Contents

1 Introduction

This manual covers the installation, operation and operational alignment of the digital (4944) and analogue (4744) audio routing cards for the ***Freeway*** series of routing switchers. Why only one manual for digital and analogue audio? Because, in order to take advantage of the latest digital technology, all audio routing is handled within the ***Freeway*** frame as a digital signal. In other words, even the analogue audio matrix comprises a digital switching core surrounded by 20 bit converters to provide analogue interfaces to the outside world. This topology has the added advantage that the internal (digital) expansion bus within both the AES router module and the analogue audio module share the same data format. Because of this, ***Freeway*** offers the possibility of format-independent signal routing. For instance, a 32x32 analogue audio router and 32x32 digital audio router can be housed in the same 3U frame and permit the routing any signal, say of analogue origin, to a digital destination and vice-versa. This flexibility represents Pro-Bel's design commitment to the future and your future needs.

n 1.1 Analogue audio routing

Freeway audio gives you up to 128x128 stereo routing in a 6U frame plus many associated features which aid a mixed mono/stereo environment, like; left/right to both, mono-mix and channel swap. Transformerless I/O circuits are level adjustable, up to a maximum of +24dBu, while outputs are indefinitely protected against short circuits.

Other notable features are:

- high packing density
- 20 bit ADC and DACs
- 24 bit digital-core routing
- channel swap for reversed stereo signals
- assignable mono-mixing of signals

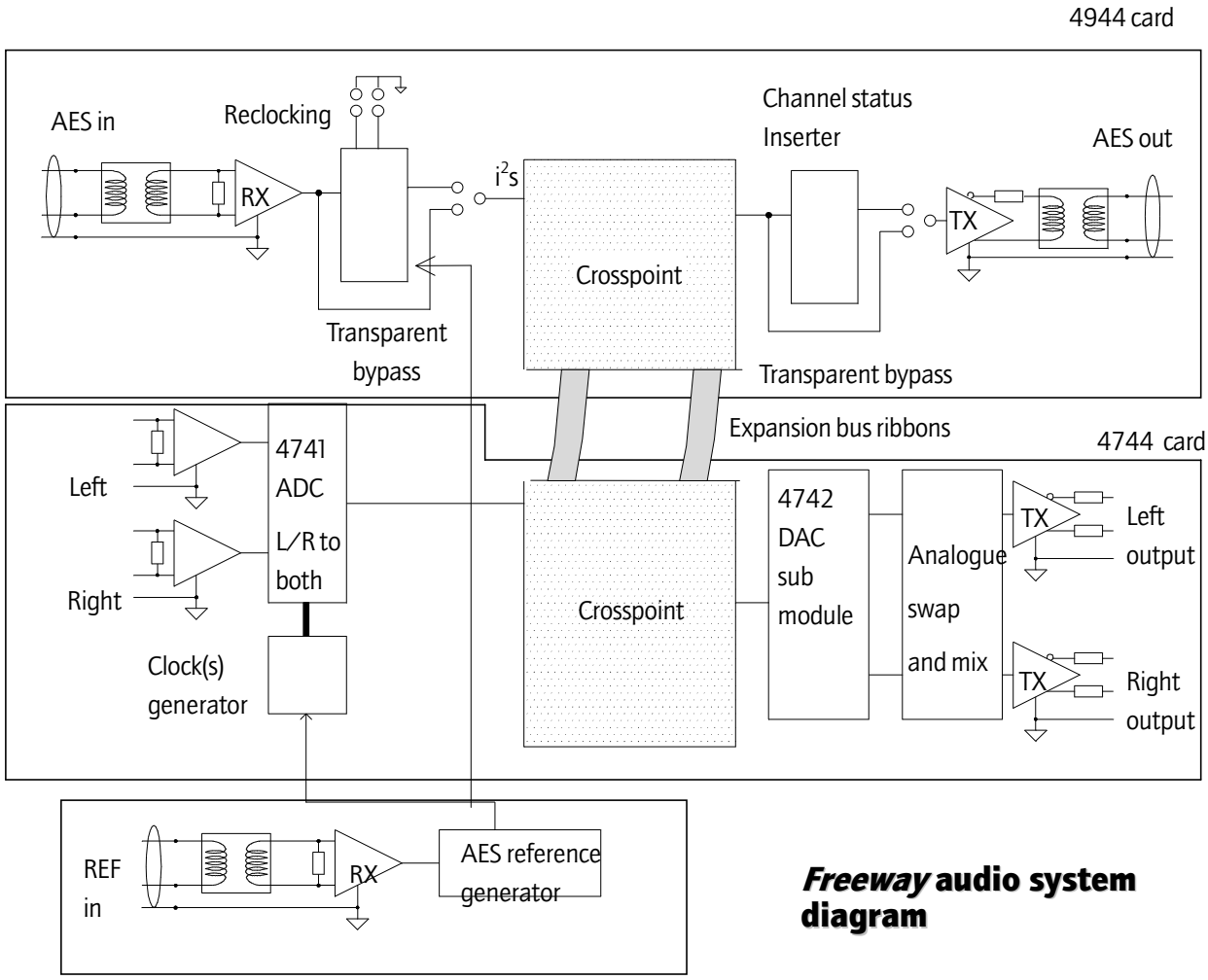
n 1.2 AES digital audio

When operated as a reframing router, Freeway AES router provides silent, 'click-less' switching between digital audio signal at 32 to 48kHz rates. Operation at rates between 22.05 and 96kHz is supported by configuring the router in a

transparent mode. To promote flexible integration within any digital audio environment, modules may be ordered for balanced or unbalanced (75Ω).operation.

Other features include:

- reclocking and reframing architecture
- optionally transparent for multi-standard 22.05-96kHz operation



***Freeway* audio system diagram**

2 AES router card theory of operation

The 4944 card is intended to work in consort with the analogue audio level, in order to provide user-friendly, future-proof, format-independent routing. In the audio system diagram above, you can see this is achieved - by adopting an identical data format for both the AES and analogue audio routing card. In order to be able to switch between digital audio sources, the AES router must perform switch transitions at data word-boundaries. For that to happen, all the digital signals must be co-timed within the ***Freeway*** frame (irrespective of their various timings at each ***Freeway*** AES signal input). The operation performed in the process of re-timing each input is termed *re-framing*. Essentially each signal is fed into a FIFO (First-In-First-Out) buffer, and is read out at the appropriate time so as to be synchronous with the AES reference signal supplied to the ***Freeway*** frame.

This concept underlies the whole rationale of the ***Freeway*** analogue/AES audio routing system. However it does impose some operational restrictions. Firstly, it prohibits the routing of signals with sample rates above 48kHz; because the reframing circuits will not operate above this frequency. Secondly the nature of the internal data format within the ***Freeway*** frame (and especially its ability to share data bus with the audio card) means the AES data has to be decoded - along with its channel status data - and encoded back to AES prior to leaving the ***Freeway*** frame. In other words, the process is not transparent to channel status data. Instead, a default channel status is over-written at all AES outputs.

So as to avoid proscribing ***Freeway***'s usefulness in all operational situations, the ***Freeway*** AES router permits the 4944 card to be configured in three ways; known as Mode 1, 2 and 3.

n 2.1 MODE 1 operation

In mode 1, the AES/EBU digital audio router is compatible with 22.05kHz and 96kHz audio data. Like this, the 4944 card operates as a straightforward, non-reclocking data router. Unless great care is taken to time-align each input to the router, this mode will result in audible glitches when switching and is incompatible with analogue I/O cards.

n 2.2 MODE 2 operation

In mode 2, the card operates in a manner in which it simply reclocks the received audio data, in order to eliminate jitter, prior to the switching core. This mode, and mode 1 ensure the router is transparent to all audio and channel status data. Mode 2 should be used where this requirement is paramount above all others and where the digital audio signal is at any recognised sample rate except 22.05kHz and 96kHz. Unless great care is taken to time each input to the router, this mode will also result in audible glitches when switching.

Note that if the unit is configured in either mode 1 or mode 2, there is no compatibility with the bus data-format of the analogue audio level, therefore mixed analogue/ digital operation is not possible.

n 2.3 MODE 3 operation

This is the preferred operational mode and results in clickless AES routing conforming to AES output timing - irrespective of input data timing. This mode results in a default channel status being 'over-written' into the AES output data stream. When used in mode 3, the router operates in a 'click-less' manner and integrates seamlessly with analogue audio router cards in a 'format-independent' audio frame.

n 2.4 Balanced/ unbalanced operation

To promote flexible integration within any digital audio environment, systems are available with either balanced (50 way 'D' type) or unbalanced (BNC) I/O.

n 2.5 Default channel status

The details of the default channel status over-written in MODE 3 operation is as follows:

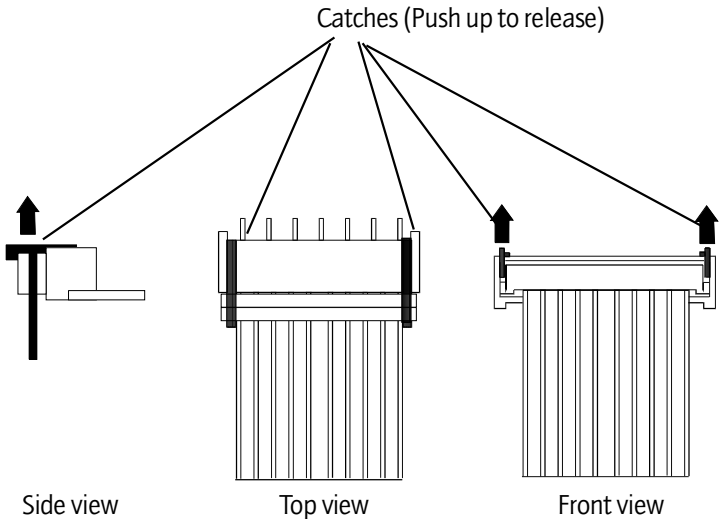
- Professional mode
- Emphasis not indicated
- Normal audio
- Stereo
- 48kHz

3 AES router card installation and configuration (4944)

n 3.1 Removal and replacement of module

The module can be removed and replaced from the frame, powered or un-powered, using the following procedure. When removing the bottom card it is necessary to remove the door before continuing. For removal purposes it is advisable to remove the ribbon cables first and then the cards.

- release the ribbon cables by pushing the catches up on either end of the connector as shown



- lift up the card ejector on the module and gently pull the card out, taking care not to catch ribbon connectors

Replacement is the reverse of above:

- slide the card along the guide rail of the required slot, gently pushing it fully home until it marries up with the connector on the motherboard

The card edge controls and indicators on the AES router card are limited to the Level and Higher Destination Decode switches and the standard 3 LED array, both of which are described in part one of the Freeway Series User guide. To recap:

n 3.2 Setting the level switch

For separate routers to be controlled independently, each must have a different level address set. This operation is achieved by means of the DIL switch marked level on the front of each ***Freeway*** card.

The levels are set thus:

SW 1	SW 2	SW 3	SW 4	Level No
0	0	0	0	1
1	0	0	0	2
0	1	0	0	3
1	1	0	0	4
0	0	1	0	5
1	0	1	0	6
0	1	1	0	7
1	1	1	0	8

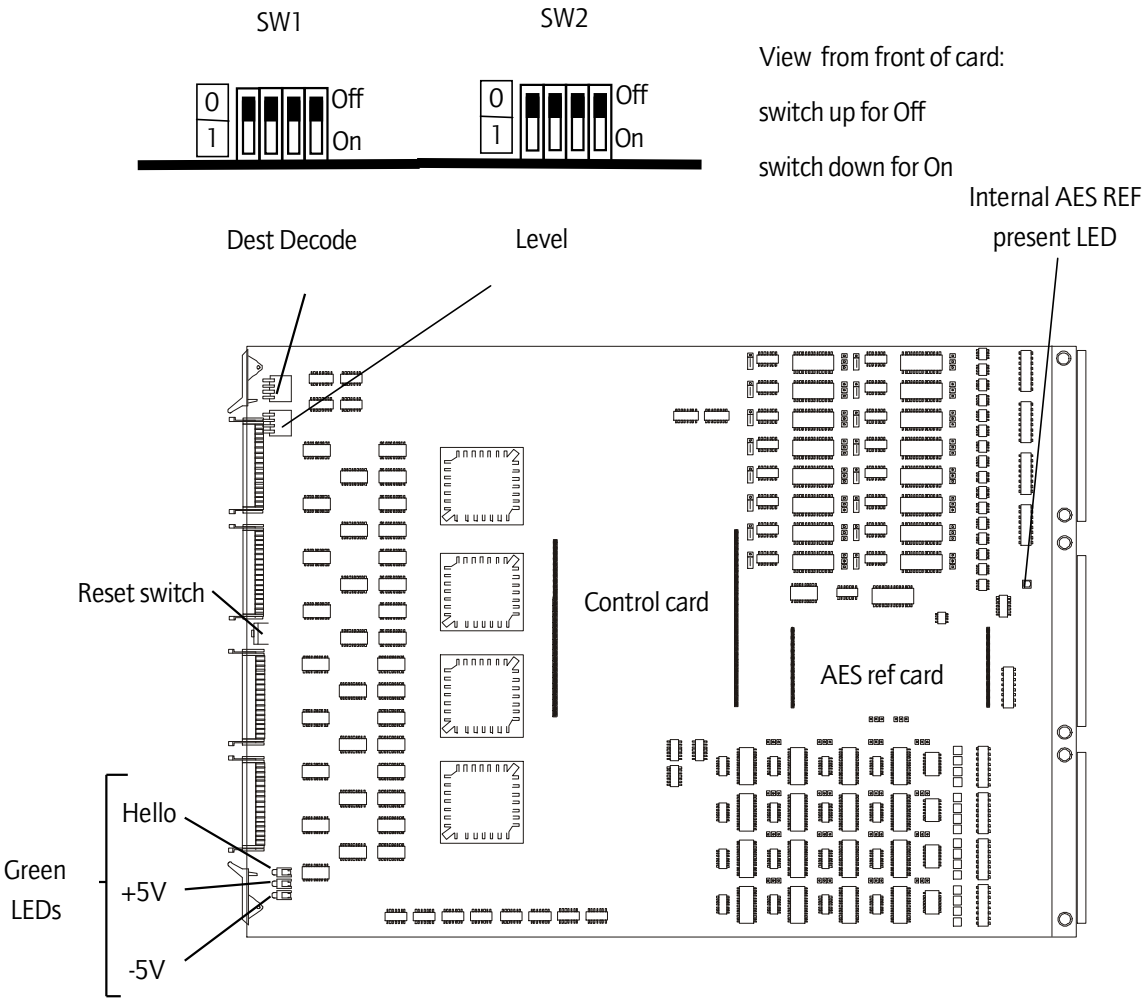
The maximum total number of independent levels is 8. A typical system might be arranged like this:

Level 1 Serial Digital Video

Level 2 Analogue Video

Level 3 AES Digital Audio

Level 4 Stereo Analogue Audio


SW1
SW2
0
1
Off
On
View from front of card:
switch up for Off
switch down for On
Internal AES REF present LED
Dest Decode
Level
Reset switch
Control card
AES ref card
Green LEDs
Hello
+5V
-5V

n 3.3 Setting the destination assign switch

The HIGHER DEST DECODE switch, located on the card edge adjacent to the LEVEL address switch, identifies the range of destinations being provided from each card on a level by level basis. In order for a module to respond correctly to switch commands issued by the ***Freeway*** controller, relevant to its destinations, the HIGHER DEST DECODE switches must be set correctly.

As ***Freeway*** 128 provides a maximum of 128 destinations, eight switch settings are required. These are detailed in the following table.

SW 1	SW 2	SW 3	SW 4	Source and destination Range
0	0	0	x	1-16
1	0	0	x	17-32
0	1	0	x	33-48
1	1	0	x	49-64
0	0	1	x	65-80
1	0	1	x	81-96
0	1	1	x	97-112
1	1	1	x	113-128

n 3.4 Card adjustments

Each channel is configurable separately which confers a great deal of operational freedom. However, beware of mixed-mode operation, unless care is taken to prevent a signal in one mode being routed to a destination which is inappropriately configured. Failure to observe this can result in high levels of noisy audio modulation which can have potentially damaging effects on downstream audio equipment, especially loudspeakers (and ears!).

Remember, unless there is an overriding good reason to adopt another mode, mode 3 is the preferred operational mode for all channels.

n 3.5 LED indications

Two of the three LEDs simply indicate that power is arriving at the board. ***Freeway*** routers all operate from two rails only (where others are needed these are generated on the ***Freeway*** cards themselves). The two rails are +5V and -5V.

The third LED is labelled 'HELLO'. This is useful in determining if the control system has spoken to a particular board and, specifically, to tell you if the LEVEL and HIGHER DEST DECODE switches are set correctly.

When the control system sends a command, for example in response to a button push, the appropriate part of the router responds, depending on how the board configuration switches are set.

If a board receives a command on which it should act, it 'winks' the 'HELLO' LED. Meaning, *'Hello, I've just received a command that's relevant according to my programmed place in the scheme of things.'*

In addition, 16 miniature LEDs appear along the front edge of the AES router card. These LEDs are intended for input-status monitoring and may be used to determine whether audio signal (or audio modulation) is present on each of the 16 inputs to the card. The operation of these LEDs is different according to the three possible operational modes of the card.

In mode 1, these LEDs flag the presence of audio input data, irrespective of audio modulation.

In mode 2, because the reclocking ICs free-run without an input signal being present, these LEDs remain permanently lit, irrespective of the condition of the AES input signals

In mode3 (the preferred operational mode) these LEDs announce the presence of audio signal modulation and remain extinguished when digital silence is present as an input. In this mode the LEDs only illuminate when an audio signal is present.

For diagnostic purposes, the AES router card is fitted with a large, dual-colour LED. This indicates whether or not the internal reference signal (TAES) is present. Green indicates that it is, while flashing red indicates that it is not. This condition may cause audio disturbances during switchingand must be rectified. The reference present LED, although mounted towards the rear of the card, can be seen when the board is housed within the frame simply by looking into the frame from the front, between the installed modules.

n 3.6 Resetting the module

There are two RESET switches available to perform a hard reset of the ***Freeway*** controller. One is located on the edge of the 2440 sub-module, while the other is on the front edge of the host card. Pressing either has the same effect.

Initiating a hard reset is similar to powering down and powering up the control frame. The controller re-boots and follows the usual power-up sequence. It should be noted that any panels connected to the system will shut down, and then be restored after initialisation is complete. It should also be noted that resetting the active controller in a dual control environment will cause the active and idle controllers to changeover.

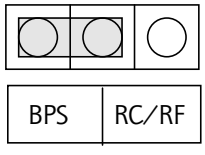
If no changes have been made to the database then no crosspoints will be changed.

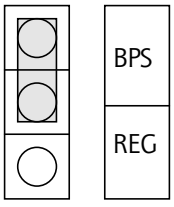
Crosspoint settings may be affected if changes to the level type have been made prior to the reset, as, during initialisation crosspoints are set according to the level types defined for each level.

It is also advisable to perform a reset after database parameters have been changed as certain operations only take effect after a reset, e.g. changing level type, panel type, source overrides, and controllable destinations.

n 3.7 Configuring mode 1

In order to set the card to operate in this mode, links on the input and output stages must be set in the BPS (Bypass) position, as shown in the following diagram. (Note that when BPS is selected on the links in the input area, the position of the links marked RC/RF, also in the input area is irrelevant.) The operation of the circuit may be determined easily from examination of the ***Freeway*** audio system diagram in Chapter 1 of this section.





n 3.8 Configuring mode 2

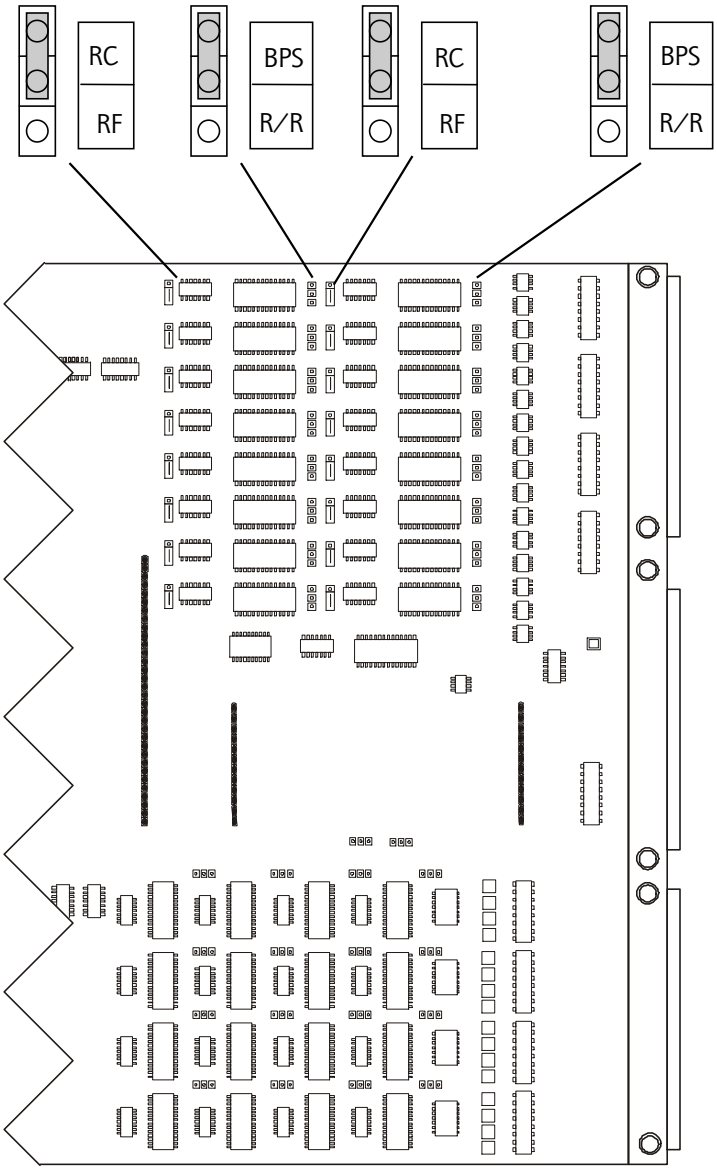
In this mode, the input data is reclocked by the input stage receiver, but bypasses the AES coder chips in the output stages. The operation of the circuit may be determined easily from examination of the ***Freeway*** audio system diagram. In order to configure this mode, the links marked BPS/RR in the input stage area must be set to the R/R position. (The R/R stands for Reclock or reframe). Next, the links marked RC/RF must be set in the RC (i.e. Reclock) position. Finally the links in the output area, marked BPS/REG must be set in the BPS position. The position of these links is illustrated in the following diagram.

n 3.9 Configuring mode 3

In this mode the input stage works in a reframing mode and the output stages are set to regenerate channel-status information. So, the input stage links must be set in the R/R position and in the RF position. And the links in the output stage must be set in the REG position, as shown in the following diagram.

The operation of the circuit may be determined easily from examination of the ***Freeway*** audio system diagram. The position of each of these links relates to each channel on the 4944 card is illustrated in the figure opposite.

However, once again, beware mixed mode operation; ideally all channels should be configured the same way.



Key:

BPS Bypass

R/R Reclock/Reframe

RC Reclock

RF Reframe

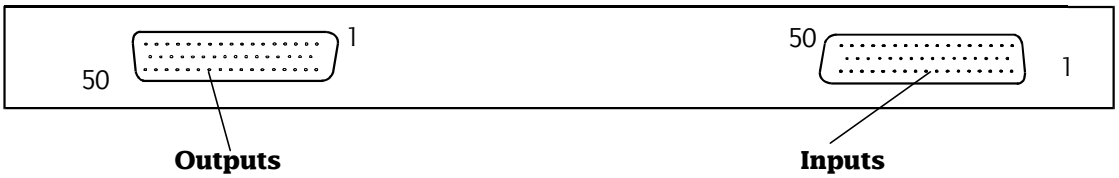
REG Regenerated channel status

n 3.10 Rear panel connections for AES

The rear connection panels are fitted with two connectors:

- One 50 way 'D' type fixed plug for inputs
- One 50 way 'D' type fixed socket for outputs

Refer to the diagram below for pinout details



Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	1 Gnd	42	9 Gnd
18	1 +	26	9 +
2	1 –	10	9 –
3	2 Gnd	11	10 Gnd
35	2 +	43	10 +
19	2 –	27	10 –
36	3 Gnd	44	11 Gnd
20	3 +	28	11 +
4	3 –	12	11 –
5	4 Gnd	13	12 Gnd
37	4 +	45	12 +
21	4 –	29	12 –
38	5 Gnd	46	13 Gnd
22	5 +	30	13 +
6	5 –	14	13 –
7	6 Gnd	15	14 Gnd
39	6 +	47	14 +
23	6 –	31	14 –
40	7 Gnd	48	15 Gnd
24	7 +	32	15 +
8	7 –	16	15 –
9	8 Gnd	17	16 Gnd
41	8 +	49	16 +
25	8 –	33	16 –

Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	1 Gnd	42	9 Gnd
18	1 +	26	9 +
2	1 –	10	9 –
3	2 Gnd	11	10 Gnd
35	2 +	43	10 +
19	2 –	27	10 –
36	3 Gnd	44	11 Gnd
20	3 +	28	11 +
4	3 –	12	11 –
5	4 Gnd	13	12 Gnd
37	4 +	45	12 +
21	4 –	29	12 –
38	5 Gnd	46	13 Gnd
22	5 +	30	13 +
6	5 –	14	13 –
7	6 Gnd	15	14 Gnd
39	6 +	47	14 +
23	6 –	31	14 –
40	7 Gnd	48	15 Gnd
24	7 +	32	15 +
8	7 –	16	15 –
9	8 Gnd	17	16 Gnd
41	8 +	49	16 +
25	8 –	33	16 –

4 AES reference generator card theory of operation (4942)

Both the AES and analogue audio router require a source of digital audio reference to function correctly. Without this reference, the clock circuitry on the 4944 and 4744 card will free-run resulting in pathological operation.

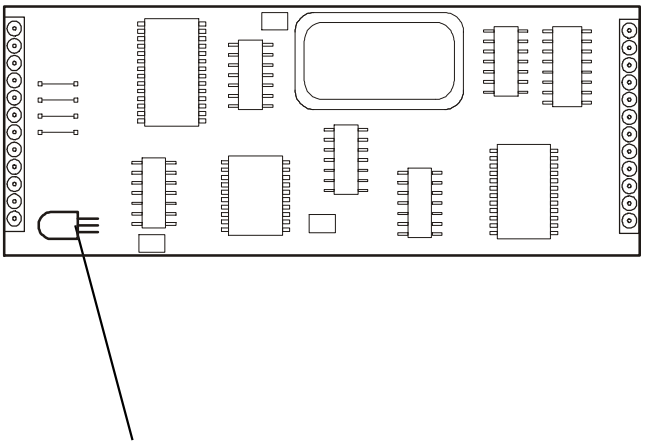
The 4942 card receives and locks to the incoming studio AES reference when it is present. If no AES reference is provided, the card generates it's own internal reference using a precision oscillator. In either case, the resultant reference is used to control the reframing circuits on the 4944 card and to drive the ADCs and DACs on the 4744 card.

When the 4942 card operates in the external-reference locked mode, it generates a reference signal which is used throughout the frame (signal = TAES) which is phase-advanced in relation to the incoming AES reference signal. The delay through the router is thereby compensated, ensuring that the signals leaving the switcher conform to the requirements of the AES 11-1997 standard *(Synchronisation of digital audio equipment in studio operations).*

5 AES reference generator card installation and configuration (4942)

For diagnostic purposes, the 4942 card carries a large, dual-coloured LED which remains lit green when a reference is present and goes red, if a reference signal is not present. This LED is brightly illuminated in either condition and may therefore be seen when the board is housed within the frame by looking between the cards from the front.

The 4942 card has no test points or user-serviceable adjustments.



6 Audio router card theory of operation (4744)

The ***Freeway*** router is implemented using 20 bit ADCs/DACs and digital-core routing technology. Bus compatibility with the AES router is adopted so that AES and analogue audio routers can integrate within one frame with inherent conversion between AES and analogue signal formats. Transformer-less input and output stages are employed, catering for signal levels up to +24dBu. In addition the outputs offer complete immunity to indefinite short circuits. Inputs are high impedance, whereas the low impedance outputs are powered by on-card DC-DC converters in order to supply the ±12V rails required for peak audio signal level handling. Levels are aligned to 'nominal' when terminated in 10k. In addition this switcher level provides: channel swap feature for reversed stereo signals and 'mono-ing' of sources (left to both, right to both and mix).

Input and output signals are treated as stereo, and as such there is no breakaway of left and right within these pairs. Advanced signal handling within the ***Freeway*** analogue audio level provides the router with the ability to 'modify' these stereo pairs, providing a flexible configuration system whereby stereo and mono signals can be accommodated in a modern broadcast environment. The audio modify functions provided for inputs are;

- normal - left channel to left, right channel to right, 0dB gain on both channels.
- channel swap
- left to both - 0dB gain
- right to both - 0dB gain,

and for outputs,

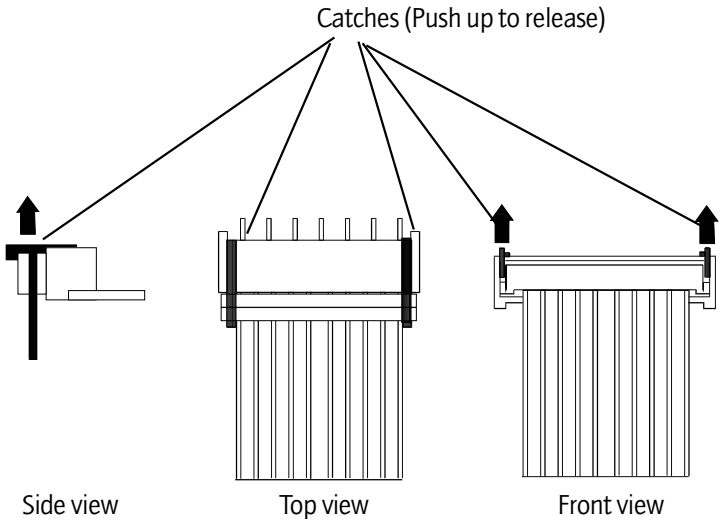
- normal - left channel to left, right channel to right, 0dB gain on both channels.
- channel swap - left to right, right to left, 0dB gain
- mono mix - (left+right)/2.

7 Audio router card installation and configuration (4744)

n 7.1 Removal and replacement of module

The module can be removed and replaced from the frame, powered or un-powered, using the following procedure. When removing the bottom card it is necessary to remove the door before continuing. For removal purposes it is advisable to remove the ribbon cables first and then the cards.

- release the ribbon cables by pushing the catches up on either end of the connector as shown



- lift up the card ejector on the module and gently pull the card out, taking care not to catch ribbon connectors

Replacement is the reverse of above:

- slide the card along the guide rail of the required slot, gently pushing it fully home until it marries up with the connector on the motherboard

Always reset card (audio reset button) immediately after pushing the card home, if this operation is performed with the power on.

Card edge controls and indicators on the AES router card are limited to the Level and Higher Destination Decode switches and the standard 3 LED array, both of which are described in the ***Freeway*** Series User guide. To recap:

n 7.2 Setting the level switch

For separate routers to be controlled independently, each must have a different level address set. This operation is achieved by means of the DIL switch marked level on the front of each ***Freeway*** card.

The levels are set thus:

SW 1	SW 2	SW 3	SW 4	Level No
0	0	0	0	1
1	0	0	0	2
0	1	0	0	3
1	1	0	0	4
0	0	1	0	5
1	0	1	0	6
0	1	1	0	7
1	1	1	0	8

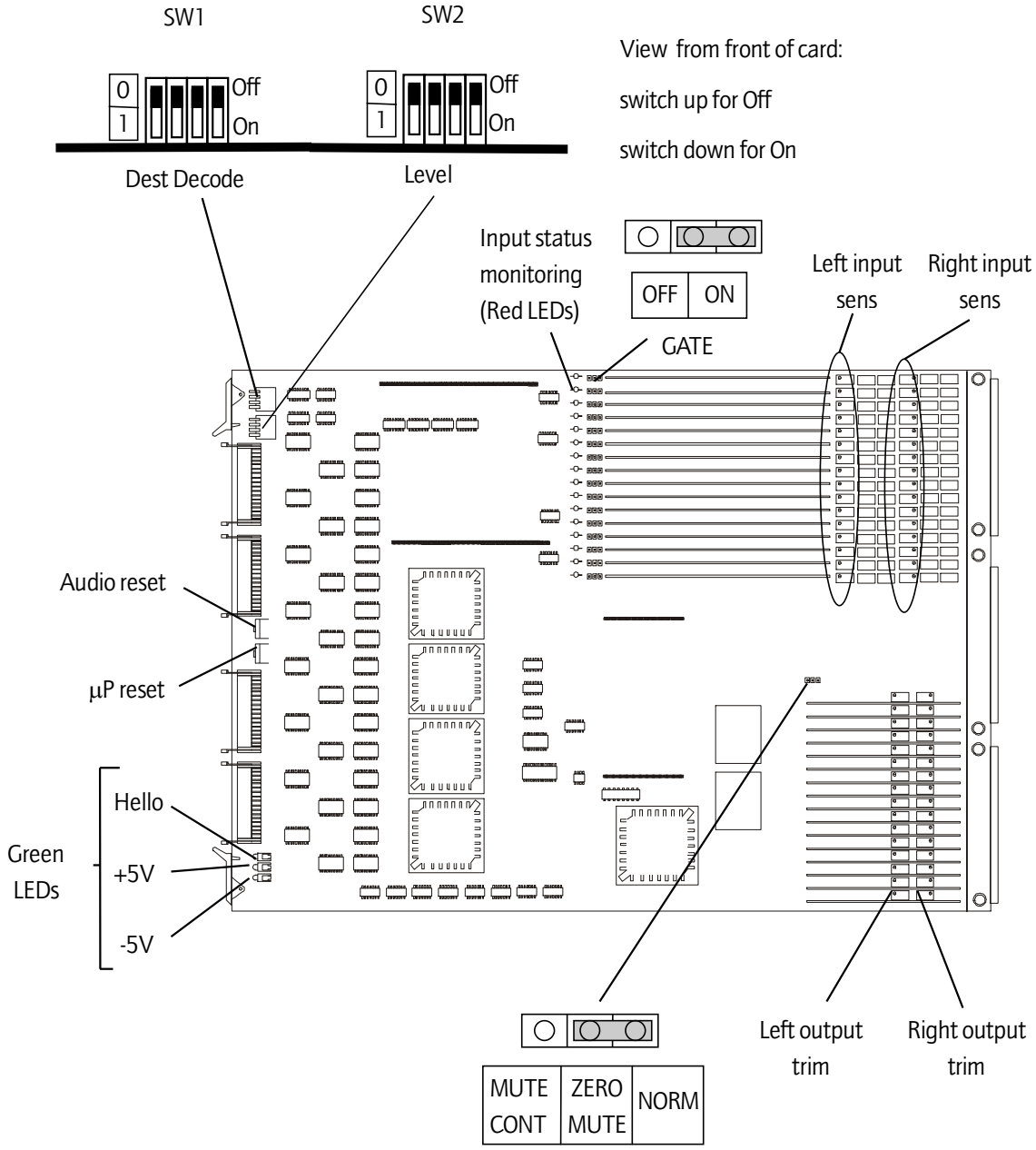
The maximum total number of independent levels is 8. A typical system might be arranged like this:

Level 1 Serial Digital Video

Level 2 Analogue Video

Level 3 AES Digital Audio

Level 4 Stereo Analogue Audio


SW1
SW2
0
1
Off
On
View from front of card:
switch up for Off
switch down for On
Dest Decode
Level
Input status monitoring (Red LEDs)
OFF
ON
GATE
Left input sens
Right input sens
Audio reset
µP reset
Green LEDs
Hello
+5V
-5V
MUTE CONT
ZERO MUTE
NORM
Left output trim
Right output trim

n 7.3 Setting the destination assign switch

The HIGHER DEST DECODE switch, located on the card edge adjacent to the LEVEL address switch, identifies the range of destinations being provided from each card on a level by level basis. In order for a module to respond correctly to switch commands issued by the ***Freeway*** controller, relevant to its destinations, the HIGHER DEST DECODE switches must be set correctly.

As ***Freeway*** 128 provides a maximum of 128 destinations, eight switch settings are required. These are detailed in the following table.

SW 1	SW 2	SW 3	SW 4	Source and destination Range
0	0	0	x	1-16
1	0	0	x	17-32
0	1	0	x	33-48
1	1	0	x	49-64
0	0	1	x	65-80
1	0	1	x	81-96
0	1	1	x	97-112
1	1	1	x	113-128

n 7.4 LED indications

Two of the three LEDs simply indicate that power is arriving at the board. ***Freeway*** routers all operate from two rails only (where others are needed these are generated on the ***Freeway*** cards themselves). The two rails are +5V and -5V.

The third LED is labelled 'HELLO'. This is useful in determining if the control system has spoken to a particular board and, specifically, to tell you if the LEVEL and HIGHER DEST DECODE switches are set correctly.

When the control system sends a command, for example in response to a button push, the appropriate part of the router responds, depending on how the board configuration switches are set.

If a board receives a command on which it should act, it 'winks' the 'HELLO' LED. Meaning, *'Hello, I've just received a command that's relevant according to my programmed place in the scheme of things.'*

In addition, 16 miniature LEDs appear along the front edge of the 4744 card. These LEDs are intended for input-status monitoring and may be used to determine whether audio signal, or audio modulation, is present on each of the 16 inputs to the card. When an input's dynamic gate is set permanently OFF, these LEDs flag the presence of audio input data, irrespective of audio modulation and therefore remain permanently lit; indicating permanently UNGATED. When an input's dynamic gate is set to ON, these LEDs announce the presence of audio signal modulation and remain extinguished when digital silence is forced as a result of the operation of the gate. In this mode the LEDs only illuminate when an audio signal is dynamically UNGATED.

For diagnostic purposes, the 4744 card is fitted with a dual-coloured LED. This indicates whether or not the internal reference signal (TAES) is present. Green indicates that it is, while flashing red indicates that it is not. This condition may cause audio disturbances during switching and must be rectified. The reference present LED, although mounted towards the rear of the card, can be seen when the board is housed within the framesimply by looking into the framefrom the front, between the installed modules.

n 7.5 Resetting the module

There are two RESET switches available to perform a hard reset of the audio card. Both are located on the front edge of the card.

The AUDIO RST switch will, when pressed, reset the ADCs and DACs on the card. It may be used when there has been a brief loss of power or station reference (this may cause the converter chips to 'crash'). Alternatively, this switch should be exercised if the card is inserted into the frame with the power on.

Note that when this switch is operated all audio signals issuing from - and routed to - the board will be mute for several seconds.

The μP RST will only operate when there is a 2440 control card installed on the card. Pressing this switch performs a hard reset of the ***Freeway*** controller..

Initiating a hard reset is similar to powering down and powering up the control frame. The controller re-boots and follows the usual power-up sequence. It should be noted that any panels connected to the system will shut down, and then be restored after initialisation has completed. It should also be noted that resetting the active

controller in a dual control environment will cause the active and idle controllers to changeover.

If no changes have been made to the database then no crosspoints will be changed.

Crosspoint settings may be affected if changes to the level type have been made prior to the reset, as, during initialisation crosspoints are set according to the level type defined fo reach level.

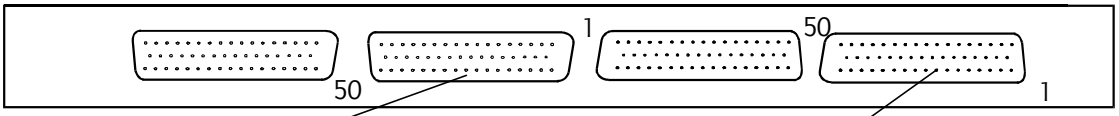
It is also advisable to perform a reset after database parameters have been changed as certain operations only take effect after a reset, e.g. changing level type, panel type, source overrides and controllable destinations.

n 7.6 Rear panel connections - analogue audio

The rear panel has 4 connectors:

- two 50 way 'D' type fixed plug for inputs
- two 50 way 'D' type fixed socket for outputs

Refer to the following diagrams for pinout details .

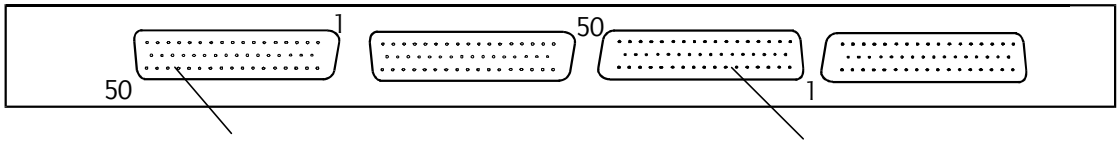


Outputs 1-8

Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	Gnd	42	Gnd
18	1L +	26	5L +
2	1L –	10	5L –
3	Gnd	11	Gnd
35	1R +	43	5R +
19	1R –	27	5R –
36	Gnd	44	Gnd
20	2L +	28	6L +
4	2L –	12	6L –
5	Gnd	13	Gnd
37	2R +	45	6R +
21	2R –	29	6R –
38	Gnd	46	Gnd
22	3L +	30	7L +
6	3L –	14	7L –
7	Gnd	15	Gnd
39	3R +	47	7R +
23	3R –	31	7R –
40	Gnd	48	Gnd
24	4L +	32	8L +
8	4L –	16	8L –
9	Gnd	17	Gnd
41	4R +	49	8R +
25	4R –	33	8R –

Inputs 1-8

Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	Gnd	42	Gnd
18	1L +	26	5L +
2	1L –	10	5L –
3	Gnd	11	Gnd
35	1R +	43	5R +
19	1R –	27	5R –
36	Gnd	44	Gnd
20	2L +	28	6L +
4	2L –	12	6L –
5	Gnd	13	Gnd
37	2R +	45	6R +
21	2R –	29	6R –
38	Gnd	46	Gnd
22	3L +	30	7L +
6	3L –	14	7L –
7	Gnd	15	Gnd
39	3R +	47	7R +
23	3R –	31	7R –
40	Gnd	48	Gnd
24	4L +	32	8L +
8	4L –	16	8L –
9	Gnd	17	Gnd
41	4R +	49	8R +
25	4R –	33	8R –



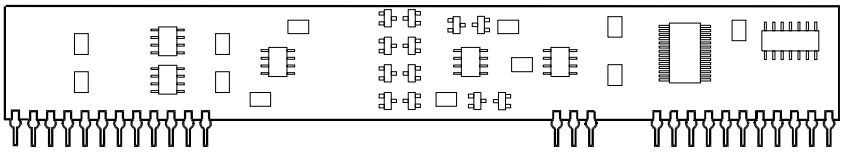
Outputs 9-16 **Inputs 9-16**

Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	Gnd	42	Gnd
18	9L +	26	13L +
2	9L –	10	13L –
3	Gnd	11	Gnd
35	9R +	43	13R +
19	9R –	27	13R –
36	Gnd	44	Gnd
20	10L +	28	14L +
4	10L –	12	14L –
5	Gnd	13	Gnd
37	10R +	45	14R +
21	10R –	29	14R –
38	Gnd	46	Gnd
22	11L +	30	15L +
6	11L –	14	15L –
7	Gnd	15	Gnd
39	11R +	47	15R +
23	11R –	31	15R –
40	Gnd	48	Gnd
24	12L +	32	16L +
8	12L –	16	16L –
9	Gnd	17	Gnd
41	12R +	49	16R +
25	12R –	33	16R –

Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	Gnd	42	Gnd
18	9L +	26	13L +
2	9L –	10	13L –
3	Gnd	11	Gnd
35	9R +	43	13R +
19	9R –	27	13R –
36	Gnd	44	Gnd
20	10L +	28	14L +
4	10L –	12	14L –
5	Gnd	13	Gnd
37	10R +	45	14R +
21	10R –	29	14R –
38	Gnd	46	Gnd
22	11L +	30	15L +
6	11L –	14	15L –
7	Gnd	15	Gnd
39	11R +	47	15R +
23	11R –	31	15R –
40	Gnd	48	Gnd
24	12L +	32	16L +
8	12L –	16	16L –
9	Gnd	17	Gnd
41	12R +	49	16R +
25	12R –	33	16R –

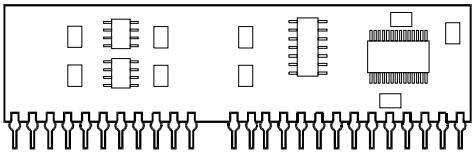
8 ADC submodule theory of operation(4741)

The 4741 sub-module comprises a stereo common-mode rejection amplifier which drives a 20 bit stereo ADC and side-chain circuitry. Signals arriving at the 4741 module (over and above the audio signals) include bit-rate and word-rate clocks, feeds and reset pulses. The two important signals leaving the sub-module include the digitally encoded PCM audio data and the side-chain gate-drive.



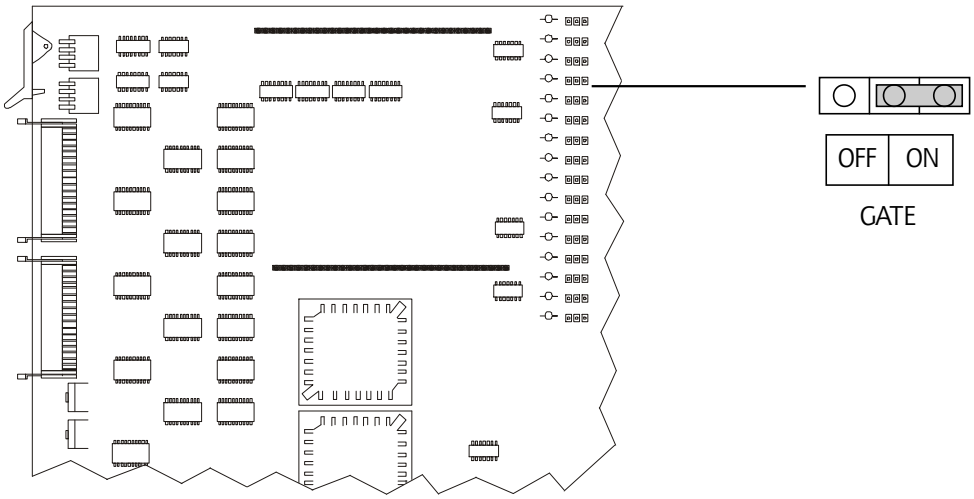
9 DAC submodule theory of operation (4742)

The 4742 sub-module incorporates a 20bit stereo DAC and unbalance to balance amplification and drive circuitry. In addition this module incorporates the circuitry used to provide the mono mix and left or right channel to both, audio modify functions. Note that in ***Freeway***, input and output signals are treated as stereo. The 4742 module incorporates all the circuitry necessary to accommodate the electrical issues relating to the handling of the summation of stereo signals, where they must be fed to a mono destination; and to the handling of mono sources within a stereo router.

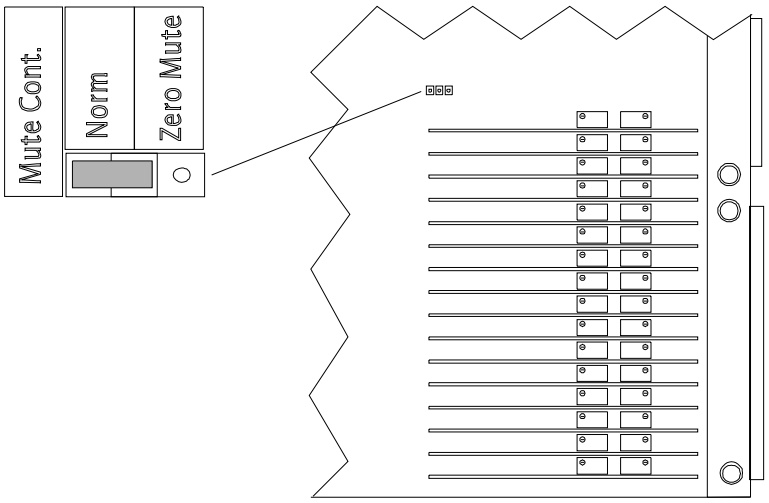


10 Setting gate and mute jumpers

Freeway incorporates a digital amplitude-driven signal gate at each analogue input. This circuit is arranged so that signals below a threshold of approximately -75dBFS (coded PCM) are forced to digital silence. Hysteresis and a time-constant of 2 seconds ensure the gate does not 'chatter' on signals which dwell at low amplitude. With the gate ON, signal to noise ratio is increased to over 100dB. Gate operation is selected according to the position of the links illustrated in the following figure.



The analogue module also features a single jumper to set the operation of the output stages. Under all operating conditions the jumper should be set to the normal (Norm) position. As with the input stages, this mode forces the output circuitry to digital silence during periods with a low level signal.


Mute Cont.
Norm
Zero Mute

11 Upgrading your *Freeway* audio router

Because ***Freeway*** is a modular router, it offers great flexibility in configuration and application. This offers you tremendous benefits - however it is necessary, so that you can make the most appropriate choice for your application or upgrade; to understand how each ***Freeway*** router type 'fits together', so that you can order the correct parts from us. But first some general points about the ***Freeway*** router 'philosophy'.

Every ***Freeway*** router starts with a base frame router 'bundle'. The order codes for all these frames are logically consistent. Each base frame 'bundle' consists of; a frame, a PSU, a microprocessor board, three rear blanking plates and the first signal card and matching rear connector panel. The μP card will be installed on the single signal card and will be configured with the default database defined earlier in this manual. In addition, included in this 'bundle' you will receive; a user manual,and mating rear connectors for all control and signal ports (with the exception of the Reference inputs and all ports which terminate in BNCs). This bundle is a 'plug-and play' 16x16 router.

To order a router larger than 16 x 16, again a simple, logical number sequence exists. This consists of the base 'bundle' described above, with extra modules to provide 32x32, 48x48, through to 128x128 in 16 input and output increments.

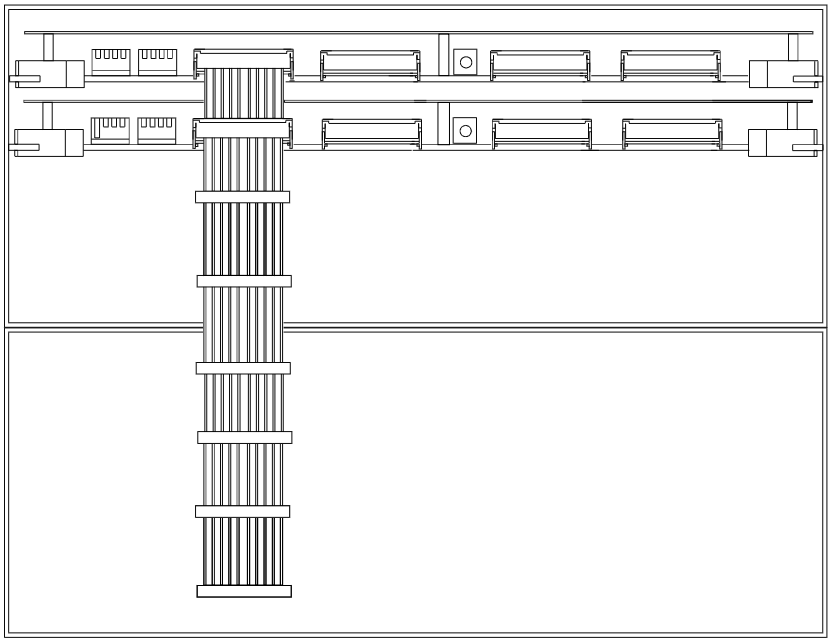
In order to expand existing ***Freeway*** routers, it is necessary to order expansion kits. Each kit contains all the necessary components for expansion to the next size of ***Freeway*** router. These vary from signal type to signal type as detailed below but, essentially, each contains; a further 16x16 router card, matching rear connector panel, appropriately numbered 17 to 32, 33 to 48, through to 113 to 128, front of card ribbon cables and, mating connectors - in the case of balanced audio levels - to effect the expansion.

Freeway 128 expansion

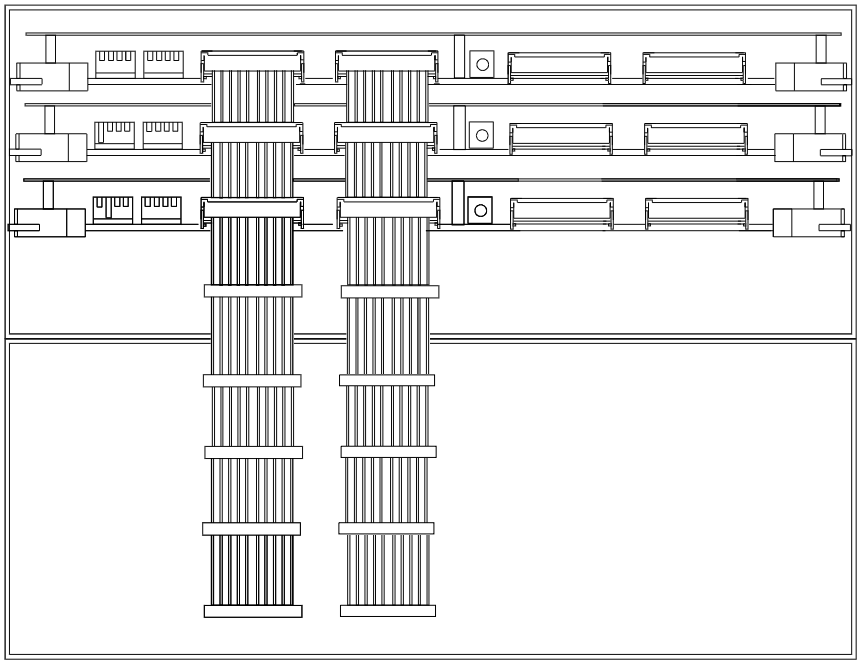
The following diagrams show the cable connections required for expanding base routers from 16x16 for all possible combinations, whether the router is all analogue, digital or mixed. Care should be taken to ensure that the level and destination assign switches are set correctly.

Freeway 128 can be expanded from 16x16 up to 128x128 in a single 6U frame, it is however possible to expand from 16x16 to 64x64 in a single 3U frame using the same ***Freeway*** 128 modules.

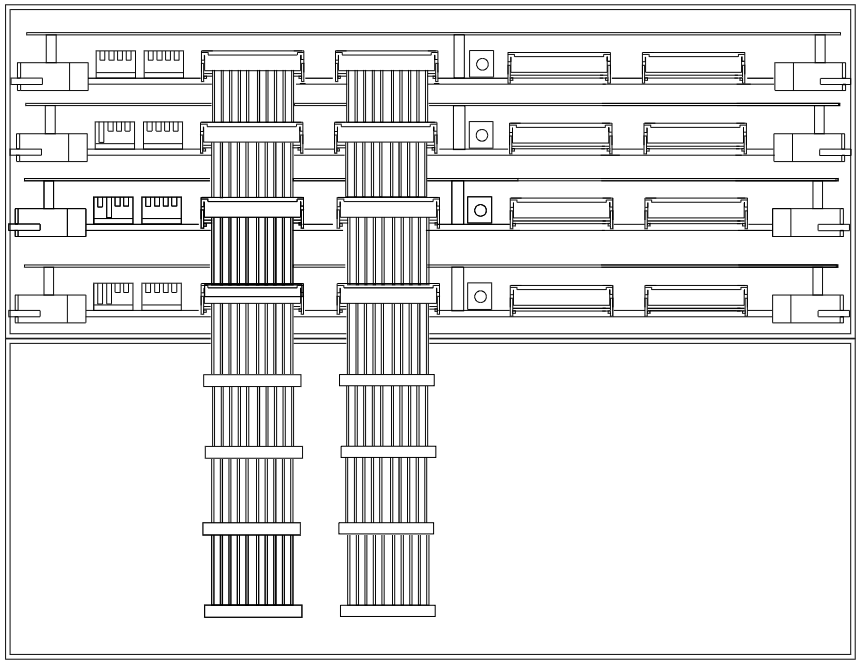
16 x 16 to 32 x 32



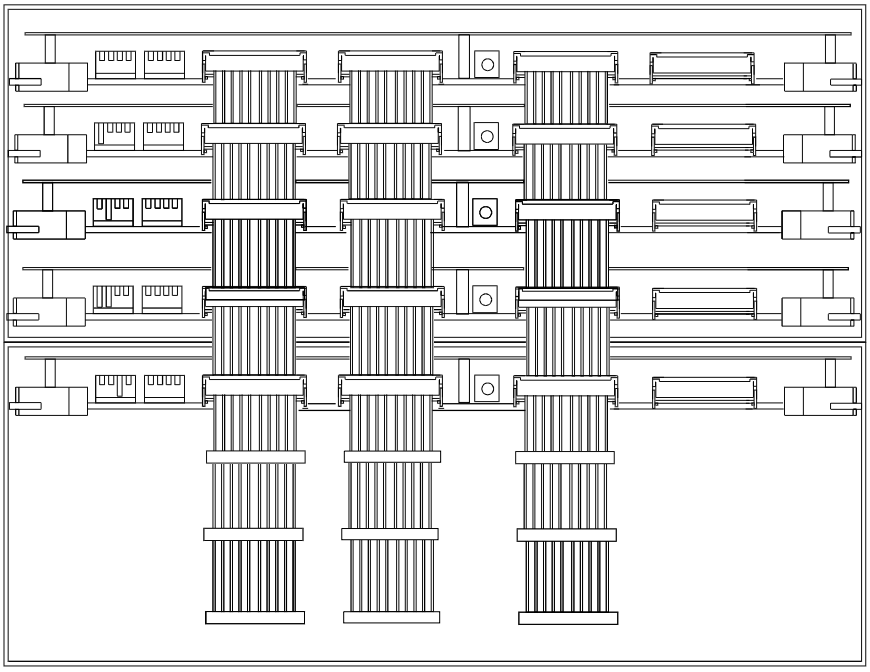
32 x 32 to 48 x 48



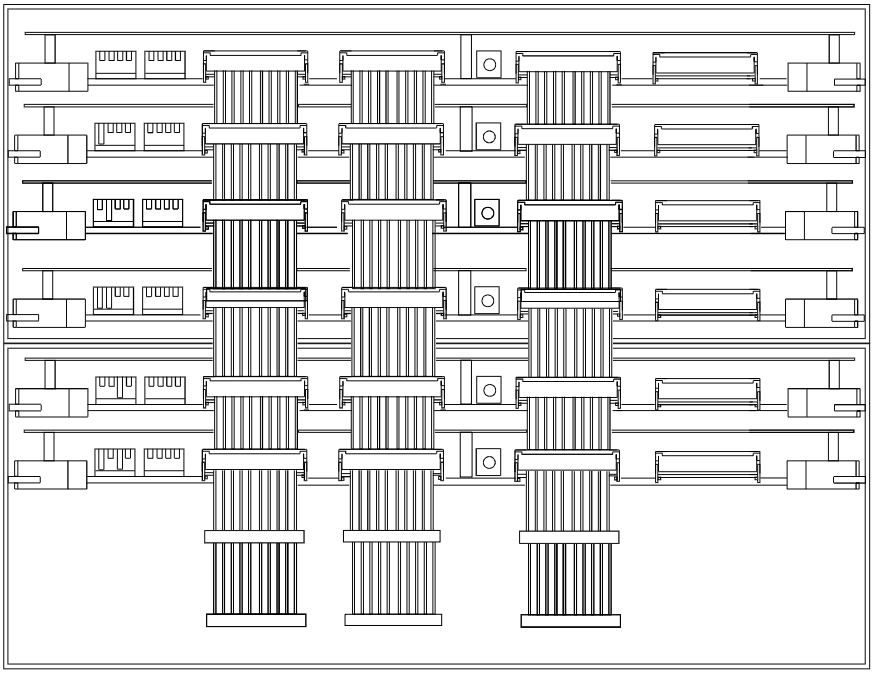
48 x 48 to 64 x 64



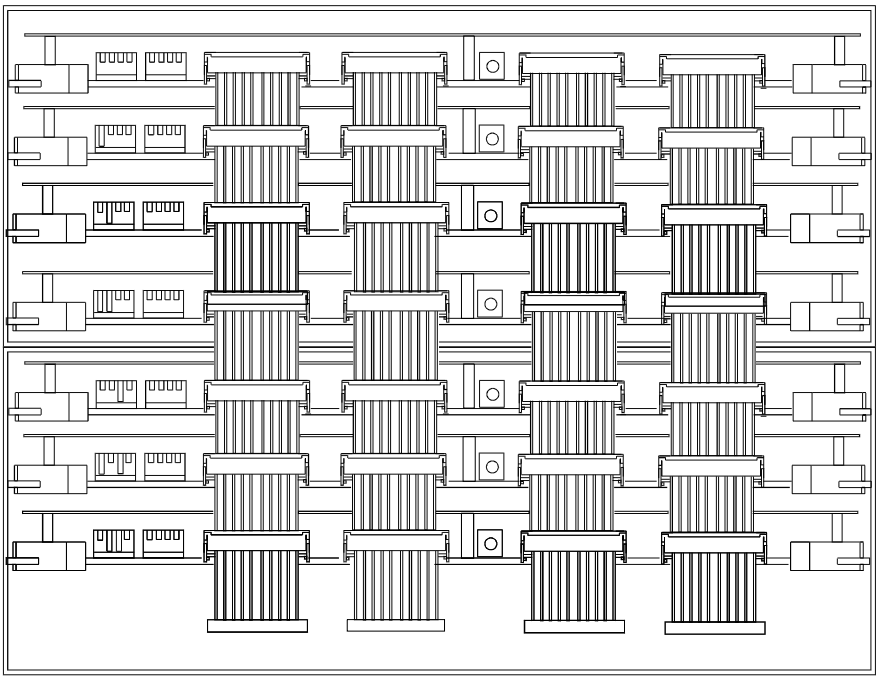
64 x 64 to 80 x 80



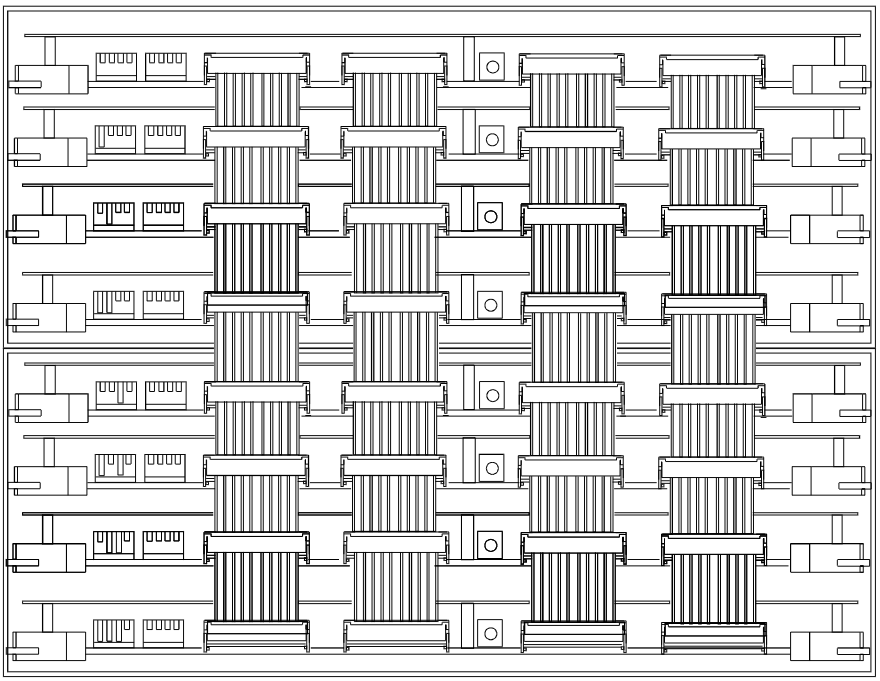
80 x 80 to 96 x 96



96 x 96 to 112 x 112



112 x 112 to 128 x 128



12 Optional hardware

There exist some further order codes which relate to optional extras and spare parts. These are detailed below:

Extra PSU, 1941	FRE-N000-BPSU
Extra μP card, 2440	FRE-N000-RCPU

Spare parts

AES signal card, 4944	FRE-N000-DAXP
AES rear connector card, balanced, 1463	FRE-N00B-DARC
AES rear connector card, unbalanced, 1749	FRE-N00U-DARC
Stereo analogue audio signal card, 4744	FRE-N000-AAXP
Stereo analogue audio rear connector card, 1747	FRE-N000-AARC
AES Reference generator card, 4942	FRE-N000-DARG
3U *Freeway* Frame, no PSU	FRE-3000-0FRM
6U *Freeway* Frame, no PSU	FRE-6000-0FRM

13 Problem solving

Card does not work at all

Things that affect general system operation:

power supply	check that the LED on either power supply is lit
decoding circuitry	check that the HELLO LED on the card lights up from time to time
AES reference signal	ensure the dual-coloured LED towards the rear of the card is green and not flashing red

Things that will not affect main system operation:

power supply	both power supply units do not have to be working, only one is required

Noisy or distorted signals present

Things that affect the signals.

wrong output data mode configuration	check that the destination on the AES card is configured correctly
brief loss of power or station reference	try resetting the ADC and DAC chips

14 Specification

n Digital input - digital output

Input impedance	110Ω (reduces to 75Ω when unbalanced rear-card fitted)
Output impedance	110Ω (reduces to 75Ω when unbalanced rear-card fitted)
Sample rate	22.05 to 96kHz (non re-clocking, non re-framing)
	32 to 48kHz (re-clocking and re-framing)
Wordlength	16 to 24bit
Performance	
Non re-clocking	Transparent to all bi-phase mark data
Re-frame performance	TBC's all inputs, outputs AES-11 compliant
	Channel status data re-written in this mode[1]
Transients	No audible clicks (when in re-frame mode)

[1]The details of the over-written channel status are as follows:

- Professional mode
- Emphasis not indicated
- Normal audio
- Stereophonic
- 48kHz sampling

n Analogue input - analogue output

Input impedance	> 10k (13.6k)
Output impedance	< 100Ω (47R per leg)
Max level	+24dBu (not achievable into a 600Ω load)
Gain stability	+/- 0.1dB/24 hours
Frequency response	+/- 1dB 20Hz to 22kHz
THD + N	< 0.1% at 1kHz, +18dBu
	< 0.1% at 1kHz, 0dBu
Dynamic range	>100dB: THD+N on -60dBFS tone referred to full scale (AES17-1991)
Signal to noise ratio	>100dB (gate operative)
Gate closure level	≈-55dBu (ie - 75dBFS), TC = 2 seconds, +2dB hysteresis
Crosstalk	<-90dB all hostile at 10kHz
Transients	No audible clicks

n Digital input - analogue output

Output impedance	< 100Ω (47Ω per leg)
Input wordlength	16 to 24 bit
Converter	20 bit, Delta Sigma
Max level	+18dBu (not achievable into a 600Ω load)
Gain stability	+/- 0.1dB/24 hours
Frequency response	+/- 1dB 20Hz to 22kHz
THD + N	< 0.01% at 1kHz, +18dBu
	< 0.1% at 1kHz, 0dBu
Dynamic range	>100dB: *THD+N on -60dBFS tone referred to full scale* (AES17-1991)
Signal to noise ratio	>100dB
Crosstalk	<-90dB all hostile at 16kHz
Transients	No audible clicks

n Analogue input - digital output

Output impedance	110Ω (reduces to 75Ω when unbalanced rear-card fitted)
Sample rate	48kHz (free running or locked to reference)
Output wordlength	20 bit
Converter	20 bit, Delta Sigma
Performance	Outputs AES-11 timing compliant
	Channel status data re-written in this mode
Transients	No audible clicks (when in re-frame mode)

15 Appendix 1- Handling mono signals

In ***Freeway***, each input and output signal are treated as a stereo pair. However, the various operational requirements issuing from stereo working practises, demand that each stereo signal has associated with it a group of signal attributes as explained above and in Part 1 of this User Guide. These attribute configuration commands issue from the 2440 control card and are interpreted and executed on the audio card. The control of these attributes is via the 2440 card's RS232 configuration port. This appendix addresses two issues: Primarily it deals with the pattern of attributes which may be associated with each router source and destination. This is preceded by a consideration of the electrical issues relating to the handling of the summation of stereo signals, where they must be fed to a mono destination; and to the handling of mono sources within a stereo router.

Historically, some broadcasters use the following definition for stereo to mono conversion:

Mono = A + B - 3dB or more clearly,

Mono = (A + B) / 1.414

Similarly, their definition for mono to stereo conversion:

A = B = Mono - 3dB

The operational ramifications of such a policy are that, where it is required that the two lines of a stereo circuit be combined to form a mono feed, then the gain should be arranged such that when tone at -3dB is applied to both inputs, then the output of the mono feed is at 0dB. Conversely, when a mono circuit is to be split to feed a pair of stereo lines, then an input of tone at 0dB should give an output of -3dB on each of the lines.

Other broadcasters take a different view. To wit, that a provision should be made for switching either the A or B stereophonic signals or, alternatively, the M signal (A + B) / 2 to the A and B programme circuits. This latter scheme is the strategy adopted in the ***Freeway*** analogue audio router.

Technically, the ***Freeway*** offers the following five output stage circuit configurations (as previously defined):

1) Normal - ie. left channel to left, right channel to right, 0dB gain on both channels.

2) Left to both - 0dB gain

3) Right to both - same as (2)

4) Channel swap - left to right, right to left, 0dB gain

5) Mono summation; (left + right) / 2

However, for an operator, some of these configurations are, best 'thought of' in terms of input or output stage configuration as explained above. This results in the following table of possible input and output configuration options. Input options are listed by row; Output options by column. Configuration states within the table itself relate to the true, electrical, condition of the 4741 sub-module output stage as defined above.

	***Normal**	***Swap**	***Mono Summation**
***Normal**	*Normal (0,0)	*Swap (0,0)	*Mono Sum' (0,0)
***Swap**	*Swap (0,0)	*Normal (0,0)	*Mono Sum' (0,0)
***Left to both**	*Left to both (0,0)	*Left to both (0,0)	*Left to both (0,0)
***Right to both**	*Right to both (0,0)	*Right to both (0,0)	*Right to both (0,0)

Note, particularly, the figures following the electrical configuration. Two figures appear in parenthesis; these relate to the signal level, on left and right channel output, resulting from an input of 0VU line-up tone from both a stereo source (on both channels) and from a mono source.

Compare this with the following table where the figures, following the output stage electrical configuration options, indicate the output stage levels resulting from adoption of the alternative policy regarding the mono-ing of stereo sources and 'stereo-ing' of mono sources (i.e. that policy which incorporates a 3dB level difference).

	***Normal**	***Swap**	***Mono Summation**
***Normal**	*Normal (0,0)	*Swap (0,0)	*Mono Sum' (+3,+3)
***Swap**	*Swap (0,0)	*Normal (0,0)	*Mono Sum' (+3,+3)
***Left to both**	*Left to both (-3,-3)	*Left to both (-3,-3)	*Left to both (0,0)
***Right to both**	*Right to both (-3,-3)	*Right to both (-3,-3)	*Right to both (0,0)

The operational advantages of the philosophy adopted in ***Freeway*** are manifest.