Contents

1 Introduction

This section of the ***Freeway*** Technical manual covers the theory of operation and installation of the ***Freeway*** 32 router modules. These modules, as their name suggests, provide a solution for applications requiring routers with a maximum size of up to 32x32.

The ***Freeway*** 32 family comprises Four router level types, incorporating serial digital video, analogue video, AES digital audio and stereo analogue audio signals. Each card provides 16 inputs and 16 outputs and, by interconnecting two cards, field expansion to a maximum size of 32 inputs and 32 outputs may be achieved. A single ***Freeway*** 32 router level occupies only two module slots in a ***Freeway*** frame.

Freeway 32 levels may be freely mixed with ***Freeway*** 64 and 128 router levels within the standard 3U and 6U ***Freeway*** frames.

System configuration details are held in the ***Freeway*** control card database, which also contains configuration data on any other routers within the configured ***Freeway*** system. Details on configuring ***Freeway*** databases is contained in the ***Freeway*** Editor Users Guide.

2 Installation and configuration

This section provides general installation and configuration information common to all modules in the ***Freeway*** 32 range. Specific requirements relating to each signal type, such as audio connector details are contained within the relevant sub-section of this part of the technical manual.

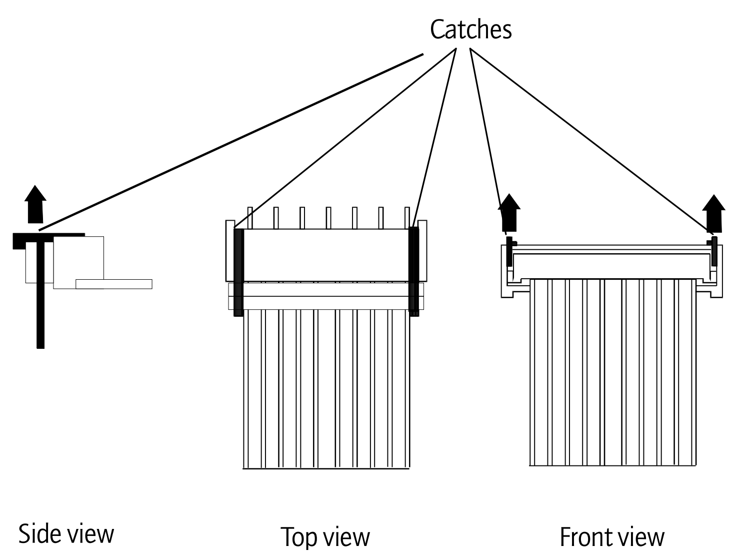
■ 2.1 Removal and replacement of modules

Freeway 32 modules can be removed from the frame and replaced, powered or un-powered, using the following procedure. When removing the bottom card from a frame, it is necessary to remove the door before continuing. For removal purposes it is advisable to remove any ribbon cables from the card edge first, 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

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



■ 2.2 Setting the level switch

A ***Freeway*** router can comprise of up to eight levels. In order for these to be independently controlled, each must have a different level address. By setting the LEVEL address switch located on the front of each ***Freeway*** module, the control system can identify each level and control it independently. It is desirable in some applications, such as component or RGB routers, to provide married switching across a number of levels. In these instances the LEVEL address should be the same for each router card.

Levels addresses are set as follows:

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

A typical system might be arranged like this:

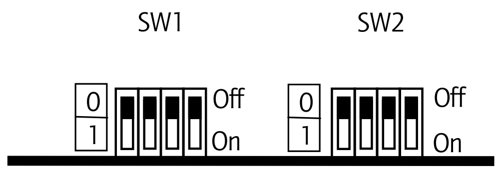
Level 1 Serial Digital Video

Level 2 Analogue Video

Level 3 AES Digital Audio

Level 4 Stereo Analogue Audio

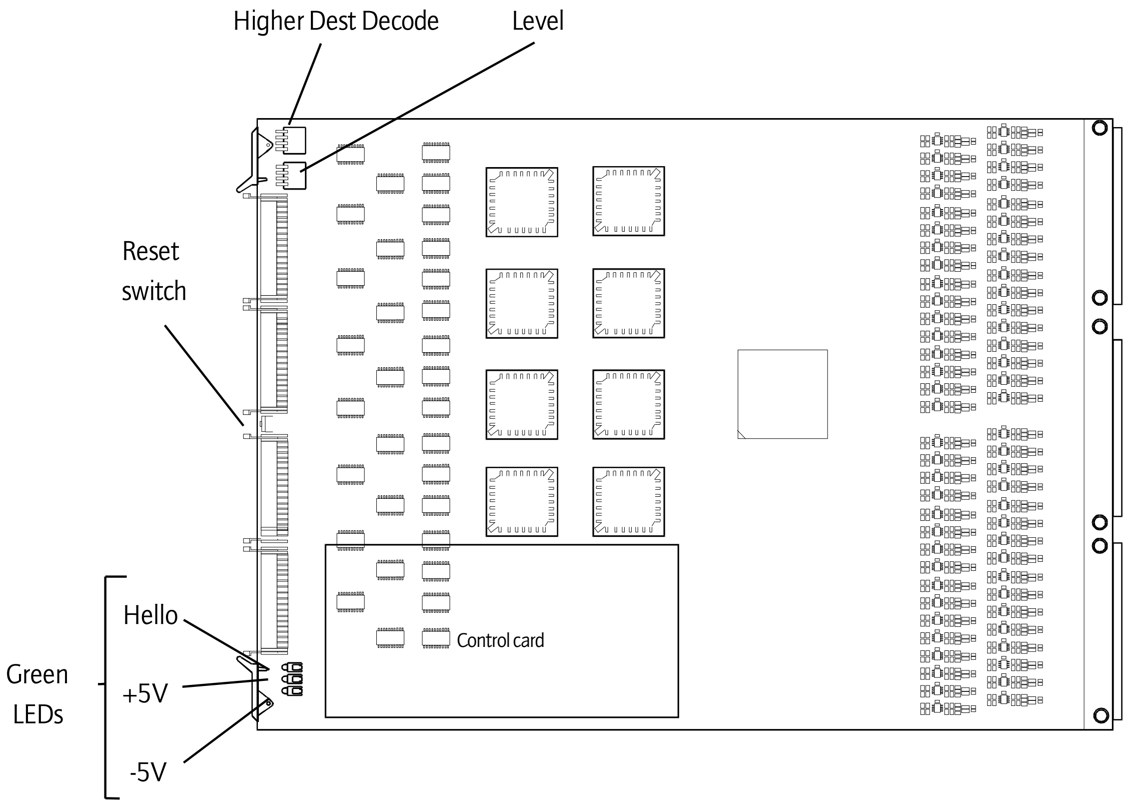
Level 5 Timecode



View from front of card:

switch up for Off

switch down for On



■ 2.3 Setting the Higher Dest Decode 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*** 32 provides a maximum of 32 destinations, only two switch settings are required. These are detailed in the following table.

SW 1	**SW 2**	**SW 3**	**SW 4**	**Destination Range**
0	0	x	x	1-16
1	0	x	x	17-32

■ 2.4 LED indications

Two of the three LEDs, located on the card edge, indicate that power is arriving to the board. ***Freeway*** routers operate from two rails only, these are +5V and -5V. Where others are required, they are derived on the ***Freeway*** cards themselves.

The third LED is labelled 'HELLO'. This is useful in determining whether 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.

When 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.'*

■ 2.5 The Freeway control card

Central to the operation of any ***Freeway*** routing system is the control card. The card, type 2440, is a sub-module fitted to any one of the router cards within the system and is used to provide control to the router and hold configuration data. If required, two cards may be fitted on separate signal modules within a ***Freeway*** system, providing main and backup operation in the event that one microprocessor card should fail. Full details on configuring the control card are given in Section 6 of the general information section o f this Manual.

Each ***Freeway*** module is fitted with the relevant header allowing it to be fitted with a controller, therefore any of the ***Freeway*** 32 modules may or may not host a control card. If it does, then it may be necessary to perform a card reset as detailed in the following section.

■ 2.6 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 type 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.

3 Serial digital video

This section details the operation and operational alignment of the serial digital video routing card (**3946**) for the ***Freeway*** 32 series of routing switchers.

■ 3.1 Introduction

The ***Freeway*** 32 serial digital video router, like the ***Freeway*** 64 variant, automatically accommodates data rates between 140 and 360Mbit/s providing full compatibility for all standard definition digital signal formats.

Each input is fitted with an adaptive cable equaliser, providing automatic equalisation for different lengths of cable on the inputs. The reclocking circuitry employed at each router output guarantees exemplary signal quality, whilst ensuring fully transparent operation for ancillary data and embedded audio.

In addition, the router provides the ability to route simultaneously, signals of both 525/60 and 625/50 standard. ***Freeway*** frames are fitted with dual reference inputs for both NTSC and PAL 'house reference' signals. Users can define, in mixed standard installations, which inputs are 525/60 and which are 625/50, ensuring the correct video reference is used to provide vertical interval switching. The reference type can either be pre-assigned, via the configuration editor, or modified dynamically using a master panel type 6276. These operations are detailed in sections 6 and 7 respectively, of the general information section of this manual.

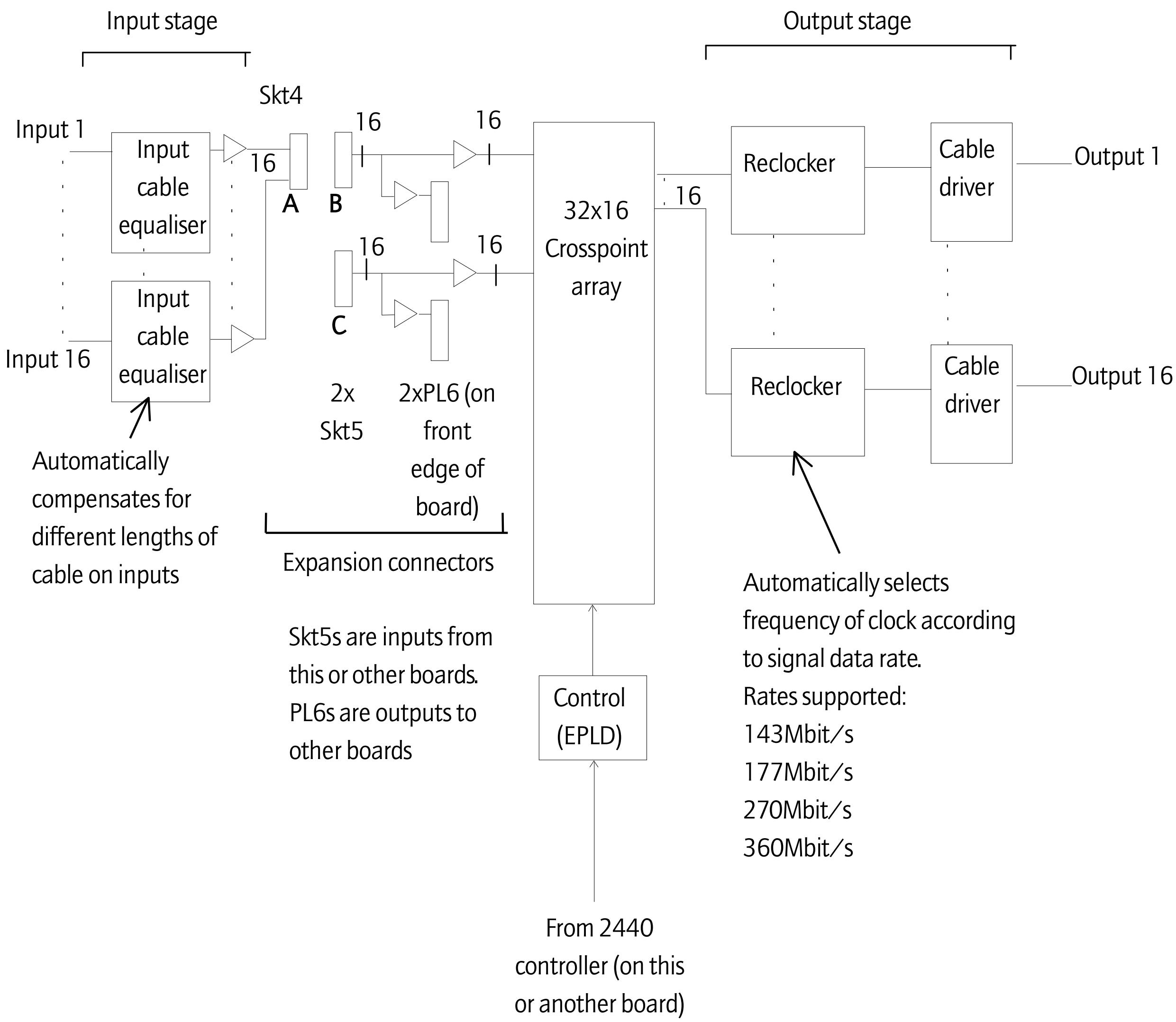
■ 3.2 Theory of operation

Each of the 16 inputs are buffered, using a receiver/equaliser before being passed to the 32x16 crosspoint array. The system controller provides the crosspoint array with destination and source address information. A strobe pulse derived from the video relevant reference input, enabling the requested routes to be switched in the correct vertical interval, is also sent to the crosspoint array.

The output stage automatically selects the correct clock frequency for the incoming signal data rate switched to it. The signal is reclocked and then buffered out via the cable driver.

A single ribbon cable fitted to each board determines the input and output range it is to be used for within the router. The following table details the cable position required for the available input and output ranges.

Input/Output	Position
1 - 16	**A** to **B**
17 - 32	**A** to **C**

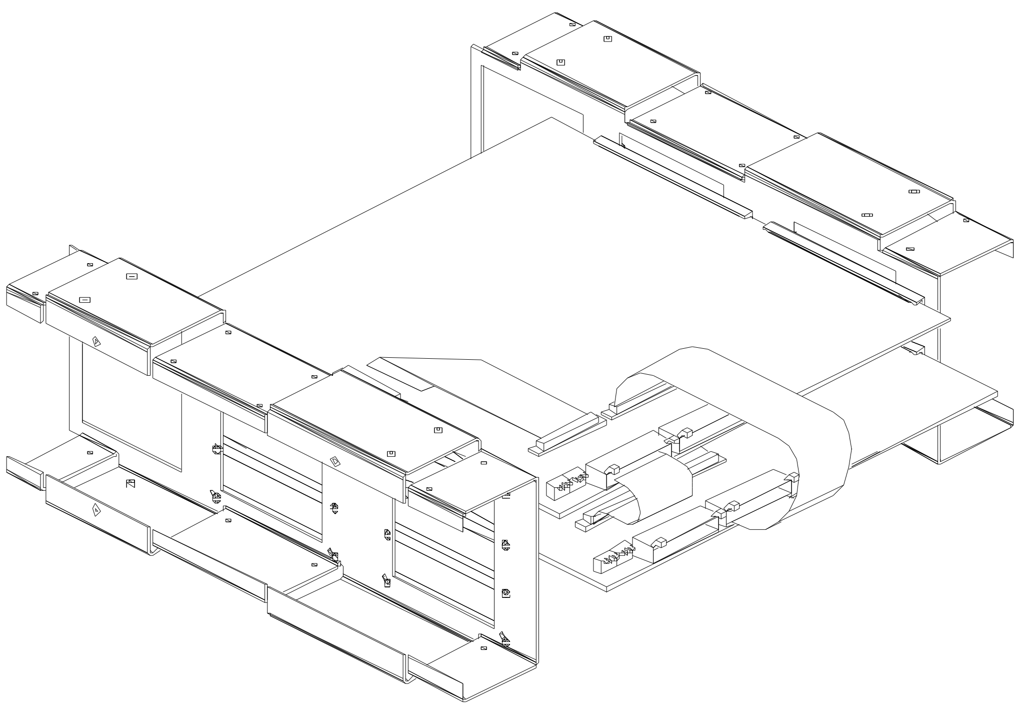


Internal block diagram

■ 3.3 Expanding from 16x16 to 32x32

The base ***Freeway*** 32 module may be expanded, with the addition of a second ***Freeway*** 32 switch module to 32x32. It is necessary to fit the expansion module in the slot adjacent to the base router card before connecting the ribbon cables across the front of the modules.

The following diagram details the cable connections required for expanding the router from 16x16 to 32x32. Care should be taken to ensure that the level and destination assign switches are set correctly, see sections 2.2 and 2.3.



Expansion from 16x16 to 32x32

■ 3.4 Specification

The following specification refers to a single ***Freeway*** 32, 16x16 serial digital video router module.

■ Inputs

Number and type:	16: Unbalanced NRZI coded serial data
Standard:	Serial EBU Tech 3267E. SMPTE 259M-ABCD
Input Impedance:	75Ω
Data rate:	140 to 360Mbit/s
Return loss:	>13dB 10MHz to 360MHz
Amplitude:	800mV p-p nominal
DC offset:	<5V
Equaliser:	Adaptive automatic for up to 250m cable (typ. Belden 8281, PSF 1/2M or equivalent)

■ Outputs

Number and type:	16: Unbalanced NRZI coded serial data
Standard:	Serial EBU Tech 3267E. SMPTE 259M-ABCD
Input Impedance:	75Ω
Data rate:	140 to 360Mbit/s
Return loss:	>13dB 10MHz to 360MHz
Amplitude:	800mV p-p nominal
DC offset:	<5V
Overshoot:	<7%

■ Performance

Data acquisition period:	20ms
Rise and fall time:	<0.5ns (rise and fall shall not differ by more than 0.25ns) 20% to 80%
Jitter:	<0.5ns (<0.75ns with >200m input cable)

■ Operating temperature

Range:	0°C to 40°C
Cooling:	Internal fans

4 Analogue video

This section details the operation and operational alignment for the analogue video routing card (**3746**) for the ***Freeway*** 32 series of routing switchers.

■ 4.1 Introduction

Freeway 32 analogue video modules each provide a 16x16 building block, housing a 32x16 crosspoint array. By interconnecting two of these modules, a 32x32 router can be constructed.

The circuitry employed within the router is transparent to all encoded vertical interval data ensuring that it is fully compatible with sound in sync (SIS) signals, while also providing a bandwidth of 30MHz.

Increasing the flexibility of the router even further, user selectable jumper links on each input enable them to be set for DC coupled or restored operation, while each output is provided with a cable equaliser to compensate for losses in external cable runs.

In addition, the router provides the ability to route, simultaneously, signals of both 525/60 and 625/50 standard. ***Freeway*** frames are fitted with dual reference inputs for both NTSC and PAL 'house reference' signals. Users can define, in mixed standard installations, which inputs are 525/60 and which are 625/50, ensuring the correct video reference is used to provide vertical interval switching. The reference type can either be pre-assigned, via the configuration editor, or modified dynamically using a master panel type 6276. These operations are detailed in sections 6 and 7 respectively, of the general information section of this manual.

■ 4.2 Theory of operation

Each of the 16 inputs provided to the switch cards are buffered using the DC couple/DC restore circuitry and are then passed to the 32x16 crosspoint array. The system controller provides the crosspoint array with destination and source addresses. Additionally a strobe pulse, derived from the relevant video reference input enabling the requested routes to be switched in the correct vertical interval, is also sent to the crosspoint array.

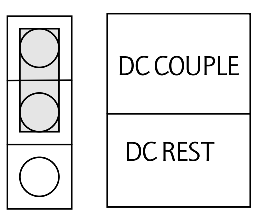
Every output is fitted with a jumper selectable equaliser, providing three equalisation/gain settings, to compensate for losses caused by external cable runs of up to 25 metres.

■ 4.3 Setting inputs for DC coupled or restored

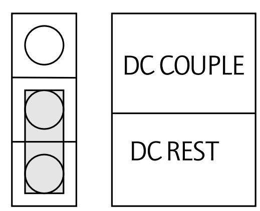
In traditional television applications a DC restore function is nearly always appropriate in order to remove DC variations between signals. Without this function, switching between signals with different *DC components* may cause frame-roll due to corruption of the sync field-block.

However in other applications, such as a wideband analogue router, the DC restore function is definitely *not* appropriate. These include the routing of computer type RGB graphics signals and medium bit rate telecom signals. In these cases a stable DC path must be provided.

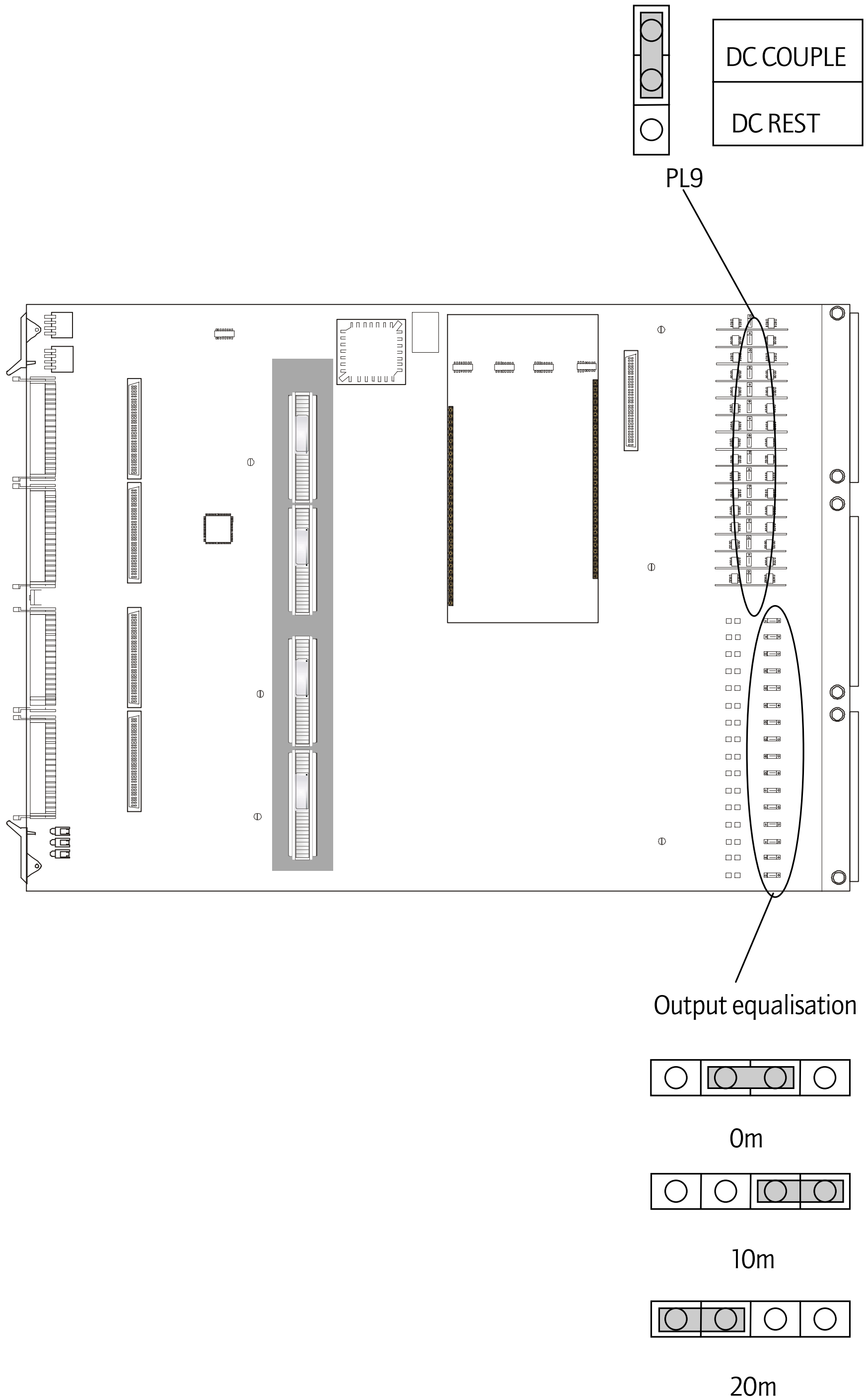
To cater for all circumstances, ***Freeway*** provides a user selectable input stage offering DC restored, or DC coupled operation. Where DC coupled operation is selected, all circuitry downstream of the input stage is DC coupled. This is selectable on an input by input basis via PL9.



DC COUPLE selection



DC RESTORE selection


DC COUPLE
DC REST
PL9
Output equalisation
0m
10m
20m

■ 4.4 Output cable equalisation

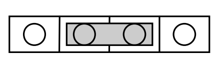
In order to maintain frequency response in situations where equipment 'following' the router is not immediately adjacent to the router frame itself, output cable equalisation may be required. Even 10 metres of good quality video cable can cause appreciable attenuation of colour information in composite signals. For this reason, ***Freeway*** includes jumper selectable output cable equalisation circuitry. This is not continuously variable, but is user selectable, on an output by output basis, with three available settings.

Provided PSF1/2, Belden 8281 or an equivalent good quality cable is used, these three settings can compensate for losses incurred by cables of up to 25 metres in length, ensuring response at subcarrier frequency never exceeds ±1% (±0.1dB).

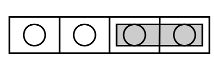
The table below details the appropriate positions for output equalisation links for given cable lengths.

Cable length	Link position
PSF 1/2 between 0 and 5 metres	0m
PSF 1/2 greater than 5 metres, but less than 15 metres	10m
PSF 1/2 greater than 15 metres, but less than 25 metres	20m

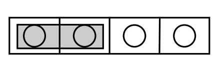
Link positions are shown below:



0m



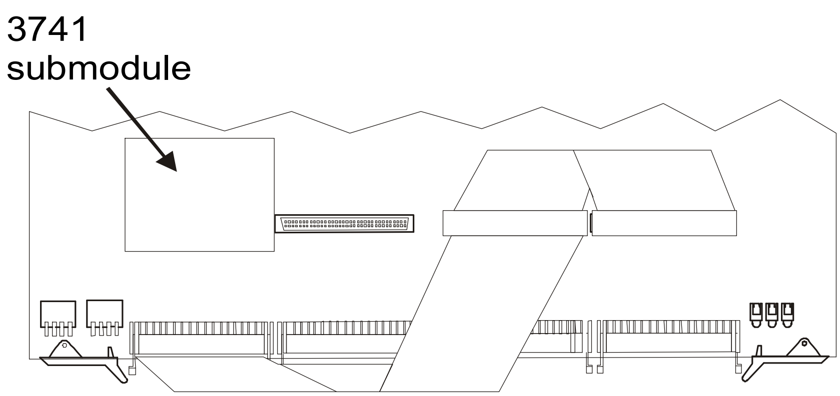
10m



20m

■ 4.5 16x16 Base card cable connection

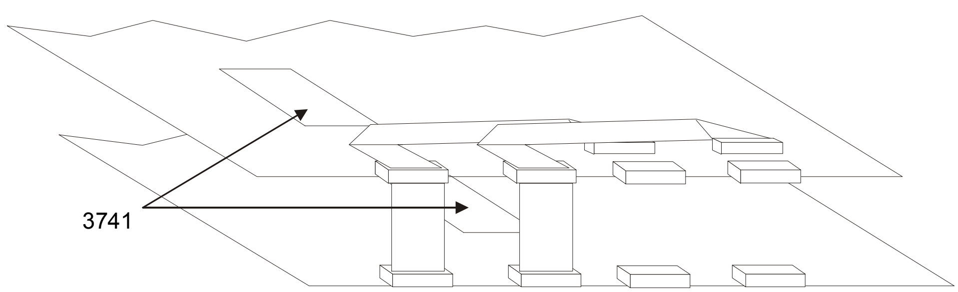
In order to compensate for variations in frequency response which inevitably occur with different numbers of sources connected to the signal ribbon on the front of analogue video ***Freeway***, special cables and submodules are supplied with 16x16 and 32x32 routers. These should be installed as shown below.



■ 4.6 Expanding from 16x16 to 32x32

The base ***Freeway*** 32 module may be expanded, with the addition of a second switch module up to a maximum size of 32x32. It is necessary to fit the expansion module in the slot adjacent to the base router card before connecting the ribbon cables across the front of the modules.

The following diagram shows the cable connections required for expanding the router from 16x16 to 32x32. Care should be taken to ensure that the level and destination assign switches are set correctly, see sections 2.2 and 2.3.



Expansion to 32x32

■ 4.7 Specification

■ Inputs

Number and type:	16: unbalanced on BNCs, 1V pk-pk amplitude
Impedance:	75Ω
Return loss:	Better than 40dB to 3.58MHz and 4.43MHz
Superimposed DC:	±1V max
Coupling:	DC or sync-tip restored

■ Outputs

Number and type:	16 unbalanced on BNCs
Impedance:	75Ω
Return loss:	Better than 40dB to 3.58MHz and 4.43MHz
DC offset:	Less than 50mV

■ Performance

Gain:	0dB ±0.1dB
Freq. Response:	±0.1dB to 8MHz,+2/-3dB to 30MHz -63dB (single adjacent) -60dB (all hostile) @ 4.43MHz
Output eq.:	Selectable cable eq. on outputs
2T Pulse/Bar:	<0.2% K
Chrom/Lum gain:	<±0.5%
Chrom/Lum delay:	<±2ns
Group Delay Var:	<5ns 50Hz to 15MHz
Differential Phase:	<0.15° @ 4.43MHz
Signal to Noise:	Better than 60dB (wideband)

Delay Variation: <±0.6ns between any input to one input

Switching Transients: <±30mV

Black Level Steps: <±250mV between inputs with same input coupling mode

5 Analogue and AES digital audio

This section of the manual covers the installation, operation and operational alignment of the digital (4946) and analogue (4746) audio routing cards for the ***Freeway*** 32 series of routing switchers.

■ 5.1 Introduction

Freeway 32 audio modules each provide a 16x16 building block, housing a 32x16 digital crosspoint array and sixteen input and output buffer circuits. Interconnecting two of these modules a 32x32 router may be constructed.

Analogue modules are fitted with 20 bit converters, surrounding the digital switching core, providing the analogue interfaces to the outside world. This approach permits analogue modules to utilise the same internal digital architecture and expansion bus as the AES router cards offering the possibility of format-independent signal routing. For example, a 16x16 analogue audio router and 16x16 digital audio router can be housed in the same frame as a 32x32 format independent router permitting analogue sources to be routed to digital destinations and vice-versa. This flexibility represents Pro-Bel's design commitment to the future and your future needs.

5.1.1 AES digital audio

Freeway AES routing can operate in either synchronous or asynchronous environments. When operated as a reframing router, ***Freeway*** provides silent, 'click-less' switching between digital audio signals matching the reference input at rates of 32 to 48kHz. Operation at rates between 22.05 and 96kHz is supported by configuring the router in transparent mode.

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

Other features include:

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

5.1.2 Analogue audio

A single ***Freeway*** 32 analogue audio level provides stereo routing, while incorporating signal processing features useful to mixed mono/stereo environments, like; left or right to both, mono-mix and channel swap. The transformerless I/O circuits are level adjustable to a maximum of +24dBu. Additionally, outputs are indefinitely protected against short circuits.

Other notable features are:

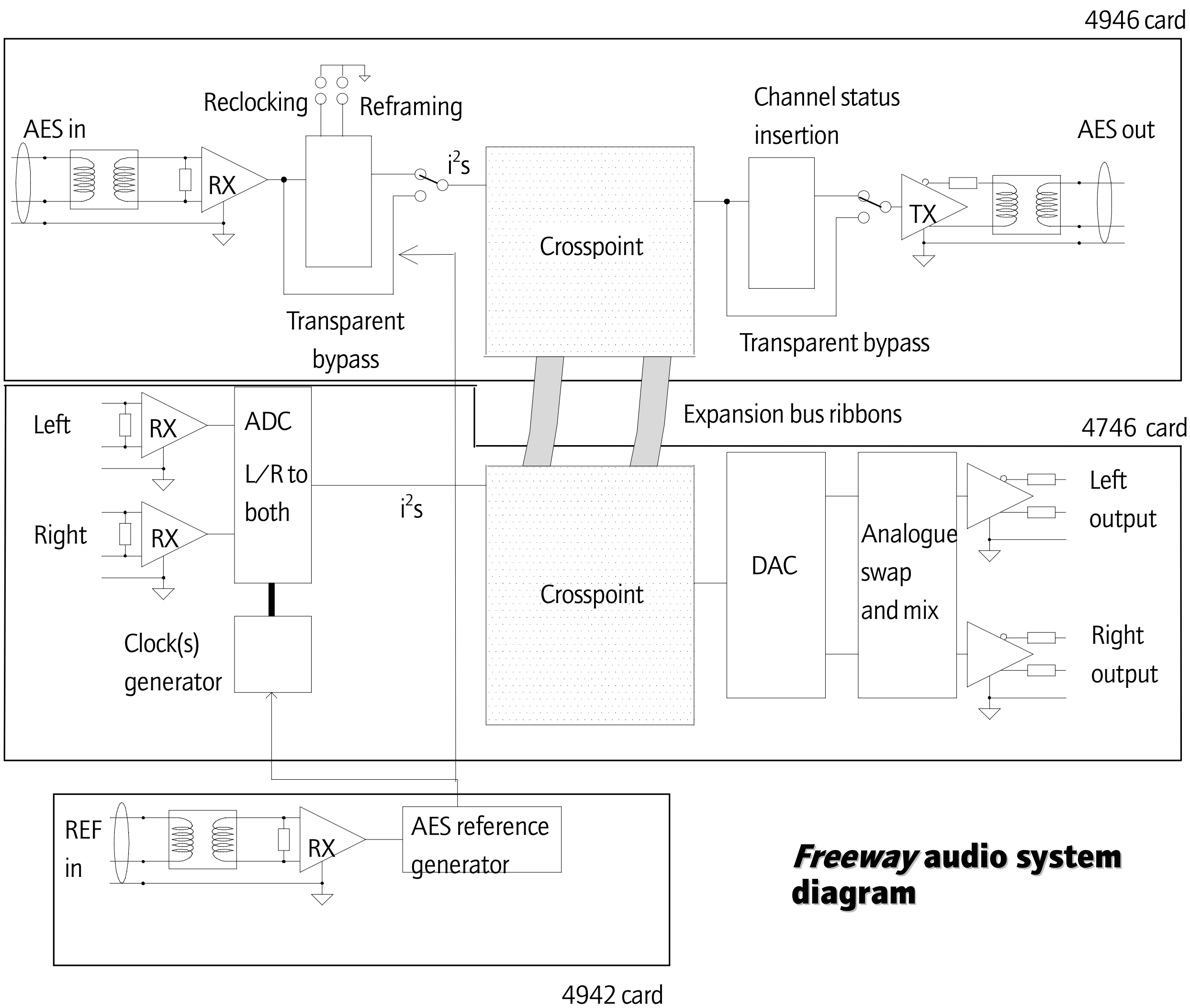
- high packing density
- 20 bit ADC and DACs
- 24 bit digital-core routing
- channel swap for reversed stereo signals
- assignable mono-mixing of signals

■ 5.2 Theory of operation

This section is divided into AES card and analogue card operation. However there is an element of commonality between the modules which is covered as a precursor to this.

Both modules have been developed to operate either as discrete, independent levels or, more importantly, together providing an enhanced audio routing architecture offering enormous flexibility without compromising signal integrity.

By utilising a common, digital, data format for module interconnection within the frame, whether the cards are analogue or digital, modules may be freely interconnected to provide a format independent, mixed analogue/ digital architecture. Building routers in this way permits analogue inputs to be routed to digital outputs and digital inputs to analogue outputs without the need for external converters. The following diagram details the architecture.



***Freeway* audio system diagram**

5.2.1 AES digital audio

The AES card can be configured to operate either synchronously or asynchronously.

In order to be able to switch synchronously between digital audio sources, switches must occur at AES frame boundaries. To achieve this, all signals presented to the crosspoint must be co-timed irrespective of their timing at the router input. This re-timing process, known as re-framing, buffers each input and locks it to the AES reference frequency. This will only work for signals of the same sample rate as the reference input.

While this method of operation is preferred, it does impose some operational restrictions; First, only signals of the same sample rate as the reference input can be re-framed. Secondly, The routing of signals with sample rates above 48kHz is prohibited as the operating range of the reframing circuits prevent them from working above this frequency. Finally, the internal data format within ***Freeway*** means that the AES data has to be decoded - along with its channel status data, and then is encoded back to AES before leaving the router. This process is not transparent to channel status data, and results in all of the AES outputs being re-written with default channel status as follows;

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

Because of these restrictions, ***Freeway*** has three operational modes permitting it to provide routing solutions for most digital audio applications. These modes are known as Mode 1, 2 and 3.

MODE 1 operation (Asynchronous 1)

In mode 1, the AES/EBU digital audio router is compatible with audio data from 22.05kHz to 96kHz. This mode enables the card to operate as a straightforward, non-reclocking data router providing transparent operation. 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.

MODE 2 operation (Asynchronous 2)

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 switching. This mode, like mode 1 ensures transparency to all audio and channel status data. Mode 2 should be used where transparency is paramount and where the digital audio signal is at any recognised sample rate, with the exception of 22.05kHz and 96kHz. Unless great care is taken to time each input to the router, this mode will, like mode 1, result in audible glitches when switching and is also incompatible with analogue I/O cards.

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.

MODE 3 operation

This is the preferred operational mode, resulting in click-less, synchronous AES routing conforming to AES output timing. Channel status is 'over-written' with default channel status into the AES output data stream. When operated in mode 3, the router provides 'click-less' switching while integrating seamlessly with an analogue audio router card in a 'format-independent' router.

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.

5.2.2 Analogue audio

The ***Freeway*** analogue audio level employs transformer-less input and output stages providing operation with signal levels of 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 10kΩ

Input and output signals are treated as stereo, and as such there is no breakaway of left and right channels within these pairs. Advanced signal handling within the ***Freeway*** analogue audio level provides the switcher with the ability to 'modify' these stereo pairs. The audio modify functions provided for inputs are;

- channel swap
- left to both
- right to both,

and for outputs,

- channel swap
- mono mix - (left+right)/2.

Ensuring that the internal bus is compatible with the digital signal module, all input and output signals arriving on and leaving the module are converted between the analogue and digital domain via 20 bit converters.. Once in the digital domain, these signals are presented to the digital crosspoint array and the internal bus permits them to be passed to a second ***Freeway*** 32 audio card.

5.3 4946 AES module installation and configuration

After setting the as detailed in section 2 of this handbook, the card can now be configured for its correct audio operating mode.

The AES router card does not require customer alignment and has no user-serviceable adjustments beyond the card edge level / destination assign switches and the link changes required to program the operational modes. As each channel is individually configurable, a great deal of operational freedom is provided. However, beware of mixed-mode operation as, the result of switching a signal in one mode to a destination configured for another mode can result in high levels of noisy audio modulation. This 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.

5.3.1 LED indications

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 change according to the operational mode the card is set for.

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

In mode 2, because the reclocking circuits free-run, even 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 are illuminated when audio signal is present at the corresponding input They will however remain extinguished when digital silence is present as an input.

For diagnostic purposes, the AES router 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 frame simply by looking into the frame from the front, between the installed modules.

5.3.2 Configuring mode 1

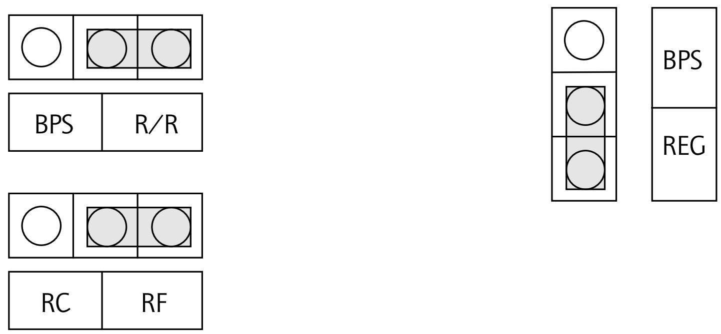
In order to set the card to operate in this mode, links on the input and output stages must be set in the BPS (Bypass) position, as shown in the following diagram. (Note that when BPS is selected on the links in the input area, the position of the links for the RC/RF selectors, also in the input area is irrelevant.) The operation of the circuit may be determined easily from examination of the ***Freeway*** audio system diagram in Chapter 2 of this section.

5.3.3 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.

5.3.4 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 on the 4946 card is illustrated in the following diagram.

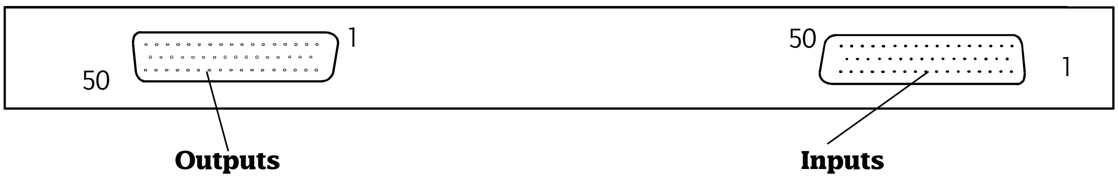
However, once again, beware of setting the router for mixed mode operation; ideally all channels should be configured the same way.

5.4 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 –

4942 AES reference generator card

5.5.1 Theory of operation

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 4946 and 4746 card will free-run resulting in pathological operation.

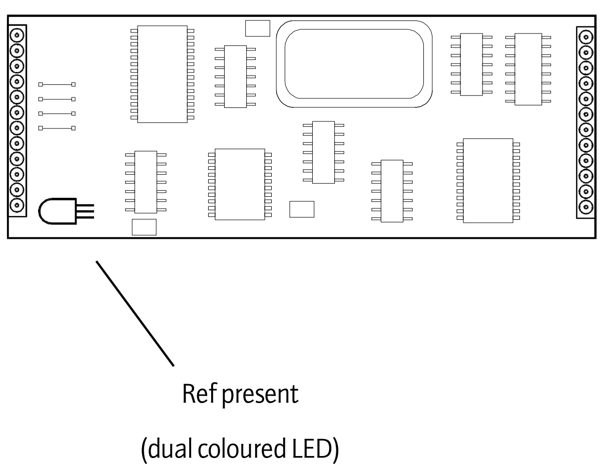
The 4942 card receives and locks to the incoming studio AES reference when present. If no AES reference is provided, the card generates it's own internal reference using a precision oscillator. In either case, the resultant reference is used to control the reframing circuits on the 4946 card and to drive the ADCs and DACs on the 4746 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).*

5.5.2 Installation and configuration

For diagnostic purposes, the 4942 card carries a 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.



5.6 4746 Analogue Audio module installation and configuration

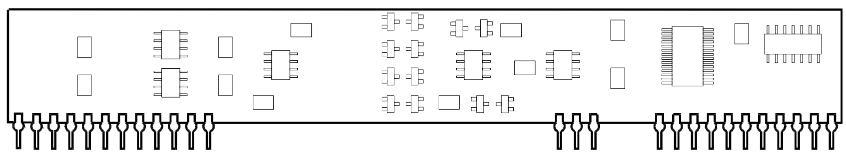
5.6.1 LED indications

In addition to the power and 'HELLO' LED's on the card edge, 16 miniature LEDs appear in the front right hand corner of the 4746 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 data, irrespective of audio modulation and therefore remain permanently lit. When the dynamic gate is set to ON, these LEDs indicate the presence of audio signal modulation and remain off 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. The setting and operation of the gate circuitry modes is covered in section 5.6.4.

For diagnostic purposes, the 4746 card carries a dual-coloured LED which remains lit green when the internal reference signal (TAES) is present. If, for some reason the internal TAES reference signal is not present, the LED flashes red. This indicates a fault condition which must be rectified to ensure correct system operation. This LED, although mounted towards the rear of the 4746 card, when illuminated in either condition can be seen by looking between the cards from the front of the frame.

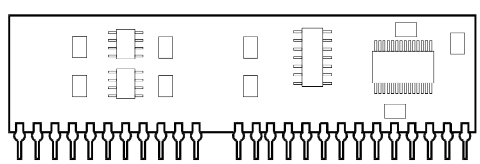
5.6.2 ADC submodule

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.



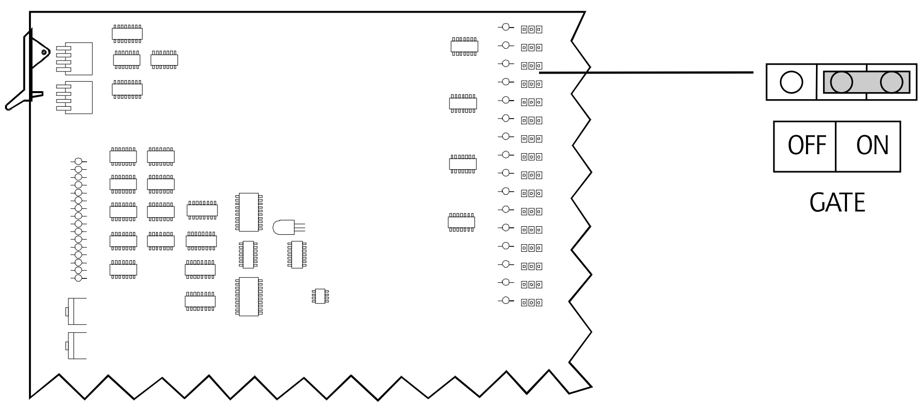
5.6.3 DAC submodule

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.

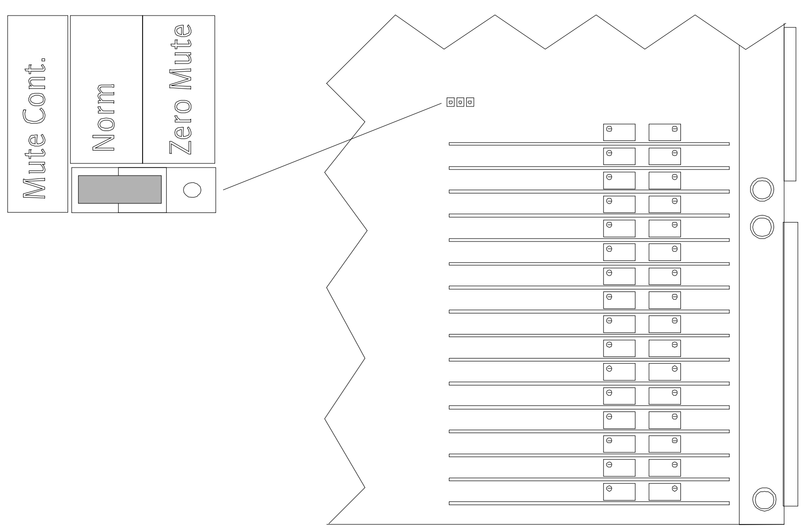


5.6.4 Setting Gate and Mute jumpers

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.

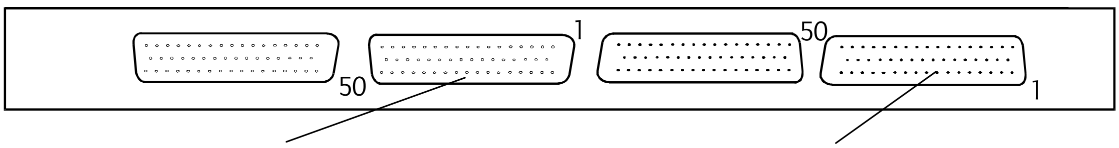


5.7 Rear panel connections for analogue audio

The rear panel has 4 connectors:

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

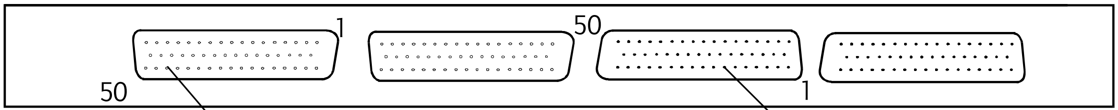
Refer to the following diagrams for pinout details



Outputs 1-8 **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 –

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 –



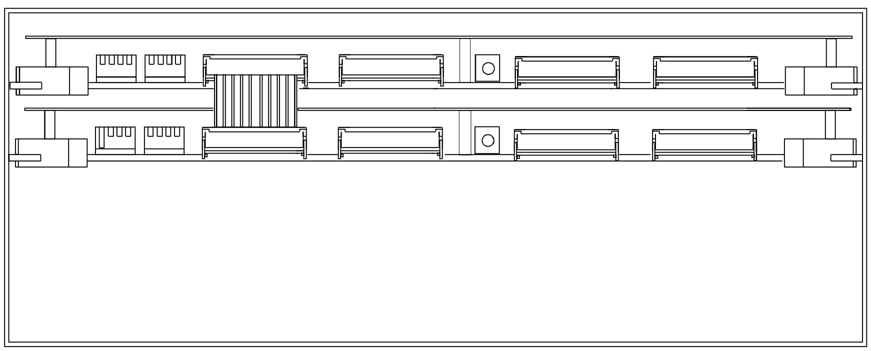
Pin	Function	Pin	Function
1	Chassis	50	Chassis
34	Gnd	42	Gnd
18	9L +	26	13L +
2	9L –	10	13L –
3	Gnd	11	Gnd
35	9R +	43	13R +
19	9R –	27	13R –
36	Gnd	44	Gnd
20	10L +	28	14L +
4	10L –	12	14L –
5	Gnd	13	Gnd
37	10R +	45	14R +
21	10R –	29	14R –
38	Gnd	46	Gnd
22	11L +	30	15L +
6	11L –	14	15L –
7	Gnd	15	Gnd
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 –

5.8 Expanding from 16x16 to 32x32

Base ***Freeway*** 32 audio modules may be expanded, with the addition of a second switch module up to a maximum size of 32x32. It is necessary to fit the expansion module in the slot adjacent to the base router card before connecting the ribbon cables across the front of the modules. As both the analogue and digital audio variants utilise a common internal, digital, signal bus it is possible to expand a 16x16 AES base router to 32x32 with an analogue expansion, and conversely an AES expansion card may be used with an analogue base router.

The following diagram shows the cable connections required for expanding a base router from 16x16 to 32x32. Care should be taken to ensure that the level and destination assign switches are set correctly, see sections 2.2 and 2.3.



5.9 Specification

Digital input - digital output

Input impedance	110Ω balanced operation; 75Ω - unbalanced
Output impedance	110Ω balanced operation; 75Ω - unbalanced
Sample rate	22.05 to 96kHz (non re-clocking, non re-framing)
	32 to 48kHz (re-clocking and re-framing)
Wordlength	16 to 24bit
Non re-clocking performance'	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

Analogue input - analogue output

Input impedance	> 10k
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

Analogue input - digital output

Input impedance	> 10k (13.6k)
Output impedance	110Ω balanced operation; 75Ω - unbalanced
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)

Digital input - analogue output

Input impedance	110Ω balanced operation; 75Ω - unbalanced
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	<-90 dB all hostile at 16kHz
Transients	No audible clicks

6 Problem solving

Card does not work at all

Things that may affect general system operation:

The green LEDs on the routing card are off

There is no power on the card.

- check that there is power from the PSUs
- check cable interconnections
- ensure that the card is properly seated in the frame

The HELLO LED on the card remains off

No command has been received by the board.

- check the power
- check that the ‘level’ and ‘higher dest decode’ switches are set correctly
- check cable interconnections

The ERROR LED is lit on the 2440 control card

There is a handshake error (faulty module)

- check router has been re-configured correctly

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 reference

- try resetting the ADC and DAC chips on the analogue audio modules

Reference present LED flashing RED

- check audio level is fitted with a 4942 reference generator module
- check router has a valid AES reference

7 Optional hardware and spare parts

The following order codes relate to options and spare parts available for use with ***Freeway*** 32 routing systems.

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

Spare parts

3U Freeway frame	FRE-3000-0FRM
6U Freeway frame	FRE-6000-0FRM
Serial digital video signal card, 3946	FRE-N032-DVXP
Serial digital video rear connector card, 1739	FRE-N000-DVRC
Analogue video signal card, 3746	FRE- N032-AVXP
Analogue video rear connector card, 1739	FRE- N000-AVRC
AES signal card, 4946	FRE- N032-DAXP
Balanced AES rear connector card, 1463	FRE- N00B-DARC
Unbalanced AES rear connector card, 1749	FRE- N00U-DARC
Stereo analogue audio signal card, 4746	FRE- N032-AAXP
Stereo analogue audio rear connector card, 1747	FRE- N000-AARC