by sending evenly spaced (linear) values as shown by the formula below:

$$\text{Controller Value} = (\text{INPUT NUMBER} - 1) * 65536 / \text{NUMBER OF INPUTS}$$

#### Other Parameters

Many other parameters such as compression ratios, delay times, EQ settings and pans can also be controlled externally. In fact, almost any DSP parameter in SymNet™ Designer can be controlled. For other parameter types, as in the above examples, sending a value of zero (0) will set the parameter to its minimum value and sending a value of (65535) will set it to its maximum value. Ratios, frequencies, width/Q, and attack/release/hold times all use a logarithmic scale. Pans and delay times use a linear scale. Quantities expressed in dB such as gains, volumes, thresholds and depths are linear in dB.



Parameters that cannot be controlled externally

The following SymNet™ Designer features cannot be controlled externally. In some cases, workarounds are suggested.

Analog In/Out: All parameters

Oscilloscope: Trigger and Auto-Range controls

Parametric EQ: Flatten All and Octaves/Q buttons

Crossover: Slope and Filter Type (i.e. Butterworth/Bessel) buttons

Matrix: Mute All and Disconnect All buttons (use individual mute or disconnect buttons instead)

Mixers: Link buttons (assign same controller to all linked faders instead)

Stereo Mixer: L and R buttons (use pan slider instead)

LCR Mixer: L, C and R buttons (use pan slider instead)

**Getting Started**Protocol

The RS-232 Accessory Remote Controller Protocol is a text-based (ASCII string) protocol. Commands are sent with simple character strings with terms separated by spaces and completed with a carriage return character <CR> (ASCII decimal 13 or hex \$0D). There are only a few commands that most applications will need to use, and they are described in the following pages. The general form for commands is:

```
<COMMAND> <PARAMETER> <PARAMETER> ...
<CR>
```

A white space character (space, tab, etc.) **must** be included between the command and each parameter. Extra white space characters can be sent for readability if desired. In this document a single space will be used. If a command is accepted, the SymNet™ unit will respond to each command with an acknowledgement string whose syntax varies with each command.

**Control Commands**(CS) Control RS-485

Use this command to move a controller position to a new *absolute* value. This command is equivalent to the receipt of a controller position change from the RS-485 port. The command must specify the RS-485 controller number and the new controller position. The syntax of the command is:

```
"CS <CONTROLLER NUMBER> <CONTROLLER
POSITION><CR>"
```

Where <CONTROLLER NUMBER> is the decimal RS-485 controller number (1-1000) assigned in SymNet™

Designer, and <CONTROLLER POSITION> is a 16 bit number in decimal (0-65535).

If the command is accepted, the SymNet™ unit will respond with the string:

```
"ACK<CR>"
```

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

```
"NAK<CR>"
```

(CC) Change RS-485 Controller

Use this command to move a controller to a new *relative* value. This command will increment or decrement a controller by a specified amount. The command must specify the RS-485 controller number, whether it should be incremented or decremented, and the amount to change by. The syntax of the command is:

```
"CC <CONTROLLER NUMBER> <DEC/INC>
<AMOUNT><CR>"
```

Where <CONTROLLER NUMBER> is the decimal RS-485 controller number (1-1000) assigned in SymNet™ Designer, <DEC/INC> is 0 to decrement and 1 to increment, and <AMOUNT> is the amount to increment or decrement (a decimal number, 0-65535). If the amount to be decremented or incremented causes the parameter to exceed its minimum or maximum value, the value will be limited to its minimum or maximum value. For example, if you increment a parameter by 10 and its current value is 65530, the new value will be limited to 65535.

If the command is accepted, the SymNet™ unit will respond with the string:

```
"ACK<CR>"
```

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

```
"NAK<CR>"
```

A typical reason for failure is that the specified controller number is not controlling anything in the current design.

(GS) Get RS-485

This command will return the controller position (value) associated with a specific controller number. The command must specify the RS-485 controller number. The syntax of the command is:

```
"GS <CONTROLLER NUMBER><CR>"
```

Where <CONTROLLER NUMBER> is the decimal RS-485 controller number (1-1000) assigned in SymNet™ Designer. If the command is accepted, the SymNet™ unit will respond with the string:

"<CONTROLLER POSITION><CR>"

Where controller position is a 16 bit number in decimal (0-65535)

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

A typical reason for failure is that the specified controller number is not controlling anything in the current design.

If the value being requested is a button that only has two states, the returned values will be either 0 or 65535, regardless of the actual value sent to the controller. For example, assume controller number 1 controls a mute button. If you send "CS <1> <754>", and then "GS <1>", it will return 0, not 754. More generally, if the parameter you are controlling has granularity coarser than the 16-bit values used, the returned values will be quantized to the granularity of the parameter. Example controls where you might observe this effect are buttons as mentioned above, selector sliders and the 0-2ms delay slider. Note that for selectors, reading back the values of the input buttons does not work correctly.

If the same controller number is controlling multiple parameters in SymNet™, the value returned is the first one assigned by the user. Because of the confusion that may arise from this, it is recommended that every parameter controlled be given a unique controller number. If you would like a single user object (e.g. single slider) to control several different parameters (e.g. three different faders), then the combining of the controls should be done in the control system software.

#### (SV) Set Volume

This command will set the analog input or output volume of one or all inputs/outputs to the specified value. The syntax of the command is:

"SV <I/O NUMBER> <VOLUME><CR>"

Where <I/O NUMBER> = 1-8 for inputs (1-8), 101-108 for the outputs (1-8) or 0 for all inputs and outputs and gain value is a decimal value in dB ranging from -96.0 to 31.5. A value of -96.0 is equivalent to mute or OFF.

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

**Example:** "SV 104 -12.5<CR>" sets the volume of

output #4 to -12.5dB.

#### (GC) Get Configuration

This command will return the number of the currently running configuration. The syntax of the command is:

"GC<CR>"

If the command is accepted, the SymNet™ unit will respond with the string:

"<CONFIG NUMBER><CR>"

If a configuration is running, the <CONFIG NUMBER> return value will be 0-8. A return value of 0 indicates that the currently running configuration is not one of the 8 configurations saved in flash and has been downloaded by the host instead.

If the command is interpreted but fails for any reason or no configuration has been downloaded or triggered, the SymNet™ unit will respond with the string:

"NAK<CR>"

#### (LC) Load Configuration

This command will load and start running the specified configurations. The syntax of the command is:

"LC <CONFIG NUMBER><CR>"

Where <CONFIG NUMBER> = 1-8.

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

#### (SU) Set Unit

This command will cause all future commands to be redirected to the unit at the specified SymLink™ address. This redirection will persist until power cycling or the next **Set Unit** command. The **Set Unit** command can only be sent if you are physically connected to the Accessory Remote Controller Port of a SymLink™ Master Unit (Device Address of 1).

**NOTE:** This is the only command that includes a hex value number. The syntax of the command is:

"SU <\$UNIT ID><CR>"

Where <\$UNIT ID> is a unique identifier for each hardware device in a SymNet™ system. If the system consists of just a single SymLink™ ring, then the UNIT ID is simply equal to the unit's device address as set by the rear panel DIP switches.

If the system contains CobraLink™ units and multiple SymNet™ rings, the then UNIT ID combines the ring

number as set by the CobraLink's rear panel DIP switches and the device address.

Combining the ring number and device address is done according to the formula:

$$\langle \$UNIT\ ID \rangle = (\langle RING\ NUMBER \rangle - 1) * \$100 + \langle DEVICE\ ADDRESS \rangle$$

If only one ring is present, then the ring number is 1.

**Example Formulas: Actual Commands to Send:**

Ring 1, Device Address 1,  $\langle \$UNIT\ ID \rangle = \$001$  SU  
1<CR>

Ring 2, Device Address 3,  $\langle \$UNIT\ ID \rangle = \$103$  SU  
103<CR>

Ring 5, Device Address 7,  $\langle \$UNIT\ ID \rangle = \$407$  SU  
407<CR>

(Note that even though a (\$) is used in the above example formulas to indicate a hex value, you do not actually use the (\$) in the actual command sent, just the hex value as a decimal number.)

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

If you do not use the **Set Unit** command, changes to RS-485 controller positions will only be sent to the unit that you are physically connected to.

(FU) Flash Unit

This command momentarily flashes the front panel LEDs of the unit being addressed. This command can be used as a quick test to verify communications. The syntax of the command is:

"FU<CR>"

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

LEDs on units other than the one to which you are physically connected can be flashed by using the Set Unit command, as previously described.

## Setup Commands

### (SP) Set Port

The **Set Port** command is used to force the port that will be used for host PC communications. The port not used for the host is available for use by accessory controllers. But, in general, when both the host PC and accessory controllers are to be used, the host should be assigned to the front panel port. See the section on **RS-232 Port Configuration** (page 5) for a full description of the issues involved with this feature. The syntax of the command is:

"SP <PORT NUMBER><CR>"

Where <PORT NUMBER> is 0, 1 or 2.

The meanings of these values are as follows:

0 - Allow the port sensing algorithm to be used on power up to determine which port will be the host port. If a host PC connection is present at the front port on power up, then the front port will be used for Host PC Control. If a host PC connection is present at the rear port on power up, then the rear port will be used for Host PC Control. This setting requires that the hardware handshaking lines (RTS and CTS) be connected on your serial port cable.

1 - (DEFAULT) Force the front panel port to be used only for host PC communications. The rear port will be available for accessory controllers.

2 - Force the rear panel port to be used only for host PC communications. The front port will be available for accessory controllers, although this is generally not done.

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

The state programmed will be saved in non-volatile memory. It does not need to be continually set. It will not hurt the unit to be repeatedly set with the same value as it is only written if a different value is set. The new state will not be used until the next time power is cycled. Keep in mind that once programmed, to change the program, you will have to connect to the port currently programmed for the accessory controllers in order for commands to be accepted. If you do not get a response to a command, you should try the other port in case the port has been previously forced with this command.

### (SQ) Set Quiet Mode

The **Set Quiet Mode** command controls the text output of the control port during responses. When quiet mode is turned on, it restricts the output to just ACK, NAK or a single value. All command descriptions above assume that quiet mode is turned on. Quiet mode ON should be used when using a controller with RS-232.

When quiet mode is set to OFF, lengthy strings intended to be read by humans are sent in response to commands. This mode is useful when using a terminal program for testing or debugging.

The syntax of the command is:

"SQ <ON/OFF><CR>"

Where <ON/OFF> is 0 = OFF, 1 = ON.

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

"NAK<CR>"

The quiet mode state will be saved in non-volatile memory. It does not need to be continually set. It will not hurt the unit to be repeatedly set with the same value as it is only written if a different value is set. New units or units upgraded from previous firmware versions default to quiet mode ON.

### (EH) Set Echo Mode

The **Set Echo Mode** command controls the text output of the control port during commands. When echo mode is turned on, all characters that are received on the RS-232 port are sent or "echoed" back. This mode is useful when using a terminal program for testing or debugging.

When quiet mode is turned off, the characters received are not echoed back. All command descriptions above assume that echo mode is turned off. Echo mode OFF should be used when using a controller with RS-232.

The syntax of the command is:

"EH <ON/OFF><CR>"

Where <ON/OFF> is 0 = OFF, 1 = ON.

If the command is accepted, the SymNet™ unit will respond with the string:

"ACK<CR>"

If the command is interpreted but fails for any reason the SymNet™ unit will respond with the string:

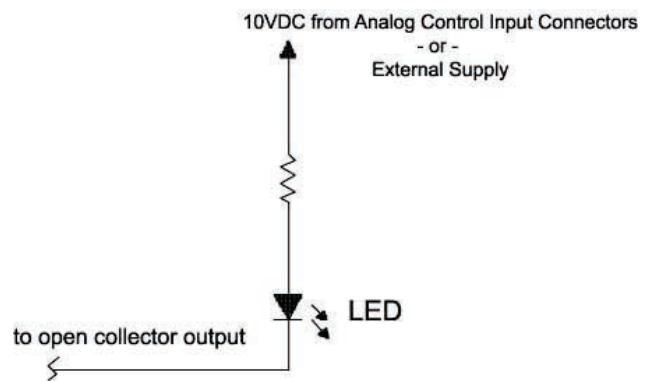
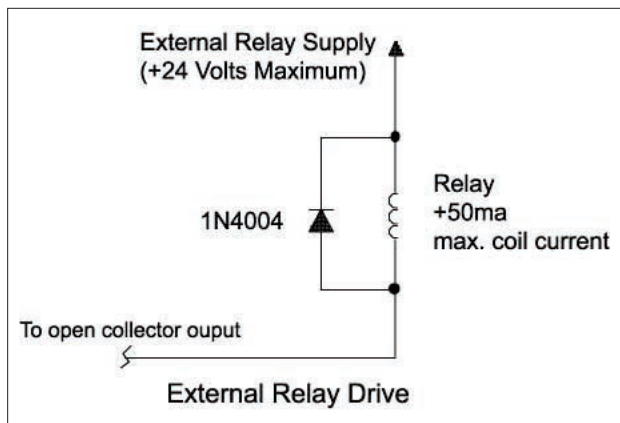
"NAK<CR>"

The echo mode state will be saved in non-volatile memory. It does not need to be continually set. It will not hurt the unit to be repeatedly set with the same value as it is only written if a different value is set. New units or units upgraded from previous firmware versions default with echo mode OFF.

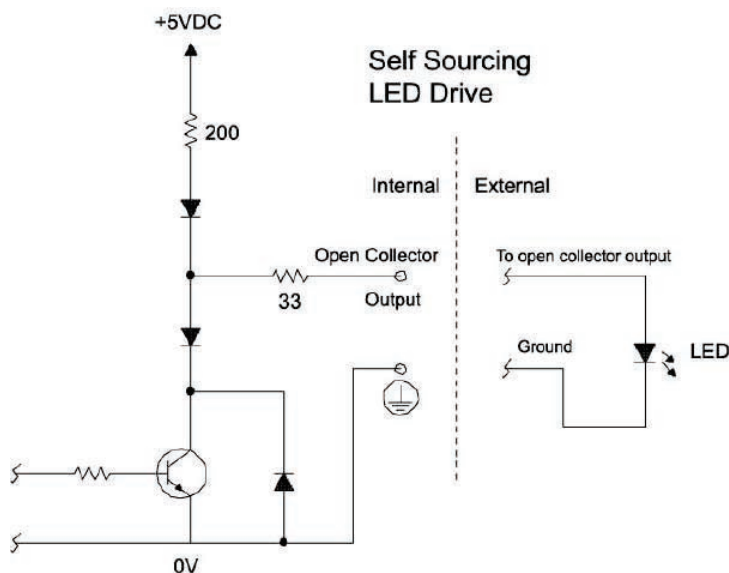
**Binary and Relay Outputs**

Outputs	Discussion	Remarks
Binary Outputs (x6)	Six NPN transistor outputs, cleverly wired to allow operation as open collector output for relay coil driving or for sourcing LED drive current. Collector and ground connections furnished. These outputs can also drive an LED directly. Current limit resistor not needed.	2N4401 transistors. Current must be < 50mA, 24V maximum. Control software determines how these are used. If you're driving a relay, be sure to include a reversed biased diode connected across the relay coil.  When driving a LED connect the LED from the output to ground.
Relay Outputs (x3)	Three SPDT relay contacts. Contact rating: 3A, 24VDC, resistive; 0.3A, 60VDC, resistive	SymNet Designer determines how these are used. Do not use at 120VAC.

**Typical Binary Output Connections**



External LED drive using external supply for more current.



## SymNet™ Designer

### Host Computer Requirements

- A 300 MegaHertz or faster PC with the Windows 95, 98, ME, or 2000 operating system.
- At least 10 megabytes of free disk space.
- 32 megabytes of RAM. We recommend at least 128 megabytes of RAM when using Windows 2000.
- An available serial port capable of operating at 57.6 or 115.2 kbaud.
- Your computer's video subsystem must be capable of operating at 1024x768 resolution using small fonts.
- A standard 9-pin serial cable to connect the PC to the SymNet hardware's front panel 9 pin RS-232 input.

### Software Installation

Use one of the following procedures to install the SymNet Designer on your Windows 98/ME/2000 computer:

#### From the SymNet Designer CD-ROM:

- The software should autorun after inserting the CD-ROM into your computer's CD-ROM drive.
- If the software does not autorun, then Click on the Start button, Run d:\setup (if your CD-ROM drive isn't d:, then substitute its drive letter)

#### From the Symetrix Website (<http://www.symetrixaudio.com>):

- 1) Download the SymNet Designer program file.
- 2) From the Start button, Run the file/program that you just downloaded to start the Setup program.

The software always starts up in offline mode. Regardless, you can explore the software, experiment to your heart's content, and perhaps even get useful work done. You can save any configurations that you create to a file that can be downloaded later into a SymNet hardware system.

#### Serial Communication

- Your computer's serial port must be capable of operating at 57600 baud or at 115200 baud.
- Use 8N1 protocol.
- Connect from your computer's RS-232 output to the RS-232 front-panel input of the SymNet hardware. If you are connecting to a SymNet ring

with multiple hardware units be sure to connect to the master unit.

- If your computer is communicating with the SymNet hardware the yellow SERIAL COMM LED(s) on the SymNet hardware front panel flashes.

### Finding and modifying your serial (COM) port settings

SymNet requires a serial port on the host computer for communications.

- 1) Click Start, Settings, Control Panel.
  - 2) From the Control Panel screen, locate the System icon and left doubleclick it.
  - 3) Find the Device Manager tab.
  - 4) Locate the Ports icon and left doubleclick it.
  - 5) The device manager now displays the ports used by the computer and their assignments. Clicking on any of them displays additional information. If you have a modem, you may need to go back to step 4, locate the Modems icon, and doubleclick it to see its COM port assignment. Sometimes your mouse may also use a serial port.
- Remember the port number of an unassigned serial port for use with SymNet. You will need to specify this in SymNet Designer's File Preferences window.

### Wire Logic

#### Wire Components

- Wires can be used either to make logical connections between a single signal source with one or more signal destinations or as a drawing tool for aesthetics.
- Wires consist of two or more wire nodes with more sequential line segments connecting them.
- The width of the line segments can either be one, two or three pixels as set in the preferences.
- Wire nodes at the end of a wire will always be visibly represented with a small square.
- Wire nodes in the middle of a wire will be invisible unless selected, or if any node on the wire is currently being drawn or edited.
- When visible, wire nodes in the middle of a line will be represented with a small ball.
- When selected a visible wire node will be red, otherwise it will be black.
- When a wire node is actively being edited, gray

crosshairs will appear radiating from each selected wire node.

- A wire node can be selected by clicking on it.
- A wire node can be unselected by clicking on it with the 'Ctrl' key pressed.
- When selecting a node, all other selections will be lost unless the "Ctrl" key is held down when the left mouse key is pressed.
- A wire's line segments are red when the wire nodes at both ends of a given segment are selected.
- Clicking on, or within five pixels of a wire's line segment will select the wire nodes on both ends of the segment.

### Hot Spots

- Hot spots are the small OPEN squares drawn on objects and used to indicate that a wire is commonly connected to the object at that point.
- Hot spots do not necessarily imply that a logical signal connection is to be made within the SymNet hardware.
- The Hot spots on modules, super-modules, bus sends, bus returns, CobraNet bundle sends, and CobraNet bundle returns always imply a logical connection can be made.
- The Hot spots on units, pictures, and External Devices never imply a logical connection can be made.

### Wire Drawing

- The drawing of a wire can be initiated by clicking on the hot spot of any object that has hot spots.
- The drawing of a wire can be initiated by right clicking on open screen area in a configuration view, design view or super module view and selecting the "Start Wire" item from the menu.
- The drawing of a wire can be initiated by right clicking on an existing wire anywhere but at the ends of that wire and selecting the "Start Wire" item from the menu.
- The drawing of an existing wire can be continued by right clicking on the end nodes of the wire and selecting the "Continue Wire" item from the menu.
- When drawing a wire, the last wire node at the

active drawing end of the wire will be selected.

- When drawing a wire, the last wire node at the active drawing end of the wire will move with the cursor without the mouse button being pressed.
- When drawing a wire, the selected node can be dropped at a specific location and a new selected node be added to the end of the wire by left clicking with the mouse at the desired location.
- When starting a new wire where a node does not already exist, a new node will be made on that existing wire.
- When drawing a wire, the crosshairs will disappear from the selected node while the mouse button is pressed to promote proper user operation.
- The exact placing of new wire nodes will be aligned to a 10 x 10 grid if the "Snap to Grid" option is selected in the 'Tools' menu.
- The exact placement of new wire nodes is limited to an orthogonal direction from the previously placed node if the 'No Diagonal Wires' option is selected in the 'Tools' menu.

### Terminating Wire Drawing

- The drawing of a wire can be terminated by right clicking with the mouse.
- The drawing of a wire can be terminated by hitting the "Esc" key.
- The drawing of a wire can be terminated by changing the window focus to a different window.
- When the drawing of a wire is terminated, the last node actively being moved will be deleted.
- When the drawing of a wire is terminated, wires with only one node will be deleted.

### Completing Wire Drawing

- When the active node at the end of a wire being drawn is placed at a hot spot of an object, the node is first fixed at that location and wire drawing is terminated.
- When an active node at the end of a wire being drawn is placed at any node or within five pixels of any line segment, the node is fixed at that location and wire drawing is terminated with the node remaining.



## Logical Connections

- Logical Connections are the implication that an actual signal in hardware will be connected by the presence of a wire connecting a single signal source to a single signal destination.
- Wires only make logical connections in a unit's design view or a super-module's view.
- Wires can be used for aesthetic purposes in configuration views or, design views or super-module views.
- If two signal sources are graphically connected by a wire, no logical connection will be made, and no wires that connect to this wire will result in a logical connection.
- The presence of wires, which connect two signal sources together, will show as errors when the Analyze feature in the 'Tools' menu is used.
- If two signal destinations are graphically connected, no logical connection will be made, unless an additional wire connects from this wire to a signal source.
- The presence of wires, which connect two signal destinations together, and are not connected to a signal source through an additional wire, will show as errors when the Analyze feature in the 'Tools' menu is used.
- Only one logical connection can be achieved with a single wire.
- Additional wires are required if a signal source is to be connected to multiple signal destinations.
- Two wires are only logically connected if they meet at the end of one of the wires.
- Since the end of a wire is indicated with a square symbol, it is easy to see where logical connections are being made.
- The actual logical connections made by all wires in a site can be displayed using the 'Update and View Netlist' item in the 'Tools' menu.
- When a wire end is logically connected to another wire through drawing or editing, where there is not already a wire node, a new wire node will be created at the junction.
- Logical connections will not actually be implemented until the design is downloaded to hardware.

## Editing Wires

- Line segments of wires can be edited by selecting the nodes at both ends of the segment.
- A single wire node can be edited.
- Any combination of wire nodes in one or more wires along with other objects can be simultaneously edited by multiply selecting as desired.
- To edit one or more wire nodes, the nodes are selected and dragged with the left mouse button depressed.
- The selected wire nodes will show crosshairs while being dragged to aid in placement.
- When a wire node is dragged within five pixels of a line segment, a new node will be created on the line segment and located at the new edited position of the dragged node, consistent with the current snap setting.
- An entire wire can be deleted by right clicking anywhere on the line and selecting 'Delete Wire' from the menu.

**Menu Bar**

*File menu commands*

New	Creates a new document.	Use this command to create a new Site File in SymNet Designer. SymNet Designer supports multiple open site files. You can open an existing Site File with the <b>Open</b> command. <b>Shortcuts</b> Toolbar: Keys:CTRL+N
Open	Opens an existing document.	The following options allow you to specify which file to open: <b>File Name</b> Type or select the filename you want to open. This box lists files with the extension you select in the List Files of Type box. <b>Files of Type</b> Select the file type *.sym. <b>Drives</b> Select the drive in which SymNet Designer stores the file that you want to open. <b>Directories</b> Select the directory in which SymNet Designer stores the file that you want to open.
Close	Closes an open document.	Use this command to close all windows containing the active site. SymNet Designer asks if you want to save changes to your document before you close it. If you close a document without saving, you lose all changes made since the last time you saved it. Before closing an untitled document, SymNet Designer displays the <b>Save As</b> and suggests that you name and save the document.
Save	Saves an open document using the same file name.	Use this command to save the active document to its current name and directory. When you save a document for the first time, SymNet Designer displays the <u>Save As dialog box</u> so you can name your document. If you want to change the name and directory of an existing document before you save it, choose the <u>Save As command</u> . <b>Shortcuts</b> Toolbar: Keys:CTRL+S
Print	Prints the currently focused (top) window.	
Print Preview	Displays the currently focused (top) window on the screen as it would appear printed.	
Print Setup	Selects a printer and printer connection.	

1 <i>Recently_ Save_File_ 1.sym</i>	Opens the named recently saved file.	
2 <i>Recently_ Save_File_ 2.sym</i>	Opens the named recently saved file.	
3 <i>Recently_ Save_File_ 3.sym</i>	Opens the named recently saved file.	
4 <i>Recently_ Save_File_ 4.sym</i>	Opens the named recently saved file.	
Preferences...	Set preferences to be saved with <u>Site File</u> for AutoSave, Communications, Downloading, and Graphics.	<p><b>AutoSave</b> Check the box to enable automatic saving of your current <u>Site File</u>. Specify the interval (in minutes) between automatic saves.</p> <p><b>Communications</b> Communications between a host PC and a SymNet ring may be via an RS-232 serial connection between the host and the SymNet ring or it may be via EtherNet if the ring contains a CobraLink unit.  If the host is not connecting to a SymNet ring but is simply connecting to a single SymNet unit such as an 8x8 then the connection must be via RS-232.  Select either <i>CobraNet</i> or <i>Serial Port</i> communications. If Serial Port is chosen then select a baud rate that your computer supports (either <i>57,600</i> or <i>115,200</i>). Your SymNet hardware units must also be set to communicate at the same rate. <i>See the section on hardware installations and setup in this Help Module for a discussion of how to set SymNet hardware rear panel DIP switches for the proper baud rate.</i>  Select the appropriate COM PORT (<i>COM1, COM2, COM3 OR COM4</i>).  SymNet 8x8, 8in, 8out, and CobraLink units all have front panel SERIAL COMM yellow LEDs that indicate communications activity with the host PC. If you are having trouble communicating with SymNet make sure that your computer and the SymNet hardware are set for the same baud rate (either <i>57,600</i> or <i>115,200</i>) and your computer COM PORT is the same as specified in this section.</p> <p><b>Downloading</b> <i>Save design before downloading</i> - Checking this box guarantees that the downloaded design can be matched to a SymNet site file on the computer at a later time.  <i>Confirm all downloads and uploads</i> - Checking this box causes SymNet Designer to ask for confirmation before proceeding to overwrite the current program in either SymNet hardware memory or PC memory.</p>

Preferences... <i>(continued)</i>		<p><b>Graphics</b></p> <p><i>Return Colors to Defaults</i> - Selecting this function reverses any color changes you may have made in your design and returns them to the SymNet Designer default settings.</p> <p><i>Wire Line Width</i> - Select either <i>1 Pixel</i>, <i>2 Pixel</i>, or <i>3 Pixel</i>. This is the wire thickness that appears both on screen and in print. The SymNet Designer default is <i>1 Pixel</i>.</p> <p><i>Offset Paste/Duplicate from Original</i> - When pasting duplicates it is desirable to offset the duplicate from the original so that the original is not 'buried'. The SymNet Designer default is <i>an Automatic</i> offset, but if you wish, you may specify custom horizontal and vertical offsets in multiples of 10 pixels.</p>
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*Edit menu commands*

<u>Undo</u> (Ctrl+Z)	Reverses the previous editing operation.	Use this command to reverse the last editing action, if possible. In parentheses following <i>Undo</i> is a number indicating the remaining number of actions that may be undone.  <b>Shortcuts</b> Keys:CTRL+Z or ALT-BACKSPACE
Redo (Ctrl+Y)	Reverses the previous Undo operation.	
Cut (Ctrl+X)	Deletes data from the document and moves it to the clipboard.	<p><b>Cut command (Edit menu)</b></p> <p>Use this command to remove the currently selected data from the document and put it on the clipboard. This command is unavailable if there is no data currently selected.</p> <p>Cutting data to the clipboard replaces the contents previously stored there.</p> <p><b>Shortcuts</b></p> <p>Toolbar:</p> <p>Keys:CTRL+X</p>
Copy (Ctrl+C)	Copies data from the document to the clipboard.	
Paste (Ctrl+V)	Pastes data from the clipboard into the document.	
Delete (Del)	Deletes the selected components, wires, external devices, pictures, and text in the active window.	
Select All	Selects all components, wires, external devices, pictures, and text in the active window.	

Duplicate (Ctrl+D)	Duplicates and pastes the selected components, wires, external devices, pictures, and text in the active window.	
Load Design Settings...	Loads a specific setting into the current configuration. The existing configuration will be overwritten.	
Save Design Settings...	Saves the current configuration settings to either a new configuration in the current site file or a settings file.	
Label...	Adds user defined text to the selected wire, module, external device, or picture.	

### View Menu Commands

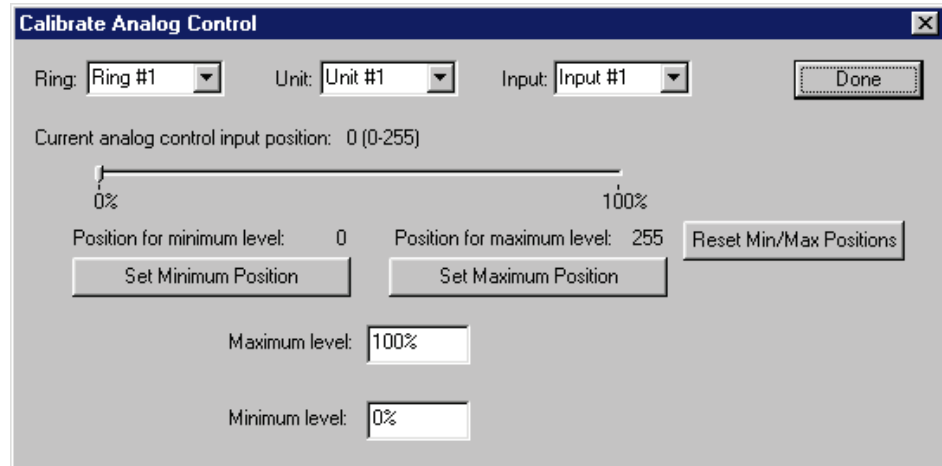
Toolbar	Toggles on or off the graphic toolbar directly underneath the Menu Bar.
Status Bar	Toggles on or off the status bar at the very bottom of the SymNet Designer Window. The status bar displays DSP usage, on or off-line status and baud rate.
Meter Bar (F7)	Toggles on or off the Meter Window.
Tool Kit (F8)	Toggles on or off the Design Tool Kit.
Browser (Ctrl+F8)	Toggles on or off the site browser.
Bring Module Views to Top (Ctrl+F7)	Expands the window of any module(s) whose views have not been closed.
Zoom In (2x) (+)	Expands the design window to twice normal resolution.
Normal (1x) (=)	Returns the design window to normal (default) resolution.
Zoom Out (.5x) (-)	Contracts the design window to half its normal resolution.

### Configuration Menu Commands

Import...	Imports a single, previously saved configuration (*.cfg) into the current site.
Export...	Exports the current configuration to a file (*.cfg).
Clear	Removes all DSP and CobraLink units from the current configuration.
Rename...	Allows naming or renaming of the current configuration.
Triggers and Power On Default...	Opens a dialog which allows configuration triggering (via RS-485 or SymNet analog control inputs) and setting the default power on configuration.
#1 - Configuration1	Brings Configuration1 into the active design window.
#2 - Configuration2	Brings Configuration2 into the active design window.
#3 - Configuration3	Brings Configuration3 into the active design window.
#4 - Configuration4	Brings Configuration4 into the active design window.
#5 - Configuration5	Brings Configuration5 into the active design window.
#6 - Configuration6	Brings Configuration6 into the active design window.
#7 - Configuration7	Brings Configuration7 into the active design window.
#8 - Configuration8	Brings Configuration8 into the active design window.
Download Configuration # n (F5)	Downloads only the selected configuration to SymNet hardware.

**Hardware Menu Commands**

Recall Configuration...	Opens a dialog window which displays the configurations currently stored in hardware. Selecting and RECALLing then uploads the selected configuration to the current configuration window in SymNet Designer.
Calibrate Analog Controls..	Opens a dialog window used to calibrate external control potentiometers connected to the analog control inputs of any networked SymNet 8x8, 8in and 8out hardware units.



**Introduction** The Calibrate Analog Control dialog box allows you to determine the way the 0-10V analog control inputs affect SymNet Designer parameters. There are two separate areas that you may which to alter:

1. You can compensate for pots that don't get all the way down to zero volts or all the way up to 10V. This could happen because of characteristics of the pot itself, or resistance in the connection between the pot and SymNet especially with long wire runs. This is referred to as "Calibrating pot range" below.
2. You can limit the range of parameters controlled by an analog input. This is referred to as "Calibrating control range" below.

**Connection** To connect a pot to SymNet, wire the wiper (usually center) terminal to the IN connector on the back of the SymNet. Wire the other two terminal to the +V and GND connectors. [INSERT DIAGRAM HERE IF WE HAVE ONE.]

It is also possible use an external voltage control source with SymNet by connecting it to the IN connector. Make sure the external voltage source outputs voltages in the range of 0-10V and is at the same ground potential (usually done by tying the grounds of the two devices together).

**Choosing the input to calibrate** Note: you must be connected to hardware and be on-line to use this dialog box.

First, choose the Ring number and Unit number for your SymNet unit using the drop-down lists at the top of the Calibrate Analog Control dialog box. For systems with just a single SymNet unit, leave Ring and Unit both set to one. Otherwise, adjust to match your hardware set-up.

	<p>Next, select the analog control input number (1-8) using the Input drop-down list. This setting should match the control input of the pot you are calibrating. If a pot is connected and the settings are correct, you should be able to turn the pot and notice the small indicator moving along the Current analog control input position line. The value of the pot (0-255) is also updated to show the current level generated by the pot. Zero represents GND or 0V, 255 represents +10V, and the range is linear.</p> <p><b>Calibrating pot range</b> To compensate for a pot that doesn't travel the entire range, make sure the pot is connected to the one of the 8 analog control input ports and the correct input is selected as described above. Turn the pot to its minimum value (usually all the way counterclockwise). Click the Set Minimum Position button. Next, turn the pot to its maximum value (usually all the way clockwise). Click the Set Maximum Position button.</p> <p>Note that you can use these settings to compensate for a reverse-wired pot. If you want to reset the calibration, click the Reset Min/Max Positions and they will be returned to their defaults.</p> <p><b>Calibrating control range</b> You can limit the range of a SymNet Designer control that is being controlled by an analog control input. For example, if a pot is controlling a volume fader, you may only want to allow the fader to go from -30dB to 0dB rather than the full -72dB to +12dB range allowed in the software. To limit the upper range of a control, enter a value less than 100% for the maximum level. To limit the lower range of a control, enter a value greater than 0% for the minimum level. When set to 100% and 0%, the control is allowed to travel the entire range shown in the SymNet designer control screen. Other values reduce this range accordingly. Some experimentation may be required to find the percentage values that limit a range appropriate for your application.</p> <p>Note that by setting the minimum value to a number larger than the maximum value, you can reverse the operation of the pot or compensate for a reverse-wired pot. If you want to reset the calibration, enter 100% for the maximum level and 0% for the minimum level.</p> <p><i>Note: If you want to reset all analog calibration data for a unit, this can be done using the Erase Memory command found under Hardware-&gt;Upgrade Firmware. Select only "Analog Calibration data" and hit ERASE.</i></p> <p>Important: All settings made using this dialog box are stored in the hardware, not in the site file. Changes made take effect immediately without the need to download the entire site.</p>
Set Clock...	Sets the current date and time for the real time clock in all networked SymNet 8x8, 8in and 8out hardware units.
Security...	Opens a dialog window used to set DEFAULT POWER ON security settings as well as security settings for a SUPERVISOR and four USERS.
Debug Hardware...	Use only as instructed to by the SymNet Technical Support Group for SymNet Engineering Group.
Upgrade Firmware...	Opens a dialog window used to upgrade firmware for both DSP and CobraLink units.

Upgrade Firmware... (continued)	<p><b>IMPORTANT:</b> In order to run SymNet Designer with hardware, the firmware in your hardware devices must match that expected by SymNet Designer. Whenever you install a new version of SymNet Designer, you should determine if firmware also requires updating. If so, the firmware must be upgraded before using SymNet Designer with the hardware.</p> <p><b>Basic definitions, i.e. What is firmware?</b> Firmware is code that runs on SymNet hardware devices. It is stored in the flash memory inside SymNet hardware devices. SymNet firmware consists of two different components, the Microprocessor file and the FPGA file. See <a href="#">“Why are there two different files?”</a> below for more information.</p> <p>Firmware <i>files</i> are stored on your PC's hard drive. They are copied to the hard drive by running the SymNet Designer set-up utility (also known as the installer). Upgrading firmware is the process of downloading the files from your PC's hard drive to your SymNet hardware devices.</p> <p><b>Do I need to upgrade firmware?</b> When you install a new version of SymNet Designer, the ReadMe file provided should tell you the version of firmware included in that release. If that version is newer than the version running in your hardware device(s) for either component, upgrading is required.</p> <p><b>Interpreting SymNet Firmware Filenames</b> Another way of determining the firmware version installed by the installer is to look at the files contained in the Upgrade directory of your SymNet Designer installation. This is typically located in C:\Program Files\Symetrix\SymNet Designer 1.1\Upgrade. The filenames of the files there indicate the type of firmware and firmware version number. This can be interpreted as follows:</p> <p><u>SN M v1101 .bin</u></p> <p>The first two letters indicate the hardware device for which the file is intended. <i>SN</i> indicates that it is for SymNet DSP or all SymNet family devices. <i>CL</i> indicates that it is for CobraLink devices only. <i>SD</i> indicates that it is for SymNet DSP devices only.</p> <p>The third letter is either <i>M</i> or <i>F</i> and stands for <b>M</b>icroprocessor file or <b>F</b>PGA file respectively. See <a href="#">“Why are there two different files?”</a> below for more information.</p> <p>The <i>v</i> indicates the start of the version number and the following 4 characters are the version number of the firmware file. The number is interpreted with the decimal point between the first and second digits, e.g. v1101 = version 1.101. The 3 character extension an additional indicator of the type of file. <i>.bin</i> files are Microprocessor files and <i>.bit</i> files are FPGA files.</p> <p>For example “SNMv1101.bin” indicates a SymNet Microprocessor file, version 1.101.</p> <p><b>Determining the current Firmware version for your devices</b> You can determine the current version of the firmware components of your hardware devices using SymNet Designer. You must have your hardware device(s) connected and powered on for this to work.</p> <p>In SymNet Designer, choose Hardware -&gt; Upgrade Firmware. The dialog that appears will tell you the current version of the firmware in your hardware devices. If you have more than one device, view each one by changing the Ring and Address. Note the version number listed after “Current Version” for both the Microprocessor file and the FPGA file. If either of these files is older than the version provided in the most recent installer, it must be upgraded. See <a href="#">“Upgrading Firmware”</a> below for step-by-step instructions.</p> <p>What if I'm still not sure if I need an upgrade? If you are still unsure if an upgrade is required, then go ahead and do the upgrade using the highest numbered files in your Upgrade directory. It will not hurt to do an unnecessary upgrade. See <a href="#">“Upgrading Firmware”</a> below for step-by-step instructions.</p>
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<p>Upgrade Firmware... <i>(continued)</i></p>	<p><b>Why are there two different files?</b> SymNet firmware has two components, the microprocessor file and the FPGA file. They are generally independent and both may need upgrading.</p> <p>The microprocessor file contains the code that SymNet's embedded microprocessor runs. This microprocessor is responsible for communicating with the host, managing the DSPs, external control, and many other tasks. The microprocessor file is common to all SymNet DSP devices and CobraLink devices.</p> <p>The FPGA (Field Programmable Gate Array) file controls the programmable logic devices used in SymNet. These devices manage the SymLink bus, facilitate DSP communication, and several other tasks.</p> <p>The FPGA file is common to all SymNet DSP devices (i.e. 8x8, 8 In, 8 Out). However, a different file is required for CobraLink devices. The file intended for SymNet DSP devices is prefixed with SD, e.g. SDFv1100.bit. The file intended for CobraLink devices is prefixed with CL, e.g. CLFv2001.bit. SymNet Designer checks the file contents to prevent you from using the wrong type of FPGA file.</p> <p><b>Upgrading Firmware</b></p> <ol style="list-style-type: none"><li>1. Launch SymNet Designer.</li><li>2. Connect your hardware devices as they would be for normal operation. During the upgrade, it is recommended you disconnect or power down all audio sources, amplifiers, and speakers connected to SymNet.</li><li>3. In SymNet Designer, choose Hardware -&gt; Upgrade Firmware. The dialog that appears will tell you the current version of the firmware in your hardware devices and allow upgrading</li><li>4. If your microprocessor file requires upgrading, click the Upgrade button under SymNet Microprocessor file. An open file dialog will appear allowing you to navigate for firmware files. By default it should take you into the C:\Program Files\Symetrix\SymNet Designer 1.1\Upgrade folder. Select the most recent file named SNMvXXXX.bin (where XXXX is the firmware version) and click Open.</li><li>5. If your FPGA file requires upgrading, click the Upgrade button under SymNet FPGA file. An open file dialog will appear allowing you to navigate for firmware files. By default it should take you into the C:\Program Files\Symetrix\SymNet Designer 1.1\Upgrade folder. For SymNet DSP units, select file named SDFvXXXX.bin (where XXXX is the firmware version) with the highest version number and click Open. For CobraLink units, select file named CLFvXXXX.bin (where XXXX is the firmware version) the highest version number and click Open.</li><li>6. If you have more than one SymNet device, select each device using the Address dropdown at the top of the dialog box and repeat steps 4-5.</li><li>7. If you are using CobraLink and have more than one ring, also repeat steps 4-5 for all devices on all rings using the Ring dropdown at the top of the dialog box.</li><li>8. When finished, click Close.</li></ol> <p>Current Versions As of this writing, the current versions of the SymNet firmware are as follows:</p> <p>SymNet Family Microprocessor file: Version 1.101 SNMv1101.bin FPGA file for SymNet DSP Devices: Version 1.100 SDFv1100.bin FPGA file for SymNet CobraLink Devices: Version 2.001 CLFv2001.bin</p>
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Mute All Outputs (F2)	Mutes or unmutes all analog outputs of all networked SymNet 8x8 and 8out hardware units.
Download Entire Site File (F4)	Writes all eight configurations from the current site file on the PC to non-volatile memory in the connected SymNet hardware.
Upload Entire Site File	Uploads the site file stored in SymNet hardware to the PC. You must close any open site file on the PC before attempting to upload from hardware.

**Tools Menu Commands**

SymLink Bus Manager...	Opens the SymLink Bus Manager dialog window which allows for creation, editing, or deletion all SymLink buses in the currently displayed configuration.
CobraNet Bundle Manager...	Opens the CobraNet Bus Manager dialog window which allows for creation, editing, or deletion all CobraNet buses in the currently displayed configuration.
Control Screen Manager...	<p>Opens the Control Screen Manager dialog window which allows for creation, editing, deletion or viewing of all Control Screens in the currently displayed configuration.</p> <p>The Control Screen Manager shows all available Control Screens in the Configuration File. It allows new screens to be added (they can also be added by dragging from the design toolkit), existing screens to have their names edited, and screens to be deleted. It also offers a quick way to view each screen.</p> <p>Another feature is the ability to display one or more screens when the SymNet Designer application is opened.</p> <p>An Override password allows the installer to set a password which enables access to all system parameters. If this password is set and enabled, then the control screens are the only way for normal users to operate the system.</p>
Super-module Manager...	Opens the Super Module Manager dialog window which allows for deleting, exporting, importing or renaming of all Super Modules in the currently displayed configuration.
Event Scheduling Manager...	Opens the Event Scheduling Manager dialog window which allows for adding, deleting, or editing of all scheduled events (relay, open collector, configuration) in the currently displayed configuration.
Output Switch Manager...	Opens the Output Switch Manager dialog window which allows setting (for the currently selected configuration) the states of the three relays and six opto isolators in the currently selected hardware unit.
External Control Manager...	Opens the External Control Manager dialog window which allows for adding, deleting, or editing of external analog, RS-485, and SymNet ARC controllers.
Presets Manager...	Opens the Presets Manager dialog window which allows for preset recall, preset module viewing, removing presets, copying the selected preset to another preset, renaming presets, creating and editing notes for each preset, and clearing all presets.
Update and View Netlist	Displays and/or updates a window showing netlist connections for the currently selected configuration file.
Edit Mode (F9)	Toggles editing ON or OFF. When toggled OFF the currently selected configuration cannot be edited.
No Diagonal Wires (F10)	Toggles ON or OFF the use of diagonal wires in the currently selected configuration.
Show Grid (F11)	SHOWS or HIDES the design grid in the currently selected configuration.
Snap to Grid (F12)	Forces wires to only pass through grid lines and not between grid lines.

Analyze (Ctrl+A)	Opens the Analyze dialog window which (selectively) places error symbols in the schematic to indicate open module inputs, open module outputs, and shorted module outputs in the currently selected configuration.
Clear Error Symbols (Ctrl+E)	Immediately clears all error symbols in the currently selected configuration.
<b>Window Menu Commands</b>	
Cascade	Creates a cascaded view of all open windows.
Tile	Creates a tiled view of all open windows.
Arrange Icons	Neatly groups the icons of minimized windows along the bottom of the main design frame.
1 Site name Configuration number : "Configuration Name"	A listing of all open (both minimized and maximized) windows. Selecting a number from 1 to n opens the selected window (if it has been minimized) and places it on top of all other open windows.
2 Site name Configuration number : "Configuration Name"	
3 Site name Configuration number : "Configuration Name"	
4 Site name Configuration number : "Configuration Name"	
n Site name Configuration number : "Configuration Name"	
<b>Help Menu Commands</b>	
Help Topics	Opens the On-screen HTML Help Module.
Contents...	Displays Help Module table of contents.
Index...	Diplays the Help Module Index.
About SymNet Designer...	Displays the application version number of the SymNet Designer you are viewing.

## The Toolkit

### *Configuration View*

#### SETTINGS

The Settings section in the Design Toolkit is used in conjunction with the Settings File Manager.

Settings are a list of module or device parameter values. They can be saved on a module or a device basis. They are useful for copying pre-existing modules or duplicating settings from one device to another.

Once a Settings file has been named in the Settings File Manager, it will appear in the design toolkit list, at both the Configuration View level and the Design View level.

In Design View level, after right clicking on a SymNet device, you can load or save those device's design settings to either a Configuration file or to a Settings file. Similarly, in Design View level, after right clicking a module that contains user variable parameters, you are given the option of loading or saving those parameter values.

#### CONTROL SCREEN VIEWER

The Control Screen Viewer contains a list of Control Screens for SymNet Designer.

Controls Screens provide a way to simplify and condense the SymNet user interface, so, for example, the user is limited to a range of controls, and will not have to and/or be allowed to adjust certain parameters in the system.

To add a Control Screen at the Configuration View or Design View level, simply select Blank Control Screen from the design toolkit and drag onto the appropriate view space.

You can add External Devices, Pictures and Text to the Control Screen by dragging from the design toolkit onto the Control Screen.

To add controls and displays from modules, you need to open to module contain the control or display you wish to add, and right click on that item. You then have the option of copying to any of the available Control Screens. Once added to a control screen you then have the option of opening that screen and dragging the item to wherever you desire.

#### EXTERNAL DEVICES

External Devices can be added to a Configuration View, Design View or Control Screen. They are a collection of small images used to add details of external devices which may be connected to a SymNet system. They can assist with documenting system level design features.

If more devices are required that are not included with SymNet Designer, then Picture or Text objects can be added by the user.

#### PRESET RECALL BUTTON

There are 16 preset recall buttons in SymNet Designer, one button for each of the 16 SymNet system presets which are stored in the SymNet hardware.

Preset recall buttons can be dragged and dropped into configuration views, specific unit design views, or onto control screens.

## Design View

MIXERS / MATRIXES

### Mixers

SymNet Designer gives you many different kinds of mixers. Mono, Stereo, and LCR from 2 to 32 inputs. The LCR mixers implement three-channel panning, where the left and right outputs are silent when a source has been panned center. The mixers have mute and solo functions as well as signal present and clip indicators. Larger mixers (> 8 channels) operate in banks of 8 channels, with an overview screen provided to allow you to see the Big Picture.

**Note.** The solo function works by muting the non-solo'd channels (solo-in-place or destructive solo). Don't confuse it with PFL or AFL. There is no separate solo bus so if you do this during operation, sound system listeners will know it.

### Matrixes

If you've used or studied the Yamaha sound reinforcement mixers, you already know what a matrix mixer does. A matrix mixer implements an M by N mix of its inputs to its outputs. SymNet Designer supports matrix mixers from 8x4 (inputs x outputs) to 32x16. For every output, there are M input controls that allow any of the M inputs to contribute to that output. Repeat this N times. Stated another way, at every mix node (intersection of an input line with an output line) there is a level control and a connect button.

The control screen for matrixes shows an overview of the connection status for all crosspoint on the left. Crosspoints that are connected are shown highlighted in green while those that aren't appear gray. The settings for the output mutes are also shown in this overview section. On the right are tabs to display the volume controls for each crosspoint and for each master output. Tabs labeled "Master" control the overall output volume for each output. Outputs can be muted using the Mute button. The Mute All button provides a shortcut to turn on the mute button for all outputs. It is a momentary button. Outputs can also be muted using the buttons at the bottom of the overview section. The other tabs are for controlling the volume and connection for each crosspoint. Pressing the Connect button will connect the corresponding input to the current tab's output. You can also make a connection using the buttons on the overview section. The Disconnect All button provides a shortcut to turn off the connect button for all outputs. It is a momentary button. For a given output, you can set the level of each input that is feeding it using the fader.

If matrixes larger than 32x16 are required, they can generally be built up from smaller matrixes. For example, a 32x32 matrix can be built from two 32x16 matrixes that share the same inputs.

### Gains

Each block is an N by N input/output block. For every input there is a corresponding output. Each input feeds its own output. There is no mixing capability (use a matrix mixer). For the 16-channel version, the control uses 3 tabs to show the information for all the channels. The first tab shows channels 1-8. The second shows 9-16. The third shows an overview of all channels.

For each input, there is:

- ***Gain fader.*** Increases or decreases the gain through the channel fader. You can also specify a precise gain value by clicking the text box at the lower right of the fader and entering the desired value in dB.
- ***Invert button.*** Inverts channel signal, similar to the phase button found on many analog consoles.
- ***Mute button.*** Mutes the channel.
- ***Solo button.*** Solos the channel by muting any non-solo'd channel.  
**Note:** This type of solo is also known as a *destructive solo*. Don't confuse it with PFL or AFL. If you do this during operation, sound system listeners will know it.
- ***Signal present indicator.*** Turns on at -54dBFS.
- ***0dBFS indicator.*** This doesn't indicate that clipping has occurred, but indicates that clipping at the output will occur unless the signal is attenuated by a downstream module.

For all modules other than the mono module there is a master fader with mute button. The master fader applies gain to all channels equally. The gain (in dB) for each channel is the sum of the channel fader and the master fader gains (in dB). The master Mute button mutes all outputs. The master fader can be used for ganging multiple signals and controlling them from a single fader. Use the individual channel faders to set the relative levels of the ganged signals and the master fader to control the overall level of all the signals. This feature is especially useful with control screens and external control.

You may add your own label to any fader by clicking the legend at the bottom of the fader.

## Inverters

Inverter modules provide a quick and efficient way to invert the polarity of a signal. Signal inversion is also provided on the analog inputs and crossover outputs. SymNet's inversion is equivalent to reversing the hot and cold wires on a balanced signal or pressing the so-called "phase" button on many analog mixing consoles. 1, 2, 4, 8, and 16 channel versions of this module are provided.

**Controls.** For each channel, a button is provided to selectively invert the signal or not. When pressed (green), the signal on that output will be inverted from the signal coming in that that input. When not pressed (gray), the output will be identical to the input.

The inversion is "dezippered" so that no clicks or pops are heard when changing the inversion setting. The signal is quickly and gracefully faded out and then faded back in inverted.

## AUTOMIXERS

**Introduction.** Automatic mixers or automixers for short, attempt to emulate and even improve on the results of a skilled operator controlling a conventional mixer with a large number of speech inputs. Consider a typical conference room scenario with ten people each with their own microphone. If all ten microphones were turned on at the same level and only one person were talking, the result would probably not be very intelligible. The other nine microphones would pick up room noise, reverberation, etc. which would degrade the sound. Furthermore, adequate volume probably could not be obtained because the maximum gain before feedback would be significantly reduced because of the extra open microphones. A skilled operator would deal with this situation by turning on only the microphones that are in use at any given time and leaving all other microphones off. An automixer performs this same function, but can react much more quickly than a human operator. Furthermore, automixers require no salary and won't take coffee breaks!

**Automixer Technology.** There are two general types of automixers built on different underlying technologies: gating and gain sharing. Gating automixers are simpler to understand and so will be described first.

With a gating automixer, essentially each channel has a noise gate on it, and a channel is either on or off. The logic to decide whether a channel should be on or off can be based on simply a fixed threshold or be a complex equation looking at priority, over-ride buttons, etc. These type of automixers also usually have a mechanism to lower the overall gain as more

microphones are open. The terms number of open microphones (NOM) and NOM attenuation are often used to describe this. A weakness of this system is that since noise gates are used, unnatural "chattering" effects can occur. Another problem is that the gate threshold must somehow be established. This can make set-up and calibration more difficult.

While a gating automixer is built around noise gates, a gain sharing automixer is built around expanders. In this type of automixer, a channel is not just on or off, but can be anywhere in between. The more that one channel dominates the rest, the more gain it gets in relation to the other channels. If two or more channels are at equal volumes, they receive equal gain. If a channel is receiving almost no signal, it receives almost no gain. In this way, the total gain is shared between all channels with the loudest channels receiving the most gain. Since this method uses expanders, operation is usually very smooth and natural with no chattering gates. Also, this method doesn't require that a threshold be set unlike with gating automixers. A threshold is used by the expanders, but it is adaptively sensed using all of the existing microphones and doesn't require any user adjustment or dedicated sense microphones. Also, NOM attenuation happens automatically since the total gain is shared between all channels. It should be noted that NOM is not a very useful concept with the gain sharing type of automixers since a channel is not just on or off.

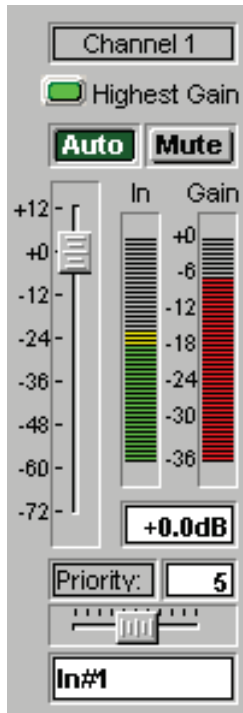
SymNet currently offers only the gain sharing type of automixers. They were chosen since they are easier to configure and use and generally sound better. Technically, SymNet's automixers use "adaptive level gain sharing" technology.

### Stand-alone Operation (Master Automixer Only).

SymNet offers two types of automixers: master and slave. This distinction is only relevant when linking multiple automixers together to create a single larger mixer (discussed below). If a simple stand-alone automixer is all that is required, use a master auto-mix module. You are given a choice of 4, 8, or 16 inputs. To conserve DSP processing, use the smallest mixer that meets your needs.

**Module Inputs/Outputs.** Automixers have inputs for each channel. Each channel also has a direct out that is affected by the automatic gain, channel fader, and channel mute (i.e. it is post auto-gain, post fader, and post mute). There is also a mix output that is the sum of all the direct outputs. The other inputs and outputs are only for linked operation and will be discussed below.

### Channel controls



Each channel has an Auto on/off button. Turn this on for all channels that require automixing. You may want to turn this off, for example if you have a channel of background music that you want at a fixed level, or you have a “Chairman” microphone that you want to remain always on. When a channel’s Auto button is off, its gain will not be adjusted automatically, and the signal level on this channel will not affect the gain of other channels (i.e. it will not affect the automix gain calculations).

The channel mute and fader are both post auto-gain. That is, nothing you do with these affects the automixing operation. This means for example, that even if a channel

is muted, it can still reduce the level of other channels if it is receiving a high level signal. To mute a signal and prevent it from effecting the automixing operation, turn Mute on and the Auto off. The Mute for each channel mutes the channel in the mix and also mutes the direct out. Similarly, the channel fader controls the mix level and direct output level for the channel. You can also control the channel level precisely by clicking in the text box and entering a dB value.

The priority control affects the automix algorithm by allowing higher-priority channels to over-ride lower ones.

This control can take any whole number value between 0 (lowest priority) and 10 (highest priority) with 5 (standard priority) as the default. You may adjust the priority either using the slider control or by clicking in the edit box and entering a whole number between 0 and 10. Increasing the value increases the priority.

If two channels are receiving signals with equal levels, the one with the higher priority will receive more gain. For every difference of one priority “unit” between channels, the higher priority channel receives 2dB more gain than the lower (assuming Slope is set to 2.0). For example, if channel one’s priority is set to 6 and channels two’s priority is set to 3 and both are receiving input signals at the same level, channel one will receive 6dB more gain than channel two. As implied above, the Slope setting also affects the priority

weighting. If the slope is set to 3.0, then each one-priority unit difference between results in a 4dB gain difference.

If all channels are of equal priority, leave all priorities set to 5.

*NOTE: In some set-ups, care must be exercised when using extreme priority differences between channels, for example 0 and 10. If the channel with the very high priority is picking up significant signal level from loudspeakers, background noise, etc. it may tend to “duck” the low priority channels even when not in use. Higher slope values can further increase this problem. If this happens in your installation, consider adding a noise gate or expander before the automixer on the highest priority channels. Set the threshold to a level so that the gate or expander isn’t opened by background noise or loudspeaker pickup.*

At the bottom of the each channel control group, a space is provided to name the channel. If desired, click in the text box and type in a name.

Channel indicators. The Highest Gain indicator lights for the channel in that has the highest gain. The highest gain is determined by the following rules: 1) If a channel is in Auto mode, the auto-gain is used. If a channel is not in Auto mode, the fader gain is used.

Each channel has two meters. The tri-color “In” meter indicates the level of the input signal. This meter is pre-fader and pre-auto-gain. The red “Gain” meter shows the auto-gain of that channel. It does include the settings of the channel fader. If the channel is not in Auto mode, this meter will indicate 0dB.

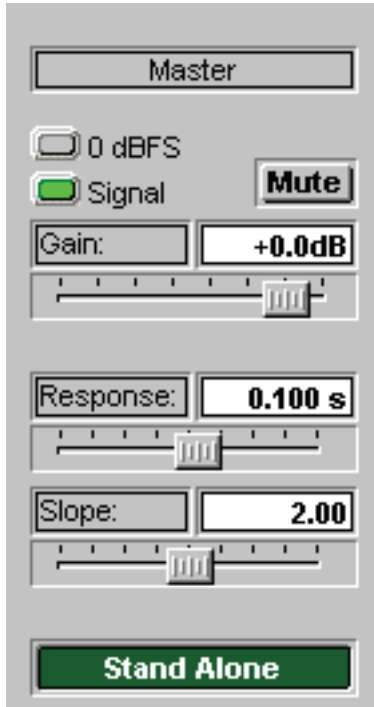
### Master controls

The master section includes master gain and mute settings. These effect only the mix output, not the channel direct outputs. The “Signal” (signal present) and “0 dBFS” LEDs indicate the level of the mix output.

The response time slider adjusts the speed at which the mixer changes its automatic gain. Fast times ensure that beginnings of words are not clipped. Slower times result in smoother, less obtrusive operation. We have found that values between .1 and 1 second work best. The automatic gain operation is designed so that it turns on a microphone much faster than it turns off, so even with a 1 second response, beginnings of words are not usually clipped. With slow times of several seconds, the automixer responds as if it has a hold time, with the last active channel remaining on for several seconds.

The slope control affects the attenuation of lower-level inputs. Higher values cause softer channels to be attenuated more than lower values do. The slope

control functions similarly to the ratio control on an expander. It is recommended that this control be left at or near 2.0. Setting it to 1.0 is equivalent to turning Auto off for all channels. Setting it to 3.0 results in more aggressive automatic gain adjustments that may sound unnatural. Higher settings also result in more over-all attenuation as more channels are open (effectively NOM attenuation). A value of 2.0 results in mathematically ideal gain sharing, which is why it is preferred.



The Stand Alone button controls whether a mixer acts independently or based on control signals from other automixers (linked). For basic stand-alone operation, this button should be turned on. For linked operation, this button should be turned off. See below for more information about linked operation.

Voice Band Filters. The automixer is equipped with a voice band filter on each channel. The filter affects only

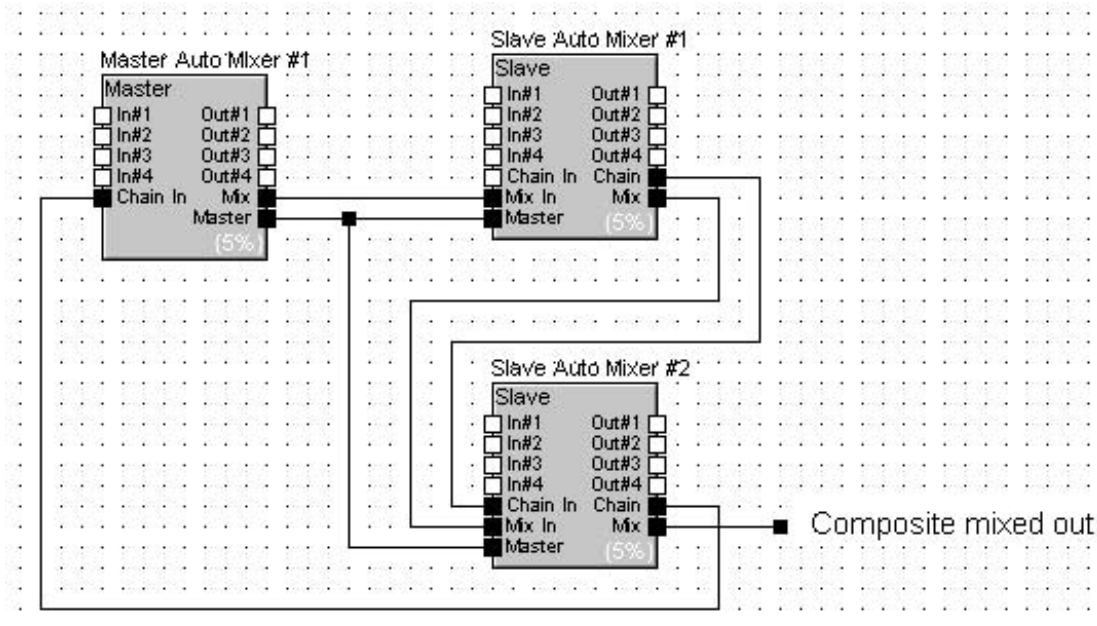
the control chain, not the audio signal path. The filter is a 4<sup>th</sup> order bandpass with 300-3k Hz bandwidth. This helps to prevent rumble, hiss and other non-speech sounds from influencing the automixer. The operation of these filters is transparent to the user.

**Linked Operation.** Individual automixers can be linked together to form larger auto-mixers. In this way, large automixing systems can be constructed modularly. There are two ways of linking automixer modules, by daisy chaining, or by using automix combiner modules.

Linking by Daisy Chaining. To link multiple automixers together without using any extra modules, you must designate one as a master and the other(s) as slaves. Use a Master Automixer for the master and Slave Automixer modules for the slaves. You can control whether the mixers function independently or as one dynamically using the Stand Alone button. For linked operation, turn the Stand Alone button off for all linked automixers.

Connect the Master output off the master module to each of the slave's Master inputs. Connect the "Chain" output in a daisy chain starting with the first slave and ending with the master. If you are using the mix outputs, connect the Mix output to the Mix In input in a daisy chain, starting with the master and ending with the last slave. The complete mix out will be available from the Mix output of the last slave. (The mix daisy chain is only required if you are using the mixed output. It is not required for linked automixer operation.)

The figure below shows the correct connections for 3 linked automixers. NOTE: The Chain and Master signals are control signals and are not intended to be





listened to. Do not route these to your speaker system!

NOTE: For proper operation, all linked automixers must be set for the same response time and slope.

Linking using Automix Combiners. For applications that require dynamic switching of mixers between stand alone and linked, this method is recommended. For detailed instructions on this method, see the section on **Room Combiners**.

### **Suggestions for Implementation.**

Mix Dynamic Control. In some applications, it may be helpful to control the dynamics of the mixed output. Putting a compressor or AGC on the automixer's mix output may help maintain consistent levels. In other environments, a noise gate or expander on the output may be appropriate.

"Mix Minus" Applications. In sites that employ multiple speaker zones, it is very helpful to turn off or down the microphones in speakers they are physically near. This can greatly increase gain before feedback and allow higher overall levels without howling or ringing. A traditional way to do this is using a "mix minus" approach, where each speaker zone receives the entire mix minus the microphone(s) that are close to it. This was often done by adding an out-of-phase copy of the input to the mix. While you could set this up in SymNet this way, a much more reliable and flexible approach is to use a matrix mixer. This allows you to control the level of each channel independently in each output.

### COMBINERS (ROOM COMBINERS)

**Introduction.** In many hotels, the ballroom and conference room space is constructed with movable walls so that the total space may be partitioned into many small rooms or fewer larger rooms. This offers great flexibility in the physical realm to accommodate a wide variety of events. Your audio system needs to offer similar flexibility to deal with the sound-reinforcement needs of such a malleable environment. In SymNet, room combiner modules offer a convenient solution to this problem.

**Functionality.** A room combiner module offers one input and output for each partitioned room in a larger space. In this context, the number of rooms in the module is the number of rooms obtained when all walls are closed. For example, a rectangular space with two moveable walls is considered to have 3 rooms.

If two rooms are combined, then the audio inputs for these two rooms are mixed together and sent to both rooms. If they are separate, then the audio is not mixed, and each room receives its respective signal. In

this case, the input is passed through to the output.

Fundamentally, a room combiner consists of a matrix mixer with equal number of inputs and outputs. Depending on how the rooms are combined, it could be acting like a mixer/distribution amp, a simple pass-through, or something in between.

While you could use also a matrix for room combining, a dedicated room combiner module offers a much simpler interface. With a matrix, one would have to laboriously figure out how to set up each matrix cross-point depending on the specific room configuration. Instead, simply indicate which rooms are combined and let SymNet figure out the rest. Room combiner modules also greatly simplify setting up external controls (contact closures, ARC).

**Controls.** The controls for a room combiner consist of push buttons to indicate that a pair of rooms is combined and text boxes to specify the pair. The number of available buttons depends on the size of the module. They range from one for a two-room combiner up to 32. In general, use the text boxes to set-up the room pairs that can be physically combined. By default, SymNet offers useful combinations, but if these don't match your physical set-up, they can easily be changed by clicking in the text box and entering a new room number. If a pair of rooms should function as one, turn on the "#n Combine" button. If the rooms should function independently, turn off the button. You can automate these buttons using external controls, so that a contact closure can be used to automatically combine or separate two rooms.

**Indirect Combining.** If rooms 1 and 2 are combined and rooms 2 and 3 are combined, then it stands to reason that rooms 1 and 3 must also be combined. This is referred to as indirect combining. SymNet room combiner modules treat indirectly combined rooms just as if they were directly combined. You do not need to explicitly (directly) combine rooms.

**Standard vs. Automix Combiners.** Standard combiners are designed to be used in systems that don't employ automixers and that need only one (mono) input per room. Automix Combiners are designed to be used in systems that use automixers in each room. They can combine individual automixers into a single large automixer or cause them to act independently.

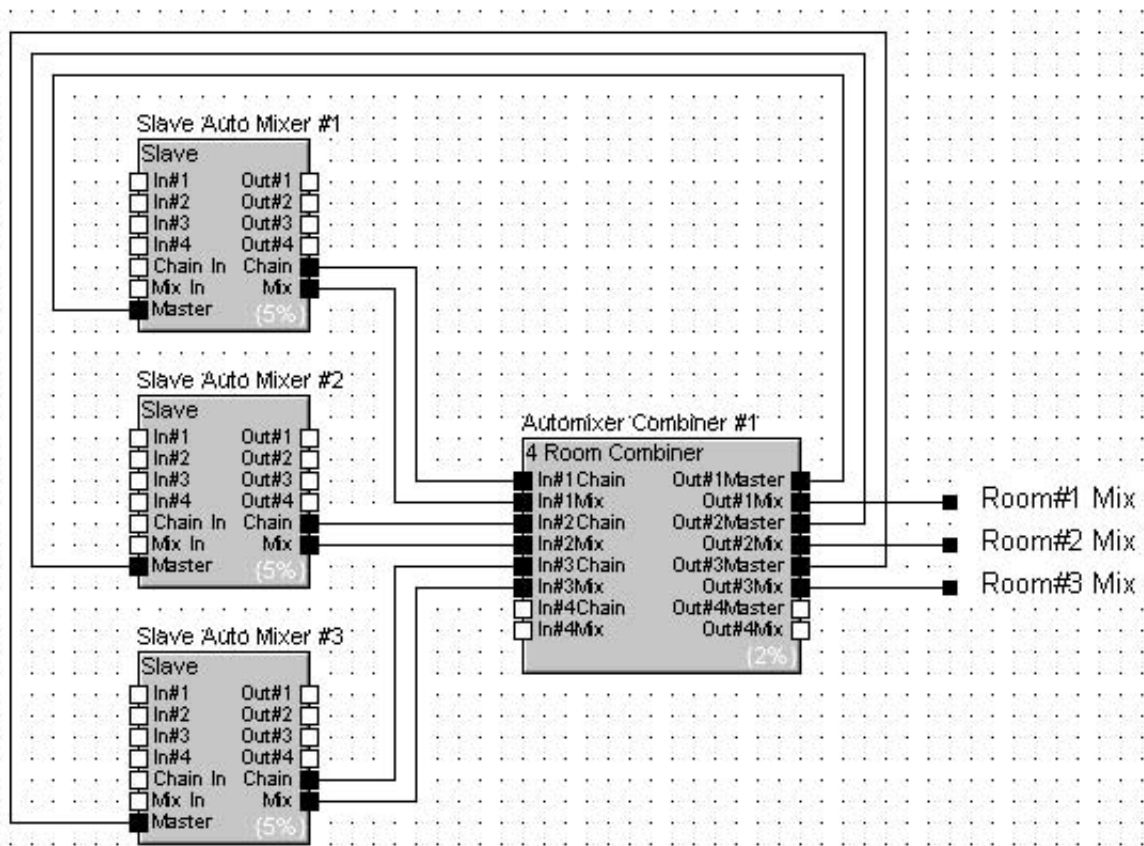
NOTE: Automixer combiners can also be used in applications where rooms employ stereo audio. Simply use the "Chain" input for left and the "Mix" input for right.

NOTE: The Chain and Master signals are control signals and are not intended to be listened to. Do not route these to your speaker system!

NOTE: For proper operation, all linked automixers must be set for the same response time and slope.

**Automix Connections.** When using an Automix combiner, use only Slave Automixer modules and make sure the Stand Alone button is not pressed. Connect each automixer's Chain output to the room combiner's Chain input. Connect each automixer's mix output to the room combiner's mix input. Connect each the room combiner's Master output back around the each automixer's Master input (not the chain input as you might expect). Send the room combiner's Mix outputs to the various room's PA system.

The figure below shows the correct connections for a 3-room set-up.



## FILTERS & EQS

**Crossovers.** Crossovers are special filters that can be used to feed the different drivers of a speaker system (woofers, tweeters, mid range, etc.) The filters used in crossovers need to skillfully handle the point where the two frequency bands overlap because at these frequencies, two different drivers are both producing the signal. The filter's phase response at these frequencies is critical to ensure that phase cancellation which can produce comb filtering does not occur.

SymNet offers 2-way, 3-way, and 4-way crossovers as well as a mono sub module. The 2 Way crossover has a high and a low output. The 3 way version adds a mid band output. The 4-way crossover has low, mid low, mid high, and high band outputs. All these crossovers have a single input signal. The mono sub module offers only a low output. It is essentially a low pass filter. It has two inputs which are summed to mono before the low pass filter is applied. If you are working with a mono signal, connect it only to input #1. When working with a stereo signal, you may want to apply some attenuation to compensate for the increased level obtained when summing the two inputs to mono.

Controls:

**Gain.** The gain adjustment provides a volume control for each frequency band.

**Invert.** This button inverts the output signal for the each frequency band. It is equivalent to reversing the hot and cold wires of a balanced connection or the two terminals on a speaker. Use this setting for correcting reverse-wired speakers or for some crossover settings that require one band to be inverted vs. the other (e.g. 12dB and 36dB Butterworth).

**Frequency.** Controls the frequency of each band. For Butterworth and Bessel type crossovers, this frequency is the 3dB down point. For L-R filters, it is the 6dB down point. Generally, the frequency settings for adjacent bands should be set to the same frequency as this yields the mathematically correct composite response. However, with some systems slight overlap or even underlap may be preferred due to room/speaker characteristics or aesthetic reasons.

**Slope (6, 12, 18, 24, 30, 36, 42, 48).** This settings controls the crossover slope in dB/octave for each band. With Bessel and Butterworth filters, "odd order" filters (6, 18, 30, and 42) are recommended. When you select Bessel or Butterworth an odd order setting is automatically chosen, but you may override this and use an even order if you desire. With L-R filters, only "even order" (12, 24, 36, 48) filters are available.

**Butterworth, Bessel, and Linkwitz-Riley (filter type).**

Each of these filter types creates a slightly different response. The standard Butterworth filter is a good compromise between a sharp but smooth cut-off and fairly good phase response. With Butterworth filters, "odd order" filters (6, 18, 30, and 42) are recommended. Only these filters have the phase responses which provide correct summing at the crossover point.

The Bessel filter has better phase response in the pass-band but does not roll-off as sharply and the summing at the crossover frequency is not perfect. The moderate improvements in pass-band response are usually not worth the disadvantages, so Bessel filters probably aren't of great value in most applications.

Linkwitz-Riley filters actually consist of two Butterworth filters in series. They have a significant advantage when used with speakers that have non-coincident drivers (not coaxial), that is the woofer and tweeter are not physically in the same location which is the case for most PA speakers. For this type of speaker, only L-R filters have zero "lobing error" which is signal peaking caused by constructive phase interference that can occur off-axis to the speakers. Linkwitz-Riley filters are very popular in the industry and are recommended for all non-coincident driver applications. One disadvantage that the L-R filter has is that the combined power response of the 2 drivers has a slight dip in the crossover range. However, this is generally not audible, especially with higher order (steeper) filters where the crossover range is very small. With L-R filters, only "even order" filters are possible (12, 24, 36, 48). Of these, the 24- and 48-dB versions are preferred.

With the mono-sub module, only the Butterworth and Bessel options are available.

A graph is provided so you can view the frequency response of the various crossover bands. You can modify the crossover parameters either by using the sliders and buttons or by clicking and dragging on the graph. Drag a green box vertically to adjust the gain of a band. Drag a yellow box horizontally to adjust the frequency of a band. Drag a white box horizontally to adjust the frequency of two adjacent bands at once.

**Mono & Stereo Parametric EQs.** With SymNet parametric equalizers you can adjust center-frequency, gain, and bandwidth. There are equalizers from one-band to eight-bands, mono and stereo. You can adjust them using the controls on the adjustment screen, or you can use the mouse to drag the curve

as you please. When using the mouse to adjust the equalization curve, use the red handle for each band to control the frequency and gain. Drag the yellow handles horizontally to adjust the width/Q.

Both mono and stereo equalizer blocks have the following controls and switches:

**Frequency.** The center frequency of the equalizer band.

**Gain.** The amount of gain or attenuation (boost or cut) applied at the center frequency.

**Width(Q).** The bandwidth of the peak or dip applied to the signal, measured in fractions of an octave.

**Width(Oct).** The bandwidth of the peak or dip applied to the signal, expressed as the Q factor. Q is a dimensionless (unitless) quantity also used to describe bandwidth.

**Bypass.** A switch that bypasses the equalizer, leaving the settings as they are. This is equivalent to disabling every band of the equalizer.

**Flatten All.** A switch that resets (destructively) all of the gain controls in the equalizer to 0dB. This is a momentary button.

**Octaves/Q.** This switch changes the units used by the Width controls between fractional octaves and Q.

**Band(n) Enabled / Bypassed.** One button for each band is provided to selectively enable or disable a given parametric band. If a band is disabled, it has no effect on the signal, regardless of the other settings for this band. Adjusting the gain of a band or clicking on it in the graph will automatically enable a band.

**Highpass and Lowpass Filters.** Highpass and Lowpass filters allow selectively modifying a signal by attenuating all signals above or below a specified cut-off frequency. They can be useful to remove noise or other unwanted frequencies. They can also be used as “keying” filters in side chain compressor and noise gate applications. SymNet offers 6dB/octave, 12dB/octave, and 24dB/octave filters. The filters with the steeper response filter more sharply but require more DSP resources. Even steeper and more flexible filters can be obtained using the Programmable Filters modules.

Controls:

- **Frequency.** Determines the cut-off frequency of the filter. For low pass filters, all frequencies above this will be progressively attenuated. For high pass filters, all frequencies below this will be progressively attenuated. Technically, this frequency is the “3dB down point”, i.e. the point where the filter response is 3dB lower than it is for unaffected signals.

- **Gain.** Determines the amount of boost or cut applied to the signal as a whole. This setting is essentially a volume adjustment.
- **Bypass.** Bypasses the module so that the input is sent unmodified to the output.

A graph is provided so you can view the frequency response of the filter. You can modify the filter parameters either by using the frequency and gain sliders or by dragging the green box on the graph. Technical note: The modules implement Butterworth filters which are generally preferred for audio because of its flat frequency response in the pass band.

**Note.** if you need a steeper filter or programmable filter slope, consider using one of the crossover modules instead. Steeper filters can also be obtained by cascading multiple filters, although using a crossover is generally preferred.

**High and Low Shelf Filters.** High Shelf and Low Shelf filters are simple filters that can be used to modify the treble or bass content of a signal. They are designed to emulate traditional analog tone or treble/bass controls. If you need to give a non-technical end user control over treble and bass, a shelf filter is the way to go. The low shelf filter can be used to boost or cut the bass from a signal. The high shelf filter can be used to boost or cut the treble from a signal.

Controls:

- **Gain.** Determines the amount of boost or cut applied.
- **Frequency.** Determines where the boost or cut takes place. For low shelf filters, all frequencies below this will be affected. For high shelf filters, all frequencies above this will be affected. Technically, the indicated frequency is the point where the filter has reached half of its specified dB gain. For example, for +6dB boost with a 1kHz frequency, the signal is boosted by +3dB at 1kHz.
- **Bypass.** Bypasses the module so that the input is sent unmodified to the output.

A graph is provided so you can view the frequency response of the filter. You can modify the filter parameters either by using the frequency and gain sliders or by dragging the green box on the graph.

**Recommended settings.** For a basic treble control, use a high shelf filter and set the frequency between 2kHz and 5kHz. For a basic bass control, use a low shelf filter and set the frequency between 200 and 500 Hz.

## Programmable Filters

Programmable filter modules allow for great flexibility in filtering signals. Use them to construct your own fully custom crossovers or for more demanding filtering applications. Highpass, lowpass, and bandpass filters are available with slopes up to 48dB/octave. Mono and stereo versions are provided, with the stereo version applying the same filtering to both channels.

### Highpass and Lowpass

The highpass and lowpass filters provide identical controls.

Controls:

- Gain. The gain adjustment provides an overall volume control for the filter.
- Invert. This button inverts the output signal of the filter. It is equivalent to reversing the hot and cold wires of a balanced connection or the two terminals on a speaker. This setting may be useful for some crossover settings that require one band to be inverted vs. the other.
- Frequency. Controls the cutoff frequency for the filter. For Butterworth and Bessel type crossovers, this frequency is the 3dB down point. For L-R filters, it is the 6dB down point. (This assumes Resonance is set to 1.0.)
- Resonance. This control adjusts the frequency response near the cut-off point. The default resonance value of 1.0 yields "standard" filters that match the other filter and crossover modules in SymNet. Increasing the resonance causes the filter response to peak before rolling off. Decreasing it causes the filter to droop. The effect is more pronounced with steeper filters. (Note: Technically speaking, the Q value of each biquad is multiplied by the resonance factor.)
- Slope (6, 12, 18, 24, 30, 36, 42, 48). This setting controls the crossover slope in dB/octave for the filter. With L-R filters, only "even order" (12, 24, 36, 48) filters are available.
- Butterworth, Bessel, and Linkwitz-Riley (filter type). Each of these filter types creates a slightly different response. See the crossovers section for more information. [create hyperlink to crossovers]
- Bypass. Pressing this button bypasses the filter so that no filtering is done and the output is identical to the input.

A graph is provided so you can view the frequency response of the filter. You can modify the filter parameters either by using the sliders and buttons or by clicking and dragging on the graph. Drag the yellow

box horizontally to adjust the frequency or vertically to adjust the gain.

### Bandpass

The bandpass filter consists of a highpass filter section and a lowpass filter section in series, each independently adjustable.

Controls:

- Gain. The gain adjustment provides an overall volume control for the filter.
- Invert. This button inverts the output signal of the filter. It is equivalent to reversing the hot and cold wires of a balanced connection or the two terminals on a speaker. This setting may be useful for some crossover settings that require one band to be inverted vs. the other.
- Frequency. Controls the cutoff frequency for each filter section. For Butterworth and Bessel type crossovers, this frequency is the 3dB down point. For L-R filters, it is the 6dB down point. (This assumes Resonance is set to 1.0.)
- Resonance. This control adjusts the frequency response near the cut-off point for each filter section. The default resonance value of 1.0 yields "standard" filters that match the other filter and crossover modules in SymNet. Increasing the resonance causes the filter response to peak before rolling off. Decreasing it causes the filter to droop. The effect is more pronounced with steeper filters. (Note: Technically speaking, the Q value of each biquad is multiplied by the resonance factor.)
- Slope (6, 12, 18, 24, 30, 36, 42, 48). This setting controls the crossover slope in dB/octave for each filter section. With L-R filters, only "even order" (12, 24, 36, 48) filters are available.
- Butterworth, Bessel, and Linkwitz-Riley (filter type). Each of these filter types creates a slightly different response. The type can be set independently for each filter section. See the crossovers section for more information. [create hyperlink to crossovers]
- Bypass. Pressing this button bypasses the filter so that no filtering is done and the output is identical to the input.

A graph is provided so you can view the frequency response of the filter. You can modify the crossover parameters either by using the sliders and buttons or by clicking and dragging on the graph. Drag a yellow box horizontally to adjust the frequency of each filter section or vertically to adjust the gain of the overall filter. Drag the white box horizontally to adjust the frequency of both filters sections at once or vertically to adjust the gain of the overall filter.

## DYNAMICS

**Compressor/Limiters.** A Compressor reduces the dynamic range of signals above a user determined threshold. Signal levels below the threshold remain unchanged.

**Sidechain.** A mono compressor has a signal input and a sidechain input labeled "Side". A stereo compressor has two signal inputs and one sidechain input labeled "Side". The "Side" input is used to allow a signal other than the input to control the compressor. Using this feature, you can do frequency-selective compression (de-essers), use the compressor as a ducker, etc. If nothing is connected to the "Side" input, then the input signal is effectively shorted to the "Side" input (standard operation).

**Mono vs. Stereo.** The controls for mono vs. stereo compressor/limiters are identical. The input and output meters for the stereo version show 2 channels vs. 1 for the mono version. For the stereo version, the compression is controlled by the loudest of the two inputs. Both outputs are affected identically.

The SymNet Compressor has the following controls:

**Threshold.** The signal level above which the compressor/limiter begins reducing the gain. Visually, the point at the knee (bend) in the input/output curve. For peak stopping, set the threshold just below the peak level that you want to stop. For dynamic range reduction, pick a threshold setting that results in a few dB of gain reduction indication with the signal levels that you are interested in.

**Knee.** The knee setting determines the compression ratio during the transition from linear (below threshold) to compressor operation. A soft knee makes this change gradually, while a hard knee makes an abrupt transition. A soft knee curve may require several dB of gain reduction before the actual compression ratio has reached the set value. For general compression, use the soft or medium settings. For limiting, use the medium or hard settings.

**Ratio.** The ratio determines the degree of output change for an above threshold change in the input. Generally ratios under 10:1 are considered compression while those above 10:1 are considered limiting.

**Attack.** The speed with which the compressor/limiter begins the gain reduction process. Although your intuition tells you that you want the fastest possible attack time, your ears will tell you otherwise. Too fast attack times strip transients of their edges, dulling the sound. Remember that momentary (brief) clipping is inaudible. Faster attack times allow shorter transients to initiate gain reduction. On the other hand, too

long attack times can allow short transients to pass unchanged, which may defeat the purpose that the compressor was intended for.

**Release.** The release time determines the moment-to-moment gain change in the compressor. Fast release times raise the subjective level, while slow release times are more useful for keeping levels under control.

**Split Frequency.** The frequency that separates the two sections of a split-compressor/limiter. This control is only available on Split compressor/limiter modules.

**Side Chain In.** When pressed, the compressor uses the side chain input to control the compression. When not pressed, the input signal is used to control the compression (standard operation). If nothing is connected to the Side input and the Side Chain In is pressed, no compression will occur (the compressor is effectively bypassed).

**Bypass.** Bypasses the compressor so that the input is sent unmodified to the output.

**Output fader.** A fader provided to control the output gain of the module. If the compressor is reducing the signal level significantly, a boost in the output gain may be required to maintain perceived volume. This is commonly called make-up gain. Split compressors have separate faders for each band.

**Meters.** A peak detecting meter showing the output signal level is provided. A meter labeled "G.R." indicates the amount of gain reduction that the compressor is currently applying. This meter is pre-output gain, meaning changes to Output gain fader do not effect this meter. Split compressors have separate gain reduction meters for each band. Stereo compressors have separate output meters for each channel.

**Single Band vs. Dual-band Compressors.** In a single-band compressor, the sidechain (portion of the compressor circuitry that derives the gain control signal for the gain control block) receives a full-band signal from the input stage. Whenever the input signal is loud enough to cross the compressor's Threshold setting, the sidechain generates a control signal that reduces the gain of the control block. The loudest source in the mix ultimately owns the compressor.

In music, typically this is the bass, although it could be the vocals or any other signal. This loudest source determines the amount of gain reduction. If the source was the bass (and it often is), then the envelope of the bass signal is superimposed on everything else. Often this is called "sucking and breathing."

One way to minimize envelope distortion (sucking and breathing) is to lengthen the release time (the time required for the compressor's gain to recover after an above-threshold transient) to some multiple of the period of the lowest frequency of interest. Unfortunately, this means that short high-frequency transients are subjected to the same release time, which tends to 'punch holes' in the program material. Yes, you can lengthen the attack time, so that the compressor is less likely to respond to short-duration overloads, but that is at risk of allowing short duration overloads to pass thru largely unchanged.

A dual-band compressor is really two-in-one. An adjustable crossover network splits the input signal into two frequency bands, then separate compressors operate on each band separately, and finally the compressor outputs are mixed together and sent to the output.

As long as the crossover frequency has been set to minimize the bass content in the high-frequency side, the bass signals can cause significant amounts of gain reduction without affecting the high-frequency compressor at all. Lest you think that this idea is new, it isn't. Radio stations typically slice and dice the audio into 8 separate bands, thrash and bash each one of them separately, and then recombine them to make the station's signature sound.

**What Can I Use a Dual-Band Compressor For?** The dual-band compressor lends itself to any application requiring full-bandwidth dynamic range processing. The dual bands let you tailor the release time to something more optimum for the low band and for the high band, letting you balance smoothness against peak stopping.

Another application is protecting the drivers in a multi-way sound system. By setting the bandsplit frequency to approximate the crossover frequency, you get the effect of having a limiter after the crossover. This even works with passive crossovers.

SymNet Designer has single and dual-band compressor/limiters in both mono and stereo versions. A stereo compressor sums the two input signals into mono, processes them to derive the gain reduction value, and then reduces the gain in *both* channels by this amount. This prevents stereo image shifts caused by unequal gain reduction in the two stereo channels.

**AGC.** AGC or Automatic Gain Control is a special case of a compressor with its threshold set at a very low level, moderate to slow attack times, long release times, and low ratios. It is intended to take signals of indeterminate levels up to a target level while maintaining program dynamics. Most AGCs incorporate

some sort of silence detection to prevent the loss of gain reduction during silent periods. This is the single feature that separates an AGC from a common, ordinary compressor/limiter.

Use an AGC to normalize the level of a CD player used for background music, foreground music, or music on hold, to remove some of the variation in level of a paging mic.

The AGC has the following controls and switches:

**Detector Threshold.** When the signal level is below Threshold, the input/output ratio is 1:1. When the signal level is above Threshold, the input/output ratio follows the Ratio control setting. Set this threshold to a level just above the noise floor of your input signal.

**Ratio.** The ratio of above-threshold input signal level change to output signal level change, measured in dB.

**Target Output Level.** The desired output signal level.

**Speed.** The recovery (return to unity gain) time of the AGC. Use Slow for music, Fast for speech.

**Contour.** Pressing the Contour button inserts a single pole 150Hz high pass filter into the side chain. This is useful to prevent the AGC from responding too strongly to signals with significant bass content. For example, without this feature, on a certain song, each kick drum hit could cause the AGC to attenuate the output level significantly. This is sometimes referred to as the "hole punching effect" because it sounds as if each bass hit is punching a hole in the audio. Turning on the Contour setting minimizes this problem.

**Bypass.** Bypasses the AGC so that the input is sent unmodified to the output.

**Mono vs. Stereo.** The controls for mono vs. stereo AGCs are identical. The input and output meters for the stereo version show 2 channels vs. 1 for the mono version. For the stereo version, the AGC gain control is controlled by the loudest of the 2 inputs. Both outputs are affected identically.

**Meters.** Peak detecting meters are provided for the input and output of the AGC. The input meter can be useful in setting the detector threshold. The output meter can be used to verify correct operation of the AGC.

**Expander Gates.** An Expander (or gate) reduces the gain of lower level signals without reducing total dynamic range. Above a user defined threshold setting, signal levels remain unchanged. Below threshold, signal are reduced by some degree. Expanders and gates differ by the rate of change of the input/output curve when the signal is *below* the threshold level. An expander reduces the level gradually for decreasing input level whereas a gate drops the gain precipitously for a small decrease below threshold level. A glance at the input/output curves for these two devices makes the differences clear.

**Sidechain.** A expander gate has a signal input and a sidechain input labeled "Side". A stereo expander gate has two signal inputs and one sidechain input labeled "Side". The "Side" input is used to allow a signal other than the input to control the expander gate. Using this feature you can use one audio signal to turn on or off another audio signal. If nothing is connected to the "Side" input, then the input signal is effectively shorted to the "Side" input (standard operation).

**Mono vs. Stereo.** The controls for mono vs. stereo expander/gates are identical. The input and output meters for the stereo version show 2 channels vs. 1 for the mono version. For the stereo version, the gain reduction is controlled by the loudest of the 2 inputs. Both outputs are affected identically.

SymNet **Expanders** have the following controls:

**Threshold.** The level that the signal must exceed to open the expander (let it pass signal)

**Ratio.** The slope of the gain curve below the threshold point. A high ratio setting begins to approximate the action of a gate.

**Attack.** The duration of the input signal, over threshold, required to open the expander. Faster attack times let shorter transients open the expander.

**Release.** The amount of time required for the gain to return to the below-threshold value after the input signal falls below threshold.

**Side Chain In.** When pressed, the module uses the side chain input to control the gating or expansion. When not pressed, the input signal is used to control the gating or expansion (standard operation). If nothing is connected to the Side input and the Side Chain In is pressed, the module will be set for maximum signal attenuation.

**Bypass.** Bypasses the module so that the input is sent unmodified to the output.

**Meter.** A gain reduction meter labeled "G.R" is provided

to that the effect of the expander or gate can be observed.

SymNet **Gates** have the following controls.

**Threshold.** The level that the signal must exceed to open the expander (let it pass signal)

**Depth.** The gain change applied to the signal when it falls below threshold and the gate closes. For example, a Depth setting of -40 dB means that when the gate is closed, the output signal will be 40 dB lower.

**Attack.** The duration of the input signal, over threshold, required to open the expander. Faster attack times let shorter transients open the expander.

**Hold.** Once the input signal crosses the threshold level, the gate remains open for the Hold time even if the input signal has fallen below the threshold level.

**Release.** The amount of time that the expander takes to lower the gain to that set by the Depth control after the input signal falls below threshold and the Hold time has expired.

**Side Chain In.** When pressed, the module uses the side chain input to control the gating or expansion. When not pressed, the input signal is used to control the gating or expansion (standard operation). If nothing is connected to the Side input and the Side Chain In is pressed, the module will be set for maximum signal attenuation.

**Bypass.** Bypasses the module so that the input is sent unmodified to the output.

**Meter.** A gain reduction meter labeled "G.R" is provided to that the effect of the expander or gate can be observed.

**Duckers.** A ducker lowers the gain in its signal path in response to a signal connected to its sidechain (or control) input. A typical ducker application is lowering the volume of background/foreground music to make way for paging. For the background music/paging application, put the ducker in series with the music signal path. Drive the sidechain input with the paging signal. Then mix the music and paging signals using a separate mixer module. There are both stereo and mono duckers in the toolbox. The duckers have the following controls:

**Threshold.** The signal level that the sidechain signal must exceed to cause gain reduction in the signal path.

**Depth.** Once the sidechain signal exceeds the threshold setting, reduce the gain by this amount.

**Attack.** The sidechain signal must exceed threshold by at least the amount of attack time for gain reduction to occur.



**Hold.** Once gain reduction has occurred, maintain that condition for the setting of the Hold control.

**Release.** Once the hold time has expired, use the setting of the Release control for the time required to return the gain through the signal path to unity.

**Meter.** A gain reduction meter labeled "Reduction" is provided so that the effect of the ducker can be observed.

#### SPL COMPUTER™

SPL computers allow adjusting program material level based on the ambient noise level. As the ambient noise increases, the program level is turned up as well. Currently a gap-sensing SPL computer module is offered. This module only "listens" to the ambient sense microphone during program material gaps, i.e. when the program level is below a certain threshold. This prevents the module from "hearing" its own output which avoids run-away feedback problems.

Mono and stereo versions have the same controls. The only difference is that with stereo versions, a stereo pair input is routed to selected stereo pairs of outputs.

Inputs:

- **In or In-L and In-R.** Program material inputs. Connect your mono or stereo program material to these inputs.
- **Sense.** Sense microphone input. Connect a signal from your sensing microphone to this input.

Outputs:

- **Out or Out-L and Out-R.** Program material outputs with SPL volume applied. Connect these to your main outputs.  
**Note:** any equalization or dynamics processing you are doing to the program material should be done before it is sent to the SPL computer. Any equalization or dynamics processing done to the program material after the SPL computer could adversely affect the SPL computer algorithm.

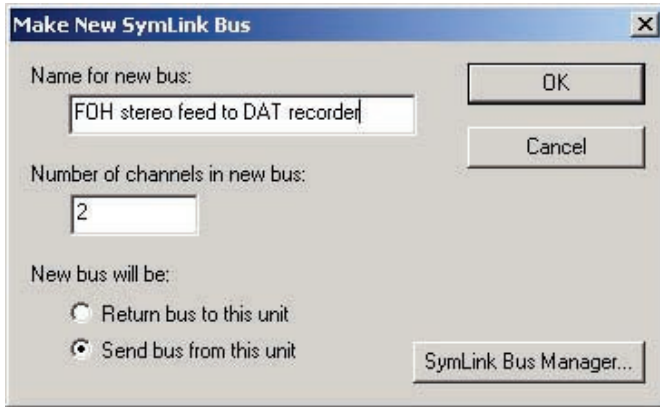
Controls & Indicators:

- **Gain indicator.** The current gain being applied by the module (assuming it is not in bypass) is displayed at the top of the window.
- **Maximum Gain.** Maximum gain in dB that the SPL computer is allowed to apply to the signal. Use this to put a limit on how loud the output can get with very loud ambient levels. Adjust using the slider or click in the text entry box to specify a numerical value. Note: the Maximum Gain cannot be set to a value less than the Minimum Gain.
- **Minimum Gain.** Minimum gain in dB that the SPL

computer is allowed to apply to the signal. Use this to put a limit on how soft the input can get with very quite ambient levels. Adjust using the slider or click in the text entry box to specify a numerical value. Note: the Minimum Gain cannot be set to a value greater than the Maximum Gain.

- **Gain-Sense Ratio.** Controls the change in gain versus the change in the ambient level. Setting this to 1.0:1 means that for every 1dB increase/decrease in the ambient level, the SPL's gain is increased/decreased by 1dB. Higher values such as 2.0:1 mean that the gain is increased by more than the ambient increase, which allows "out-shouting the crowd". A setting of 0.5:1 means that the gain is only changed by 0.5dB for every 1dB ambient change giving a more subtle effect.
- **Speed.** Controls the rate at which the module changes the gain, specified in seconds. Longer times can cause a very gradual fade up or down in response to changing ambient levels.
- **Gap Threshold.** Controls the level under which the program material must be in order for it to be considered a "gap". When the program material is less than this level for at least the Gap Time, the Gap Detect LED will light and the SPL will respond to the ambient level. When the program material is above this level, the SPL will not make adjustments based on the ambient level. This level should be set so that the Gap Detect LED lights whenever the program material is soft enough that the ambient sense microphone does not pick up a significant amount of program material, i.e. the ambient noise dominates the program pick-up. By positioning the sense microphone so to minimize pick-up of the program material you can get away with a higher gap threshold and hence sense more often, e.g. in softer musical passages. If your program material has regular gaps (e.g. a paging signal or background music with clear breaks between songs) you may be able to set this threshold quite low to just above the noise floor of the program material. In doing so, you will only be sensing during actual gaps in the music/paging signal.
- **Gap Time.** Controls the length of time in milliseconds that the program material must be "silent" (below the gap threshold) to be considered a gap. This setting can be used to compensate for the reverberation time of a live room. It can prevent the algorithm for responding to the reverberation tail of a page or other program material. Settings in the 100-200ms range are good for most environments, though very live rooms may require settings of 1 second or more.

- Max Gap Interval. If no gaps occur in the program material in this amount of time, the module forces a gap by momentarily muting the audio.
- Gap Detect LED. This LED lights when a gap is detected and the module is responding to the sense input.
- Force Gap Now button. Pushing this button forces a gap and sense immediately by momentarily muting

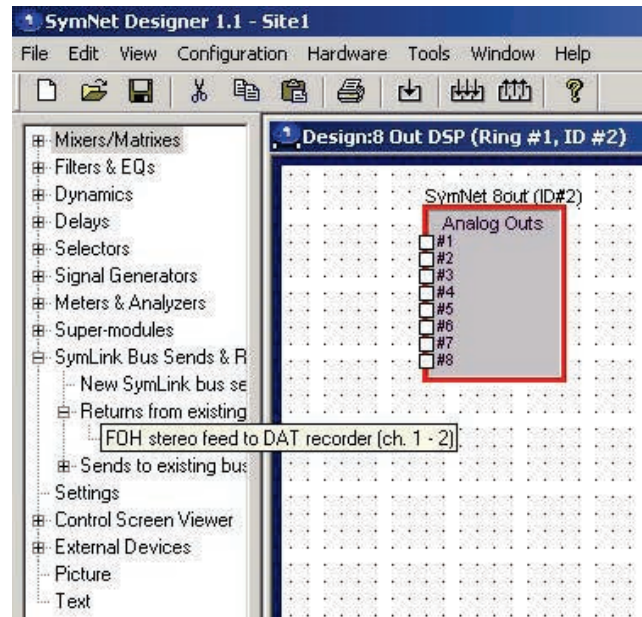


- the audio.
- Bypass button. Pressing the button bypasses the module so that the input(s) are sent unmodified to the output(s).
  - Sense threshold controls. The threshold sets the sense input level at which the module applies unity gain. This should be set to the average or typical ambient level of the room during calibration. A meter displays the current sense RMS input level as a reference. Use the fader or numerical entry to adjust the threshold. The calibrate button forces the threshold to be set to the current meter reading. Ideally, calibration should be done with an average ambient level and no program material playing.
  - Sense Statistics controls. A readout is provided showing the highest and lowest sense values logged since the last reset. Sense values are only logged during gaps. Pressing the Reset button clears these values. Use this feature to monitor the ambient noise levels in a room over time.

#### DELAYS

SymNet has three different delays in its toolbox, in both mono and stereo versions. They differ in the delay range: 0-2 milliseconds, 0-340 milliseconds, and 0-2 seconds. You enter the delay time either in milliseconds, feet, or meters. The speed of sound is temperature dependent, and you can enter the ambient temperature if you wish. The default setting is 68F.

#### ROUTERS



This family of modules allows flexible routing and selecting of signals, from many inputs to one output or from one input to many outputs.

**Input Selectors.** The input selectors are selector switches. 2, 4, 8, and 16 input versions both mono and stereo are provided. Exactly one of the inputs is routed to the single output. When the input selection changes, a quick crossfade occurs to ensure a smooth transition without any clicks or pops.

Mono and stereo versions have the same controls. The only difference is that with stereo versions, multiple stereo pairs of inputs are routed to a stereo pair output.

Controls:

- Input buttons. One button per input is provided. Pushing the button selects the corresponding input.
- Input slider. This control can also be used to select the input. It is provided primarily for external control. If you are controlling an input selector from an ARC, analog pot/switch, or other external controller, assign this slider to an external control rather than the individual input buttons.
- Mute. This button smoothly mutes the output of the selector, effectively selecting a silent audio source.

A space is provided to name the inputs. Click in the box adjacent to the button and enter a name. The name entered will also appear on the module's input labels.

**Note:** unlike an electromechanical switch, you can't run these selectors backwards; i.e. as output selectors. A separate output selector module is provided for this application.

**Output Selectors.** The output selectors route a

single input to exactly one output. 2, 4, 8, and 16 output versions both mono and stereo are provided. When the output selection changes, a quick a fade out and simultaneous fade in occur to ensure a smooth transition without any clicks or pops.

Mono and stereo versions have the same controls. The only difference is that with stereo versions, a stereo pair input is routed to one of several stereo pairs of outputs.

Controls:

- **Output buttons.** One button per output is provided. Pushing the button routes the input to the corresponding output and “unroutes” it from any other outputs. Only one button can be pushed at a time.
- **Output slider.** This control can also be used to select the output. It is provided primarily for external control. If you are controlling an output selector from an ARC, analog pot/switch, or other external controller, assign this slider to an external control rather than the individual output buttons.
- **Mute.** This button smoothly mutes all outputs of the selector.

A space is provided to name the outputs. Click in the box adjacent to the button and enter a name. The name entered will also appear on the module's output labels.

**Note:** If you need to route an input to several different outputs at once, use an output distributor module instead.

**Output Distributors.** The output distributors route a single input to some, all, or none of a group of outputs. 2, 4, 8, and 16 output versions both mono and stereo are provided. When an output setting changes, a quick a fade out or fade in occurs to ensure a smooth transition without any clicks or pops.

Mono and stereo versions have the same controls. The only difference is that with stereo versions, a stereo pair input is routed to selected stereo pairs of outputs.

Controls:

- **Output buttons.** One button per output is provided. Pushing the button routes the input to the corresponding output. Any number of buttons including all or none can be pushed at once.
- **Mute.** This button smoothly mutes all outputs of the distributor.

A space is provided to name the outputs. Click in the

box adjacent to the button and enter a name. The name entered will also appear on the module's output labels.

**Note:** If you want to route an input to exactly one output at once, use an output selector module instead.

SIGNAL GENERATORS

SymNet Designer has noise (pink and white) generators as well as tone (sine, square, sawtooth or triangle) generators. Pink noise has equal energy per unit bandwidth. Viewed on a constant-bandwidth spectrum analyzer (RTA), it has a flat frequency spectrum. White noise has equal energy per unit hertz. Because of the way that our ears evaluate the loudness of sounds, white noise sounds like it has more high frequency energy than low frequency energy. Viewed on a constant bandwidth spectrum analyzer, white noise has a spectrum that increases in amplitude at 3dB/octave.

These noise and tone generators are a little bit different from traditional test instruments. They are meant to go inline (series) with a signal. When the generator is set to Bypass, the input connects to the output. When the generator is taken out of bypass mode, then it's signal appears at the output. This lets you insert the generator for testing, without having to use one of the selector modules to insert it. All of the generators have output level controls, and the tone generators have frequency controls as well.

The sine tone generator can provide a constant or swept frequency sine wave output. The controls are:

- **Level.** Adjusts the peak output level in dBFS. Adjust using the slider or click in the text entry box to specify a numerical value. You can also use one of the six buttons to choose a preset level.
- **Frequency.** Controls the frequency of the tone generator. Adjust using the slider or click in the text entry box to specify a numerical value in Hz. You can also use one of the five buttons to choose a preset frequency. In sweep mode, the frequency slider moves to indicate the current frequency.
- **Sweep button.** Puts the tone generator in sweep mode. The sweep controls discussed below affect the sweep. Pressing the button while a sweep is in progress stops the sweep at the current frequency.
- **Sweep Start.** Sets the starting frequency of the sweep in Hz.
- **Sweep End.** Sets the ending frequency of the sweep in Hz.

**Note:** for a downward sweep, make Sweep Start

larger than the Sweep End.

- **Sweep Time.** Controls the time to complete the sweep in seconds.

**Note:** Adjusting any of the above three sweep parameters while a sweep is in progress will cause the sweep to start over.

- **Repeat button.** When turned on, this causes the sweep to restart immediately after it finishes. When off, the tone generator will remain at the Sweep End frequency when the sweep finishes.

**Bypass.** Pressing this button routes the input to the output and turns off the sine wave generator. If no input is present, this effectively mutes the tone generator.

#### METERS & ANALYZERS

SymNet Designer provides various ways to graphically see what is going on inside the SymNet hardware.

The SymNet Meters are modularly configurable bar graph style meters, using peak detection. They span a range of +0dBFS down to -72dBFS. There are no controls.

The SymNet Oscilloscopes are used to obtain waveform information. Both single and continuous triggering is provided, as well as an Auto-Range feature which expands and contracts the vertical display range, allowing both large and small signals to be conveniently tracked and displayed. This feature can be turned off, making the vertical range fixed at full scale. The oscilloscope operates like a traditional oscilloscope, meaning that the signal level corresponds to a voltage level in the analog world.

#### SUPERMODULES

Super-modules A super-module is a collection of SymNet modules configured to do a particular task. The super-module wraps this set of modules into a 'magic box' that has input and output terminals. Use this if you have a particular set of processing to do and need to repeat it through your system. Double clicking a super-module reveals its insides and allows setting individual processors.

You can use a control screen or screens to control selected parts of the super-module functionality.

The Super-module Manager (Tools/Super-module Manager) lets you delete, export, import, and rename super-modules.

To create a Super-module:

- Click on Super-modules located in the Toolkit.
- Click on Blank Super-module.

- Specify the number of inputs and outputs you want in the dialog box.

- Click OK.

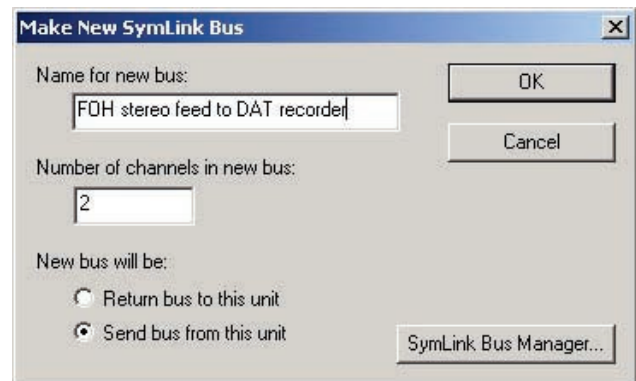
If you wish to increase the number of inputs or outputs in your Super-module, add a new Super-module Input or Output from the tool-kit. If you wish to decrease the number of inputs or outputs in your Super-module, delete an input or output block from the Super-module.

**Note:** When deleting an I/O block, the remaining blocks will be re-numbered so they remain consecutive.

#### SYMLINK BUS SENDS & RETURNS

(see also [CobraLink Overview](#))

The bus send and return modules let you send and return signals via the SymLink bus that interconnects

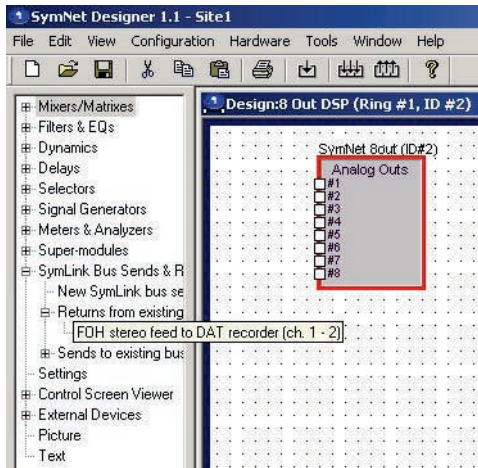


all of the SymNet units in a system. You can bus up to 64 channels of 32 bit floating point digital audio between the physically separate hardware units. You do this by placing bus interface modules as needed in a design. A bus module provides a gateway to any other unit on the SymLink bus having a correspondingly named bus interface module. This allows individual designs to be kept to a manageable size, while providing a mechanism to build huge multi-unit architectures. SymNet Designer allows the user to download an updated design to all units on the SymLink bus at once while keeping all designs in a single computer file as well as in non-volatile hardware memory.

To add a new bus send/return module to a design:

1. Access the Bus Sends and Returns in the Toolkit.
2. Drag a New *SymLink Bus Send/Return* module from the Toolkit onto your design.
3. Within the *Make New SymLink Bus* dialog box, give your new bus a name, specify the number of channels,

and specify whether it is a send or return bus.



To use an existing bus send/return module in a design (assume, for example, that you've added and named a send bus to get signals onto the bus and now it's time for the return bus to get signals off the bus in another hardware unit):

1. Select *SymLink Bus Sends and Returns* in the Toolkit.
2. Under *SymLink Bus Sends and Returns* select *Returns from existing buses*.
3. Locate the name of the send bus you just created and drag it into your design making the appropriate connections. You can also create, modify, or delete SymLink buses using the SymLink Bus Manager found under the menubar item Tools.

## SETTINGS

The Settings section in the Design Toolkit is used in conjunction with the Settings File Manager.

Settings are a list of module or device parameter values. They can be saved on a module or a device basis. They are useful for copying pre-existing modules or duplicating settings from one device to another.

Once a Settings file has been named in the Settings File Manager, it will appear in the design toolkit list, at both the Configuration View level and the Design View level.

In Design View level, after right clicking on a SymNet device, you can load or save those device's design settings to either a Configuration file or to a Settings file. Similarly, in Design View level, after right clicking a module that contains user variable parameters, you are given the option of loading or saving those parameter values.

## CONTROL SCREEN VIEWER

The Control Screen Viewer contains a list of Control Screens for SymNet Designer.

Controls Screens provide a way to simplify and condense the SymNet user interface, so, for example, the user is limited to a range of controls, and will not have to and/or be allowed to adjust certain parameters in the system.

To add a Control Screen at the Configuration View or Design View level, simply select Blank Control Screen from the design toolkit and drag onto the appropriate view space.

You can add External Devices, Pictures and Text to the Control Screen by dragging from the design toolkit onto the Control Screen.

To add controls and displays from modules, you need to open to module contain the control or display you wish to add, and right click on that item. You then have the option of copying to any of the available Control Screens. Once added to a control screen you then have the option of opening that screen and dragging the item to wherever you desire.

## PRESET RECALL BUTTON

There are 16 preset recall buttons in SymNet Designer, one button for each of the 16 SymNet system presets which are stored in the SymNet hardware.

Preset recall buttons can be dragged and dropped into configuration views, specific unit design views, or onto control screens.

## EXTERNAL DEVICES

External Devices can be added to a Configuration View, Design View or Control Screen. They are a collection of small images used to add details of external devices which may be connected to a SymNet system. They can assist with documenting system level design features.

If more devices are required that are not included with SymNet Designer, then Picture or Text objects can be added by the user.

## Real Time PC Control

### CONTROL SCREENS

A control screen allows you to copy displays (meters and graphs) and controls (sliders and switches) from a SymNet module for the purpose of creating a custom control screen. You have the ability to copy only the controls you want, allowing you to hide the remaining controls out of harm's way. You can add text and pictures (using bitmap files) as needed. Use this to create simplified groups of controls that allow your user to adjust or access things that are needed for operation, but preventing access to parameters that shouldn't be user adjusted.

You can create or edit a control screen using the [Control Screen Manager \(Tools Menu\)](#).

You can create or edit a control screen directly from a DSP module. Open the DSP module and choose the control that you want to add to your control screen. Right click on the control and choose 'Copy (*name of control*) to Control Screen'. You can choose a new or existing control screen. With the control screen open you can move and size controls and add labels to identify the controls. Control screens are automatically saved with the site file.

### CREATING AND CONTROLLING PRESETS FROM SYMNET DESIGNER

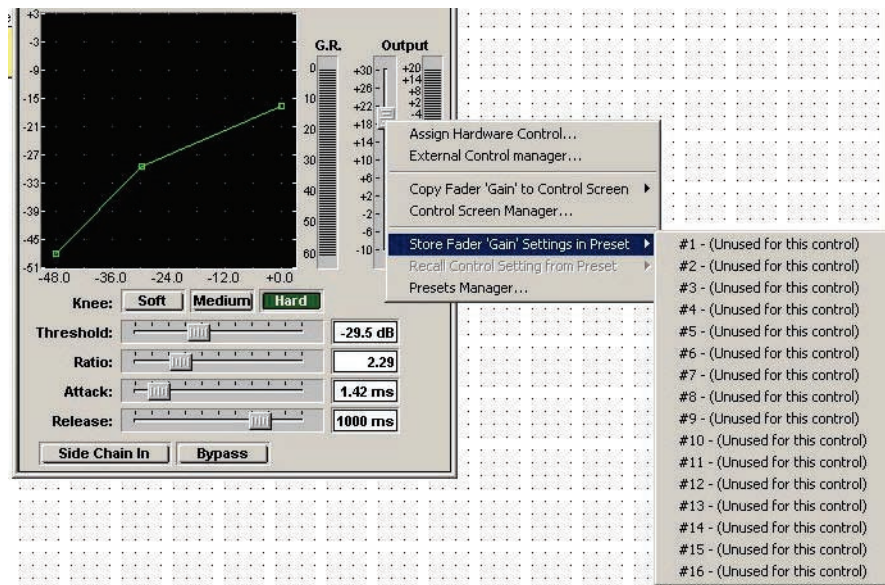
(Note: For details on how to select presets from external controllers study the SymNet RS-232 & RS-485 Control Protocol.)

Most SymNet DSP module controls can be directly assigned to presets. These controls include faders and buttons. 'Radio buttons', or buttons that select one of several settings, typically cannot be directly assigned to presets.

Note: The control settings for entire DSP modules may be assigned to presets although there is a downside to this in terms of system response time. Since the presets stored in SymNet hardware can respond to either PC control or external RS-232 or RS-485 control or both, storing unused control settings in presets will slow system response because of the unnecessary serial data transmission.

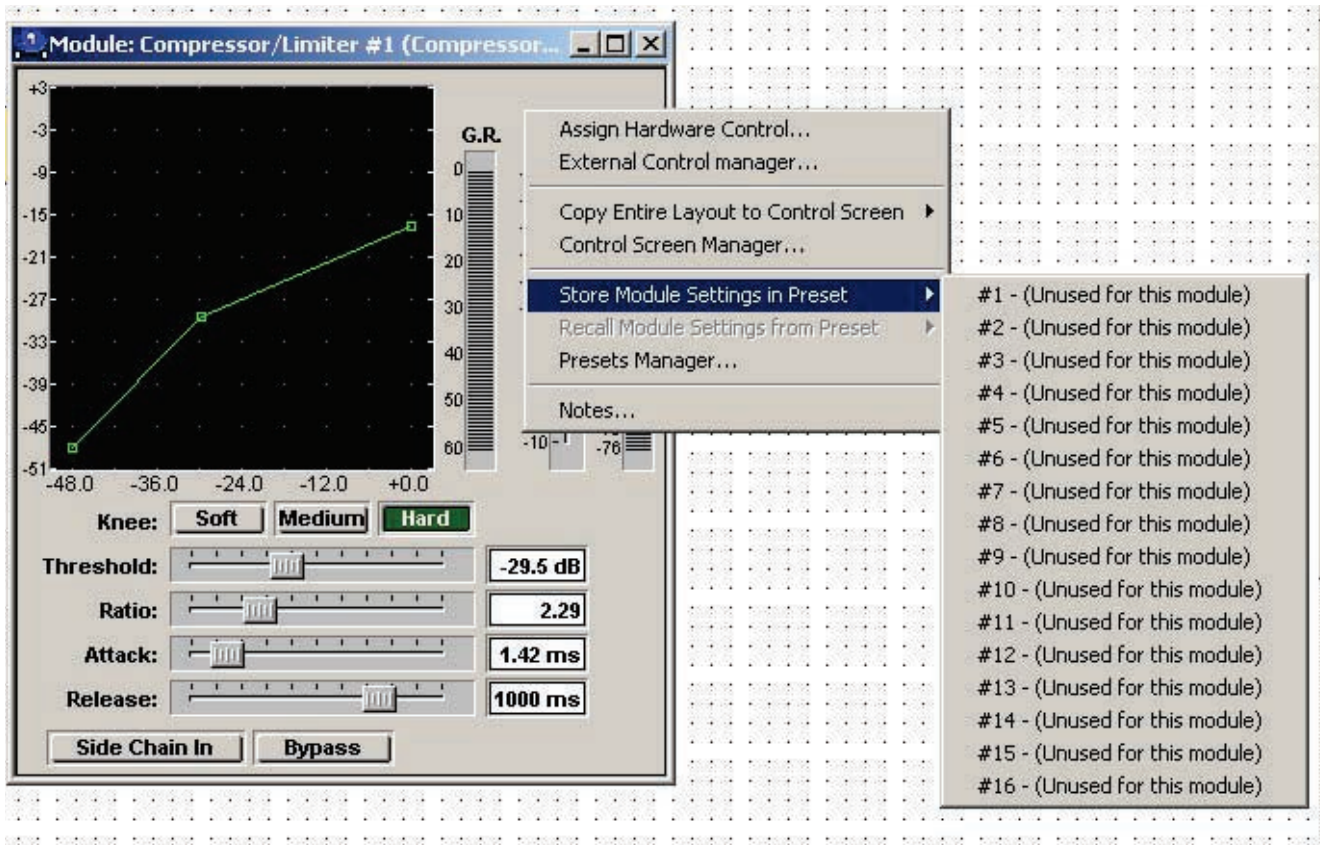
To assign a control parameter to a preset from within a DSP module do the following:

- Left click to select the desired control.
- Right click the selected control.
- Highlight 'Store Fader (or Button) 'Control Name' in Preset'
- Left click the desired preset (1-16)



To assign the control parameters from an entire DSP module to a preset do the following:

- Left click on the background of DSP module window avoiding any controls or display boxes.
- Right click and highlight 'Store Module Setting in Preset'.
- Left click the desired preset (1-16).





## Appendix

### Bibliography

For additional information, refer to the following books and publications:

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- R. Schulein, "In Situ Measurement and Equalization of Sound Reproduction Systems," *J. Audio Eng. Soc.* V23, p178 (1975)
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### Delay

Aside from a replacement for tape slap echo, the most common use for time delay in a sound system is acoustical alignment. It doesn't really matter if you're micro-aligning a center cluster or equalizing the arrival time of sound emanating from a nearby fill speaker, you're still using time delay.

SymNet's A/D and D/A converters force a minimum delay of about 1.3 mS. So, although the SymNet Designer software allows you to set extremely short delay times, the time shown does not include the conversion delay. Furthermore, the minimum delay increments are limited to integer multiples of the period of the sample rate (20.8 microseconds/0.2809 inches/7.134mm).

**Note:** If you are using the delays for loudspeaker source alignment, you can ignore the conversion delay since it affects all delayed outputs equally. You may still need to consider it when setting the arrival time of the

loudspeaker system relative to the acoustical source.

For arrival time equalization, the SymNet has a range of about 2300 feet (690 meters) down to under one inch (6mm). Since the user interface accepts distances, simply enter the distance between the two sources. Press the Enter key. Now add approximately 20 milliseconds (Haas effect) to the time shown in the delay time window. If you can measure the arrival time difference, your ears may tell you differently in some cases. Trust your ears.

You can compensate for ambient temperature by changing the temperature shown in the Environment window. For most short delays, you can ignore the variation in the speed of sound caused by temperature. Don't forget to consider the conversion delay (especially important for short delay times).

### Equalization

A carefully equalized sound system blends electro-acoustic controls with the acoustics of the space. Careful design requires paying attention to detail, knowing when to ignore something and knowing when to stop. It is definitely not something you can do in five minutes with a real-time analyzer, SMAART, TEF, or other analysis tool. The fundamentals of this process aren't necessarily complicated but they can sometimes be tedious.

- **Aiming.** Take the time to ensure that the loudspeakers cover the listening area. Walk the area with a sound level meter. A good system should vary no more than +/-2dB front-to-back and +/-2dB side-to-side. Use your ears as well, listening for obvious changes in timbre as well as comb-filter effects. If there are any coverage problems, solve them before attempting any sort of system equalization.
- **Balance.** Adjust the crossover's balance controls for flattest response between the various system elements (low and hi, low, mid, and hi, etc.).
- **Rough tuning.** Place the measurement microphone in a typical audience seating location. Make a measurement. Save it. Move the microphone to another location. Repeat the measurement and storage process. You'll want to measure several locations that represent a reasonable sample of the listening area. In large systems, you'll need to do this by zones (assuming that each zone has its own equalizer). Now average the stored curves and plot the result. This average curve is the inverse of the curve that you'll need to create using the equalizer.

You can make this less time consuming by using a microphone multiplexer and several microphones located in different locations. If you see a major dip or peak during any individual measurement, be sure to move the microphone to check for room nodes or cancellation caused by a nearby reflecting surface.

- *Fine tuning.* It's time to listen now. You may want to alter the rough tuning slightly in the interests of making the system sound more natural. You may need to change the basic high-frequency/low-frequency balance of the system, either via the crossover or via the equalizer.
- *Do not* apply large amounts of boost in an attempt to 'fill-in' a hole in the response. This hole may be caused by some acoustic phenomenon within the room. Equalization won't fix it. It will make things worse. If necessary, you need to find the source of the absorption and remedy it.
- *Feedback tuning.* With a live microphone(s), bring the sound system gently up to feedback.

**Clever and sneaky trick:** if you have a compressor in the system, temporarily set its ratio as high as possible and lower the compression threshold. This will keep the system from running away with itself as you approach feedback.

- If you hear the system ringing at two frequencies simultaneously, you're probably done. Check the acoustic gain. If necessary, add a small amount of attenuation to reduce the gain at the feedback frequency. Raise the gain again. You should stop when the system rings at two or more frequencies simultaneously. Again, listen to the system and make adjustments needed for naturalness. A persistent gain-before-feedback problem may be the result of poor aiming way back in the beginning of this process.
- If you used the clever and sneaky trick, be sure to restore the compressor settings.

### Sidechain

The SymNet Designer compressors, limiters, expanders, gates, and duckers have sidechain inputs. In any dynamics control device (analog or digital), there is an audio path and there is a control signal path. The control signal path represents the conversion of the audio signal level into a gain control signal. In most dynamics devices, the input signal is also the input signal to the control signal processor.

A useful tool is the ability to modify the signal used

by the control signal processor. For many dynamics devices, modifying the frequency response of the sidechain signal can help prevent extraneous signals from causing unwanted gain reduction.

- A compressor with its sidechain signal driven by a split from a microphone signal reduces its gain in response to the microphone signal level; a rudimentary ducker.
- Putting a highpass filter in series with the sidechain signal into a compressor can help prevent the compressor from punching holes in the signal in response to a P-Pop into a microphone.
- A gate, with its sidechain (or key) signal driven from another source means that the key signal must be present for the gate to pass its signal.

The SymNet Designer sidechain connections are unique because they auto-detect when there is a signal connected to their sidechain input. If you connect nothing to this terminal, then the sidechain gets its signal from the input terminal. Connect something to this terminal and that signal is the sidechain signal.

### SymNet™ Technology Overview

A technical paper written by engineers, for engineers. No advertising hype guys or spin doctors were allowed to contribute to this brilliant technical compendium. The following document may or may not have been spell checked. We prefer to spend our time working on the important stuff.

SymNet™ Designer is the Windows Application that configures and controls the SymNet™ Audio Matrix Hardware. SymNet™ Designer uses CAD technology to allow the audio system designer to construct digital audio processes much like electrical engineers design hardware. The designs generated by the designer are quickly compiled and downloaded to the target hardware in a single button press.

Our CAD approach doesn't limit the system designer to a collection of processes, or even a set of collections, pre-determined at the factory. The user is able to, module by module, select any number of processes needed to perform a particular job. A "Run time linker" is used to facilitate this flexibility. The DSP processing code for each process is modularized in a code file. When the user downloads the design, the code files for all the modules chosen are dynamically and automatically placed on one of four powerful floating point DSP engines within each hardware SymNet™ hardware unit. DSP and memory resources are assigned to each instance of each module in the design, as they are available. In addition, the

connections between modules are implemented by “linking” the memory locations of different modules. Much like a CAD program, SymNet™ Designer maintains a “Net List” or connection list between processing objects. This Net List can be viewed or printed as a list of point-to-point connections. SymNet™ is also capable of performing electrical rules checking which graphically highlights connections that the user has made which cannot be interpreted.

Connections are not limited to these automatic connections within a single hardware unit. The user can buss up to 64 channels between the physically separate hardware units. He does this by placing bus interface modules as needed in a design. These bus modules provide gateway to any other unit on the SymLink bus which has a correspondingly numbered bus interface module. This allows individual designs to be kept to a manageable size, while providing a mechanism to build huge multi-unit processing architectures. SymNet™ Designer allows the user to download an updated design to all units on the SymLink Bus at once while keeping all designs in a single file or hardware preset.

SymNet™ Designer is a full-featured application providing all the features power users of CAD programs have come to expect. This includes drag and drop editing, multi-level undo and redo, programmable auto-save, wire-frame select, and the ability to customize the interface to particular markets through the use of color, fonts, bitmaps, and added text.

Of particular interest is our Control Set View. This feature allows the contractor to create custom control screens that can be created by the contractor, but operated by the end-user. Advanced security features allow end-user access to just those control aspects that the contractor or system designer deems allowable.

Super-modules are another of SymNet's™ advanced features. Super-modules allow complex multi-module designs to be created labeled and represented as one module on screen. These super modules can then be placed repeatedly in one or more designs as needed.

Our Preset Management System allows the contractor to develop value added customized presets that can, in turn, be marketed to end users or other contractors. Module, super-module, and site presets can be customized and collected into Preset Files. Any number of Preset Files can be dynamically loaded on a system at one time.

SymNet™ Audio Matrix Floating point DSP hardware available in various input/output configurations. Analog Signal Path The SymNet™ analog input and output

circuitry has been designed with both a high degree of flexibility and maximum audio quality in mind. Fully balanced connections are used throughout, and high quality 24-bit converters are used for both inputs and outputs.

Analog input section The analog input section accommodates signals with nominal levels of –50dBu to +4dBu. By default, headroom is 20dB, meaning for example, that with a +4dBu reference level, signals up to +24dBu can be passed without clipping. The analog input section provides the analog to digital converter (ADC) with a signal that is as hot as possible without ever clipping. Signals are connected via detachable, balanced Euro-block connectors. The first thing in the analog input path is a high-precision, low-noise pre-amplifier circuit. It provides up to 54dB of gain. Its function is to boost low level signals (microphones, instrument inputs, consumer line-level signal, etc.) so that thereafter, all signals are nominally +4dBu. The pre-amplifier has four switchable gain settings as follows: +54dB for low-level microphone inputs +44dB for hotter microphone inputs +11.8dB brings consumer line-level signals at –10dBv up to +4dBu unity gain for professional line-level signals already at +4dBu.

Following the pre-amplifier, there is digitally controlled volume control circuit that provides fine-tuned gain in 0.5dB steps. This is used to fine-tune the input signal level if it doesn't exactly match one of the pre-set levels. Furthermore, the user may use this chip to increase or decrease head room. For example, if an input signal doesn't have much dynamic range, a gain could be applied so that the signal applied to the ADC is closer to 0dBFS. This arrangement allows the user flexibility in constructing the optimum gain staging for his application.

A/D Conversion Following the volume control chip, the signal is digitized by the ADC. An advanced 24-bit 128x over sampling DS converter is used. This chip uses an enhanced dual-bit architecture, which achieves wider dynamic range, but still keeps much the same superior distortion characteristics as conventional single bit ADCs. Following the ADC, the signal is kept in the digital domain for all processing, until it is sent out the analog output section.

Analog output section The first stage of analog output section is the digital to analog converter (DAC). SymNet™ utilizes advanced 24-bit 128x oversampling DS ?converter. Like the ADC, an enhanced dual-bit architecture is used, which achieves wider dynamic range, but still keeps much the same superior distortion characteristics as conventional single bit DACs. Following the DAC, there is a volume control section

that provides gain changes from -95.5dB to +31.5dB in 0.5dB steps. This allows the user to match the output level to a wide variety of devices, from +4dBu professional devices to microphone-level inputs with no external level-shifting required. With the volume control set to unity gain (0dB), the output section is calibrated for +4dBu operation with 20dB headroom. This means that a digital signal of 0dBFS corresponds to a +24dBu output signal. If other signal levels are required, this is easily accommodated by changing the volume. Following the volume control, the signal is output on balanced Euro-block connectors with an output impedance of 300 ohms.

**Floating Point DSP** SymNet™ makes use of Analog Devices SHARC DSPs, which use 32 and 40 bit floating point processing. Compared to 24-bit fixed point processing used in other devices (typical of Motorola DSP chips), floating point processing offers significant benefits to the user in both audio quality and ease of use.

**Limitations of fixed point processing** A problem with fixed point processing is that if significant gain changes occur, data loss or, worse-yet, clipping distortion can occur. For example, consider the case of processing a 24 bit audio signal using 24 bit fixed point processing. If in some process, you attenuated the signal by 42 dB, the new signal would have only 17 bits of information in it. Seven bits have been lost forever due to the gain reduction. Worse yet is the problem of clipping distortion. If a significant gain is applied to a signal that is already near 0dBFS, the signal will be clipped at 0dBFS resulting in audible distortion. Even if another process downstream reduces the signal level back to what would have been below 0dBFS, the clipping has already occurred the distortion remains. Fixed point processes may try to build in some headroom above 0dBFS, but in doing so they must inevitably give up some bits to do so. For example, if 12dB (2 bits) of head-room was built in, a 24-bit system now is only really a 22-bit system.

**How floating point processing works** In contrast, with floating point processing, all available bits are always allocated to the signal regardless of the signal level. Basically, floating point uses a few bits as an exponent to set the "rough" signal level and then allocates the rest of the bits to storing the actual signal value independent of level. Hence, regardless of the signal level, from -200dB and below to 100's of dB above 0dBFS, the signal is stored with optimum precision and no clipping distortion. The SHARC offers both 32-bit and 40-bit extended precision processing. With 32-bit processing there are 25 bits allocated to storing the

signal regardless of level. This means that the precision is always better than 24 bit fixed point by at least one bit, and at low signal levels, by significantly more.

With 40 bit extended precision processing, 33 bits are available to store the signal. In SymNet™, 40-bit processing is used within DSP modules, and the data is converted to 32 bit when routed between modules or over the SymLink bus.

**Practical benefits of SymNet's™ floating point processing** What practical benefit does using floating point processing give the user? Gain staging issues between multiple processing modules can be ignored. If one module reduces the signal level by 50dB and another process later on boosts it back up, no data loss will occur. If a module applies a huge gain, and a later module reduces it back down, no clipping distortion will occur. With fixed point systems, the user must be careful with signal levels to avoid clipping and excessive data loss at every processing module output. The one place where the user must watch the signal level is just before it is sent to the DAC, since all DACs are fixed point. In the SymNet™ system, if you noticed that your signal was clipping just before it was being sent to the DAC, you could turn it down right at the output to fix the problem. With fixed point systems, you would need to search back through every processing module to find the source of the clipping.

**SymLink Bus** A SymNet™ system is comprised of one or more SymLink hardware units connected by a common bus. This bus is known as SymLink.

**Topology** A closed ring topology is implemented between multiple SymNet™ units. Each unit has two unidirectional SymLink ports. One port is an input port and is intended to connect to an upstream neighbor. The second port is an output port is intended to connect to the downstream neighbor. The result is a ring of data flow.

**Electrical** The SymLink bus uses low-voltage differential signaling (LVDS) as defined in the TIA/EIA-644 standard. This standard allows for high data rates with reduced power consumption and EMI emissions. SymNet™ uses standard, low cost 100-ohm shielded CAT5 cable. This cable consists of four twisted pairs with a shielded jacket.

# Index

## Symbols

8x8, 8in, 8out 9  
8x8, 8in, 8out installation 10

## A

AGC 61  
Analog Control Inputs 29  
Analyze (Ctrl+A) 49  
Architects and Engineers Specifications 4  
ARC (Adaptive Remote Control) 25  
ARC Power Supply (ARC-PS) 28  
Automatic Gain Control 61  
Automixers 52  
AutoSave 41

## B

Binary and Relay Outputs 36  
BreakIn12, BreakOut12 Installation 22  
BreakIn12, BreakOut12 Overview 22

## C

Calibrate Analog Controls.. 44  
Clear Error Symbols (Ctrl+E) 49  
Clock 45  
CobraLink Hardware Installation 20  
CobraLink Overview 16  
CobraNet Bundle Manager... 48  
Combiners (Room Combiners) 55  
Communications 41  
Compressor/Limiters 60  
Configuration Menu Commands 43  
Configuration View 50  
Contact Information 5  
Contents 1  
Control Screens 69  
Control Screen Manager... 48  
Control Screen Viewer 50, 69  
Copyright, Trademarks, Notices 8  
Copy (Ctrl+C) 42  
Cut (Ctrl+X) 42

## D

Delays 65  
Delete (Del) 42  
Design View 51  
DeviceAddress 14  
Device Addressing 17  
Downloading 41  
Duplicate (Ctrl+D) 43  
Dynamics 60

## E

editing wires 39

Edit menu commands 42  
Edit Mode (F9) 48  
EQs 57  
Event Scheduling Manager... 48  
Expander Gates 63  
External Control Manager... 48  
External Devices 50

## F

Factory Contact Information 5  
File menu commands 40  
Filters & EQs 57

## G

Gains 51  
Gates 63  
Glossary 3

## H

Hardware Menu Commands 44  
Hardware Overview 9  
host computer requirements 37

## I

Interconnecting Multiple Units via Sym-  
Link™ 24  
Inverters 52

## L

Label... 43  
Limiters 60  
Load Design Settings... 43

## M

Matrixes 51  
Menu Bar 40  
Mixers 51

## O

Output Switch Manager... 48

## P

Paste (Ctrl+V) 42  
Preferences... 41  
presets 69  
Presets Manager... 48  
PRESET RECALL BUTTON 50, 69  
Programmable Filters 59

## R

Real Time PC Control 69  
Recall Configuration... 44  
Redo (Ctrl+Y) 42  
Release Highlights 6  
Routers 65  
RS-232 & RS-485 29

RS-232 control via PC 15

## S

Save Design Settings... 43  
Security 45  
Select All 42  
serial (COM) port settings 37  
serial somunication 37  
Settings 50, 69  
SHARC® Floating-Point DSP 9  
Signal Generators 66  
Software Installation 37  
SPL Computer™ 64  
Super-module Manager... 48  
Supermodules 67  
SymLink Bus Manager... 48  
SymLink Bus Sends & Returns 67  
SymNet Control Protocol 29

## T

The Toolkit 50  
Tools Menu Commands 48  
Triggers and Power On Default... 43

## U

Undo (Ctrl+Z) 42  
Update and View Netlist 48  
Upgrade Firmware... 45, 46

## V

View Menu Commands 43

## W

Window Menu Commands 49  
wire logic 37