

- **[3.8] What is the difference between interlaced and progressive video?**

There are basically two ways to display video: *interlaced scan* or *progressive scan*. Progressive scan, used in computer monitors and digital televisions, displays all the horizontal lines of a picture at one time as a single *frame*. Interlaced scan, used in standard television formats (NTSC, PAL, and SECAM), displays only half of the horizontal lines at a time (the first *field*, containing the odd-numbered lines, is displayed, followed by the second field, containing the even-numbered lines). Interlacing relies on phosphor persistence of the TV tube to blend the fields together over a fraction of a second into a seemingly single picture. The advantage of interlaced video is that a high refresh rate (50 or 60 Hz) can be achieved with only half the bandwidth. The disadvantage is that the horizontal resolution is essentially cut in half, and the video is often filtered to avoid flicker (interfield twitter) and other artifacts.

It may help to understand the difference by considering how the source images are captured. A film camera captures full frames in intervals that are 1/24th of a second long, whereas a video camera alternately scans fields of odd and even lines in 1/60th of a second intervals, resulting in interlaced frames that are 1/30th of a second long. (Unlike projected film, where the entire frame is shown in an instant, many progressive-scan displays trace a series of lines from top to bottom, but the end result is about the same.)

DVD is specifically designed to be displayed on interlaced-scan displays, which represent 99.9 percent of the more than one billion TVs worldwide. However, most DVD content comes from film, which is inherently progressive. To make film content work in interlaced form, the video from each film frame is split into two video fields — 240 lines in one field, and 240 lines in the other— and encoded as separate fields in the MPEG-2 stream. A complication is that film runs at 24 frames per second, whereas TV runs at 30 frames (60 fields) per second for NTSC, or 25 frames (50 fields) per second for PAL and SECAM. For PAL/SECAM display, the simple solution is to show the film frames at 25 per second, which is a 4 percent speed increase, and to speed up the audio to match. For NTSC display, the solution is to spread 24 frames across 60 fields by alternating the display of the first film frame for 2 video fields and the next film frame for 3 video fields. This is called *2-3 pulldown*. The sequence works as shown below, where A through D represent film frames; A1, A2, B1, and so on represent the separation of each film frame into two video fields; and 1 through 5 represent the final video frames.

Film frames: | A | B | C | D | Video fields:  
|A1 A2|B1 B2|B1 C2|C1 D2|D1 D2| Video  
frames: | 1 | 2 | 3 | 4 | 5 |

For MPEG-2 encoding, repeated fields (B1 and D2) are not actually stored twice. Instead, a flag is set to tell the decoder to repeat the field. (The inverted order of C2 and C1, and D2 and D1 are because of the requirement that top and bottom fields alternate. Since the fields are from the same film frame, the order doesn't matter.) MPEG-2 also has a flag to indicate when a frame is progressive (that the two fields come from the same instant in time). For film content, the `progressive_frame` flag should be true for every frame. See [3.4](#) for more MPEG-2 details.

As you can see, there are a couple of problems inherent in 2-3 pulldown: 1) some film frames are shown for a longer period of time than others, causing *judder*, or jerkiness, that shows up especially in smooth pans; 2) if you freeze the video on the third or fourth video frame when there is motion in the picture you will see two separate images combined in a flickering mess. Most DVD players avoid the second problem by only pausing on coherent frames or by only showing one field, although some allow you to freeze on flicker-frames. (This is what the frame/field still option in the player's setup menu refers to.)

Most DVD players are hooked up to interlaced TVs, so there's not much that can be done about artifacts from film conversion. However, see [1.40](#) for information about progressive DVD players.

For more on progressive video and DVD, see [part 5](#) and [player ratings](#) in the excellent [DVD Benchmark](#) series at Secrets of Home Theater and High Fidelity, and Dan Ramer's [What The Heck Is 3:2 Pulldown?](#) at DVDFile.com.

*Note:* "2-3 pulldown" is the same term as "3:2 pulldown," but this FAQ uses the "2-3" notation to indicate that it's a sequence, not a ratio, and that in practice 2 video fields are usually created from the first film frame.