TANDEM-300

Single embedder/de-embedder and audio processor

USER MANUAL

Crystal Vision

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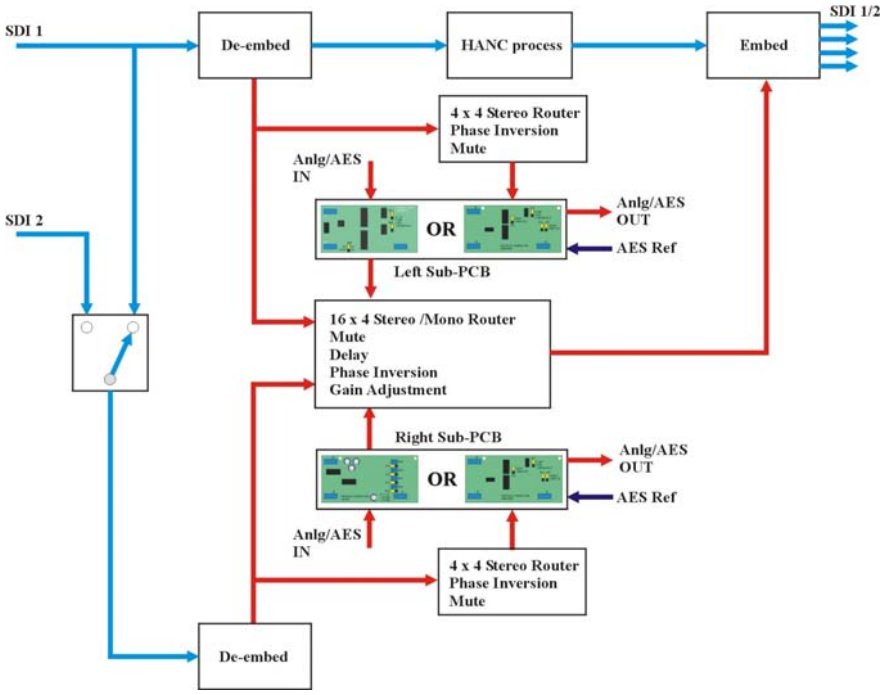
1 Introduction

The TANDEM-300 (Twin ANalogue or Digital EMbedder/de-embedder) Audio Processor is based on the TANDEM-100/200 architecture to provide audio-processing functions for embedded, analogue and AES/EBU audio.

TANDEM-300 accepts either a single or dual SDI inputs with or without embedded audio and may be equipped with up to two piggyback audio option cards to provide for analogue or digital external audio inputs or outputs. Audio may be selected from any input and routed to the SDI output for embedding or any audio output option card that may be fitted.

The available audio processing functions are:

- Audio gain adjustment
- Audio replacement
- Channel swapping / shuffling
- Stereo to mono conversion
- Phase reversal
- Dual SDI inputs and dual de-embedders for to allow audio to be transferred from second SDI input (Audio Bridge)
- Audio delay



TANDEM-300 basic architecture

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

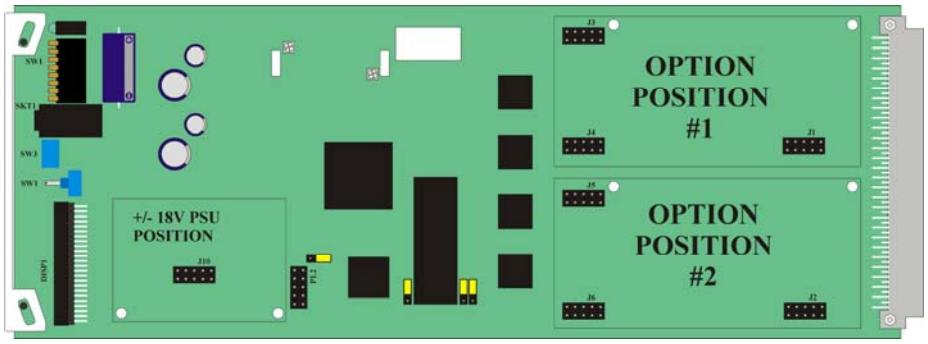
Additional functions include:

- audio source preview monitoring
- Correction and masking of corrupted audio data
- HANC processor for data packet management
- optional SDI 'PLL'
- AES breakout for external processing
- external AES or word clock reference input for digital output modules
- EDH insertion on embedder and de-embedders
- control and status monitoring via board edge or frame/remote control panel or Statesman
- buffered SDI and AES outputs
- audio error masking and protection in de-embedders – handles untimed or asynchronous SDI with minimum corruption
- GPI control of configuration set-ups

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

TANDEM-300 has a single SDI output and two SDI inputs. Up to two audio option cards may be fitted in either of two positions. The terms Side 1 and Side 2 are used to describe the option card positions.

The option card position for Side 1 is at the top of the modules and the slot for Side 2 is at the bottom of the module. An 18 volt regulator option card is also required for analogue input or output cards.



TANDEM-300 - sub-pcb or option card positions #1 and #2

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

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

The codes refer in practice to installed option cards and basic functions such as embedder or de-embedder. These codes are introduced here to make understanding board edge control easier.

Code	Function in Mode 1 and other modes
A	de-embedder SDI 1 (main SDI input)
B	de-embedder (may be selected to provide de-embedded sources from SDI1 or SDI 2 (second SDI input)
C	embedder SDI 1
G	input option SDI 2
H	input option SDI 2
I	output option SDI 1
J	output option SDI 2
E	De-embedder ‘A’ is renamed ‘E’ to indicate no option card fitted on ‘Side 1’
F	De-embedder ‘B’ is renamed ‘F’ to indicate no option card fitted on ‘Side 2’

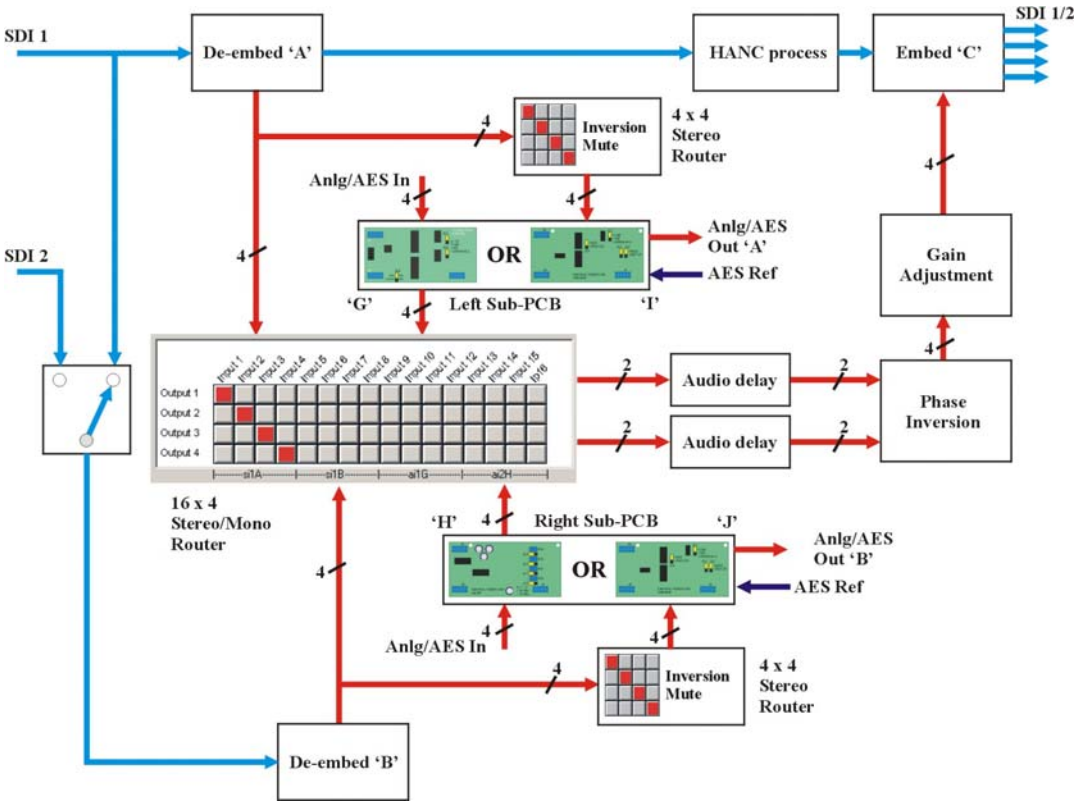
Note: If no option cards are fitted Codes E and F appear in the status display at the card edge to replace de-embedder codes A and B for Side 1 and Side 2 respectively. However, monitoring quality de-embedded audio is still output via the headphone socket and the rear connector – refer to the Monitoring section for further details.

1.1 Audio and data processing

The main 16 x 4 embedding router is designed to selected either stereo or combined (mono) de-embedded signals to any of the four channel outputs destined to be re-embedded in the SDI signal.

Two de-embedders are provided to enable TANDEM-300 to work in either single or dual SDI input mode.

In single SDI mode four channels may be de-embedded from two groups from SDI input '1'. In dual SDI mode, four channels are de-embedded from one group from SDI input 1 and four channels are de-embedded from one group from SDI input '2'. Any of these de-embedded signals may be assigned to outputs by TANDEM-300s built in routers.



TANDEM-300

Routed audio can be delayed up to 0.68 seconds for each channel pair sent to the output embedder. The audio channels can also be muted, adjusted for gain from 0 to 8 times unity gain and inverted.

The de-embedded audio may also be routed independently of the main embedding router to any output option cards that are fitted. The 4 x 4 external audio output routers cannot produce mono signals but can invert or mute the analogue or digital audio outputs.

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.

Handling 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 PLL module, like a ‘time base corrector’ that may be inserted into the SDI output path.

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-300 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.

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:

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

Please refer to the Statesman 'Recalling Defaults' or the card edge section 6.3 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 Statesman 'Audio Routing' or section 6.4 for card edge controls).

Monitoring

TANDEM-300 is equipped with two monitoring outputs:

- analogue headphone output
- analogue or AES rear connector output

The rear connector output is fed from a monitoring 'bus' that may be switched between OFF (silence or high impedance), a copy of the analogue headphone output or an automatically assigned AES output. The rear connector monitoring may be used to extract a 'breakout' monitoring quality output, 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.

The AES output monitors the following audio:

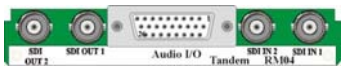
- de-embedded audio if a Demux (de-embedder) is enabled
- audio routed to an output option card if the Demux (de-embedder) is disabled
- audio silence if Demux (de-embedder) is disabled no output option-card is fitted

Note: The analogue monitoring output can provide a Demux output even if an output option is not fitted.
Setting all but a selected card's monitoring BUS to OFF allows multiple TANDEM or Demon cards to be selectively monitored.
The AES monitoring bus may be used for re-processing. AES signals can be fed to a gain control, compressor or other process and then fed back into a digital input card for further TANDEM processing or routing.

1.2 Rear connector options

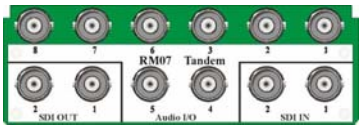
TANDEM-300 fits into FR2AV 2U frame for up to 12 Crystal Vision modules, the FR1AV 1U frame for up to 6 Crystal Vision modules and the DTB-AV Desk top box for up to 2 Crystal Vision modules.

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



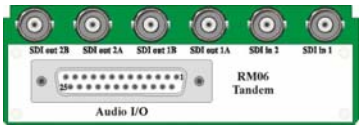
RM04

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



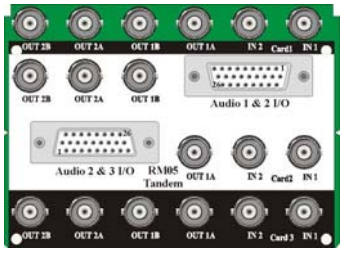
RM07

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



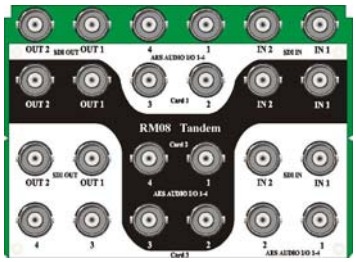
RM06

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



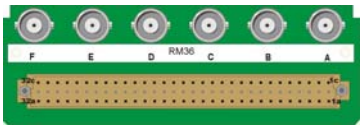
RM05

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.

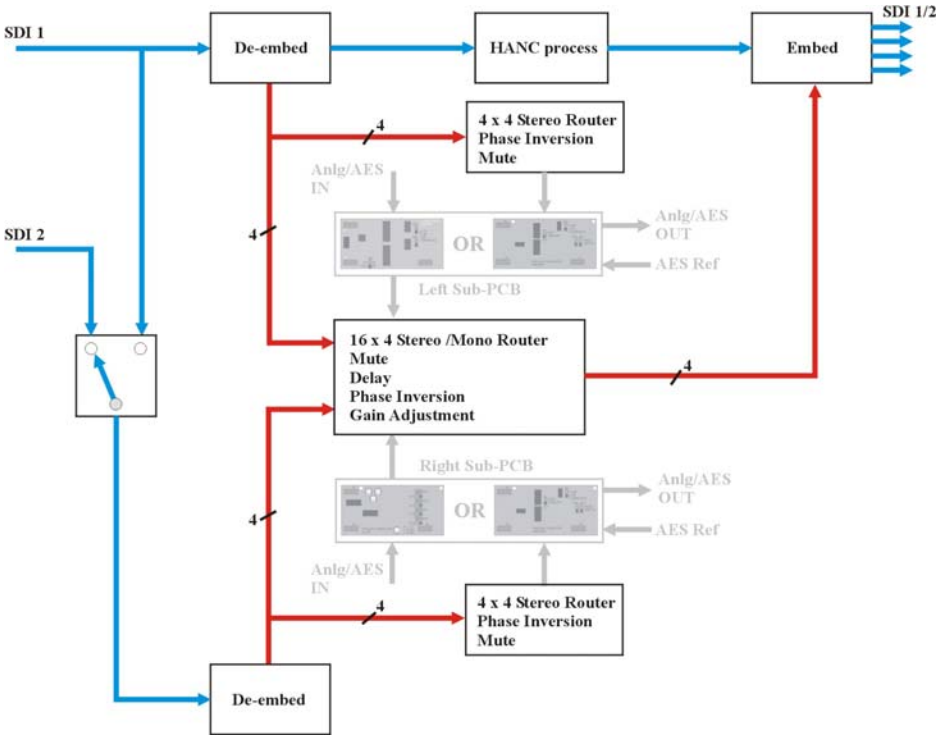
1.3 Applications

TANDEM-300 is very flexible and a range of applications can be served depending on the option cards fitted and the configuration set.

Applications include audio embedding from external analogue or digital audio sources, re-embedding from one or two SDI sources and de-embedding as analogue or digital audio sources.

Even without any audio option cards fitted, TANDEM-300 can easily be configured to support a wide range of functions such as sports commentary or multiple language production.

For example, in Dual SDI mode, TANDEM-300 will provide an Audio Bridge between two SDI inputs so that embedded audio from two separate SDI sources can be combined in just one.



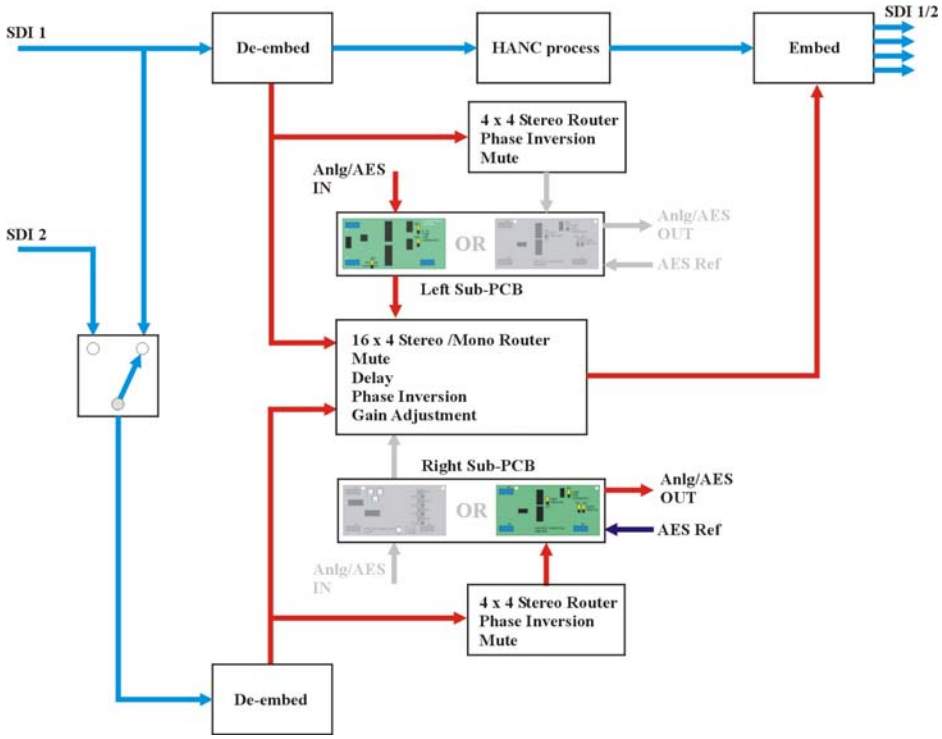
TANDEM-300 in Dual SDI 'Audio Bridge' mode

The 'shuffled' or routed audio can be further processed to correct for gain or phase problems. Moreover, any stereo source can be converted to mono, allowing up to four mono commentary feeds if required.

If multiple languages or commentaries are already available embedded within a single SDI feed, Single SDI mode will allow audio channels to be freely selected from up to two groups and then re-shuffled and embedded in any group for local or language specific consumption.

With audio option cards fitted, say both an input and an output card, local contributions from external analogue or digital audio sources can be made. The output card allows sources from one of the SDI inputs to be de-embedded and used locally.

Monitoring quality audio can always be de-embedded and used locally even when no audio option cards are fitted.



TANDEM-300 in Single SDI 'Audio Bridge' + External Audio mode

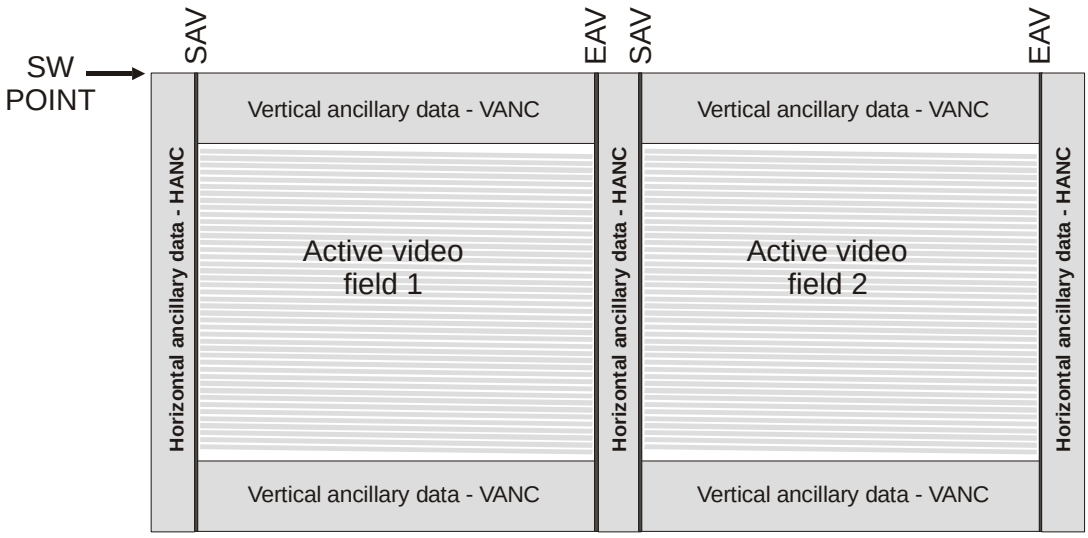
As with the previous example, the 'shuffled' or routed audio can be further processed to correct for gain or phase problems. Moreover, any stereo source can be converted to mono, allowing up to four mono commentary feeds if required.

If multiple languages or commentaries are already available embedded within a single SDI feed, Single SDI mode will allow audio channels to be freely selected from up to two groups and then re-shuffled and embedded in any group for local or language specific consumption.

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-300 ‘side’ can de-embed up to four additional audio channels from one of the four groups of its SDI input stream and can embed four audio channels into one of four possible audio groups in the output SDI stream.

The following ancillary data handling options are provided:

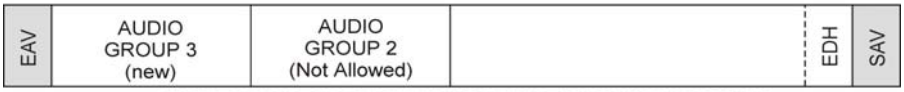
- Support for contiguous HANC data packing
- Automatic mark audio group for deletion
- Blank entire HANC data space, except the EDH insert before embedding
- Wide range of formats to embed on all HANC lines or leave a gap around the vertical switching point
- Variable error masking and error handling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

VIDEO SIGNAL HANC BEFORE EMBEDDING

VIDEO SIGNAL HANC AFTER CONTIGUOUS EMBEDDING



VIDEO SIGNAL HANC AFTER NON-CONTIGUOUS EMBEDDING

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-300 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.

Note: The embedded audio of SDI 1 AND SDI 2 MUST be synchronous with the same source as the video content of both SDI signals. TANDEM-300 cannot process asynchronous sources, though time offset is allowed.

Trading process speed for robustness

SONY and SMPTE embed/de-embed modes for the TANDEM-300:

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.

3 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. Statesman provides a user friendly means of configuring and operating the TANDEM-300 with the benefit of see-at-a-glance status monitoring. Most functions can be accessed from Statesman menus. Some advanced functions may only be available from the card edge.

The main Statesman application communicates with each module in a frame through an active control panel. An active panel must be fitted to allow for Statesman control.

3.1 Installation

Minimum pre-requisites:

- A PC running Windows 98, NT4 with SP 5 or higher or Windows 2000
- A parallel port dongle supplied with the Statesman software package
- An RS422 serial connection from the host PC to the Remote 2 connector on an FR1AV or FR2AV Crystal Vision frame with at least one TANDEM-300 module and/or other Statesman compatible module
- An active control panel MUST be fitted to the frame with version 1.50 or above firmware
- 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

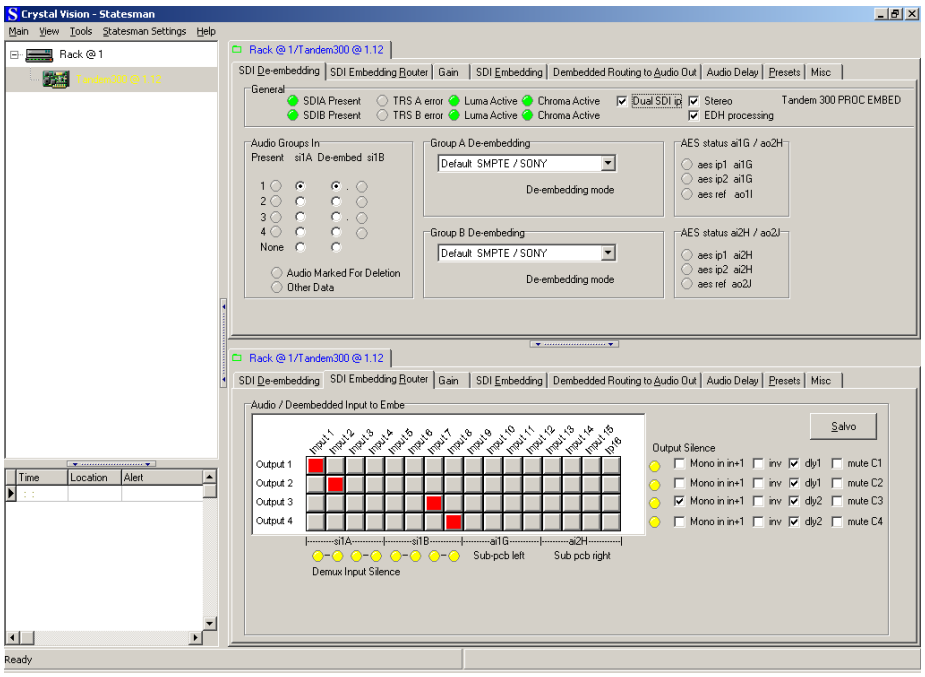
The Statesman PC Control System may be run from the Crystal Vision programs folder via the Start menu or by double-clicking on the Crystal Vision.exe file in the installed program directory.

When the program runs it 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.

4 Statesman operation

The initial view will show an explorer style view of the connected frames and modules. Double-click on a module to display the main application control panes.



Statesman main application window

The two large control panes shown in the upper and lower halves of the window may display different menus for the same card, or controls for different cards. 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.

The two panes allow dual-control display of both TANDEM-300 circuit paths or ‘sides’, or two functions such as both embed and output routing can be shown for the same ‘side’.

Shorthand codes are used for sources and destinations at the card edge and Statesman has been designed with this in mind

The following shorthand codes may be encountered when using Statesman:

Code	Function – (Dual SDI ip) mode
SDI 1	SDI input ‘1’
SDI 2	SDI input ‘1’
A	de-embedder SDI 1
B	de-embedder SDI 2
C	embedder SDI 1
D	embedder SDI 2 (Not supported in TANDEM-300)
G	input option SDI 2
H	input option SDI 2
I	output option SDI 1
J	output option SDI 2

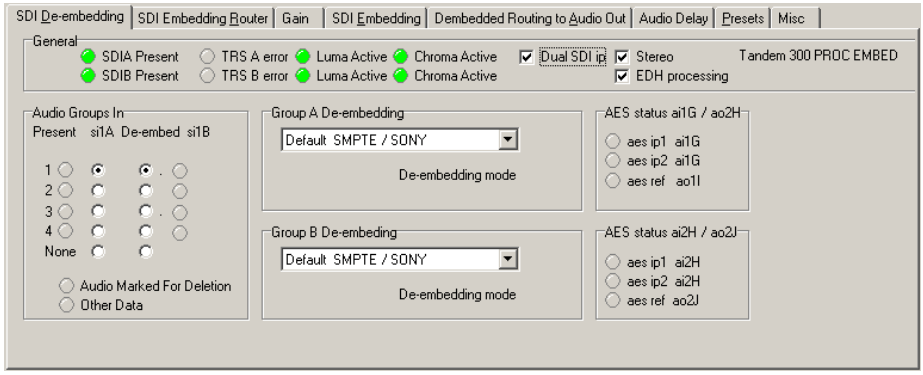
4.1 Selecting single or dual-input

TANDEM-300 can be configured for ‘Single SDI input’ use or ‘Dual SDI input use’.

Single SDI mode allows up to 8 monaural or 4 stereo audio sources to be routed from both of TANDEM-300’s de-embedders (‘A’ and ‘B’) for up to two audio groups from TANDEM-300’s SDI 1 input.

Dual SDI mode can route up to 4 monaural or 2 stereo audio sources from the ‘A’ de-embedder for up one audio group from SDI 1 and up to 4 monaural or 2 stereo audio sources from the ‘B’ de-embedder for up one audio group from SDI 2. There are still 8 monaural or 4 stereo de-embedded audio sources, but this time from selected groups from two SDI streams.

To change the SDI input mode click to place a tick in the ‘Dual SDI ip’ box in the General area of the SDI De-embedding tab. To revert to single SDI input mode, click in the ‘Dual SDI ip’ box to clear it and remove the tick.

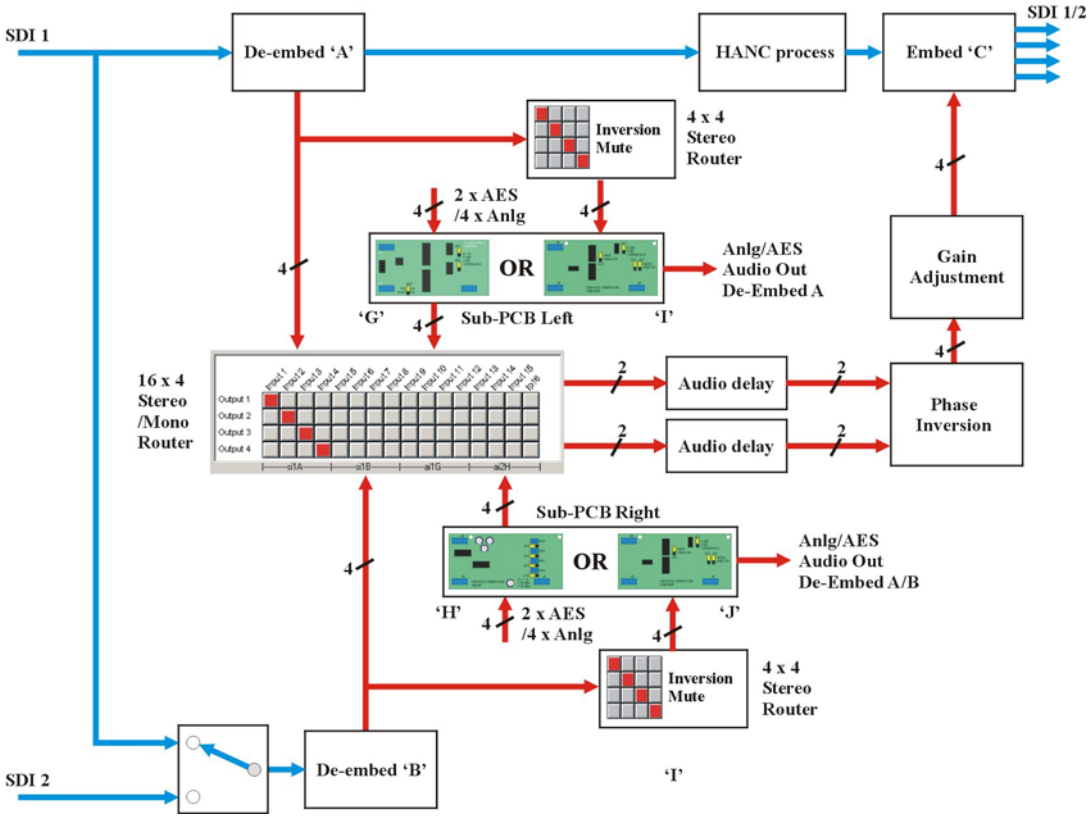


TANDEM-300 Mode tab

Warning: This is the only place in the Statesman GUI that will indicate if ‘Dual SDI ip’ mode has been selected. Source labelling will continue to refer only to SDI 1.

Audio routing

The first task to perform when routing audio is to choose 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-300 in mode 1

Tip: If TANDEM-300 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 9.3 if default settings are required. Audio group selection should be checked after loading default routing.

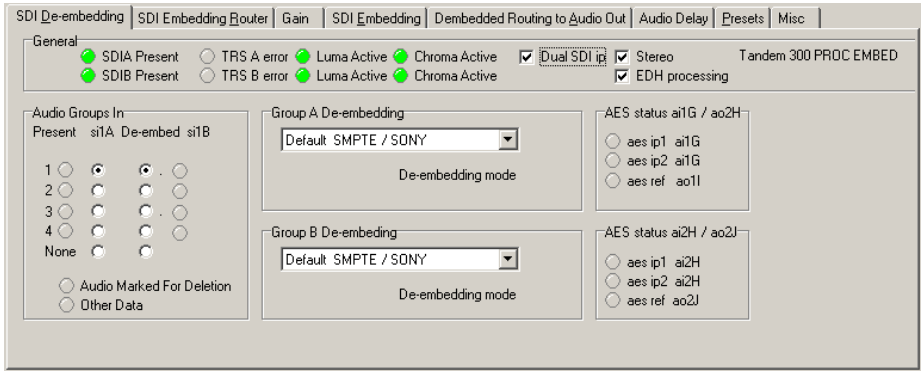
Selecting audio groups for de-embedding

In Single SDI i/p mode TANDEM-300 can de-embed any audio channel from any two incoming audio groups from the SDI 1 stream.

In Dual SDI i/p mode TANDEM-300 can de-embed any audio channel from any one incoming audio groups from the SDI 1 stream, and any audio channel from any one incoming audio groups from the SDI 2 stream.

In either mode up to four stereo (or stereo converted to mono) de-embedded or external audio sources can be selected and embedded into any channel of any one audio group in the outgoing SDI stream.

The status of all four incoming audio groups for both SDi 1 and SDI 2 are shown in the Audio Groups In area of the SDI De-embedding tab. The status of the SDI video itself is shown in the General area of the SDI De-embedding tab.



Selecting SDI groups

Select the group required in the 'Audio Group In' section to de-embed or select 'None' to turn de-embedding off for both the 'A' and 'B' de-embedders.

Selecting the de-embedding mode

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

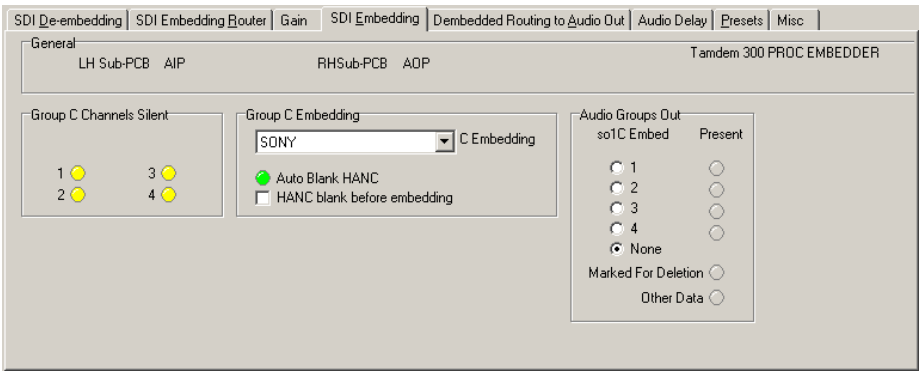
- Sony audio fifo min – fastest processing delay
- Sony audio fifo mid – medium processing delay
- Sony audio fifo max – slow processing delay
- SMPTE/SONY – slowest processing delay - use when input may not be in Sony format

AES input status

The AES external signal and reference input status is shown using card edge reference codes.

Selecting audio groups for embedding

Select the group required in the 'Audio Group Out' section to embed into or select 'None' to turn embedding off for the SDI output stream.



SDI1 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.

Selecting the embedding mode

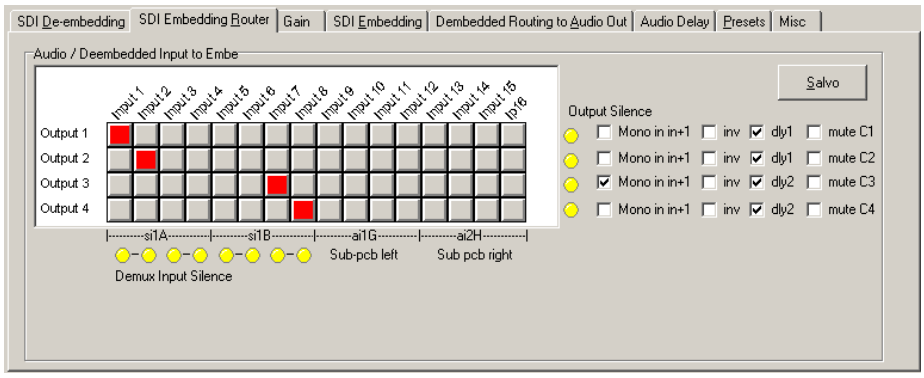
The embedding format is also selected from within the SDI Status menu. Select from the following modes:

- 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.

Using the Embedding routers

Once de-embedding and embedding groups have been chosen, audio sources can be can be selected with the 16 x 4 embedding router.



Side 1 Embedding Router for mode 1

Router sources appear in groups of four columns labelled input 1 to 16 above the columns and with A and B demux codes and H and G input option codes underneath the columns.

The four router outputs are shown by the rows labelled Output 1 to 4 on the left of the router display, whilst processing options are selected for each output with the check boxes on the right of the display.

Assign 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.

Using the stereo to mono converters

TANDEM-300 has 8 built in stereo to mono converters that may be applied independently to each adjacent pair of the embedding router inputs. If 'Mono in in+1' is selected for any output row, the output will always be the sum of left-most (odd numbered) audio source and its immediate neighbour on its right (next even numbered source).

To reflect this operation, only left-most sources can be successfully highlighted when Salvo is pressed when summed (mono) is applied to an output row. If a right-most input is selected when an output row is in mono mode and Salvo is pressed, only the left-most input of the pair will be highlighted.

When an output row is in normal stereo mode (Mono in in+1 not ticked), either the left-most or the right-most audio channel of an adjacent pair can be selected (but not both).

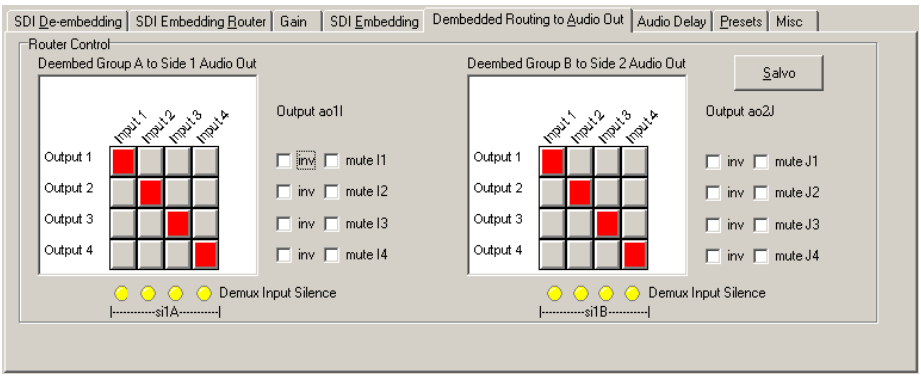
Note: The TANDEM-300 router does not support summing input channels unless they are left-most/right-most pairs. For example, it is not possible to select input 1 + input 3, only input 1 + input 2 OR input 3 + input 4.

Applying delay, phase inversion and mute

Check the 'inv' box to apply a phase inversion to an output and dly1/dly 2 to apply the delay configured using the delay tab menu. Check 'mute' to output silence (zero gain) for selected output row.

Routing de-embedding sources to audio outputs

Sources from the 'A' de-embedder can be routed to any external 'I' output audio option card on side 1. Sources from the 'B' de-embedder can be routed to any external 'J' output option card on side 2. The SDI stream de-embedded from is determined by the SDI input mode selected (Single or Dual).



Side 1&2 Output Router for mode 1

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. Click on the Salvo button when finished. Valid selections will turn bright red and new source-destination assignments will be loaded into the output routing table.

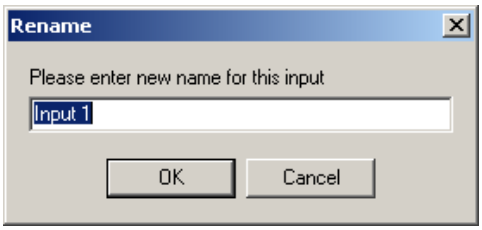
Applying delay, phase inversion and mute

Check the 'inv' box to apply a phase inversion to an output. Check 'mute' to output silence (zero gain) for selected output row.

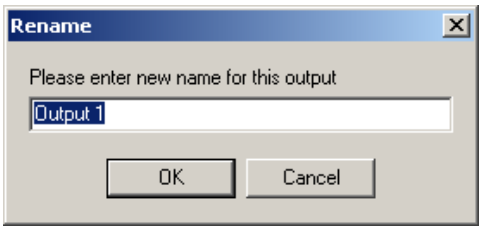
Note: Delay and stereo to mono conversion cannot be applied to external outputs.

Editing router input and output names

Each of the input and output names may be edited for both embed and output routers.



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-300 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.

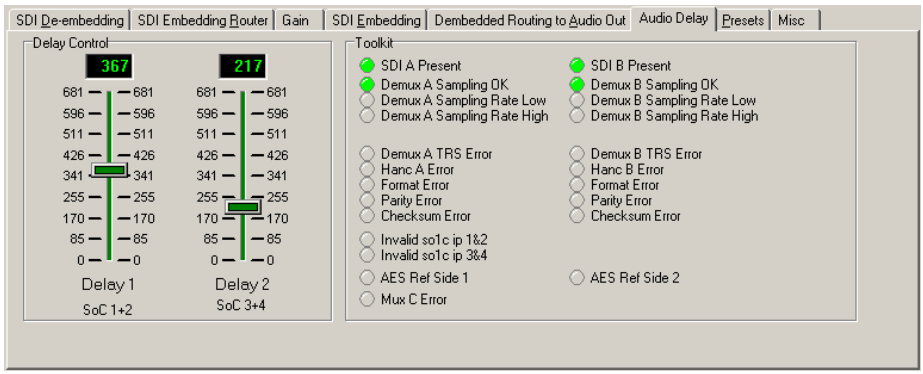
TANDEM-300 should not be set to embed any further groups unless the option to blank the HANC space before embedding is selected.

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.

Setting 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.

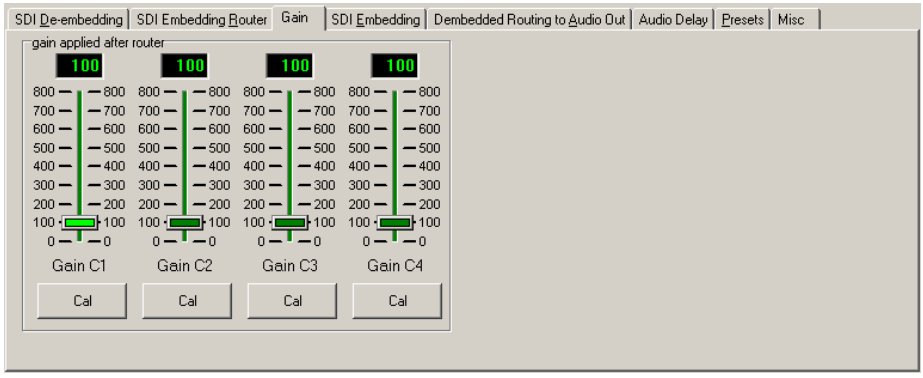


Audio delay for mode 1

The destination pairs 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 channel gains

The gain of the four out put channels feeding the SDI output stream embedder can be varied from 0 to 8 times unity gain.



Gain menu

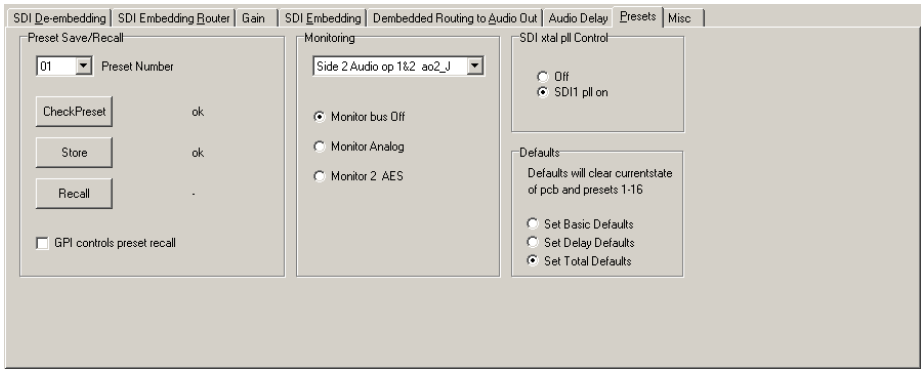
To adjust channel gain click on the appropriate slider and drag it up or down whilst holding the left mouse button down. The gain applied will be shown in the read-out display above the slider. To calibrate a channel to exactly unity gain click on the CAL button beneath the appropriate slider or right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

SDI Crystal control

There is a single PLL module that may be inserted into the SDI output path (SDI 1 On) 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 minimize 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 is situated in the input SDI path prior to processing, so all of the functions of that side, as well as the SDI output, benefit.

Recalling defaults

A facility is provided to load default routing assignments including delay and preset values for embedder and de-embedder groups, which will be valid for the current TANDEM-300 installation.

There are three options, ‘Basic’, ‘Total’ and ‘Delay’. The ‘Basic’ option routes directly without delay whereas the ‘Delay’ option routes via the currently selected audio delay. Total recalls all factory defaults for all parameters including the 'Basic + Delayed' routing parameters.

The ‘Total’ default, which provides a simple way to quickly achieve stored settings for direct or delayed audio paths, involves the following sequence:

- 'Delay' default is recalled and those settings stored in presets 8 through to 15
- ‘Basic' default is recalled and those settings stored in presets 0 through to 7
- Factory default values are applied to Silence Detect Delay, Error Level and AES phase

When the ‘Total’ default operation completes, the audio paths are all routed one-to-one directly (non-delayed).

It is recommended that Total Defaults are recalled after a Mode change or if option-cards have been changed.

Total Defaults should also be recalled if the existing routing table has become corrupted or invalid. This could occur as a result of changing sub-boards or upgrading firmware.

Recalling any preset 8~15 will reload one-to-one audio routing with delay in every path. Recalling any preset 0~7 will again reload one-to-one audio routing, but without delay.

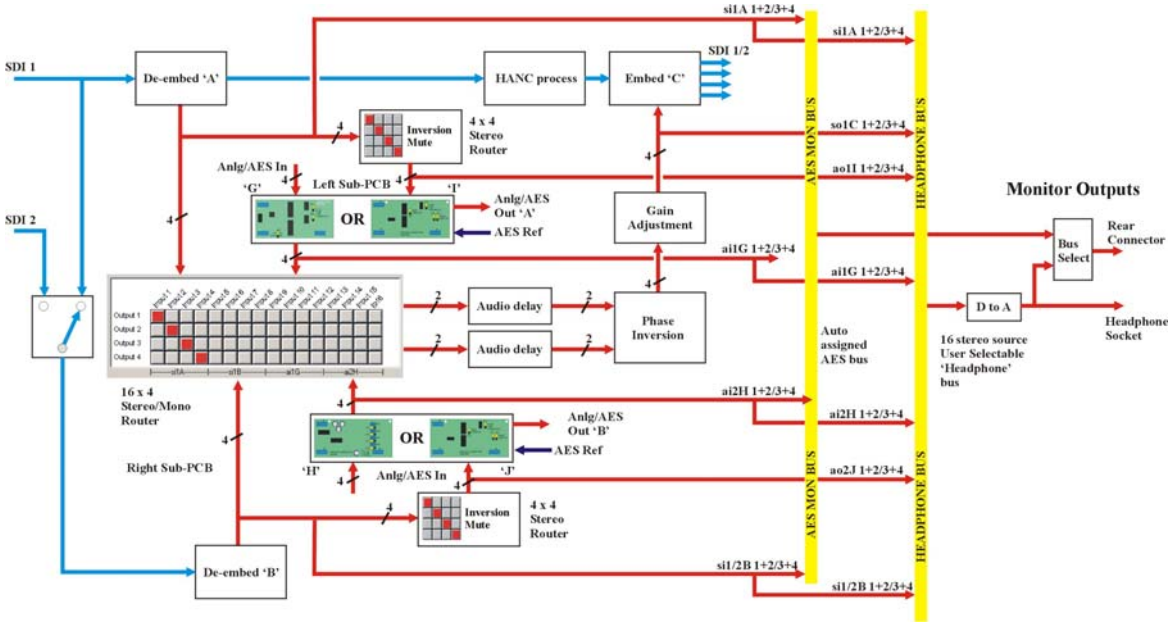
Presets may be re-called, 'edited' by changing settings and then re-saved until the required routing has been obtained.

TANDEM-300 applications are unlikely to require simple one-to-one routing and Audio Group selections for de-embedders ‘A’ & ‘B', and for embedder ‘C’ will almost certainly need to be set differently to the default settings.

Note: Only routing or delay information is recalled with the load ‘defaults’ function. Other data such as embedder or de-embedder settings remain as they were. It is recommended to manually check the current group in/out, embedder/de-embedder and mute/invert settings.

Audio Monitoring

A powerful 16-source stereo monitoring bus provides audio monitoring at the card-edge headphone socket and rear connector.



TANDEM-300 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.

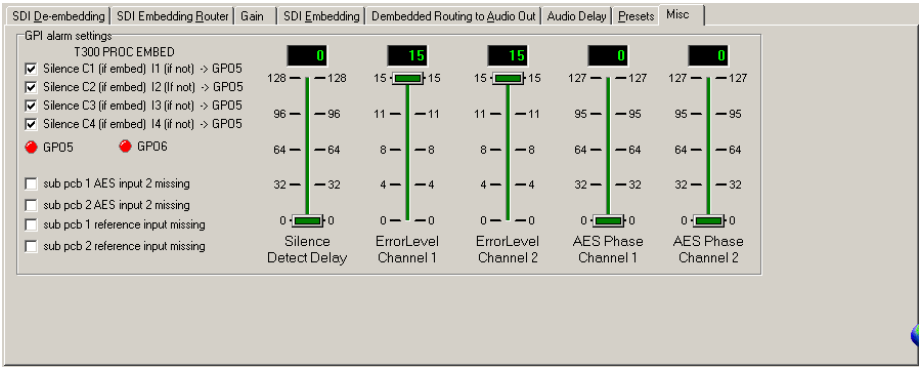
The RM04 and frame rear connector can also receive the same user-selectable analogue monitoring signal as the headphone socket or an automatically assigned AES monitor output. The AES output can be routed via external devices to further process TANDEM audio which may then be re-entered into digital audio input cards in the same or another TANDEM card.

TANDEM-300 switches the AES monitor bus to monitor de-embedder outputs when de-embedders are on and input card outputs when de-embedders are off. If there are no input cards then digital silence will be output when de-embedders are off.

See section 7.4 for further discussion of audio monitoring and pinout details.

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 – Silence Detect Delay, Error Level Ch1/2, AES Phase Ch1/2 & GPI Alarms

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 7.3 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.

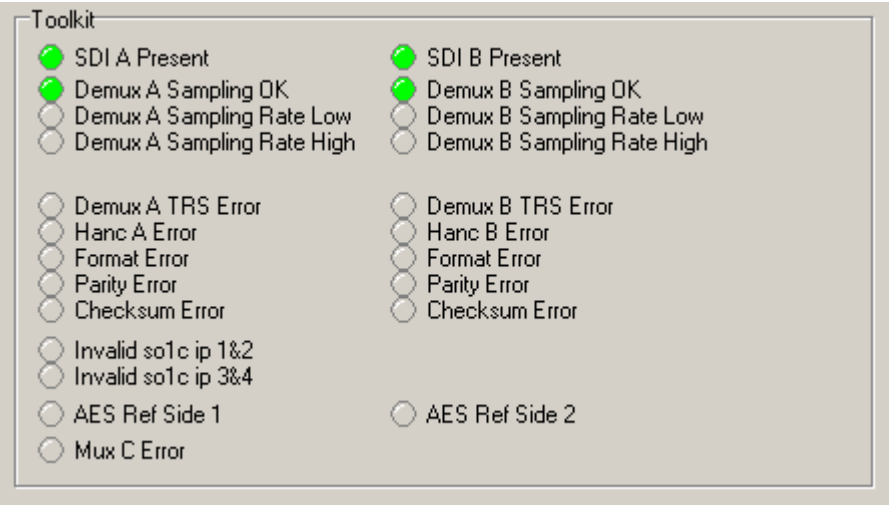
The AES output phase may be varied over a range of just over 360 degrees. The slider readout display shows a reading of 0 to 127 for indication purposes only.

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, accessed from the Audio Delay menu, provides comprehensive error reporting and status information.

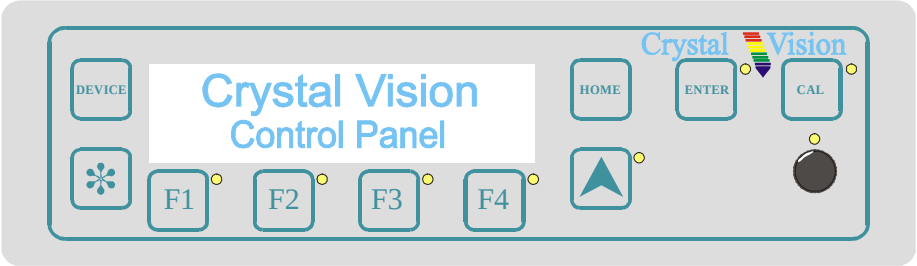


TANDEM-300 Toolkit

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

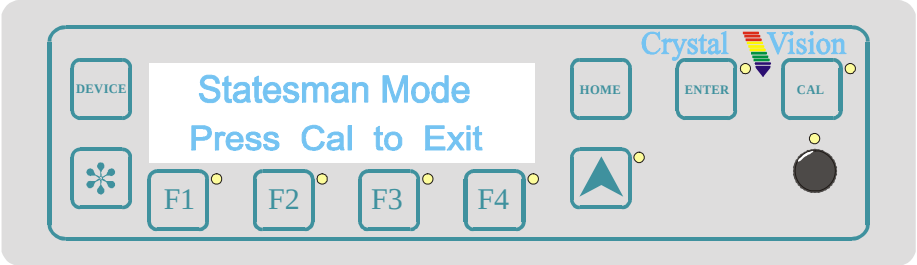
5 The active control panel

The Crystal Vision active control panel is available as an integral part of the FP2-LF front door for the FR2AV 2U frame, the FR1AV frame, and the DTBAV desktop box or as a remote panel. Only one control panel can be connected to any frame, although one panel can control two frames.



The Crystal Vision control panel

At power up, the two line 20-character screen will display ‘Crystal Vision’ followed by the firmware version number for the control panel. If the control panel firmware has been updated for Statesman control, Statesman Mode will be entered and the message, ‘Press CAL to Exit’ will be displayed.



Statesman mode is entered by default

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

Note: TANDEM-300 does not currently support the use of the active control panel. Contact your Crystal Vision sales representative if active control panel support is required.

6 Using card edge controls

6.1 Introduction

Once the start-up initialisation procedure is complete, the TANDEM-300 card can be controlled or configured from the card edge or the Statesman PC interface. This chapter will concentrate on the card edge controls.

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.

TANDEM-300 card edge

In general the Menu DIL 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.

Main menus

Select main menus with MENU DIL switch levers as follows:

Menu switch	Menu
	• Status/Config menus – Default - all levers OFF (UP) and SEL switch = 0. (default normal monitoring 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)
	• Audio gain menu – levers 5 and 6 ON (DOWN) all others OFF (UP)
	• Flag & status menu – lever 6 ON (DOWN) all others OFF (UP)
	• Trouble shooting status menu – lever 7 ON (DOWN) all others OFF (UP)

If a setting is adjusted by mistake, changing the menu (piano MENU or SEL switches) will discard the unwanted setting, providing this is done before Menu switch 1 has been toggled down and up. After a setting has been saved to memory, it can only be 'undone' by re-selecting the previous setting and saving it again by toggling Menu switch 1 again.

The 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	Not available with TANDEM-300
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, DOP2-75/110
J*n*	Option card audio destination on side 2	Option card must be AOP2, DOP2-75/110
M1 - 4	Stereo to mono converter	Mono source or destination
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.

Note: An update will be required to discuss Dual SDI mode selection when implemented.

TANDEM-300 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.

Note: TANDEM-300 does not support an embedder on Side 2.

6.2 Card edge status menus

General Status Only menus

The SEL hex switch provides access to a range of status displays when the MENU DIL 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 the SDI input is absent 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 de-embed audio/silence	Shows active de-embed audio channels ‘s’ = silence (> 50dB FS), number = active channel 12ss = Audio channels 1&2 active, 3&4 silent (<50dB FS)	N/A
4	Active embed audio/silence	As above for embed channels	N/A
5	Option cards fitted	aip : AIP2 option card aop: AOP2 option card dip : DIP2 option card dop7: DOP2-75 option card dop1: DOP2-110 option card RS2: DIP2RS option card RS4: RS4 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

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	Not supported by TANDEM-300	ADJ=*n*
A	Audio bus settings for audio monitor	AUDbus=OFF, ON or AUTO. Shaft encoder only sets ON/OFF. AUTO set by remote panel	ADJ= ON/OFF
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 C 1+2	Set using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
D	Audio delay C 3+4	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 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

Note: Remember that the '=' sign before a group number indicates an existing group. Audio routing is described in detail in section 8.4. Audio monitoring is described in section 7.4 and GPI enable/disable options are described in section 7.3.

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.

Ancillary data status

The ancillary data status display is obtained with MENU DIL, 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 8.8 for a detailed explanation
F	SD2 1234dE	

Input and output trouble shooting status

The Input and Output status information used mainly for trouble shooting is obtained with MENU DIL, lever 7 ON (DOWN), all other levers UP (OFF**).**

SEL	Display	Comments
0-5	De-embedding status	See Problem Solving for a more detailed explanation of the status reports available
6-8	General status	
9-C	Embedding status	

6.3 Selecting default routing

A facility is provided to load default routing assignments including delay and preset values for embedder and de-embedder groups, which will be valid for the current TANDEM-300 installation.

There are three options, ‘Basic’, ‘Total’ and ‘Delay’. The ‘Basic’ option routes directly without delay whereas the ‘Delay’ option routes via the currently selected audio delay. Total refers to a composite 'Basic + Delayed' selection.

The ‘Total’ default, which provides a simple way to quickly achieve stored settings for direct or delayed audio paths, involves the following sequence:

- 'Delay' default is recalled and those settings stored in presets 8 through to 15
- ‘Basic' default is recalled and those settings stored in presets 0 through to 7
- Factory default values are applied to Silence Detect Delay, Error Level and AES phase

When the ‘Total’ default operation completes, the audio paths are all routed one-to-one directly (non-delayed).

Total Defaults should be recalled if the existing routing table has become corrupted or 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’, ‘Delay Def’ and ‘Total Def,’.

All three options will attempt to select one-to-one routing (in1.1 to out 1.1, in1.2 to out 1.2 etc) according to the fitted sub-boards.

SEL	Meaning	Comments
B	Defaults?	Use the Shaft Encoder to select Basic, Delay or Total .

When the desired option is displayed, toggle piano switch 1 down and then up again to implement the routing.

Recalling any preset 8~15 will reload one-to-one audio routing with delay in every path. Recalling any preset 0~7 will again reload one-to-one audio routing, but without delay.

Presets may be re-called, 'edited' by changing settings and then re-saved until the required routing has been obtained. TANDEM-300 applications are unlikely to require simple one-to-one routing and Audio Group selections for de-embedders ‘A’ & ‘B’, and for embedder ‘C’ will almost certainly need to be set differently to the default settings.

Note: Only routing or delay information is recalled with the load ‘defaults’ function. Other data such as embedder or de-embedder settings remain as they were. It is recommended to manually check the current group in/out, embedder/de-embedder and mute/invert settings (card-edge section 6.4).

6.4 Audio routing

Routing audio on the TANDEM-300 involves selecting valid audio sources and destinations. The available options depend on the sub-boards that have been fitted and the mode selected.

Changing or establishing new Routing settings involves the following steps:

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

Tip: If TANDEM-300 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. Please refer to the previous section (6.3) if default settings are required.

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 above table summarises the available source and destination group assignments.

SEL No.	Description	Comments	ADJ funct
6	A (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	B (SD 1/2) 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	C (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	D (SD 2) embed audio group	Not supported by TANDEM-300	ADJ=*n*

Note: Remember that the '=' sign before a group number indicates an existing group already present in the incoming SDI signal.
When embedding, a space just before a group number, ' 'n, indicates a non-existent group or new group to be formed.

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**
If the display test starts with C, 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**
If the display test starts with C, 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'. If there is no other audio input or data input other than the conflicting audio group input, HANC blanking will automatically be asserted.

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 DIL lever 4 ON (DOWN), is used to select the source for each destination available on the board.

Available sources can be routed to embed destination C with the embedding routing. De-embedded sources can be routed via output routing to option card destinations I or J (if fitted).

The destination is selected using the SEL switch and the source is selected using the ADJ shaft encoder. Save each source assignment by toggling MENU switch 1 down and then up again.

SEL No.	Display: available sources	Source description ADJ selects source	Display: valid destination	Dest description SEL selects dest
0 - 3	A1 - A4 (B1 - B4) G1 - G4 (H1 - H4) M1 – M2	Varies according to options fitted	C1 - C4	Audio data embedded into side 1 SDI stream.
4 - 7	(A1 - A4) B1 - B4 (G1- G4) H1 - H4 M1 – M2	Varies according to options fitted	M1 – M4	Stereo pair fed to stereo combiners M1 to M4
8 – B	A1 – A4	Data de-embedded from SDI stream, side 1.	I1 - I4	Output option card fitted to side 1
C - F	B1 – B4	Data de-embedded from B de-embedder (SDI 1/2)	J1 - J4	Output option card fitted to side 2

Note: The source and destination codes are the same as used in status displays.
Unavailable destinations are preceded by [no] in the display.
Rotation of the ADJ shaft encoder cycles through available sources and delay and phase options – see next section for details.
Output option-card codes may be used even when no output option is present. This is done to act as phantom destinations to allow the analogue monitoring output to select routed (shuffled) de-embedded audio even though an output option-card is not physically present.

Assigning delay/phase inversion and muting

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

Delay can only be associated with embed routing. It is not possible to assign delay in a path that involves output routing to external audio outputs.

The following table provides examples of delay and phase assignments:

ADJ	S	DP	D	Delay/Phase
Advance ADJ	B1	>	J1	Source B1 routed to destination J1, no delay, normal phase
Advance ADJ	B1	D>	J1	Source B1 routed to destination J1, delayed, normal phase
Advance ADJ	B1	d>	J1	Source B1 routed to destination J1, delay assigned but not available, normal phase
Advance ADJ	B1	/	J1	Source B1 routed to destination J1, no delay, phase inverted
Advance ADJ	B1	D/	J1	Source B1 routed to destination J1, delayed & phase inverted
Advance ADJ	B1	d/	J1	Source B1 routed to destination J1, delay assigned but not available & phase inverted
Advance ADJ	B1	Mu	J1	Source B1 routed to destination J1, but muted
Advance ADJ	B2	>	J1	Further clockwise rotation selects next source, no delay, normal phase

Note: The column headings S (Source), DP (Delay/Phase) and D (Destination), represent the contents of the 10-digit display for valid destinations and sources.
ADJ rotation may be in either direction. Clockwise rotation follows the sequence illustrated, anti-clockwise rotation reverses the sequence. Choose rotation direction to reach the desired source and delay/invert/mute function as quickly as possible
See next section to set delay values.

Further source destination 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 (but not available) and phase inverted before final routing to channel 3 on the destination embedder.

Setting audio delays and silence detect delay

The amount of silence detect or threshold 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 detect delay 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 C 1+2 Del1 xxms	Set delay 'xx' for side 1, Embedder Channels C 1+2 using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
D	Audio delay C 3+4 Del2 xxms	Set delay 'xx' for side 1, Embedder Channels C 3+4 using ADJ shaft encoder in 1ms steps from 1 – 681ms	ADJ= delay
E	Silence detect delay Sil DL xxs	Set silence detect or 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 embedder channels C 1+2 and C3+4 are entered into the TANDEM-300 database the moment the ADJ shaft encoder is turned. 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 detect delay, where the shaft encoder changes assigned values, switch 1 of the MENU switch must be toggled between ON and OFF to save the new value in the TANDEM-300 database.

6.5 Setting audio gains

Audio gain may be set independently for each of the four audio channels leaving the TANDEM-300 embedding router. 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	AG1.1 100. Side 1 Audio Channel 1 set to unity gain.	ADJ= 0 to 799%
1	CH 2	AG1.2 100. Side 1 Audio Channel 2 set to unity gain.	ADJ= 0 to 799%
2	CH 3	AG1.3 100. Side 1 Audio Channel 3 set to unity gain.	ADJ= 0 to 799%
3	CH 4	AG1.4 100. Side 1 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.

6.6 Audio monitoring

Audio monitoring is provided at the card edge with a miniature stereo jack socket. The same signal can 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 DIL 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 analogue 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 normally fed to the AOP or DOP card. Phantom destination codes are used to allow the analogue monitoring output to select routed de-embedded audio even though an output option-card is not physically present
Audio monitoring is further discussed in section 10.3.

6.7 Enabling/disabling GPI inputs

The GPI inputs can be used to recall TANDEM-300 setups that have been stored previously. This recall function can be disabled from the card edge.

Ensure that all MENU DIL switch levers are 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

6.8 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 DIL switch 2 ON (DOWN)
- Select appropriate preset with the rotary SEL switch
- To store a preset put the MENU DIL lever-1 down and then up again
- To recall a preset put the MENU DIL lever-8 down and then up again

The status display will indicate the status of each preset 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.

Note: 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-300 at the same time as presets are being updated.

6.9 Data packet management settings

Contiguous packing

TANDEM-300 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.

The menu contiguous packing menu is obtained with MENU DIL, lever 5 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position 8 for side 1. The display will confirm TANDEM's selection of contiguous packing.

SEL	Display	Comments
8	SD1 contig	TANDEM always selects contiguous packing
9	Does not affect TANDEM-300	

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 DIL, 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-300 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 '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 'C' embedding is enabled, or if 'Mark for Deletion' or '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.

The EDH menu is obtained with MENU DIL, 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 DIL, 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 DIL 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-300 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-300 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 DIL 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	Not used by TANDEM-300	ADJ=XXXX

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

6.10 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 DIL 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

This function is used with AIP2, DIP2RS, and RS4 cards so that the embedded insert may carry a channel status message to indicate if the audio source was a true stereo signal, or two monaural signals. This message is also applied to AES outputs from the DOP2 cards when no input is present, or no AES message available.

6.11 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 DIL switch 5 is down.

SEL no	Display	Description	ADJ funct
E	S1AESph xxx	Use shaft encoder to select 0-127	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 127 for indication purposes only.

The AES output frequency is set by the frequency of the by the frequency of the video signal carried by the SDI signal. 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.

6.12 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 1/2 / De-embedder B

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'

Note: Silence detect delay is not applicable to any of the above alarms

Assigning GPI outputs

When only MENU DIL 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	Mode 1 examples and comments	ADJ funct
0	1.1sl mask or 1.1sl flag	Selects silence of audio ch 1 embedder C, or ch 1 de-embedder A if embedder is off, to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
1	1.2sl mask or 1.2sl flag	Selects silence of audio ch 2 embedder C or ch 2 de-embedder A if embedder is off to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
2	1.3sl mask or 1.3sl flag	Selects silence of audio ch 3 embedder C or ch 3 de-embedder A if embedder is off to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
3	1.4sl mask or 1.4sl flag	Selects silence of audio ch 4 embedder C or ch 4 de-embedder A if embedder is off to be flagged or ignored (mask) by the GPO 5 output.	ADJ= flag or mask
4	2.1sl mask or 2.1sl flag	Selects silence of audio ch 1 de-embedder B to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
5	2.2sl mask or 2.2sl flag	Selects silence of audio ch 2 de-embedder B to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
6	2.3sl mask or 2.3sl flag	Selects silence of audio ch 3 de-embedder B to be flagged or ignored (mask) by the GPO 6 output.	ADJ= flag or mask
7	2.4sl mask or 2.4sl flag	Selects silence of audio ch 4 de-embedder B 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
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 an AES reference is input to that sub-board.*	ADJ= rfflg or rfmask
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 2 input is unaffected by this option.*	ADJ= inflg or inmask
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 an AES reference is input to that sub-board.*	ADJ= rfflg or rfmask

Note: 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.

6.13 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 SDI PLL mode

Select the PLL mode from Off or Sdi 1 (Sdi 2 is not supported by TANDEM-300).

Note: An explanation of the PLL function may be found in the Introduction and the appropriate mode section of the Statesman chapter.
Menus for SEL positions 3 to F are not used or for factory use only.

6.14 Operating mode

TANDEM-300 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	Display	Comments
0	MODE = 30X	Not supported by TANDEM-300 – do not use
1	SET MODE = X	Not supported by TANDEM-300 – do not use

6.15 Miscellaneous functions

Firmware version number

The TANDEM-300 firmware version number is obtained with MENU DIL, lever 6 ON (DOWN), all other levers UP (OFF**)** and the SEL switch in position D.

SEL	Display	Comments
D	TANDEM 6.00	TANDEM firmware version number

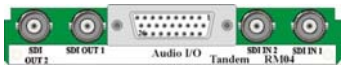
Note: Menu C and additional menus beyond D are for Crystal Vision engineering staff only.

7 Installation

TANDEM-300 may be fitted into three of the Crystal Vision range of rackframes:

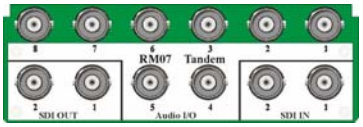
- FR2AV 2U frame for up to 12 TANDEMs or other single height Crystal Vision modules,
- FR1AV 1U frame for up to 6 TANDEMs or other single height Crystal Vision modules
- DTB-AV 1U Desk top box for up to 2 TANDEMs or other single height Crystal Vision modules.

There are six 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.



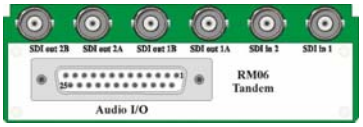
RM04

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



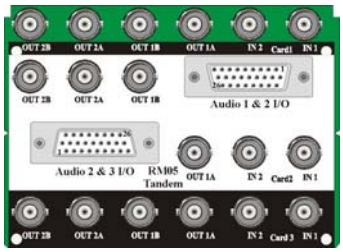
RM07

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



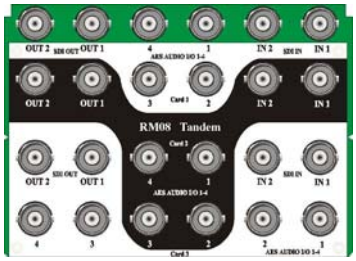
RM06

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



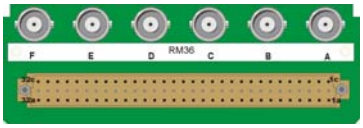
RM05

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

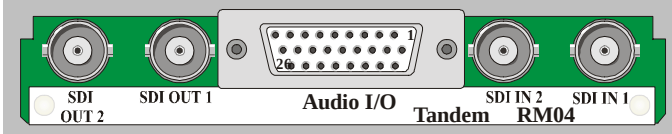
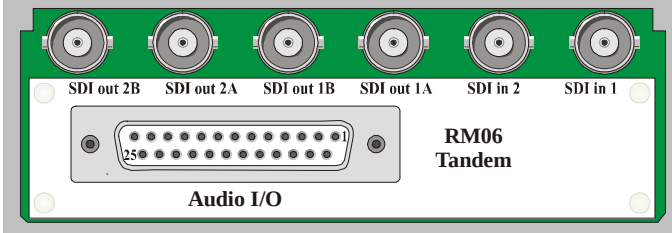
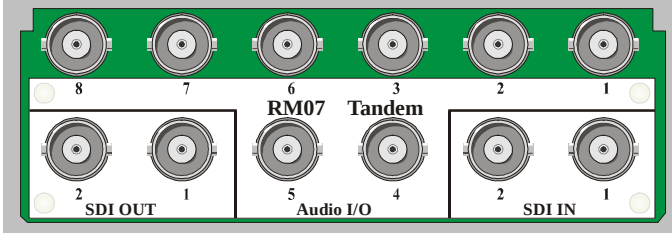
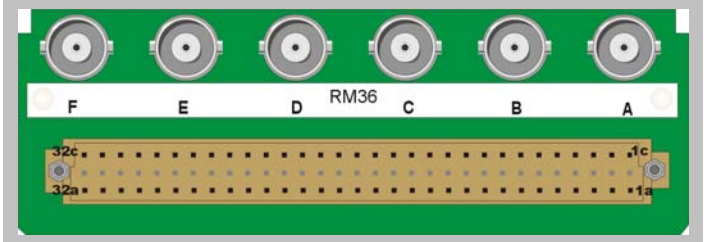
6 TANDEMs in 2U 3 in 1U
Analogue / 110Ω digital audio
2nd SDI output

The single-width rear connector achieves maximum card density with up to 12 TANDEM cards in a FR2AV 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.

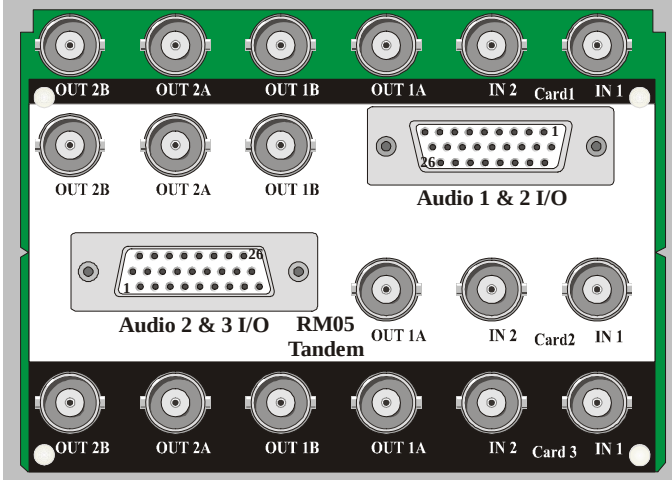
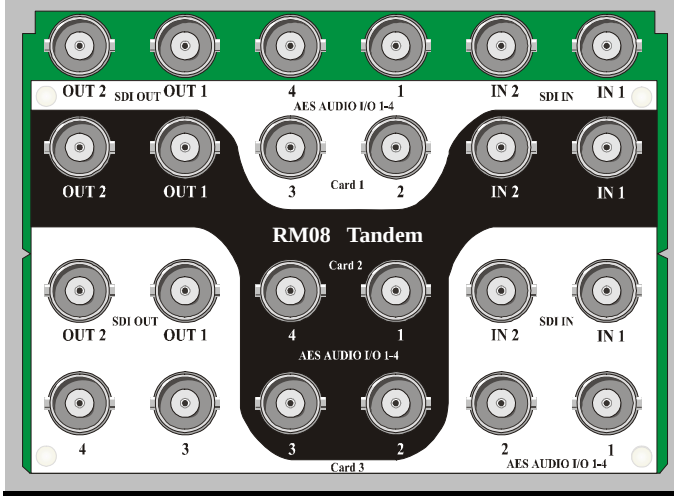
The loss of second SDI output can be avoided by using a taller rear module. A double-height single card rear module allows access to all connections at six cards per 2U frame and three cards per 1U frame. A special all-connection triple card rear module achieves nine cards per 2U frame.

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 FR2AV 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

Note: 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.
TANDEM-300 does not use SDI 2 OUT on any rear connector.

Rear Connectors	Description
	**RM05** • 9 TANDEMs in FR2AV 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 FR2AV 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

Note: 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.
TANDEM-300 does not use SDI 2 OUT on any rear connector.

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

7.1 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 has 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+ (AES mon 1)				21
Mon L- (AES mon 2)				22
GND				23
GND				24
Mon R+ (AES mon 3)				25
Mon R- (AES mon 4)				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: AES/EBU monitor outputs are unbalanced. SD 1 denotes 'side 1', SD 2 denotes 'side 2'.

RM06 pin-out

The **RM06** normal density 25 way 'D' female socket has 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-300 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-300 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
SD 2 1L+	SD 2 AES1+	SD 2 AES1a+	SD 2 AES1a	c17
SD 2 1L-	SD 2 AES1-	SD 2 AES1a-	GND	c19
SD 2 1R+	SD 2 AES1scrn	SD 2 AES1b+	SD 2 AES1b	c20
SD 2 1R-	NC	SD 2 AES1b-	GND	c22
SD 2 2L+	SD 2 AES2+	SD 2 AES2a+ OR AES ref+	SD 2 AES2a+ OR AES ref+	c23
SD 2 2L-	SD 2 AES2-	SD 2 AES2a- OR AES ref-	SD 2 AES2a- OR AES ref-	c25
SD 2 2R+	SD 2 AES2scrn	SD 2 AES2b+	SD 2 AES2b	c26
SD 2 2R-	NC	SD 2 AES2b-	GND	c28
NC	NC	NC	NC	c29
Common Connections				
Mon L+				a2
Mon L-				a3
Mon R+				a5
Mon R-				a6
GPI 1				a16
GPI 3				a17
GPI 5				a18
GPI 2				a19
GPI 4				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

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

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

7.2 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.

7.3 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 1/2 De-embedder B

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.

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

DTB-AV 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. Frame ground is pin 15.

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)

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

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.

7.4 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:

FR2AV Frame

Active slot used with RM06/RM07	Active slots used with RM05/RM08	REMOTE 1 pins Analogue: L+, L-, R+, R- AES: mon1, mon2, mon3, mon4	REMOTE 3 pins Analogue: L+, L- R+, R- AES: mon1, mon2, mon3, mon4
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

FR1AV Frame

Active slot used with RM06/RM07	REMOTE 1 pins Analogue: L+, L-, R+, R- AES: mon1, mon2, mon3, mon4
1	7, 16, 17, 25
3	4, 14, 13, 23
5	10, 11, 19, 20
GND	2

Analogue and (AES/EBU) monitoring

DTB-AV Frame

Active slot used with RM06/RM07	REMOTE 1 pins Analogue: L+, L-, R+, R- AES: mon1, mon2, mon3, mon4
1	9, 10, 11, 12
GND	2

Analogue and (AES/EBU) 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-300 has a very powerful 16-source audio monitor router. The dual channel output is converted to a balanced stereo signal and is fed to the card edge headphone socket. The same signal can also be made available at the rear connector. Any of the following 16 stereo audio signal sources may be selected:

- 8 de-embedder outputs; A1+2, A3+4, B1+2 and B3+4
- 8 de-embedder router feeds to output sub-PCB cards; I1+2, I3+4, J1+2 and J3+4, if available (routing may affect channel assignment)
- 8 direct input sub-PCB card outputs; G1+2, G3+4, H1+2 and H3+4, if available
- 8 embedding router feeds to embedders; C1+2, C3+4, D1+2 and D3+4

The analogue output is in the form of four wire connections, 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 an analogue monitoring bus output is selected, 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.

If an AES monitoring bus is selected, the 4 wires may be re-assigned to the AES bus. These same connections will then carry unbalanced digital audio as AES_mon_1, AES_mon_2, AES_mon_3 and AES_mon_4.

The AES bus is NOT selectable in the same way as the analogue monitoring output. The 4 AES monitor outputs are automatically routed as follows:

Side 1	De-embedder A ON	Input card fitted (excluding Mode 3)	De-embedder A OFF or no input card #1
AES mon 1	si1A 1 + 2	ai1G 1 + 2	'-' digital silence
AES mon 2	si1A 3 + 4	ai1G 3 + 4	'-' digital silence

Side 2	De-embedder B ON	Input card fitted (excluding Mode 3)	De-embedder B OFF or no input card #2
AES mon 3	si2B 1 + 2	ai2H 1 + 2	'-' digital silence
AES mon 4	si2B 3 + 4	ai2H 3 + 4	'-' digital silence

AES silence will be output if there is no suitable source for that AES output and if Demux A or B are set to ON, but have no selected Audio Group input present. Column three does not apply to Mode 3, as RS4 cards can not receive any external signal inputs.

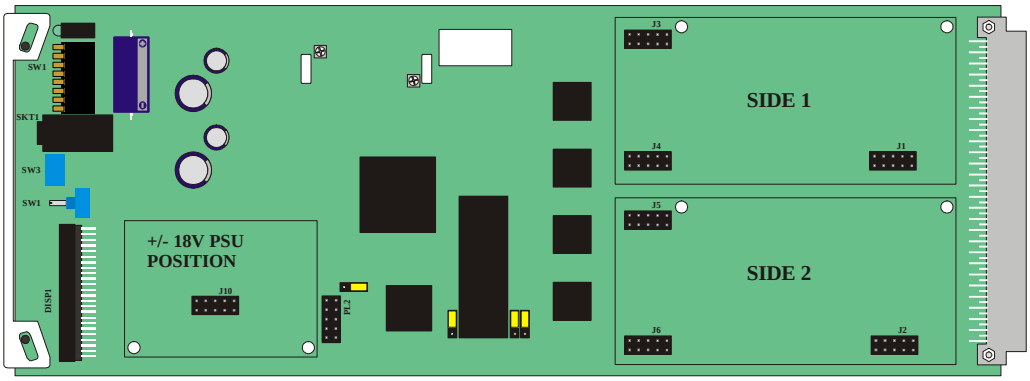
A number of TANDEM-100, TANDEM-300 and Demon modules may be wired to a shared pair of active loudspeakers. Audio levels to be monitored via the analogue bus or using headphones should not exceed +10 VU (-8 dBFS) or overload distortion may occur.

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.

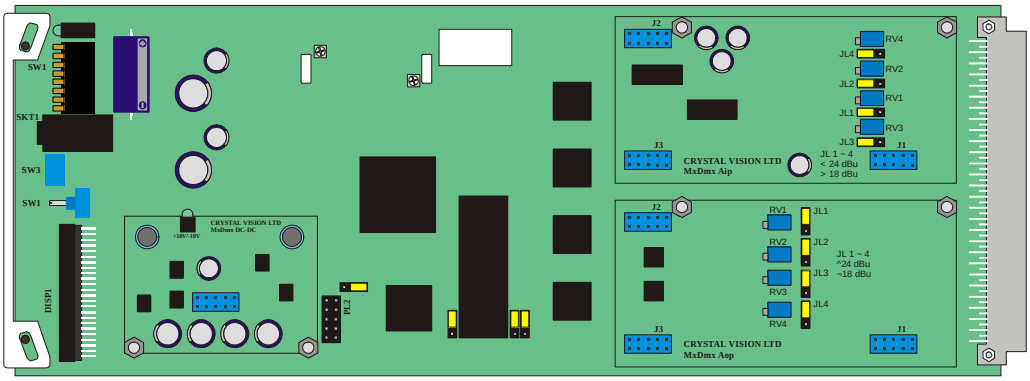
TAD202 has a dedicated analogue audio bus output, which can NOT be switched to a high impedance state. TAD202 can not share the same analogue bus connections as TANDEM-100, TANDEM-300, & Demon.

7.5 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.



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



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

To fit a sub-module proceed as follows:

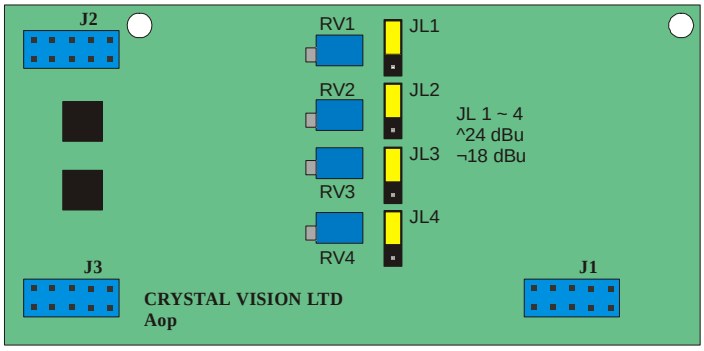
- ensure that all static electricity precautions have been taken
- fit two module retaining screws (3x10mm) from below the main PCB, and add a nylon spacer (3x3mm) on top of the TANDEM PCB to each screw for each sub-module location – hold screws firmly in place
- offer up the chosen sub-module to its 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 (status menu 5) explained in section 9.2.

7.6 Sub-module link settings

AOP2

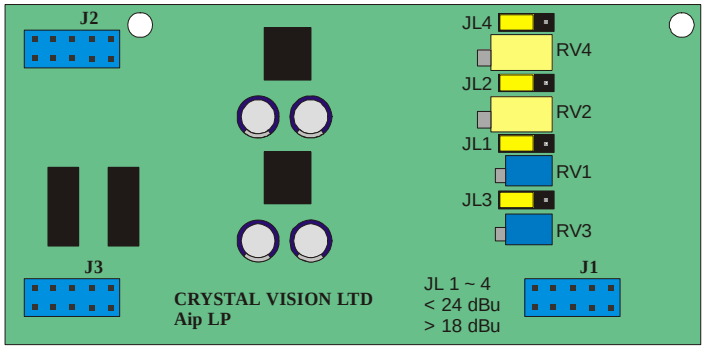


The analogue audio output module provides 2 stereo pairs or four mono outputs that may be used as destinations when routing de-embedded signals. Link jumpers are provided to allow 0dBFS to be set to +18dBu or +24 dBu. The variable adjustments on the card are set at the factory and should not require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

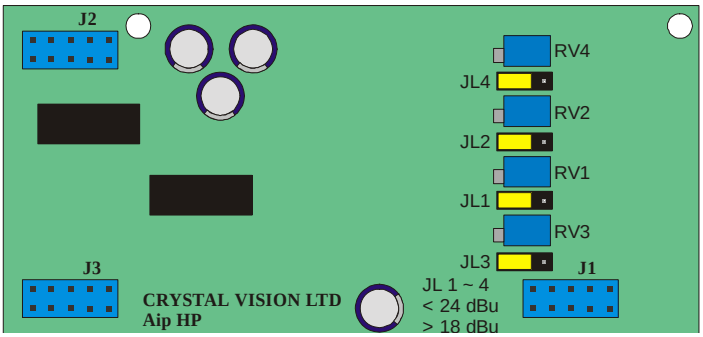
Selectable jumper links are provided to change input and reference terminations and pre-set levels, depending on sub-module features.

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.*



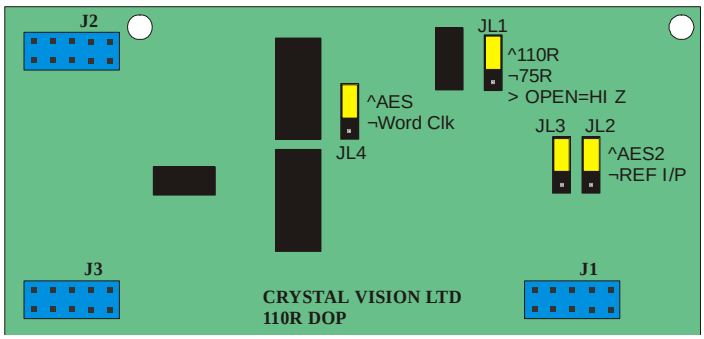
AIP2-HP



This analogue audio input module provides identical connections to the standard AIP2, but with better performance. The higher power requirement means that TANDEMs fitted with one or two of these modules should be associated with a vacant slot. For this reason it is best used with the RM06 or RM36 (one card in two slots) or with the RM05 (two cards in slots 1 & 3 out of four), which provide the maximum available connections.

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.*

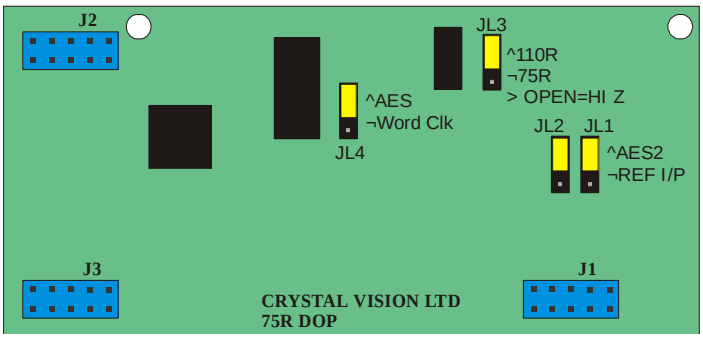
DOP2-110



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.

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).

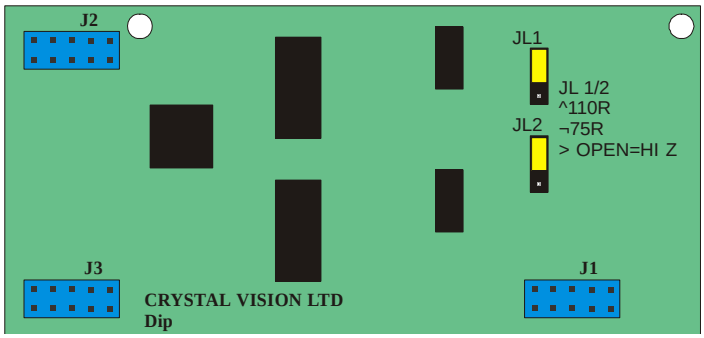
DOP2-75



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.

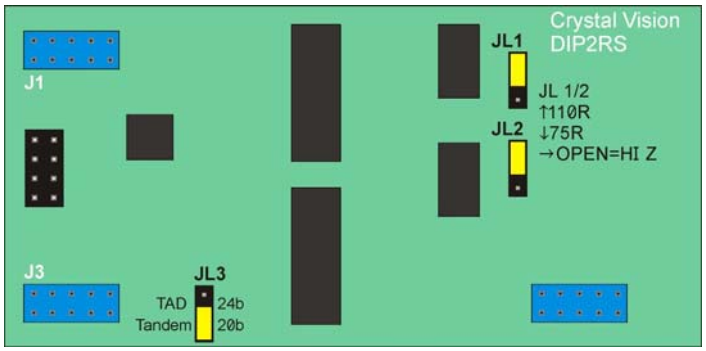
In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06 and RM36 rear modules, in place of a 2nd buffered output. The reference may be selected between AES reference or word clock with JL4. Use JL1 and JL2 together to select between AES2 (2nd 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. 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.

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.

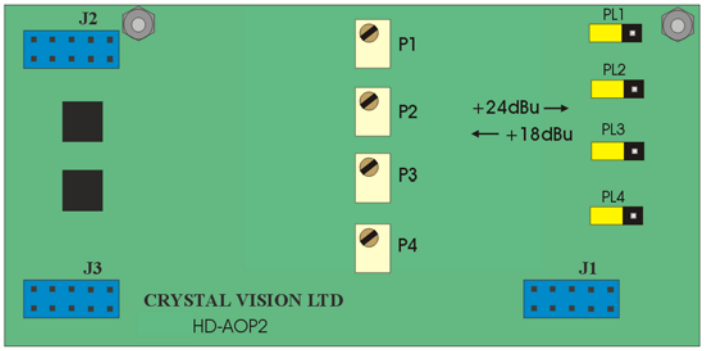
If the V bit is consistently high, to indicate continuous error states, or to indicate non audio data, then the processor will give a silent output. All other cards, except RS4, pass audio data unaltered even when V bit is set or held high.

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.

Note: 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.

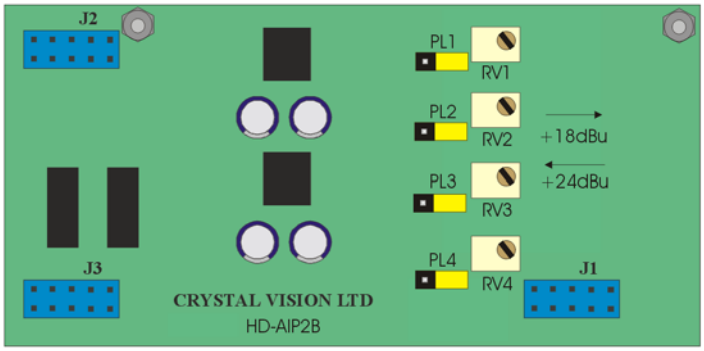


HD-AOP2

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

HD-AIP2

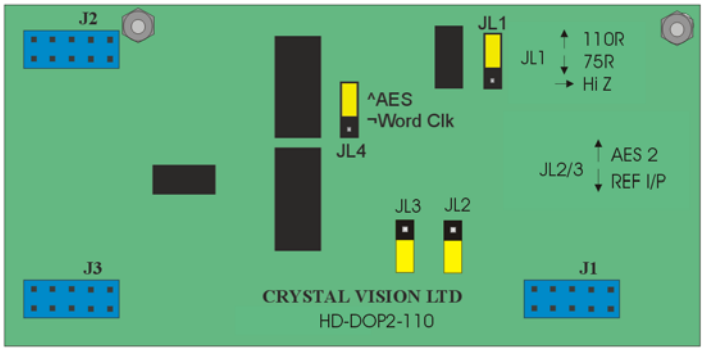
The analogue audio input module provides two stereo pairs or four mono signals that may be used as a source in subsequent embedding. Link jumpers are provided to allow 0dBFS to be set to +18dBu (rearwards, towards J1) or +24dBu (forwards, towards J2/3). The variable adjustments on the card are set at 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.

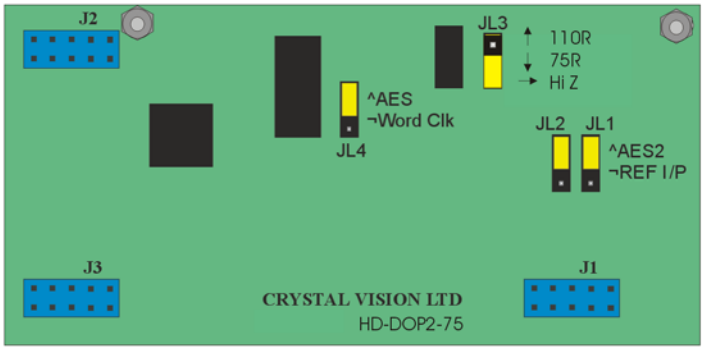


HD-DOP2-110

In addition, jumper links are provided to configure an optional external reference when using the RM04, RM05 RM06and 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.

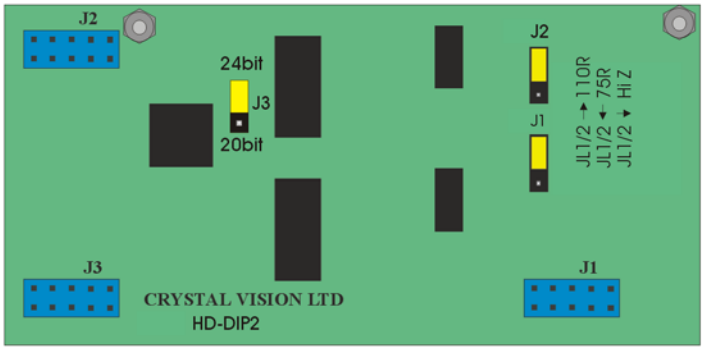


HD-DOP2-75

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.

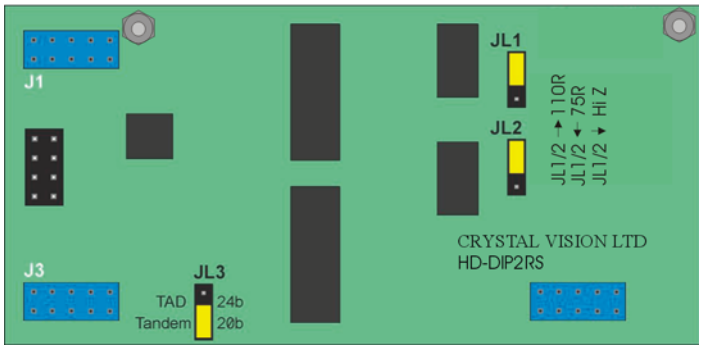


HD-DIP2

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-300 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.

8 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.

8.1 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

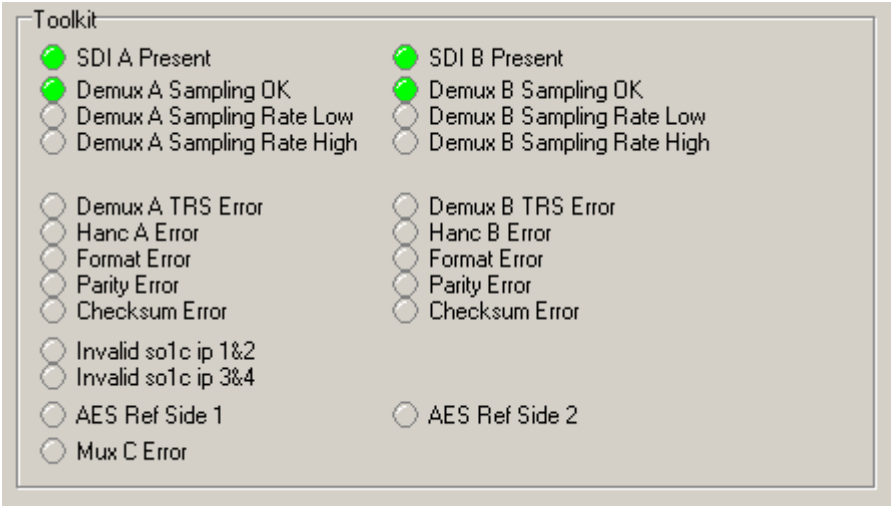
8.2 Card edge error messages

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	Does not affect TANDEM-300
Switches?	More than one menu switch in the DOWN position
No DC-DC	No dc-dc converter fitted (when analogue i/o)

8.3 Statesman error reporting

The Statesman Toolkit, which is accessible from the Audio Delay tab, has been provided to provide comprehensive error reporting and status information.



TANDEM-300 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’ embedder is 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’ 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

Note: Card–edge warnings do not appear within Statesman.

8.4 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

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 embedded audio of SDI 1 AND SDI 2 is synchronous with the same source as the video content of both SDI signals. TANDEM-300 cannot process asynchronous sources, though time offset is allowed.

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 Trouble Shooting menus on the next pages for further help

8.5 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).

There are two general formats for these status reports. If possible the status for each TANDEM-300 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	Not used by TANDEM-300
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-300 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-300 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 another embedder in a second TANDEM module to insert the new audio.

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	Not used by TANDEM-300
B	Mx_xx_yy Codes: Ctg, Ovr, Blk, Del, na	SDI1 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 8.2 and the Ancillary Data Status menu discussed in section 8.2/8.8 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 8.5

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	Card-edge section
all up	0 - 5	display status	6.2
	6 - 9	select audio group	6.2, 6.4
	A, B	select audio monitor	6.2, 6.6
	C, D	adjust audio delay	6.2, 6.4
	E	adjust silence time	6.2, 6.4
	F	GPI enable / disable	6.2. 6.7
2 only down	0 - 15	preset 0-15 save / recall	6.8
3 only down	0 - 1	display mode	6.14
	2	SDI PLL mode	6.13
	3 - F	Not used by TANDEM-300	6.15/16
4 only down	0 - F	configure audio routing	6.4
5 only down	0, 1	select error handling level	6.9
	2 - 5	embed / de-embed formats	6.9
	6, 7	select stereo/dual mono	6.10
	8, 9	contiguous pack (embed) – always contig	6.9
	A, B	Blank HANC	6.9
	C, D	EDH on/off	6.9
	E, F	adjust AES phase	6.11
5&6 only down	0-3	Audio gain menus for Embedder output channel 1-2	6.5
6 only down	0-9	GPI output error masking	6.12
	B	load default settings	6.3
	C	diagnostic data	n/a
	D	firmware version number	6.15
	E, F	display ancillary data status	6.2, 6.9
7 only down	0-5	De-embedded signal status	6.2, 8.5
	6-8	General status	6.2, 8.5
	9-C	Output signal status	6.2, 8.5

9 Specification

TANDEM-300 motherboard

Inputs

Video	2 channel Serial Digital Component (SDI) 270Mbit to EBU 3267-E & SMPTE
Cable equalisation	>200m Beldon 8281 or equivalent (video)
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	1 channel Serial Digital Component (SDI) 270Mbit to EBU 3267-E & SMPTE 259M (Audio is embedded to SMPTE or SONY format) with four buffered outputs when using suitable rear connectors
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
	AES/EBU monitoring also available on rear connector
Crystal oscillator	For continuous AES/EBU output at all times
Embed/de-embed timing	Inter-channel variation: less than 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 1.141µs
	Round trip audio delay measured by taking de-embedded audio output from side 2, and re-embedding into side 1.
	Minimum times with SDI PLL set to OFF (actual times may vary with Mode & other selections). Selecting SDI PLL ON will add a variable amount of delay of between 0.6 and 8.9 microseconds, dependant on the severity of jitter and wander of the incoming SDI 270 Mb/s clock rate.
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
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 detect delay	Silence detect delay for both sides is adjustable for the 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
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.
Total harmonic distortion	0.003% THD+N rms., 22Hz to 22kHz typ.
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
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.
Total harmonic distortion	0.002% THD+N rms., 22Hz to 22kHz typ.
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

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 Each of the two AES signal outputs has a second buffered output, which may be available dependant on the RM module fitted.
Reference	Available instead of 2nd buffered output on some rear connector modules. Link selected May be AES reference or Word clock – link select