ZON Low-Level Serial Communications Protocol

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Oxmoor Corporation, LLC

ZR-98 DEBUG SERIAL INTERFACE

The debug serial interface is a special serial interface used for engineering and manufacturing test of the router. In future releases, a special procedure may be required before the ZR-98 will accept debug commands. All debug commands start with a tilde (‘~’), which is not a valid starting character for the normal ZR-98 serial command set, and are terminated by a carriage return.

Minimal syntax checking and parsing is performed on commands from the debug interface, so commands must be entered exactly as shown. Do not assume extra whitespace or special characters will be ignored.

As of router firmware version 1.0.8, only the debug command interface described in this document is supported.

Document Purpose & Confidentiality

This document describes the low-level engineering interface to the router. Future router firmware versions will support a different, more verbose, command interface. While this document may be distributed outside of Oxmoor Engineering for the purpose of integration with 3rd party control systems, it remains the **confidential property of Oxmoor Corporation, LLC and should be not duplicated or distributed without the permission of Oxmoor Corporation**.

This document is updated as new firmware is released. At present, this document is not under document control. Commands herein are subject to change with each firmware release.

Connection Protocol

RS-232 9600 Baud N81

No flow control.

Note: When the router comes out of reset, version and status information is written out the serial port. If you do not see human readable data after reset on a router which has been flashed then there is a connection problem.

Command Syntax

~<CMD><CR>

Where <CMD> is one or more characters as defined below, and <CR> is a carriage return.

Command Destinations

The ZR-98 router is a distributed architecture design, so there are numerous microprocessors running in parallel on the board. The micro which is connected via the external serial port is capable to sending and receiving to/from the other microprocessors. This micro is referred to as “Motherbrain”. All commands are received by the Motherbrain. Based on the command, the contents may be forwarded to another micro, or may be processed directly by Motherbrain.

The Fatherbrain Microprocessor carries on communications with external ZON devices, such as any connected ZAC-60 amp/controllers. So, when data is to be directed to a ZAC-60 controller, the command goes from Motherbrian to Fatherbrain to the ZAC-60.

An array of four(4) Digital Audio Processors (DAPs) are also attached to the Motherbrain. The Motherbrain is only capable of addressing a single DAP at a time. Audio commands, such as mute or page are directed to the currently addressed DAP. See the ~1, ~2, ~3, and ~4 commands below to change the currently addressed DAP.

A programmed logic device called the EARS is also attached to the Motherbrain, and is interfaced with via 2 shift registers. The EARS acts as a large switch matrix which determines which of the variety of available audio inputs are routed to each ZAC-60 controller at a given time. The EARS also determines which audio input is driving the page bus.

Motherbrain Commands

Command	Description
~1<CR>	Select DAP#1. Selects DAP#1 as the *current DAP*, this makes it the destination for all DAP-related commands. After POR, the *current DAP* is set to #1.
~2<CR>	Select DAP#2. Selects DAP#1 as the *current DAP*, this makes it the destination for all DAP-related commands. After POR, the *current DAP* is set to #1.
~3<CR>	Select DAP#3. Selects DAP#1 as the *current DAP*, this makes it the destination for all DAP-related commands. After POR, the *current DAP* is set to #1.
~4<CR>	Select DAP#4. Selects DAP#1 as the *current DAP*, this makes it the destination for all DAP-related commands. After POR, the *current DAP* is set to #1.
~A<CR>	Selects analog input A of the *current DAP*. Use the ~1 - ~4 commands to select the current DAP.
~B<CR>	Selects analog input B of the *current DAP*. Use the ~1 - ~4 commands to select the current DAP.
~E<BAY>CMD><CR>	<BAY> must be 'A' – 'D'. Sends <CMD> to the device attached to expansion bay <BAY>
~F<CMD><CR>	Sends <CMD> to Fatherbrain. See the Fatherbrain Communications section for a list of Fatherbrain commands.
~f<CMD><CR>	Sends <CMD> to Fatherbrain, but when transmitting to Fatherbrain, the <CR> is stripped. For example, "~fABC<CR>" only sends "ABC" to Fatherbrain. Whereas, "~FABC<CR>" sends "ABC<CR>" to Fatherbrain.
~L<S><CR>	Starts flash load mode, with the starting sector set according to the S parameter. S is an character and must be one of the following: A: Start flashing at the ZAC A data area. B: Start flashing at the ZAC B data area. C: Start flashing at the ZAC C data area. D: Start flashing at the ZAC D data area. R: Start flashing at the ZPR data area. M: Starting flashing at the beginning of flash memory. (flash entire chip) Once flash mode has been started, the serial interface changes until flashing it complete. See Flash Communications for more detail.
~M<CR>	Mutes the *current DAP's* mixer. All inputs are muted.
~N<CR>	Puts the *current DAP's* mixer in normal operation mode, which is SDIN1 at unity, SDIN2 muted, and Analog In muted.
~P<CR>	Puts the *current DAP's* mixer in paging mode, which is SDIN1 muted, SDIN2 muted, and Analog In at unity.
~p<N><CR>	Puts the Motherbrain in 'passthrough' mode to the Fatherbrain. While in the mode, the next <N> bytes receiving via the serial port are routed directly to Fatherbrain.
~R<N><CR>	INTERNAL USE ONLY
~U<CR>	Prints the status of the I/O pins on all six ports of the micro.
~V<CR>	Prints the current firmware version for the Motherbrain.
~X<VAL><CR>	Writes to EARS "Control Register X", where <VAL> is a hexadecimal number. NOTE: <VAL> *must* be four digits in length to ensure a 16-bit write. So, to write 0x1 you should use "~X0001<CR>".

	Appendix A contains detailed information about the structure inside the EARS.
~Y<VAL><CR>	Writes to EARS "Control Register Y", where <VAL> is a hexadecimal number. NOTE: <VAL> *must* be four digits in length to ensure a 16-bit write. So, to write 0x1 you should use "~Y0001<CR>". Appendix A contains detailed information about the structure inside the EARS.

Fatherbrain Communications

Commands which are destined for the Fatherbrain always start with '~F'. Any data sent from the fatherbrain will be prefixed with an '>' in the output. Otherwise, commands which are ultimately destined for Fatherbrain are not different in syntax than ones destinated for Motherbrain.

For example, if you send:

~FV<CR> *Asking for the Fatherbrain's version*

You will receive as output:

>V0.0.0 *The > character indicates Fatherbrain's reply.*

Command	Description
~FV<CR>	**Version**. Prints the fatherbrain's firmware version.
~FC<CR>	**Connect Status**. Indicates the connection status of each ZAC as four integer numbers, as in "1 0 1 0". A '1' indicates the ZAC is connected, a '0' indicates it is not connected. The first number corresponds to the first ZAC. For example, if ZAC C is connected but the other three are not, this command will report "0 0 1 0".
~FB<N><CR>	**Channel Status Block**. Reports the channel status block for the ZAC indicated by <N>.
~FL<S><CR>	Starts flash load mode, with the starting sector set according to the S parameter. S is an character and must be one of the following: R: Start flashing at the ZPR data area. M: Starting flashing at the beginning of flash memory. (flash entire chip) Once flash mode has been started, the serial interface changes until flashing it complete. See Flash Communications for more detail.
~FM<CR>	**Master/ Slave**. Indicate the status of the master/slave switch. Reply will be an M for master or S for slave.
~F1<STR><CR>	**Transmit to ZAC #1**. Takes the string specified by <STR>, appends a <CR> to it and sends it to ZAC #1. Every character after the '1' and before the <CR> is considered to be part of the string.
~F2<STR><CR>	**Transmit to ZAC #2**. Takes the string specified by <STR>, appends a <CR> to it and sends it to ZAC #2. Every character after the '1' and before the <CR> is considered to be part of the string.
~F3<STR><CR>	**Transmit to ZAC #3**. Takes the string specified by <STR>, appends a <CR> to it and sends it to ZAC #3. Every character after the '1' and before the <CR> is considered to be part of the string.
~F4<STR><CR>	**Transmit to ZAC #4**. Takes the string specified by <STR>, appends a <CR> to it and sends it to ZAC #4. Every character after the '1' and before the <CR> is considered to be part of the string.
~FS<N>	**Report Source**. Forces the father brain to report the source for ZAC #N. This is identical to the command sent when a ZAC changes sources, and will possibly cause the motherbrain to switch sources and it useful to 'resync' a particular ZAC's source assignment.
~Fa<CR>	**Load ZAC #1 Source Table**. This prepares the fatherbrain to transmit the source table to ZAC #1. All this command does is allow fatherbrain to pass the next 512 bytes received to ZAC#1 is a raw manner. It does *not* put the ZAC into flash mode, the commands to set the ZAC up must be sent prior to sending this command.
~Fb<CR>	**Load ZAC #2 Source Table**. This prepares the fatherbrain to transmit the source table to ZAC #2. All this command does is allow fatherbrain to pass

	the next 512 bytes received to ZAC#1 is a raw manner. It does *not* put the ZAC into flash mode, the commands to set the ZAC up must be sent prior to sending this command.
~Fc<CR>	**Load ZAC #3 Source Table**. This prepares the fatherbrain to transmit the source table to ZAC #3. All this command does is allow fatherbrain to pass the next 512 bytes received to ZAC#1 is a raw manner. It does *not* put the ZAC into flash mode, the commands to set the ZAC up must be sent prior to sending this command.
~Fd<CR>	**Load ZAC #4 Source Table**. This prepares the fatherbrain to transmit the source table to ZAC #4. All this command does is allow fatherbrain to pass the next 512 bytes received to ZAC#1 is a raw manner. It does *not* put the ZAC into flash mode, the commands to set the ZAC up must be sent prior to sending this command.

ZAC-60 Communications

Commands destined for a connected ZAC-60 controller must be sent via the Fatherbrain. The basic format is "~F<ZAC>~<CMD><CR>", where <ZAC> must be '1' – '4' depending on which of the four ZAC's is to be addressed.

NOTE: All example commands below are shown as if they were destined for ZAC A, so the <ZAC> parameter is a '1'.

Command	Description
~F1~I<CR>	**Incoming Page.** ***ZAC Version 1.50 or later.*** Forces the ZAC into "receive page" mode. This paints the display appropriately and forces the amp to assume the default page level for the ZAC.
~F1~F<CR>	**Finish Page.** ***ZAC Version 1.50 or later.*** Forces the ZAC to exit "receive page" mode. This returns the ZAC to its previous state and returns the amp to its previous volume.
~F1~P<Y/N><CR>	**Want Pages.** If the <Y/N> parameter is 'Y', the ZAC will receive pages. If the <Y/N> parameter is 'N', the ZAC will ignore pages. This setting only lasts until the next power cycle. To change the default page setting after a hard power cycle, the setting must be flashed into the ZAC's setting table via the ZON Config application.
~F1~M<Y/N><CR>	**Want Monitor.** If the <Y/N> parameter is 'Y', the ZAC will allow monitoring. If the <Y/N> parameter is 'N', the ZAC will not allow monitoring. This setting only lasts until the next power cycle. To change the default monitor setting after a hard power cycle, the setting must be flashed into the ZAC's setting table via the ZON Config application.
~F1~D<CR>	**Forced Reset.** Forces the audio processor inside the controller to execute a reset and re-configure itself.
~F1~+<CR>	**Discrete Power On.** ***Version 2.04 or later.***
~F1~-<CR>	**Discrete Power Off.** ***Version 2.04 or later.***
~F1~R<VAL><CR>	**Emulate IR Code.** ***Version 2.10 or later.*** Emulates the discrete IR code indicated by the hexadecimal value specified by <VAL>. A list of IR codes is included at the rear of this document.
~F1~@<VAL><CR>	**Change Source.** ***Version 2.04 or later.*** Sets the ZAC's current audio source to the source code indicated by the hexadecimal value <VAL> which ranges from 0x4001 for ZIM Input 1 to 0x4009 for the local router input.
~F1~V<VAL><CR>	**Set Volume**. ***ZAC Version 1.50 or later, serial 0903 or later.*** Sets the volume of the ZAC to <VAL> , where <VAL> is from 0-31, inclusive.
~F1~B<VAL><CR>	**Set Bass**. ***ZAC Version 1.50 or later, serial 0903 or later.*** Sets the bass of the ZAC to <VAL> , where <VAL> is from 0-48, inclusive.
~F1~T<VAL><CR>	**Set Treble**. ***ZAC Version 1.50 or later, serial 0903 or later.*** Sets the trebl of the ZAC to <VAL> , where <VAL> is from 0-48, inclusive.
~F1~L<VAL><CR>	**Set Balance**. ***ZAC Version 1.50 or later, serial 0903 or later.*** Sets the balance of the ZAC to <VAL> , where <VAL> is from 0-48, inclusive.
~F1~E<VAL><CR>	**Set EQ**. ***ZAC Version 1.50 or later, serial 0903 or later.*** Sets the EQ setting of the ZAC to <VAL> , where <VAL> is from 0-3, inclusive. All-pass is 3.

Flash Mode Communications

Flash Mode is used to re-flash all or part of the motherbrain and fatherbrain flash memories. Flash mode must be entered with the '~L<CR>' command for motherbrain and the '~FL<CR>' command for fatherbrain.

Once flash mode has been successfully entered, the string "FLASH START<CR>" will be sent out the serial port. Note: For fatherbrain, the string at the PC will be ">FLASH START<CR>", since all fatherbrain replies are prefixed with a '>'.

When flash mode is exited, the micro will send the string "FLASH DONE<CR>" to the PC. (In the case of fatherbrain, ">FLASHDONE<CR>"). Flash mode may be exited through a command, as shown below, or may be exited automatically when the current sector reaches the "sacred zone", a collection of sectors that cannot be flashed.

Flash mode maintains a pointer to the *current sector*. When you enter flash mode, the current sector pointer was selected by a parameter to the command which entered flash mode. See the command tables above for more information.

As soon as flash mode is entered, the micro is expecting one of the commands below. Note that these commands are *single characters* and are interpreted as soon as the character is received. No terminating <CR> is used.

F	**Start Flashing Current Sector.** The next 512 bytes received via the serial port will be written to the current flash sector exactly as received. There must be an inter-character interval of 1ms between each byte sent. The sector is erased as soon as the F command is received. Once the 512'th byte is received, the micro responds immediately with a hexadecimal 16 byte checksum of the bytes flashed. At this point, the micro is expecting another command from this table.
E	**Erase Current Sector.** The current flash sector is erased.
N	**Next Sector.** Advances the current sector by 512 bytes. Flashing a sector does not automatically advance the pointer, this command must be used.
D	**Done.** Exits flash mode and returns to normal command mode. If the entire chip has been re-flashed it may be necessary to reset the router before normal operation resumes.

When the micro receives a flash command, it replies with the command exactly as received. I.e. if you send 'F', your should see 'F' as a reply as soon as the command has been processed.

Replies

Unrecognized commands are replied to with the command received, followed by a '?'. Commands which have been processed successfully are replied to with the string 'OK'.

Known issue: With Router firmware versions prior to 1.1.0, all commands, even unrecognized ones are responded to with "OK"

Expansion Bay Communications

Commands which are destined for the Expansion Bays always start with '~En', where n is the bay number. Any data sent from the Expansion Bay will be prefixed with an '#' in the output. Otherwise, commands which are ultimately destined for Expansion Bays are not different in syntax than ones destined for Motherbrain.

The following table is the set of core Expansion Bay commands that are supported by all expansion modules. Commands that are specific to the modules are appended to '~En'.

For example, if you send:

~EAV<CR> *Asking for the Expansion Bay 1 version*

You will receive as output:

#ID ZIR 1.5.0 *The # character indicates an expansion module's reply.*

Command	Description
~E<BAY>V<CR>	**Version**. Prints the Expansion Bay firmware version.

Additional commands, beyond the version command depend on the particular module be addressed. See the particular Expansion Module's documentation for more details.

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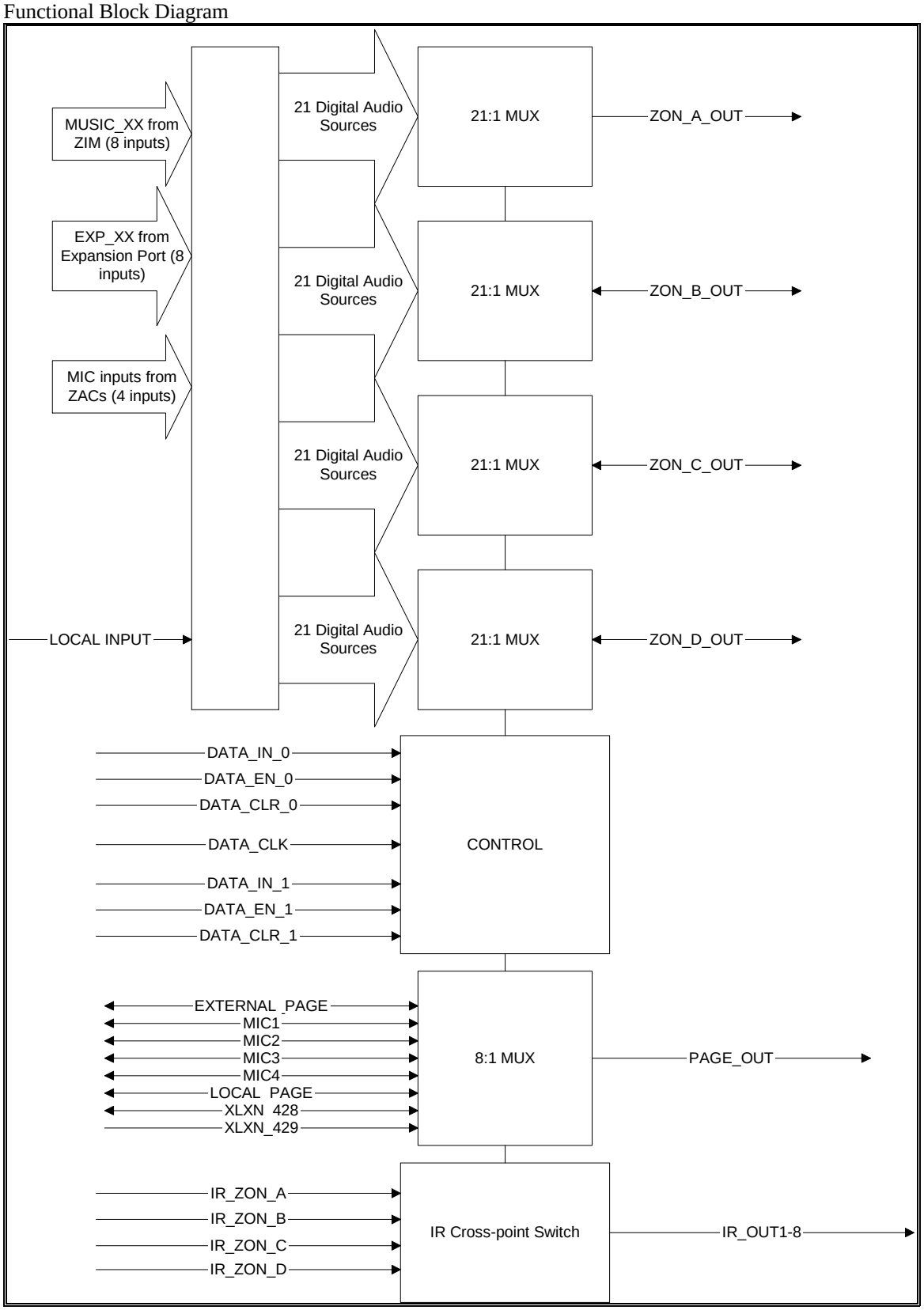
Module	Document Number
ZIR-232	1700075
ZEP-11	--

Appendix A – EARS2003

Functional Block Diagram



Control Registers

Control Register X. This register is accessed by the ~X<VAL><CR> command, where <VAL> is the four digit hexadecimal number to be written to the register. The contents of this register determine the audio source which is routed to the ZAC-60's connected to the A, B, and C positions on the router.

a15	a14	a13	a12	a11	a10	a9	a8	a7	a6	a5	a4	a3	a2	a1	a0
ZON C Source						ZON B Source					ZON A Source				

ZON A Source

a4	a3	a2	a1	a0	Source
0	0	0	0	0	MUSIC_1A
0	0	0	0	1	MUSIC_1B
0	0	0	1	0	MUSIC_2A
0	0	0	1	1	MUSIC_2B
0	0	1	0	0	MUSIC_3A
0	0	1	0	1	MUSIC_3B
0	0	1	1	0	MUSIC_4A
0	0	1	1	1	MUSIC_4B
0	1	0	0	0	EXPANSION_1
0	1	0	0	1	EXPANSION_2
0	1	0	1	0	EXPANSION_3
0	1	0	1	1	EXPANSION_4
0	1	1	0	0	EXPANSION_5
0	1	1	0	1	EXPANSION_6
0	1	1	1	0	EXPANSION_7
0	1	1	1	1	EXPANSION_8
1	0	0	0	0	MIC_A
1	0	0	0	1	MIC_B
1	0	0	1	0	MIC_C
1	0	0	1	1	MIC_D
1	1	1	1	1	LOCAL_SOURCE

ZON B Source

a9	a8	a7	a6	a5	Source
0	0	0	0	0	MUSIC_1A
0	0	0	0	1	MUSIC_1B
0	0	0	1	0	MUSIC_2A
0	0	0	1	1	MUSIC_2B
0	0	1	0	0	MUSIC_3A
0	0	1	0	1	MUSIC_3B
0	0	1	1	0	MUSIC_4A
0	0	1	1	1	MUSIC_4B
0	1	0	0	0	EXPANSION_1
0	1	0	0	1	EXPANSION_2
0	1	0	1	0	EXPANSION_3
0	1	0	1	1	EXPANSION_4
0	1	1	0	0	EXPANSION_5
0	1	1	0	1	EXPANSION_6
0	1	1	1	0	EXPANSION_7
0	1	1	1	1	EXPANSION_8
1	0	0	0	0	MIC_A
1	0	0	0	1	MIC_B
1	0	0	1	0	MIC_C
1	0	0	1	1	MIC_D
1	1	1	1	1	LOCAL_SOURCE

ZON C Source

a14	a13	a12	a11	a10	Source
0	0	0	0	0	MUSIC_1A
0	0	0	0	1	MUSIC_1B
0	0	0	1	0	MUSIC_2A
0	0	0	1	1	MUSIC_2B
0	0	1	0	0	MUSIC_3A
0	0	1	0	1	MUSIC_3B
0	0	1	1	0	MUSIC_4A
0	0	1	1	1	MUSIC_4B
0	1	0	0	0	EXPANSION_1
0	1	0	0	1	EXPANSION_2
0	1	0	1	0	EXPANSION_3
0	1	0	1	1	EXPANSION_4
0	1	1	0	0	EXPANSION_5
0	1	1	0	1	EXPANSION_6
0	1	1	1	0	EXPANSION_7
0	1	1	1	1	EXPANSION_8
1	0	0	0	0	MIC_A
1	0	0	0	1	MIC_B
1	0	0	1	0	MIC_C
1	0	0	1	1	MIC_D
1	1	1	1	1	LOCAL_SOURCE

Control Register Y. This register is accessed by the ~Y<VAL><CR> command, where <VAL> is the four digit hexadecimal number to be written to the register. The contents of this register determine the audio source which is routed to the ZAC-60 connected to the ‘D’ position on the router, as well as the audio which is placed on the page bus.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
								PAGE Source			Zon D Source				

ZON D Source

b4	b3	b2	b1	b0	Source
0	0	0	0	0	MUSIC_1A
0	0	0	0	1	MUSIC_1B
0	0	0	1	0	MUSIC_2A
0	0	0	1	1	MUSIC_2B
0	0	1	0	0	MUSIC_3A
0	0	1	0	1	MUSIC_3B
0	0	1	1	0	MUSIC_4A
0	0	1	1	1	MUSIC_4B
0	1	0	0	0	EXPANSION_1
0	1	0	0	1	EXPANSION_2
0	1	0	1	0	EXPANSION_3
0	1	0	1	1	EXPANSION_4
0	1	1	0	0	EXPANSION_5
0	1	1	0	1	EXPANSION_6
0	1	1	1	0	EXPANSION_7
0	1	1	1	1	EXPANSION_8
1	0	0	0	0	MIC_A
1	0	0	0	1	MIC_B
1	0	0	1	0	MIC_C
1	0	0	1	1	MIC_D
1	1	1	1	1	LOCAL_SOURCE

Page Source

b7	b6	b5	Source
0	0	0	EXTERNAL_PAGE
0	0	1	MIC_A
0	1	0	MIC_B
0	1	1	MIC_C
1	0	0	MIC_D
1	0	1	LOCAL_PAGE
1	1	0	SPARE
1	1	1	SPARE

Discrete IR Codes Table

To be used when sending emulated IR codes via the ~F1~R<VAL><CR> command.

Key codes listed in the table below should be specified as <VAL>

Key	Description
01	Previous Source
02	Next Source
03	Page
14	Power On/Off
15	Mute On/Off
16	Volume Up
17	Volume Down
20	Discrete Mute On
21	Discrete Mute Off
22	Discrete Power On
23	Discrete Power Off
24	EQ Setting Rock
25	EQ Setting Jazz
26	EQ Setting Voice
27	EQ Setting Off
28	Fade Out
29	Fade In
2A	Increase Bass (+0.5dB per click)
2B	Decrease Bass (-0.5dB per click)
2C	Increase Treble (+0.5dB per click)
2D	Decrease Treble (-0.5dB per click)
2E	Move Balance to Left (24 positions between center and full left)
2F	Move Balance to Right (24 positions between center and full right)
30	Select Source ZIM-1
31	Select Source ZIM-2
32	Select Source ZIM-3
33	Select Source ZIM-4
34	Select Source ZIM-5
35	Select Source ZIM-6
36	Select Source ZIM-7
37	Select Source ZIM-8
38	Select Source Local Input
39	Select Source ZAC-A
3A	Select Source ZAC-B
3B	Select Source ZAC-C
3C	Select Source ZAC-D
41	Set Volume -63dB
42	Set Volume -59dB
43	Set Volume -55dB
44	Set Volume -51dB
45	Set Volume -48dB
46	Set Volume -45dB
47	Set Volume -42dB
48	Set Volume -40dB
49	Set Volume -38dB
4A	Set Volume -36dB
4B	Set Volume -34dB
4C	Set Volume -32dB
4D	Set Volume -30dB
4E	Set Volume -28dB
4F	Set Volume -26dB
50	Set Volume -24dB
51	Set Volume -22dB
52	Set Volume -20dB
53	Set Volume -18dB
54	Set Volume -16dB
55	Set Volume -14dB
56	Set Volume -12dB
57	Set Volume -10dB
58	Set Volume -8dB
59	Set Volume -6dB
5A	Set Volume -4dB
5B	Set Volume -2dB
5C	Set Volume 0dB (Unity)
5D	Set Volume +2dB
5E	Set Volume +4dB
5F	Set Volume +6dB
60	Bass Adjust -6dB
61-77	Discrete Bass Adjust in 0.5dB increments.
78	Bass Adjust +0dB
79-8F	Discrete Bass Adjust in 0.5dB increments.
90	Bass Adjust +6dB
91	Treble Adjust -6dB
92-A8	Discrete Treble Adjust in 0.5dB increments.
A9	Treble Adjust +0dB
AA-C0	Discrete Treble Adjust in 0.5dB increments.
C1	Treble Adjust +6dB
C2	Balance Adjust Full Left
C3-D9	Discrete Balance Adjust in increments from Full Left to Center
DA	Balance Center
DB-F1	Discrete Balance Adjust in increments from Center to Full Right
F2	Balance Full Right
F3	Unused
FF	Wakeup Controller (Light backlight, do nothing else)