



Lattis Matrix Switcher

1600 and 800 Series Owner's Manual

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Introduction

Thank you for selecting a Vaux Lattis Matrix Switcher. These systems have been designed for the utmost in performance and reliability. There are currently four models in the Lattis Matrix Switcher family:

LE-800A	8-source by 8-zone, audio-only	LE-800AV	8-source by 8-zone, audio/video
LE-1600A	16-source by 16-zone, audio-only	LE-1600V	16-source by 16-zone, video-only

The LE-800A, LE-800AV, and LE-1600A systems provides high-fidelity stereo line-level switching, zoned volume/bass/treble/muting, programmable min/max/mute/initial-volumes, and other customizable features. The systems may be controlled using infrared remote controls, keypads, and/or RS-232 serial control from a computer or other control system (e.g. AMX, Crestron...). The source inputs are driven from any line-level source, while the volume-controlled zone outputs connect to power amplifiers for each stereo zone. In the case of the LE-800AV and LE-1600V, the video switching is line-level composite video, for NTSC or PAL systems.

Matrix Switching and Zone Expansion

The Lattis Matrix Switcher is a multi-source/multi-zone audio (or audio/video) distribution and control system. A Lattis system allows multiple audio (or audio/video) sources to be routed to multiple zones (one or more rooms). Each zone of the system has independent control over source-selection, volume/bass/treble levels, muting, etc.

Multiple Lattis Matrix Switchers may be combined to expand the number of zones. For example, three 16x16 Lattis LE-1600A switchers may be use to provide a 16-source by 48-zone system. The units are simply programmed to respond to different “Base-Zones,” (1, 17, and 33) allowing contiguous zone numbers from 1 to 48. A Vaux system may expand this way to a total of 255 zones. The audio sources may be daisy-chained between multiple Lattis Matrix Switchers by ordering the optional ribbon-cable expansion kit. If your switcher does not have the ribbon-cable option, you may use “Y-cables” to split each channel to multiple Lattis inputs, or a “Distribution-Amp” (DA) may be used to buffer each source for driving multiple switchers. For video sources (when using a Lattis LE-800AV or LE-1600V), a DA is not needed since each source has a buffered output which is used to connect to the video input of the next switcher. With video signals, a Y-cable cannot be used since it is mandatory to maintain proper 75-ohm video line impedance. You may also mix and match Lattis switchers to provide different features. For example, an 8x8 audio-only LE-800A may be combined with an 8x8 audio/video LE-800AV, providing eight sources by sixteen zones (eight of these zones have video).

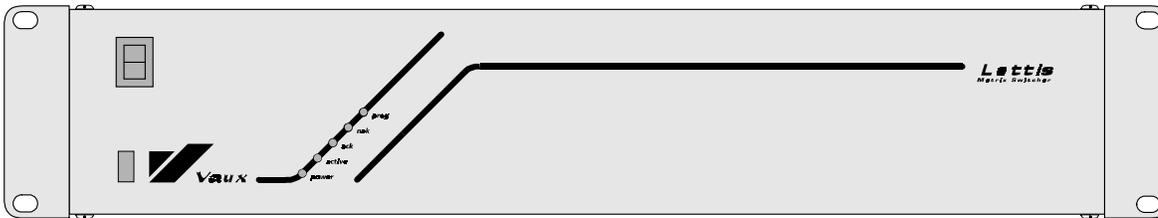
IR Remote Control and Keypad Operation

Lattis Matrix Switchers may be operated by hand-held Vaux RC-16-IR infrared (IR) remote controls. The remote controls allow selection of A/V source, adjustment of each zone’s Volume/Bass/Treble levels, as well as system setup and programming functions. The Vaux RC-16 remote control is easily programmed to control one specific numbered zone – the remote’s zone number may easily be changed to move the remote to a different room. IR control from multiple rooms will require a wired or wireless IR-Repeater system, which uses IR sensors in each room. The Vaux RC-16-IR remote may also be used to teach the Vaux control codes (for one zone) to a third-party hand-held “learning” remote. Additionally, third-party IR-learning keypads may also be employed, using a Vaux RC-16-IR remote to teach the Lattis commands to the keypad.

Computer Control Systems

The Lattis Matrix Switcher may be completely controlled by an attached computer, or other control system (such as AMX or Crestron) which communicates over a serial, RS-232 connection. The host computer has complete control over A/V zone switching, volume/bass/treble levels for each zone, etc. The Lattis system sends messages to the control system confirming actions for not only RS-232 commands, but also for RF-, IR-, or keypad-generated commands, closing the loop on the whole system. The control system may optionally poll periodically for system status, or may simply ignore messages for a basic command-only interface. Serial communication uses the VauxProtocol standard, presented later in this manual.

Lattis Matrix Switcher Front Panel



Power Switch

Infrared Control Sensor (below switch, left of logo)

Power light

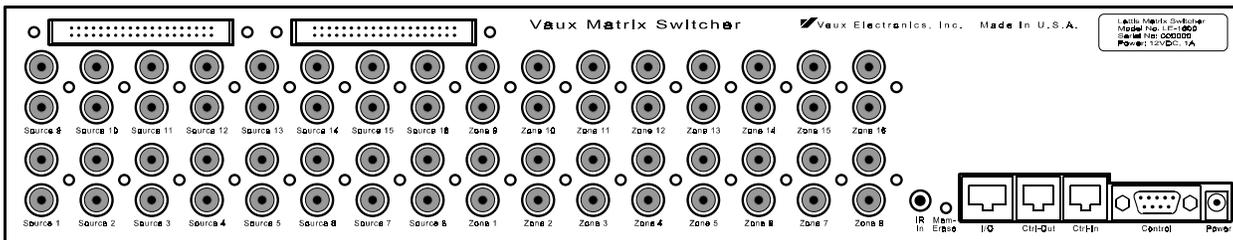
Active light (one or more zones on)

Ack light (acknowledge – command accepted)

Nak light (negative acknowledge – command ignored)

Prog light (power-up testing and program-mode)

Lattis Matrix Switcher (LE-1600A) Rear Panel



A/V Source Inputs (phono jacks) — 8/16 inputs for line-level stereo audio (& composite video on 800AV/1600V).

A/V Zone Outputs (phono jacks) — 8/16 outputs for line-level stereo audio (& composite video on 800AV/1600V).

The audio outputs are volume/bass/treble/mute controlled within the Lattis Matrix Switcher and connect to zone power amplifiers (sized appropriately for each zone).

Optional, one or two 40-conductor ribbon cables for daisy-chaining audio sources.

IR-In jack (3.5mm phone) for connection of IR-Repeater system, or other modulated IR input.

Memory-Erase button. Careful — will restore all programmable parameters to factory settings.

I/O connector (8P8C): System-Active (5V) signal. Other connections for future use.

Ctrl-Out connector (6P6C) Expansion port for RS-232/IR daisy-chaining to Ctrl-In connector on next switcher.

Ctrl-In connector (6P6C) (see Ctrl-Out).

Control connector (9-pin DB-9-F) RS-232 serial control port..

Power connector (2.1mm connector, auto-polarity) For 12 VDC, 1 A adapter.

Parts Checklist

When unpacking your Lattis system, ensure that you have received the following:

- Lattis Matrix Switcher (LE-800A, LE-800AV, LE-1600A, LE-1600V)
- AC Adapter – 12 VDC, 1 A
- Owner's Manual

Other components you may need:

- Vaux RC-16-IR infrared remote control(s)
- Infrared repeater system
- Keypad control system
- Source components, zone power amplifiers, speakers
- Audio/Video connecting cables
- RS-232 connecting cable
- Ribbon-cable kit for daisy-chaining audio sources to multiple switchers. The switchers must be ordered with the ribbon connectors installed, and ordered with ribbon cable(s) for connecting two to ten switchers. An eight-source switcher uses a single 40-conductor ribbon cable, and a sixteen-source switcher uses two ribbon cables. The audio sources connect to the lowest switcher in the rack, and the ribbon cable(s) run vertically to provide all switchers with the input sources.

Installation

The Lattis Matrix Switcher is quite flexible, in that it can integrate with a variety of A/V devices and control systems, and may be configured a variety of ways. Installation of the Lattis System is described below:

1. System Power: Place the Lattis Matrix Switcher near your audio/video components. Turn off the Lattis front panel switch and plug the AC power adapter's cable into the rear panel Power connector on the Lattis Matrix Switcher. Plug the adapter into a standard electrical outlet — select an outlet which is not controlled by a wall switch.
2. Optional IR Input from IR Repeater Systems (modulated IR input source): Connect to the rear-panel IR-In jack, or affix an IR emitter over the front-panel sensor.
3. Optional IR Input from IR-learning Keypads (modulated IR input source): Connect to the rear-panel IR-In jack, or affix an IR emitter over the front-panel sensor.
4. Optional RS-232 Computer or Control System Connection: Connect your computer or control system, using a properly wired RS-232 cable, to the 9-pin Control connector on the rear panel of Lattis Matrix Switcher System. For more information on the VC-232 interface, refer to a later manual section.
5. Connection of A/V Source components: Plug your Audio/Video source components into the Lattis Source inputs using appropriate cabling.

Note: Lattis Video Switchers (LE-800AV and LE-1600V) use a dual-port connector for source inputs. The video input signal connects to the *black* phono jack on the Source side – the *yellow* phono jack above this connector provides a 75-ohm buffered output for looping the source to other destinations (such as a second switcher).
6. Connection of A/V Zone amplifiers: Connect the Lattis Zone audio outputs to power amplifiers appropriate for each zone. For video-capable switchers, connect the video outputs to video monitors, or, for longer runs, to composite buffer amplifiers or video modulators. Run the speaker wiring and video cables to each zone. NOTE: Do not use level-sensing audio amp powering options — low volumes may turn the amp off.

Note: Lattis Video Switchers (LE-800AV and LE-1600V) use a dual-port connector zone outputs. Each Zone output has two independent 75-ohm buffered output ports, allowing connection of two video cables to different destinations.
7. Power-up the system: Turn on the Lattis Matrix Switcher using the front-panel switch — a string of front-panel lights indicates that the Switcher is running.
10. Install Two (2) “AA” batteries in the RC-16 remote control(s) (alkaline preferred).

RC-16 Remote Control

- The RC-16 Remote Control has four lighted "Mode" keys, which select one of four operating modes. Pressing a mode button will flash the light twice and change the "Current-Mode." When non-mode buttons are pressed on the remote, the appropriate mode light flashes to confirm the button press, as well as the Current-Mode in use. The remote acts as four totally-different remotes in each of these modes.
- *A/V* is the normal mode for turning a zone on or off, selecting sources, and adjusting volume in a zone. The remote's "Current-A/V-Zone" may be changed to correspond to the room in which the remote is located (up to 90 zones and 8 clusters may be controlled). You may select 8 or 16 sources for the zone, depending on your system.
- Note that some RC-16 buttons are not used with Vaux Lattis switchers -- for Vaux Aris systems, you may also use the RC-16 to control source equipment using learned IR codes (play, pause, channel, digits...).
- *Macro* mode is not used with Lattis switchers (Aris-only).
- *Lights* mode is not used with Lattis switchers (Aris-only).
- *Aux* mode is for future use.
- Some other buttons will always switch the remote to a/v mode (regardless of the mode it was set to previously): zone, on/off, volume, mute, shift, prog, and source-select (tuner, cd...).
- During operation or programming, pressing an incorrect button will result in an "Error" flash -- this is a flash of all four of the lighted mode buttons on the remote (a/v, macro, lights, & aux).
- The RC-16 Remote Control uses two "AA" alkaline batteries. Battery life is typically one year, but will depend on how frequently the remote is used. When the remote's operating range seems shorter, or operation seems intermittent or erratic, the batteries likely need to be changed. Batteries contain nasty stuff which gets released in landfills -- to keep our groundwater clean, please dispose of used batteries at a recycling center.
- When inserting batteries, all four mode lights flash, indicating that the stored parameters have been restored to Factory-Settings:

Current-A/V-Source	01 (tuner)
Current-A/V-Zone	01
Current-Lighting-Device	11 (X-10 address A1)
Current-Aux-Device	01

Programming the System

Setting each Zone's Initial Volume Level (and maximum level)

When you have the system running, you will likely wish to tailor each room's initial volume level (the level to which it first turns on). You can also set the maximum volume of the amplifier at this point.

- Set the RC-16 remote control so you are controlling the desired zone (01 to 90). Press the **Zone** button, followed by two-digits corresponding to the desired zone. eg: *Zone-0-1* will select zone 01, and *Zone-1-2* will select zone 12. This zone is saved in the remote until you change it again.
- Turn down power amp's level control for this zone to about 25%
- Select a nominal-level source such as a CD or Tuner.
- Using the RC-16 remote control, turn the zone's volume up to maximum.
- Adjust the power amp's level control to the loudest level you wish the zone to reach.
- Using the RC-16 remote, turn the volume down to the desired initial (turn-on) level.
- Press **Shift-FFwd** on the RC-16 (Shift followed by the FFwd key).
- Repeat for other zones.

Remote Control Setup Commands (shift-pause-x):

Note: Zone must be on and unmuted to change these (zone 1-90).

shift-pause-1	Zone-Initial-Volume-To-Current (L/R levels)
shift-pause-2	Zone-Mute-Volume-To-Current (left level)
shift-pause-3	Zone-Min-Volume-To-Current (left level)
shift-pause-4	Zone-Max-Volume-To-Current (left level)
shift-pause-5	Zone-Previous-Volume-Flag-Off (zone turns on with programmed Initial Volume – normal)
shift-pause-6	Zone-Previous-Volume-Flag-On (zone turns on at previous level, saved when zone last turned off)
shift-pause-7	Zone-Audio-Mode to Mono
shift-pause-8	Zone-Audio-Mode to Stereo (normal)
shift-pause-9	Zone-Restore-Factory-Settings (Initial-Vol, etc., this zone only)

Examples (first set RC-16 to desired zone, then select a source):

- to configure a zone's maximum volume level (power amp has gain adjust):
 - turn power amplifier's gain down (to perhaps 30 %)
 - adjust volume, using remote control, to maximum
 - adjust power amplifier's gain to loudest acceptable volume level
- to configure a zone's maximum volume level (power amp has no gain adjust):
 - adjust volume, using remote control, to desired level
 - press shift-pause-4 to store this volume as the Maximum-Level
- to configure a zone for a fixed initial (turn-on) volume level:
 - press shift-pause-5 to turn Previous-Volume-Flag off
 - adjust volume to desired level
 - press shift-pause-1 to store this volume as the Initial-Level
- to configure a zone for using Previous-Volume as initial level:
 - press shift-pause-6 to turn Previous-Volume-Flag on
- to configure a zone for a desired mute level:
 - adjust volume to desired level
 - press shift-pause-2 to store this volume as the Mute-Level
- to configure a zone for a desired minimum volume level:
 - adjust volume to desired level
 - press shift-pause-3 to store this volume as the Minimum-Level
- to restore a zone's programmable parameters to factory settings:
 - press shift-pause-9, and reset a zone's initial/mute/min/max/tapers...

Audio/Video Operation

For all operations below, change the RC-16 remote control to the desired zone, if needed. The remote also needs to be in a/v mode for the following operations: press the RC-16's a/v mode button to change to a/v mode (the button will flash twice). Note: the remote is automatically placed in a/v mode when you press certain buttons.

Setting the RC-16's Current-A/V-Zone:

- For all operations below, set the RC-16 remote so you are controlling the desired zone (01 to 90). Press the **Zone** button, followed by two-digits corresponding to the desired zone -- eg: *Zone-0-1* will select zone 01, and *Zone-1-2* will select zone 12. This zone is saved until you change it again.
- You may also control a *Cluster* (a group of multiple zones that is programmed into the Lattis system), by selecting zones 91 to 98, for Clusters 1 to 8. Only certain functions are available during Cluster operation.
- You may also choose zone 00, which is a special *All-Zones* code. Only certain functions are available during All-Zones operation.
- Note: the remote is automatically placed in a/v mode when you press the zone button.

Selecting a Source:

- Press an RC-16 Source button (*Tuner, CD...*)
Note: This will automatically place the remote in A/V mode.
- The Lattis **Ack** light will flash. The source is routed to the zone at the programmed Initial-Volume-Level for the zone (or, the Previous-Volume, if the zone is so configured). If the zone is currently on, the new source will be at the current volume level.
- The Lattis **Active** light will be on when any zone is in use.
- If the Lattis's **Nak** light flashes, the requested zone is not valid for this Lattis unit. (eg: selecting zone 09 when only 01 to 08 are valid in an 8x8 switcher).
- If you have a 16-source LE-1600A or LE-1600V, you access the upper sources by pressing the *Shift* button, followed by a source button:

button	selects	button	selects
tuner	source 1	shift-tuner	source 9
cd	source 2	shift-cd	source 10
dss	source 3	shift-dss	source 11
vcr1	source 4	shift-vcr1	source 12
vcr2	source 5	shift-vcr2	source 13
dvd	source 6	shift-dvd	source 14
tape	source 7	shift-tape	source 15
aux	source 8	shift-aux	source 16

Turning the Zone Off:

- Press the RC-16's **On/Off** button -- the Lattis **Ack** light flashes, and the zone turns off (note: pressing the **On/Off** button again turns the zone on with the previous source).
- If the Lattis **Nak** light flashes, the requested zone is not valid for this Lattis unit.

Adjusting Zone Volume and Muting:

- Press the RC-16's *Volume-Up/Down* buttons, and release at desired volume level.
Note: This will automatically place the remote in A/V mode.
- Press the RC-16's *Mute* button -- the zone volume lowers to the programmed Mute-Volume-Level for the zone. Pressing Mute again will restore original volume.
- The Lattis *Ack* light flashes during volume adjust or mute. If the Lattis *Nak* light flashes, the requested zone is not valid for this Lattis unit, or the zone is not currently on.

Adjusting Zone Bass/Treble:

- Press the RC-16 *Shift* button, and then press a *Channel-Up/Down* button to adjust Bass, or a *Volume-Up/Down* button to adjust Treble. Each Shift-button-press adjusts up or down one step (can not press-and-hold for Bass/Treble adjustment)
- The Lattis *Ack* light flashes as the level is adjusted. If the Lattis *Nak* light flashes, the requested zone is not valid for this Lattis unit, or the zone is not currently on.
- You may restore *Flat* Bass/Treble (both to 0-dB) by pressing *Shift-Rew* on the RC-16.

VauxProtocol Commands & Messages (RS-232 Control)

Connection of a control system or computer to the Vaux switcher's Control (RS-232) serial port allows you to fully control the system using a selection of "Commands," and to obtain immediate or polled feedback on system status by listening to "Messages." This Command/Message language is called VauxProtocol.

Using VauxProtocol, and/or infrared remote control commands, you may control Vaux systems to distribute audio/video signals throughout a house or building. Vaux switchers are available in sizes up to 16-by-16, and switchers may be combined, for up to 255 audio and/or video zones, driven by up to 16 a/v sources -- and controlled via a single serial port. Using an RC-16 remote control gives access to 90 zones and 16 sources.

Zones, Groups, and Clusters.

Each room that needs a/v, will be driven from a Zone on the Vaux switcher. Each zone can independently select from multiple sources, each zone can have the same, or different, source for audio and video, and each zone has full volume/bass/treble/mute capability.

Single-command control of multiple zones at a time is provided with zone Groups. The group commands allow selection of up to eight consecutive zones, starting at any zone. There is no limit to the number of groups, since the definition is embedded in the command.

Groups can be used with adjoining areas that would normally have the same source selection, such as the Master-Bedroom/Master-Bath, or Foyer/Great-Room/Dining-Room/Lavatory. Separate zones drive each room, with zone commands providing individual room volume control. Group commands allow master control of source-selection, and simultaneous volume adjustment of all zones in the group.

Groups can also be used within a room, such as when a powered subwoofer augments the main audio system. Both the subwoofer and the main audio amps are driven from separate zones, and hence have individual volume control with zone commands. Group commands provide master source-selection, volume-absolute/relative/ramping control, and muting.

A Vaux remote control can access eight Clusters, which are pre-programmed zone group definitions. Clusters have the same constraints as zone groups (ie: up to eight consecutive zones, starting at any zone). Clusters are part of the switcher configuration -- the factory setting provides a few ready-to-use clusters, or they may be changed using programming commands. To access clusters 1 to 8 from an RC-16, the remote control is set to Zone-91 through 98, respectively. Only source-selection, volume, and muting commands may be used when the remote is set to a cluster, and cluster volume from the remote control does not allow press-and-hold operation as it does for zones (clusters are 2-dB up/down per press). Note that RS-232 VauxProtocol commands do provide group ramping operation. Clusters can be accessed via VauxProtocol commands, but this is intended primarily for testing, since the group commands are more flexible and do not require system programming, as do clusters.

Send Commands, and Receive Messages

You will likely only need to implement a handful of Commands/Messages in a typical application. In fact, the simplest application merely sends basic routing and volume Commands, and ignores any received Messages. The next level of complexity involves interpreting the Messages that are returned in response to control operations – these Messages are returned for both RS-232 Commands and button-press actions on handheld remote-controls. You may watch for an expected message immediately after sending a Command (single-threaded program), or you may have a separate section of code that parses the messages independently of the command processing code, and then updates internal variables and displays (multi-threaded program). This allows you to close-the-loop on the whole system (232 and IR control). You may send commands from the control section of your 232 code, and/or use IR control from remotes or keypads -- your message-handler will update variables/displays in the background. If you wish to ensure that your 232 command resulted in an action, you may monitor internal variables after sending your command (instead of waiting for a specific message), and implement timeout/retry/alert handling as desired for your application.

VauxProtocol Commands begin with an asterisk (*) character, followed by two letters (uppercase or lowercase) defining the type of command, one or more comma-delimited decimal-number parameters, and finally a carriage-return and/or line-feed character (CR/LF). The CR/LF characters are the only non-printable ascii characters used in VauxProtocol, and are identified in Vaux documentation as <cr>.

The first number parameter is a "command-id" number, defining the specific action for this type of command, and which parameters follow to complete the command. If a Command (optionally) includes an extra parameter, the last parameter is presumed to be a checksum. An example command:

***CW,40,3,5,4 <cr>**

Similarly, VauxProtocol Messages begin with an exclamation (!) character, followed by one letter defining the type of message, one or more comma-delimited decimal number parameters, and a terminating CR/LF. Optionally, you can force leading zeroes in Messages, for fixed three-digit parameters (eg: 003,012). Many Commands return the same status Message – simplifying parsing code. An example message:

!S,40,3,5,4 <cr>

The serial port requires 38400 baud, 8 data bits, no parity, 1 stop bit, with Xon/Xoff flow control enabled.

Command Flexibility

Letters in the Command header may be upper or lowercase, and spaces can appear in the commands, as desired.

The decimal number parameters in Commands are ascii-encoded-decimal number strings that normally range from 0 to 255. There may be any number of digits in a parameter (eg: 5, 21, 114), and a parameter may optionally include any number of leading zeroes (ie: 002, 02, and 2 are all equivalent).

Parameters normally should not exceed 255, although larger numbers are allowed. Numbers greater than 255 are truncated to 1-byte internally (this is actually handy for the optional checksum parameter, discussed later).

A null parameter (nothing between the commas) will evaluate to 0. An 'X' character may be placed in a parameter position, and will evaluate to 255, which, in some commands, is used to IGNORE the parameter.

A comma ',' is used to delimit parameter fields. An underscore character '_' may optionally be substituted for the comma delimiter.

Commands are terminated with a carriage-return (CR) and/or line-feed (LF) character (CR = 0x0d = 13; LF = 0x0a = 10), to work with string terminations found in various programming environments:

- linux/unix systems use LF (\n aka newline)
- macintosh systems use CR (\r aka return)
- windows/dos systems use CR/LF (\r\n)

Vaux documentation uses the symbol <cr> to indicate termination of Commands (CR and/or LF accepted), and termination of Messages (CR and LF are sent).

A Command will be discarded if 1) it is truncated with a premature CR, LF, or *, 2) if the delimit character is anything other than comma or underscore, or 3) if non-digit chars are embedded in the numerical parameters (except 'X' may be used in place of a parameter, evaluating to 255 -- this is used to ignore the parameter, for commands that allow it).

Four VauxProtocol Command formats are defined:

Control-Write:	*CW,id,num1(,num2)...<cr>	or	*CW_id_num1(_num2)...<cr>
Control-Read (poll):	*CR,id,num1(,num2)...<cr>	or	*CR_id_num1(_num2)...<cr>
Program-Write:	*PW,id,num1(,num2)...<cr>	or	*PW_id_num1(_num2)...<cr>
Program-Read:	*PR,id,num1(,num2)...<cr>	or	*PR_id_num1(_num2)...<cr>

User applications use the Control-Write (*CW) Commands, and parse the resulting Status-Messages. User applications may also use the Control-Read (*CR) Commands, if it is desired to handle Message parsing on a periodically-pollled basis. The Program-Write (*PW) and Program-Read (*PR) Commands are for programming the system configuration, and are not to be employed in a user application, except as part of a setup function. Do not use *PW commands in power-up boot code, since power-fluctuations at boot time (eg: power restoring after an outage), could result in corrupted parameters.

Optional Command Checksums

If a Command includes an extra parameter, the last parameter is presumed to be a checksum of all preceding parameters. The checksum can be truncated to 1-byte before being sent (overflow discarded) or it can simply be the total sum (which, if over 255, gets truncated to 1-byte internally).

Example command to set Zone-7 volume to 0-dB:

*CW,23,7,32,0	this is normal command with no checksum
*CW,23,7,32,0,62	this is command with checksum (23+7+32+0=62)

Example command to set Zone-241 volume to 0-dB:

*CW,23,241,32,0	this is normal command with no checksum
*CW,23,241,32,0,296	this is command with total checksum (23+241+32+0=296)
*CW,23,241,32,0,40	this is command with truncated (1-byte) checksum (296-256=40)

Routing Commands & Messages:

- For zone 0 (all zones), no messages are returned (multiple zones/switchers would be responding together).
- A muted zone will be unmuted if route commands are received (except route-muted cmds).
- Group commands apply to a group of up to eight consecutive zones, as defined in the command.

Control-Write Cmd	Description	Command	Status-Message
Route-Audio/Video	(note 3, 4, 5)	*CW,10,zon,ssa,ssv <cr>	!S,3,zon,sta,stv,ssa,ssv,vvl,vvr,bas,trb <cr>
Route-Audio	(note 1, 5)	*CW,11,zon,ssa <cr>	!S,1,zon,sta,ssa,vvl,vvr,bas,trb <cr>
Route-Video	(note 2)	*CW,12,zon,ssv <cr>	!S,2,zon,stv,ssv <cr>
Route-AV	(note 3, 5)	*CW,13,zon,src <cr>	!S,3,zon,sta,stv,ssa,ssv,vvl,vvr,bas,trb <cr>
Route-Muted	(note 3, 4, 6)	*CW,14,zon,ssa,ssv <cr>	!S,1/2/3 (as appropriate)
Route-at-Volume	(note 3, 4, 7)	*CW,15,zon,ssa,ssv,vra <cr>	!S,1/2/3 (as appropriate)
Route-at-Volume-Muted	(note 3, 4, 8)	*CW,16,zon,ssa,ssv,vra <cr>	!S,1/2/3 (as appropriate)
Group-Route-Audio/Video	(note 3, 4, 9)	*CW,60,gbz,gzd,ssa,ssv <cr>	!S,1/2/3 (for each zone in group)
Group-Route-Muted	(note 3, 4, 6, 9)	*CW,61,gbz,gzd,ssa,ssv <cr>	!S,1/2/3 (for each zone in group)

zon is zone 0 to 255 (when permitted, 0=all-zones, with no messages returned)

ssa is audio source 0 to 8 (0=off) (or 0 to 16, for 16-source switchers) (see note 4)

ssv is video source 0 to 8 (0=off) (or 0 to 16, for 16-source switchers) (see note 4)

src is audio and video source 0 to 8 (0=off) (or 0 to 16, for 16-source switchers)

vra is route-at volume (left and right) 1 to 35 (2-dB/increment) (see note 10)

vvl is left volume level 0 to 35 (2-dB/increment) (see note 10)

vvr is right volume level 0 to 35 (2-dB/increment) (see note 10)

bas is bass level 0 to 8 (3-dB/increment) (see note 11)

trb is treble level 0 to 8 (3-dB/increment) (see note 11)

sta is audio-state code 0=off, 1=on, 2=on/muted-audio

stv is video-state code 0=off, 1=on

gbz is group-base-zone 1 to 249; on 8-zone increments (eg: 1, 9, 17...) (see note 9)

gzd is group-zone-definition 0 to 255 (each bit specifies 1 of 8 zones, starting at gbz) (see note 9)

Routing Notes:

Note 1 -- Audio-only route commands (may use Zone-0) (*CW,11):

- to audio-only switcher: route audio, update audio state, send audio mssg
- to video-only switcher: ignore
- to a/v switcher: route audio, update audio state, send audio mssg

Note 2 -- Video-only route commands (may use Zone-0) (*CW,12):

- to audio-only switcher: ignore
- to video-only switcher: route video, update video state, send video mssg
- to a/v switcher: route video, update video state, send video mssg

Note 3 -- Audio/Video route commands (may use Zone-0, as appropriate) (*CW,10/13/14/15/16/60/61):

(the audio unit tracks and reports video state, and video unit is silent – eg: LE-1600A and LE-1600V together)

- to audio-only switcher: route audio, update audio AND VIDEO state, send a/v mssg
- to video-only switcher: route video, update video state -- NO MSSG
- to a/v switcher: route a/v, update a/v state, send a/v mssg

Note 4 – Audio and/or Video route commands (may use Zone-0, as appropriate) (*CW,10/14/15/16/60/61):

- Source parameters ssa and ssv may both be defined, or either may be IGNORE (to only set one source)
For IGNORE, set the parameter to 255, or, optionally, insert the 'X' character.

Note 5 -- Routing audio using standard route commands (*CW,10/11/13/60):

- 1) Routing a source when zone is currently off:
 - Routes and sets zone volume to:
 - a) Normal (factory setting) route volume uses programmed "Zone-Initial-Volume."
 - b) Optionally, may configure route volume to be "Previous" volume.
(this was level when zone was last turned off)
(the implementation actually updates Zone-Initial-Volume at every zone turn-off).
- 2) Routing a source when zone is currently on (skipped if source is the same):
 - Routes at current zone volume.
- 3) Routing a source when zone is currently muted:
 - Routes and unmutes to previous volume (level when zone was muted).

Note 6 -- Routing audio using Route-Muted commands (*CW,14/61):

- 1) Routing a source when zone is currently off:
 - Routes and places zone in muted state, and sets unmute volume to:
 - a) Normal (factory setting) unmute level uses programmed "Zone-Initial-Volume."
 - b) Optionally, may configure unmute level to be "Previous" volume.
(this was level when zone was last turned off)
(the implementation actually updates Zone-Initial-Volume at every zone turn-off,
then this route-muted command loads unmute levels from initial).
- 2) Routing a source when zone is currently on (skipped if source is the same):
 - Routes at current zone volume.
NOTE: DOES NOT MUTE IF ZONE IS ON
- 3) Routing a source when zone is currently muted:
 - Routes and leaves zone in muted state.
 - Unmute level will be previous volume (level when zone was muted).

Note 7 -- Routing audio using Route-At-Volume commands (*CW,15):

- 1) Routing a source when zone is currently off:
 - Routes and sets zone volume to specified volume level.
- 2) Routing a source when zone is currently on:
 - Routes at specified volume level (if source is the same, just updates volume).
- 3) Routing a source when zone is currently muted:
 - Routes and unmutes to specified volume level.

Note 8 -- Routing audio using Route-At-Volume-Muted commands (*CW,16):

- 1) Routing a source when zone is currently off:
 - Routes and places zone in muted state, and unmute level will be specified volume level.
- 2) Routing a source when zone is currently on (NOTE: DOES NOT MUTE IF ZONE IS ON):
 - Routes at specified volume level (if source is the same, just updates volume).
- 3) Routing a source when zone is currently muted:
 - Routes and leaves zone in muted state, and unmute level will be specified volume level.

Note 9 -- Routing using Group commands (*CW,60/61):

Routes are reported for each zone defined in the group. Group commands apply to a group of eight consecutive zones, as defined in the command by gbz and gzd. Parameter gbz is group-base-zone, and gzd is group-zone-definition, which define a group of up to eight zones. If the group is defined such that the zones are on different switchers, the returned messages will collide and be garbled – therefore, gbz should be restricted to 8-zone increments (1, 9, 17...).

Each bit in gzd corresponds to one of eight zones, with bit-0 (LSB) being the lowest zone, and the bit-7 (MSB) being the highest zone. If the bit is 1, the zone is included in the group, and if the bit is 0, it is excluded.

The first zone (selected by bit-0) is defined as group-base-zone gbz. The next seven bits in gzd correspond to the next seven zones above gbz. For example, if gbz = 9 and gzd = 155, the group includes zones 9, 10, 12, 13, and 16. First, choose gbz, then to select the appropriate gzd, you need to set the gzd bits corresponding to the desired zones.

Zone	gzd-bit	bit-value	1=included	add bit-values
9 = gbz	bit-0	1	1 (lsb)	1
10	bit-1	2	1	2
11	bit-2	4	0	0
12	bit-3	8	1	8
13	bit-4	16	1	16
14	bit-5	32	0	0
15	bit-6	64	0	0
16	bit-7	128	1 (msb)	128
				<u> </u>
				= 10011011 = 155 = gzd

Therefore, when we choose gbz = 9, and set the appropriate bits in gzd to include zones 9, 10, 12, 13, and 16 in the group, we need gzd = 155. You can get this gzd either by converting the binary value 10011011 to decimal, or by adding the bit-values that correspond to the included zones (128+16+8+2+1 = 155).

For testing clusters, use the group commands but set gbz to cluster 1 to 8, and gzd to 0.

Note 10 –Volume Levels (vvl, vvr, vra) are 2-dB/increment (except for 0 = -80dB):

35	+6 dB	26	-12 dB	17	-30 dB	8	-48 dB
34	+4 dB	25	-14 dB	16	-32 dB	7	-50 dB
33	+2 dB	24	-16 dB	15	-34 dB	6	-52 dB
32	0 dB (pass)	23	-18 dB	14	-36 dB	5	-54 dB
31	-2 dB	22	-20 dB	13	-38 dB	4	-56 dB
30	-4 dB	21	-22 dB	12	-40 dB	3	-58 dB
29	-6 dB	20	-24 dB	11	-42 dB	2	-60 dB
28	-8 dB	19	-26 dB	10	-44 dB	1	-62 dB
27	-10 dB	18	-28 dB	9	-46 dB	0	-80 dB

Note 11 – Bass/Treble Levels (bas, trb) are 3-dB/increment:

8	+12 dB
7	+9 dB
6	+6 dB
5	+3 dB
4	0 dB (flat)
3	-3 dB
2	-6 dB
1	-9 dB
0	-12 dB

Volume/Bass/Treble/Mute Commands & Messages:

- Volume/bass/treble/mute commands will only affect zones that are not off (ie: zones that are on or muted).
- A muted zone will be unmuted if volume adjustment commands are received.
- Group commands apply to a group of up to eight consecutive zones, as defined in the command.

<i>Control-Write Cmd Description</i>	<i>Command</i>	<i>Status-Message</i>
Absolute-L/R-Volume (note 1, 2, 4, 7)	*CW,20,zon,vvl,vvr,tpr <cr>	IS,20,zon,sta,vvl,vvr <cr>
Absolute-Volume (note 2)	*CW,23,zon,vol,tpr <cr>	IS,20,zon,sta,vvl,vvr <cr>
Volume-Up (2-dB)	*CW,24,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Volume-Down (2-dB)	*CW,25,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Left-Volume-Up (note 4)	*CW,26,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Left-Volume-Down (note 4)	*CW,27,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Right-Volume-Up (note 4)	*CW,28,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Right-Volume-Down (note 4)	*CW,29,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Balance-to-Left (note 5)	*CW,30,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Balance-to-Right (note 5)	*CW,31,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Ramp-Volume-Up	*CW,35,zon <cr>	(none)
Ramp-Volume-Down	*CW,36,zon <cr>	(none)
Ramp-Volume-Stop (note 3)	*CW,37,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
NOTE: volume ramps at 2-dB/100-msec until stopped, or Min/Max-Vol reached!		
Absolute-Bass/Treble (note 1)	*CW,40,zon,bas,trb <cr>	IS,40,zon,bas,trb <cr>
Flat-Bass/Treble (0-dB)	*CW,41,zon <cr>	IS,40,zon,bas,trb <cr>
Bass-Up (3-dB/step)	*CW,42,zon <cr>	IS,40,zon,bas,trb <cr>
Bass-Down (3-dB/step)	*CW,43,zon <cr>	IS,40,zon,bas,trb <cr>
Treble-Up (3-dB/step)	*CW,44,zon <cr>	IS,40,zon,bas,trb <cr>
Treble-Down (3-dB/step)	*CW,45,zon <cr>	IS,40,zon,bas,trb <cr>
Audio-Mute-Toggle	*CW,50,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Audio-Mute-On	*CW,51,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Audio-Mute-Off	*CW,52,zon <cr>	IS,20,zon,sta,vvl,vvr <cr>
Group-Volume-Up (2-dB) (note 6)	*CW,62,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr> (for each zon in group)
Group-Volume-Down (2-dB) (note 6)	*CW,63,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr> (for each zon in group)
Group-Ramp-Volume-Up (note 6)	*CW,64,gbz,gzd <cr>	(none)
Group-Ramp-Volume-Down (note 6)	*CW,65,gbz,gzd <cr>	(none)
Group-Ramp-Volume-Stop (note 3, 6)	*CW,66,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr>> (for each zon in group)
Group-Mute-Toggle (note 6)	*CW,67,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr> (for each zon in group)
Group-Mute-On (note 6)	*CW,68,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr> (for each zon in group)
Group-Mute-Off (note 6)	*CW,69,gbz,gzd <cr>	IS,20,zon,sta,vvl,vvr <cr> (for each zon in group)

zon is zone	1 to 255 (zone-0 not permitted)
vvl is left volume level	0 to 35 (2-dB/increment) (see note 1, 7)
vvr is right volume level	0 to 35 (2-dB/increment) (see note 1, 7)
vol is volume (left and right)	0 to 35 (2-dB/increment) (see note 7)
bas is bass level	0 to 8 (3-dB/increment) (see note 8)
trb is treble level	0 to 8 (3-dB/increment) (see note 8)
tpr is taper-enable	0=no-taper, 1=taper-volume
sta is audio-state code	0=off, 1=on, 2=on/muted-audio
gbz is group-base-zone	1 to 249; on 8-zone increments (eg: 1, 9, 17...) (see note 6)
gzd is group-zone-definition	0 to 255 (each bit specifies 1 of 8 zones, starting at gbz) (see note 6)

Volume/Bass/Treble/Mute Notes:

Note 1 – Absolute Left and/or Right Volume (*CW,20), and Absolute Bass and/or Treble (*CW,40) commands:

Volume level parameters vvl and vvr may both be defined, or either may be IGNORE (to only set the one channel)
For IGNORE, set the parameter to 255, or, optionally, insert the ‘X’ character. Either bas or trb may be set to IGNORE.

Note 2 – Tapering with Absolute Volume commands (*CW,20/23):

If parameter tpr is set to 0, the absolute volume is set immediately. If tpr is set to 1, the level tapers-up or down using the zone’s tud/tdd taper configuration.

Note 3 –Volume-Ramping commands (*CW,35/36/37/64/65/66):

Volume levels are reported only when ramping is stopped (not at each increment).

Note 4 – Mono zone with Left and/or Right Volume commands (*CW,20/26/27/28/29):

If a zone is programmed for mono operation, the same source must be routed to both the L&R channels, but these volume commands allow you to provide independent volume control for two mono areas. You may also apply relative-up/down control to both L&R as a “master” control of this 2-channel area, while retaining independent “sub-zone” control over each channel with the individual (L or R) volume commands. This is handy in patios etc.

Note 5 – Zone Balance commands (*CW,30/31):

The Balance-to-Left command increases the left channel by 2-dB, and decreases the right channel by 2-dB. The Balance-to-Right command is the opposite. For finer control you can adjust only one channel with the *CW,24/25 commands. The left and right volumes may remain at different levels -- the volume up/down and ramping commands operate on both channels, relative to the volume of each. Balance is maintained when muting/unmuting, and running volume to the rails and back. After balancing a zone, adjust the volume to the desired level for zone turn-on, and save the current levels as the Initial-Volume-Levels (balance will be maintained, since left and right initial levels are saved).

Polling Commands & Messages:

As defined above, Status-Message are sent automatically in response to Control-Write Commands, but system status may also be determined at any time by polling, using these optional Control-Read Commands. Applications that parse and process Status-Messages in real-time will not need these Commands, but applications can ignore Messages until periodic polling intervals, and then issue Polling Commands to update variables and displays.

<i>Control-Read Cmd Description</i>	<i>Command</i>	<i>Status-Message</i>
Read-Zone-Audio-Status	*CR,1,zon <cr>	!S,1,zon,sta,ssa,vvl,vvr,bas,trb <cr>
Read-Zone-Video-Status	*CR,2,zon <cr>	!S,2,zon,stv,ssv <cr>
Read-Zone-Audio/Video-Status	*CR,3,zon <cr>	!S,3,zon,sta,stv,ssa,ssv,vvl,vvr,bas,trb <cr>
Read-Zone-Audio/Video-Sources	*CR,10,zon <cr>	!S,10,zon,ssa,ssv <cr>
Read-Zone-Audio-Source	*CR,11,zon <cr>	!S,11,zon,ssa <cr>
Read-Zone-Video-Source	*CR,12,zon <cr>	!S,12,zon,ssv <cr>
Read-Zone-Volumes	*CR,20,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Read-Zone-Bass/Treble	*CR,40,zon <cr>	!S,40,zon,bas,trb <cr>
Read-Group-All-Current (note 1)	*CR,80,gbz <cr>	!S,81... through !S,88...
Read-Group-Audio-States (note 1)	*CR,81,gbz <cr>	!S,81,bzn,sta1,sta2...sta8 <cr>
Read-Group-Video-States (note 1)	*CR,82,gbz <cr>	!S,82,bzn,stv1,stv2...stv8 <cr>
Read-Group-Audio-Sources (note 1)	*CR,83,gbz <cr>	!S,83,bzn,ssa1,ssa2...ssa8 <cr>
Read-Group-Video-Sources (note 1)	*CR,84,gbz <cr>	!S,84,bzn,ssv1,ssv2...ssv8 <cr>
Read-Group-Left-Volumes (note 1)	*CR,85,gbz <cr>	!S,85,bzn,vvl1,vvl2...vvl8 <cr>
Read-Group-Right-Volumes (note 1)	*CR,86,gbz <cr>	!S,86,bzn,vvr1,vvr2...vvr8 <cr>
Read-Group-Bass-Levels (note 1)	*CR,87,gbz <cr>	!S,87,bzn,bas1,bas2...bas8 <cr>
Read-Group-Treble-Levels (note 1)	*CR,88,gbz <cr>	!S,88,bzn,trb1,trb2...trb8 <cr>
Read-System-Information (note 2, 3)	*CR,100,bzn <cr>	!S,100,bzn,fam,fid,0,0,svh,svl <cr>
Read-Acknowledge (note 2, 4)	*CR,101,bzn <cr>	!S,101,bzn <cr>

zon is zone	1 to 255
bzn is Base-Zone for switcher	1 to 249 for 8-zone, or 1 to 241 for 16-zone switcher (eg: 1, 9, 17...)
gbz is group-base-zone	1 to 249; on 8-zone increments (eg: 1, 9, 17...) (see note 1)
sta is audio-state code	0=off, 1=on, 2=on/muted-audio
stv is video-state code	0=off, 1=on
ssa is audio source	0 to 8 (0=off) (or 0 to 16, for 16-source switchers)
ssv is video source	0 to 8 (0=off) (or 0 to 16, for 16-source switchers)
vvl is left volume level	0 to 35 (2-dB/increment)
vvr is right volume level	0 to 35 (2-dB/increment)
bas is bass level	0 to 8 (3-dB/increment)
trb is treble level	0 to 8 (3-dB/increment)
fam,fid is Family,Family-ID	10,5 = LE800A; 10,6 = LE800AV; 10,7 = LE1600A; 10,8 = LE1600V
svh,svl is Software-Version-High,Low	(0 to 99 each, eg: 6,0 is version 6.0)

Polling Notes:

Note 1 – Read-Group Commands:

The Read-Group commands will only return a message if the specified gbz parameter matches the programmed Base-Zone in the switcher configuration. Unlike the other group commands, these include all eight zones starting at gbz.

The Read-Group Commands return 8 parameters, starting at Base-Zone (params for bzn, bzn+1...bzn+7). For a 16-zone switcher, two messages are returned: the first message starts at Base-Zone (params for bzn, bzn+1...bzn+7), and the second message starts at Base-Zone+8 (params for bzn+8, bzn+9...bzn+15),

Note 2 – Base-Zone Commands:

The Base-Zone-related commands will only return a message if the specified bzn parameter matches the programmed Base-Zone in the switcher configuration.

Note 3 – System-Information Message (!S,100):

The SysInfo message is sent in response to a *CR,100,bzn Polling Command, and is also sent at system boot.

When both video-only and audio-only switchers have the same base-zone (eg: LE-1600A and LE-1600V), the video switcher sends the message 16-ms after the audio switcher (the worst-case SysInfo message is under 10-ms).

At boot time of an installation with multiple daisy-chained switchers, the messages are delayed 32-ms for every 8 zones in the base-zone, so there is no overlap in the messages. Any video-only switchers are delayed an additional 16-ms, as described above. You may process the messages to extract the bzn and fam/fid parameters, to determine exactly how many zones are available, and which zones are audio and/or video.

<u>Boot-time Delay</u>	<u>Switcher Type</u>	<u>Switcher Base-Zone</u>	<u>Message</u>
0 ms	audio or a/v	1	!S,100,1...
16 ms	video-only	1	!S,100,1...
32 ms	audio or a/v	9	!S,100,9...
48 ms	video-only	9	!S,100,9...
64 ms	audio or a/v	16	!S,100,16...
80 ms	video-only	16	!S,100,16...
(etc)			

You could also poll for the full configuration of a multi-switcher installation, by polling with incremental base-zones (eg: 1, 9, 17, 25, 33...), and processing the messages that are returned.

Note 4 – Read-Acknowledge Command:

The Read-Acknowledge command may be used to poll for existence of a switcher (with less complexity than polling with the SysInfo command). When both video-only and audio-only switchers have the same base-zone (eg: LE-1600A and LE-1600V), the video switcher sends the message 16-ms after the audio switcher.

This command is also useful in programs where you issue multiple commands (eg: multiple routes), and wish to wait for completion – you may issue a Read-Acknowledge command, and wait for the response before continuing in your program.

Miscellaneous Status Messages:

These miscellaneous Status Messages are returned for various system actions:

Sensor-State-Change messages	!S,180,sen,sst,0,0 <cr>	sen is sensor-id; sst is new state
VI input on I/O jack	!S,180,1,sst,0,0 <cr>	sst=0: VI=low, sst=1: VI=high
Diagnostic messages (normally disabled)	!S,190,dgc,opt,0,0 <cr>	dgc is diagnostic-id; opt is option
Watchdog-Reset occurred	!S,190,0,0,0,0 <cr>	
Cmd-Error: Invalid Base-Zone cmd	!S,190,3,0,0,0 <cr>	
Cmd-Error: Invalid Cmd-Type	!S,190,3,1,0,0 <cr>	(not *CW, *CR, *PW, or *PR)
Cmd-Error: Invalid Cmd-Parameter	!S,190,3,2,0,0 <cr>	(invalid cmd-id, wrong number of parameters bad param value, or checksum error)
IR command request	!S,197,zon,irs,irf,0 <cr>	(factory-use)
Unknown RC command	!S,198,rb1,rb2,rb3,rb4 <cr>	(factory-use)
Internal diagnostic	!S,199,p1,p2,p3,p4 <cr>	(factory-use)

Configuration (Programming) Commands & Messages:

In many applications, the factory settings are just right, but you may want to tweak some parameters, such as the Zone-Initial-Volume (zone-turn-on) levels. You can adjust zone settings using the *PW commands below – some of the zone configuration settings may also be adjusted using an RC-16 remote control.

The Program-Read (*PR) and Program-Write (*PW) Commands are for programming the system configuration, and are not to be employed in a user application, except as part of a setup function. Do not use *PW commands in power-up boot code, since power-fluctuations at boot time (eg: power restoring after an outage), could result in corrupted parameters.

<i>Program-Read-Cmd Description</i>		<i>Command</i>	<i>Config-Message</i>
Read-All-Config-Tables		*PR,8,bzn <cr>	!C,9... for all zones on switcher
Read-Zone-Config-Table		*PR,9,zon <cr>	!C,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr>
Read-Min/Max-Volume-Levels	(note 1, 11)	*PR,10,zon <cr>	!C,10,zon,vll,vhh <cr>
Read-Initial-Volume-Levels	(note 2, 11)	*PR,12,zon <cr>	!C,12,zon,vil,vir <cr>
Read-Mute-Level/Audio-Mode	(note 3, 11)	*PR,14,zon <cr>	!C,14,zon,vmm,mod <cr>
Read-Bass/Treble-Levels	(note 4, 12)	*PR,16,zon <cr>	!C,16,zon,bas,trb <cr>
Read-Taper-Delays	(note 5)	*PR,18,zon <cr>	!C,18,zon,tud,tdd <cr>
Read-Source-Trim-Level	(note 6)	*PR,22,1,ssa <cr>	!C,22,1,ssa,ast <cr>
Read-All-Source-Trim-Levels	(note 6)	*PR,23,1 <cr>	!C,22 for all sources on switcher
Read-Cluster-Definition	(note 7)	*PR,70,1,clu <cr>	!C,70,1,clu,gbz,gzd <cr>
Read-All-Cluster-Definitions	(note 7)	*PR,71,1 <cr>	!C,70 for clusters 1 to 8
Read-Base-Zone	(note 8)	*PR,100,0,0 <cr>	!C,100,0,0,0,bzn <cr>
Read-Tmp-Config-Flags	(note 9)	*PR,240,1,flg <cr>	!C,240,1,flg,fst <cr>
<i>Program-Write-Cmd Description</i>		<i>Command</i>	<i>Config-Message</i>
Write-Zone-Parameter-Config-Table		*PW,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr> !C,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr>	
Write-Min/Max-Volume-Levels	(note 1, 11)	*PW,10,zon,vll,vhh <cr>	!C,10,zon,vll,vhh <cr>
Write-Initial-Volume-Levels	(note 2, 11)	*PW,12,zon,vil,vir <cr>	!C,12,zon,vil,vir <cr>
Write-Mute-Level/Audio-Mode	(note 3, 11)	*PW,14,zon,vmm,mod <cr>	!C,14,zon,vmm,mod <cr>
Write-Bass/Treble-Levels	(note 4, 12)	*PW,16,zon,bas,trb <cr>	!C,16,zon,bas,trb <cr>
Write-Taper-Delays	(note 5)	*PW,18,zon,tud,tdd <cr>	!C,18,zon,tud,tdd <cr>
Write-Source-Trim-Level	(note 6)	*PW,22,1,ssa,ast <cr>	!C,22,1,ssa,ast <cr>
Write-Cluster-Definition	(note 7)	*PW,70,1,clu,gbz,gzd <cr>	!C,70,1,clu,gbz,gzd <cr>
Write-Base-Zone	(note 8)	*PW,100,0,0,0,bzn <cr>	!C,100,0,0,0,bzn <cr>
Write-Tmp-Config-Flag	(note 9)	*PW,240,1,flg,fst <cr>	!C,240,1,flg,fst <cr>

The following are miscellaneous Program Commands:

<i>Program-Cmd Description</i>	<i>Command</i>	<i>Message</i>
Zone-Setup (note 10)	*PW,40,zon,sid <cr>	!C,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr>
Restore-All-Factory-Settings	*PW,254,0,0,1 <cr>	!C,254,0,0 <cr> (Factory-Settings-Restored), and the front-panel light-bar will flash.
Force-System-Reset	*PW,255,0,0,1 <cr>	(factory-use)
Get-SX-Slave-Revision	*PR,255,0 <cr>	!C,255,sxh,sxl <cr> (factory-use)

zon is zone	1 to 255
vll is Minimum-Volume-Level	0 to 35 (2-dB/increment) (see note 1, 11) Factory-Setting = 0 (-80 dB)
vhh is Maximum-Volume-Level	0 to 35 (2-dB/increment) (see note 1, 11) Factory-Setting = 35 (+6 dB)
vil is Initial-Left-Volume-Level	0 to 35 (2-dB/increment) (see note 2, 11) Factory-Setting = 22 (-20 dB)
vir is Initial-Right-Volume-Level	0 to 35 (2-dB/increment) (see note 2, 11) Factory-Setting = 22 (-20 dB)
vmm is Mute-Volume-Level	0 to 35 (2-dB/increment) (see note 3, 11) Factory-Setting = 0 (-80 dB)
mod is Zone-Mode	0 to 3 (see note 3) Factory-Setting = 1 (stereo/use-initial-vol)
bas is bass level	0 to 8 (3-dB/increment) (see note 4, 12) Factory-Setting = 4 (0 dB)
trb is treble level	0 to 8 (3-dB/increment) (see note 4, 12) Factory-Setting = 4 (0 dB)
tud is Taper-Up-Delay	1 to 30 (ms/2-dB-step) (see note 5) Factory-Setting = 20
tdd is Taper-Down-Delay	1 to 30 (ms/2-dB-step) (see note 5) Factory-Setting = 5
ssa is audio source	1 to 8 (or 1 to 16, for 16-source switchers)
ast is source-trim-attenuation	0 to 10 (see note 6) Factory-Setting = 0 (0-dB)
clu is cluster number	1 to 8 (see Note 7)
gbz is group-base-zone	1 to 249; on 8-zone increments (eg: 1, 9, 17...) (see note 7)
gzd is group-zone-definition	1 to 255 (each bit specifies 1 of 8 zones, starting at gbz) (see note 7)
bzn is Base-Zone for switcher	1 to 249 for 8-zone, or 1 to 241 for 16-zone switcher (see note 8) (eg: 1, 9, 17...) Factory-Setting = 1
flg is flag	1 to 3 (see note 9)
fst is flag state	1 (on) or 0 (off) (see note 9) Factory-Setting = 0
sid is Zone-Setup id	1 to 9 (see note 10)

Configuration Notes:

Note 1 – Zone Min/Max-Volume Levels

Min-vol has priority over mute-vol and initial-vol, and is the absolute min volume zone will reach. If min-vol incorrectly set above max-vol, then min-vol will be presumed to be zero. Max-vol has priority over all other settings, and is the absolute max volume zone will reach.

Note 2 – Zone Initial-Volume Levels

Min-Vol and Max-Vol should be set before setting Initial-Volumes. If initial-vol incorrectly set above max-vol, then initial-vol will be presumed to be max-vol. If initial-vol incorrectly set below min-vol, then initial-vol will be presumed to be min-vol. Initial-vol levels include both left and right levels, and should be set after performing a balance adjustment on a zone.

Note 3 – Zone Mute-Volume Level and Audio Mode

Min-Vol and Max-Vol should be set before setting Mute-Volume. Mute always acts upon both L&R channels, even though L&R volume levels may differ; balance is preserved when zone is unmuted. Mute-vol is a ceiling, not an absolute level. If mute-vol set above min-vol, zone volume levels may go below mute-vol level. When muting, volumes above mute-vol will lower to mute-vol level, but volumes below mute-vol will not change. If mute-vol incorrectly set above max-vol, then mute-vol will be presumed to be max-vol. If mute-vol incorrectly set below min-vol, then mute-vol will be presumed to be min-vol.

Audio-Mode byte mod is a collection of bits, of which only bits 0 and 1 are currently defined:

Bit 0 (lsb) is MODE_STEREO_BIT: 1 = stereo (normal) or 0 = mono.

Bit 1 is MODE_PREVIOUS_VOL_BIT: 1 = turn-on-at-prev-vol, 0 = turn-on-at-initial-vol (normal).

The factory setting for mod is 1, which is stereo and turn-on-at-initial-vol.

To choose the appropriate mod, you need to set the bits appropriately:

Definition	mod-bit	bit-value	1=on	add bit-values
MODE_STEREO_BIT	bit-0	1	1 (lsb)	1
MODE_PREVIOUS_VOL_BIT	bit-1	2	1	2
(unused)	bit-2	4	0	0
(unused)	bit-3	8	0	0
(unused)	bit-4	16	0	0
(unused)	bit-5	32	0	0
(unused)	bit-6	64	0	0
(unused)	bit-7	128	0 (msb)	0
				= 10011011 = 3 = mod

Therefore, when mod = 3, the zone will be stereo, and will turn on at previous volume.

Note 4 – Zone Bass/Treble Levels

Bass and Treble levels are technically part of the zone configuration (*PW cmds), but also have analogous control (*CW) commands, for normal adjustment. The *CW commands are to be used in the user program, and also update an active zone with the new bass/treble levels. The *PW commands are used for simply changing the switcher configuration, and changes will not be noticed until the zone is turned off and then back on.

Note 5 – Zone Taper Delays

Taper delays are inserted between each 2-dB volume step to provide a pleasant transition when muting/unmuting, routing sources, or when using the taper option with absolute volume commands. It generally sounds better to have a longer taper-up delay than taper-down delay.

Note 9 – Temporary Configuration Flags:

There are some flags that may be turned on to change aspects of the system – the power-up state for all flags is 0 (off).

fig = 1 = Echo-Chars	When on, RS-232 characters are echoed (for testing only)
fig = 2 = Show-Diagnostic-Mssgs	When on, diagnostic messages (!S,190 to !S,199) are enabled
fig = 3 = Leading-Zeroes-in-Mssgs	When on, message parameters use fixed 3-char format.

Note 10 – Zone-Setup Command:

These Setup commands are handy for configuring zones, and are identical to the setup commands available using the RC-16 remote control (shift-pause-#, where # is the sid digit). The zone must be on and not muted to use these commands

sid = 1	Set Zone-Initial-Volumes to current left/right levels
sid = 2	Set Zone-Mute-Volume to current (left) level
sid = 3	Set Zone-Min-Volume to current (left) level
sid = 4	Set Zone-Max-Volume to current (left) level
sid = 5	Set Previous-Volume-Flag Off (zone turns on with programmed Initial-Volume level) (normal)
sid = 6	Set Previous-Volume-Flag On (zone turns on at previous level, saved when last turned off)
sid = 7	Set Audio-Mode to Mono
sid = 8	Set Audio-Mode to Stereo (normal)
sid = 9	Restore Zone-Factory-Settings (restored on this one zone only)

Note 11 –Volume Levels (vvl, vvr, vra) are 2-dB/increment (except for 0 = -80dB):

35 +6 dB	26 -12 dB	17 -30 dB	8 -48 dB
34 +4 dB	25 -14 dB	16 -32 dB	7 -50 dB
33 +2 dB	24 -16 dB	15 -34 dB	6 -52 dB
32 0 dB (pass)	23 -18 dB	14 -36 dB	5 -54 dB
31 -2 dB	22 -20 dB	13 -38 dB	4 -56 dB
30 -4 dB	21 -22 dB	12 -40 dB	3 -58 dB
29 -6 dB	20 -24 dB	11 -42 dB	2 -60 dB
28 -8 dB	19 -26 dB	10 -44 dB	1 -62 dB
27 -10 dB	18 -28 dB	9 -46 dB	0 -80 dB

Note 12 – Bass/Treble Levels (bas, trb) are 3-dB/increment:

8 +12 dB
7 +9 dB
6 +6 dB
5 +3 dB
4 0 dB (flat)
3 -3 dB
2 -6 dB
1 -9 dB
0 -12 dB

Remote-Control Equivalent Commands and Messages:

Pressing buttons on Vaux remote controls or keypads initiates actions equivalent to the following VauxProtocol Commands. Since these actions result in the same Messages being sent (as they would for the equivalent Command), the control system must only parse one set of Messages. This means that the control system is always up-to-date on zone-routes, volume-levels, and other system parameters, regardless of whether they were initiated by a VauxProtocol command, or by a remote-control button press.

Remote-Control Button-Press	Equivalent Command	Status-Message
Source-Select (tuner...) or Zone-Off	*CW,13,zon,src <cr>	!S,3,zon,sta,stv,ssa,ssv,vvl,vvr,bas,trb <cr>
Volume-Up/Down/Release (note 1)	*CW,35/36/37,zon <cr>	!S,20,zon,sta,vvl,vvr <cr> (when button released)
Bass-Up/Down (shift-chan-up/dn)	*CW,42/43,zon <cr>	!S,40,zon,bas,trb <cr>
Treble-Up/Down (shift-vol-up/dn)	*CW,44/45,zon <cr>	!S,40,zon,bas,trb <cr>
Flat (shift-rewind)	*CW,41,zon <cr>	!S,40,zon,bas,trb <cr>
Mute-Toggle (mute)	*CW,50,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Mute-On (shift-mute)	*CW,51,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Mute-Off (shift-a/b)	*CW,52,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Clusters (note 2) – messages are sent for each zone in cluster-group:		
Cluster-Source-Select (tuner...) or Off	*CW,60,gbz,gzd,src,src <cr>	!S,3,zon,sta,stv,ssa,ssv,vvl,vvr,bas,trb <cr>
Cluster-Vol-Up/Down	*CW,62/63,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Cluster-Mute-Toggle/On/Off	*CW,50/51/52,zon <cr>	!S,20,zon,sta,vvl,vvr <cr>
Source-Trim-Down (shift-down)	*PW,22,src,240 <cr>	!C,22,src,ast <cr>
Source-Trim-Up (shift-up)	*PW,22,src,241 <cr>	!C,22,src,ast <cr>
Zone-Setup (shift-pause-#)	*PW,40,zon,# <cr>	!C,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr>
Initial-Vol-to-Current (shift-ffwd)	*PW,40,zon,1 <cr>	!C,9,zon,vll,vhh,vil,vir,vmm,mod,bas,trb,tud,tdd <cr>
Set-Base-Zone (prog/hold-#-#) (## = bzn: 01 to 98)	*PW,100,0,0,0,bzn <cr>	!C,100,0,0,0,bzn <cr>
Restore-All-Factory-Settings (prog/hold-9-9)	*PW,254,0,0,1 <cr>	!C,254,0,0 <cr>

Note 1 – Volume adjustment:

Volume ramps at 2-dB/100-msec until button released, or Min/Max-Vol reached!

Note 2 – Clusters:

Clusters 1 to 8 accessed by setting remote to zones 91 to 98, respectively.

Clusters must be programmed to define gbz and gzd for each cluster.

Note 3 – Zone-Setup Command:

These Setup commands are handy for configuring zones, and are identical to the setup commands described in the previous section. The zone must be on and not muted to use these commands

- sid = 1 Set Zone-Initial-Volumes to current left/right levels
- sid = 2 Set Zone-Mute-Volume to current (left) level
- sid = 3 Set Zone-Min-Volume to current (left) level
- sid = 4 Set Zone-Max-Volume to current (left) level
- sid = 5 Set Previous-Volume-Flag Off (zone turns on with programmed Initial-Volume level) (normal)
- sid = 6 Set Previous-Volume-Flag On (zone turns on at previous level, saved when last turned off)
- sid = 7 Set Audio-Mode to Mono
- sid = 8 Set Audio-Mode to Stereo (normal)
- sid = 9 Restore Zone-Factory-Settings (restored on this one zone only)

Control Serial Port (EIA/RS-232)

The Control Port is designed to connect directly to any control system or computer that has a standard RS-232 serial port.

A cable (not supplied) is needed to connect the Control Port to the control system or computer serial port. The Control Port has a DB-9-F (female) connector – the connector pinout is defined below. Typically, only three wires are needed: TX, RX, and Ground. If your serial port expects handshake inputs (on CTS, DSR, and/or DCD), you may be able to either change your port configuration to ignore these signals, or you may provide either the 5V or 12V signals from the Vaux Control connector to drive them active.

The serial port requires 38400 baud, 8 data bits, no parity, 1 stop bit, with Xon/Xoff flow control enabled.

The baud-rate may optionally be changed to 9600 for control systems that cannot communicate at 38400.

To set 9600-baud:

Turn off switcher, press and HOLD the Mem_Erase pushbutton,

Turn switcher back on, holding button until PROG light goes off, then release button. The PROG light will flash and then the light-bar will indicate system is running -- serial port is now at 9600-baud.

To return to 38400-baud, you must restore factory settings:

While system is running, press and release the Mem_Erase pushbutton. The PROG light will turn on for a couple of seconds while settings are restored, and then the light-bar will indicate system is running -- serial port is now at 38400-baud, and all other factory settings are restored (initial turn-on volumes...).

The baud-rate setting is saved in non-volatile memory.

The serial port on the controlling system must be configured according to its manufacturer's instructions. Information transfer between the controlling computer and the Vaux system is in the VauxProtocol format — a Vaux-defined command language comprised of various commands and messages.

Control Port (RS-232 Interface) (DB-9 F Connector):

Pin	Vaux Control Port	Signal Direction	Standard Computer Port
1	5V *	>	DCD (Data Carrier Detect)
2	Data Out	>	RXD (Receive Data)
3	Data In	<	TXD (Transmit Data)
4	[do not use]		DTR (Data Terminal Ready)
5	Signal Ground		Signal Ground
6	12V *	>	DSR (Data Set Ready)
7	[do not use]		RTS (Request To Send)
8	[do not use]		CTS (Clear To Send)
9	[do not use]		RI (Ring Indicator)

- Typical Connections: Data-In (TXD), Data-Out (RXD), and Signal Ground.
- Minimal Connections: Data-In (TXD), and Signal Ground (for commands only)
- * If CTS, DSR, or DCD is needed by your serial port, connect to the 5V or 12V signal (1-mA max load).
- The DB-9 shield rim (the "D") is connected to signal ground.

Maintenance and Service

Vaux systems are designed to be maintenance-free, but do contain sensitive electronic parts. Avoid rough treatment to assure best performance. If you must ship the system, use the original packaging (or equivalent) for protection. The enclosures may be cleaned with a soft, slightly-damp soft cloth. Never use detergents, excess water, treated cloths, harsh cleaning agents, or sprays.

This product is to be serviced only by the manufacturer or its authorized service agents. For instructions on how to obtain service, call the Vaux Electronics Service Department. Attach your sales receipt to this manual for future reference, should service be required during the warranty period. Also, record your Serial Number(s) on the cover of this manual. Serial Numbers can be found on rear-panel labels.

For more information on product service, see the Limited Warranty section.

Limited Warranty

What does your warranty cover?

Any defect in material or workmanship.

For how long after the original purchase?

Five-year limited warranty on Lattis Matrix Switchers. One-year limited warranty on Vaux Remote Controls.

What will we do?

If your Vaux product is defective and returned within 30 days of the date it was purchased, we will replace it at no charge to you. If your Vaux product is returned after 30 days, but within the warranty repair period, we will repair it, or, at our option, replace it at no charge to you. If we repair your Vaux product, we may use new or reconditioned replacement parts. If we choose to replace your Vaux product, we may replace it with a new or reconditioned unit of the same or similar design. The repaired or replacement unit will be warranted for either (a) 90 days or (b) the remainder of the original warranty period, whichever is longer.

How do you make a warranty claim?

To get warranty service for your Vaux product, you must provide proof of purchase. The "Purchase Date" is the date shown on your invoice. Within 30 days of the Purchase Date, return your Vaux product to your place of purchase for immediate replacement. After 30 days of the date it was purchased, call the Vaux Service Department to obtain a Return Materials Authorization (RMA) Number and ship the Vaux product standard UPS or equivalent to the Vaux Electronics Service Dept. Provide necessary additional shipping insurance. Most shipping companies' basic insurance coverage is only \$100.00. Include in the package a copy of the sales receipt or other evidence of date of original purchase. Also print your name, shipping address (no PO boxes), phone number and a description of the defect. Write the RMA number on the shipping label or prominently on the outside of the box. Properly pack your unit, include any cables, etc., which were originally provided with the product. Please use the original carton and packing materials, or equivalent. Pay any charges billed to you by the Vaux Service Department for service not covered by the warranty. Your repaired unit will be shipped to you prepaid freight.

What does your warranty not cover?

This warranty does not cover any upgrades of system hardware or software to revisions later than that which shipped with the system when originally purchased. If this Vaux product includes infrared learning, this warranty does not cover incompatibility with third-party remote controls, such as, but not limited to: wired-remote controls, RF remote controls, ultrasonic remote controls, pre-programmed universal remote controls (third-party codes are sometimes distorted), products that operate over 100kHz, products that use obscure or multi-frequency infrared signals. This warranty does not cover defects resulting from accidents, damage while in transit to the Vaux Service Department, alterations, products which have been modified or incorporated into other products, unauthorized repair, tampering, failure to follow instructions, neglect, misuse, fire, flood, lightning damage, meteorite bombardment, regional or global warfare, or acts of God. This warranty does not cover customer instruction, installation and set-up, or batteries.

If your product is not covered by our warranty, call the Vaux Service Department for advice as to how we may repair your Vaux product, and other repair information, including charges. At our option, we may replace, rather than repair, your Vaux product with a new or reconditioned one of the same or similar design. The repaired or replacement product will be warranted for 90 days. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

Limitations

Implied warranties, including those of fitness for a particular purpose and merchantability (an unwritten warranty that the product is fit for ordinary use), are limited to one year from date of purchase. We will not pay for loss of use (eg: during warranty repair), inconvenience, loss or theft of your Vaux product, or property damage caused by your Vaux product or its failure to work, or any other incidental or consequential damages.

Safety Information

- As with any product, basic safety precautions should be observed during handling and use of this system.
- Before using your system, please follow and adhere to all warnings, safety and operating instructions located on the product and in this owner's manual. Retain this manual for future reference.
- All warnings on the system components and in the instruction manual should be adhered to
- Do not expose the system to extreme temperatures, such as found near a hot radiator or stove.
- Do not locate AC-powered equipment near water, for example, near a bathtub, shower or pool. Immersion of the system in water could cause an electrical shock. Keep hands out of toasters.
- The components should be mounted only as directed in the instruction manual. Provide proper ventilation for any components which generate heat. Do not situate a component such that its ventilation openings are blocked or impeded. Components are to be situated away from heat sources such as amplifiers, heat registers, and stoves.
- Components are to be connected to a power supply only of the type described in the instruction manual, or as marked on the component. Polarities must be observed as necessary. Any grounding or polarization means of the component should not be defeated. Power cords should be routed such as to provide protection against pinching, abrasion, excess flexing, etc.
- Do not place lighted candles, cigarettes, cigars, etc. on the system.
- Never install or modify wiring during a lightning storm.
- Care should be taken so that objects do not fall onto, or liquids do not spill into, the system.
- Do not attempt to disassemble the enclosures. There are no customer serviceable components inside.
- If this system operates on batteries, adhere to the following precautions:
- Any battery may leak electrolyte if mixed with a different battery type, if inserted incorrectly, or if all batteries are not replaced at the same time.
- Any battery may leak electrolyte or explode if disposed of in fire or an attempt is made to charge a battery not intended to be recharged.
- Discard leaky batteries immediately. Leaking batteries can cause skin burns or other personal injury., and can damage electronic components.
- Always dispose of batteries properly — please recycle when possible. Do not eat.
- Remove batteries from your system if it will not be used for an extended period of time.

This equipment generates and uses radio frequency energy which may interfere with residential radio and television reception if not properly installed and used in accordance with instructions contained in this manual. Reasonable protection against such interference is ensured, although there is no guarantee this will not occur in a given installation. If interference is suspected, and verified by powering this equipment on and off, try to correct the interference by one or more of the following measures: re-orient the radio/television receiver's antenna; relocate the television or radio equipment with respect to the Vaux equipment; plug the equipment into separate electrical outlets.