TANDEM-110

Dual embedder/de-embedder and audio processor

USER MANUAL

Crystal Vision

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1 Introduction

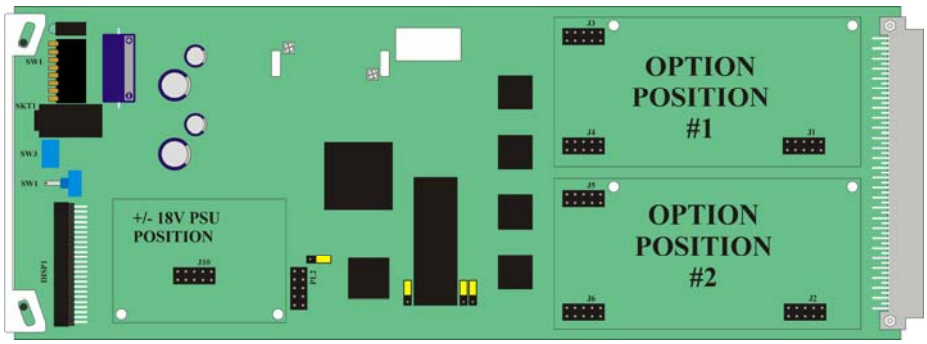
The TANDEM-110 (Twin ANalogue and Digital EMbedder/de-embedder) can be configured with two piggyback option cards to provide two functions at once – embed analogue or digital audio into SDI or de-embed analogue or digital audio from SDI. There are two independent SDI signal paths and each SDI path contains, in addition to data management processing, either a de-embedder or an embedder.

In addition to multi-mode dual embedding and de-embedding TANDEM-110 incorporates a number of powerful features. For example, adjustable audio gain and delay is provided to compensate for video processing and system gain errors, analogue monitoring can be used to preview sources and audio quality is ensured with sophisticated error masking.

The main features are as follows:

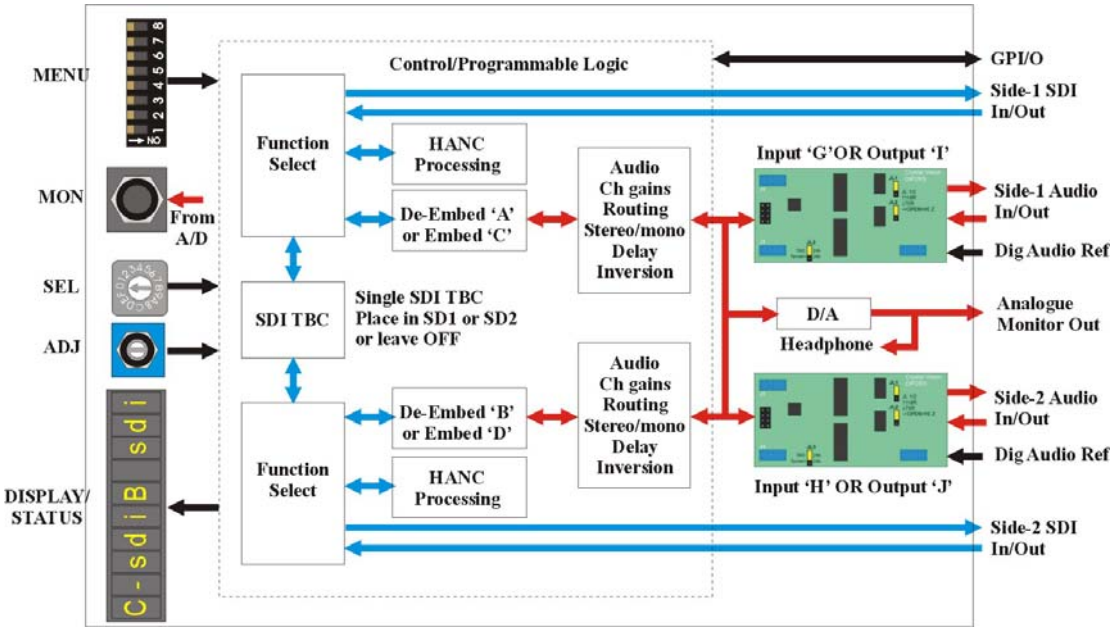
- dual embedder/de-embedder or mixed embedder/de-embedder
- built-in dual multi-channel digital audio delay
- adjustable audio channel gains
- stereo to mono conversion
- dual HANC processors for independent data packet management
- audio source preview monitoring
- optional SDI 'TBC'
- optional external AES or word clock reference input for digital output modules
- optional EDH insertion on embedder and de-embedder
- control/status monitoring via board edge, remote control panel and Statesman
- buffered SDI and AES outputs
- audio error masking and protection in de-embedders – handles untimed or asynchronous upstream SDI switching with minimum corruption
- GPI control of configuration set-ups

The option card position for side 1 is at the top of the module and the slot for side 2 is at the bottom of the module.



TANDEM-110 - option card positions #1 and #2

An 18 volt regulator option card is also required for analogue input or output cards.



TANDEM-110 architecture

Piggyback option cards determine TANDEM-110 functionality since internal logic is effectively re-programmed to create the required functions and interconnections whenever different option cards are fitted.

Changing sub-PCB cards from an input to an output type, or vice versa, will result in a re-configuration of the TANDEM-110.

An embedder will change to a de-embedder when the card is changed from input to output, and a de-embedder will change to an embedder when the card is changed from output to input, the next time power is applied. Any preset memories previously stored will be lost and may need to be replaced.

The external digital reference is either Word Clock or an AES reference and is only used for digital output option cards.

The available option cards are:

- DIP2 – 2 x AES/EBU inputs for synchronous 48kHz audio, 75 Ohm, 110 Ohm, HiZ
- DIP2RS – 2 x AES/EBU inputs with re-sampler for asynchronous audio (30 to 108kHz), 75 Ohm, 110 Ohm, HiZ
- DOP2-110 – 2 x AES/EBU outputs, 110 Ohm balanced, AES reference input
- DOP2-75 – 2 x AES/EBU outputs, 75 Ohm unbalanced, AES reference input
- AIP2 – Analogue dual stereo audio input
- AOP2 – Analogue dual stereo audio output

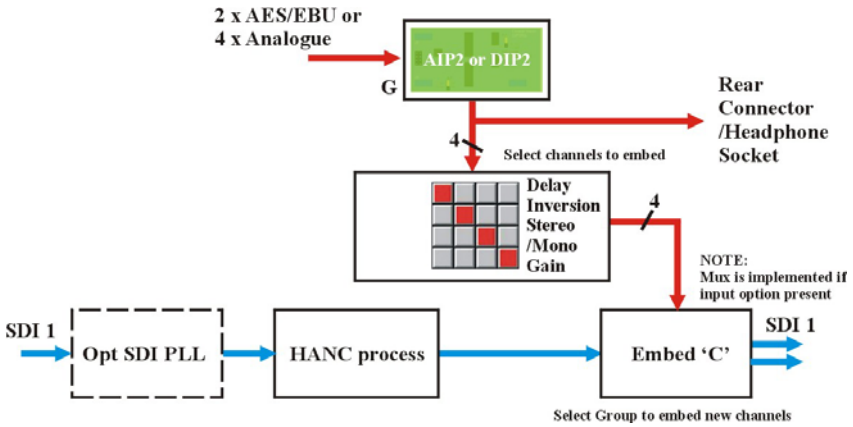
Control is available from the card edge, active control panels or by serial control from Statesman, a dedicated software application.

1.1 TANDEM-110 configurations

Each side is independent and three configurations are supported, dual de-embedder, dual embedder or a mixed embedder/de-embedder. Routed audio can be delayed up to 0.68 seconds per side and/or inverted.

Embedder

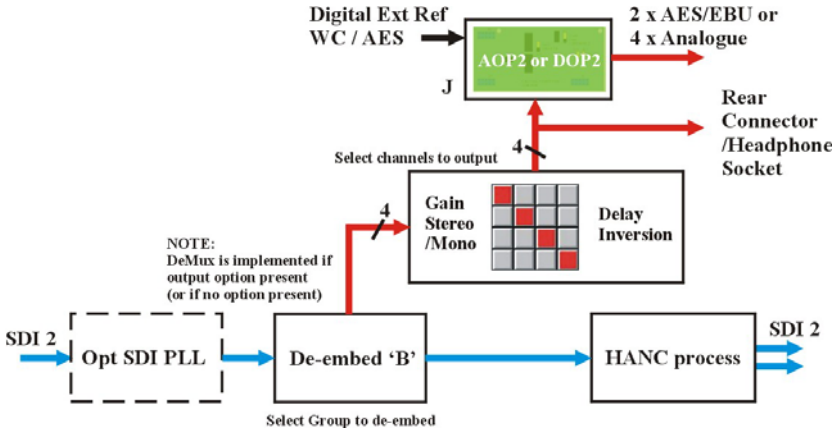
For each side with an input option card, audio channels can be selected from any four mono channels available from the input card which can then be routed to any one of the four available groups in the output SDI stream via that side's embedder.



TANDEM-110 side 1 with input option

De-embedder

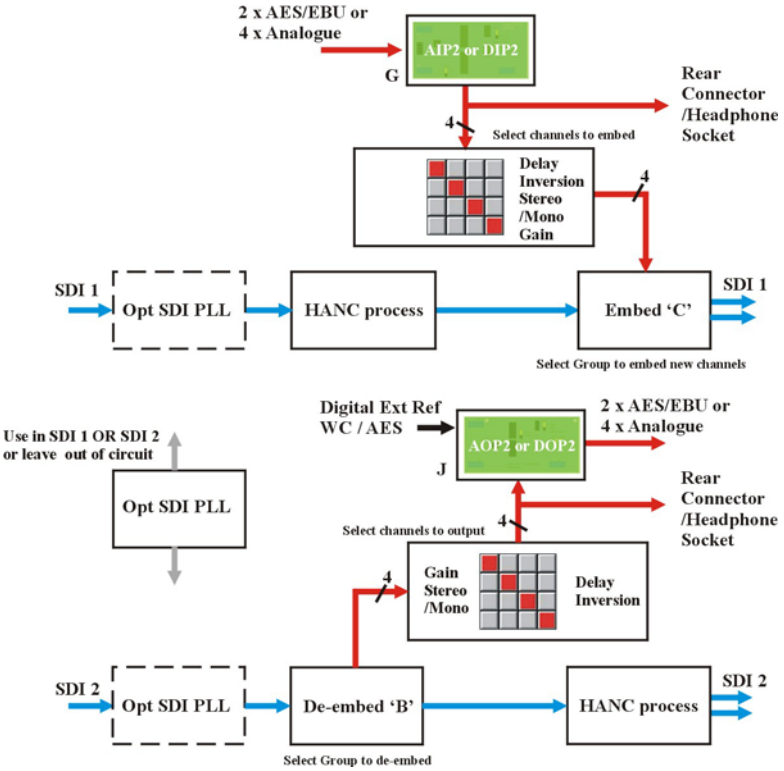
For each side with an output option card, up to four mono audio channels can be selected from any one of the four groups from that side's SDI input. These four channels can then be routed to any of the four mono channels available on the output card.



TANDEM-110 side 2 with output option

Mixed embedder/de-embedder

To configure a mixed embedder/de-embedder, an audio input option card fitted in side 1 and an audio output option card fitted into the side 2.



TANDEM-110 with input opt side 1/output opt side 2 -
option card assignment must be as shown for mixed embedder/de-embedder

Routing restrictions

The following routing restrictions apply to a TANDEM-110:

- TANDEM-110 does not provide an embedder AND a de-embedder function for the same SDI data stream - re-embedding of de-embedded data *with only one side* is not supported
- If there is an input option board, then an embedder function will be provided, if there is an output option board or NO option card fitted, then a de-embedder function will be provided
- If no option card is fitted, the de-embedder function can only be used by the Audio Monitoring function via the front PCB jack socket or the monitoring audio bus rear connector
- If only one option card is to be fitted, then that card MUST be on side 1.
- TANDEM-110 does not support an input option in SDI 2 and an output option in SDI 1 - always fit an input option in SDI 1 and an output option in SDI 2 when using an input/output pair – see supported configurations table
- Audio and video signals cannot be routed between one SDI circuit and the other
- Audio channels must be chosen from within one group when embedding or de-embedding

Supported configurations

The following table shows the supported configurations:

Support	Side 1	Side 2
YES	Input option (G) + Embed/Mux (C)	De-embed/Demux (B) + Output option (J)
NO	De-embed/Demux (A) + Output option (I)	Input option (H) + Embed/Mux (D)
YES	Input option (G) + Embed/Mux (C)	Input option (H) + Embed/Mux (D)
YES	De-embed/Demux (A) + Output option (I)	De-embed/Demux (B) + Output option (J)
NO	De-embed/Demux (A/E)* + Embed/Mux(C)	De-embed/Demux (B/F)* + Embed/Mux(D)

The card edge control interface uses a condensed code to refer to source and destination functions when routing audio through the module.

Code	Function	Code	Function
A	de-embedder or DEMUX SDI 1	**G**	input option SDI 1
B	de-embedder or DEMUX SDI 2	**H**	input option SDI 2
C	embedder or MUX SDI 1	**I**	output option SDI 1
D	embedder or MUX SDI 2	**J**	output option SDI 2
E	No option card on Side 1	**F**	No option card on Side 2

Note: Channel assignments may be altered when monitoring embedded audio.
*If no option cards are fitted Codes E and F appear in the status display at the card edge to replace de-embedder codes A and B for Side 1 and Side 2 respectively. However the audio router will still function and monitoring quality de-embedded audio is still output via the headphone socket and the rear connector – refer to the Monitoring section for further details.
For more advanced features and functions use the TANDEM-200 which allows simultaneous embedding and de-embedding and enhanced audio and video routing functions.

1.2 TANDEM-110 functions

Setting audio channel gains

Each TANDEM-110 side is equipped with four channels of variable audio gain to help compensate for inconsistencies in system levels.

The gain range provided is variable from zero (mute) to eight times unity gain (799%).

Stereo to mono conversion

Facilities are provided to convert stereo or adjacent dual channels to mono. The conversion works slightly differently, depending on whether an input or output card is fitted.

If audio channels are derived from an external source via a digital or analogue input card, the mono function follows the router and any of the four output channels can be set as the mono sum of its stereo pair.

If audio channels are de-embedded from the incoming SDI signal the mono function precedes the router and input channels 1&2 and input channels 3&4 can be configured as either a stereo or mono source prior to being fed to an analogue or digital output card.

Ancillary data

Ancillary data can be placed in both the vertical and horizontal blanking intervals of the serial component video signal (SDI). The vertical ancillary data space or VANC is used for such data as VITS or VITC whilst AES/EBU digital audio data is embedded in the horizontal blanking data interval or HANC.

Data packet management provides controls to choose how new audio packets created for re-embedding audio are inserted into the HANC data space.

Data packet management provides the following ancillary data handling options:

- Support for contiguous HANC data packing
- Automatic mark audio group for deletion
- Blank entire HANC data space, except the EDH insert
- Wide range of formats to embed on all HANC lines or leave a gap around the vertical switching point
- Variable error masking and error handling
- Enable or disable EDH processing

Details of HANC processing and EDH processing can be found in the Data Packet Management chapter.

SDI PLL function

There is a single module, like a "time base corrector" that may be inserted into either SDI 1 only, SDI 2 only, or left out of circuit (OFF).

The SDI signal accumulates an ever-increasing amount of jitter as it progresses through an SDI installation, and as it passes through most equipment in its path. To minimise this effect, TANDEM-110 has an SDI crystal controlled re-clocker which sets the output SDI signal to the same mean frequency as the input, but re-clocked by a crystal controlled Phase Locked Loop [PLL]. This produces extremely low jitter in the SDI output, even in the presence of a very high level of jitter in the incoming signal. Typically, jitter of 1 or 2 nanoseconds peak to peak will be reduced to a few hundred picoseconds.

The PLL can be placed in either an SDI 1 or SDI 2 input path prior to processing, so all of the functions of that side, as well as the SDI output, benefit.

Factory defaults

A facility is provided at the card-edge to load ‘factory defaults’ for routing, delay and preset data into TANDEM’s non-volatile memory. It is strongly recommended that the appropriate factory defaults be loaded after any of the following:

- a change of Mode
- whenever sub-PCB cards have been changed
- at any time card edge or other menus appear corrupted

Please refer to section 5.2 for details of the available factory defaults that may be recalled.

Note: Always check that the appropriate groups are selected for embedding or de-embedding after loading defaults (refer to section 5.3 for card edge controls).

Monitoring

TANDEM-110 is equipped with two monitoring outputs:

- analogue headphone output
- analogue rear connector output

The rear connector output is fed from a monitoring ‘bus’ that may be switched between silence and a copy of the analogue headphone output.

The rear connector monitoring may be used to extract a ‘breakout’ ‘monitoring quality’ output, even when an output option card is not fitted.

The analogue output can be manually selected as adjacent pairs or routed using the in-built routing to extract non-adjacent signals from the same group.

External reference

Digital output option cards may be used with an external word clock or AES reference. Link jumpers are provided on the digital option cards to select 110 Ohm, HiZ or 75 Ohm impedance.

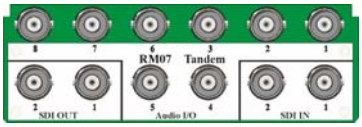
1.3 Rear connector options

TANDEM-110 fits into 2U FR2AV or Indigo frame for up to 12 Crystal Vision modules, the 1U FR1AV or Indigo frame for up to 6 Crystal Vision modules and a Desk top box for up to 2 Crystal Vision modules.

There are five different types of rear module to cater for all Crystal Vision frames and to provide a wide range of I/O options.

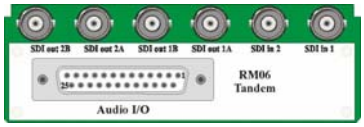
RM04

12 TANDEMs in 2U, 6 in 1U
Analogue / 110Ω digital audio
No 2nd SDI output



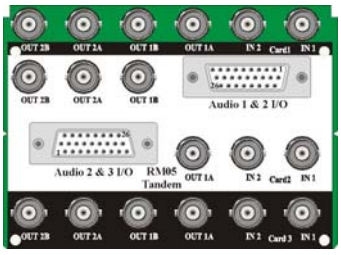
RM07

6 TANDEMs in 2U 3 in 1U
75Ω digital audio
No 2nd SDI output



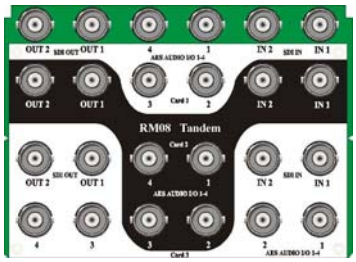
RM06

6 TANDEMs in 2U 3 in 1U
Analogue / 110Ω digital audio
2nd SDI output



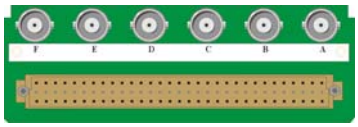
RM05

9 TANDEMs in 2U
Analogue / 110Ω digital audio
2nd SDI output



RM08

9 TANDEMs in 2U
75Ω digital audio
No 2nd audio or SDI output



RM36

6 TANDEMs in 2U 3 in 1U
Analogue / 110Ω digital audio
2nd SDI output

Further details of the rear modules can be found in the installation chapter

There are five different types of rear module to provide a wide range of I/O options. If maximum card density is important the slimmest single-width rear connector allows for 12 TANDEM cards in a 2U frame, albeit at the expense of losing the second buffered SDI outputs. This solution also demands a high-density multiway connector for balanced digital audio I/O, but all connections, including GPIs and analogue preview monitoring are available.

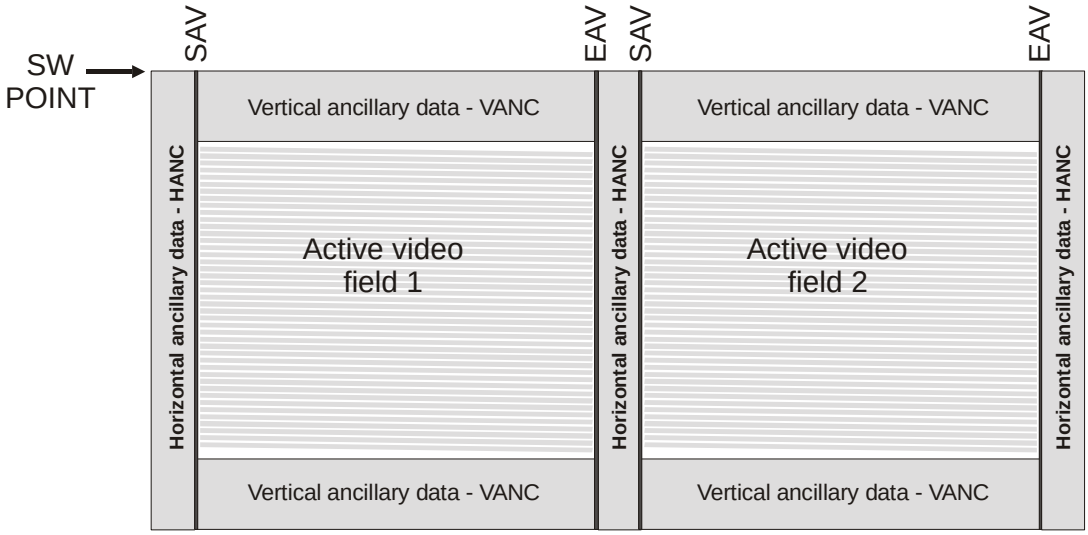
However, the loss of second SDI output can be avoided by using a taller rear module. A double-height single card rear module allows access to all connections at six cards per frame and a special all-connection triple card rear module achieves nine cards per frame.

There are also double-height single-card and triple-card rear modules available with BNCs for unbalanced *digital* audio. However, the double-height version does not have the second SDI output and the triple does not have the second digital audio outputs.

2 Data packet management

Ancillary data can be placed in both the vertical and horizontal blanking intervals of the serial component video signal (SDI).

The VANC or Vertical ANCillary data space is used for ancillary data such as VITS or vertical time code whilst AES/EBU digital audio data is embedded within in the horizontal blanking data interval or HANC.



There is room for four groups of AES/EBU digital audio between the end of active video (EAV) and the start of active video (SAV). A group is comprised of two AES/EBU stereo signals or four monaural channels.

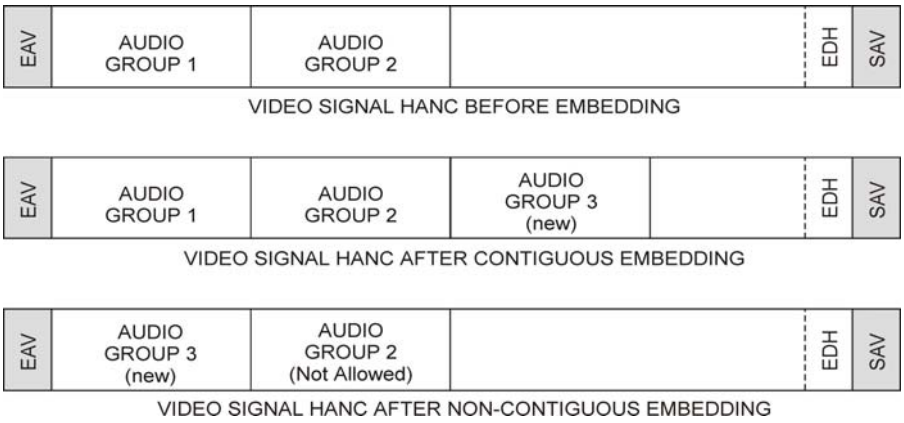
Each TANDEM-110 ‘side’ can de-embed up to four additional audio channels from one of the four groups of its SDI input stream or it can embed four audio channels into one of four possible audio groups in the output SDI stream. Embedding and de-embedding is not supported by a TANDEM-110 on one side.

The following ancillary data handling options are provided:

- Support for contiguous HANC data packing
- Automatic mark audio group for deletion
- Blank entire HANC data space, except the EDH insert before embedding
- Wide range of formats to embed on all HANC lines or leave a gap around the vertical switching point
- Variable error masking and error handling
- Enable or disable EDH processing

2.1 HANC processing

Contiguous packing ensures that new audio data packets are embedded at the first free location after the EAV in the HANC.



Contiguous packing allows for all four groups and other data, such as groups 'marked for deletion' to co-exist sequentially in the HANC. For example, there is only one input audio group present and it is specifically desired to overwrite it and there is a good reason not to use Blank HANC.

Blank HANC removes all incoming ancillary data except EDH after the inputs have been read and before any new data is embedded.

If an incoming audio group is the same as an audio group selected for output in that SDI path it will normally be flagged as 'marked for deletion' so that downstream devices do not detect that group. However, if there is only one audio group present in the input SDI stream, then the HANC space is automatically blanked before embedding. This does not remove any meaningful data, but it leaves only one audio group occupying the HANC space.

2.2 EDH processing

EDH is in the HANC space one line per field on lines 5 & 318 for 625 and lines 9 & 272 for 525.

EDH processing may be selected to be 'OFF' (pass through) or 'ON' (include EDH functions). EDH off/pass through disables the EDH function. When set to ON then the EDH function calculates and inserts new Active Picture and Full Field EDH values.

If 'Mark for Deletion', 'Blank HANC' are in place then EDH CRC values will no longer be valid. In this case, new EDH insert CRC values are calculated and inserted into the EDH data block in each TV field.

2.3 Vertical switching

When upstream input switching occurs or when input drop-out occurs the embedded digital audio can suffer degradation and loss of synchronisation. The result could produce audible defects.

Repeating samples from a buffer during the disturbance can ease the problem or in the case of upstream switching, lines around the standard switching point can simply be avoided and not used for digital audio.

There are a number of methods in use for avoiding the switching point suggested in SMPTE recommendation RP168. SMPTE standards 272M and 291M suggest the use of a single line gap after the switch point, but larger gaps around the switch point are sometimes required to provide sufficient robustness. In addition, there is equipment already in the market place manufactured by Sony before the SMPTE recommendation was implemented that embeds on all lines. For these reason both SMPTE and proprietary embedded formats need to be supported.

The card edge display uses the following text to distinguish between the two basic embedded audio formats:

- SMPTE: no data on lines around the preferred switching point e.g. lines 5,6,7,8 in 625 and lines 9,10,11,12 in 525
- SONY: data on every line

TANDEM modules provide a range of embedding and de-embedding formats that provide a trade off between robustness and processing delay.

The de-embedding and embedding formats do not have to be the same. De-embedding can be set to look at all lines for embedded audio whilst embedding can be done according to SMPTE recommendations with a switch-point gap.

This allows TANDEM-110 to convert material from SONY formats to SMPTE. It is also possible to convert SMPTE to SONY format, however, in this case the de-embed mode should be placed in the special setting of SONY/SMPTE or ‘ALL’ rather than SONY.

Trading process speed for robustness

SONY and SMPTE embed/de-embed modes for the TANDEM-110:

Embed modes **Card edge (Statesman)**	**Speed >>**	**Robustness >>**
SONY1 (Sony audio fifo min)	* * * * * * * * *	* *
SONY2 (Sony audio fifo short)	* * * * * * * *	* * *
SONY3 (Sony audio fifo medium)	* * * * * * *	* * * *
SONY4 (Sony)	* * * * * *	* * * * *
SMPTE1 (SMPTE audio fifo min)	* * * * *	* * * * * * *
SMPTE2 (SMPTE audio fifo short)	* * * *	* * * * * * * *
SMPTE3 (SMPTE audio fifo medium)	* * *	* * * * * * * * *
SMPTE4 (SMPTE)	* *	* * * * * * * * * *
De-embed modes **Card edge (Statesman)**	**Speed >>**	**Robustness >>**
SONY1 (Sony audio fifo min)	* * * * * * * * *	* *
SONY2 (Sony audio fifo short)	* * * * * * * *	* * *
SONY3 (Sony audio fifo medium)	* * * * * * *	* * * *
ALL (SMPTE/Sony)	* *	* * * * * * * * * *

Note: The text in brackets is used by the Statesman PC interface and is the equivalent of the preceding text displayed at the card edge.

The fastest de-embedding processing results from using SONY1. The slowest and safest of the de-embedding modes is ‘ALL’, and is recommended when the input cannot be guaranteed to be always in SONY format.

The fastest embedding mode is also SONY1, since the buffer memory required is the smallest. SMPTE modes require some extra audio data to be held in a longer queue to bridge over the vertical switch point gaps. SMPTE4 is the slowest but also the most robust mode.

If de-embed is set to ANY SONY mode, and the incoming SDI has SMPTE format embedded audio, it will automatically change to ‘ALL’ de-embed mode within a fraction of a second. However, there could be some corruption of audio, especially with SONY1 or SONY2 de-embed selected, during a second or two while de-embed mode automatically changes over. It is strongly recommended NOT to select any SONY de-embed mode if there is a chance of SMPTE mode inputs, except if the changeover always occur whilst ‘off-air’.

SONY1 or SONY2 embed and de-embed formats (or SMPTE1 and SMPTE2 formats) should be avoided if there is likely to be corruption of signals as may occur during SDI or AES source switching. SONY4 is the most robust, SONY3 is a good compromise between speed and robustness, and SONY2 is a tighter compromise where speed is of high importance.

SMPTE embedding formats are more robust than SONY, and SMPTE1 and SMPTE2 are a relatively tight compromise on robustness where speed of turn round (embed + de-embed) is very important. The SMPTE4 setting is very robust and can withstand the highest levels of data corruption. SMPTE3 is a good compromise between speed and robustness.

De-embed ALL is the most robust of any de-embed settings, and should always be selected whenever speed of embedding + de-embedding is not critical. Even that turn round time is relatively short and is unlikely to have adverse effect on the relative timing of audio to video signals.

It is NOT recommended to change from a lower setting to a faster setting whilst 'on-air', as there may be a momentary corruption of audio briefly just after the change. This particularly applies to SONY1 and SONY2 de-embedding, and to some degree to SONY1, SONY2, SMPTE1 and SMPTE2 embedding. Other functions or selections are more robust and unlikely to result in momentary loss of audio data, but selection changes should really be applied whilst off-air.

Measuring process delay

Practical measurement of the processing delays associated with the available embedding and de-embedding formats has been done by configuring one side as an embedder and feeding the embedded data into the other side configured as a de-embedder.

The following table compares minimum multiplex + de-multiplex transport (or embed + de-embed turn round) times with the SDI PLL set to OFF for digital and analogue I/O:

Example mode combination	Digital delay DIP2>DOP2	Analog delay AIP2>AOP2
SONY1 embed + SONY1 de-embed – fastest SONY setting	310µs	1,540µs
SONY4 embed + ALL de-embed – preferred general SONY setting	830µs	2,070µs
SMPTE1 embed + ALL de-embed – fastest SMPTE setting	670µs	1,900µs
SMPTE4 embed + ALL de-embed – preferred general SMPTE setting	835µs	2,075µs

Note: Actual times may vary with Mode and other selections.
Changing DPI2+DOP2 to AIP2+AOP2 adds approximately 1,240µs.
SDI in to SDI out is 1.481µs (400 clock cycles at 270 MHz) with SDI PLL set to OFF.
Selecting PLL ON will add a variable amount of delay between 0.6 and 8.9 microseconds, dependent on the severity of jitter and wander of the incoming 270 Mb/s SDI clock rate.

Installing Statesman

The Crystal Vision Statesman PC control software is designed to control a range of Crystal Vision modules via serial control from a PC.

The main Statesman application communicates with each module in a frame through an active control panel with a LCD display or a Statesman only panel without a LCD. Statesman will not be able to detect modules in a frame with only a passive front panel.

2.4 Installing Statesman

Minimum pre-requisites:

- A PC running Windows 2000 or Windows XP
- A parallel port dongle supplied with the Statesman software package
- An RS422 serial connection from the host PC to the RS422 Remote connector on a Crystal Vision frame with at least one TANDEM110 module and/or other Statesman compatible module
- An active control panel MUST be fitted to the frame with version 1.63 or above firmware – if it is an Indigo frame the firmware must be V1.04 or above
- An optional RS422 to RS232 converter if the PC has no RS422 ports

Installing Statesman

- Refer to the readme and/or help file on the CD before proceeding
- To view all application windows, set graphics resolution to at least 1024 x 768
- Remove any previous version of the Statesman software using the Add/Remove Programs application in the Windows Control Panel
- Ensure that the Statesman dongle is fitted to the parallel port of the host PC
- Insert the Statesman CD and the installation should start immediately – if it does not, run the setup.exe file on the CD
- Obey any installation program prompts and restart the PC when prompted

Running Statesman for the first time

The Statesman PC Control System may be run from the Crystal Vision programs folder via the Start menu or by double-clicking on the Crystal Vision.exe file in the installed program directory.

When the program runs it will require licence information and an administrator name and password. It will also need to know which computer port is being used to connect to a Crystal Vision frame(s).

2.5 Statesman operation

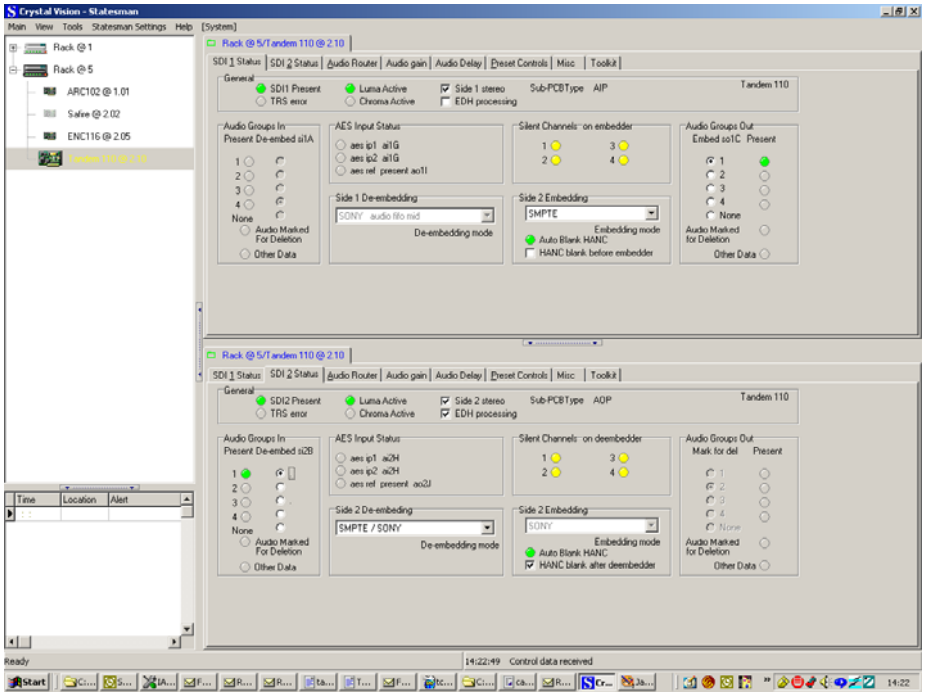
Once Statesman is configured it should automatically detect any statesman compatible modules in the connected frame or frames and display them in the main application left hand explorer-style window.

Open any frame by clicking on the '+' sign or by double clicking on a frame. Installed modules should be shown with module icons. Frame and module icons can be named as desired by right-clicking or using the edit menu and choosing rename.

To aid user recognition of module and frame status quickly, the following colour and size coding is used:

- A module is shown present by full colour and absent by greyed colour
- A module is shown open by large icon size and closed by small icon
- A module is the source of an active alarm if red and not alarmed if green

Double-clicking on a module will enable the display of the main application menus.



Statesman main application window

The two large control panes shown in the upper and lower halves of the window may be used to display both TANDEM-110 circuit paths or 'sides', two functions such as both routing tables can be shown for the same 'side', or menus for two different modules.

Click on the horizontal button-bar between the two panes to close the lower plane or drag the button to vary the size of the panes.

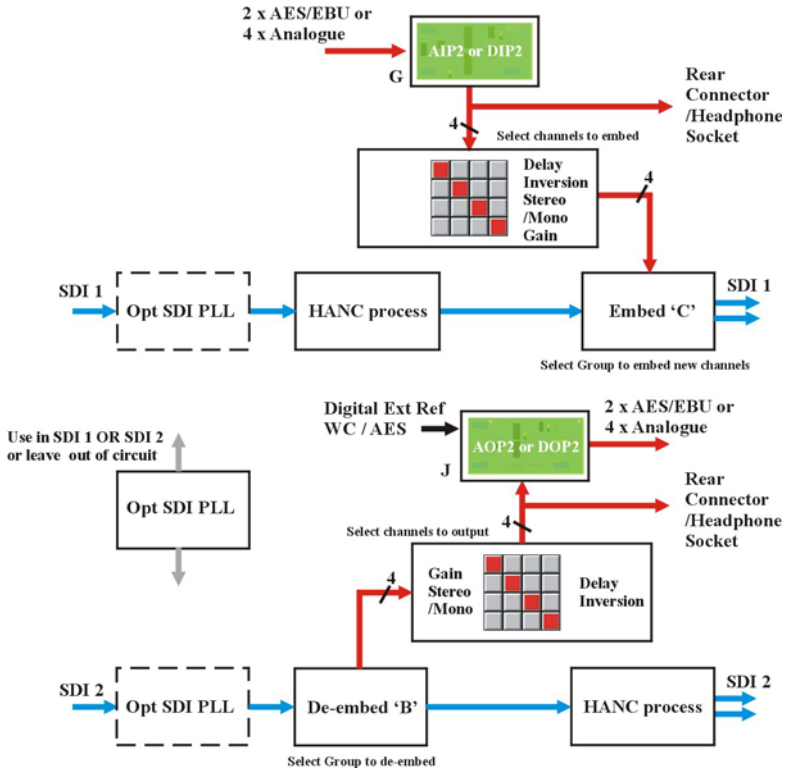
Warning: Always ensure that the active front panel (if fitted) is in STATESMAN mode. If the front panel is active, control via Statesman will be subject to high latency and the response to changes will be slow. For further details of Statesman configuration please refer to the Statesman manual.

The following card-edge shorthand codes are used for sources and destinations:

Code	Function	Code	Function
A	de-embedder SDI 1	**G**	input option SDI 2
B	de-embedder SDI 2	**H**	input option SDI 2
C	embedder SDI 1	**I**	output option SDI 1
D	embedder SDI 2	**J**	output option SDI 2

Audio routing and processing options

The first task to perform when routing audio for the first time is to chose which audio groups will be involved in de-embedding and embedding. The next task is to decide if any available external audio sources will be used and if there will be any external audio destinations. Available external sources and destinations are entirely dependent on the option cards fitted.



TANDEM-110 as mixed embedder

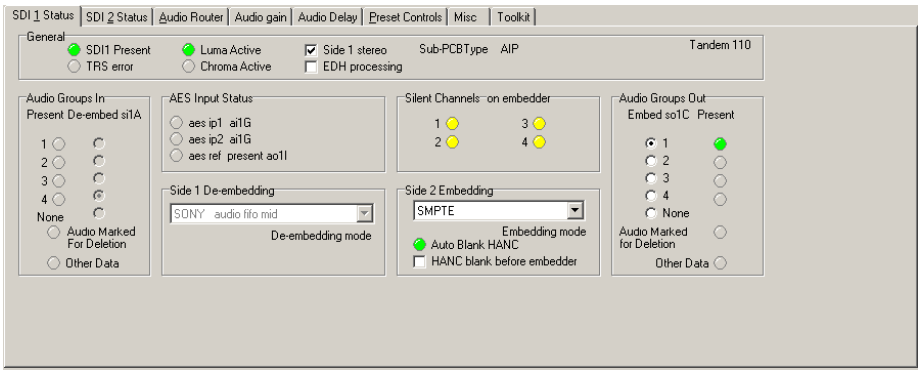
TANDEM-110 can de-embed any audio channel from any one incoming audio group from the SDI stream and output it in any digital or analogue channel of an output option card on the same side. Alternatively, it can embed any audio channel from a digital or analogue input card into any channel of any one audio group in the outgoing SDI stream on the same side.

Tip: If TANDEM-110 firmware or sub-boards have been changed it is recommended to start by loading valid default settings for the entire routing table held in TANDEM's non-volatile memory. This will prevent erroneous settings from appearing in the routing assignment menus. From firmware V5.15 this function is performed automatically (card-edge display shows Save Pre15 > Pre1). Please refer to Using card edge controls section 5.2 if default settings are required. Audio group selection should be checked after loading default routing.

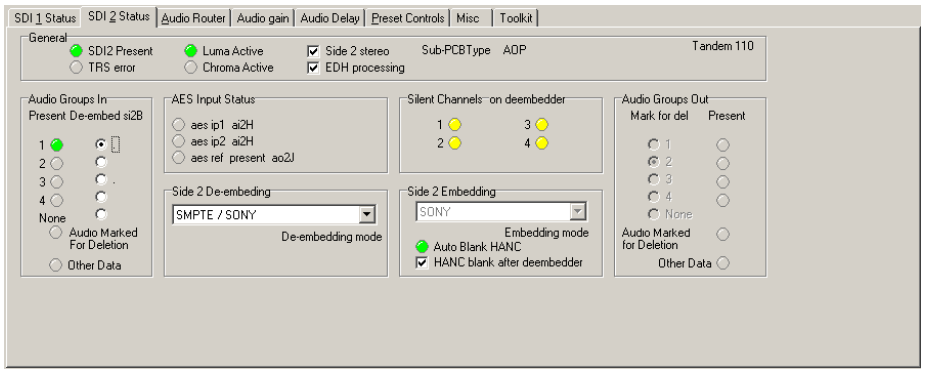
Selecting audio groups for de-embedding

The status menu is used to select the audio groups chosen for de-embedding or embedding in addition to displaying SDI and audio signal status, and installed option cards.

The status of all four incoming audio groups in the SDI stream is displayed next to four select buttons on the left of the SDI 1 and SDI 2 Status menus.



SDI Status for side 1



SDI Status for side 1

Select the group required in the ‘Audio Group In’ section to de-embed or select ‘None’ to turn de-embedding off for each side.

Selecting the de-embedding mode

Select the appropriate de-embedding format for each side from the following modes:

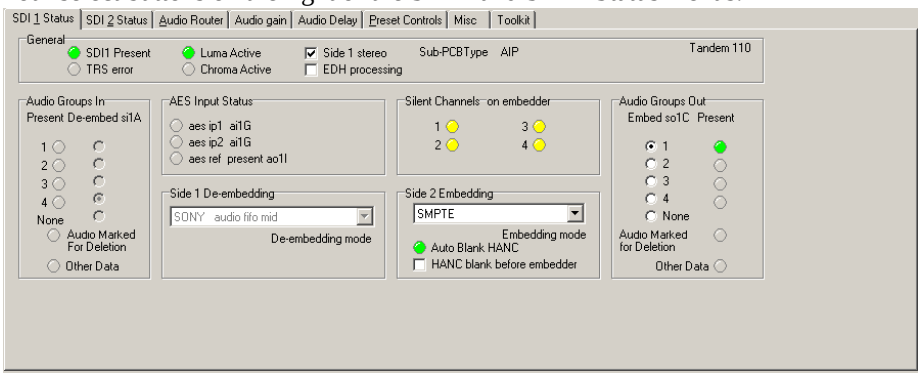
- Sony audio fifo min – fastest processing delay
- Sony audio fifo mid – medium processing delay
- Sony audio fifo max – slow processing delay
- SMPTE/SONY – slowest processing delay - use when input may not be in Sony format

AES input status

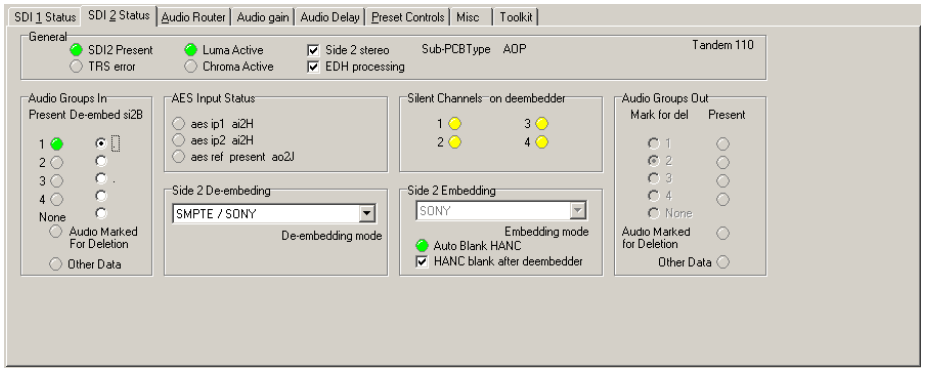
The AES external signal and reference input status is shown using card edge reference codes. The selection of external audio is made using ‘Audio Output Routing’.

Selecting audio groups for embedding

Carrier presence status of all four audio groups in the output SDI stream is displayed next to four select buttons on the right of the SDI 1 and SDI 2 Status menus.



SDI Status for side 1



SDI Status for side 1

Select the group required in the ‘Audio Group Out’ section to embed into or select ‘None’ to turn embedding off for each side.

Selecting the embedding mode

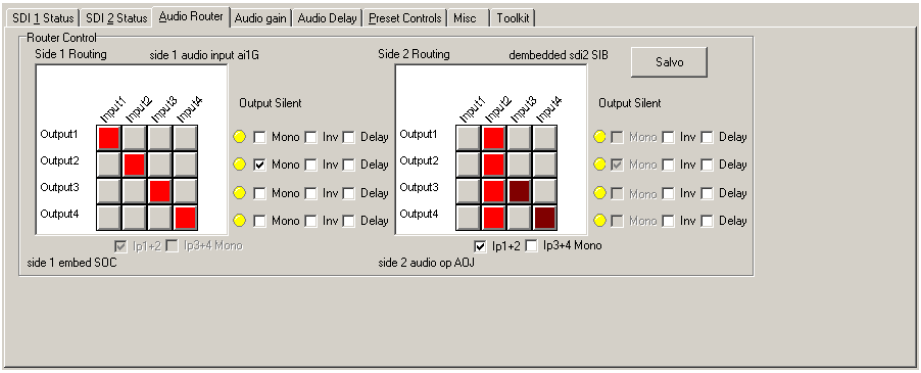
The embedding format is also selected from within the SDI Status menu. Select from the following modes:

- SONY audio fifo min – (SONY 1) shortest processing delay
- SONY audio fifo mid – (SONY 2) medium processing delay
- SONY audio fifo max – (SONY 3) large processing delay
- SONY – (SONY 4) largest processing delay
- SMPTE audio fifo min – (SMPTE 1) shortest processing delay
- SMPTE audio fifo mid – (SMPTE 2) medium processing delay
- SMPTE audio fifo max – (SMPTE 3) large processing delay
- SMPTE – (SMPTE 4) slowest and most robust processing

Embedding modes are discussed in-depth in the Data packet management chapter.

Routing audio

Once de-embedding and embedding groups have been chosen, routing can be selected with the router for each side.



Router control for side 1 (input card) and side 2 (output card)

Route source to destinations by clicking on the crosspoint squares in the matrix. Any selections made will turn dark red. Invalid selections will be rejected and returned to the last valid selection. Click on the Salvo button when finished. Valid selections will turn bright red and new source-destination assignments will be loaded into the routing table.

If an input option card (G) is fitted on side 1, sources from that input card can be routed to the embedder (C) on the same side. If an output option card (I) is fitted on side 1, sources from a de-embedder (A) on side 1 can be routed to that output card.

If an input option card (H) is fitted on side 2, sources from that input card can be routed to the embedder (D) on the same side. If an output option card (J) is fitted on side 2, sources from a de-embedder (B) on side 2 can be routed to that output card.

Note: Routing between sides is not supported by a TANDEM-110.

Assigning delay, inversion and stereo to mono conversion

To assign delay to a selected route check the associated ‘Delay’ box. To invert the phase of the audio in a selected route check the associated ‘Inv’ box. Mono options are explained in the next section.

If an input card is fitted, the mono function follows the router and any of the four output channels can be set as the mono sum of its stereo pair. If an output card is fitted, the mono function precedes the router and input channels 1&2 and input channels 3&4 can be configured as either a stereo or mono source.

In the diagram, the side 1 router on the left has an input card fitted. Four mono select checkboxes are on the output side of the router indicating separate control of each channel. The two mono checkboxes on the input side are greyed out to indicate that they are inactive.

The right hand router has an output card fitted. Two mono select checkboxes are on the input side of the router indicating combined control of each channel pair 1&2, and 3&4. The four mono checkboxes on the output side are greyed out to indicate that they are inactive.

Editing router input and output names

Each of the input and output names may be edited for each router.

Changing router input name

Changing router output name

To edit a source or destination name click on the Input or Output text, and a Rename menu will appear. Enter the desired names in the box provided and click OK. The new name will be stored in the host PC, and appear each time Statesman is used.

HANC processing

TANDEM-110 provides an option to blank the HANC space before embedding takes place to make room for new audio groups. If only one audio group is present in the incoming SDI data stream, and a new audio group of the same number is to be embedded, then the HANC space is blanked automatically and the 'Auto Blank HANC' LED is illuminated.

To manually blank the HANC space before embedding tick the 'HANC blank before embedding' box.

The HANC error indicator will illuminate if there is no further room in the HANC space to add another audio group.

TANDEM-110 should not be set to embed any further groups unless the option to blank the HANC space before embedding is selected.

Caution should be exercised when adding further embedded audio when 'marked for Deletion' or 'Other Data' are already present. The HANC space could then be over-filled and data lost. The EDH is particularly vulnerable in Sony mode as the tail end of the insert may overwrite the EDH data.

The subject of HANC processing is discussed in detail in the Data packet management chapter.

Adjusting audio delay

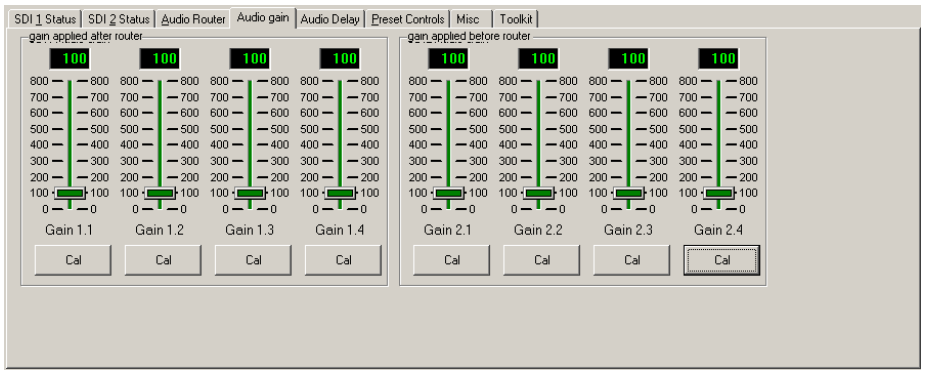
Once routing and delay has been assigned the value of the delay can be set using the sliders on the Audio Delay menu.

Audio delay for side 1 and side 2

The destinations for which the delay is active will be shown using the card edge codes under each slider. Delay can be set from 0 to 681 milliseconds.

Adjusting audio gains

The audio gain for each of the four audio channel inputs to the routing table for each side may be adjusted from zero (mute) to eight times unity gain.



Audio gain for side 1 and side 2

To adjust channel gain click on the appropriate slider and drag it up or down whilst holding the left mouse button down. The gain applied will be shown in the read-out display above the slider.

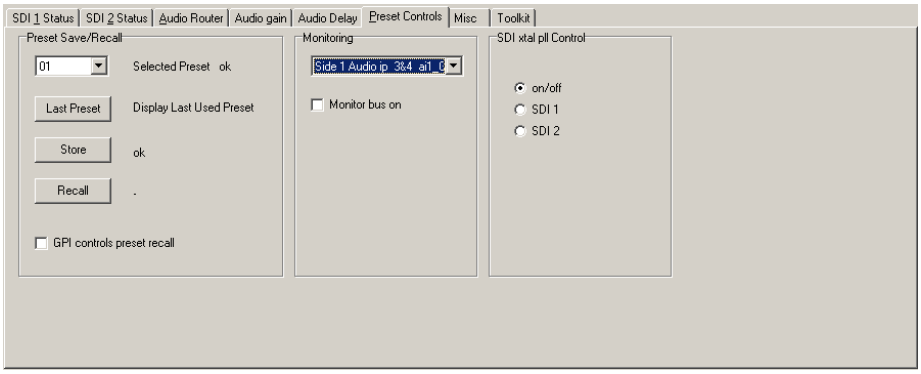
To calibrate a channel to exactly unity gain click on the CAL button beneath the appropriate slider or right click the slider and choose ‘calibrate’.

To gang gain slider controls together to move them as one, right click on the slider chosen as the master with the CTRL key held down and then, whilst continuing to hold the CTRL key, right click on one or more further gain sliders to use as slaves.

To clear ganged gain controls and restore them to individual use, select ‘Clear Ganged Controls’ in the Tools menu.

Preset Controls

The Preset Controls menu provides access to setup presets, monitoring assignments and SDI crystal PLL embed reference selection.



Preset Controls menu

Using Presets

Up to sixteen setups may be stored and recalled from Statesman, the card edge control or by external GPIs. Presets store board setup data including operating mode and option card status. It is not possible to recall a preset if the operating mode or option card configuration is different to those established when the preset was created. The presets are currently numbered 0-15.

To store a preset proceed as follows:

- Ensure ‘GPI controls preset recall’ is unchecked
- Select appropriate preset with the Preset Number drop-down menu
- Click on ‘CheckPreset’ to find an empty preset
- Click on ‘Store’ to save setup data into the selected preset

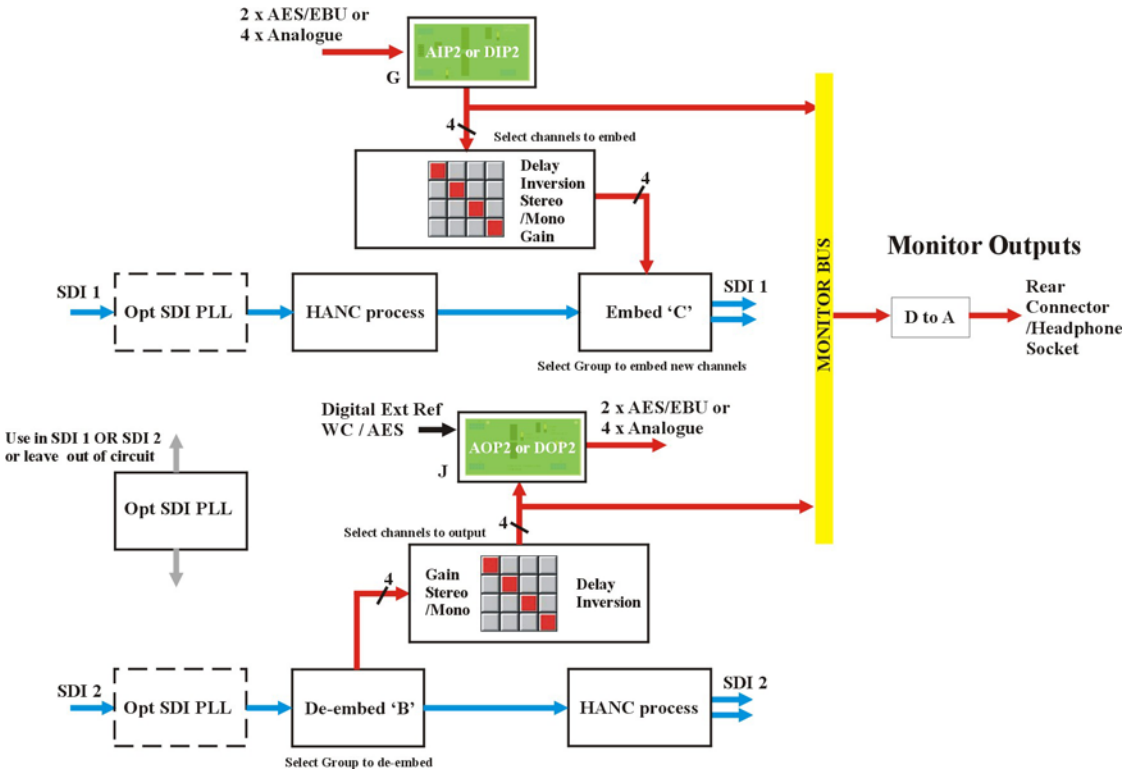
To recall a preset proceed as follows

- Ensure ‘GPI controls preset recall’ is unchecked
- Select appropriate preset with the Preset Number drop-down menu
- Click on ‘Recall’ to recall setup data from the selected preset

‘GPI controls preset recall’ should not be checked whilst presets are being created or recalled by this menu to prevent inadvertent GPI operation. Enable ‘GPI controls preset recall’ when finished if required.

Audio Monitoring

A powerful monitoring bus provides audio monitoring at the card-edge headphone socket and rear connector.



TANDEM-110 audio monitoring

A fully selectable analogue monitoring output is fed to a miniature stereo jack socket at the card edge. Select any valid stereo signal to be monitored with the monitoring drop-down list.

The RM04 and frame rear connector can also receive the same user-selectable analogue monitoring signal as the headphone socket. This output may be switched on or off using the 'Monitor bus on' check box in the Preset menu.

SDI Crystal control

The embedder SDI crystal PLL may be left to free run or locked and inserted into either to SDI 1 or SDI 2.

The SDI signal accumulates an ever-increasing amount of jitter as it progresses through an SDI installation, and as it passes through most equipment in its path. To minimise this effect, TANDEM has an SDI crystal controlled re-clocker. This is a form of 'Time Base Corrector' which sets the output SDI signal to the same mean frequency as the input, but re-clocked by a crystal controlled Phase Locked Loop [PLL], to produce extremely low jitter in the SDI output.

The PLL may be switched into either input SDI path (but not both) prior to processing, so all of the functions of that side, as well as the SDI output, benefit.

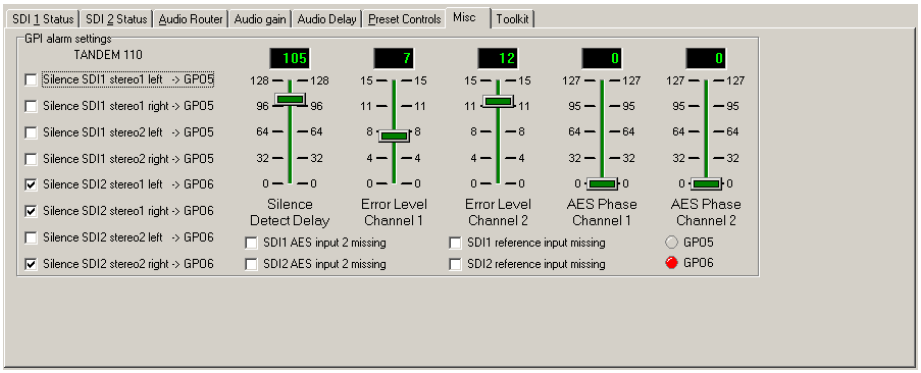
When two halves of a TANDEM are cascaded, select the final output side to have the PLL function, unless there are problems with very high jitter in the SDI input signal, in which case apply the SDI PLL to the input SDI path. If both TANDEM sides are in use independently choose the side that offers the best influence on the whole system.

Select from the following options:

- On/Off – Off selects free-run, On makes PLL available to either SDI 1 or 2
- SDI 1 – PLL locked and inserted I into to SDI 1
- SDI 2 – PLL locked and inserted into to SDI 2

Miscellaneous

The miscellaneous menu provides access to GPO 5 and 6 assignment, silence delay and AES phase. In addition, video and AES input presence is included.



Miscellaneous – GPI Alarms & input status

Using GPI outputs

There are two GPI outputs, GPO5 and GPO6, which may be assigned to twelve different analogue and/or digital input silence alarms. Audio silence is deemed to refer to embedder audio signals only, unless that embedder is OFF - in which case de-embedder signals are tested for silence. If silence is sustained for more than the 'silence detect delay' the assigned GPO will be asserted low as an alarm when 'flag' is selected.

Visual indication of GPO 5 and 6 status is also provided.

See section 6.2 for further discussion of GPIs and pinout details.

Silence detect delay

Silence detect or threshold delay can be set at the card edge or via Statesman. The left hand control slider of the Miscellaneous menu sets the silence detect delay from 0 to 128 seconds for the amount of time a signal is allowed to remain below –50dB wrt Full Scale before a silence error is flagged. Actual values start at 1.5s, 8s and then in increments of 8s to 120s.

Although the slider control sends a controlling message to TANDEM to select the time delay in one-second increments, TANDEM rounds down the value sent. For example, if a value of 7 or less, it is rounded down to 1.5 seconds, or for 8 - 128 seconds to the nearest whole multiple of 8 seconds that fits the selected value, up to a maximum of 120 seconds.

Error level

Error masking cannot be completely disabled. Level 0 to level 15 provide progressively more and more advanced error handling capability with level 0 providing basic error handling and level 15 providing full error handling.

This setting should be left in the default position of 15. However lower values may be useful in fault finding. For example changing the error masking to 0 may be useful when attempting to listen to faults in the input data stream, or if the faults are so bad that the error masking simply mutes the channel.

Adjusting AES phase

The phase of the digital audio output may be adjusted with respect to the AES reference, providing an AES reference is applied and the appropriate jumper link is set on the DOP2-75 or DOP2-110 sub-board.

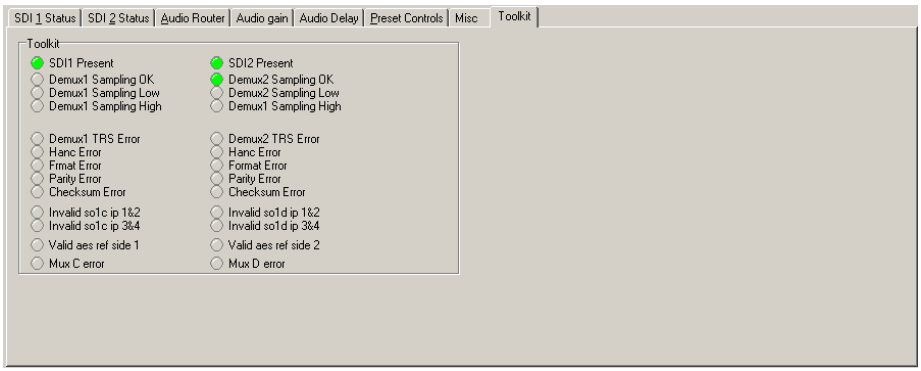
The AES output phase may be varied over a range of just over 360 degrees. The slider readout display shows a reading of 0 to 127 for indication purposes only.

The AES output frequency is set by the frequency of the video signal carried by the SDI signal. The AES output clock is synthesised at a fixed rate derived internally from the TRS sync signals.

The AES reference input signal must be the same as that of the incoming video to be useable, otherwise it will not work correctly. This is normally the case as the AES reference signal and the embedded SDI audio data will have been locked to the station master video source, so that the 48kHz sample rate and AES word rate are both considered synchronous with the video signal.

Using the Toolkit

The Toolkit menu, provides comprehensive error reporting and status information.



TANDEM-110 Toolkit

Refer to the Trouble Shooting chapter for more information on the Toolkit.

3 The active control panel

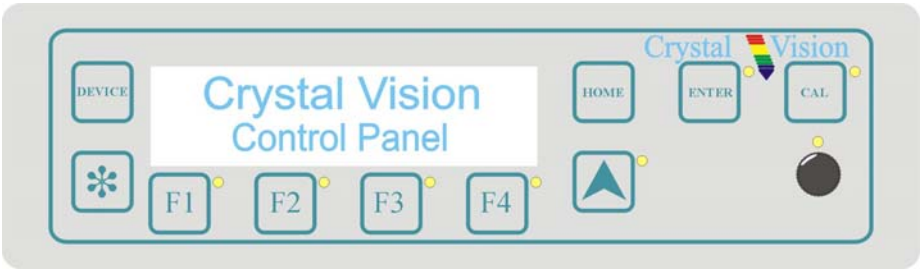
This operational guide assumes that the panel has been setup according to the Panel setup procedure described in the Crystal Vision Controls Panel manual.

Note: It is **ESSENTIAL** that the Panel setup procedure is followed and any old or unknown passwords cleared prior to using the panel for the first time.

At power up, the two line 20-character screen will display ‘Crystal Vision’ followed by the firmware version number for the control panel. All eight control panel key LEDs will illuminate.

The Crystal Vision control panel start up display

'Control Panel' then briefly replaces the version number display.



If the control panel firmware has been updated for Statesman control (version 1.5.0 or higher), Statesman Mode will be entered and the message, ‘Press CAL to Exit’ will be displayed and the CAL LED will light.

Statesman mode is entered by default

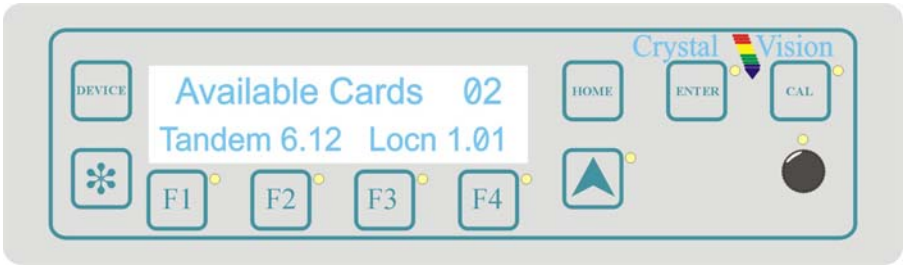
To continue with control panel operation or configuration, press the ‘CAL’ key once. A second press of the ‘CAL’ key will return to Statesman control.

The control panel will display the name of the card that first responds to the polling request together with its location number.

The location number consists of the frame number plus the card position in the frame.

Selecting the TANDEM110

To select a particular card in a frame, press the DEVICE key to go to the Device menu. The top line of the display will show 'Available Cards X', where X is the number of cards that have responded so far to the polling request.



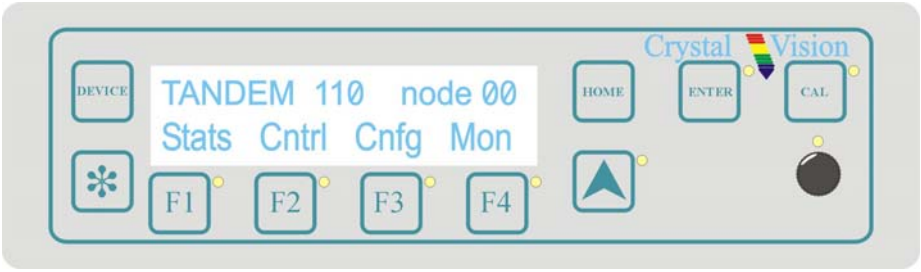
The available cards menu

Rotate the shaft encoder and the bottom row will display the successfully polled cards by name and location or slot number.

In the example above, the card displayed is located in the first frame in slot number 1.

When the desired card is selected press the ENTER key to access that card's HOME menu.

If remote control has been enabled, the control panel will then enter card mode and communicate with the selected module at the node number last displayed in the available cards list.



The TANDEM-110 home menu

Note: The TANDEM-110 card will not be listed as available until after the 16 second power up initialisation procedure is complete.

Navigating the display

The functions assigned to control panel keys are dependent on the card selected for control, and the panel mode. The following list illustrates the functions when controlling the TANDEM110:

- DEVICE – enters Device menu to select a card or card to control / enter Panel setup when held down during power up / shows frame status when pressed from Statesman mode
- CAL – Enter or leave Statesman mode / enter panel diagnostics mode when held down during power up / updates the display
- Asterisk – enters board rename menu from the Device menu
- F1 to F4 – soft keys, function assigned within each menu
- HOME – moves the display to the home menu
- ENTER – accept current selection
- Upward arrow – used to move up the menu structure / enter lock panel menu from the Device menu
- Rotary control – shaft encoder used to select options or variable data

Note: Please refer to the Crystal Vision Control Panel manual for details of the Panel Setup, Lock Panel and Diagnostic menus.

Updating the display

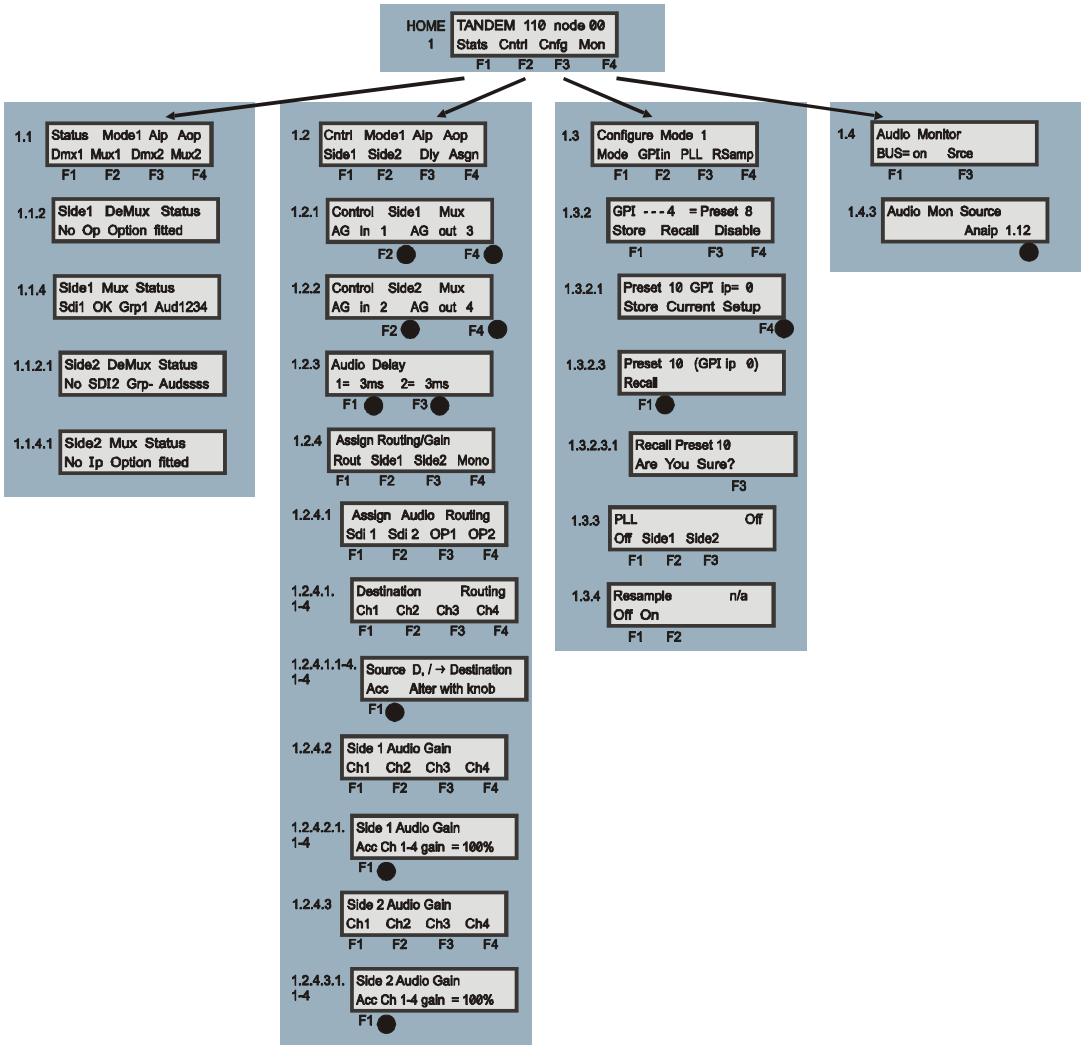
The values displayed on an active front panel are only updated when an adjustment is made and when changing menu level. If mode changes occur through the use of Statesman, card edge controls or through automatic response to the input video signal, the text displayed on the active front panel will not be updated immediately. If necessary, press CAL to update the display.

3.1 The TANDEM-110 menu structure

The main top-level menus for a module are obtained by pressing the F1, F3 and F4 keys from that module's HOME menu. Menu keys are illuminated when active and when further menus are available. The four top-level TANDEM-110 menus are:

- STATS (Status) – press F1
- CNTRL (Control and Routing) – press F2
- CNFG (Configure) – press F3
- MON (Monitoring) – press F4

The following chart shows the majority of the available TANDEM-110 menus. The actual menus available may vary slightly as TANDEM-110 software is updated.



The TANDEM-110 menu tree

Note: Function keys and shaft encoder LEDs are illuminated when active.
Menus or function keys associated with the shaft encoder for changing assigned values are shown with a black circle.

Menu numbering scheme

This manual uses a simple menu numbering convention based on the sequence of keys required to reach each menu from the top level home menu. For example, menu 1.1.2 is reached from the home menu by pressing F1, then F2. Menu 1.1.2.1 is reached by pressing F1, F2 and then F1 again.

Option codes

The following option codes are used in all TANDEM-110 control panel menus:

Menu code	Option code
Aip	AIP2
Aop	AOP2
Dip	DIP2
Rs2	DIP2RS
Dop7	DOP2-75
Dop1	DOP2-110

Shorthand codes

The following shorthand codes are used in all TANDEM-110 control panel menus:

Menu code	Function description
SDI	Serial Digital Interface or serial component digital signal
SD	Side or ‘circuit’ of which there are two on each TANDEM-110 card
Mux1/Mux2	Embedder or multiplexer on side 1 or 2
Dmx1/Dmx2	De-embedder or demultiplexer on side 1 or 2
Opt	Generic term for ‘Option’ card
OP	Generic term for Option card output
AG	Embedded audio group
D	Delay activated (per side)
/	Phase inversion
G	GPI
er	EDH errors above threshold detected
s	Audio signal silent (below –50dBs FS)
-	Signal not present

Note: Take care not to confuse SDI with SD, or OP with Opt.

3.2 Status

Pressing F1 from the home menu will bring up the top status menu. The status menus provide the following information:

- Current mode (always 1) and installed sub-modules and function performed by each side
- Video and audio status

Status menu structure	Description
1.1 Status Mode1 Aip Aop Dmx1 Mux1 Dmx2 Mux2 F1 F2 F3 F4	Top line: Mode (always 1) and options fitted on each side Bottom line: F1 to F4 select further status menus for sdie1 and side 2
1.1.2 Side1 DeMux Status No Op Option fitted	Side 1 DeMux status Sdi1 OK Grp'n' Aud1234 (No Sdi1 if no SDI i/p) No Op Option fitted if Input option or none on side 1
1.1.4 Side1 Mux Status Sdi1 OK Grp1 Aud1234	Side 1 Mux status Sdi1 OK Grp'n' Aud1234 (No Sdi1 if no SDI i/p) No Ip Option fitted if Output option or none on side 1
1.1.2.1 Side2 DeMux Status No SDI2 Grp- Audssss	Side 2 DeMux status Sdi2 OK Grp'n' Aud1234 (No Sdi2 if no SDI i/p) No Op Option fitted if Input option or none on side 2
1.1.4.1 Side2 Mux Status No Ip Option fitted	Side 2 Mux status Sdi2 OK Grp'n' Aud1234 (No Sdi2 if no SDI i/p) No Ip Option fitted if Output option or none on side 2

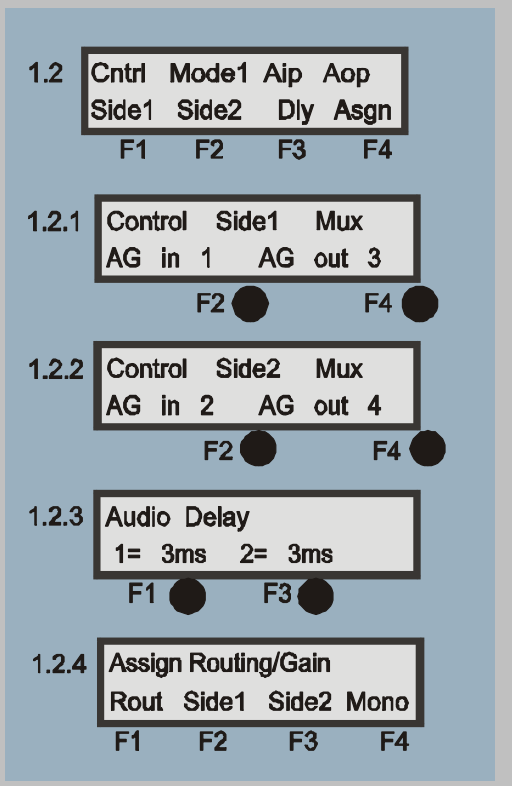
Notes:
Grp may be – for none or 1, 2, 3 or 4
Aud may be s for silence or 1, 2, 3 and 4

3.3 Audio routing and processing options

Pressing F2 from the home menu will bring up the top Control menu. The control menus provide the following functions:

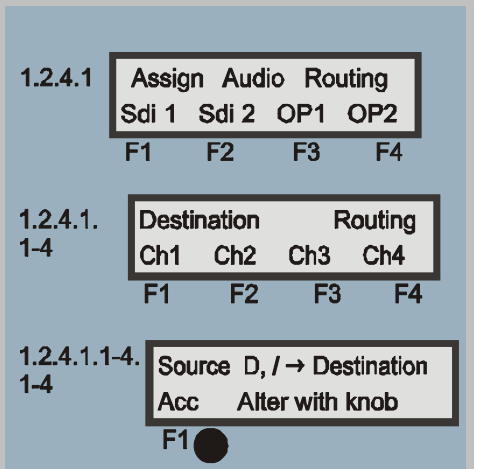
- Current mode status and installed sub-module status
- Audio group select for each side's embedder and/or de-embedder
- Each side's audio delay
- Source and destination routing

Selecting audio group and delay values

Select Group and Delay Value	Description
	CONTROL Top line: Mode and options fitted on each side Bottom line: F1: side 1 group select, F2: side 2 group select, F3: delay and F4: routing assign sub-menus Side 1 group select F2 and shaft encoder selects input group F4 and shaft encoder selects output group Side 2 group select F2 and shaft encoder selects input group F4 and shaft encoder selects output group (Enter saves Group selection) Audio delay value (1-681ms) for each side F1 and shaft encoder control delay for Side 1 F3 and shaft encoder control delay for Side 1 Audio routing and gain Press F1 for routing assignment menu Press F2 for Side 1 audio levels menu and F3 for Side 2 audio levels menu See 'Assign Audio Routing' table for more details Press F4 for Mono menu

Note: The presence of an audio group in the serial data stream is indicated by '=' before the audio group number in menu 1.2.1.

Assigning audio routing, phase and delay

Assign Audio Routing	Description
	Audio routing: destinations depend on options fitted F1 = Sdi 1 – if input option fitted on side 1 F2 = Sdi 2 – if input option fitted on side 2 F4 = Aop/Dop – if output option fitted on side 1 F4 = Aop/Dop – if output option fitted on side 2 'Destination' may be Embedder1, Embedder 2, OP Option 1 or OP Option 2 Select appropriate 'F' button to route to audio channels 1-4 Select 'source' with shaft encoder to route to 'destination' and 'channel' chosen in previous menu Source may be Dmx1, Dmx2, Opt1, Opt2 Destination may be Mux1, Mux2, Opt1, Opt2 Shaft encoder also selects Delay (D), Inversion (/) and Normal (>)

Notes: Audio assign menus, (1.2.4.1.1-4.1-4) may be used as a status display to read current audio routing assignments using providing F1 (Acc) is not pressed.
Use F1 to cycle through delay and/or phase inversion choices.

Delay and phase codes:

The following codes are used for delay and phase inversion

> **Normal phase and no delay**
> **D> Delay**
> **/ Inverted Phase**
> **D/ Delay + inversion**

Tip: If TANDEM-110 firmware or sub-boards have been changed it is recommended to start by loading valid default settings for the entire routing table held in TANDEM's non-volatile memory. This will prevent erroneous settings from appearing in the routing assignment menus. From firmware V5.15 this function is performed automatically (card-edge display shows Save Pre15 > Pre1). . This facility is only available from the card edge – (Defaults: Lever 6 DOWN, SEL switch = B) - please refer to section 5.2 for further details. Always check that the appropriate groups are selected for embedding or de-embedding after loading defaults (section 5.3 for card edge controls).

Note: Routing with the TANDEM-110 must involve either an embedder and an input card or a de-embedder and an output card. Routing between sides is not supported.

Routing assignment examples

As explained in the Introduction chapter, there are three configurations available. These are dual de-embedder, dual embedder or a mixed embedder/de-embedder. Audio can be routed in the following ways:

Embedding Route any channel from an audio input sub-module to any group within the embedder on the same side

De-embedding Route de-embedded audio channel from any group within the input SDI bit stream to an audio output sub-module on the same side

Delay Delay and phase inversion may be applied independently on each side

Example 1

To embed audio from channel 1 from an input option on side 1 into channel 2 of SDI 1, Group 2, proceed as follows:

- Select output group 2 with menu 1.2.1 for side 1

  Menu 1.2.1 shows:

Control Side1 Mux
AG in 1 AG out 2
F2 F4

  Ensure Audio Group out is set to 2. Press **F4** and rotate **shaft encoder** until **AG out 2** is displayed. (Remember to press Enter to save group selection.)

- Select desired destination (Sdi 1 Ch2) and source (Opt1 Ch1) with menu 1.2.4

  Menu 1.2.4 shows:

Assign Audio Routing
Sdi1 Aop2
F1 F4

  Press F1 to bring up destination (Embedder) routing for Channels 1-4 for side 1
  Menu 1.2.4.1 shows:

Embedder 1 Routing
Ch1 Ch2 Ch3 Ch4
F1 F2 F3 F4

  Press F2 to bring up source/delay select for Embedder(Mux) 1, Channel 2
  Menu 1.2.4.1.2 shows:

Opt1Ch1 > Mux1 Ch2
Acc Alter with Knob
F1

  Use shaft encoder to select source channel from Input Option on side 1, further rotation selects delay/phase inversion for the chosen route
  Press F1 (Acc) to accept the displayed route and chosen phase/delay
  If delay and phase inversion had been required, routing display should be:

Opt1Ch1 D/ Mux1 Ch2
Acc Alter with Knob

Example 2

To de-embed audio from Group 3, Sdi 2, channel 3 and route it to channel 3 of an analogue output option on side 2 proceed as follows:

- Select input group 3 with menu 1.2.2 for side 2

  Menu 1.2.2 shows:

  Control Side2 Mux
  AG in 3 AG out 2
  F2 F4

  Ensure Audio Group in is set to 3. Press **F2** and rotate **shaft encoder** until **AG in 3** is displayed. (Remember to press Enter to save group selection.)

- Select desired destination (Aop2 Ch3) and source (Dmx2 Ch3) with menu 1.2.4

  Menu 1.2.4 shows:

  Assign Audio Routing
  Sdi1 Aop2
  F1 F4

  Press F4 to bring up destination (Aop2) routing for Channels 1-4 for side 2
  Menu 1.2.4.4 shows:

  OP Option 2 Routing
  Ch1 Ch2 Ch3 Ch4
  F1 F2 F3 F4

  Press F3 to bring up source/delay select for the channel 3, OP option, side 2
  Menu 1.2.4.4.3 shows:

  Dmx2Ch3 > Opt2 Ch3
  Acc Alter with Knob
  F1

  Use shaft encoder to select source channel from De-embedder(Dmx) on side 2, further rotation selects delay/phase inversion for the chosen route
  Press F1 (Acc) to accept the displayed route and phase/delay
  If delay but no phase inversion had been required, routing display should be:

  Dmx2Ch3 D> Opt2 Ch3
  Acc Alter with Knob

Assigning mono/stereo options

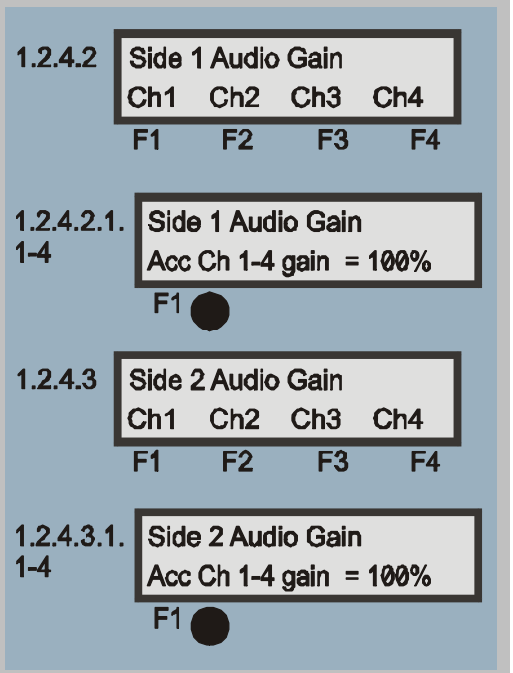
If an input card is fitted, the mono function follows the router and any of the four output channels can be set as the mono sum of its stereo pair. If an output card is fitted, the mono function precedes the router and input channels 1&2 and input channels 3&4 can be configured as either a stereo or mono source.

The following menus are obtained by pressing F4 (Mono) from the Cntl > Asgn menu and rotating the shaft encoder control to display the sub-menus appropriate for the option cards fitted on each side and the audio channel pairs. Press F1 to sum the channels selected or F2 to restore them as individual channels.

Select mono options	Description
1.2.4.4 SDI1/2 ch1-4 embed chan Mono Not Mono Chan→ F1 F2	This menu will be available for any side with an embedder present (ie input card fitted) Chan-> indicates that the shaft control is active, and will select side/router channels
SDI1/2 ch1-4 embed mono Mono Not Mono Chan→ F1 F2	Press F1, 'Mono' to change the display to 'embed mono' Press F2, 'Not Mono' to return the display to 'embed chan'
OP 1&2/3&4 not summed Sum Not Sum Chan→ F1 F2	This menu will be available if an output card is fitted Chan-> indicates that the shaft control is active, and will select side/router channels
OP 1&2/3&4 summed Sum Not Sum Chan→ F1 F2	Press F1, 'Sum' to change the display to 'summed' Press F2, 'Not Sum' to return the display to 'not summed'
SDI1/2 no embedder Mono Not Mono Chan→ F1 F2	If no input card fitted on side 2, the display will read:- SDI2 no embedder
No Op card side 1/2 Sum Not Sum Chan→ F1 F2	If no output card is fitted on side 1, the display will read No Op card side 1/2

Note: SDI1, SDI2 and option card mono channels are all selected by the shaft control from the mono menu.
If any menus shown here are not available, then the option cards fitted do not support those functions. The display will always indicate if an input card (embedder function) or output card is not fitted.

Setting audio channel gains

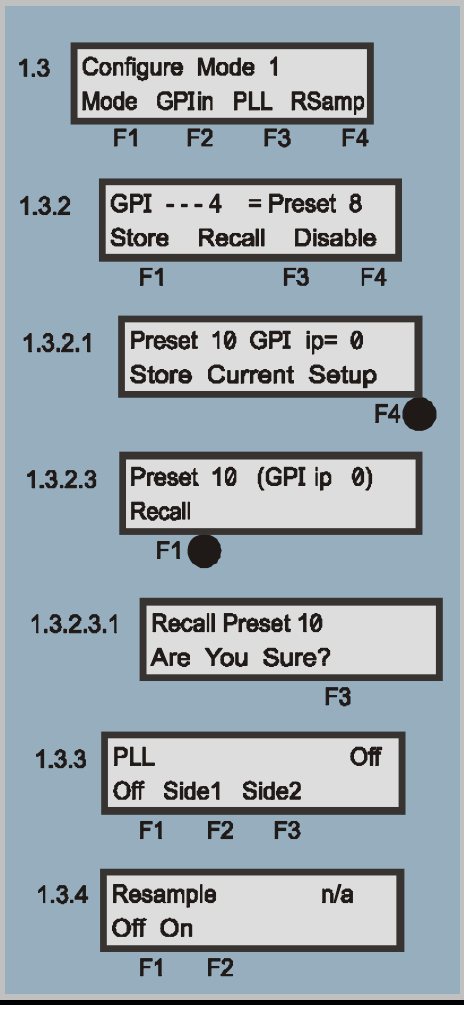
Set audio gains	Description
	Audio Gain Side 1 Press F1 for Ch1 router input gain Press F2 for Ch2 router input gain Press F3 for Ch3 router input gain Press F4 for Ch4 router input gain Shaft encoder changes gain of selected channel from 0 to 799% F1 accepts new value Audio Gain Side 2 Press F1 for Ch1 router input gain Press F2 for Ch2 router input gain Press F3 for Ch3 router input gain Press F4 for Ch4 router input gain Shaft encoder changes gain of selected channel from 0 to 799% F1 accepts new value

Note: Gain is in percentage with 0% = Mute and 799% = 8 x gain (approx).

3.4 Configuration

Pressing F3 from the home menu will bring up the top Configuration menu. The configuration menus provide the following functions:

- Current mode status and mode select (TANDEM-110 is mode 1 only)
- Configure GPI and store and recall presets
- SDI PLL On/Off and Resample On/Off

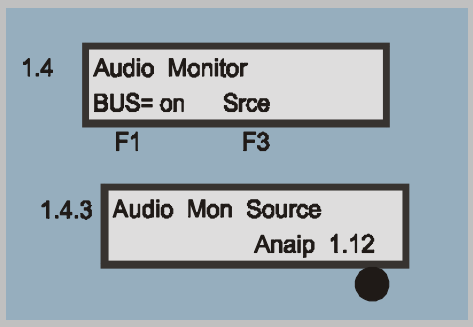
Configure menu structure	Description
	Configure Mode status (always 1) F1: Mode (do not use), F2: GPIs and Presets, F3: PLL (SDI TBC), F4: Resample On/Off Configure GPI GPI 1234 = PRESET (0 to 15) F1: Store, F3: Recall, F4: Disable Store preset Preset no. GPI status F4 saves setup selected by shaft encoder Recall preset preset no. GPI status F14 saves setup selected by shaft encoder Recall preset confirmation Recall preset no. F3 recalls selected preset SDI PLL F1: in Side1, F2: in Side2 or F3: Off Resample – for DIP2-RS option cards only, n/a will be shown if no DIP2-RS card is fitted. F1: Off, F2: On

Notes: Mode selection is not available in the TANDEM-110.
Preset recall is not available from the control panel unless GPIs have been disabled.
It is strongly recommended to DISABLE GPIs when working on presets to avoid the possibility of GPI inputs causing preset memory data to re-configure TANDEM-110 at the same time as presets are being updated.

3.5 Audio monitoring

Pressing F3 from the home menu will bring up the top Audio Monitoring menu. The configuration menus provide the following functions:

- Select audio monitoring source
- Enable/Disable rear monitoring bus

Audio monitoring menu structure	Description
	Audio Monitor F1 toggles rear audio monitor bus output (Headphone connector always ON) F3 selects source menu Audio monitoring source Shaft encoder selects *source reference*

Note: For further configuration options available from the card edge controls, refer to the chapter on Card edge configuration.

4 The card edge display

The auto-configuration process, performed when a TANDEM-110 is first powered up, normally returns the card to the state it was when powered down. If the audio option piggyback cards have been changed, the following default settings are normally selected:

- Audio group source and destinations (default: group1)
- Audio gains (unity gain/100%)
- On-card audio routing (default: dual embedder, dual de-embedder or mixed embedder/de-embedder – option card dependent)
- Delay (default: none)
- Phase inversion (default: normal)

The TANDEM-110 card can be controlled or configured once this 16-second initialisation procedure is complete.

The front edge of the card provides power rail monitoring, menu selection, an analogue audio monitoring output, rotary set-up controls and a ten-digit visual status display.

In general the Menu switch is used to select one of four main menus, whilst the SEL rotary hex switch selects sub-menus or internal variables. The ADJ shaft encoder is used to assign values to variables (such as audio delay or routing assignments).

Changes made using the shaft encoder are generally not implemented immediately. The display will normally flash alternately between bright and dim to indicate that the displayed value may no longer be current when the ADJ shaft encoder is turned. To save a new value simply toggle MENU switch 1 down and then up again.

If a setting is adjusted by mistake, changing the menu (piano MENU or SEL switches) will discard the unwanted setting.

Main menus

Select main menus with MENU switch levers as follows:

Menu switch	Menu
	• Status/Config menus – all levers OFF (UP). This should be the default setting if card edge controls are not in use
	• Preset menu – lever 2 ON (DOWN) all others OFF (UP)
	• PLL menu – lever 3 ON (DOWN) all others OFF (UP)
	• Audio routing menu – lever 4 ON (DOWN) all others OFF (UP)
	• Setup menu – lever 5 ON (DOWN) all others OFF (UP)
	• Stereo/mono menu – levers 4 and 4 ON (DOWN) all others OFF (UP)
	• Audio gain menu – levers 5 and 6 ON (DOWN) all others OFF (UP)
	• Flag & status menu – lever 6 ON (DOWN) all others OFF (UP)

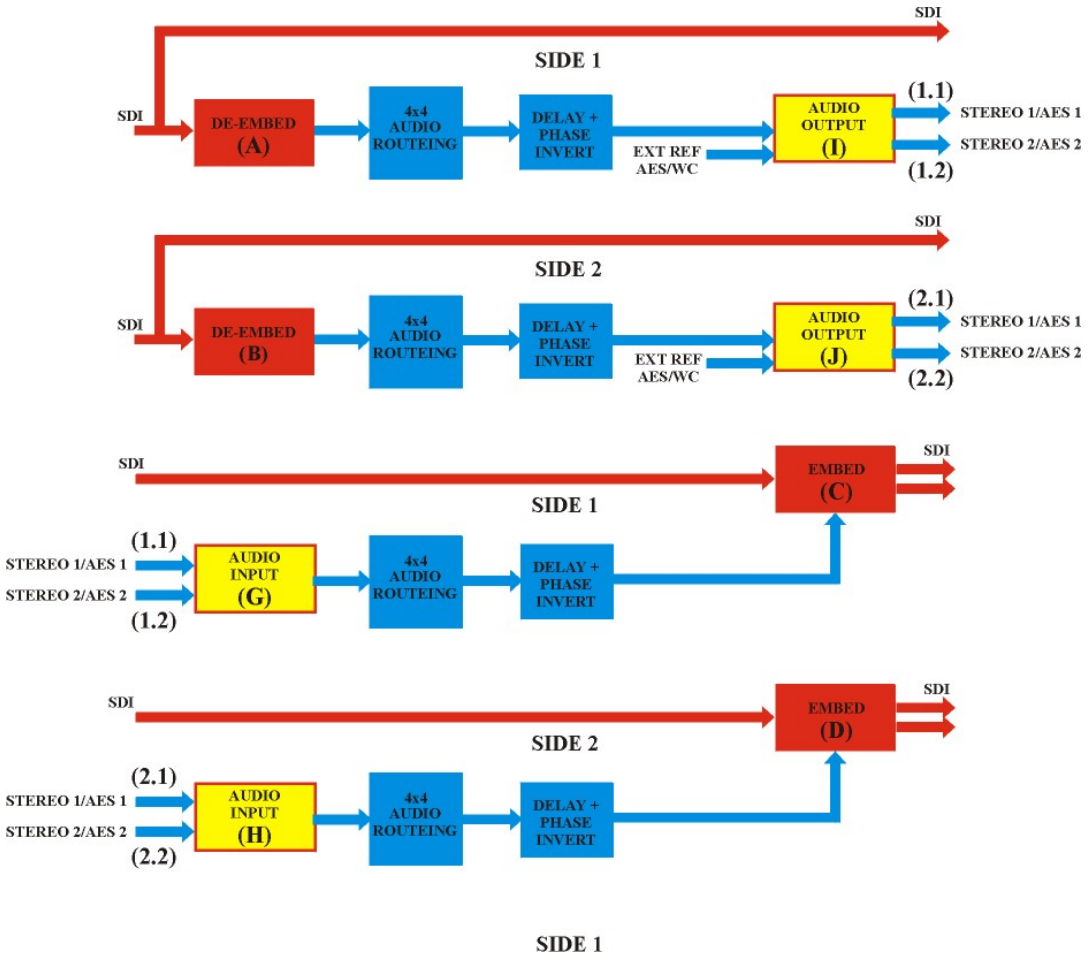
Card edge display codes

A condensed code is used to maximise the information that can be shown on the ten-bit status display. Codes used for sources and destinations are as follows:

Code	Meaning	Comments
A*n*	De-embedded audio source on side 1	
B*n*	De-embedded audio source on side 2	
C*n*	Embedded audio destination on side 1	
D*n*	Embedded audio destination on side 2	
G*n*	Option card audio source on side 1	Option card must be AIP2, DIP2 or RS4
H*n*	Option card audio source on side 2	Option card must be AIP2, DIP2 or RS4
I*n*	Option card audio destination on side 1	Option card must be AOP2 or DOP2-75/110
J*n*	Option card audio destination on side 2	Option card must be AOP2 or DOP2-75/110
1.1	AES 1 or Stereo Pair 1 on side 1	Each analogue or digital output has two buffered outputs (labelled a & b) which may be available at the rear connector. Please see the Installation section for connector details.
1.2	AES 2 or Stereo Pair 2 on side 1	
2.1	AES 1 or Stereo Pair 1 on side 2	
2.2	AES 2 or Stereo Pair 2 on side 2	
‘ ’*n*	New audio group	Group n does not exist in the SDI stream
=*n*	Existing audio group	Group n already exists in the SDI stream

Note: n denotes “1 2 3 4” individual active mono channels.

The following diagram illustrates the use of the card edge display codes for four basic embedding or de-embedding scenarios available for the TANDEM-110:



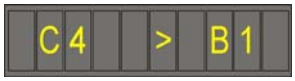
TANDEM-110 modes with card edge codes

Notes: If no audio input card is fitted, the embedder code is changed to indicate that de-embed sources only are available (C becomes E and D becomes F).
However, TANDEM-110 does NOT support re-embedding any de-embedded sources on the same side.

TANDEM-110 display examples

Routing

In the following routing display the source appears on the left and the destination on the right.



A channel 1 de-embedded source on side 2 (B1) is routed to channel 4 of a side 2 audio output card (J4).

Option cards fitted

The following display shows the option cards fitted to each side. The display is split so that side 1 options are shown on the left of the display and side 2 options are shown on the right.

Side 1 has an AES/EBU digital input card (dip) and side 2 has an AES/EBU 75 Ohm digital audio output card (dop7).

SDI signal status

This display indicates the presence or absence of a serial digital video (SDI) signal on each side.

A serial digital video (SDI) signal is not present on side 1 whilst an SDI signal is present on side 2.

Notes: When the display is split between side 1 and 2, the initial character for each side, shows that side's typical function. In the two examples above, the letter 'C' on the left of the display indicates that side 1 will typically operate as an embedder and the letter 'B' at the start of the right hand side of the display shows that side 2 will use de-embedded sources. Refer to the code table on the previous page for more information.

4.1 Card edge status menus

Status Only Menus

The SEL hex switch provides access to a range of status displays when the MENU DIP levers are all OFF (UP). The available status-only displays (SEL positions 1-5) are summarised in the following table:

SEL No.	Description	Examples and comments	ADJ funct
0	Auto	Display shows first three status menus (SEL positions 1, 2 & 3) on a priority basis. Use this setting when card edge controls are not in use.	N/A
1	SDI signal status	sdi = SDI present, -sdi = SDI not present For example: C-sdiB sdi indicates that side 1 is being used as an embedder, that the SDI input is absent, that side 2 is being used as a de-embedder and that the SDI input is present	N/A
2	AES & Ref I/P status (Note: if AIP or AOP fitted display is the same as SEL 5)	If DIP fitted Cas12 = Side 1 AES 1&2 channels present Cas-2 = Side 1 AES 2 channel present only Das34 = Side 2 AES 3&4 channels present Cas2- Das-4 = AES 2 present on side 1 and AES 4 present on side 2 If DOP fitted Aref1 = AES reference 1 present Aref- = AES reference 1 absent Bref2 = AES reference 2 present Aref1 Bref- = AES reference present on side 1, but absent on side 2	N/A
3	Active audio/silence	Shows active audio channels (> 50dB FS) 's' = silence, number = active channel 12ss = Audio channels 1&2 active, 3&4 silent (<50dB FS)	N/A
4	Audio	Future additional audio signals	N/A
5	Option cards fitted	aip: AIP2 option card aop : AOP2 option card dip : DIP2 option card RS2: DIP2RS dop7: DOP2-75 option card dop1: DOP2-110 option card	N/A

Note: For the above menus, the display is split between sides 1 and 2. The five left-most characters refer to side 1 and the five right-most characters refer to side 2.

Status/Config menus

WARNING: For the first five SEL status positions the shaft encoder is not active and settings cannot be changed, for SEL positions 6 to F, the shaft encoder will alter (but not save) the assigned values as indicated in the remainder of the table. Do **NOT** touch the ADJ shaft encoder when using these SEL positions for status information.

SEL No.	Description	Examples and comments	ADJ funct
6	SD 1 de-embed audio group	A=Agroup=*n*, where *n* is -(no group) or 1,2,3,4. Shaft encoder changes value of *n*	ADJ=*n*
7	SD 2 de-embed audio group	B=Bgroup=n, where n is -(no group) or 1,2,3,4. Shaft encoder changes value of n	ADJ=*n*
8	SD 1 embed audio group	C=Agroup=n, where n is -(no group) or 1,2,3,4. Shaft encoder changes value of n	ADJ=*n*
9	SD 2 embed audio group	D=Bgroup=n, where n is -(no group) or 1,2,3,4. Shaft encoder changes value of n	ADJ=*n*
A	Audio bus settings for audio monitor	AUDbus=OFF or AN.	ADJ= ON/AN
B	Audio monitor source	Selects stereo source for headphone socket and rear audio monitoring bus if enabled Amon = XX XX, where XX XX indicates the stereo pair monitored	ADJ= stereo pair select
C	Audio delay side 1	Set using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
D	Audio delay side 2	Set using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
E	Silence threshold	Set using ADJ shaft encoder for the delay time (DL) in seconds after which a channel is considered silent (< -50dB wrt Full Scale). Available values start at 1.5s, 8s and then in increments of 8s until 120s	ADJ= threshold
F	GPI Enable/Disable	Disables General Purpose Inputs. General Purpose Outputs (GPOs) are not disabled	ADJ= disable /enable

Notes: Remember that the '=' sign before a group number indicates an existing group. Audio routing is described in detail in section 5.3. Audio monitoring is described in section 5.5 and GPI enable/disable options are described in section 5.6.

Ancillary data status

The ancillary data status display is obtained with Menu lever 6 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position E for side 1 and F for side 2.

SEL	Display	Comments
E	SD1 1234dE	See section 5.7 for a detailed explanation
F	SD2 1234dE	

4.2 Selecting default operational settings

A facility is provided to load default operational settings, including routing data, which will be valid for the current TANDEM-110 installation. This is useful if the existing settings have become corrupted or are invalid. This could occur as a result of changing sub-boards or upgrading firmware.

The menu is obtained with Menu lever 6 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position B. The display will read ‘Defaults?’ Turn the shaft encoder to select between ‘Basic Def?’ and ‘Delay Def?’

Both options select one-to-one routing (in1.1 > out 1.1, in1.2 > out 1.2 etc) according to the fitted sub-boards.

The ‘Basic’ option routes directly without delay whereas the ‘Delay’ option routes via the currently selected audio delay. Neither option selects any phase inversion. When the desired option is displayed, toggle piano switch 1 down and then up again to implement the routing.

SEL	Meaning	Comments
B	Defaults?	Use the Shaft Encoder to select direct or delay routing.

Once the appropriate defaults have been loaded, set the desired Audio Group selections, as explained in section 5.3, to A/B/C/D = -/1/2/3/4 to suit your installation

4.3 Audio routing and processing options

Routing audio on the TANDEM-110 involves selecting valid audio sources and destinations. The available options depend on the sub-boards that have been fitted.

Tip: If TANDEM-110 firmware or sub-boards have been changed it is recommended to start by loading valid default settings for the entire routing table held in TANDEM's non-volatile memory. This will prevent erroneous settings from appearing in the routing assignment menus. From firmware V5.15 this function is performed automatically (card-edge display shows Save Pre15 > Pre1). Please refer to the previous section (5.2) if default settings are required.

Changing or establishing new Routing settings involves the following steps:

- Select appropriate groups for de-embedding and embedding
- Select appropriate sources and destinations

Selecting groups

When embedding or de-embedding, the source and destination groups should be selected as part of the audio routing setup. This is accomplished using the status display; Menu switch with all levers OFF (UP). The SEL switch selects each side's de-embedding or embedding functions and the ADJ shaft encoder selects the available groups. Save the group assignment by toggling MENU switch 1 down and then up again.

The follwing table summarises the available source and destination group assignments:

SEL No.	Description	Comments	ADJ funct
6	SD 1 de-embed audio group	A=Agroup=*n*, where *n* = -(no group) or 1,2,3,4. Shaft encoder changes value of *n*	ADJ=*n*
7	SD 2 de-embed audio group	B=Bgroup=*n*, where *n* = -(no group) or 1,2,3,4. Shaft encoder changes value of *n*	ADJ=*n*
8	SD 1 embed audio group	C=Agroup=*n*, where *n* = -(no group) or 1,2,3,4. Shaft encoder changes value of *n*	ADJ=*n*
9	SD 2 embed audio group	D=Bgroup=*n*, where *n* = -(no group) or 1,2,3,4. Shaft encoder changes value of *n*	ADJ=*n*

Notes: Remember that the '=' sign before a group number indicates an existing group, when embedding a space before a group number, ' 'n, indicates a non-existent group or new group to be formed.
E and F replace C and D respectively, if there is no analogue or digital input sub-board.

Group examples

- Select a group from within the SDI stream for de-embedding

  Example: **A=Agroup=n or B=Agroup=n**
  If the display text starts with A or B, de-embedding is implied. Providing the '=' sign appears before the group number, audio will be de-embedded.

- An attempt is made to de-embed from a non-existent group

  Example: **A=Agroup n or B=Agroup n**
  If the display test starts with A or B, de-embedding is implied. However, if the '=' sign does NOT appear before the group number, then NO audio will be de-embedded at this in time as no suitable input is currently present.

- Select a new group to embed to

  Example: **C=Agroup n or D=Agroup n**
  If the display test starts with C, D, E, or F embedding is implied. Providing there is NO '=' sign before the group number, then there is no conflicting audio group present and audio will be embedded into that SDI stream.

- Select an existing group to embed to

  Example: **C=Agroup=n or D=Agroup=n**
  If the display test starts with C, D, E, or F embedding is implied. The '=' sign before the group number indicates that it already exists. There is a conflicting audio group present.
  New audio will be embedded into that SDI stream and the incoming Audio Group will be disabled automatically by changing the incoming Audio Group ID to 'Marked for Deletion'.

Tip: Always set embed or de-embed functions to unassigned when NOT in use (eg A=Agroup-). The '-' sign will disable auxiliary functions such as 'Marked for Deletion' and will help avoid invalid operations or unexpected results.

Selecting sources and destinations

This menu, obtained with Menu lever 4 ON (DOWN), is used to select the source for each destination available on the board. The destination is selected using the SEL switch whilst the source and its delay and phase setting is selected using the ADJ shaft encoder. Save each source assignment by toggling MENU switch 1 down and then up again.

SEL No.	Sources	Source description ADJ selects source	Further ADJ rotation selects delay/phase	Dest	Dest description SEL selects dest
0 - 3	G1 - G4	Audio from input option on side 1	> Normal phase D> Delay assigned / Inverted Phase D/ Delay + inversion	C1 - C4	Audio embedded into side 1 SDI
4 - 7	H1 – H4	Audio from input option on side 2	> Normal phase D> Delay assigned / Inverted Phase D/ Delay + inversion	D1 - D4	Audio embedded into side 2 SDI.
8 – B	A1 – A4	Audio de-embedded from SDI side 1	> Normal phase D> Delay assigned / Inverted Phase D/ Delay + inversion	I1 - I4	Output option card on side 1
C - F	B1 – B4	Audio de-embedded from SDI side 2	> Normal phase D> Delay assigned / Inverted Phase D/ Delay + inversion	J1 - J4	Output option card on side 2

Notes: The source and destination codes are the same as used in status displays except that ‘I’ and ‘J’ will be replaced by ‘E’ and ‘F’, respectively, if no option card is fitted, to indicate that no outputs exist, except via the audio monitor function.
Unavailable destinations are followed by [no] in the display.
Routing must involve either an embedder and an input card or a de-embedder.
Routing between sides is not supported and audio routing directly from a de-embedder to an embedder (i.e. A1 > E1 or B2 > F2) is NOT supported by TANDEM-110, even though such assignments may be displayed at the card edge.

Assigning delay and phase inversion

When a source has been chosen for each destination during audio routing, it is possible to set the audio processing options by further rotation of the ADJ shaft encoder. The available options are delay, phase inversion, delay plus phase inversion and normal.

Notes: The value of the delay assigned to each side using sub-menus C and D of the Status Menu.

Routing assignment examples

- A de-embedded source on side 2 is routed to a digital output sub-board on side 2

Example: **B1 > J1**
Channel 1 is selected from the source and routed to channel 1 on the destination.

- An input on the digital sub-board on side 1 is embedded into the SDI stream on side 1

Example: **G1 > C3**
Channel 1 is selected from the source and routed to channel 3 on the destination.

- An input on the digital sub-board on side 1 is embedded into the SDI stream on side 1 after delay and phase inversion

Example: **G1 D/ C3**
Channel 1 is selected from the source delayed and phase inverted and then routed to channel 3 on the destination.

- An input on the digital sub-board on side 1 is delayed and then embedded into the SDI stream on side 1

Example: **G1 D C3**
Channel 1 is selected from the source delayed but not phase inverted and then routed to channel 3 on the destination.

Setting delay/silence threshold delay

The amount of delay can be set independently for each side in 1ms steps from 1 – 681ms using sub-menus C and D of the Status/Config menu MENU switch all levers UP (or OFF). The silence threshold for both sides is set using Status/Config sub-menu E. The following table summarises the choices:

SEL No.	Description	Examples and comments	ADJ funct
C	Audio delay side 1 Del1 xxms	Set delay ‘xx’ for side A using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
D	Audio delay side 2 Del2 xxms	Set delay ‘xx’ for side B using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
E	Silence threshold delay Sil DL xxs	Set silence threshold delay for both sides using ADJ shaft encoder for the amount of time a signal is allowed to remain below –50dB wrt Full Scale before a silence error is flagged. ‘xx’ values start at 1.5s, 8s and then in increments of 8s to 120s	ADJ= silence threshold delay

The values for audio delay for side 1 and side 2 are entered into the TANDEM-110 database the moment the ADJ shaft encoder is turned. This is the sole exception to the use of switch 1 of the MENU dip switch to save shaft encoder values. This has been provided

to allow delay values to be updated as soon as the shaft encoder is altered to ease the task of setting audio delay empirically.

For all other menus, including silence delay threshold, where the shaft encoder changes assigned values, switch 1 of the MENU dip switch must be toggled between ON and OFF to save the new value in the TANDEM-110 database.

Setting audio gains

Audio gain may be set independently for each of the four audio channels on each TANDEM 110 side. The gain is variable from zero (mute) to eight times unity gain (799%).

The Audio Gain menu is obtained by setting MENU levers 5 and 6 both ON (DOWN) and all other levers UP or OFF.

The ADJ shaft encoder varies the gain for the channel selected with the SEL switch..

The available audio gain settings are summarised in the following table:

SEL No.	Audio gain	Examples and comments	ADJ funct
0	CH 1, Side 1	AG1.1 100. Side 1 Audio Channel 1 set to unity gain.	ADJ= 0 to 799%
1	CH 2, Side 1	AG1.2 100. Side 1 Audio Channel 2 set to unity gain.	ADJ= 0 to 799%
2	CH 3, Side 1	AG1.3 100. Side 1 Audio Channel 3 set to unity gain.	ADJ= 0 to 799%
3	CH 4, Side 1	AG1.4 100. Side 1 Audio Channel 4 set to unity gain.	ADJ= 0 to 799%
4	CH 1, Side 2	AG1.1 100. Side 2 Audio Channel 1 set to unity gain.	ADJ= 0 to 799%
5	CH 2, Side 2	AG1.2 100. Side 2 Audio Channel 2 set to unity gain.	ADJ= 0 to 799%
6	CH 3, Side 2	AG1.3 100. Side 2 Audio Channel 3 set to unity gain.	ADJ= 0 to 799%
7	CH 4, Side 2	AG1.4 100. Side 2 Audio Channel 4 set to unity gain.	ADJ= 0 to 799%

Notes: The gain setting is associated with router inputs, rather than audio sources or destinations. This means that audio gain settings will apply to the current routing table and will not change if (say) a different audio group is chosen for de-embedding.

Mono operation

If an input card is fitted, the mono function follows the router and any of the four output channels can be set as the mono sum of its stereo pair. If an output card is fitted, the mono function precedes the router and input channels 1&2 and input channels 3&4 can be configured as either a stereo or mono source.

The Mono menu is obtained by setting MENU levers 4 and 5 both ON (DOWN) and all other levers UP or OFF.

Rotate the ADJ shaft encoder to toggle between mono and not mono modes for the function chosen with the SEL switch.

The available mono/stereo settings are summarised in the following table:

SEL No.	Function	Mono	Not mono	ADJ toggle action
0	Side 1, C Embedder	CH 1, op mono	CH 1, op not mono	Switch C1 output between mono and not mono
1	Side 1, C Embedder	CH 2, op mono	CH 2, op not mono	Switch C2 output between mono and not mono
2	Side 1, C Embedder	CH 3, op mono	CH 3, op not mono	Switch C3 output between mono and not mono
3	Side 1, C Embedder	CH 4, op mono	CH 4, op not mono	Switch C4 output between mono and not mono
4	Side 2, D Embedder	CH 1, op mono	CH 1, op mono	Switch D1 output between mono and not mono
5	Side 2, D Embedder	CH 2, op mono	CH 2, op mono	Switch D2 output between mono and not mono
6	Side 2, D Embedder	CH 3, op mono	CH 3, op mono	Switch D3 output between mono and not mono
7	Side 2, D Embedder	CH 4, op mono	CH 4, op mono	Switch D4 output between mono and not mono
8	Side 1, De-embedder	A1 + 2 mono	A1 A2	Switch A1 and A2 inputs between mono and not mono
9	Side 1, De-embedder	A3+4 mono	A3 A4	Switch A3 and A4 inputs between mono and not mono
A	Side 2, De-embedder	B1 + 2 mono	B1 B2	Switch B1 and B2 inputs between mono and not mono
B	Side 2, De-embedder	B3+4 mono	B3 B4	Switch B3 and B4 inputs between mono and not mono

Notes: Mono/not mono status can only be changed for those functions supported by the option cards fitted. No Dn pres or No Cn pres will be shown if there is no input card in side 1 or side 2 respectively, where n is the channel number (nothing to embed).
No A1, A2/A3, A4 or No B1, B2/B3, B4 will be shown if there is no output card on side 1 and side 2 respectively (nothing to de-embed to).

4.4 Audio monitoring

Audio monitoring is provided at the card edge with a miniature stereo jack socket. The same signal may also be routed to the rear connector. The stereo source monitored can be selected from any valid audio destination using the shaft encoder in Status/Config sub-menu 11 (MENU switch all levers UP or OFF, SEL switch to position 11).

The available audio monitoring settings are summarised in the following table:

SEL No.	Description	Examples and comments	ADJ funct
A	Audio bus settings for audio monitor	AUDbus=OFF or ON. Shaft encoder set ON/OFF.	ADJ= ON/OFF
B	Audio monitor source	Allows stereo source to be selected for headphone socket and rear audio monitoring bus if enabled. Amon = xxxx, where xxxx indicates the stereo pair selected for monitoring using the ADJ shaft encoder. Examples: A1 A2, A3 A4, B3 B4,	ADJ= stereo pair select

Notes: When monitoring de-embedders, the audio channels can only be chosen from groups selected in sub-menu 6 and 7 in the Status/Config menu.
The source for monitoring is selected prior to the audio routing in an embedder, and accesses the input audio signals from the AIP or DIP card. The monitoring source for de-embedded audio is taken after the audio routing, and accesses the output audio signals fed to the AOP or DOP card.

4.5 Enabling/disabling GPIs

The GPI inputs can be used to recall TANDEM-110 setups that have been stored previously. This recall function can be disabled from the card edge.

Ensure that all MENU switch all levers UP or OFF and the SEL switch is in position F. Use the shaft encoder to select Disable or Enable.

SEL No.	Description	Examples and comments	ADJ funct
F	GPI Enable/disable	Disables General Purpose Inputs. General Purpose Outputs (GPOs) are not disabled.	ADJ= Disable/ Enable

4.6 Using presets

Up to sixteen setups may be stored for the board and recalled either from the board control or through the use of external GPIs. Presets store board setup data including operating mode and option card status. It is not possible to recall a preset if the operating mode or option card configuration is different to those established when the preset was created. The presets are currently numbered 0-15.

To store or recall a preset proceed as follows:

- Disable GPIs – see previous section
- Enter the preset menu Menu switch 2 ON (DOWN)
- Select appropriate preset with the rotary SEL switch
- To store a preset put the Menu lever-1 down and then up again
- To recall a preset put the Menu lever-8 down and then up again

The status display will indicate the status of each pre-set as it is selected:

Preset status	Meaning
Valid	A preset has been stored at this location with the same option cards and mode as now. It can be recalled or over written.
Invalid	The preset cannot be recalled since the mode or option card configuration has changed. It can be over written with a fresh preset.
Empty	No setup data is stored at this location.

Notes: Presets cannot be saved or recalled from the card edge unless GPIs are disabled. This is done to avoid the possibility of GPI inputs causing preset memory data to re-configure TANDEM-110 at the same time as presets are being updated

4.7 Data packet management settings

Contiguous packing

TANDEM-110 supports contiguous packing, which ensures that new audio data packets are embedded at the first free location after the EAV in the HANC. Contiguous packing allows for all four groups and other data, such as groups 'marked for deletion' to co-exist sequentially in the HANC.

Non-contiguous packing would overwrite existing data. Although this saves on HANC space the start of the next group is likely to be damaged on some TV lines.

Marking groups for deletion

If an incoming audio group is the same as an audio group selected for output in that SDI path it can be flagged as 'marked for deletion' so that downstream devices do not detect that group.

TANDEM-110 will automatically assign 'mark for deletion' for a side configured as a de-embedder and 'contiguous packing' for a side configured as an embedder.

The packing status is obtained with Menu lever 5 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position 8 for side 1 or 9 for side 2.

SEL	Display	Comments
8	SD1 contig or markdel	Shaft encoder will not be active since the assignment is automatic
9	SD2 contig or markdel	

Blanking HANC before embedding

This removes all incoming ancillary data except EDH after the inputs have been read and before any new data is embedded.

The menu is obtained with Menu lever 5 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position A for side 1 and B for side 2. Turn the shaft encoder to select between 'SDx blank' or 'SDx noblnk', where x is the TANDEM-110 side 1 or 2.

SEL	Display	Comments
A	SD1 blank or noblnk	Use shaft encoder to select blank or noblnk. It is recommended to leave this setting as 'noblnk' for normal operation.
B	SD2 blank or noblnk	

Enabling EDH functions

EDH functions may be selected to be 'pass through or OFF' or 'include EDH functions or ON'.

In de-embedder only mode, the EDH functions checks EDH incoming performance, but does not alter EDH insert CRC values.

If 'Mark for Deletion', 'Blank HANC', or embed mode are in place then EDH CRC values will no longer be valid. In this case, new EDH insert CRC values are calculated and inserted into the EDH data block in each TV field.

The EDH menu is obtained with Menu lever 5 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position C for side 1 and D for side 2. Turn the shaft encoder to select between 'EDH on' and 'EDHoff'.

SEL	Display	Comments
C	SD1 EDH on or EDHoff	Use shaft encoder to select 'EDH on' or 'EDHoff'. It is recommended to leave this setting as 'EDH on' for normal operation.
D	SD2 EDH on or EDHoff	

Viewing ancillary data status

An ancillary data monitoring facility has been provided to show the following:

- SDI status
- Input audio group present
- Deletion status
- EDH data present

The ancillary data status display is obtained with Menu lever 6 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position E for side 1 and F for side 2.

SEL	Display	Comments
E	SD1 1234dE	See notes and examples for detailed explanation
F	SD2 1234dE	

Note: If no SDI input is present on that side the display will read, 'no inp'.
'd' indicates the presence of embedded audio marked for deletion.
'E' indicates the presence of EDH inserts.
'-' indicates that a possible input (group, deletion flag or EDH insert) is not present.

Examples: SDI 1----E Audio Group 1 and EDH only present.
SDI -23-d- Audio Groups 2, 3 and 'Marked for Deletion' present.

Tip: A much wider range of Demux and Mux status reporting, including HANC status, is discussed in Chapter 6, Problem solving.

Error handling

The following table summarises the error handling options. To enter this menu, ensure that only MENU dip switch 5 is down.

SEL no	Display	Description	ADJ funct
0	SD1erlevnn	Error masking on channel A audio outputs Level 0 provides minimal error masking, 15 is maximum (default)	ADJ=nn
1	SD2erlevnn	As 0 for channel B	ADJ=nn

Error masking cannot be completely disabled. Level 0 to level 15 provide progressively more and more advanced error handling capability with level 0 providing basic error handling and level 15 providing full error handling.

Note: This setting should be left in the default position of 15. However lower values may be useful in fault finding. For example changing the error masking to 0 may be useful when attempting to listen to faults in the input data stream, or if the faults are so bad that the error masking simply mutes the channel.

Embedding formats and vertical switching

When upstream input switching occurs or when input drop-out occurs the embedded digital audio can suffer degradation and loss of synchronisation. The result could be audible defects.

Repeating samples from a buffer during the disturbance can ease the problem or in the case of upstream switching, lines around the standard switching point can simply be avoided and not used for digital audio.

SMPTE standards 272M and 291M and SMPTE recommendation RP168 suggests the use of a single line gap, but larger gaps are sometimes required to provide sufficient robustness. In addition, there is equipment already in the market place manufactured by Sony before the SMPTE recommendation was implemented that embeds on all lines. For these reason both SMPTE and proprietary embedded formats need to be supported.

The two basic embedded audio formats supported by TANDEM-110 are as follows:

- SMPTE: no data on lines around the preferred switching point e.g. lines 5,6,7,8 in 625 and lines 9,10,11,12 in 525 and corresponding lines in the alternate fields
- SONY: data on every line

TANDEM modules provide a range of embedding and de-embedding formats that provide a trade off between robustness and processing delay.

The de-embedding and embedding formats do not have to be the same. De-embedding can be set to look at all lines for embedded audio whilst embedding can be done according to SMPTE recommendations with a switch-point gap.

This allows TANDEM-110 to convert material from SONY formats to SMPTE. It is also possible to convert SMPTE to SONY format, however, in this case the de-embed mode should be placed in the special setting of ‘ALL’ rather than SONY.

TANDEM allows the user to also handle a wide variety of embedded audio formats when 'ALL' is selected. Some formats exceed the minimal buffer memory requirements by a wide margin, but will still be safely de-embedded by TANDEM. The selection 'ALL' is automatically selected by TANDEM internal logic if a SMPTE or extreme format of embedding is detected. There may be a moment's loss of good audio if one of the SONY modes is selected and then later the input format changes from Sony to SMPTE or an extreme format.

The following table summarises the available choices. To enter this menu, ensure that only MENU dip switch 5 is down.

SEL no	Display	Description	ADJ funct
2	SD1A_XXXX	The following de-embedding modes are available: SONY1, SONY2, SONY3, ALL	ADJ=XXXX
3	SD2B_XXXX	As SEL 2 for side 2	ADJ=XXXX
4	SD1C_XXXX or SD1E_XXXX	The following embedding modes are available: SONY1, SONY2, SONY3, SONY4, SMPTE1, SMPTE2, SMPTE3, SMPTE4	ADJ=XXXX
5	SD2D_XXXX or SD2F_XXXX	As SEL 4 for side 2	ADJ=XXXX

Note: Please refer to the ‘Data packet management’ chapter for details of HANC processing and embedding formats.

4.8 Setting the stereo/dual mono status flag

Use this setting to control the ‘stereo’ or ‘dual mono’ status flag in the AES output.

To enter this menu, ensure that only MENU switch 5 is down.

SEL no	Display	Description	ADJ funct
6	SD1xxxxx	Use shaft encoder to select ‘stereo’ or 2Xmono	ADJ=xxxxx
7	SD2 xxxxx	As SEL 6 for side 2	ADJ=xxxxx

4.9 Adjusting AES/EBU output phase

The phase of the digital audio output may be adjusted with respect to the AES reference, providing an AES reference is applied and the appropriate jumper link is set on the DOP2-75 or DOP2-110 sub-board.

To enter this menu, ensure that only MENU dip switch 5 is down.

SEL no	Display	Description	ADJ funct
E	S1AESph xxx	Use shaft encoder to select 0-255	ADJ=xxx
F	S2AESph xxx		ADJ=xxx

The AES output phase may be varied over a range of just over 360 degrees. The display shows a reading of 0 to 255 for indication purposes only.

The AES output frequency is set by the frequency of the embedded audio in the incoming SDI signal The AES reference input signal must be the same as that of the incoming sudio to be useable, otherwise it will not work correctly. This is normally the case as the AES reference signal and the embedded SDI audio data will have been locked to the station master video source, so that the 48kHz sample rate and AES word rate are both considered synchronous with the video signal.

4.10 Assigning GPI outputs

GPO 5 and GPO 6 can be assigned from Statesman and/or the card-edge controls to signal an error condition when loss of video, audio or AES reference occurs.

GPO 5 and GPO 6 may be assigned to signal paths as follows:

GPO 5 assignment	GPO 6 assignment
SDI 1 / De-embedder A / Embedder C	SDI 2 / De-embedder B / Embedder D

Immediate alarms

The following signal loss conditions will cause an alarm to be asserted via GPO 5 or GPO 6 irrespective of any user alarm selection:

Alarm signal trigger	Immediate GPO alarm
SDI input loss	Always
Embedded audio insert input loss	When de-embedder is set to 'ON'
Primary AES input loss	If DIP2 or DIP2RS fitted

Note: There is no switch option to flag/mask the immediate alarms above.

The following signal loss conditions will cause an immediate alarm to be asserted via GPO 5 or GPO 6 provided the alarm has not been 'masked' or deselected in Statesman:

Alarm signal trigger	Immediate GPO alarm
Secondary AES input loss	It will be ignored if set to 'mask'
AES reference loss	It will be ignored if set to 'mask'

When only MENU DIP lever 6 is ON(DOWN) and all others are OFF (UP). GPI outputs may be assigned by SEL positions 0-9 as summarised in the following table:

SEL No.	Description	Examples and comments	ADJ funct
0	1.1sl mask or 1.1sl flag	Selects SDI 1 audio channel 1 signal silence to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
1	1.2sl mask or 1.2sl flag	Selects SDI 1 audio channel 2 signal silence to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
2	1.3sl mask or 1.3sl flag	Selects SDI 1 audio channel 3 signal silence to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
3	1.4sl mask or 1.4sl flag	Selects SDI 1 audio channel 4 signal silence to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
4	2.1sl mask or 2.1sl flag	Selects SDI 2 audio channel 1 signal silence to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
5	2.2sl mask or 2.2sl flag	Selects SDI 2 audio channel 2 signal silence to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
6	2.3sl mask or 2.3sl flag	Selects SDI 2 audio channel 3 signal silence to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
7	2.4sl mask or 2.4sl flag	Selects SDI 2 audio channel 4 signal silence to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
8	S1AESinflg or S1AESinmsk	Selects SDI 1 AES 2 input signal missing to be flagged by the GPO5 output. This menu only appears if a DIP is fitted in SD1. AES 1 input is unaffected by this option.	ADJ= inflg or inmask
9	S2AESinflg or S2AESinmsk	Selects SDI 2 AES 2 input signal missing to be flagged by the GPO6 output. This menu only appears if a DIP is fitted in SD2. AES 1 input is unaffected by this option.	ADJ= inflg or inmask
8	S1AESrfflg or S1AESrfmsk	Selects SDI 1 reference input signal missing to be flagged by the GPO5 output. This menu only appears if a DOP2-75 or DOP2-110 is fitted in SD1 and a reference is input to that sub-board.	ADJ= rfflg or rfmask
9	S2AESrfflg or S2AESrfmsk	Selects SDI 2 reference input signal missing to be flagged by the GPO6 output. This menu only appears if a DOP2-75 or DOP2-110 is fitted in SD2 and a reference is input to that sub-board.	ADJ= rfflg or rfmask

Notes:

Audio silence is deemed to refer to embedder audio signals only, unless that embedder is OFF - in which case de-embedder signals are tested for silence.
If silence is sustained for more than the silence detect delay the assigned GPO will be asserted low as an alarm when ‘flag’ is selected.
If an ‘input missing’ flag is effectively turned off by the ‘inmsk’ or ‘rfmsk’ setting it will also be ignored in the ‘Auto’ menu (all menu levers ON/UP, SEL=0) as an error condition.

4.11 Selecting the PLL mode

The PLL menu is obtained with MENU DIL, lever 3 ON (DOWN) and all other levers UP (OFF**)**.

SEL	Display	Comments
2	PLL Off, 1 or 2	Select the PLL mode from Off, Sdi 1 or Sdi 2 with the shaft encoder.

Note: Details of the PLL function may be found in the Introduction and the Statesman chapter.

4.12 Selecting the re-sampling mode

The re-sampling menu is obtained with MENU DIL, lever 3 ON (DOWN) and all other levers UP (OFF**)**.

SEL	Display	Comments
3	Resamp On, Off or n/a	Re-sampling is applicable for DIP2RS cards only.

4.13 The operating mode

TANDEM-110 does not support modes other than mode 1. For this reason the MODE change function will be disabled. It is documented here for completeness only. The menu is obtained with Menu lever 3 ON (DOWN) and all other levers UP (OFF**)**.

SEL	Meaning	Comments
0	Display present mode	Display will be MODE = 1
1	Select mode	Disabled on TANDEM-110. Display will be 0
2 - 15	Not used at present	

4.14 Miscellaneous functions

Firmware version number

The TANDEM-110 firmware version number is obtained with Menu lever 6 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position C.

SEL	Display	Comments
D	TANDEM 6.12	TANDEM firmware version number

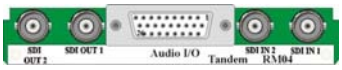
Note: SEL position C and menus beyond D provide information for Crystal Vision technical staff only.

5 Installation

TANDEM-110 may be fitted into three of the Crystal Vision range of rackframes:

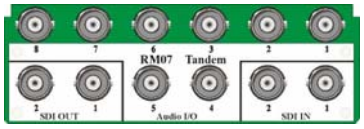
- 2U Indigo or FR2AV frame for up to 12 TANDEMs or other single height Crystal Vision modules,
- 1U Indigo or FR1AV frame for up to 6 TANDEMs or other single height Crystal Vision modules
- 1U Desk top box for up to 2 TANDEMs or other single height Crystal Vision modules.

There are five types of rear connector available to cater for all frames and to provide system flexibility by allowing a mix between access to all connections and maximum module packing density. Both balanced and unbalanced audio connectors are catered for.



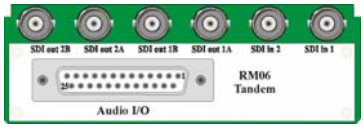
RM04

12 TANDEMs in 2U, 6 in 1U
Analogue / 110Ω digital audio
No 2nd SDI output



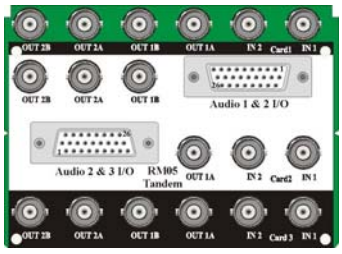
RM07

6 TANDEMs in 2U 3 in 1U
75Ω digital audio
No 2nd SDI output



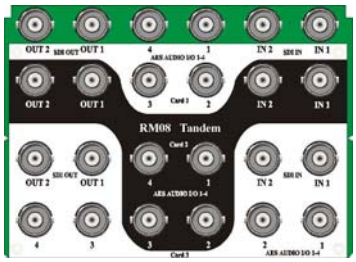
RM36

6 TANDEMs in 2U 3 in 1U
Analogue / 110Ω digital audio
2nd SDI output



RM05

9 TANDEMs in 2U
Analogue / 110Ω digital audio
2nd SDI output



RM08

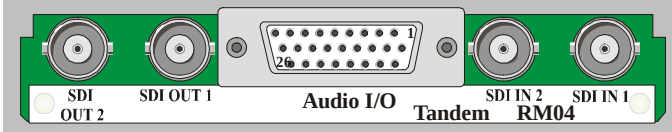
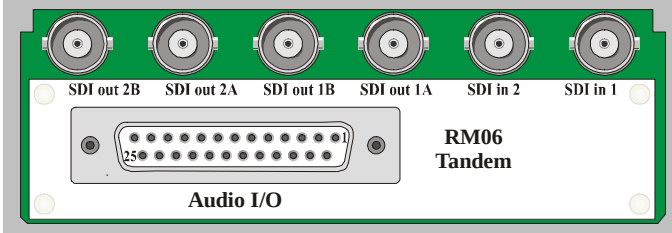
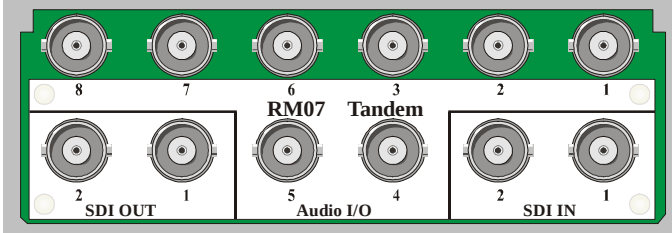
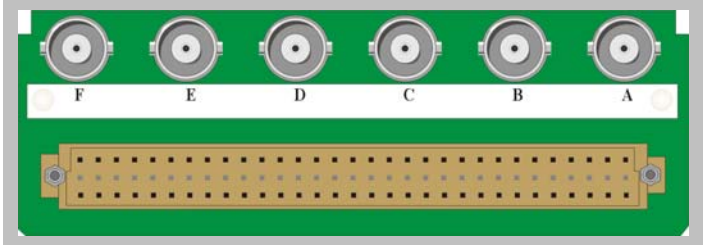
9 TANDEMs in 2U
75Ω digital audio
No 2nd audio or SDI output

The single-width rear connector achieves maximum card density with up to 12 TANDEM cards in a 2U frame, albeit at the expense of losing the second buffered SDI outputs. This solution also demands a high-density multiway connector for balanced digital audio I/O, but all connections, including GPIs and analogue preview monitoring are available.

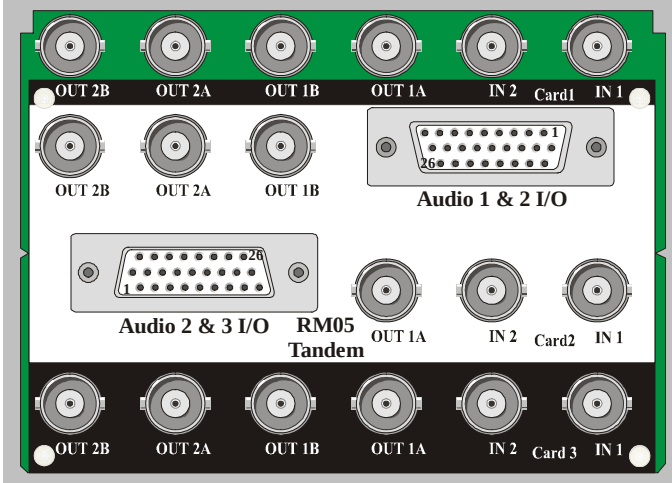
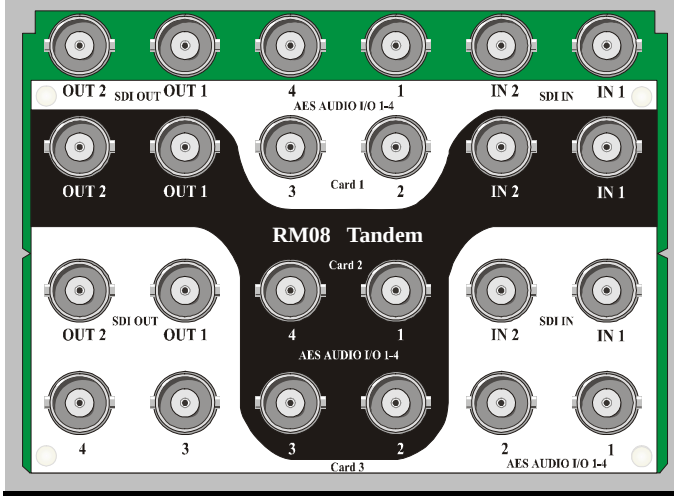
The loss of second SDI output can be avoided by using a taller rear module. A double-height single card rear module allows access to all connections at six cards per 2U frame and three cards per 1U frame. A special all-connection triple card rear module achieves nine cards per 2U frame.

There are also double-height single-card and quad-height triple-card rear modules available with BNCs for unbalanced *digital* audio. However, the double-height version does not have the second SDI output and the triple does not have the second digital audio outputs. Triple height modules only fit in the 2U frame

The available rear connector details are as follows:

Rear Connectors	Description
	**RM04** • 12 TANDEMs in 2U, 6 in 1U • 2nd SDI outputs not available • Balanced digital or 110Ω analogue audio • Audio monitoring bus and AES bus on Audio I/O connector • GPI lines available at frame remote connectors • All frame slots can be used
	**RM06** • 6 TANDEMs in 2U, 3 in 1U • All connections available • Balanced digital or 110Ω analogue audio • Audio monitoring bus and AES bus on frame remote connectors • GPI lines available at Audio I/O connector and frame remote connectors • Slots 1,3,5,7,9 and 11 used
	**RM07** • 6 TANDEMs in 2U, 3 in 1U • Only signal I/O available • 2nd SDI outputs not available • 75Ω unbalanced digital audio • Audio monitoring bus, AES bus and GPI lines available at the frame remote connectors • Slots 1,3,5,7,9 and 11 used
	**RM36** • 6 TANDEMs in 2U, 3 in 1U • All connections available • Balanced digital or 110Ω analogue audio • Audio monitoring bus and AES bus on frame remote connectors • GPI lines available at Audio I/O connector and frame remote connectors • Slots 1,3,5,7,9 and 11 used

Notes: The TANDEM card fits in the upper of the two slot positions for the RM06 RM07 and RM36. No card is fitted in the lower slot.

Rear Connectors	Description
	**RM05** • 9 TANDEMs in 2U frame • 3 TANDEMs per rear connector • All connections available • Balanced digital or 110Ω analogue audio • Audio monitoring bus, AES bus and GPI lines also available at frame remote connectors • Card 1 fits in slots 1, 5 and 9 • Card 2 fits in slots 2, 6 and 10 • Card 3 fits in slots 3, 7 and 11 • No card fits in 4, 8 or 12
	**RM08** • 9 TANDEMs in 2U frame • 3 TANDEMs per rear connector • Only signal I/O available • 75Ω unbalanced digital audio • Audio monitoring bus, AES bus and GPI lines available at frame remote connectors • Card 1 fits in slots 1, 5 and 9 • Card 2 fits in slots 2, 6 and 10 • Card 3 fits in slots 3, 7 and 11 • No card fits in 4, 8 or 12

Notes: Three TANDEM cards can be fitted in both the RM05 and RM08 rear modules. Card 1 fits in the top position, card 2 in the second from the top and card 3 fits in the third from the top. No card is fitted in the lowest slot position.

For details of fitting rear connectors please refer to the appropriate frame manual.

5.1 Rear module connections

The pin assignments on the 'D' connectors on the RM04, RM05 and RM36 are dependent on the sub-modules fitted.

RM04 pin-out

The **RM04** hi-density 26 way 'D' female socket as the following pin assignments for each fitted audio option card:

RM04

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
GND	GND	GND	GND	1
SD 1 1L+	SD 1 AES1+	SD 1 AES1a+	SD 1 AES1a	2
SD 1 1L-	SD 1 AES1-	SD 1 AES1a-	GND	3
SD 1 1R+	SD 1 AES1scrn	SD 1 AES1b+	SD 1 AES1b	4
SD 1 1R-	NC	SD 1 AES1b-	GND	5
SD 1 2L+	SD 1 AES2+	SD 1 AES2a+ OR AES ref+	SD 1 AES2a+ OR AES ref+	6
SD 1 2L-	SD 1 AES2-	SD 1 AES2a- OR AES ref-	SD 1 AES2a- OR AES ref-	7
SD 1 2R+	SD 1 AES2scrn	SD 1 AES2b+	SD 1 AES2b	8
SD 1 2R-	NC	SD 1 AES2b-	GND	18
GND	GND	GND	GND	9
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	14
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	15
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	10
SD 2 1R-	NC	SD 2 AES1b-	GND	11
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	16
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	17
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	12
SD 2 2R-	NC	SD 2 AES2b-	GND	13
Common Monitoring Connections				
GND				19
GND				20
Mon L+				21
Mon L-				22
GND				23
GND				24
Mon R+				25
Mon R-				26

The monitoring connections are the same for all fitted option cards.

The RMO4 rear module allows cards to be placed in all 12 frame slots.

Note: when DOP2-75 or DOP2-110 is used and unbalance AES reference (i.e. 75 ohm co-ax) or World Clock is used for AES ref+, ensure that AES ref- (pin 17 on 26 way D-type) is connected to GND.

RM06 pin-out

The **RM06** normal density 25 way 'D' female socket as the following pin assignments for each fitted audio option card:

RM06

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
GND	GND	GND	GND	4
SD 1 1L+	SD 1 AES1+	SD 1 AES1a+	SD 1 AES1a	18
SD 1 1L-	SD 1 AES1-	SD 1 AES1a-	GND	19
SD 1 1R+	SD 1 AES1scrn	SD 1 AES1b+	SD 1 AES1b	5
SD 1 1R-	NC	SD 1 AES1b-	GND	6
SD 1 2L+	SD 1 AES2+	SD 1 AES2a+ OR AES ref+	SD 1 AES2a+ OR AES ref+	20
SD 1 2L-	SD 1 AES2-	SD 1 AES2a- OR AES ref-	SD 1 AES2a- OR AES ref-	21
SD 1 2R+	SD 1 AES2scrn	SD 1 AES2b+	SD 1 AES2b	7
SD 1 2R-	NC	SD 1 AES2b-	GND	8
GND	GND	GND	GND	17
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	9
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	10
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	22
SD 2 1R-	NC	SD 2 AES1b-	GND	23
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	11
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	12
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	24
SD 2 2R-	NC	SD 2 AES2b-	GND	25
Common GPI Connections				
GND				17
GPI 1				1
GPI 3				2
GPI 5				3
GND				13
GPI 2				14
GPI 4				15
GPI 6				16

The monitoring connections are the same for all fitted option cards.

The RM06 and RM07 rear modules allow cards to be placed in frame slots 1,3,5,7,9 and 11.

RM05 pin-out

The **RM05** upper and lower hi-density 26 way 'D' female sockets are assigned pin-out for three TANDEM-110 cards for each fitted audio option card as follows:

RM05 – upper hi-density 26 way 'D' female connector – Card 1

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
GND	GND	GND	GND	1
SD 1 1L+	SD 1 AES1+	SD 1 AES1a+	SD 1 AES1a	2
SD 1 1L-	SD 1 AES1-	SD 1 AES1a-	GND	3
SD 1 1R+	SD 1 AES1scrn	SD 1 AES1b+	SD 1 AES1b	4
SD 1 1R-	NC	SD 1 AES1b-	GND	5
SD 1 2L+	SD 1 AES2+	SD 1 AES2a+ OR AES ref+	SD 1 AES2a+ OR AES ref+	6
SD 1 2L-	SD 1 AES2-	SD 1 AES2a- OR AES ref-	SD 1 AES2a- OR AES ref-	7
SD 1 2R+	SD 1 AES2scrn	SD 1 AES2b+	SD 1 AES2b	8
SD 1 2R-	NC	SD 1 AES2b-	GND	18
GND	GND	GND	GND	9
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	14
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	15
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	10
SD 2 1R-	NC	SD 2 AES1b-	GND	11
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	16
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	17
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	12
SD 2 2R-	NC	SD 2 AES2b-	GND	13

RM05 – lower hi-density 26 way 'D' female connector – Card 3

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
GND	GND	GND	GND	1
SD 1 1L+	SD 1 AES1+	SD 1 AES1a+	SD 1 AES1a	2
SD 1 1L-	SD 1 AES1-	SD 1 AES1a-	GND	3
SD 1 1R+	SD 1 AES1scrn	SD 1 AES1b+	SD 1 AES1b	4
SD 1 1R-	NC	SD 1 AES1b-	GND	5
SD 1 2L+	SD 1 AES2+	SD 1 AES2a+ OR AES ref+	SD 1 AES2a+ OR AES ref+	6
SD 1 2L-	SD 1 AES2-	SD 1 AES2a- OR AES ref-	SD 1 AES2a- OR AES ref-	7
SD 1 2R+	SD 1 AES2scrn	SD 1 AES2b+	SD 1 AES2b	8
SD 1 2R-	NC	SD 1 AES2b-	GND	18
GND	GND	GND	GND	9
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	14
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	15
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	10
SD 2 1R-	NC	SD 2 AES1b-	GND	11
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	16
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	17
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	12
SD 2 2R-	NC	SD 2 AES2b-	GND	13

The second TANDEM-110 card uses pins 19 to 26 of both the upper and lower hi-density 26 way 'D' female connectors.

RM05 – upper hi-density 26 way 'D' female connector – Card 2

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
SD 1 1L+	SD 1 AES1+	SD 1 AES1a+	SD 1 AES1a	19
SD 1 1L-	SD 1 AES1-	SD 1 AES1a-	GND	20
SD 1 1R+	SD 1 AES1scrn	SD 1 AES1b+	SD 1 AES1b	21
SD 1 1R-	NC	SD 1 AES1b-	GND	22
SD 1 2L+	SD 1 AES2+	SD 1 AES2a+ OR AES ref+	SD 1 AES2a+ OR AES ref+	23
SD 1 2L-	SD 1 AES2-	SD 1 AES2a- OR AES ref-	SD 1 AES2a- OR AES ref-	24
SD 1 2R+	SD 1 AES2scrn	SD 1 AES2b+	SD 1 AES2b	25
SD 1 2R-	NC	SD 1 AES2b-	GND	26

RM05 – lower hi-density 26 way 'D' female connector – Card 2

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	19
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	20
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	21
SD 2 1R-	NC	SD 2 AES1b-	GND	22
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	23
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	24
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	25
SD 2 2R-	NC	SD 2 AES2b-	GND	26

The RM05 and RM08 rear modules allow cards to be placed as follows: card 1 fits in slot 1, 5 and 9, card 2 fits in slots 2, 6 and 10 whilst card 3 fits in slots 3, 7 and 11. No cards are fitted in slot positions 4, 8 and 12.

RM07 BNC assignments

The eight Audio I/O BNCs are assigned functions as follows:

RM07 SDI 1				
Sub Board	BNC 1	BNC 2	BNC 3	BNC 4
DIP2	AES1 I/P	Not used	AES2 I/P	Not used
DOP2	AES1 O/P	AES1 O/P	AES2 O/P / Ref I/P	AES2 O/P

RM07 SDI 2				
Sub Board	BNC 5	BNC 6	BNC 7	BNC 8
DIP2	AES1 I/P	Not used	AES2 I/P	Not used
DOP2	AES1 O/P	AES1 O/P	AES2 O/P / Ref I/P	AES2 O/P

Note: When DOP2 is used, BNC 3 can be used for the reference input for side 1 and BNC 7 can be used for the reference input for side 2.

RM08 BNC assignments

The four AES Audio I/O BNCs at the top of the RM08 are assigned functions as follows:

RM08 SDI 1		
Sub Board	BNC 1	BNC 2
DIP2	AES1 I/P	AES2 I/P
DOP2	AES1 O/P	AES2 O/P / Ref I/P

RM08 SDI 2		
Sub Board	BNC 3	BNC 4
DIP2	AES1 I/P	AES2 I/P
DOP2	AES1 O/P	AES2 O/P / Ref I/P

Note: When DOP2 is used, BNC 2 can be used for the reference input for side 1 and BNC 4 can be used for the reference input for side 2.

RM36 BNC assignments

The RM36 is an “easywire” alternative to the RM06. Both rear modules share common video connections but the RM36 uses a DIN 41612 connector in place of the D-type connector found on the RM06.

BNC	Connection
A	SDI 1
B	SDI 2
C	SDI OUT 1A
D	SDI OUT 1B
E	SDI OUT 2A
F	SDI OUT 2B

RM36 Pin-out

DIN41612 pin-out.

AIP2/AOP2	DIP2/DIP2RS	DOP2-110	DOP2-75	Pin-out
SD 1 1L+	**SD 1 AES1+**	**SD 1 AES1a+**	**SD 1 AES1a**	c5
SD 1 1L-	**SD 1 AES1-**	**SD 1 AES1a-**	**GND**	c6
SD 1 1R+	**SD 1 AES1scrn**	**SD 1 AES1b+**	**SD 1 AES1b**	c8
SD 1 1R-	**NC**	**SD 1 AES1b-**	**GND**	c9
SD 1 2L+	**SD 1 AES2+**	**SD 1 AES2a+ OR AES ref+**	**SD 1 AES2a+ OR AES ref+**	c11
SD 1 2L-	**SD 1 AES2-**	**SD 1 AES2a- OR AES ref-**	**SD 1 AES2a- OR AES ref-**	c12
SD 1 2R+	**SD 1 AES2scrn**	**SD 1 AES2b+**	**SD 1 AES2b**	c14
SD 1 2R-	**NC**	**SD 1 AES2b-**	**GND**	c15
GND	**GND**	**GND**	**GND**	c17
SD 2 1L+	**SD 2 AES1+**	**SD 2 AES1a+**	**SD 2 AES1a**	c19
SD 2 1L-	**SD 2 AES1-**	**SD 2 AES1a-**	**GND**	c20
SD 2 1R+	**SD 2 AES1scrn**	**SD 2 AES1b+**	**SD 2 AES1b**	c22
SD 2 1R-	**NC**	**SD 2 AES1b-**	**GND**	c23
SD 2 2L+	**SD 2 AES2+**	**SD 2 AES2a+ OR AES ref+**	**SD 2 AES2a+ OR AES ref+**	c25
SD 2 2L-	**SD 2 AES2-**	**SD 2 AES2a- OR AES ref-**	**SD 2 AES2a- OR AES ref-**	c26
SD 2 2R+	**SD 2 AES2scrn**	**SD 2 AES2b+**	**SD 2 AES2b**	c28
SD 2 2R-	**NC**	**SD 2 AES2b-**	**GND**	c29

Common Connections	
Mon L+	a2
Mon L-	a3
Mon R+	a5
Mon R-	a6
GPI 1	a16
GPI 2	a17
GPI 3	a18
GPI 4	a19
GPI 5	a20
GPI 6	a22
Ground	c4, c7, c10, c13, c16, c17, c18, c21, c24, c27, c30, a1, a4, a7,
No Connection	c1-3, c31-32, a8-15, a22-32

Note: Use RM36 with DIN41612 female connector with solder lugs, which can be purchased from Harting (part number 09-03-264-6823).

5.2 Signal earthing

Digital audio inputs are designed to have floating 'signal low' connections for cable screens, with internal RC networks connected between cable screens and chassis ground. This helps reduce the risk of high earth currents when AC power is induced into the cable, or when an offset voltage exists between the product chassis and the local signal source ground or chassis.

The internal RC network components fitted in the DIP2 and DIP2RS input cards are as follows:

Component	Signal low (screen)	Chassis ground
1µF capacitor + 10K ohm resistor	AES1 – , AES2 –	PCB GND

Notes:

Video and audio output cable screens are normally hard-wired directly to local chassis ground.

5.3 Using GPI outputs

GPO 5 and GPO 6 can be assigned from Statesman and/or the card-edge controls to signal an error condition when loss of video, audio or AES reference occurs.

GPO 5 and GPO 6 may be assigned to signal paths as follows:

GPO 5 assignment	GPO 6 assignment
SDI 1 / De-embedder A / Embedder C	SDI 2 / De-embedder B / Embedder D

A GPO will be asserted low if any of the following conditions arise:

- loss of SDI input
- loss of selected embedded audio group input if de-embedder enabled
- loss of AES 1 input to DIP2 or DIP2-RS card
- loss of AES 2 input to DIP2 or DIP2-RS card if that error condition in enabled by Statesman, or set to 'flag' by card-edge control - ignored if box not ticked, or set to 'mask', respectively.
- loss of AES reference input to DOP2-75 or DOP2-110 if that error condition in enabled by Statesman, or set to 'flag' by card-edge control - ignored if box not ticked, or set to 'mask', respectively
- loss of 'active audio content' if that error condition in enabled by Statesman, or set to 'flag' by card-edge control - ignored if box not ticked, or set to 'mask', respectively

Loss of active audio content or silence occurs when audio peaks are sustained at below 30 VU / -50 dBFS for a period longer than the Silence Detect Delay.

Note: Values for Silence Detect Delay for both sides start at 1.5s and then in increments of 8s from 8s to 120s

GPI Presets

With GPI control enabled, remote switches can be used to recall any of the 16 stored preset configurations. The GPI lines are normally pulled up on-board to +5V via 2k2 ohm resistor and can be used with closed-contact switches or +5V to +24V logic levels.

Each slot has an associated set of GPI connections for remote control and external status outputs on the frame rear-panel remote connectors. For convenience, GPI lines are associated with reference codes ‘a’ to ‘f’ in the connector pin-out tables for each frame.

The following table shows how the four GPI lines 'a' to 'd' are used as a four-bit binary code to select up to sixteen TANDEM-110 presets.

GPI Functions	Op=open, Cl=closed (connect to ground)															
Pre-set	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
'a'	Op	Cl	Op	Cl	Op	Cl	Op	Cl	Op	Cl	Op	Cl	Op	Cl	Op	Cl
'b'	Op	Op	Cl	Cl	Op	Op	Cl	Cl	Op	Op	Cl	Cl	Op	Op	Cl	Cl
'c'	Op	Op	Op	Op	Cl	Cl	Cl	Cl	Op	Op	Op	Op	Cl	Cl	Cl	Cl
'd'	Op	Op	Op	Op	Op	Op	Op	Op	Cl	Cl	Cl	Cl	Cl	Cl	Cl	Cl

2U Indigo and FR2AV GPI Connections

GPI lines 1 to 6 of each TANDEM card are brought to one of the four remote connectors at the rear of the FR2AV frame as follows:

Slot	GPI 1		GPI 2		GPI 3		GPI 4		GPI 5		GPI 6	
no.	**pin**	**rem**	**pin**	**rem**	**pin**	**rem**	**pin**	**rem**	**pin**	**rem**	**pin**	**rem**
1	8	1	9	1	18	1	26	1	19	2	20	2
2	7	1	16	1	17	1	25	1	10	2	11	2
3	8	3	9	3	18	3	26	3	19	4	20	4
4	7	3	16	3	17	3	25	3	10	4	11	4
5	5	1	6	1	15	1	24	1	1	2	2	2
6	4	1	14	1	13	1	23	1	3	2	4	2
7	5	3	6	3	15	3	24	3	1	4	2	4
8	4	3	14	3	13	3	23	3	3	4	4	4
9	3	1	12	1	22	1	21	1	12	2	13	2
10	10	1	11	1	19	1	20	1	21	2	22	2
11	3	3	12	3	22	3	21	3	12	4	13	4
12	10	3	11	3	19	3	20	3	21	4	22	4

Note: Remote (rem) 1 and Remote (rem) 3 are 26 way high density 'D' type female sockets and frame ground is pin 2 in each case. Remote (rem) 2 and Remote (rem) 4 are 26 way high density 'D' type male plugs and frame ground is pin 6 in each case.

.1U Indigo and FR1AV GPI connections

GPI lines 'a' to 'f' of each TANDEM card connect to one of two rear remote connectors as follows:

Slot no.	'a' pin	'b' pin	'c' pin	'd' pin	'e' pin	'f' pin
1	8 (1)	9 (1)	18 (1)	26 (1)	19 (2)	20 (2)
2	7 (1)	16 (1)	17 (1)	25 (1)	10 (2)	11 (2)
3	5 (1)	6 (1)	15 (1)	24 (1)	1 (2)	2 (2)
4	4 (1)	14 (1)	13 (1)	23 (1)	3 (2)	4 (2)
5	3 (1)	12 (1)	22 (1)	21 (1)	12 (2)	13 (2)
6	10 (1)	11 (1)	19 (1)	20 (1)	21 (2)	22 (2)

Table shows pin number (Remote number)

Notes: Remote 1: 26 way high density D-type socket. GND is pin 2 and +5V @500mA is pin 1.
Remote 2: 26 way high density D-type plug. GND is pin 6 and +5V @500mA is pin 15.

Desktop box GPI connections

GPI lines ‘a’ to ‘f’ of each TANDEM card connect to the rear remote connector as follows:

Slot no.	‘a’ pin	‘b’ pin	‘c’ pin	‘d’ pin	‘e’ pin	‘f’ pin
1	1	2	3	4	5	6
2	9	10	11	12	13	14

Note: Remote connector is 15 way normal density D-type socket. GND is pin 15.

5.4 Monitoring Audio Outputs

The monitoring signals available at the Remote 1 and Remote 3 connectors at the rear of the frame are dependent on the frame and the rear modules used:

2U Indigo and FR2AV Frame

RM36/RM07 slots	RM05/RM08 slots	REMOTE 1 pins Analogue: L+, L-, R+, R-	REMOTE 3 pins Analogue: L+, L- R+, R-
1		7, 16, 17, 25	
3	**1, 2, 3**		7, 16, 17, 25
5		4, 14, 13, 23	
7	**5, 6, 7**		4, 14, 13, 23
9		10, 11, 19, 20	
11	**9, 10, 11**		10, 11, 12, 20
GND		2	2

Analogue and (AES/EBU) monitoring

1U Indigo and FR1AV Frame

RM36/RM07 slots	REMOTE 1 pins Analogue: L+, L-, R+, R-
1	7, 16, 17, 25
3	4, 14, 13, 23
5	10, 11, 19, 20
GND	2

Analogue monitoring

Desktop box

RM36/RM07 slots	REMOTE 1 pins Analogue: L+, L-, R+, R-
1	9, 10, 11, 12
GND	2

Analogue monitoring

The RM04 rear module provides access to all GPIs and audio monitoring signals. The Remote 1 and 3 frame rear connectors cannot be used to access TANDEM module audio monitoring connections when the RM04 rear connector is used.

When using the triple card rear modules RM05 and RM08 in the FR2AV, only one TANDEM card should be selected to output monitoring analogue audio at any one time. Multiple audio signals could cause the audio to be attenuated and possibly distorted. Select Audio Bus ON for the required TANDEM output, and Audio Bus OFF for the other two TANDEM cards sharing the same rear module and monitoring outputs.

Using monitoring outputs

TANDEM-110 has a dedicated audio monitor router that monitors the connection between each option card and the main router. One output is converted to a balanced stereo signal and is fed to the card edge headphone socket. The same output can also be made available at the rear connector by enabling the 'Monitor Bus'. The following stereo audio signal sources may be selected:

- 8 router feeds to output sub-PCB cards; I1+2, I3+4, J1+2 and J3+4, if available
- 8 direct input sub-PCB card outputs; G1+2, G3+4, H1+2 and H3+4, if available

The analogue output is a four wire connection; each wire carries Left+, Left-, Right+, and Right-, which form two balanced line drivers. The '+' and '-' outputs each being true and complimentary (inverted) drives from each signal source.

If enabled the analogue monitoring audio four-wire circuit is connected to the 26 way high density connectors or the rear extension of the rack frame, and also to extra pins on the RM04.

A number of TANDEM-110, TANDEM-200 and Demon modules may be wired to a shared pair of active loudspeakers. Audio levels to be monitored via the analogue bus or using headphones should not exceed +10 VU (-8 dBFS) or overload distortion may occur.

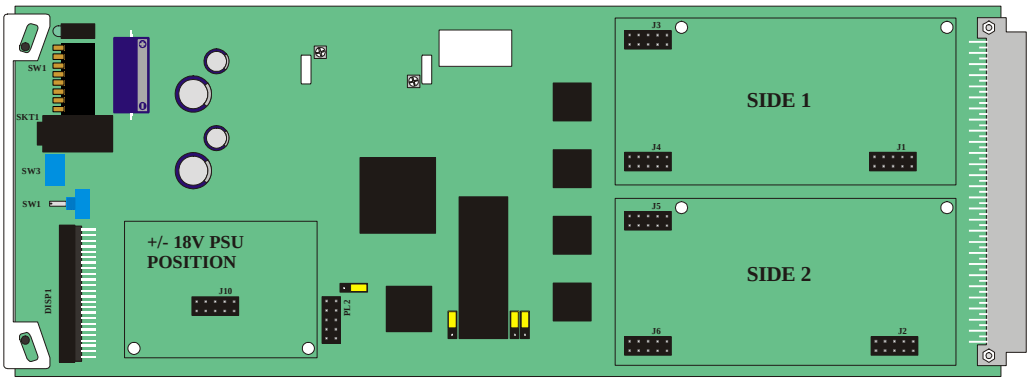
When 'OFF' is selected, the Bus goes high impedance. Should two or more TANDEMs be selected as 'Bus ON' when there are multiple TANDEMs sharing common active loudspeakers, the audio will be the sum of all channels set to ON. In this case the output is likely to suffer distortion at high signal levels.

TAD202 has a dedicated analogue audio bus output, which can NOT be switched to a high impedance state. TAD202 can not share the same analogue bus connections as TANDEM-110, TANDEM-200, & Demon.

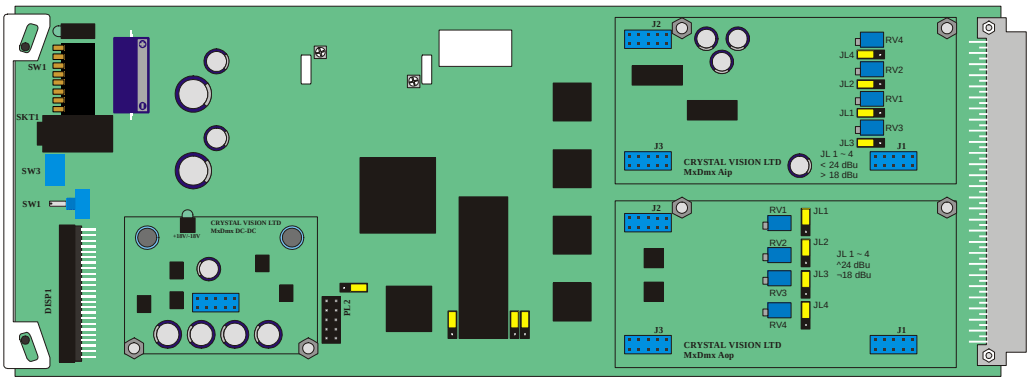
5.5 Fitting audio sub-modules

Each TANDEM card can take up to two of the five available audio I/O sub-modules. Each sub-module plugs via headers on the main card and is retained by screws and nuts. If one or more analogue audio sub-modules are used an additional +/- 18V DC PSU sub-module is also fitted.

As of late 2006 the full range of I/O sub PCBs were supplemented with the new HD range of I/O sub PCBs. Both ranges of sub PCB are fully compatible and can be mixed in use on the TANDEM standard definition range.



TANDEM-110 card showing audio sub-module and PSU sub-module positions



TANDEM-110 card showing analogue audio sub-modules and PSU sub-module fitted

To fit a sub-module, proceed as follows:

- ensure that all static electricity precautions have been taken
- fit two module retaining screws (3x10mm) from below the main PCB, and add a nylon spacer (3x3mm) on top of the TANDEM PCB to each screw for each sub-module location – hold screws firmly in place
- offer up the chosen sub-module to its intended position on the TANDEM main card
- check that the orientation is correct and that retaining holes and header sockets line up with the corresponding holes and header plugs on the main card
- push the sub-module in place firmly taking care not to bend any pins
- fit the retaining fibre washers, internal serrated washers and nuts to the two retaining screws

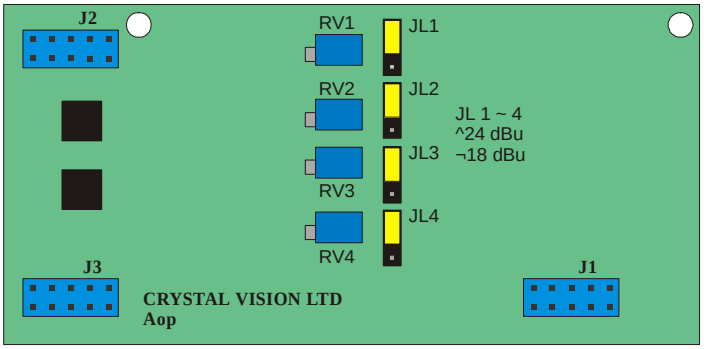
Removal is the reverse of the above procedure.

Notes: All items are supplied with the TANDEM module.
All sub-modules must be fitted with the component side uppermost and flat (track side) down, facing the TANDEM PCB. Fitting sub-modules with the component face downwards may result in fatal damage.
To check which modules are fitted when a TANDEM is already in place in its frame, use the option status check (menu 5) at the card edge or the active control panel status menu or the Statesman status screen.

5.6 Sub-module link settings

AOP2

The analogue audio output module provides 2 stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals. Link jumpers are provided to allow 0dBFS to be set to +18dBu or +24 dBu. The variable adjustments on the card are set at the factory and should not require re-adjustment. Set channel 1 with JL1/RV1, channel 2 with JL2/RV2, channel 3 with JL3/RV3 and channel 4 with JL4/RV4.

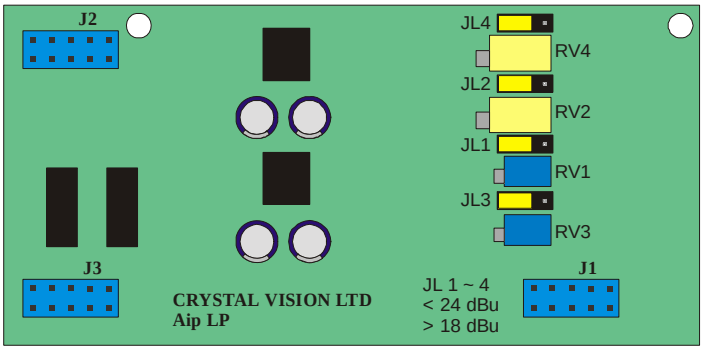


AOP2

Selectable jumper links are provided to change input and reference terminations and pre-set levels, depending on sub-module features.

AIP2

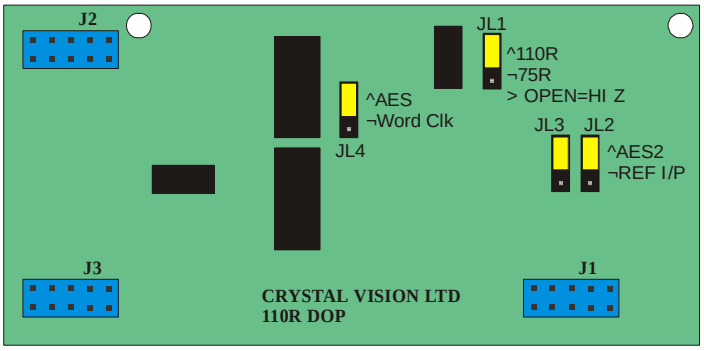
The AIP2 is identified on the silkscreen as the AIP2-LP to indicate its lower power consumption. The analogue audio input module provides 2 stereo pairs or four mono signals that may be used as a source in subsequent embedding. Link jumpers are provided to allow 0dBFS to be set to +18dBu (rearwards, towards J1) or +24dBu (forwards, towards J2/3). The variable adjustments on the card are set at the factory and should not require re-adjustment. Set channel 1 with JL4/RV4, channel 2 with JL2/RV2, channel 3 with JL1/RV1 and channel 4 with JL3/RV3. *Take care to note the adjustment and channel numbering on this sub-board.*



AIP2

DOP2-110

This digital audio output module provides 2 110 Ohm AES stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals.

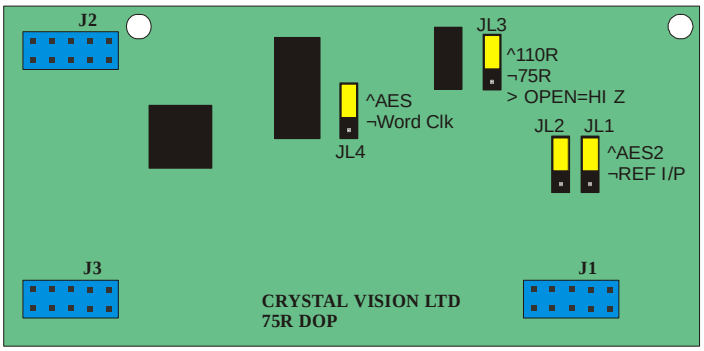


DOP2-110

In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06 and RM36 rear modules, in place of a 2nd buffered output. The reference may be selected between AES reference or word clock with JL4. Use JL3 and JL4 together to select between AES2 (2nd buffered output – upper two pins) or REF I/P (external reference – lower 2 pins). Link jumper JL1 is provided to select the external reference input, which is always fed via a 'D' connector, between 110 Ohm (upper 2 pins), HiZ (balanced – centre pin only) or 75 Ohm (unbalanced – lower 2 pins).

DOP2-75

This digital audio output module provides 2 75 Ohm AES stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals.

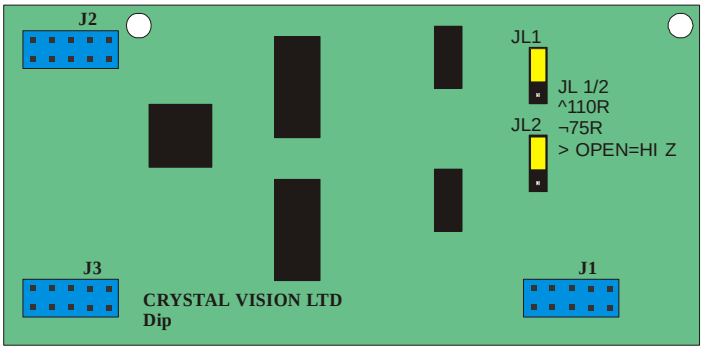


DOP2-75

In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06 and RM36 rear modules, in place of a 2nd buffered output. The reference may be selected between AES reference or word clock with JL4. Use JL1 and JL2 together to select between AES2 (2nd buffered output – upper 2 pins) or REF I/P (external reference – lower 2 pins). Link jumper JL3 is provided to select the external reference input, which is always fed via a 'D' connector, between 110 Ohm (upper 2 pins), HiZ (balanced – centre pin only) or 75 Ohm (unbalanced – lower 2 pins).

DIP2

This digital audio input module provides 2 AES stereo pairs or four mono channels that may be used as sources in subsequent embedding.

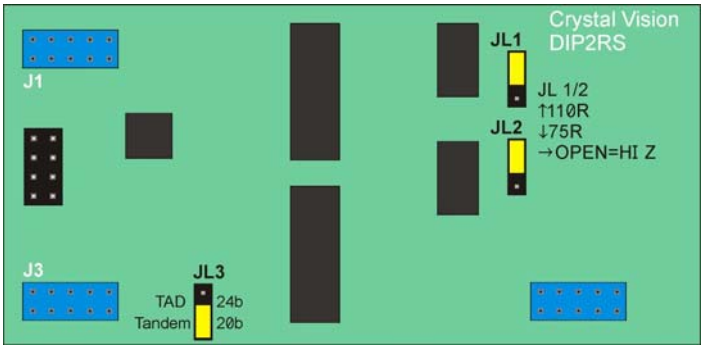


DIP2

Link jumpers are provided to select between 110 Ohm (upper 2 pins) , HiZ (balanced – centre pins only) or 75 Ohm (unbalanced – lower 2 pins).

DIP2RS

This digital audio input module provides 2 AES stereo pairs or four mono channels with an integral re-sampler for use when the AES input is either asynchronous, or at a sample rate other than 48 kHz.



DIP2RS

The sample rate inputs can work with signals from less than 30 kHz to 108 kHz. It is particularly useful for asynchronous 48 kHz inputs, and other sample rate inputs such as 44.1 kHz & 96 kHz.

The signal output from the DIP2-RS to the TANDEM is at 48 kHz derived from the video content of the SDI signal into which it is to be embedded.

Because of the processing of the audio waveform, error words indicated by V bit set high are ignored. Occasional errors marked by V bit high such as would be the case with a noisy or too long AES input path, are masked out by the processing.

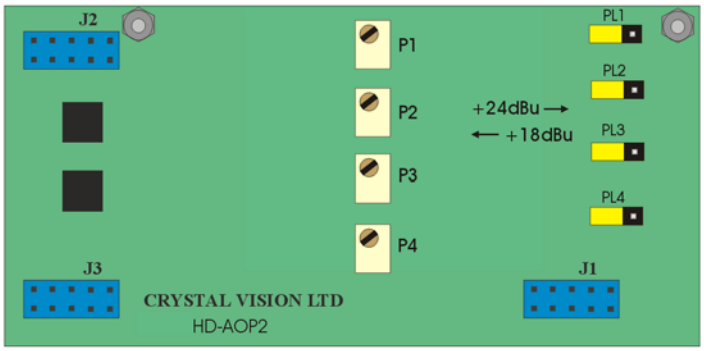
If the V bit is consistently high, to indicate continuous error states, or to indicate non audio data, then the processor will give a silent output. All other cards, except RS4, pass audio data unaltered even when V bit is set or held high.

Link jumpers are provided to select between 110 Ohm (upper 2 pins), HiZ (balanced – centre pins only) or 75 Ohm (unbalanced – lower 2 pins). Jumper JL3 must be in the TANDEM position.

Notes: Balanced outputs require the use of rear modules with a 'D' type connector and unbalanced outputs are for use with BNCs.
HiZ is achieved by removing termination jumpers – they can be parked for safe keeping by replacing them using only one pin.

HD-AOP2

The analogue audio output module provides two stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals. Link jumpers are provided to allow 0dBFS to be set to +18dBu or +24 dBu. The variable adjustments on the card are set at the factory and should not require re-adjustment. Set channel 1 with PL1/P1, channel 2 with PL2/P2, channel 3 with PL3/P3 and channel 4 with PL4/P4.

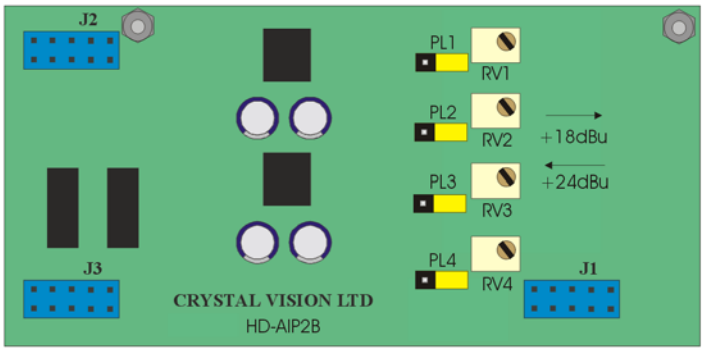


HD-AOP2

Selectable jumper links are provided to change input and reference terminations and pre-set levels, depending on sub-module features.

HD-AIP2

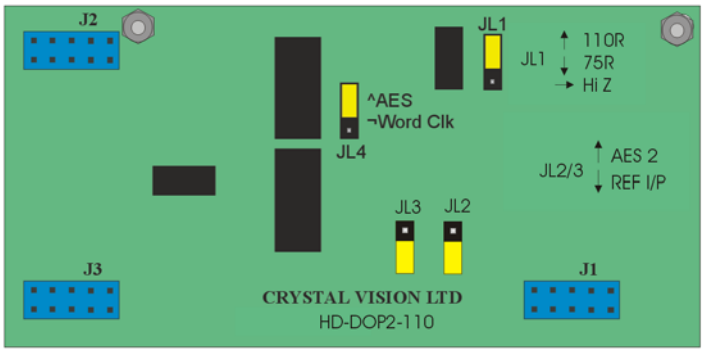
The analogue audio input module provides two stereo pairs or four mono signals that may be used as a source in subsequent embedding. Link jumpers are provided to allow 0dBFS to be set to +18dBu (rearwards, towards J1) or +24dBu (forwards, towards J2/3). The variable adjustments on the card are set at the factory and should not require re-adjustment. Set channel 1 with PL2/RV2, channel 2 with PL1/RV1, channel 3 with PL4/RV4 and channel 4 with PL3/RV3. *Take care to note the adjustment and channel numbering on this sub-board.*



HD-AIP2

HD-DOP2-110

This digital audio output module provides two 110 Ohm AES stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals.

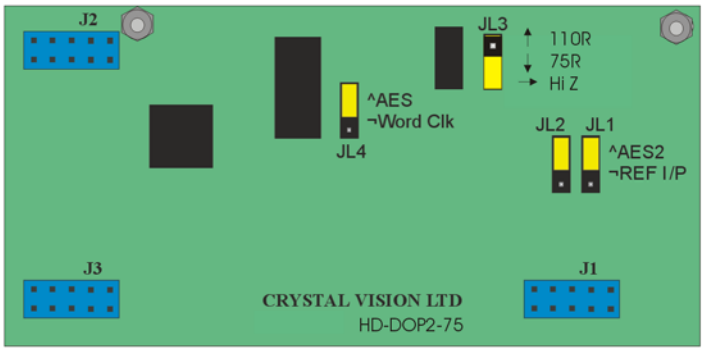


HD-DOP2-110

In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06 and RM36 rear modules, in place of a 2nd buffered output. The reference may be selected between AES reference or word clock with JL4. Use JL2 and JL3 together to select between AES2 (2nd buffered output – upper two pins) or REF I/P (external reference – lower 2 pins). Link jumper JL1 is provided to select the external reference input, which is always fed via a 'D' connector, between 110 Ohm (upper 2 pins), HiZ (balanced – centre pin only) or 75 Ohm (unbalanced – lower 2 pins).

HD-DOP2-75

This digital audio output module provides two 75 Ohm AES stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals.

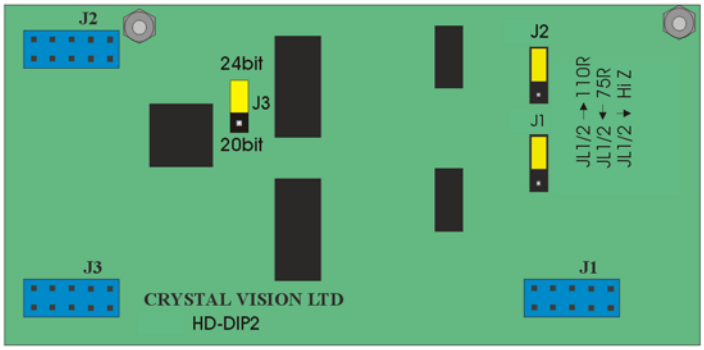


HD-DOP2-75

In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06 and RM36 rear modules, in place of a 2nd buffered output. The reference may be selected between AES reference or word clock with JL4. Use JL1 and JL2 together to select between AES2 (2nd buffered output – upper 2 pins) or REF I/P (external reference – lower 2 pins). Link jumper JL3 is provided to select the external reference input, which is always fed via a 'D' connector, between 110 Ohm (upper 2 pins), HiZ (balanced – centre pin only) or 75 Ohm (unbalanced – lower 2 pins).

HD-DIP2

This digital audio input module provides two AES stereo pairs or four mono channels that may be used as sources in subsequent embedding.

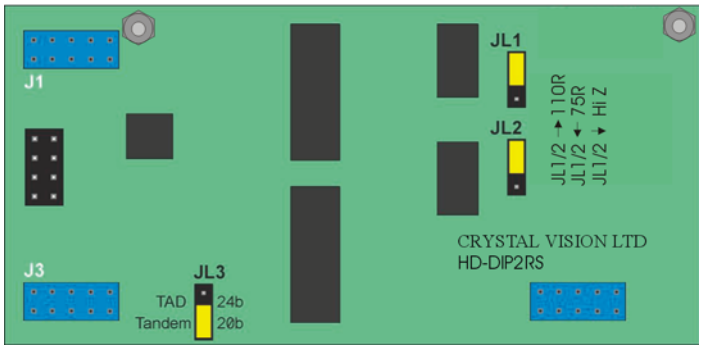


HD-DIP2

Link jumpers are provided to select between 110 Ohm (upper 2 pins) , HiZ (balanced – centre pins only) or 75 Ohm (unbalanced – lower 2 pins). **J3 must be selected for 20-bit.**

HD-DIP2RS

This digital audio input module provides two AES stereo pairs or four mono channels with an integral re-sampler for use when the AES input is either asynchronous, or at a sample rate other than 48 kHz.



HD-DIP2RS

The sample rate inputs can work with signals from less than 30 kHz to 108 kHz. It is particularly useful for asynchronous 48 kHz inputs, and other sample rate inputs such as 44.1 kHz and 96 kHz.

The signal output from the DIP2-RS to the TANDEM-110 is at 48 kHz derived from the video content of the SDI signal into which it is to be embedded.

Because of the processing of the audio waveform, error words indicated by V-bit set high are ignored. Occasional errors marked by V-bit high such as would be the case with a noisy or too long AES input path, are masked out by the processing.

If the V-bit is consistently high, to indicate continuous error states, or to indicate non-audio data, then the processor will give a silent output. All other cards, except RS4, pass audio data unaltered even when V bit is set or held high.

Link jumpers are provided to select between 110 Ohm (upper two pins), HiZ (balanced – centre pins only) or 75 Ohm (unbalanced – lower two pins).

Notes: In general, balanced outputs require the use of rear modules with a D-type connector and unbalanced outputs are for use with BNCs.
HiZ is achieved by removing termination jumpers – they can be parked for safe keeping by replacing them using only one pin.

6 Problem solving

Trouble shooting may be performed by using the card edge or remote status panel displays. In addition audio monitoring of input and output busses is provided from both the card edge headphone socket and the multi-way socket on the RM04 rear connector.

Card edge status LEDs

Board edge LEDs provide status reporting and may be useful when fault finding.

The following table summarises the card edge LED functions and colours:

Power rail	Led Colour	Description
+3V	Green	+3 volt power supply rail OK
+5V	Green	+5 volt power supply rail OK

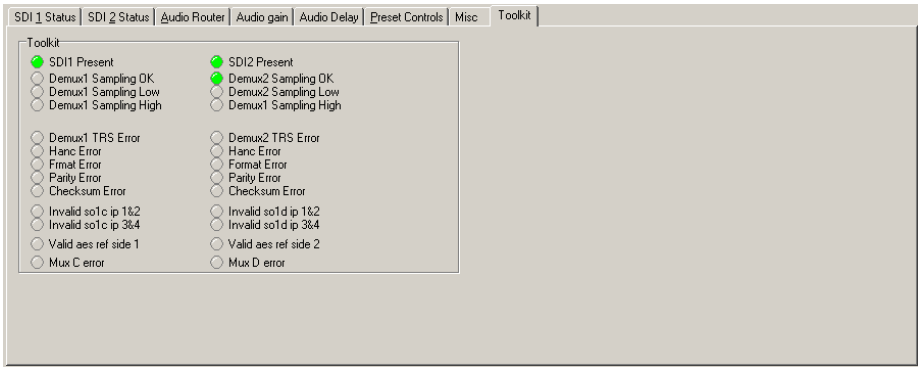
Card edge error messages

If option cards are fitted incorrectly, the following error messages will appear

Code	Meaning
wrong ip L	Left sub-pcb (input type) is incorrect
wrong op R	Right sub-pcb (output type) is incorrect
no ip pcb	No input sub-pcb fitted
no op pcb	No output sub-pcb fitted
PCBs swap!	Input and output pcbs have been swapped L<->R
AIP not B	AIP2 card is the wrong format
Switches?	More than one menu switch in the DOWN position
No DC-DC	No dc-dc converter fitted (when analogue i/o)

Statesman error reporting

The Statesman Toolkit, which is accessible from the Toolkit tab, provides comprehensive error reporting and status information.



TANDEM-110 Toolkit

Toolkit provides details of the general status of the de-embedder, embedder, and HANC space data which includes the following:

- 'low / high sample rates' indicate incorrect number of incoming audio samples beyond manageable error rates [both high+low = wildly varying sample rate]
- 'hanc error' indicates insufficient spare space in HANC to insert further embedded audio, or HANC space is filled with unspecified signals, such as 'blank' space that is not true black [e.g. analogue blanking prior to A-to-D conversion without true digital blanking applied]
- 'format' error refers to errors in the format or structure of the embedded audio data packets
- 'invalid' digital audio signals fed to the "C" & "D" embedders are indicated by the "V" bits set to logic 'high'
- "V" bit high is set by the AES standard as indicating 'invalid' audio data, or possibly non-linear audio data, such as compressed multichannel audio data which can not be directly converted back to audible signals
- Mux "C" or Mux "D" errors indicate non operational status for that embedder, such as lack of HANC space [HANC blanking may cure that], or some other error settings or application error

Sample problems and their solution:

The Power OK LEDs are not illuminated

Check that the frame PSU is functioning – refer to the appropriate frame manual for detailed information

There is no video output

Check that valid SDI inputs are present and that any cabling is intact

There are no audio outputs

Check for audio signals using headphones connected to the front PCB mini jack

Check that functioning analogue or digital audio output cards are fitted securely

Check that any audio cabling is intact

Check that audio channel levels have not been inadvertently set to zero gain

The digital audio output produces clicks and pops in downstream equipment

Check that an appropriate external reference synchronous with both the incoming SDI video and the system audio clock is connected

Check that the downstream equipment is properly referenced to the system audio reference

The digital audio is not timed with the video (lip sync error)

Check the digital audio delay for each TANDEM channel

Audio phase is incorrect

Check digital audio phase inversion is not selected, or if not set, then select it

The rear audio monitoring does not work

Check that the rear audio BUS is set to ON

Audio has been selected for embedding but fails to be inserted

Check that there is sufficient valid HANC space for the insertion to take place

Refer to the Data Packet Management chapter for further help

The card no longer responds to Statesman/front panel control

Check that the card is seated correctly and that the Power OK LED is lit

Check that the Comms LED in an Indigo frame flashes when Statesman communication control is attempted

Check any active control panel/Statesman cabling

Check if the control panel/Statesman can control another card in the same rack

If necessary re-set the card

Statesman settings change unexpectedly

Active control panel or card edge control settings may have overridden Statesman settings if they were changed more recently

Card edge settings have changed unexpectedly

Statesman or active control panel settings may have overridden card edge control settings if they were changed more recently

Active control panel settings change unexpectedly

Statesman or card edge control settings may have overridden control panel settings if they were changed more recently

Re-setting the card

If required, the card may be reset by simply removing the rack power and re-applying power after a few seconds or by removing the card from the rack re-inserting the card. It is safe to re-insert the card whilst the rack is powered.

Default setting may be re-loaded into the card if required – see the Card edge chapter, section 5.2.

Card edge trouble shooting menus

The SEL hex switch provides access to a range of additional status displays when MENU DIL lever seven is (ON) DOWN and all others are all OFF (UP).

The status reports have two formats. If possible the status for each TANDEM-110 side function is shown in one menu display. If there is insufficient room in the display for both sides, two SEL menus are used. A couple of examples will illustrate the formats used.

The Demux Input Status for side 1 (SDI 1) is shown on the card edge display in the form A=n_1234dO. A second menu shows the status of SDI 2. In this case the codes used are as follows ‘n’ is the Audio Group selected, ‘1234’ are the available groups, ‘d’ indicates that at least one group is marked for deletion and ‘O’ indicates the presence of ‘other’ typically non linear data embedded in the HANC space. A dash ‘-’ in place of one of the Audio Groups indicates that it is not present and the ‘_’ underscore character simply means a single character space in the display.

The Status of the Demux Sample Rate (DSR) is shown in the form DxCs_xx_yy, where ‘xx’ represents the DSR status of SDI1 and ‘yy’ represents the DSR status of SDI2. For example when DxSr_Ok_Ok is displayed, the first Ok refers to SDI1 DSR and the second Ok refers to the DSR for SDI2.

The following table explains some of the main codes used in the trouble shooting menus:

Code	Meaning	Comments
A	SDI 1 Demux Input	
B	SDI 2 Demux Input	
C	SDI 1 Mux Output	
D	SDI 2 Mux Output	
n_1234	Audio Group selected and Audio Groups present	Example: A=1_1234, Audio Group 1 selected and Audio Groups 1 – 4 present on side 1
-	No embedded audio for group indicated	Example A=1_12 – 4 : no embedded audio in group 3 on side 1
na	Not available	Used to show status cannot be shown since the required input is not present
d	Embedded audio Marked for Deletion	Audio data is marked for deletion either by TANDEM-200 or by upstream equipment. Example A=1_1234d:
no INP	No SDI input	Example A=__no INP, no SDI input on side 1
ni	No SDI input	Used in some menus – see further tables
O	Other embedded data present in HANC space	Other data include SMPTE-291M format data Example: A=1_1234_O, Other data detected in one or more Audio Groups
Ok	Parameter within normal operating range	Example: DxSr_Ok_Ok, Demux Sample Rate has correct number of samples per TV frame sequence for both SDI1 and SDI2
Er/Err	Erroneous values	Example: Mx_Err, Multiplex (Embed) error

The Demux Input status-only display is summarised below:

SEL No.	Display	Audio input status examples and comments
0	A=n_1234dO	SDI1 Demux Status, where n is input Audio Group Selected Example: A=2_1-34_O, Audio Group 2 selected and Audio Groups 1, 2 and 4 present on side 1, Other data present
1	B=n_1234dO	SDI2 Demux Status, where n is input Audio Group Selected Example: B=__no INP, no SDI input on side 2
2	DxSr_xx_yy Codes: Ok, Lo, Hi, Wd, na, ni	SDI1 & SDI2 Demux Sample Rates. Ok – correct number of samples per TV frame sequence Lo – sample rate too low Hi – sample rate too high Wd – wild sample rate fluctuation Example: DxSr_na_Ok, No embedded audio in SDI 1 input, SDI2 Sample Rate normal
3	DxCs_xx_yy Codes: Ok, Er, na, ni	SDI1 & SDI2 Demux Checksum Status. Ok – checksum correct Example: DxCs_Ok_Er, SDI1 correct, but SDI2 has a checksum error as a result of corrupted data inside an audio block, or checksum value.
4	DxPy_xx_yy Codes: Ok, Er, na, ni	SDI1 & SDI2 Demux Parity Status. Ok – parity correct Example: DxPy_Er_Ok, SDI2 correct but SDI1 has corrupted data inside the embedded audio block. This may result in an incorrect parity value at the end of each sample.
5	DxCF_xx_yy Codes: Ok, Er, na, ni	SDI1 & SDI2 Demux Channel Format and Data Block Status. Ok – parity correct Example: DxCF_Ok_ni, SDI 1 Channel Format correct, no SDI signal on side 2 If in error, incorrect data values may occur during an insert.
6	HANC_xx_yy Codes: Ok, Er, na, ni	SDI1 & SDI2 Demux Channel HANC Status. Ok indicates good values which include good ‘black’ or ‘blank’ space in HANC of at least 56 contiguous words. Example: HANC_ni_Ok, SDI1 is not present but SDI2 has a normal HANC

Note: TANDEM-110 will attempt to correct some classes of error but in severe cases the audio may be muted.
If there are less than 56 contiguous words of ‘black’ or ‘blank’ space in the HANC, there may not be sufficient space to embed a further Audio Insert. To be able to embed new audio data, it may be necessary to blank the entire HANC area.
Investigate the reasons why there is so much data in the HANC space if necessary try HANC blanking in upstream equipment where appropriate. If only one audio insert is to be preserved, de-embed that, HANC blank and then re-embed it. Use a second embedder to insert the new audio – mode 2 suits this requirement best.

SEL No.	Display	Video input status examples and comments
7	TRS_xx_yy Codes: Ok, Er, ni	SDI1 & SDI2 Demux Channel TRS Status. TRS errors may result in corrupted audio data. Example: TRS_ni_Ok, SDI1 is not present, SDI2 does not have a TRS error. Er is displayed for erroneous TRS values.
8	Vd_nLC_nLC Codes: 5, 6, L, C, x, ni	SDI1 & SDI2 Demux Channel Chrominance and Luminance Status. n - video standard, 6 for a 625 input and 5 for a 525 input L - Active Luminance is shown by 'L' or 'x' for dark or near dark values – signal peaks below 12.5% of Peak White. C - Active Chrominance is shown by 'C' or 'x' for monochrome or near monochrome values – chroma peaks less than 12.5% Saturation. Example: Vd_6LC__ni, SDI 1 is 625 with significant Luminance and Chrominance content, but SDI2 is absent.

Note: The continued presence of 'x' values for Chrominance or Luminance may indicate an error condition, such as no picture or lack of colour.

The Mux Output status-only display is summarised below:

SEL No.	Display	Audio output status examples and comments
9	C=n_1234dO or C=n_Mx_Err	C Mux (embedder) status, where n is output Audio Group selected. Mx_Err indicates that data could be damaged Example: C=2_1-34_O, Audio Group 2 selected and Audio Groups 1, 3 and 4 present at C embedder input, Other data present
A	D=n_1234dO or D=n_Mx_Err	D Mux (embedder) status, where n is input Audio Group selected Mx_Err indicates that data could be damaged Example: D=__no INP, no SDI input on side 2
B	Mx_xx_yy Codes: Ctg, Ovr, Blk, Del, na	SDI1 & SDI2 Mux Output Modes Ctg - indicates Contiguous mode Ovr - indicates Overwrite mode (non-contiguous) Blk - indicates that the input HANC has been deleted Del - indicates Mark for Deletion has been selected Example: Mx_Ctg_Blk, Embedded audio in SDI 1 output is Contiguous, SDI2 original HANC data has been deleted.
C	MxVb_12_34 Codes: V, o, na	SDI1 & SDI2 AES Input Validity Bit Status. Format is MxVb_12_34 for four AES inputs. This shows the AES 'V' bits on any incoming digital audio feeds to DIP2 PCBs fitted for SDI1 or SDI2 multiplexers. V - indicates active high or Validity Error o - indicates Validity OK na – indicates no DIP2 PCB Example: Mx_VV_na, AES inputs on DIP2 side 1 has Validity Bit set high, but side 2 has no DIP2 fitted.

Note: Mux status SEL '9', 'A' and 'B' can be used to discover what has happened to the SDI HANC content. If HANC Blanking has been selected, then there will be nothing in the output (C= ----) or only one Audio Group inserted by the Multiplexer (C=1 1)
If Mx_Err is displayed in SEL 'C' menu it is warning that data could be damaged during embedding. A likely cause might be that unsuitable embedding settings have been selected when pre-existing audio or data already exists. In this case blank the entire HANC to intentionally remove ALL pre-existing embedded audio data on the incoming SDI signal. The SEL 'B' status menu will then show Blk for the output affected.
If the Validity bit is set high in the SEL 'C' status menu, it indicates that non-linear or compressed audio data may be present. It is unlikely that this audio will be directly usable if an attempt to convert it to listenable 'audio' in a digital to analogue conversion.

Warning: It is not recommended to attempt to listen to AES streams that have the Validity bit set on headphones or loud speakers as damage to hearing or equipment may result.

Further help

Other Status menus such as the Status Only menus discussed in section 5.1 and the Ancillary Data Status menu discussed in section 5.7 will also prove to be useful during fault finding.

It is also useful to listen to any valid audio destination with a pair of headphones using the audio monitoring facility discussed in section 5.4

If the Auto menu is left as the default for the card edge display, (All MENU levers UP, SEL position 0), then the first three status menus will be displayed on a priority basis. This will provide continuous monitoring of SDI signal status, AES and Ref I/P status and whether any active audio channels fall silent (<50dB FS). This is recommended for normal operation.

Control cross reference

Piano switch	Hex switch	Description	Statesman	Card-edge section	Front panel menu
all up	0 - 5	display status	SDI 1/2 Status	5.1	1.1
	6 - 9	select audio group	SDI 1/2 Status	5.3	1.2.1, 1.2.2
	A, B	select audio monitor	Preset Controls	5.4	1.4
	C, D	adjust audio delay	Audio Delay	5.3	1.2.3
	E	adjust silence time	Misc	5.3	n/a
	F	GPI enable / disable	Preset Controls	5.5	1.3.2.4
2 only down	0 - 15	preset 0-15 save / recall	Preset Controls	5.6	1.3.2
3 only down	0 - 1	display mode – always 1	n/a	5.14	1.3.1
	2	SDI PLL mode	Preset Controls	5.12	1.3.3
	3	Resample mode	n/a	5.12	1.3.4
	4 - F	Factory use only	n/a	5.14	n/a
4 only down	0 - F	configure audio routing	Audio Router	5.3	1.2.4
5 only down	0, 1	select error handling level	Misc	5.7	n/a
	2 - 5	embed / de-embed formats	SDI 1/2 Status	5.7	n/a
	6, 7	select stereo/dual mono	SDI 1/2 Status	5.8	n/a
	8, 9	contiguous pack (embed) – always contig	n/a	5.7	n/a
	A, B	Blank HANC	n/a	5.7	n/a
	C, D	EDH on/off	SDI 1/2 Status	5.7	n/a
	E, F	adjust AES phase	Misc	5.9	n/a
5&6 only down	0-3	Audio gain menus for embedder router inputs	Audio Gain	5.3	1.2.4.2
6 only down	0-9	GPI output error masking	Misc	5.10	n/a
	B	load default settings	n/a	5.2	n/a
	C	diagnostic data	Tool Kit	n/a	n/a
	D	firmware version number	Board Info	5.14	1./Device
	E, F	display ancillary data status	Tool Kit	5.1, 5.7	n/a
7 only down	0-5	De-embedded signal status	SDI 1/2 Status	7.0	1.1.1, 1.1.3
	6-8	General status	Tool Kit	7.0	1.1
	9-C	Output signal status	SDI 1/2 Status	7.0	1.1.2, 1.1.4

7 Specification

TANDEM-110 motherboard

Inputs

Video	2 channel Serial Digital Component (SDI) 270Mbit to EBU 3267-E & SMPTE
Cable equalisation	>200m Beldon 8281 or equivalent (video)
	Input return loss >15db at 270Mbs
Audio inputs	Dependent on sub-modules fitted
	SDI embedded to SMPTE272M-AD
External reference	Digital output sub-modules may have an external AES/EBU reference See section on sub-modules for more information

Outputs

Video	2 channel Serial Digital Component (SDI) 270Mbit to EBU 3267-E & SMPTE 259M (Audio is embedded to SMPTE or SONY format) - Two buffered outputs are available for each TANDEM-110 channel with suitable rear connectors
	Output return loss >15db at 270Mbs
Audio	Dependent on sub-modules fitted
	SDI embedded to SMPTE272M-A
Monitoring	1 x miniature front mounted audio jack and switch selects individual stereo audio analogue monitoring on both embedder and de-embedder Also available on rear connector
Crystal oscillator	Free running SDI signal can be maintained at embedder output to support extended video loss and to allow an SDI transport for continuous AES/EBU output at all times
Embed/de-embedder timing	Inter-channel variation: 1 clock cycle
	AES/EBU digital audio time delay format dependent – Side1 to Side 2 delay round-trip varies from 310µs to 835µs
	Analogue audio time delay format dependent – Side1 to Side2 round trip delay varies from 1,540µs to 2,075µs
	SDI video delay 400 clock cycles at 270MHz or 1.481µs
	Note: Round trip audio delay measured by taking de-embedded audio output from one side, and re-embedding into other side.
De-embedding format	Automatic selection of SMPTE or SONY formats or manual selection

Embedding formats	Operator selection of enhanced SMPTE or SONY formats
Standard selection	525/625 automatic
EDH	EDH insertion on embedder and EDH checking on de-embedder
Audio channel gain	Eight channels of variable audio gain provided from 0% (mute) to 799%
Delay/Phase inversion	Dual channel digital audio delay - OFF or pre-settable in 1ms steps from 1 – 681ms. In addition each channel may be phase inverted
Silence threshold delay	Silence threshold delay for both sides is pre-settable for the amount of time a signal is allowed to remain below –50dB wrt Full Scale before a silence error is flagged. Values start at 1.5s, 8s and then in increments of 8s to 120s
Setups	Sixteen set-ups are available to store setup data. They may be recalled either from the board control or through the use of external GPIs
GPIs	Four GPIs are available for external recall of setups and two are available to provide alarm monitoring
Status monitoring	Front card edge visual monitoring with alphanumeric and LED indicators. Remote control panel also available
	Maskable GPI output of inputs/references present and silence
Weight	250g with two sub-modules fitted

AIP2: Dual analogue audio input sub-module

Audio input	2 analogue stereo pairs or 4 mono channels, 20 bit quantising A to Ds, High input impedance (20K Ohm) balanced
	Frequency response 20Hz to 20kHz (+/- 0.05db)
Level range	0dBFS = +28dBu max / 0dBFS = +12dBu max
	Default level: 0dBFS = +18dBu or +24dBu by on-board link
Signal to noise	-89dBu / -107 dBFS (+18dBu) rms., 22Hz to 22kHz typ.
Dynamic range	>109db with respect to full scale
Total harmonic distortion	0.003% THD+N rms., 22Hz to 22kHz typ. (<-90db at 1kHz)
Interchannel crosstalk	-118 dB @ 1kHz, -98 dB @ 20 kHz, rms., typ.
Synchronisation	Digitised output of analogue A to D is automatically locked to video

AOP2: Dual analogue audio output sub-module

Audio output	2 analogue stereo pairs or 4 mono channels, 20 bit quantising A to Ds, Low output impedance (66 Ohm) balanced
	Frequency response 20Hz to 20kHz (+/- 0.1db)
Level range	0dBFS = +28dBu max / 0dBFS = +12dBu max
	Default level: 0dBFS = +18dBu or +24dBu by on-board link
Signal to noise	- 92dBu / -103 dBFS (+18 dBu) rms., 22Hz to 22kHz typ.
Dynamic range	>109db with respect to full scale
Total harmonic distortion	0.002% THD+N rms., 22Hz to 22kHz typ. (<-90db at 1kHz)
Interchannel crosstalk	-112 dB @ 1kHz, -98 dB @ 20 kHz, rms., typ.

DIP2: Dual digital audio input sub-module

Audio input	2 x 20 bit stereo pairs. AES3 110 Ohm or HiZ (balanced) D Type, or AES3-id (unbalanced) 75 Ohm BNC. Set by on-board links
Synchronisation	Synchronous audio to video 48kHz
	Asynchronous audio to video 48kHz + or – 50 ppm

DIP2RS: Dual digital audio input re-sampler sub-module

Audio input	2 x 20 bit stereo pairs. AES3 110 Ohm or HiZ (balanced) D Type, or AES3-id (unbalanced) 75 Ohm BNC. Set by on-board links.
Synchronisation	Asynchronous audio to video 30kHz to 108kHz sample rates
Total harmonic distortion	0.00017% THD+N rms
Signal to noise	-117 dBFS, 22Hz to 22kHz typ

DOP2-110 and DOP2-75: Dual digital audio output sub-modules

Audio output	2 x 20 bit AES/EBU stereo pairs. DOP2-110, 110 Ohm or DOP2-75 (unbalanced) 75 Ohm BNC. Factory configuration only
Reference	Available instead of 2nd buffered output on some rear connector modules. Link selected
	May be AES reference or Word clock – link select

Ordering information

TANDEM 110	Twin ANalogue and Digital EMbedder/de-embedder
RM04	Single slot frame rear module
RM36/07	Double slot frame rear module
RM05/08	Triple slot frame rear module
AIP2	Dual analogue audio input sub-module
AOP2	Dual analogue audio output sub-module
DIP2	Dual digital audio input sub-module
DIP2RS	Dual digital audio input re-sampler sub-module
DOP2-110/DOP2-75	Dual digital audio output sub-modules
Statesman	PC Control System
Indigo 2	2U frame without active control panel for up to 12 modules
Indigo 1	1U frame without active control panel for up to 6 modules
Indigo DT	1U Desk top box without active control panel for up to 2 modules
Indigo 2A	2U frame with active control panel for up to 12 modules
Indigo 1A	1U frame with active control panel for up to 6 modules
Indigo DTA	1U Desk top box with active control panel for up to 2 modules
Indigo 2S	Statesman enabled only 2U frame for up to 12 modules
Indigo 1S	Statesman enabled only 1U frame for up to 6 modules
Indigo DTS	Statesman enabled only 1U Desk top box for up to 2 modules