



DTS CAE-4
Encoder System Manual

Revision 2.2

Table of Contents

<u>1</u>	<u>Introduction</u>	1
1.1	<u>OVERVIEW</u>	1
1.2	<u>REGULATORY NOTICES</u>	2
1.2.1	<u>Emi Notice</u>	2
1.2.2	<u>Patents</u>	2
1.3	<u>RETURNS</u>	2
1.4	<u>WARRANTY INFORMATION</u>	3
<u>2</u>	<u>Unpacking</u>	4
2.1	<u>UNPACKING</u>	4
<u>3</u>	<u>Encoder Box Controls and Connectors</u>	5
3.1	<u>QUICK-START SET-UP</u>	5
3.2	<u>ELECTRICAL SPECIFICATIONS</u>	5
3.3	<u>FRONT PANEL CONTROLS AND INDICATORS</u>	5
3.3.2	<u>Surround Switch 0dB/-3dB</u>	6
3.3.3	<u>TC Trig/TC bypass</u>	6
3.3.4	<u>Lfe On/Lfe Off</u>	6
3.3.5	<u>1509k/754k</u>	6
3.3.7	<u>DVD Status Indicator</u>	6
3.3.8	<u>CD Status Indicator</u>	7
3.3.9	<u>TC Indicator Light</u>	7
3.3.10	<u>READY Light</u>	7
3.3.11	<u>RESET Switch (momentary)</u>	7
3.4	<u>REAR PANEL CONNECTORS</u>	7
3.4.1	<u>Mains Power with Power On/Off Switch</u>	7
3.4.2	<u>Time code Input</u>	8
3.4.3	<u>Bitstream Output</u>	8
3.4.4	<u>L/R Digital Audio Input</u>	8
3.4.5	<u>LS/RS Digital Audio Input</u>	8
3.4.6	<u>Center/SubWoofer Digital Audio Input</u>	8
3.4.7	<u>Input Channel Mapping</u>	8
<u>4</u>	<u>Example: Production Setups</u>	9
4.1	<u>GENERIC SETUP</u>	9
4.2	<u>AUTHORING SYSTEMS SUPPORT</u>	12

5 DTS Record Panel Software 13

5.1 OVERVIEW..... 13

5.1.1 Panel..... 13

5.1.2 Using Panel in CD Code (44.1)..... 14

5.1.2 Optional Dos Utilities..... 14

6 E175-01 DVD Timecode Controller 16

6.1 E175-01 DVD FEATURES 16

6.1.1 Interface I/O..... 16

6.1.2 Power..... 16

6.2.2 Signal..... 16

6.2 SETUP & INITIALIZATION..... 17

6.3 FUNCTIONAL DESCRIPTION..... 17

7 CAD-4 Professional Decoder 19

7.0 SET-UP..... 19

7.1 MAINS POWER..... 19

7.2 INTERFACE..... 19

7.2.1 Inputs..... 19

7.2.2 Digital Outputs..... 19

7.3.3 Analog Outputs..... 19

7.3 STATUS INDICATORS..... 19

Appendix A 20

Time code embedding specifications..... 20

A1.0 DTS Bitstream Time code Embedding Specification..... 20

Coding of preamble..... 21

Table 1 Preamble Words..... 21

32-bit mode..... 21

16-bit mode..... 21

burst info..... 21

Table 2 burst info..... 21

data type..... 22

Table 3 Values of data type..... 22

Reserved bits..... 22

error flag..... 22

data type dependent..... 22

data stream number..... 22

length code..... 22

Burst spacing..... 23

The null data type	23
The DTS data type	23
Table 4 Values of data type dependent When data type = 1	23
Placement of DTS frames into data bursts	23
1.4.2 The time stamp data type	24
Figure 1. Encoding audio with time code.	24
1.4.3 Preamble values	24
Time stamp payload	24
Figure 2. Time stamps and DTS frames in the IEC958 data stream.	26
Table 6 Frame Rate Code	26

Appendix B 27

<i>Compacting files using the Join program</i>	27
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DTS Encoding System User Information 27

1 Introduction

1.1 OVERVIEW

This manual describes the configuration and operation of the DTS Professional Audio Equipment, which includes the CAE-4 Professional Encoder, the CAD-4 Decoder, and the E175-01 DVD Timecode Controller. This is the reference equipment to create DTS bitstreams from 5.1 source material for DVD-Video and CD.

The manual explains the general requirements for encoding. It also outlines specific production scenarios. The scenarios serve as examples for configuring production environments.

Operating software is included in this package (on CD-ROM), and it runs on Windows 95, 98, 2000 or NT systems. Use of the DTS Record Panel is described in Section 5 of the manual. At the end of each project, always comply with standard industry practice for Quality Control (QC). It is strongly recommended that QC always include critical listening of encoded material to verify acceptability of content for end users.

A software playback panel will be available in the upcoming months. Until then it may be necessary to use a third party program (ie; Sound Forge) for play back of DTS files directly from your computer. A typical application is illustrated in Figure 6.

The E175-01 DVD Timecode Controller is described in Section 6 of this manual. It is used to sync picture content with audio content for DVD-Video applications, enabling users to select an encoding project start and end time.

Minimum Computer Requirements to operate the DTS Record Panel software:

1. Windows 95, 98, 2000 or NT
2. A PC with a minimum of 64 Mbytes of memory, a separate system drive and a data drive with 4Gbytes (content dependent) free on hard drive.
3. You will need to turn off background programs running (ie; screen savers, virus scan – off, etc). This will insure a successful DTS encode bitstream capture into the computer.
4. It is suggested that an AGP video card be used where possible.

Sound Cards tested and verified for use with DTS Pro Audio Equipment:

1. SEK'D-PRODIF 96 Pro
2. Lynx One
3. Zefiro ZA2
4. MOTV 308/PC1324

1.2 REGULATORY NOTICES

1.2.1 *Emi Notice*

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Canadian Department of Communications compliance statement:

This equipment does not exceed Class A limits per radio noise emissions for digital apparatus set in the Radio Interference Regulation of the Canadian Department of Communications. Operation in a residential area may cause unacceptable interference to radio and TV reception, requiring the owner or operator to take whatever steps are necessary to correct the interference.

Avis de conformite aux normes du ministere des Communications du Canada:

Cet equipment ne depasse pas les limites de Classe A D'emission de bruits radioelectriques pour les appareils numeriques telles que prescrites par le Reglement sur le brouillage radioelectrique etabli par le ministere des Communications du Canada. L'exploitation faite en milieu residentiel peut entrainer le brouillage des receptions radio et television, ce qui obligerait le proprietaire ou l'operateur a prendre les dispositions necessaires pour en eliminer les causes.

1.2.2 *Patents*

The DTS system has been granted the following patents:

US Pat. Nos. 5,451,942, 5,956,674, 5,974,380, 5,978,762 and other worldwide patents issued and pending. "DTS" and "DTS Digital Surround" are registered trademarks of Digital Theater Systems, Inc., Copyright 2000 Digital Theater Systems, Inc. All rights reserved.

1.3 RETURNS

If any of the items on your packing list cannot be found, contact DTS with the P/N and description of the missing item(s). Refer to information below before sending any product back to DTS.

For warranty repair, exchange or getting replacement parts, please call your local DTS office or dealer.

A DTS **Return Authorization** ("RA") number is **required** before sending any item back to the factory. At the time of the call, DTS will require that you provide the serial number of any unit(s) for return **before** warranty replacement units will be sent. All return packaging should be clearly marked with the Return Authorization number on the outside of the package.

Please send all returns to:

North America

Digital Theater Systems, Inc.
5171 Clareton Drive
Agoura Hills, California 91301-4523 USA
Telephone: (818) 706-3525
or toll free in USA: 800-959-4109
Customer Service Fax: (818) 879-2746

Europe

DTS SA
Unit 5, Ruscombe Lane
Tavistock Industrial Estate
Twyford, Berkshire RG10-9NJ
UK
Telephone: 44-1189-349199
Fax: 44-1189-349198

1.4 WARRANTY INFORMATION

Equipment manufactured by DTS, Inc. is warranted against defects in materials and workmanship for one year from date of purchase. There are no other expressed or implied warranties.

DTS, Inc. obligation is restricted to repair and/or replacement of defective parts. Under no circumstances will DTS, Inc. be liable for any other damage, either direct or consequential.

All requests for repairs or information should include the unit serial number to ensure rapid service.

DTS OFFICES AND TECHNICAL SUPPORT

North America (corporate headquarters)

Telephone: (818) 706-3525

Fax: (818) 706-1868

DTS engineers are available to assist you. If you have an emergency after business hours, please leave a message on the answering service and we will return your call as soon as possible.

Europe (UK)

Telephone: 44-1189-349199

Fax: 44-1189-349198

INTERNET users may email DTS at the following address: **dkrasnow@dtsonline.com**

DTS Web Site: **www.dtsonline.com**

Future updates/new releases of the DTS Record Panel will be provided via the website.

2 Unpacking

2.1 UNPACKING

The packaging is designed for typical shipping and handling. Upon receipt of shipment, check for signs of damage before opening and report all damage to the carrier. All shipments made from DTS are the customer's responsibility once they leave our premises.

Before installation it is suggested that a complete inventory be taken to minimize problems or questions during installation. Additionally, save all packing material until installation is complete in the unlikely event that a component(s) requires return to the factory. Use the packing slip that came with your unit to verify received inventory.

The following is a sample packing list for a single system.

Typical DTS Pro Audio Equipment Package consists of:

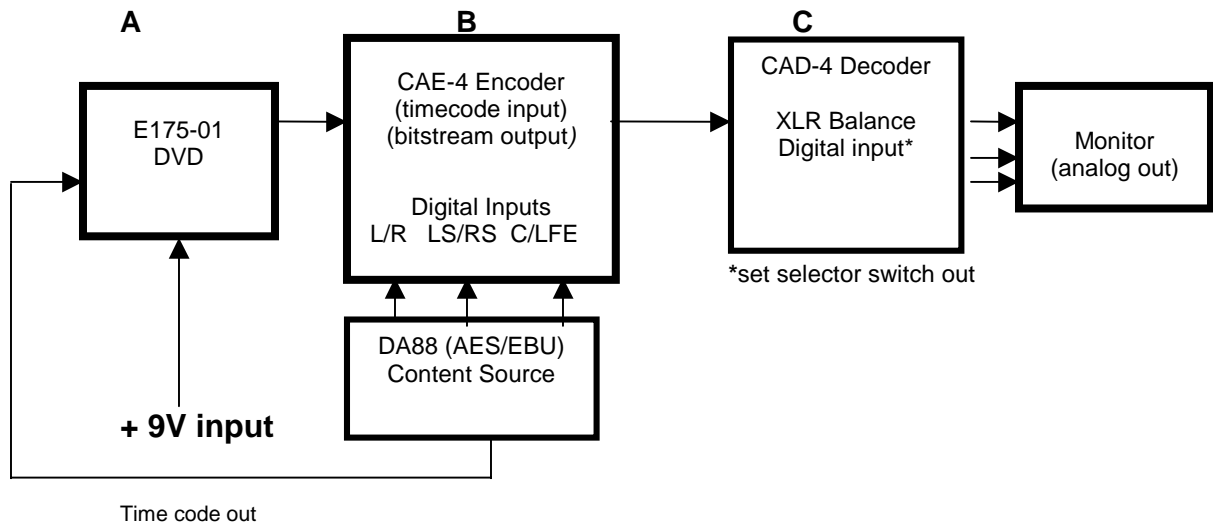
- CAE-4 Professional Encoder
- CAD-4 Decoder
- E175-DVD Timecode Controller
- E175-DVD (1/4" Jack) to Encoder (XLR) Cable assembly
- E175-DVD power adapter
- DTS Software suite including the DTS Record Panel and bitstream tools software on CD-ROM
- Record Panel software on CD-ROM
- CAE-4 Encoder System Manual
- Spec Sheets for the CAE-4 Encoder and CAD-4 Decoder

3 Encoder Box Controls and Connectors

3.1 QUICK-START SET-UP

The diagram below illustrates a quick verification procedure for DTS equipment functionality with minimal interface. If any system interface problems are encountered, refer to this simple set-up.

Time code Input #1 (From DA88)



AC Adapter

XLR-1/4inch cable provided.

Place CAE-4 into TC bypass to verify operation without E175-01 DVD.

Verify decoder mains switch on side of unit is set to proper mains voltage. Monitor output with amp/speakers.

Check time code trigger by setting up E175-01 DVD per section 6. Place CAD-4 into TC trig position to start encoding on user selected start time.

3.2 ELECTRICAL SPECIFICATIONS

See spec sheets for summary specifications.

3.3 FRONT PANEL CONTROLS AND INDICATORS

The four pushbuttons from the left have LED indicators to show their status. Pressing the button after reset changes the state of the control. *The only way to set the control back to its default state is to press reset again.* **Always press the reset switch after changing a front panel switch or introducing new content type (44.1K to 48K) at the AES/EBU input.**

CD Mode ENCODER SPECIAL NOTE

1234kbps is the only active mode for CD. The active front panel switches in CD mode are TC TRIG or TC BYPASS and LFE ON or LFE OFF. In CD Mode, even though the other switches show lighted LEDs when switched to other positions, they are ignored by the encoder processor.

In DVD mode, ALL front panel switches are fully activated.

3.3.2 Surround Switch 0dB/-3dB

In the 0dB position the LS/RS surround channels are not attenuated, which is the typical setting for consumer encoding. The -3dB position setting attenuates the surround channels by 3 dB, to accommodate the differences in theatrical consumer monitoring levels used while mixing.

3.3.3 TC Trig/TC bypass

In the TC TRIG State, the encoder will start encoding when the E175DVD start time is passed. The Encoder will embed time code (DVD Mode) into the DTS output bitstream per appendix A. The E175DVD is enabling encoding when incoming time code is between the user entered start and end times. The green encoding indicator on the

E175DVD will be on when valid time code is output. **Note:** The "End" time must be greater than the "Start" time. If the end time is not known, it should be entered with a large number (up to 24 hours). **Refer to section 6** for operation of the E175DVD. Verify the start and end times are entered on the E175DVD screen. The TC Status LED will blink at a 15Hz (fast) rate before the Encoder trigger point indicating that it is receiving time code and then blink at a 5Hz(slow) rate after passing the trigger point. The TC LED will be off with no time code present.

The **TC BYPASS** switched mode does not require a time code generator input. The Encoder will not embed time code. Once locked to valid AES/EBU digital inputs, the Encoder will start encoding within a few seconds of turning the mains power on. The Encoder, the TC LED, and READY LED indicators will remain solid green.

3.3.4 Lfe On/Lfe Off

This switch controls the encoding of the LFE (subwoofer) channel. With the switch in the ON position, the encoder will brickwall lowpass the LFE input of the 120Hz and encode the filtered audio into a discrete LFE channel in the bit stream with the switch in the OUT position, audio in the LFE input channel is ignored.

3.3.5 1509k/754k

1509kbps/754kbps are bit rate options for DVD encoding.

The bitrate for CD encoding is fixed at 1234 kbps.

3.3.7 DVD Status Indicator

This light indicates digital inputs at 48k samples/seconds. When the DVD led is "ON", the encoder will automatically select a bit stream.

Note: with no digital input, the DVD and CD LEDs flash in alternating sequence until an input is applied.

3.3.8 CD Status Indicator

This indicates digital inputs at 44.1K samples/seconds. When the CD Led is ON, the encoder will automatically select a bit stream peak MSB value of 14 bits.

3.3.9 TC Indicator Light

This light can be in 3 states; blinking, steady or off.

Blinking slow: TC is present and before the encoder's trip point.

Blinking fast TC is present and past the encoder's trip point.

Off: TC is not present.

3.3.10 READY Light

The ready light indicates normal or faulty encoding.

Steady: Input AES/EBU audio is present and since reset was last pressed, encoding has started and has been continuous.

Blinking: Since reset was last pressed, encoding has started and then stopped for any amount of time. If encoding restarted, LED will continue to blink until the encoder is reset again.

Off: Encoding is not occurring. Normal for a few seconds after RESET has been pressed.

3.3.11 RESET Switch (momentary)

Forces the encoder to update its input bitstream and front panel switch settings. Always Depress the RESET switch after making any mode selection changes. In addition, RESET clears the fault indication of the READY light. If a problem fails to clear with a RESET, cycle the mains power switch.

3.4 REAR PANEL CONNECTORS

From left to right the connectors are as follows:

3.4.1 Mains Power with Power On/Off Switch

Autosensing 100-240VAC 50-60 Hz, 25 watts.

3.4.2 Time code Input

3 pin XLR female, balanced 110 ohms.

3.4.3 Bitstream Output

3 pin XLR male, AES/EBU 110 ohms.

3.4.4 L/R Digital Audio Input

3 pin XLR female AES/EBU 110 ohms.

3.4.5 LS/RS Digital Audio Input

3 pin XLR female AES/EBU 110 ohms.

3.4.6 Center/SubWoofer Digital Audio Input

3 pin XLR female AES/EBU 110 ohms.

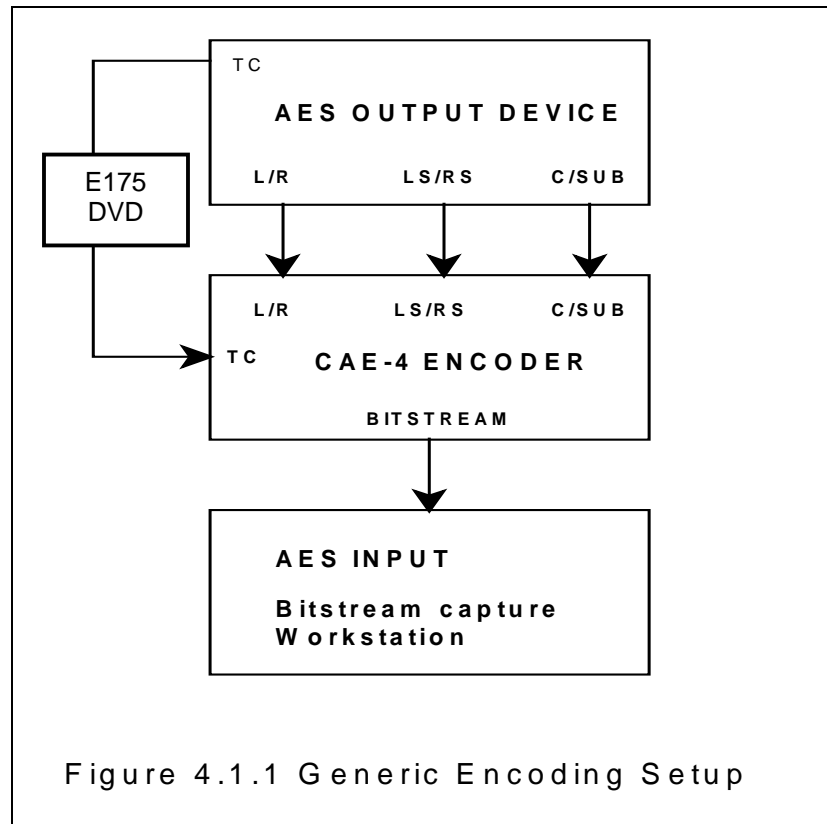
3.4.7 Input Channel Mapping

The AES input pairs channel assignments are fixed. Should you have a different input pair arrangement, you may need a router to format the source material accordingly to accommodate the input pairs specified in 3.4.4 – 3.4.6.

4 Example: Production Setups

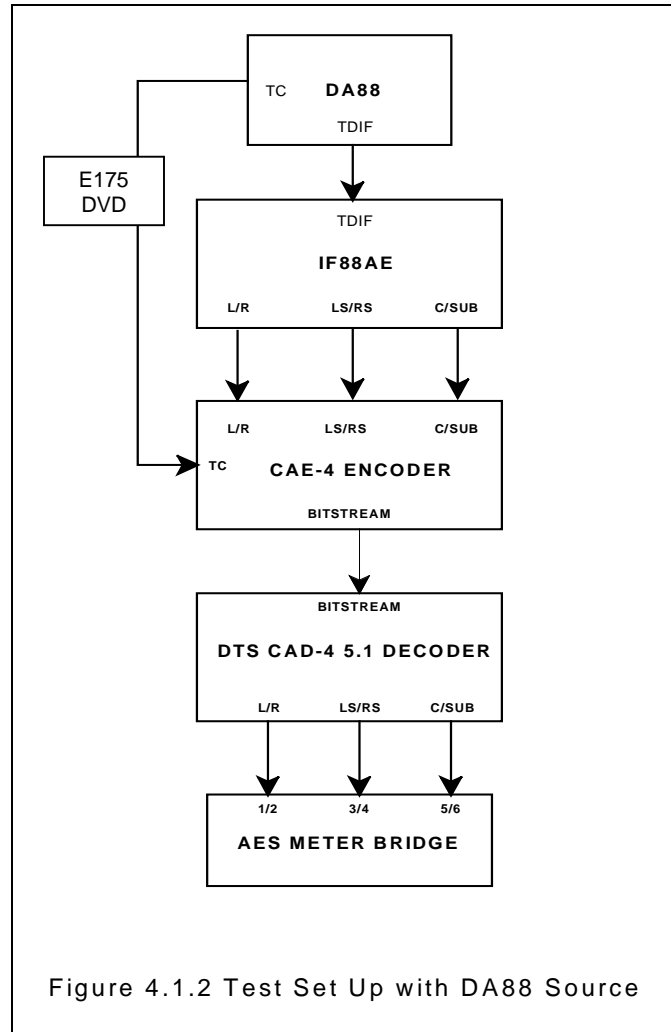
4.1 GENERIC SETUP

Figure 4.1.1 outlines the minimum system elements required for DTS encoding using the CAE-4.



First, source material must be supplied to the encoder as three AES/EBU digital inputs plus time code. The encoded bit stream is then sent to an AES digital bitstream capture workstation. As the following examples illustrate, the source material can be provided from digital recorders and digital audio workstations. The recording device is typically a digital audio workstation such as a PC compatible computer equipped with a digital input audio card.

Figure 4.1.2 shows a test set up using industry standard equipment.



The TDIF output of a Tascam DA88 is converted by a Tascam IF88AE into the three AES/EBU channels required by the encoder; L/R, LS/RS, C/SUB. The TC OUT of the DA88 is connected to the E175 directly to the Encoder TC IN. The BITSTREAM OUT of the encoder is connected to the DIGITAL INPUT of the DTS CAD-4 Decoder where it is converted back into L/R, LS/RS, C/SUB AES formatted outputs. These three outputs are monitored by an AES Meter Bridge. The six analog audio outputs are connected to a 5.1 audio monitor for audible evaluation.

The TDIF output of a Tascam DA88 is converted by a Tascam IF88AE into the three AES/EBU channels required by the encoder; L/R, LS/RS, C/SUB. The TC OUT of the DA88 is connected to the E175 and then directly to the encoder TC IN. The BITSTREAM OUT of the encoder is connected to the DIGITAL INPUT of the DTS CAD-4.5.1 Studio Decoder where it is converted back into L/R, LS/RS, C/SUB AES formatted outputs. These three outputs are monitored by an AES Meter Bridge. The six analog audio outputs are connected to a 5.1 audio monitor for audible evaluation.

To operate the test setup, perform the following steps after cabling as shown in the diagram.

- Turn on power to encoder.
- Load source material onto the DA88. Source material must be 48k to allow DVD encoding or 44.1k to allow CD encoding.
- Select LFE ON or LFE OFF.
- Select surround 0db or -3db.
- *If DVD (48k) source material is being used, select high or low encoding rate. CD source material (44.1k) will always be encoded at 1234kbps.*
- Select TC BYPASS/TC TRIGGER
- Press Reset

The audio from the DA88 which has been encoded then decoded will now be available at the meter bridge and the monitors.

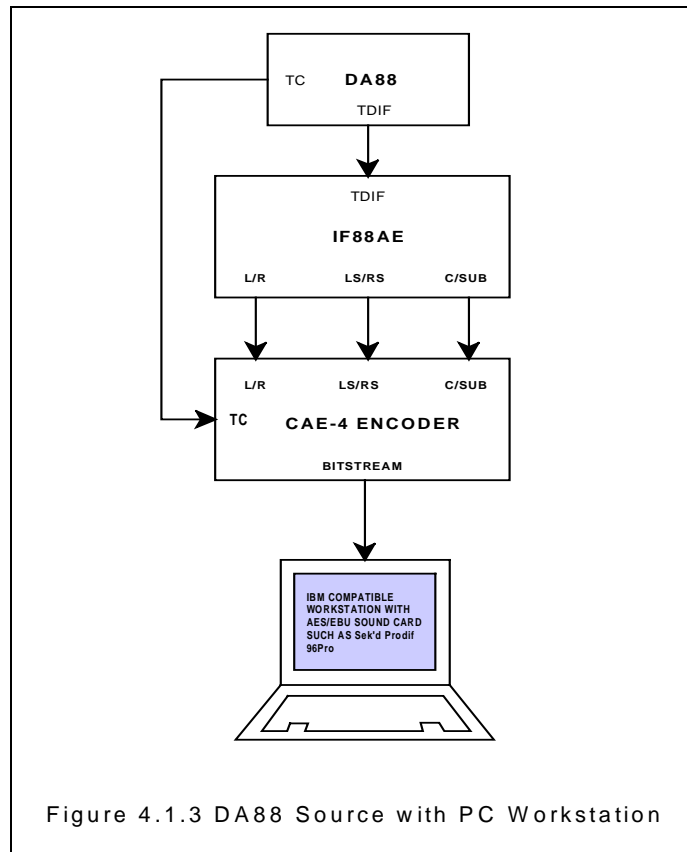
Figure 4.1.3 shows a DA88 source and an IBM Compatible workstation with a Sek'd PRODIG 96Pro digital sound card as a recorder.

If the encoder is set to "TC Trigger," one must enter START and END time on the E175 (per item 6.3)

A simple recording session with this setup and the DTS Record Panel software (referred to as the Panel) is now described:

- Run the Panel (**See Section 5 for set-up overview**) on the PC.
- Open the Project menu. Define a path and name for the project. The output file which is eventually recorded will be assigned a name automatically.
- Click on setup. Set source to desired device. Select desired input source.
- Select the desired encoder settings on the front panel of the encoder.
- Press the encoder reset button.
- Click record on the Panel program.
- Press play on the DA88
- Click stop on the Panel program when all of the desired source material has been encoded and decoded.

- Stop the DA88.



- Select the bit depth and whether the surround are ES encoded.
- Click on **CHECK** on the Panel program. An edit box will summarize the Format, bit rate, start and stop time codes.

4.2 AUTHORING SYSTEMS SUPPORT

We are working to certify the following authoring systems for DTS. Contact your authoring system provider if you have any questions regarding the interface.

Daikin Scenarist
 Spruce Technologies
 Sonic Solutions
 Sony
 Toshiba
 MEI

5 DTS Record Panel Software

5.1 OVERVIEW

The DTS record panel (PANEL) is provided to simplify the encoding check process. Start by creating a directory called DTS Panel and copy all of the programs into this file.

Information regarding selecting 16bit - 16bit ES, ect...describing the meaning and use of ".dts" (padded file) ".cpt" (compact)

5.1.1 Panel

The Panel is a windows program capable of running on Windows 95, 98 and NT. The Panel provides a method for recording or "capturing" the DTS Bitstream. Once captured, the Bitstream can then be analyzed for dropouts and other syntax errors by using the check function on the panel.

The edit function can then be used to properly format the bitstream to accommodate the CD or DVD authoring system, and can be used to trim the beginning and end of the file as needed.

A project file (*.prj) is created that details all of the actions taken by the PANEL program. The project file can be opened with.

The following sound cards have been verified to be compatible:

Lynx One

ZEFIRO ZAZ

MOTV 308/PCI324

SEK'D-PRODIF 96 Pro

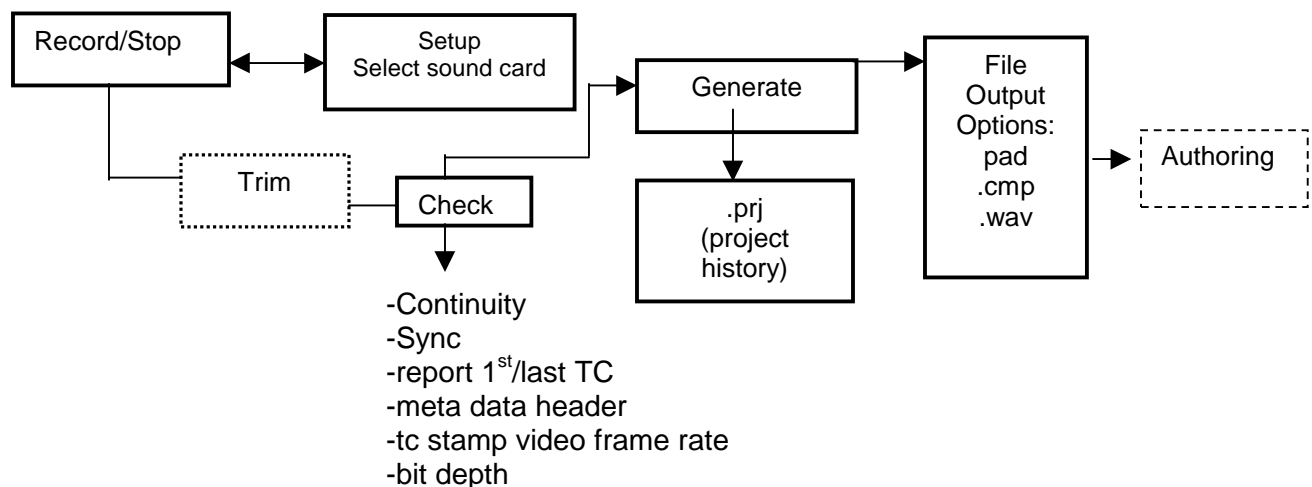


Figure 5.0 Record Panel Process Flow

5.1.2 Using Panel in CD Code (44.1)

Below is a description of the overall flow process for creation of DTS CD content. Note: it is recommended to use an external program (Sound Forge, MS player or equivalent) to support playback of the .wav files. Future release of the Panel software will include a play panel.

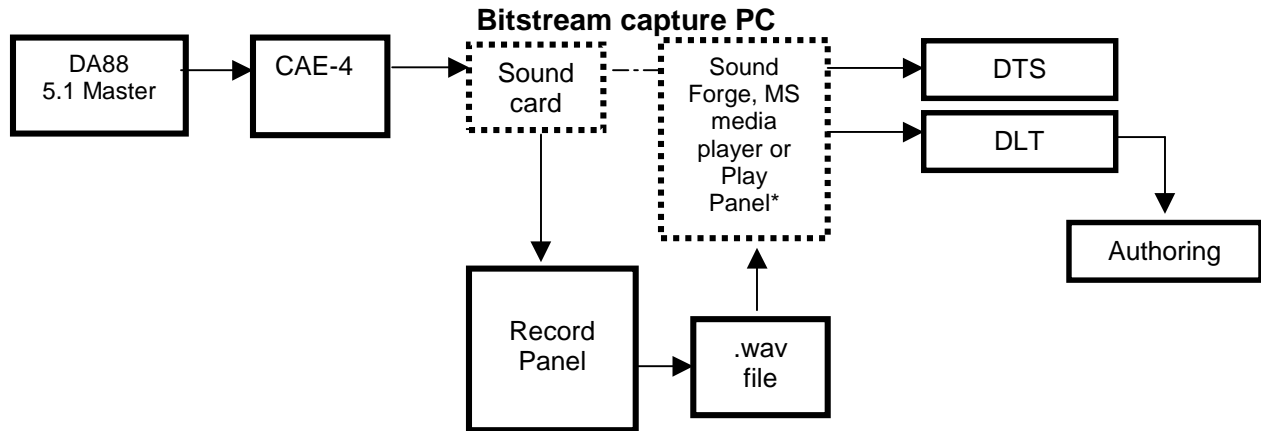


Figure 6.0 CD content Process Flow

5.1.2 Optional Dos Utilities

5.1.2.1 DTS Expand

The DTSExpand is a DOS program. This program will create a new padded (*.DTS) file from a compacted (*.CPT), and file outputs a padded file.



Syntax Expand path:\file.(source) name.cpt path:\(output) filename.dts.

The Expand program will require the frame size information listed below:

Prompt for the source file DTS framesize

<u>Rate(kbps)</u>	<u>Compacted Frame Size</u>
1509.25	2013
754.50	1006

5.1.3.2 DTSbin2wave

DTS 2Bin is a DOS program. The bin2wave will convert a padded file to a wave file.



5.1.3.3 DTS2CPT

Syntax DS2cpt path : ("source") filename.dts path:\(output) filename.cpt. DTS2cpt will create a new padded (*.dts) file compacted (*.cpt) file.

6 E175-01 DVD Timecode Controller

6.1 E175-01 DVD FEATURES

- Starts/Stops the Encoder on user specified time
- Runs on a valid SMPTE time code input
- Accepts all standard frame rates 29.97/30ndf, 29.97df, 25df and 25f.
- All settings are saved in non-volatile memory
- The unit may be mounted into a 19 inch equipment rack or be placed on a desktop.

6.1.1 Interface I/O

6.1.2 Power

- Connect mains to AC power adapter. Connect the 9VDC output of the converter labeled +9VDC 500ma (Note: center pin is +9V and the outside ring is ground) into the rear of the E175-01 DVD. Attach a chassis ground to the rear of the unit or if rack mounted verify chassis ground continuity.

6.2.2 Signal

- Plug a 1/4" jack (stereo or mono) from the time code source to the "time code input #1" rear input jack.

<u>Signal Name</u>	<u>Using TRS Plug)</u>	<u>(Using A 1/4" Phono Plug)</u>
Time Code High	Tip	Tip
Time Code Low	Ring	Sleeve
Shield	Sleeve	

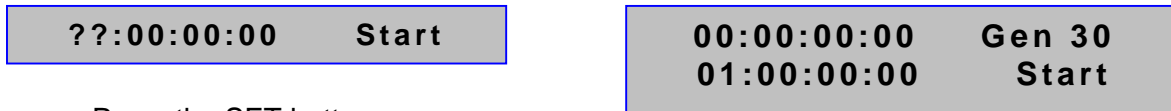
- Plug the "time code output" 1/4" jack (provided) from the E175DVD to the CAE-4 Time code input.
- Note: The only functional I/O on the E175DVD is the time code input and time code output#1.

6.2 SETUP & INITIALIZATION

When first applying power, the E175DVD will show the current revision for about five seconds and then default to a menu (Start or End). If this does not occur for any reason the processor can be reset by disconnecting and then reconnecting the main power. After five seconds the display should look like:

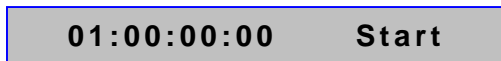
Setting the Start time:

Press the DISPLAY button until the following is displayed on the lower line.



- Press the SET button.
- Press the *right arrow* to change the cursor position (blinking digit).
- Press the *up arrow* to increase the value or DISPLAY+up arrow to decrease the value.
- Press the *DISPLAY + Right arrow* to **zero** the display. Press *store* when all entries are complete.

Below is an example of a valid 1 hour start time:



- Upon the first power up out of the box, memory initialization may be required. If any of the display locations show a "????", then zero out the display before entering numeric start/stop data.

NOTE: When keeping the *DISPLAY* button pressed and then pressing the up button one can scroll the numbers in the reverse direction. Also, keeping the up button pressed will cause the numbers to auto increment.

- Upon achieving the correct start time, press "STORE".
- Then press the "DISPLAY" until the "end" time appears.
- Repeat the step above for inputting the "end" time. Then depress "STORE" to save the end time.

6.3 FUNCTIONAL DESCRIPTION

When the incoming time code matches the stored "Start" time, the green encoding status LED will turn on and stay on until the end time is reached. The top line of the display indicates the actual time code output of the E175-01 DVD. The Encoder will trigger while in "TC TRIG" position, when the E175-01 DVD passes the "Start" time (green LED on).

The Encoder needs to be in a pre-trigger reset mode before the E175DVD reaches the "Start" time. Before the E175DVD start point the Encoder TC LED will blink fast (15Hz) then at the trigger point the TC LED will blink slow (5Hz) and the READY LED will be solid on.

The upper right hand corner of the display indicates the frames per second (ie; 30, 25, dp)

7 CAD-4 Professional Decoder

7.0 SET-UP

7.1 MAINS POWER

On the side of the chassis you will find a mains power selector switch. Verify the switch is in the correct position for you region. Slide to the 230V position or the 115V position.

7.2 INTERFACE

7.2.1 Inputs

There is a choice of 3 inputs available, these are Optical, 75 ohm or Balanced Digital (XLR). Press the digital input selector switch IN for 75 ohm OR press the digital input selector OUT for Balanced Digital (XLR).

7.2.2 Digital Outputs

The 3 AES/EBU outputs are paired as: Center/Sub, SurrR/SurrL, Right/Left

7.3.3 Analog Outputs

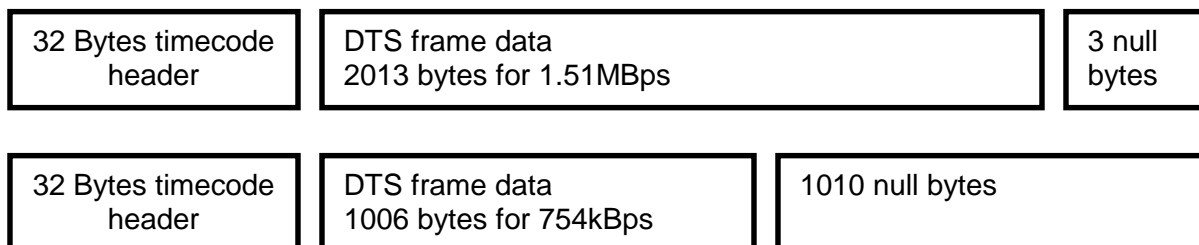
All analog outputs are balanced XLR.

7.3 STATUS INDICATORS

The Power status monitors the presence of Mains power. The DTS status monitors the presents of a DTS decoded output. The Lock status detects an incoming DTS bitstream.

Appendix A

Time code embedding specifications



754kbps

00000000	F872	4E1F	0002	0060	00D1	0014	0053	0023	.rN.
00000010	0566	0011	0000	0000	F872	4E1F	00DB	1F70	.f..
00000020	7FFE	8001	FC3C	3ED2	75E0	OD3A	OOD9	8C53
00000030	189C	E739	8000	002D	B6DB	6DFF	FFFF	FFFF	...9.
00000040	FFFF	FFFF	FFFF	FFFF	FFFF	44D0	OOD0	DOD0	.t..
00000050	0074	1000	1D00	00D5	OOD5	OOD5	BBDB	O49D	B.,
00000060	1209	C22C	C2BD	3516	1039	707B	749B	AFBF	
00000070	5E34	8888	8868	6856	4466	4235	12AF	28C8	
00000080	8A86	6888	4834	F2D0	EECC	CACC	CAC8	A693	
00000090	108C	EAA4	6844	2422	4432	FOCA	EAA4	4842	
000000A0	2222	4220	0000	0000	OOD0	OOD0	OOD0	00D0	
000000B0	EA80								

A1.0 DTS Bitstream Time code Embedding Specification

The purpose of this specification is to define how the DTS bitstream incorporates time code embedding (time stamping) into a single bit stream. The majority of this information is extracted from the Advanced Television Systems Committee standard describing time code stamping and is consistent with the physical and logical IEC958 interface specification.

Time code embedding indicates the absolute time at which the encoded audio samples are taken. The time code is encoded as values of SMPTE time code.

Coding of preamble

The data to be transmitted is formed into bursts of data. A 64-bit preamble is added to the beginning of each burst. The remainder of the burst is then the data payload. The preamble occupies 16 bits in each of 4 sub-frames. The preamble is considered to be four 16-bit words designated as Pa, Pb, Pc, Pd. The contents of these four words are specified in Table 1. When placed into a sub-frame, the MSB of a 16-bit preamble word is placed into time slot 27, and the LSB is placed into time slot 12. The combination of Pa and Pb form a 32-bit sync code. This allows a receiver to find the preamble with a very small probability of mis-detection.

Table 1 Preamble Words

Preamble word	Contents
Pa	16 bit sync word 1 = 0xF872
Pb	16 bit sync word 2 = 0x4E1F
Pc	16 bit burst_info value.
Pd	16 bit length_code (unsigned integer), equal to the number of data bits in the following data burst

32-bit mode

The 4 preamble words are contained in 2 sequential frames. The frame beginning the data burst contains preamble word Pa in the Ch1 sub-frame, and Pb in the Ch2 sub-frame. The next frame contains Pc in Ch1 and Pd in Ch2.

16-bit mode

The 4 preamble words are contained in 4 sequential sub-frames of the individual channel (Ch1 or Ch2) being employed to convey the DTS data stream. The sub-frame (of the channel being used) beginning the data burst contains preamble word Pa, the next sub-frame (of the channel) in the burst contains Pb, etc.

burst_info

The 16-bit burst_info value contains information about the data which will be found in the burst. The contents of burst_info is specified in Table 2. Bit 15 of burst_info is considered the MSB.

Table 2 burst_info

Bit(s)	Value
0-4	Data_type (5-bit unsigned integer = 0-31)
5-6	Reserved (shall be set to '00')
7	Error_flag 1 indicates data burst may contain errors, 0 indicates data may be valid
8-12	Data_type_dependent
13-15	Data_stream_number

data_type

The 5-bit data_type field indicates what type of data, (DTS, time stamp, etc.) will be found in the burst. Three values of data_type are defined in this specification. See Table 3.

Table 3 Values of data_type

Value	Meaning
0	Null data
1	DTS data
2	Time Stamp
3-31	Reserved

Reserved bits

Bits 5 and 6 are reserved. These bits shall be set to a value of '00'. Receivers of this data stream may ignore the contents of these bits.

error_flag

The error_flag bit is available to indicate if the contents of the burst contains data errors. If a data burst is thought to be error free, or if the data source does not know if the data contains errors, then the value of this bit shall be set to a '0'. If the data source does know that a particular data burst contains some errors this bit may be set to a '1'. The use of this bit by receivers is optional.

data_type_dependent

The data_type_dependent field contains 5 bits whose meaning is intended to be dependent on the value of data_type.

data_stream_number

The 3-bit data_stream_number indicates to which virtual data stream the burst belongs. Eight codes (0-7) are available so that up to eight independent data streams (each of any assigned data type) may be carried in the IEC958 data stream in a time multiplex. Each independent data stream shall use a unique value for data_stream_type.

In the consumer application the following constraints shall apply. If a single data stream is carried, the value of data_stream_number shall be 0. If a set of data streams are carried, one of the streams shall have a data_stream_number of 0. If a receiver is only capable of selecting and processing a single data stream, it shall receive and process data_stream_number 0. Stream 0 thus has the highest priority, and should carry the most important data. The MSB of the 3-bit stream number is placed in bit number 15.

length_code

The length_code indicates the length of the data payload in bits, from 0 to 65535. The size of the preamble is not counted in the value of length_code.

Burst spacing

In order to facilitate the implementation of the autodetection function there is one requirement on burst spacing. There shall not be a sequence of 4096 or more IEC958 frames which contain at least one data burst, without the beginning of at least one of the data bursts preceded by two IEC958 frames which have sub-frame contents in time slots 12-27 of all 0's. Since the sub-frame contents of time slots 12-27 are set to all zeros between data bursts, this requirement is automatically met unless there are sequences of data bursts so tightly packed that there is never (in a span of 4096 IEC958 frames) a sequence of 2 all-zero frames preceding any burst.

The null data_type

A null data type is provided so that the preamble sync codes may be inserted occasionally into the data stream. This could potentially enhance reliable autodetection of whether or not the sub-frame contains PCM audio or digital data.

The null burst data_type has a value of 0x0. In a null data burst, the length_code, error_flag, and data_type_dependent values shall all be set to '0'. The data_stream_number shall be set to 0x7.

If the burst frequency of the data being conveyed is low, or the interface is idle (no data to convey) there may be long periods of inactivity which may be autodetected as PCM silence. Placement of null data bursts allows sync codes to be detected, allowing an autodetector to realize that the sub-frame contents should be considered to be data and not PCM audio. Thus use of null data bursts is optional.

The DTS data_type

When DTS data is conveyed, data_type has a value of 0x1. In this case, the value of data_type_dependent shall be as shown in Table 4.

Table 4 Values of data_type_dependent When data_type = 1

burst_info bit number	Data_type_dependent bit number	Meaning
8-10	0-2	Value of bsmode in DTS elementary stream
11-12	3-4	Reserved, shall be set to '00'

The DTS syntactical element bsmode is a 3-bit field. The left-most bit of this value is placed in burst_info bit number 10. Receivers may ignore the contents of the reserved bits.

Placement of DTS frames into data bursts

The DTS data stream consists of a sequence of DTS sync frames. Each DTS sync frame represents 1536 encoded audio samples. DTS sync frame boundaries occur at a frequency of exactly once every 1536 IEC958 frames. Each burst of DTS data shall contain one complete DTS sync frame. The length of the DTS data burst will depend on the encoded bit rate (which determines the DTS sync frame length). The data bursts containing DTS sync frames shall occur at a regular rate, with each DTS burst beginning 1536 IEC958 frames after the beginning of the preceding DTS burst (of the same data_stream_number).

1.4.2 The time stamp data_type

Time stamps are useful in applications where time information must be kept closely associated with encoded audio data (see Figure 1).

Values of SMPTE time code occur only once per picture frame, and thus have a resolution in their value of approximately 33 ms (for 30 Hz frame rate). Audio samples occur much more frequently, approximately once every 21 μ s (48 kHz sample rate). The DTS audio access units occur every 32 ms (48 kHz sample rate).

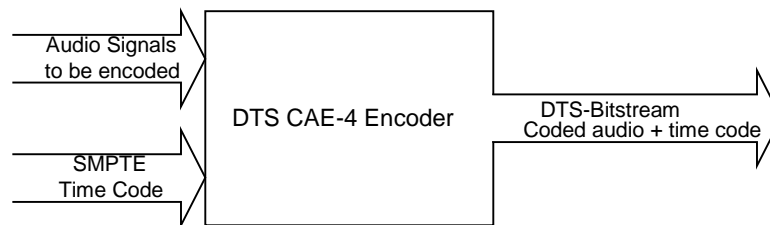


Figure 1. Encoding audio with time code.

1.4.3 Preamble values

Time stamps are conveyed by data bursts with a data_type value of 0x2. The value of data_type_dependent shall be set to 0x0 for the payload defined below. (In the future, other payload types may be defined for different values of data_type_dependent.) The length_code shall indicate the actual length of the time stamp payload.

Time stamp payload

The time stamp payload, shown in Table 5, has a minimum length of six 16-bit words which have a defined meaning. Additional 16-bit words may be optionally added, but the meaning of these words is not specified.

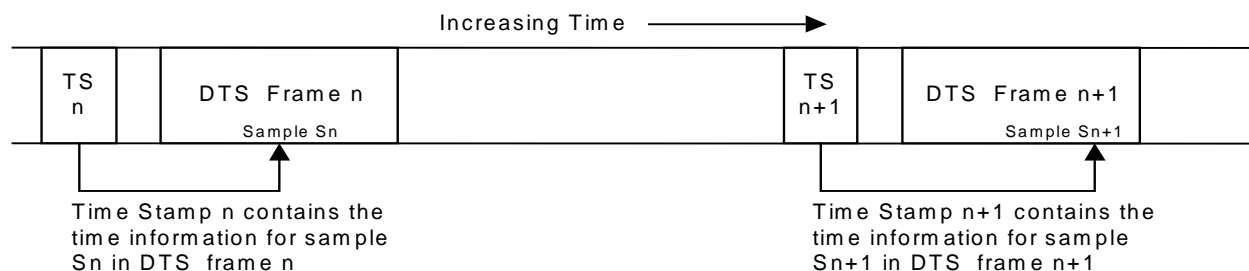
Table 5 Time Stamp Payload

Time Stamp Payload Word		MSB Bit Number LSB															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Usr8, Usr7, Hours	[63]	[62]	[61]	[60]	[55]	[54]	[53]	[52]	[59]	[58]	H20	H10	H8	H4	H2	H1
1	Usr6, Usr5, Minutes	[47]	[46]	[45]	[44]	[39]	[38]	[37]	[36]	[43]	M4 0	M2 0	M1 0	M8	M4	M2	M1
2	Usr4, Usr3, Seconds	[31]	[30]	[29]	[28]	[23]	[22]	[21]	[20]	[27]	S40	S20	S10	S8	S4	S2	S1
3	Usr2, Usr1, cf, df, Frames	[15]	[14]	[13]	[12]	[7]	[6]	[5]	[4]	[11]	[10]	F20	F10	F8	F4	F2	F1
4	Sample Number	S15	S14	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	S0
5	Reserved, Flags	R	R	R	R	R	R	R	R	R	R	a3	a2	a1	a0	f1	[10]

Table Entries

- [63] Bit number 63 of SMPTE time code word
- H20 This bit has a value of 20 hours
- R Reserved bit, set to '0'
- Usr8 The 8th group of user bits in the SMPTE time code word
- cf Color frame flag bit
- df Drop-frame flag bit
- f1 Flag bit number 1
- S15 Sample number, bit 15
- a3 Frame rate code, bit 3

The first four words contain an hours, minutes, seconds, frame count. Space is available to carry the user group, color frame flag, drop frame flag, and unassigned bits from a SMPTE time code word. Flag bit f1 (in word 5) is set to a '1' if this information has been copied from a source of SMPTE time code into the upper bits of payload words 0-3. If flag bit f1 is set to a '0', this information has not been provided, and the upper bits of payload words marked [] are all set to '0'. The sample number in word 4 is an unsigned integer which indicates the sample number (Sn in Figure 2) to which the time code value applies. The sample number does not have to be exactly correct, but should indicate an audio sample within ± 0.5 ms of the ideal value. Word 5 contains 10 reserved bits (in bits 6-15), a 4-bit frame rate code (a3-a0), the f1 flag bit, and the drop-frame flag bit (bit 10 of the SMPTE time code word) if the timing source is SMPTE time code. The drop-frame flag bit is always provided in bit 0 of word 5; its presence in bit 6 of word 3 is conditional on the value of the f1 flag bit. The meaning of the frame rate code is shown in Table 6.



If the value of sample number S_n contained in time stamp n is ≥ 1536 (the number of samples in an DTS frame), it points to sample $1536 - S_n$ in DTS frame n+1

Figure 2. Time stamps and DTS frames in the IEC958 data stream.

Table 6 Frame Rate Code

Frame Rate Code				Frame Rate
a3	a2	a1	a0	
0	0	0	0	not indicated
0	0	0	1	24 ÷ 1001 (23.98)
0	0	1	0	24
0	0	1	1	25
0	1	0	0	30 ÷ 1001 (29.97)
0	1	0	1	30
0	1	1	0	50
0	1	1	1	60 ÷ 1001 (59.94)
1	0	0	0	60
-	-	-	-	reserved
1	1	1	1	reserved

Additional payload words containing arbitrary information may be optionally provided. The meaning of any additional payload information is not specified. Receivers should be capable of operating whether or not additional information is present. The presence of additional information may be determined by the value of the length_code in the burst preamble. If the value length_code is 0x0060 then no additional information is present. If the value of length_code is greater than 0x0060 then additional information is present.

Appendix B

Compacting files using the Join program

If for some reason, your DVD authoring system cannot use padded files, and you have access to a PC and can run a DOS program, you can use the attached executable file to generate a compacted file directly from the padded file.

- 1) Place a copy of the Join program in the same folder as your source padded file.
- 2) In DOS, navigate to the folder with the files.
- 3) Type Join, then press enter key.
- 4) Enter the code for the frame rate.
- 5) At the File 1 prompt, enter the source file name, with extension.
- 6) At the File 2 prompt, enter the word **end** (lower case).
- 7) Enter a new output file name.
- 8) Enter DVD frame size - for 754 kbps, 1006; for 1509 kbps 2013.
- 9) Enter sample rate - 48000.
- 10) Enter sample frame size - 512.
- 11) Enter time code trigger position, the time code position where the source file starts. Get this information at the **end** of the *.prj file where the output file information is
- 12) Enter the time code start position, where you need the output file to start from. At this point you may select to start from a point after the trigger point.
- 13) Enter the end time, where you want the output file to stop. At this point you may select to stop the file at a point earlier than the end of the source file.

It should be noted that on some versions of Microsoft NT a line entry bug occurs. The first typed letter will be ignored. Please watch the entry line to insure that your typing appears on the screen. No problems exist with any other Microsoft operating systems.

Editing files using the Join program

If for some reason, a continuous file needs to be created from, and you have access to a PC and can run a DOS program, you can use the attached executable file to generate a compacted file directly from the padded file.

- 1) Place a copy of the Join program in the same folder as your source padded file.
- 2) In DOS, navigate to the folder with the files.
- 3) Type Join, then press enter key.
- 4) Enter the code for the frame rate.
- 5) At the File 1 prompt, enter the PART 1 source file name, with extension.
- 6) At the File 2 prompt, enter the PART 2 source file name, with extension.
- 6) At the File 3 prompt, enter the word **end** (lower case).
- 7) Enter a new output file name.
- 8) Enter DVD frame size – 1006 for 754 kbps *.cpt files, 2013 for 1509 kbps *.cpt files, 2048 for padded *.dts files.
- 9) Enter sample rate - 48000.
- 10) Enter sample frame size - 512.
- 11) Enter time code trigger position for PART 1, the time code position where this source file starts. Get this information at the **end** of the *.prj file with the output file information.
- 11) Enter time code trigger position for PART 2, the time code position where this source file starts. Get this information at the **end** of the *.prj file with the output file information.
- 12) Enter the time code start position, where you need the output file to start from. At this point you may select to start from a point after the trigger point.
- 13) Enter the end time, where you want the output file to stop. At this point you may select to stop the file at a point earlier than the end of the source file.

It should be noted that on some versions of Microsoft NT a line entry bug occurs. The first typed letter will be ignored. Please watch the entry line to insure that your typing appears on the screen. No problems exist with any other Microsoft operating systems.

DTS Encoding System User Information

Further clarification in regards to the bitstream capture computer configuration is provided with in this notice.

- The system must be equipped with separate system and data hard drives. The bitstream will be recorded to the separate data drive. A partitioned drive will not work efficiently and will probably cause dropouts while recording. There must be sufficient space for workspace and generated files. It is suggested that no smaller than a 4 GB drive be used. The drive should be rated for multimedia applications.
- Only one sound card should be installed in the PC and it should not be sharing its IRQ with another card.
- Certain types of video cards can take over data transfers on the bus. If possible, an AGP video board should be used, as these do not rob resources from data transfers. If this is not possible and dropouts occur, the display should be set to its minimum performance setting (usually VGA).
- All background programs need to be set to off. This includes virus scans, screen savers, etc.)
- Frequently, in the CMOS setup, there is a switch that can be set for allowing or disallowing interrupts during writing. This should be set so that writing data to the hard disk is not interrupted. The wording for this varies machine to machine.