REVISION HISTORY

REVISION	DESCRIPTION	DATE
1.0	Original Version	Apr 02
1.1	Added section 4.2 on channel status LEDS	Apr 02
1.2	Added warning on connecting shields for balanced audio connections	Aug 03

1. OVERVIEW

The 7720DAC-A4 is a high-quality, 24-bit, digital to analog audio converter that provides conversion of 2 AES channels to 4 balanced analog audio channels.

The incoming sample rate may be either 48 kHz or 44.1 kHz, both within ±100 ppm limits. The 7720DAC-A4 will autodetect the sample rate. Level control is provided via a card edge rotary knob and toggle switch and the level can be read out from a card edge display for convenience. The full scale analog signal can be calibrated to accommodate peak levels ranging from +12 dBu to +25 dBu with 0.1 dB steps.

The audio DAC features a card edge PPM meter for quick confidence monitoring. Four separate peak volume indicators are provided via bargraphs for quick validation of audio program material.

Features

- 24-bit, high-quality digital to analog audio conversion
- Support for 4 channels of audio
- Separate versions available for balanced or unbalanced AES
- AES channels 1 & 2 are fully independent
- 48 kHz and 44.1 kHz sample rates with automatic detection
- Automatic input AES equalizer for both coax and twisted pair inputs
- Low impedance (66 ohm) balanced output drive
- Can drive 600 ohm loads up to +24 dBm
- Output short protection, inaudible on adjacent channels
- Analog audio output levels are set by software control using card edge control and an LED display
- 0 dBFS programmable from +12 dBu to +25 dBu in 0.1 dB steps with hi-Z loads
- 0 dBFS programmable from +12 dBm to +24 dBm in 0.1 dB steps with 600 ohm loads
- A card edge display provides a 4 channel bargraph type peak volume indicator display for confidence monitoring
- To help with level calibration, the display can show received digital peak levels for each channel as numerical dBFS values. It is accurate between 0 and -80 dBFS with 1 dB resolution, updated once a second.
- High jitter immunity

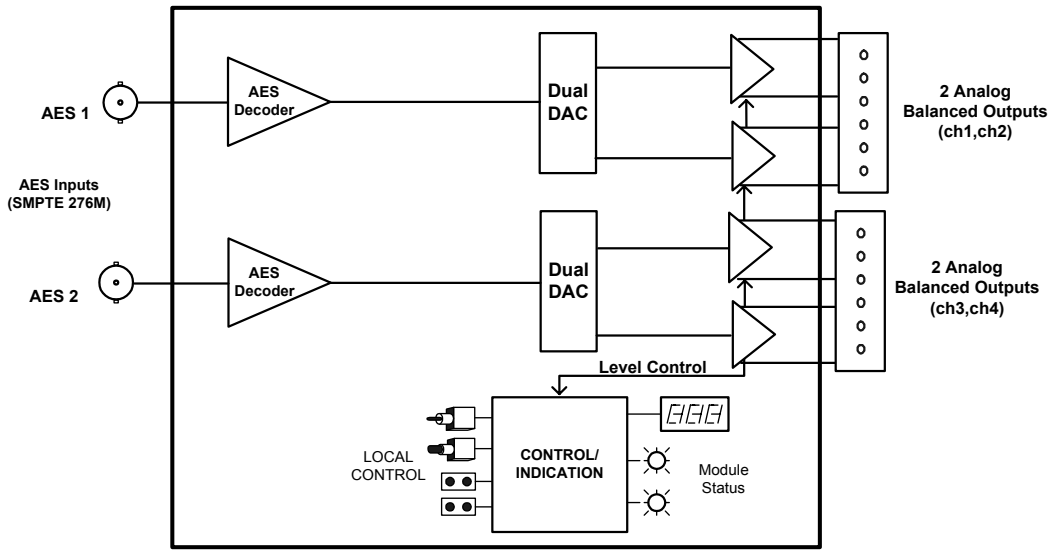

Figure 1: 7720DAC-A4 Block Diagram

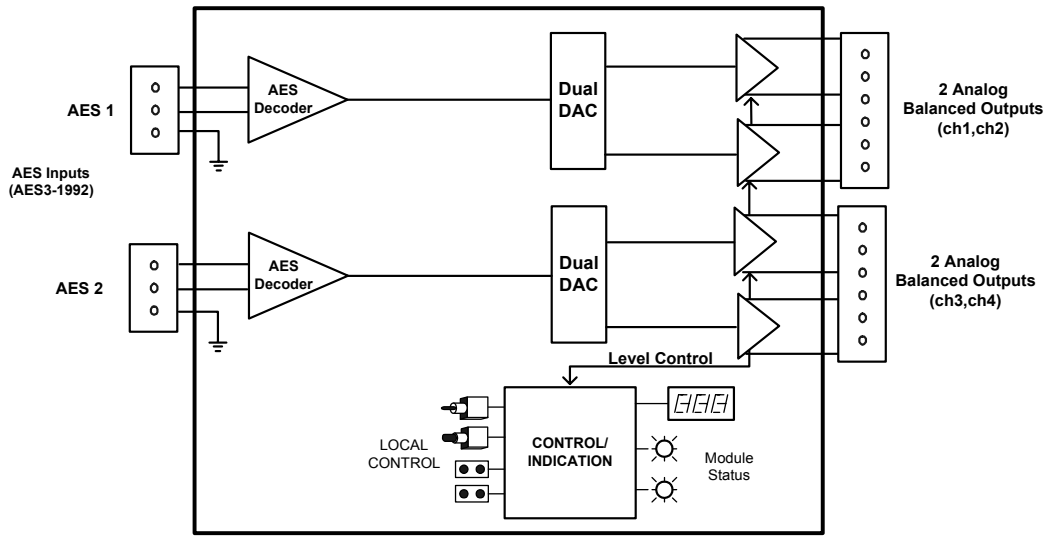

Figure 2: 7720DAC-A4-B Block Diagram

2. INSTALLATION

The 7720DAC-A4 modules each come with a companion rear plate that has 2 BNC connectors and two 6 pin terminal strips. The 7720DAC-A4-B modules convert balanced AES audio and each come with a companion rear plate that has 2 3 pin terminal strips and two 6 pin terminal strips. For information on mounting the rear plate and inserting the module into the frame see section 3 of the 7700FR chapter.

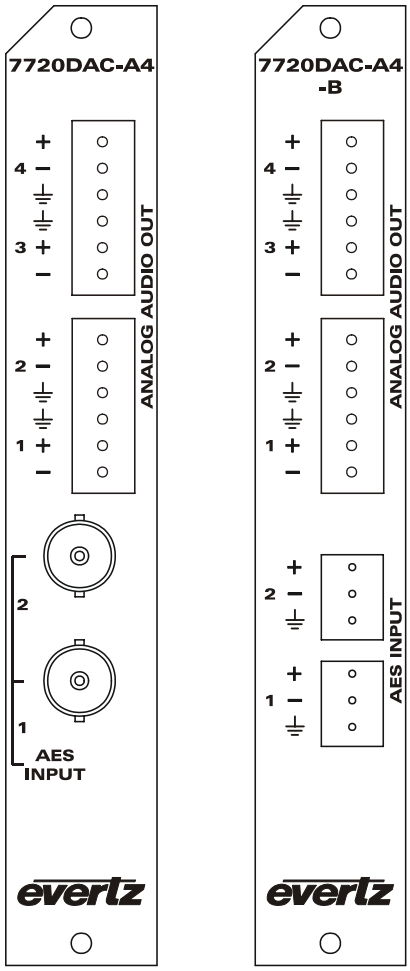

Figure 3: 7720DAC-A4 Rear Panels

2.1. AES AUDIO CONNECTIONS

The 7720DAC-A4 converts unbalanced AES audio and has two BNC connectors for inputting unbalanced AES signals compatible with the SMPTE 276M standard. The 7720DAC-A4-B converts balanced AES audio and has two 3 pin terminal strips for inputting balanced AES signals compatible with the AES3-1992 standard. The input audio cables can be secured into the removable portion of the terminal strips using a small screwdriver. The removable part of the terminal strip is then inserted into the rear panel.

2.2. ANALOG AUDIO CONNECTIONS

The 7720DAC-A4 has two 6 pin terminal blocks containing balanced analog audio that has been converted from the input AES audio. The output audio cables can be secured into the removable portion of the terminal strips using a small screwdriver. The removable part of the terminal strip is then inserted into the rear panel. The left/right channels from the AES IN 1 input will come out the Analog Audio 1 and 2 outputs respectively. The left/right channels from the AES IN 2 input will come out the Analog Audio 3 and 4 outputs respectively.

Caution should be exercised when connecting cable shield to the "shield ground" as this input has only a limited tolerance for any arising ground loop currents.

When using 7720DAC-A4, the shield should be connected at one end of the cable, only. Which end of the cable shield should be grounded, source or destination, is a matter of local practice / preference. For an authoritative guide to cable shield connections, please refer to Rane Note 151 ("Grounding and Shielding Audio Devices", http://www.rane.com/pdf/note151.pdf). For the purposes of interpreting this very thorough application note, be advised that 7720ADC-A4 connector pin "shield ground" is internally connected to "signal ground" (not "chassis ground").

Shield ground loops currents may arise, if the source equipment "shield ground" potential is significantly different from 7720ADC-A4 local power ground and the shield is grounded at both ends. The card can tolerate about 0.5A of any resulting ground loop current. Exceeding this limit risks causing catastrophic failure of the card.

3. SPECIFICATIONS

3.1. UNBALANCED AES AUDIO INPUTS (7720DAC-A4)

Number of Inputs:	2
Standard:	SMPTE 276M, unbalanced AES
Connectors:	BNC per IEC 169-8
Signal Level:	0.1 to 2.5 Vp-p
Equalization:	>1000m @ 48kHz with 1 Vp-p drive and Belden 8281 or equivalent coax cable
Resolution:	24 bits
Sample Rate:	44.1, 48 kHz; ±100 ppm (other rates between 42 - 50 kHz will remain audible but somewhat distorted)
Input Impedance:	75 Ω, AC-coupled
Return Loss:	< 25 dB, 0.1 - 6.0 MHz
BNC Grounding:	AC-coupled (for 60 Hz ground loop current protection)

3.2. BALANCED AES AUDIO INPUTS (7720DAC-A4-B)

Number of Inputs:	2
Standard:	AES3-1992, balanced AES
Connectors:	3 pin removable terminal strip
Signal Level:	0.2 to 10.0 Vp-p
Equalization:	>400m @ 48kHz with 2 to 10 Vp-p drive and Belden 1800B or equivalent shielded twisted pair cable
Resolution:	24 bits
Sample Rate:	44.1, 48 kHz; ±100 ppm (other rates between 42 - 50 kHz will remain audible but somewhat distorted)
Input Impedance:	110 Ω ± 10%, transformer coupled
Shield Grounding:	AC-coupled (for 60 Hz ground loop current protection)

3.3. ANALOG AUDIO OUTPUT:

Number of Outputs: 4
Type: Balanced analog audio
Connector: two 6 pin removable terminal strips
Output Impedance: 66 Ω
Signal Level: 0dB FS => +12 to +25 dBu into 10 K ohm load (user settable)
0dB FS => +12 to +24 dBu into 600 ohm load
Frequency Response: < ± 0.05dB (20Hz to 20kHz)
Dynamic Range: 24 bits
THD+N: < -100dB RMS @ 20Hz to 20kHz, with 24dBu output, unweighted
SNR: > 110dB RMS (20Hz to 20kHz), unweighted
Crosstalk Isolation: > 110dB RMS (20Hz to 20kHz), unweighted
Inter-Channel Phase Error: < ± 1° (20Hz to 20kHz)
Digital to Analog Delay: 0.95m Sec

3.4. ELECTRICAL

Voltage: + 12VDC
Power: 12 watts
EMI/RFI: Complies with FCC Part 15, class A and EU EMC directive.

3.5. PHYSICAL

7700 or 7701 frame mounting:
Number of slots: 1

Stand Alone Enclosure:
Dimensions: 14 " L x 4.5 " W x 1.9 " H (355 mm L x 114 mm W x 48 mm H)
Weight: approx. 1.5 lbs. (0.7 Kg)

4. STATUS INDICATORS

The 7720DAC-A4 has 2 LED modules status indicators, 8 LED audio channels status indicators, and a 4 digit alphanumeric display on the front card edge to show operational status of the card at a glance. The card edge pushbutton is used to select various displays on the alphanumeric display. The location of the status LEDs is shown in Figure 5.

4.1. MODULE STATUS LEDS

MODULE OK This Green LED will be On when the module is operating properly

LOCAL FAULT The LED will be on solid when there is a fault in the module power supply or its digital electronics are failing their self-test.

4.2. CHANNEL STATUS INDICATOR LEDS

On the card edge, each channel has two indicator LEDs: one red (bottom side of the card) and one green (top side of the card). The group of LEDs closest to the toggle switch represents CHANNEL 1 (left channel in AES input 1), followed by LEDs for CHANNEL 2, 3, and 4. The table below summarizes their meaning:

Green LED	Red LED	Meaning
Off	Solid RED	Input AES is not recognized: There is no input, or cable length is too long, or sample rate is outside of 42-50 kHz range The analog outputs will be muted
Flickering GREEN	Flashing And flickering RED	Input AES is between 42-50 kHz but the signal is getting too weak to recognize The analog output audio will show a varying degree of distortion
Solid GREEN	Flashing RED	Input AES is between 42-50 kHz but it is outside of both 44.1 kHz (±100 ppm) and 48 kHz (±100 ppm) specs The analog output audio should be intelligible but will show a varying degree of distortion
Solid GREEN	Off	valid AES input

Table 1: Card Edge CHANNEL Status LEDs

4.3. DOT-MATRIX DISPLAY

Additional signal and status monitoring is provided via the 4-digit dot-matrix display located on the card edge. The rotary switch position determines what is displayed on the dot matrix display. When it is set to position 0, the input audio peak levels are shown using bar graphs on the display. Pressing the toggle switch up when the rotary switch is at position 0 will orient the display vertically; pressing the toggle switch down will orient the display horizontally. When it is set to 1 to 4 the peak level corresponding to 0 dBFS input for each of the channels will be displayed, and can be set using the toggle switch (see section 5.1.1). When the rotary switch is at position 5, the display will show lock status and the detected sample rates for each AES input (see section 4.3.2). When the rotary switch is at position 6, the display will show the numerical values of peak levels found in each input channel (see section 4.3.3).

4.3.1. Audio Level Bar Graphs

When the rotary switch is set to position 0, each section of the dot matrix display shows a bar graph representation of the peak level for one of the audio channels. Channel 1 is shown on the left (top) section and channel 4 is shown on the right (bottom) section. Each section of the display is comprised of a 5 x 5 array of dots. Diagonal rows of dots represent one of 9 different signal peak levels as shown below.

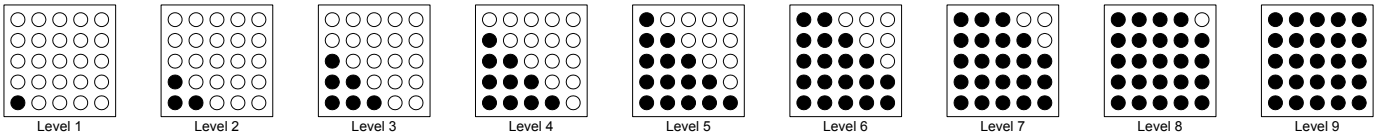

Figure 4: Bar Graph Displays

The signal levels shown in Table 2 are nominally in dBFS units. Table 2 also shows the peak levels in dBu when the peak level is set so that 24 dBu = 0 dBFS (see section 5.1.1). The ballistics of the bar graph

display follow the AES/EBU guidelines and have the attack time constant set to 0 seconds, and the decay time constant set to 1.5 seconds / 20 dB.

Bar Graph Level	dBFS	dBu
Level 1	-60	-36
Level 2	-36	-12
Level 3	-30	-6
Level 4	-24	0
Level 5	-21	3
Level 6	-18	6
Level 7	-15	9
Level 8	-12	12
Level 9	-6	18

Table 2: Bar Graph Levels

4.3.2. Detected Sample Rate Display

When the rotary switch is set to 5, the display will show lock status and the detected sample rates for each AES input. The left (or top) two digits will show the rate of AES 1, and the right (or bottom) two digits will show the rate of AES 2. Table 3 summarizes the meaning of the display content:

Display	Meaning
XX	input AES is not recognized: there is no input, or cable length is too long, or sample rate is outside of 42 - 50 kHz range the analog output audio will be muted
44 (flashing)	Input sample rate is between 42 - 46 kHz and it is either outside of 44.1 kHz (±100 ppm) spec or the signal is getting too weak to recognize. The analog output audio should be intelligible but will show a varying degree of distortion
48 (flashing)	Input is between 46 - 50 kHz and it is either outside of 48 kHz (±100 ppm) spec or the signal is getting too weak to recognize. The analog output audio should be intelligible but will show a varying degree of distortion
44	valid 44.1 kHz (±100 ppm) input
48	valid 48 kHz (±100 ppm) input

Table 3: Sample Rate Display

4.3.3. Detected Numerical Peak DBFS Levels Display

When the rotary switch is set to 6, the display will show the numerical values of peak levels found in each input channel. By using the toggle switch, the display can be changed to display any 1 of the 4 input audio channels. Each time, the display will show the channel number, followed by the "-" (minus) sign, and a 2 digit number representing the detected peak level in dBFS.

E.g.: if the display reads "2-13", then it means that channel 2 (the right channel in AES 1) had peak levels reaching -13 dBFS.

If the input doesn't lock properly, the peaks will read as "??".

This measurement is updated about once a second and is accurate to within 1 dB from 0 down to -80 dBFS. Below –80 dBFS, the displayed value is only approximate.

5. CARD EDGE CONTROLS

On the card edge there is a toggle switch and a ten position rotary switch that are used to choose what will be displayed on the dot matrix display, and to set the gain for each of the analog channels.

5.1. AUDIO LEVELS, HEADROOM, CLIPPING AND THE BAR GRAPHS

This section contains notes to understand how the 7720DAC-A4 relates analog audio levels, digital audio levels, and the displayed bar graph levels.

Before you can calibrate the audio digital to analog converter, you must know a couple of system issues specific to your application. What is your customary analog reference level and how much headroom do you have in the digital audio signal? By adding these two values together, you will get the analog peak output level that corresponds to saturated digital word (i.e.: the highest level that can be represented without distortion with the digital numbers). This level is called 0dB FS (FS stands for "full scale"). For instance, if your analog program reference level (also known as “standard operating level” or SOL) is 4dBu and you have 20dB of headroom in the "digital world", then 0dB FS should correspond to an analog level of 24dBu. Once the audio output level is calibrated, when you apply a –20dBFS digital signal, the analog level will be4dBu.

The AES input audio and the bargraphs are all based on the digital quantized signal. The card edge bargraph display is scaled to 0dB FS.

5.1.1. Audio Level Calibration

The toggle switch and rotary switch on the card edge of the 7720DAC-A4 allow independent audio level control of all four channels. To set the level of one of the audio channels, select the channel number using the rotary switch. The corresponding channel number will be displayed on the dot matrix display. Alternately, the current level setting for the selected channel will be displayed. This level is shown in dBu units. To increase the level, press the toggle switch in the up (toward the dot matrix display) position. To decrease the level, press the toggle switch down. The level is adjusted in 0.1 dBu steps, and will be displayed on the dot matrix display. To adjust the gain for other channels first select the channel using the rotary switch then adjust the level using to toggle switch. When you are finished setting the levels, return the rotary switch to position 0. The calibrated levels will be saved and recalled after a power loss.

6. JUMPERS

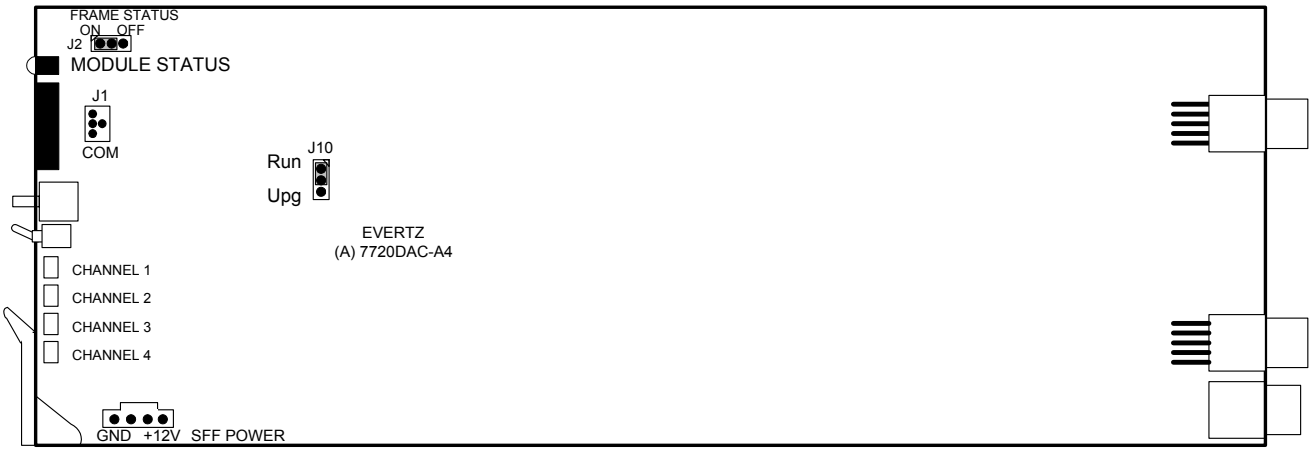

Figure 5: Location of Jumpers

6.1. SELECTING WHETHER LOCAL FAULTS WILL BE MONITORED BY THE GLOBAL FRAME STATUS

FRAME STATUS

The FRAME STATUS jumper J2 located at the front of the module determines whether local faults (as shown by the Local Fault indicator) will be connected to the 7700FR frame's global status bus.

To monitor faults on this module with the frame status indicators (on the Power Supply FRAME STATUS LED's and on the Frame's Fault Tally output) install this jumper in the On position. (Default)

When this jumper is installed in the Off position, local faults on this module will not be monitored.

6.2. CONFIGURING THE MODULE FOR FIRMWARE UPGRADES

UPGRADE

The UPGRADE jumper J10 located at the front of the module is used when firmware upgrades are being done to the module. For normal operation it should be installed in the *RUN* position. See the *Upgrading Firmware* chapter in the front of the binder for more information.

To upgrade the firmware in the module unit pull it out of the frame. Move Jumper J10 into the *UPGRD* position. Install the Upgrade cable provided (located in the vinyl pouch in the front of this manual binder) onto header J1 at the card edge. Re-install the module into the frame. Run the upgrade as described in the *Upgrading Firmware* chapter in the front of the binder. Once the upgrade is completed, remove the module from the frame, move J10 into the *RUN* position, remove the upgrade cable and re-install the module. The module is now ready for normal operation.

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