Film-Tech

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POST PRODUCTION
GUIDE

DIGITAL THEATER SYSTEMS
Digital Sound For Movies

TM-E229
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DTS Commitment

Beginning with its first release, *Jurassic Park*, Digital Theater Systems has positioned itself as the worldwide standard release format for digital motion picture sound tracks. In the history of motion picture sound, no format has ever been so readily accepted. This stems from DTS' commitment to insuring that sound track reproduction is faithful to the original creative intent. For the producer/director this means technical support and advice during the re-recording and print mastering process; for the distributor, print (CD-ROM and film) quality control and responsive, timely service; for the exhibitor, comprehensive installation and after-market support; and for the movie-goer, an exciting motion picture experience.

DTS Licensing

The first step in the DTS process is the completion of the DTS License Agreement. Under the terms of the License Agreement DTS, will provide:

a)   The necessary audio processing equipment (DTS Tower) to produce a DTS print master.

b)   The services of a DTS Studio Services Engineer for equipment setup and print mastering if required.

c)   CD-ROM mastering of the 6-track print master.

d)   Production CD-ROMs in quantities specified by the client.

e)   Access to the DTS Theater Database to aid in booking the film.

f)   Technical assistance for theaters and studios.

How DTS Works

Six digital audio channels in a 5.1 format (i.e., left, center, right, left surround, right surround and subwoofer) are recorded on to a CD-ROM. A simple, robust, and easy to read time code track is simultaneously recorded on to the optical negative as the standard stereo optical sound track is exposed. This track is printed on a safe, non-contact area of the film, inside the normal SMPTE specified soundtrack exposure aperture (see the track specification and position details on page 12). This location is not used for picture or audio.

A miniature reader, smaller than a person's fist, is mounted on to the projector, between the feed arm and the projection head. The reader is not sprocket driven, does not increase the load on the projector motor, and has a long life L.E.D. light source. A prewired cable connects the reader to the main electronic package of the system. Power for the reader is supplied from the main electronics. Logic and audio signal switching relays control the selection of the DTS digital audio track or the backup analog track.

The film is threaded through the reader and the rest of the normal film path. When the reader begins reading time code, the audio from the CD-ROM will play synchronously with the picture, the audio becomes a slave to the projector, and consequently, the audio editing will match any physical edit of the film.

Analog Audio Processing

There are 6 source channels: left, center, right, left surround, right surround and subwoofer. The front channels are recorded on the disc without any manipulation. The subwoofer information is filtered with a steep lowpass at 80Hz and is added to each of the surround channels. The resulting 5 audio channels are then digitized and recorded on to the CD-ROM. Upon playback, each surround channel is crossed over with the subwoofer at 80Hz. A sum of the surround channels is also created for mono surround theaters.

DTS Technical Specifications

Frequency Response	Left	20Hz - 20kHz
	Center	20Hz - 20kHz
	Right	20Hz - 20kHz
	Left Surround Right Surround	80Hz - 20kHz (The surround channels are crossed over to the subwoofer at 80Hz, ensuring that the surround speakers are not over-driven with low frequency information and still providing full frequency bandwidth surround channels.)
	Subwoofer	20Hz - 80Hz (Includes the subwoofer channel information and the surround channel's information below 80Hz.)
System Capacity player.		Approximately 100 minutes of 5.1 audio per disc, three discs per

Mixing For DTS Release

DTS Tower

The DTS Tower has all the mixing, matrixing and monitoring functions needed to prepare a DTS print master for 6-track CD-ROM or 2-track (Lt/Rt or SVA) analog release. The Tower includes a main electronics package, power supply, remote control and a meter bridge.

The Tower does not contain any noise reduction, house equalization, ganged volume controls or optical preamplifiers.

6-track Mix

For the 6-track mix, the Tower emulates the DTS-6 and DTS-6D playback unit's frequency response characteristics. This includes the low pass filtering of the subwoofer channel and the crossover between the surround channels and the subwoofer.

2-track (Lt/Rt) Mix - DTS Stereo

From four or six track stems, the Tower will accurately matrix a surround-encoded stereo sound track that is completely compatible with theater cinema processors and home surround decoder equipment. For monitoring on the mixing stage, a Dolby^{TM} Cat. 150 surround decoder is integrated into the Tower's electronics. The monitor level can be altered for SR^{TM} noise reduction encoded sound tracks. External SR™ or "A" type noise reduction is required for recording the Lt/Rt print master.

Music and Effects

The Tower can be used for making 6-track, 4-track or 2-track M&E's.

Creating The Print Master

The DTS Consultant

A DTS consultant can be present at the print master session to assist with the setup of the equipment and assure correct monitoring levels. Afterwards, the DTS consultant will coordinate the remainder of the mastering process and follow the project through to the mass production of CD-ROM discs.

The 6 Track Print Master

The print master can be recorded on 6 track 35mm magnetic with SR^{TM} encoding, on Akai DD-8, Tascam MMR-8, Tascam DA-88, or on Sony PCM-3324/48 DASH format. It is typically a discreet six track recording; the 5.1 encoding is done during the transfer process to disc. Please ensure the following details when preparing a print master:

1. The film/tape speed may be any speed that can be recorded to optical. The two primary speeds are 24FPS and 25FPS. Please write the film/tape speed clearly on the labels.
2. If there is timecode, the frame rate should be 30 FPS NDF or 25 FPS, although any nondrop timecode frame rate is acceptable provided that it was used to synchronize the picture. Dropframe rates must not be used.
3. The transfer to the DTS disc recorder is via A to D converters, therefore the sampling rate of a DD-8, MMR-8, DA-88 or DASH print master can be any rate.
4. Head tones on all channels and on all reels. 1 kHz 50%, Dolby Level, -20dBFS 185nW/m$^{2.}$ Note: there is 20 dB of headroom above this level.
5. 35mm mag reel one should have pink noise at the head for azimuth/EQ adjustment.
6. Record a standard sync pop 2-second before the first frame of sound.
7. Since the DTS recorder triggers off the sync pop, voice slates should not be used so that false triggers can be avoided.
8. Record an end pop on all reels **except the last reel** - or a write a clear label showing the end time or feet/frame number.
9. Write clear labels with track layout, tone position and level. Although any track layout can be used, the preferred track layout is: 1-Left, 2-Left Surround, 3-Center, 4-Right Surround, 5-Right, 6-Subwoofer.
10. The DTS player has no delay for the surround channels. If a delay in the surrounds is desired it should be indicated to the DTS consultant before the transfer is made. Delay will be inserted into the surround channels during transfer. The amount of delay should be specified.
11. The print master must have pull ups 20 frames in duration or an accurate accounting of the LFOA (Last Frame Of Action) for all reels.
12. Do not use the SRD MOD for DTS transfer.

<u>2-track (Lt/Rt)</u>

A 2-track print master can be recorded with SR^{TM} or "A" type noise reduction. Since optical tracks for film have much lower headroom than most other modern media, DTS has created devices to aid in overcoming this. The DTS stand-alone Optical Simulator has thresholds of 100%, 115%, or 130%, selectable by the user. The Simulator "clips" the audio when the levels exceed the threshold, providing a sonic indication of over-modulation. The stand-alone Simulator also has over modulation LED indicators. DTS has also created a device called The Compactor; a six band, stereo compressor used to fit signal levels within the limitations of the film medium. These controls can also be adjusted to limit for headroom restrictions of other media, such as laser disc or television versions.

Both the Compactor and the stand-alone Optical Simulator can be provided by the DTS consultant at the Print Mastering session.

CD ROM Mastering

After the film has been print mastered, the 6-track original will be transferred onto CD-ROM. This process involves real-time 6-track print master playback into DTS analog to digital converters, which feed the digital input of the DTS-P8 hard disc recorder. The incoming data stream is compressed using APTX-100, formatted and recorded on to a removable hard drive. When all reels have been transferred to the hard drive, a write once CD-ROM disc is made. Each disc contains up to 100 minutes of 5.1 audio. Most films require two discs. In the unusual situation of a film length greater than 200 minutes, please contact DTS.

Currently there are DTS P8 hard disc recorders in the following locations:

- DTS, Agoura Hills, California
- Universal Studios, Los Angeles, California
- Todd-AO, Hollywood, California
- Signet Sound, Hollywood, California
- Sound One, New York, New York
- Sky Walker Ranch, San Francisco, California
- DTS UK, Twyford, UK
- AVIO, Paris, France
- Studio Sound, Rome, Italy
- Cinecolor Laboratory, Bangkok, Thailand
- Real Image, Madras, India
- Buena Vista Studios, Burbank
- Shanghai Paradise Studios, Shanghai, China

DTS' standard procedure is to create two write-once discs - one for approval and mass production, the other for screening or archive. An approval screening, utilizing the write once disc and a composite print with DTS timecode is required before disc production can begin.

Optical Track and Printing DTS Timecode

The DTS timecode track is exposed on to the negative simultaneously with the analog SVA track. This timecode does not interfere with the analog track.   A special timecode generator and an exposure head are fitted into a standard Westrex stereo optical recorder, or an M W Albrecht Laser Camera. The generator and exposure head are provided to selected transfer facilities. Currently, the following locations are equipped to make DTS optical negatives:

- Walt Disney Studios, Burbank, California
- Warner Bros. Studios, Burbank California
- Sony Studios, Culver City, California
- Todd-AO, Hollywood, California
- NT Audio, Santa Monica, California
- Twentieth Century Fox, Century City, California
- Universal Studios, Universal City, California
- Warner-Hollywood, West Hollywood, California
- Sound One, New York, New York
- Todd-AO, New York, New York
- T Astraltech, Montreal, Canada
- DeLuxe, Toronto, Canada
- McClear Pathe, Toronto, Canada
- Studio L'Equippe, Brussels, Belgium
- Anvil Post Production, London UK
- Pinewood Studios, London, UK
- Technicolor, London, UK
- Les Audis De Joinville, Paris, France
- Cine Stereo, Paris, France
- SIS, Paris France
- Dubbing Bros, Paris, France
- Finlab, Helsinki, Finland
- ARRI Contrast, Berlin, Germany
- Geyer Berlin, Germany
- Bavaria Kopierwerk, Munich, Germany
- ABC & Kopiwerk, Wiesbaden, Germany
- Eglifilm and Video, Zurich, Switzerland
- Europa Studios, Broma, Sweden
- Fotofilm, Madrid, Spain
- Madrid Film, Madrid, Spain
- Image Film, Barcelona, Spain
- International Recording, Rome, Italy
- SEFIT Margutta, Rome, Italy
- Cine Citta, Rome, Italy
- Imag Studio, Istanbul, Turkey
- Prasad Labs, Madras, India
- Sujadha Recording, Madras, India
- Empire Audio, Bombay, India
- Cinecolor Laboratory, Bangkok, Thailand
- National Library of Norway, Oslo
- Listo Film, Vienna, Austria
- Johan Ankerstjerne, Copenhagen, Denmark
- Magyar Film, Budapest, Hungary
- Barandov Studios, Prague, Czech Republic
- Kodak Poland, Warsaw
- Shanghai Paradise Studios, Shanghai, China
- Atlab, Sydney, Australia
- AOI Studio, Tokyo, Japan
- Tokyo TV Center, Tokyo, Japan
- Nikkatsu Film Studio, Tokyo, Japan

DTS Serial Numbers

Intrinsic to each DTS optical negative is the reel number and a production serial number issued by DTS. This serial number is unique to each film and is provided to the facility in writing (via fax) along with any special instructions. <u>The serial number is essential and is provided by the DTS Office as follows:</u>

DTS Productions in North and South America
Phone: +1 818 706 3525
Fax: +1 818 706 1868
5171 Clareton Drive
Agoura Hills
CA 91301 USA

DTS Productions in Europe
Phone: +44 118 934 9199
Fax: +44 118 934 9198
Unit 5 Tavistock Industrial Estate
Ruscombe Lane
Twyford
RG10 9 NJ UK

No special printing equipment is needed at the laboratory, as the analog track and the DTS timecode are both inside the standard SMPTE optical sound track exposure area.

DTS Serial Numbers for Alternative Versions

If there is a different cut of the film to accommodate foreign censors or different title sequences a new reel number or serial number must be assigned.

If there is an alternate version of the film in its original language, and data space remaining on the disc set, the alternate version's reels can be added to the disc with an alternate reel number. For example, a film has a domestic and foreign cut that differs in one reel only.

	Original Version	Alternative Foreign Distributor
Film Reel 1AB	DTS Reel 1	DTS Reel 13 (Distributor Logo)
Film Reel 2AB	DTS Reel 2	DTS Reel 2
Film Reel 3AB	DTS Reel 3	DTS Reel 3
Film Reel 4AB	DTS Reel 4	DTS Reel 4
Film Reel 5AB	DTS Reel 5	DTS Reel 5
Film Reel 6AB	DTS Reel 6	DTS Reel 6

 If reel 1AB is the reel that has two versions and it is a 6-reel picture, then the domestic reel 1AB would be designated reel 1 on the CD-ROM. The optical negative would have DTS timecode programmed as reel 1 and would be marked on the can as REEL 1AB DOMESTIC. The foreign version of reel 1AB would be designated reel 13 on the CD-ROM, the optical negative would have DTS timecode programmed as reel 13 and would be marked on the can as REEL 1AB FOREIGN. The DTS system does not require that the reel numbering be sequential.

DTS CD-ROM Compatibility Between Original & Foreign Versions

In order to maintain CD-ROM compatibility between original and foreign versions of a film, the foreign language version <u>must</u> be identical to the original version (OV) language print and therefore mixed to the OV print. The serial number will remain the same as the original language version; thus, any language print may be played with any language CD-ROM.

Whilst it is important to ensure that all reels are the same length as the OV print, variations usually occur in reel 1. It is therefore essential to establish the correct position for the academy leader and the 2 second sync pop, as the original start mark from the OV print may have been replaced by a Censor Certificate and/or distribution logo. The position should be clear from the sync pop on the M & E tracks, or by clearly identifying the First Frame Of Action from the OV print (assuming that the first frames of the reel are not black).

If the foreign release prints require a local distribution logo, this must be cut on to the front of reel 1 of the foreign release prints <u>after</u> dubbing is complete.

If the local distribution logo requires DTS digital sound or the foreign version of the film differs from the OV, for example, due to censor cuts, please contact DTS for further information.

Quality Control

Inspecting the sound negative

This is best done by the lab quality control staff or negative cutter. Inspection assures proper synchronization between the DTS timecode and the analog sound track.

DTS Negatives

Before printing using a new DTS sound negative, it is important to check the position of the timecode relative to the 2-second sync pop. This is best done by the lab after the negative comes out of processing or by the negative cutter before the sound track negative is mounted for printing.   Please refer to the DTS Track Specification drawing.

Working from the leading (beginning) edge of the 2-pop, measure four perforations (one frame).   This is where the DTS timecode begins. The acceptable tolerance range is -1/2 perforation to +1 perforation. Outside this range the negative is unacceptable for use. If the negative does not pass inspection, the optical negative supplier or DTS should be contacted immediately.
Note the first 3 feet of DTS timecode are equally spaced dashes.

Composite Prints

The same technique and tolerances are used when inspecting a composite print. In addition to verifying the 2-pop and the DTS timecode, the relationship of the sound track and the picture needs to be examined. The 2-pop is properly placed at 7 feet 12 frames, measured from the start mark. On an Academy leader this is four frames before the 4-foot mark. There is a small diamond in the center of the frame.

The Check Disc

The write once disc is checked by playing it with the print, with the analog sound head bypassed or the exciter lamp turned off. If there are any substantial timecode problems, the system will attempt to revert to the analog track and since the head is bypassed or the lamp is off, there will be an audible drop out during the bad timecode section. For each write once disc created, a quality control/approval screening is required. Client involvement is not required.

A standard DTS-6 player can also be used as a quality control unit. An RS-232 serial printer can be connected to the timecode reader D connector through a translator box available from DTS. The player will send the following data to a standard RS-232 printer for a paper report of these parameters:

1.   Film serial number
2.   Reel number
3.   Number of accumulated timecode dropouts
4.   Position (in feet) of each drop out in excess of 20 frames

This is also available from an upgraded DTS-6D player

The print (and therefore the negative) is considered good if the dropouts (if any) are each less than twenty frames in length. If the quality report indicates a position to inspect (#4 above), the negative should be inspected along with the print to determine if the errors are from the printing process or the negative. Your DTS consultant can assist with this inspection.

<u>The Production Sample</u>

After the write once disc is approved, it is sent for mass production. After production, a random disc sample is screened for quality and final approval. Once approved, the production discs are released for distribution.

<u>Multiple sound negatives</u>

It is customary to make multiple sound negatives for large releases. All sound negatives must be inspected. A composite check print from each negative must be screened. The screening can be done with a copy of the approved write once disc or a production disc.

Delivery of DTS Discs

<u>Write once discs</u>

Once the sound track has been digitized, it takes approximately 1 hour to make each write once disc set of the complete sound track.

<u>Production discs</u>

Standard turn around time for production discs is five working days. Under special circumstances, production turn time can be reduced to as few as two working days. However, expediting fees will be charged accordingly. Working days exclude Sundays, and holidays. Contact the DTS office for details.
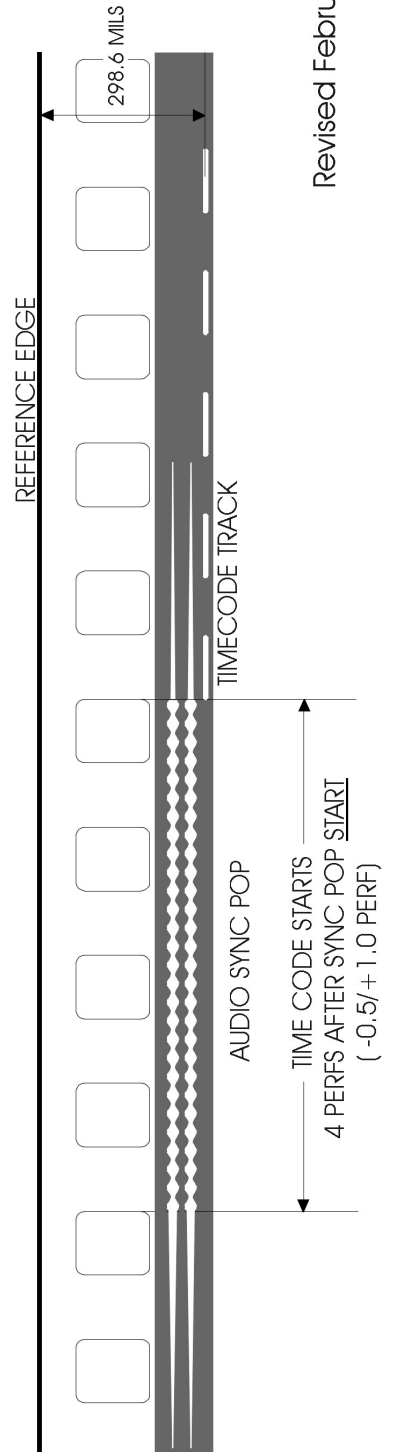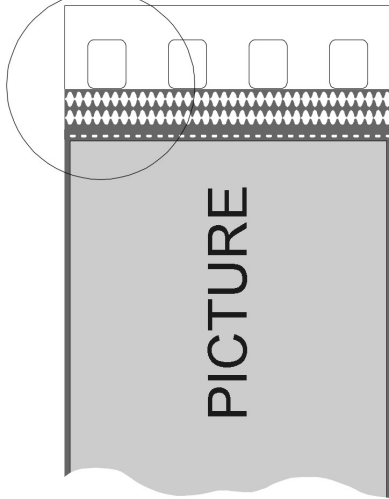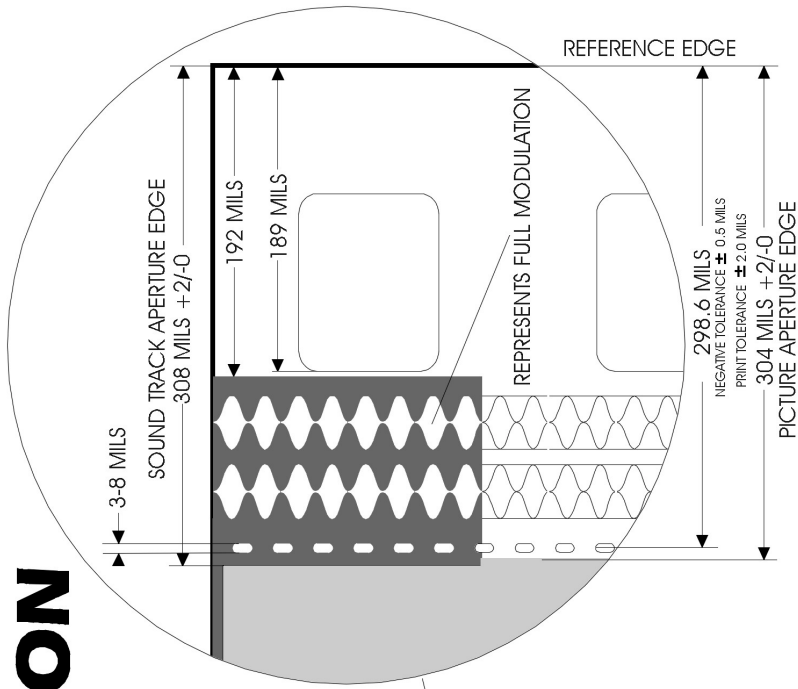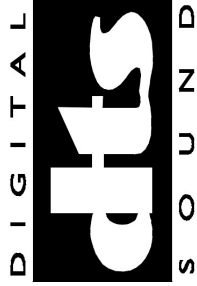
<u>Disc Distribution</u>

The discs will be packed according to client instructions.

DTS Release Check List

___ **License Agreement** - A signed copy of the License Agreement must be delivered to the DTS office.

___ **Schedule** - Inform the DTS office of when and where the mix will begin, what are the likely print mastering dates, contact people during the mix and any other pertinent information.

___ **Tower delivery and set up on mixing stage** - (if required) The DTS consultant will meet with the mixers on the first day of the mix.

___ **Print master 2-track (Lt/Rt)** - The DTS consultant can be present for this session. Before the 2-track print master is completed, inform the DTS office or consultant as to where the optical negative will be shot.

___ **Serial number** - DTS Office assigns a serial number and informs the optical recording facility by fax.

___ **Shoot the optical negative.**

___ **Develop and inspect negative** - The negative inspection is best done by the lab quality control staff or by the negative cutter. See page 4

___ **Print composite check print.**

___ **Print master 6-track** - The DTS consultant can be present for this session.

___ **Digitize 6-track print master** - DTS will need the 6-track print master to create the CD-ROM discs.

___ **Make write once CD-ROMs.**

___ **Digital QC screening** - Screen write once CD-ROMs with check print. See page 4

___ **CD-ROM production** - After the above screening, release the approved CD-ROMs for mass production.

___ **Analog QC screening** - Screen the check print analog track.

___ **Other format QC screening** - Screen any other format.

___ **Release sound track negative** - When all formats have been approved, the negative can be released for printing. *Remember - all printing negatives must be inspected and composite check prints from each negative must be QC screened.*

___ **Production CD-ROM QC screening** - Screen production CD-ROM sample with any composite print made from an approved sound negative.

DTS TRACK SPECIFICATION

DIGITAL dts SOUND

PICTURE

REFERENCE EDGE

SOUND TRACK APERTURE EDGE
308 MILS +2/-0

192 MILS

189 MILS

3-8 MILS

REPRESENTS FULL MODULATION

298.6 MILS
NEGATIVE TOLERANCE ± 0.5 MILS
PRINT TOLERANCE ± 2.0 MILS
304 MILS +2/-0
PICTURE APERTURE EDGE

REFERENCE EDGE

298.6 MILS

TIMECODE TRACK

AUDIO SYNC POP

TIME CODE STARTS
4 PERFS AFTER SYNC POP START
(-0.5/+ 1.0 PERF)

Revised February 24, 1999

D I G I T A L
dts ®
S O U N D

Appendix A

Subject: Setting Sound Pressure Levels

Setting the Sound Pressure Levels (SPL) in theaters and studios is a simple procedure, and should be done routinely. Follow these simple guidelines:

DTS-6 or DTS-6D (Theater) SPL calibration:

Remove the front panel, which covers the output trim potentiometers. Set your SPL meter for C Weighting, Slow Response. Insert the "Rev C" or "DS1" test disc and allow the disc to load. The first thing heard will be 1 kHz across all channels on the "Rev C" test disc only (the "DS1" only has pink noise). Press the small increment button on the lower right twice to change to the pink noise signals on individual channels. The disc will then automatically step through each channel. Adjust the six "6 track" potentiometers for the following readings on your SPL meter:

Left	85 dB SPL
Left Surround	82 dB SPL
Center	85 dB SPL
Right Surround	82 dB SPL
Right	85 dB SPL
Sub Woofer	**91 dB SPL**

DTS Tower (Studio) SPL calibration:

Using a 1 kHz tone, align the Tower according to the instructions in the respective manual. Once this is done, send pink noise at 0 VU into the Tower. Set your SPL meter for C Weighting, Slow Response. Adjust the "To Monitor" potentiometers for the following readings on your SPL meter:

Left	85 dB SPL
Left Surround	82 dB SPL
Center	85 dB SPL
Right Surround	82 dB SPL
Right	85 dB SPL
Sub Woofer	**88 dB SPL**

Subject: SMPTE RP200 changes DTS subwoofer level (REVISED)   August 1999

At a SMPTE meeting held in late 1998, all three digital sound companies agreed to comply with the recommended practice for subwoofer level, **SMPTE RP200**. The subwoofer level has changed to enable the use of one master recording when transferring to all three digital sound processes and to provide playback consistency in theaters. As of **January 1, 1999**, the recorded subwoofer level on 6-track masters has been lowered to the SMPTE recommended level of 10dB in-band gain (as compared to the screen channels).

To comply with this new standard, all DTS films released in North America after January 1, 1999 have been transferred into the DTS digital process with **subwoofer at 10dB in-band gain**. The **SMPTE RP200** logo is clearly visible on the discs of these films.

Because the recorded subwoofer level has been lowered, the DTS theater subwoofer playback should be increased. Increasing the DTS subwoofer level compensates for the new lowered recording level, resulting in the same playback as before the change.

To maintain the integrity of the cinema sound equipment, DTS discs of pre 1999 films should be played only after the subwoofer playback level has been restored to the previous 88 dBC level.

Technicians should follow these steps

Equipment needed: DTS Setup Disc, DS1 or Rev. C

1.   Verify the cinema processor is correctly calibrated. Follow the manufacturer's recommendations for proper playback levels (when using a DTS-6AD, see 4. Below).
2.   Using the DTS Setup Disc, adjust the DTS output levels as normal**:** L, C, R to 85dB SPL and surround(s) to 82 dB SPL* *in the theater*.
3.   Adjust the **DTS-6 or DTS-6D subwoofer to 91dBC SPL** in *the theater*.
4.   When adjusting the output of the **DTS-6AD Cinema Processor** using the internal pink noise generator, adjust the DTS subwoofer to 85dBC SPL in *the theater*.

NOTE
    * It is recommended that the subwoofer amplifier be turned off during the surround level adjustments. Turn the subwoofer amp back on after the surround levels have been set.

Please refer any questions to DTS technical support