

# Personal Video Archiving - Preserving Your Analog and Digital Memories

Convert DV and HDV camcorder video formats to Blu-ray Video and burn it on Blu-ray disc using Linux tools.

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# Overview

This document describes the methods used to achieve a "backup type" or intermediate codec for non-edited source video camcorder formats, compatible with and viewable on Blu-ray hardware players. After you have moved your camcorder media onto a computer disk, you can with some extra effort, transfer them for safekeeping and longer term storage on simple viewable Blu-ray video discs.

Transferring camcorder media to digital files on a computer, and next to optical Blu-ray video media is especially important for legacy tape-based camcorders, because tape will degrade over time. You can do this using a combination of free tools on Linux, generic and independent of any NLE.

In this case we use and keep interlaced video as on the source or digitized video (PAL 50i, 25 fps) for both DV and HDV formats. As confirmed by the `ffmpeg` output below, DV uses 25 Mbps data rate (DV25), is Standard Definition (SD), resolution 720×576, 8 bits color depth 4:2:0, display aspect ratio (DAR) 4:3 while HDV is High Definition HD video, resolution 1440×1080, DAR 16:9, 8 bits color depth 4:2:0.

We utilize or keep relative low MPEG-2 video compression at the same bit-rate 25 Mbps as the original video recorded onto the source tapes. That is about 13 GB per hour video and audio in total, and about 3 hours playtime with 40 GB BD-video size (of max 46.5 GB) on each 50 GB BD-R DL Blu-ray disc. Audio is transcoded to uncompressed LPCM compatible with BD-video.

In this how-to we combine **ffmpeg**, **tsMuxeR** and **xorriso** to create the MTS-video stream, to create the Blu-ray ISO image, and to burn the image to Blu-ray video disc. The benefit of using `tsMuxer` here, is its support of UDF version 2.50 as required by the Blu-ray video standard. Listed next are the possible camcorder video formats on Blu-ray video discs.

- **DV** (1995) transfer to SD-blu-ray video (re-encoding video to `mpeg2`, re-encoding DV LPCM audio to Blu-ray LPCM)

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- **HDV** (2004) transfer to blu-ray video (copying mpeg2 video, re-encoding MP2 audio to Blu-ray LPCM or AC3)
  - **AVCHD** (2006-current) transfer to Blu-ray video (copying H.264 video and AC3 audio)

An alternative method as described in the CinGG manual, is to use *mkudffs* and *bdwrite* packaged with CinGG, to create the udfs image and burn it to Blu-ray disc using *growisofs* or *dd*.

[https://cinelerra-gg.org/download/CinelerraGG\\_Manual/Creating\\_Blu\\_ray\\_Without\\_Re.html](https://cinelerra-gg.org/download/CinelerraGG_Manual/Creating_Blu_ray_Without_Re.html)

There are other methods described on the internet and there are alternatives to the software programs used here that work as well.

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# Video recording formats

A description of the most common video recording formats for consumer and prosumer equipment; camcorders, analog video cassette recorders (VCR decks), digital video hard disc recorders, and optical disc recorders (DVD, Blu-ray).

## 2.1 Analog video (legacy) onto magnetic tape cassettes

### 2.1.1 VHS (1976), VHS-C (1982), and Video8 (1984)

- Composite Audio/Video is encoded on one channel with maximum horizontal resolution 240 (250) dots (or visually resolvable vertical picture lines) for VHS/VHS-C and 280 dots for Video8 (2.7MHz video bandwidth).
- In comparison, horizontal resolution bandwidth for PAL broadcast: 5.0-5.5 MHz, NTSC: 4.2 MHz.
- It is the horizontal resolution that makes the big difference in picture quality since all video formats have the same number of vertical resolution (or visible horizontal scan lines); always 576 for PAL/SECAM and 486 for NTSC.
- RCA (phono) connectors: yellow for composite video, red and white for left and right audio signals.
- 21-pin SCART Euro connector with optional RCA adapter.
- Magnetic tape media in full size VHS (1/2") cassettes, VHS-C (1/4") compact and 8 mm cassettes.
- Cassette adapters to playback compact VHS-C cassettes on full size VHS decks/players.

### 2.1.2 SVHS (Super VHS, 1987), SVHS-C (-Compact, 1987) and Hi8 (1989)

- S-Video (separate video, Y/C) encodes video **luma** (brightness/contrast/black&white) and **chroma** (color) on two separate channels, achieving higher image quality and amount of picture details over composite video.
- Max visible horizontal resolution is 400 dots for SVHS/SVHS-C and 440 dots for Hi8 systems on high-end VCR machines (4.5 MHz decks). In practice

consumer/prosumer camcorder recordings quality vary from about 330-350 dots horizontal resolution (3.5MHz), which is equivalent to analog TV set quality.

- 4-pin mini-DIN S-video connector for Y/C video, red and white RCA line connectors for left and right audio; optional SCART Euro adapter with 4-pin video and RCA audio connectors.
- In comparison, analog Component video (three component YPbPr) has the highest color resolution and is encoded over three channels with green, blue and red RCA connectors (consumer) or with BNC connectors (prosumer), additional red and white phono line connectors for audio.

## 2.2 Digital video

### 2.2.1 DV (1995), Digital8 (1999)

- DV refers to a family of codecs and tape formats used for storing digital video, especially on MiniDV cassettes, the most popular tape format, or on Digital8 cassettes using a DV codec.
- DV codecs are still sometimes used when dealing with legacy standard definition SD video:
  - PAL: 625i50, 720 × 576 frame size, 25 fps, 8 bit 4:2:0 subsampling
  - NTSC: 525i60, 720 × 480 frame size, 30 fps, 8-bit 4:1:1 subsampling
- The same frame size is used for 4:3 and 16:9 frame aspect ratios, resulting in different pixel aspect ratios for fullscreen and anamorphic widescreen video.
- DV uses lossy, DCT algorithm intraframe video compression 5:1 on a frame-by-frame basis.
- Audio almost exclusively is stored as 16-bit LPCM at 48 kHz sampling rate, 1.5 Mbit/s stereo.
- Data rate is about 25 Mbit/s for video, thus DV25, and an additional 1.5 Mbit/s for PCM audio.
- Total stream is 29 Mbps, or 3.6 MiB/s. The information output is approximately 200 MiB per minute, 12 GiB or 13 GB per hour playtime.
- DV camcorders and decks have IEEE 1394 (FireWire, i.LINK) ports for digital video transfer.
- **DV50** (Digital-S or D-9 and DVCPRO50) is a 50 Mbit/s variant of DV with improved 4:2:2 chroma subsampling and 3.3:1 compression. This in effect cuts total record time of any given storage medium in half compared to DV25.
- DV was strongly associated with the transition from analog to digital desktop video production.
- Digital8 equipment recorded in DV format only, but usually could playback Video8 and Hi8 tapes as well, and were also capable to do analog to digital video conversion during playback.
- Most (but not all) modern digital camcorders provided an analog-to-digital

"passthrough" capability. This feature fed an analog input signal (usually via S-Video, sometimes RCA) into the camcorder and output a standard DV signal. The camcorder converts the analog signal on-the-fly using a hardware encoder. The input device could be your old analog camcorder (playing 8 mm or Hi8 tapes), a VHS/VHS-C video player, to convert analog to digital output via Firewire **dv** file extension.

### 2.2.2 DVD-Video (1996)

DVD-Video discs are intended for full-length movies and offer a range of features including the following:

- Playing time: a nominal 133 minutes playing time for DVD-5 or each side of a DVD-10 and 240 minutes for DVD-9 using opposite track path format. In practice playing times are often reduced in favour of improved quality.
- Video encoding: MPEG-2 ([MP@ML](#)) or MPEG-1.
- Audio Quality and Languages: Dolby Digital, DTS, MPEG-2 or Linear PCM audio for up to 5.1 channel surround sound.
  
- To record digital video, DVD-Video uses [H.262/MPEG-2 Part 2](#) compression at up to 9.8 Mbit/s, maximum of 10.08 Mbit/s can be split amongst audio and video. DVD-Video supports video with a [bit depth](#) of 8 bits per color, encoded as [YCbCr](#) with 4:2:0 [chroma subsampling](#). The H.262/MPEG-2 Part 2 format supports both interlaced and progressive scan content.
- As for lines of horizontal resolution, DVD has about 500. In analog output signal terms, typical luma frequency response maintains 53/145 full amplitude to between 5.0 - 5.5 MHz. This is below the 6.75 MHz native frequency of the MPEG-2 digital signal. Chroma frequency response is one-half that of luma.

The following formats are allowed for H.262/MPEG-2 Part 2 video:

- At a display rate of 25 frames per second, interlaced or progressive scan (commonly used in regions with 50 Hz image scanning frequency, compatible with analog 625-line PAL/SECAM):
  - 720 × 576 pixels (D-1 resolution, 4:3 fullscreen or 16:9 anamorphic widescreen aspect ratio)
- At a display rate of 29.97 frames per second, interlaced or progressive scan (commonly used in regions with 60 Hz image scanning frequency, compatible with analog 525-line NTSC):

720 × 480 pixels (D-1 resolution, 4:3 or 16:9)

The official allowed formats for the audio tracks on a DVD-Video are:

- PCM: 48 kHz or 96 kHz sampling rate, 16 bit or 24 bit Linear PCM, 2 to 6 channels, up to 6,144 kbit/s; N. B. 16-bit 48 kHz 8 channel PCM is allowed by the DVD-Video specification but is not well supported by authoring applications or players.
- AC-3: 48 kHz sampling rate, 1 to 5.1 (6) channels, up to 448 kbit/s.
- MP2: 48 kHz sampling rate, 1 to 7.1 channels, up to 912 kbit/s.
- DTS: 48 kHz or 96 kHz sampling rate; channel layouts = 2.0, 2.1, 5.0, 5.1, 6.1; bitrates for 2.0 and 2.1 = 377.25 and 503.25 kbit/s, bitrates for 5.x and 6.1 = 754.5 and 1509.75 kbit/s.
- File system:
  - Almost all DVD-Video discs use the UDF bridge format, which is a combination of the DVD MicroUDF (a subset of UDF 1.02) and ISO 9660 file systems.
  - The UDF bridge format provides backwards compatibility for operating systems that support only ISO 9660.
  - Most DVD players read the UDF filesystem from a DVD-Video disc and ignore the ISO9660 filesystem.

### 2.2.3 HDV (2003)

- HDV was a successor format to DV with an updated video codec, and used the same MiniDV cassette format, optional specifically for HDV recording on tape with reduced drop-out rate.
- Some manufacturers offered on (larger) camera hard disk recording units capable of recording HDV both onto tape and/or onto file-based media via FireWire connection.
- HDV camcorders can typically switch between HDV/MP2 and SD-DV/PCM recording modes.
- HDV 1080i with horizontal resolution 1440 is twice the 720 resolution of DV and DVD, and the perceived sharpness with HDV is much higher when scaled up to full HD (TV) resolution.

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<ul style="list-style-type: none"><li>• <b>HDV 1080i</b> specification (HD2):</li><li>• 1080/ 50i (PAL), 1080/ 60i (NTSC)</li><li>• 1440 × 1080, anamorphic pixels 4:3=1.33</li><li>• 16:9 Display aspect ratio<ul style="list-style-type: none"><li>- 720×480/ 60i (SD-DV 4:3 og 16:9)</li><li>- 720×576/ 50i (SD-DV 4:3 og 16:9)</li></ul></li><li>• MPEG-2 interframe GOP (<b>MP@H-14</b>)</li><li>• 8 bit color depth 4:2:0 subsampling</li><li>• 25 Mbps data rate after compression (20:1)</li><li>• MP2/MPEG-1 Audio Layer II</li><li>• Stereo (2-ch), 384 kbps</li><li>• A/V out: HDMI, Component, S-video/RCA</li><li>• IEEE 1394 (MPEG-2-TS) stream interface</li><li>• M2T file extension</li></ul>	<ul style="list-style-type: none"><li>• <b>HDV 720p</b> specification (HD1):</li><li>• 720/25p, 720/50p,720/30p, and 720/60p</li><li>• 1280 x 720, Pixel aspect ratio 1.0</li><li>• 16:9 Display aspect ratio</li></ul> <ul style="list-style-type: none"><li>• MPEG-2 (<b>MP@H-14/HL</b>)</li><li>• 8 bit color depth 4:2:0 subsampling</li><li>• 19.4 Mbps data rate after compression</li><li>• MP2/MPEG-1 Audio Layer II</li><li>• Stereo (2-ch), 384 kbps</li><li>• A/V out: HDMI, Component, S-video/RCA</li><li>• IEEE 1394 (MPEG-2-TS) stream interface</li><li>• M2T file extension</li></ul>
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### 2.2.4 AVCHD (2006-current)

- AVCHD stands for *Advanced Video Coding High Definition*, in particular, *MPEG-4 Part 10: AVC/H.264*. The intent of the H.264/AVC project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards (i.e., half or less the bit rate of MPEG-2, H.263, or MPEG-4 Part 2).
- AVCHD is a file based format for digital camcorders to record and playback 1080i and 720p HD-video onto certain random access media. Memory cards, thumb drives, and HDDs use the FAT file system. This highly compressed video allows for recording long videos in high definition.
- AVCHD was originally a simplified version of the Blu-ray standard to enable DVD and BD-based camcorders. Recordable optical discs use UDF or ISO9660 derived from the Blu-ray disc specification. For example, it utilizes a legacy 8.3 file naming system while Blu-ray disc uses long filenames.
- MTS file extension changes to M2TS when MTS recorded data is transferred to the computer for storing the video in a Blu-ray disc.
- Playback is possible on an AVCHD-compatible Blu-ray Disc player/recorder, DVD player/recorder, or PlayStation 3, the 8 cm DVDs (discs recorded in AVCHD) you have recorded or DVDs (discs recorded in AVCHD) and Blu-ray Discs created by importing videos to a PC or Blu-ray Disc player.

- Today AVCHD is the most popular camcorder format for consumers and prosumers, and is also available as AVCHD Progressive/PCM models for professional use.
- AVCHD supports both *AVCHD-SD Standard Definition* and *AVCHD 1080i High Definition* interlaced video, while AVCHD 1080i is available with most AVCHD camcorders. AVCHD supports 720-line progressive recording mode at frame rates of 24 and 60 frames/s for 60 Hz models and 50 frames/s for 50 Hz models.
- Also, 3D (MVC format) and 1080/60p(1080/50p) video formats were added as an extension to the AVCHD format to create the *AVCHD Ver. 2.0, 2011* (AVCHD 3D, AVCHD Progressive) format. Compatibility in AVCHD Ver. 2.0 format compliant devices is secured by being standardized as the AVCHD format.

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### 8 cm DVD/Built-in/SD Memory/M-Stick:

- 1920×1080/ 60i, 50i, 24p
- 1440×1080/ 60i, 50i, 24p
- 1280×720/ 60i, 50i, 24p
- 720×480/ 60i (SD 4:3 og 16:9)
- 720×576/ 50i (SD 4:3 og 16:9)
- 16:9 Display aspect ratio
- MPEG-4 Part 10: AVC / H.264
- 8 bit color depth 4:2:0 subsampling
- ≤ 24 Mbps data rate
- ≤ 18 Mbps data rate for DVD
- Dolby Digital AC-3 , 64-640 kbps  
2 ch stereo and 5.1 (5-ch + subw.) surround
- Linear PCM, 1.5 Mbps (2 ch)  
1~ 7.1 channels
- A/V out: HDMI, Component, S-video/RCA
- MPEG-2 Transport Stream
- MTS file extension (recorded)

### Built-in media/SD Memory/Memory Stick:

- 1920×1080/ 60p, 50p
- 1440×1080/ 60p, 50p
- 1280×720/ 60p, 50p
- 16:9 Display aspect ratio
- MPEG-4 Part 10: AVC / H.264
- 8 bit color depth 4:2:0 subsampling
- ≤ 28 Mbps data rate
- Dolby Digital AC-3, 64-640 kbps  
1~ 5.1 channels
- Linear PCM, 1.5 Mbps (2 ch)  
1~ 7.1 channels
- A/V out: HDMI, Component, S-video/RCA
- MPEG-2 Transport Stream
- MTS file extension (recorded)

### 2.2.5 Blu-ray BD-Video (2006), UHD-video (2016)

All standard DVDs will play on existing Blu-ray players, making the switch to Blu-ray much easier than the switch from VHS to DVD. Ultra HD Blu-ray is the latest

version available, supporting 4K resolution content. Historically, Blu-ray Disc allows video with a color (bit) depth of 8-bits per color YCbCr with 4:2:0 chroma subsampling (colors compressed to 25% of uncompressed), which means 256 possible values for red, green and blue; 16.7 million colors in total. Ultra-HD Blu Ray is 10-bit 4:2:0 to reduce color banding, giving 1024 values for RGB, 1.0 billion colors in total, or 64x more than 8-bit.

BDMV Video encoding:

- UDF2.5 as file system (BD-R/RE, 2005)
- M2TS file extension
- H.262/MPEG-2 Part 2 ([MP@HL](#), [MP@ML](#))
- H.264/MPEG-4 AVC ([HP@4.1](#), [MP@4.1](#))
- SMPTE VC-1 ([AP@L3](#))
- H.265/H.265/MPEG-H Part 2 (HEVC) (only Ultra HD Blu-ray on High-density optical disc)

BD Video movies have a maximum data transfer rate of 54 Mbit/s, a maximum AV bitrate of 48 Mbit/s (for both audio and video data), and a maximum video bit rate of 40 Mbit/s., BD disc capacities, each with its own data rate:

- 25 GB (BD-R SL)
- 50, 66 GB (BD-R DL) at 72 or 92 Mbit/s (50 GB BD-R DL 4x read speed supports UHD-video)
- 100 GB (TL), 128 GB (QL) at 92, 123, or 144 Mbit/s (BD-R XL)

Supported video formats (shortened):

<b>Format</b>	<b>Resolution and frame rate</b>	<b>Display aspect ratio</b>
4K UHD	3840x2160 60p, 50p	16:9
	3840x2160 25p, 24p	16:9
HD	1920x1080 60p, 50p	16:9
	1920x1080 25p, 24p	16:9
	1920x1080 29.97i, 25i	16:9
	1440x1080 29.97i, 25i	16:9
HD	1440x1080 24p	16:9
	1280x720 59.94p, 50p 1	16:9
	1280x720 24p	16:9
SD	720x480 29.97i, 25i	4:3 or 16:9

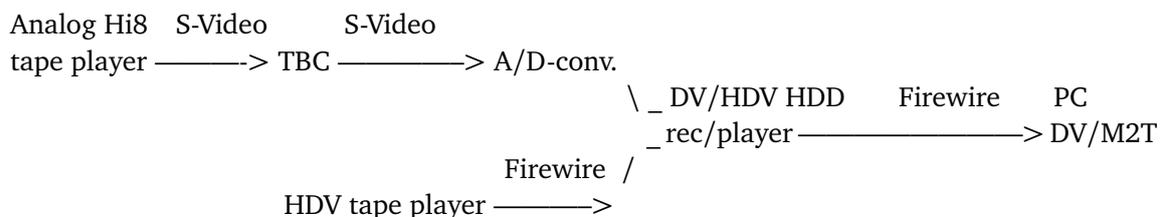
# How to digitize and capture analog video to digital SD video format with A/D video conversion

## 3.1 Methods and workflow

There are a number of ways to get analog source recorded video digitized and captured into the computer.

- One way is to use the passthrough feature of an available miniDV camcorder or the digital output of a Sony Digital 8 camcorder to convert the Hi8 source to DV, which is then sent via firewire to the computer.
- Another alternative might be a Linux supported external capture card to USB3 (often MPEG-4), or find a higher-end internal PCIe analog video capture card to store uncompressed, 422 or DV video.
- A third way is to use a standalone analog to digital A/D converter and capture device. This might be to DV HDD recorder or optional to a high-end analog/SDI and a SSD 422 codec (i.e ProRes) recorder.

An example workflow and setup for this third way:



- A fourth, interesting way as discussed on the CinGG mailing list (yet to be tested), is to combine a HDMI-USB3 capture dongle with an Analog Video to Digital HDMI miniConverter (ADC). The analog video player output (via TBC) connects to the actual input connectors (S-video/RCA or possibly Component) of the adapter. Reference the following from/to:  
<https://lists.cinelerra-gg.org/pipermail/cin/2021-October/003960.html>  
<https://lists.cinelerra-gg.org/pipermail/cin/2021-October/003970.html>

S-Video Out -> A/D video converter -> HDMI/USB3-> HDMI/USB3 capture card

## 3.2 Equipment and setup

- The first required is a tape player device (VCR deck or camcorder) to playback the analog video tape cassette formats, either VHS/ SVHS, VHS-C/ SVHS-C or Video8/ Hi8. Use a video head cleaning tape before use. Wind and rewind the tape cassette before playback in Edit mode "ON" to minimize picture deterioration.
- A second recommended device for all capture methods is a Time Base Corrector (TBC). Connected to the analog output of a VCR, a good TBC can make wonder and remove most or all of the flagging, shaky pictures, wavy lines, and other time base problems from a videotape, to get a clearer and more steady picture. The best is a standalone, fullframe high-resolution TBC of broadcast quality; minimum is a line-based TBC built in high-end VCR decks.
- A third, optional feature before digitizing is a noise filter to reduce/soften noise and grain (snow) from bad VHS tape recordings, or also when video that is over-processed using sharpness controls and enhancers. Noise filter adjustment may be part of the TBC setup and preview, or fixed built in the playback VCR. Optional a standalone Video corrector/processor if available can be used, where also optional brightness, contrast and color saturation/correction can be adjusted.

## 3.3 Example articles and references

- Digitizing Analog Video through a Digital Camcorder (Michael Steil, 2022)  
<https://www.pagetable.com/?p=1697>
- How to Get the Best Images Digitizing SD Video (TBC/ProRes, Larry Jordan, 2021)  
<https://larryjordan.com/articles/how-to-get-the-best-images-digitizing-sd-video/>

### 3.3. Example articles and references

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- Digitize analog cassettes (VHS or 8 mm) with Linux (USB/H.264, Corinne HENIN, 2021)  
[https://www.arsouyes.org/en/blog/2021/2021-05-17\\_Numerisation\\_VHS](https://www.arsouyes.org/en/blog/2021/2021-05-17_Numerisation_VHS)
- The Digitization of VHS Videotapes – Technical Bulletin 31 – Canada.ca (Joe Iraci, 2020)  
<https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/technical-bulletins/digitization-vhs-video-tapes.html>
- Hi8 to DVD Workflow in Linux (Eric Olson, Renomath (2012))  
<https://renomath.org/video/linux/hi8/>
- Transfer VHS/DVD Media or Video8/Hi8 Tapes into CINELETTA-GG (chpt. 13.4 manual)  
[https://cinelerra-gg.org/download/CinelerraGG\\_Manual/Transfer\\_VHS\\_DVD\\_Media\\_or\\_V.html](https://cinelerra-gg.org/download/CinelerraGG_Manual/Transfer_VHS_DVD_Media_or_V.html)

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# DV files converted to Blu-ray compliant MPEG-2/LPCM and authored to SD BD-Video

## Step 1

- Prepare a 40 GB continuously DV input file by joining and concatenating the actual dv clips in order. Each digitized Hi8 video tape was automatically split and recorded as a numbered series of 2.0 GB dv files each.
- Naming convention used, for example, for Tape #1 with clips in order: dv01, dv01-01, dv01\_02, dv01\_03, etc. For the full example at the end of this article, the concatenated DV41\_02+DV42+DV43\_02 contains the clips from on dv41\_02+a11 dv42 up to and including dv43\_02.

## Step 2

- Encode DV to MPEG-2 video and "re-encode" uncompressed PCM to Blu-ray PCM audio and remux to interlaced SD-BD-video.mts:

```
ffmpeg -i DV41_02+DV42+DV43_02.dv -c:v mpeg2video -refs 1 -bf 2 -b:v 25M -  
↳ maxrate 25M -minrate 25M -bufsize 28M -muxrate 28M -dc 10 -c:a  
↳ pcm_bluray -mpegts_m2ts_mode 1 -flags +ilme+ildct SD-BD_DV41_02+  
↳ DV42+DV43_02.mts
```

## Step 3

- Run **tsMuxer** (screenshot of tsMuxer usage is displayed at the end of this article). The following parameters are shown for tsMuxer\_SD\_M2TS:

---

Input file: SD-BD\_DV41\_02+DV42+DV43\_02.mts  
Tracs: MPEG-2 video stream and LPCM audio stream  
Output: SD-BD\_DV41\_02+DV42+DV43\_02.iso

#### Step 4

- Burn the iso SD-BD-Video image with **xorriso** on a BD-R DL 50 GB disc:

```
xorriso -as cdrecord -v -sao dev=/dev/sr1 SD-BD_DV41_02+DV42+DV43_02.iso
```

---

# HDV.m2t files converted and authored to HD BD-Video

## Step 1

- Prepare the source HDV.m2t file using hdv clips as for DV above.

## Step 2

- Copying the mpeg2 video, re-encoding MP2 audio to Blu-ray LPCM. If using an ffmpeg version lower than 5.1, substitute ac3 for pcm\_bluray and add -b:a 384 to override lower default.

```
ffmpeg -i HDV.m2t -c:v copy -c:a pcm_bluray -mpegtts_m2ts_mode 1 HDV.mts
```

## Step 3

- Run **tsMuxer** (screenshot of tsMuxer usage is displayed at the end of this article).  
Input file: HD-BD\_HDV.mts  
Tracs: MPEG-2 video stream and LPCM audio stream  
Output: HD-BD\_HDV.iso

## Step 4

- Burn the iso HD-BD-Video image with **xorriso** on a BD-R DL 50 GB disc:

```
xorriso -as cdrecord -v -sao dev=/dev/sr1 HD-BD_HDV.iso
```

---

## Full example output

### 6.1 DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio, authored to SD BD-Video and burned to a BD-R DL

17/01-2023  
SD-BD\_DV41\_02+DV42+DV43\_02

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#### Step 1

```
cd /run/media/terje/Seagate_8TB_back/video/DV

cat dv41_02.dv dv41_03.dv dv41_04.dv dv41_05.dv dv41_06.dv dv41_07.dv dv41_08.
↳ dv dv41_09.dv dv42.dv dv42_01.dv dv42_02.dv dv42_03.dv dv42_04.dv
↳ dv42_05.dv dv42_06.dv dv42_07.dv dv42_08.dv dv42_09.dv dv43.dv dv43_01.
↳ dv dv43_02.dv > /home/terje/Videoklipp/SD-BD-DV-iso/DV41_02+DV42+
↳ DV43_02.dv
```

---

```
cd /home/terje/Videoklipp/SD-BD-DV-iso

du -sh DV*
40G DV41_02+DV42+DV43_02.dv
```

---

#### Step 2

---

## 6.1. DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio, authored to SD BD-Video and burned to a BD-R DL

```
cd /home_lp154/terje/Videoklipp/SD-BD-DV-iso

ffmpeg -i DV41_02+DV42+DV43_02.dv -c:v mpeg2video -refs 1 -bf 2 -b:v 25M -maxrate
↳ 25M -minrate 25M -bufsize 28M -muxrate 28M -dc 10 -c:a pcm_bluray -
↳ mpegts_m2ts_mode 1 -flags +ilme+ildct SD-BD_DV41_02+DV42+DV43_02.mts

ffmpeg version 5.1.2 Copyright (c) 2000-2022 the FFmpeg developers
built with gcc 12 (SUSE Linux)
.....

(NOTE: the @ sign represents the pound sign in the next 21 lines)

Input @0, dv, from 'DV41_02+DV42+DV43_02.dv':
Metadata:
  timecode : 00:19:52:24
  Duration: 03:15:53.28, start: 0.000000, bitrate: 28800 kb/s
  Stream @0:0: Video: dvvideo, yuv420p, 720x576 [SAR 16:15 DAR 4:3], 25000 kb/s,
    ↳ 25 fps, 25 tbr, 25 tbn
  Stream @0:1: Audio: pcm_s16le, 48000 Hz, stereo, s16, 1536 kb/s
Stream mapping:
  Stream @0:0 -> @0:0 (dvvideo (native) -> mpeg2video (native))
  Stream @0:1 -> @0:1 (pcm_s16le (native) -> pcm_bluray (native))
Press [q] to stop, [?] for help
[mpeg2video @ 0x558bb9453ac0] Warning vbv_delay will be set to 0xFFFF (=VBR) as
↳ the specified vbv buffer is too large for the given bitrate!
Output @0, mpegts, to 'SD-BD_DV41_02+DV42+DV43_02.mts':
Metadata:
  timecode : 00:19:52:24
  encoder : Lavf59.27.100
  Stream @0:0: Video: mpeg2video (Main), yuv420p(bottom coded first (swapped)),
    ↳ 720x576 [SAR 16:15 DAR 4:3], q=2-31,25000 kb/s, 25 fps, 90k tbn
  Metadata:
    encoder : Lavc59.37.100 mpeg2video
  Side data:
    cpb: bitrate max/min/avg: 25000000/25000000/25000000 buffer size: 28000000
    ↳ vbv_delay: N/A
  Stream @0:1: Audio: pcm_bluray, 48000 Hz, stereo, s16, 128 kb/s
  Metadata:
    encoder : Lavc59.37.100 pcm_bluray
frame=293832 fps=373 q=2.5 Lsize=41027202kB time=03:15:53.28 bitrate=28595.8
↳ kbits/s speed=14.9x
video:35867310kB audio:2212922kB subtitle:0kB other streams:0kB global headers:0kB
↳ muxing overhead: 7.738845%

-----
du -sh *.mts
```

6.1. DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio,  
authored to SD BD-Video and burned to a BD-R DL

---

```
40G SD-BD_DV41_02+DV42+DV43_02.mts
```

---

### Step 3

- Run **tsMuxer** (screenshots of tsMuxer usage are displayed at the end of this article).  
Input file: HD-BD\_HDV.mts  
Tracs: MPEG-2 video stream and LPCM audio stream  
Output: HD-BD\_HDV.iso
- 

```
du -sh *.iso
39G SD-BD_DV41_02+DV42+DV43_02.iso
```

---

### Step 4

```
MediaRange BD-R DL
```

```
eject /dev/sr1
eject -t /dev/sr1
```

```
umount /dev/sr1
umount: /dev/sr1: not mounted.
```

```
-----
xorriso -devices
xorriso 1.5.4 : RockRidge filesystem manipulator, libburnia project.
```

```
Beginning to scan for devices ...
Full drive scan done
```

```
-----
0 -dev '/dev/sr0' rwrw-- : 'HL-DT-ST' 'BD-RE BH10LS30'
1 -dev '/dev/sr1' rwrw-- : 'ASUS' 'BW-16D1X-U'
```

```
-----
Device og media info for a new BD-R DL (MediaRange):
```

6.1. DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio,  
authored to SD BD-Video and burned to a BD-R DL

```
xorrecord -dev=/dev/sr1 -atip  
xorriso 1.5.4 : RockRidge filesystem manipulator, libburnia project.
```

```
Drive current: -outdev '/dev/sr1'  
Media current: BD-R sequential recording  
Media status : is blank  
Media summary: 0 sessions, 0 data blocks, 0 data, 46.6g free  
Device type : Removable CD-ROM  
Vendor_info : 'ASUS'  
Identifikation : 'BW-16D1X-U'  
Revision : 'A105'  
Driver flags : BURNFREE  
Supported modes: SAO TAO  
Current: BD-R sequential recording  
Profile: 0x0043 (BD-RE)  
Profile: 0x0042 (BD-R random recording)  
Profile: 0x0041 (BD-R sequential recording) (current)  
Profile: 0x0040 (BD-ROM)  
Profile: 0x002B (DVD+R/DL)  
Profile: 0x001B (DVD+R)  
Profile: 0x001A (DVD+RW)  
Profile: 0x0016 (DVD-R/DL layer jump recording)  
Profile: 0x0015 (DVD-R/DL sequential recording)  
Profile: 0x0014 (DVD-RW sequential recording)  
Profile: 0x0013 (DVD-RW restricted overwrite)  
Profile: 0x0012 (DVD-RAM)  
Profile: 0x0011 (DVD-R sequential recording)  
Profile: 0x0010 (DVD-ROM)  
Profile: 0x000A (CD-RW)  
Profile: 0x0009 (CD-R)  
Profile: 0x0008 (CD-ROM)  
Profile: 0x0002 (Removable disk)  
Mounted Media: 41h, BD-R sequential recording  
Product Id: CMC MAG/DI6/0  
Producer: CMC Magnetics Corporation  
Manufacturer: 'CMC MAG'  
Media type: 'DI6'
```

Burning the 40 GB SD-BD-Video iso image to a BD-R DL disc:

27 min

```
xorriso -as cdrecord -v -sao dev=/dev/sr1 SD-BD_DV41_02+DV42+DV43_02.iso
```

6.1. DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio,  
authored to SD BD-Video and burned to a BD-R DL

---

```
xorriso 1.5.4 : RockRidge filesystem manipulator, libburnia project.
Drive current: -outdev '/dev/sr1'
Media current: BD-R sequential recording
Media status : is blank
Media summary: 0 sessions, 0 data blocks, 0 data, 46.6g free
Beginning to write data track.
.....
xorriso : UPDATE : 39219 of 39251 MB written (fifo 71%) [buf 100%] 6.1x.
xorriso : UPDATE : 39245 of 39251 MB written (fifo 80%) [buf 100%] 6.1x.
xorriso : UPDATE : 39251 of 39251 MB written (fifo 0%) [buf 100%] 1.5x.
xorriso : UPDATE : 39251 of 39251 MB written (fifo 0%) [buf 100%] 0.0x.
xorriso : UPDATE : Closing track/session. Working since 1587 seconds
xorriso : UPDATE : Closing track/session. Working since 1588 seconds
.....
xorriso : UPDATE : Closing track/session. Working since 1627 seconds
Writing to '/dev/sr1' completed successfully.

xorriso : NOTE : Re-assessing -outdev '/dev/sr1'
xorriso : NOTE : Disc status unsuitable for writing
Drive current: -outdev '/dev/sr1'
Media current: BD-ROM
Media status : is written , is closed
Media summary: 1 session, 20096864 data blocks, 38.3g data, 0 free
```

## 6.1. DV files converted to Blu-ray compliant MPEG-2 video and LPCM audio, authored to SD BD-Video and burned to a BD-R DL

