



Video Interlacing and Field Dominance within FlipFactory

The concept of interlaced video and field dominance are two confusing areas within the world of digital video. A misunderstanding of these issues can often lead to less than optimal image quality within the output video. Telestream's FlipFactory® contains provisions for optimizing the quality of output video, but these features can only be applied if FlipFactory is made aware of the specific characteristics of both the input source and the desired output source.

In general, from the perspective of the casual observer, video can be thought of as being comprised of several independent snapshots, called *frames*. The concept of a frame-rate determines how quickly a given number of frames are displayed over a given time period (typically 1 second, hence the parameter frames-per-second or *fps*). Within the United States, the frame-rate of 29.97 is commonly utilized for broadcast video. For the sake of simplicity, this can be rounded to 30 frames per second.

Hardware devices, televisions in particular, do not deal with video in terms of frames. Rather, they process video using the notion of a *field* (or a half-frame). A field is comprised of either the odd horizontal lines (an odd field or a top field), or it is comprised of the even horizontal lines (an even field or bottom/lower field).



Knowing that there are two fields within every video frame, it is obvious that a television displays 60 fields every second (using a frame-rate of 30 as an example). Thus, each field is displayed at intervals of $1/60^{\text{th}}$ of a second.

This is an extremely important concept within interlaced video. Each individual field occurs at a different point in time than every other individual field. If this concept of distinct times for fields is not considered when processing the video, the results will be immediately noticeable when subsequently rendered on an interlaced monitor.

Unlike television monitors that are inherently interlaced, computer monitors are almost always progressive in nature. That is, they update the image only once for each frame of video. Because of this, both fields that make up a video frame are shown simultaneously. This behavior is referred to as a progressive scan display.

This characteristic of computer monitors, in particular, make it very difficult to diagnose interlacing issues when the video is rendered on a computer monitor. The video in question may appear perfectly normal on a computer monitor, while the same video will have obvious problems when rendered on an interlaced display.



Common Problems

If your video is field inverted (jittery or shaky) when played on an analog/composite monitor:

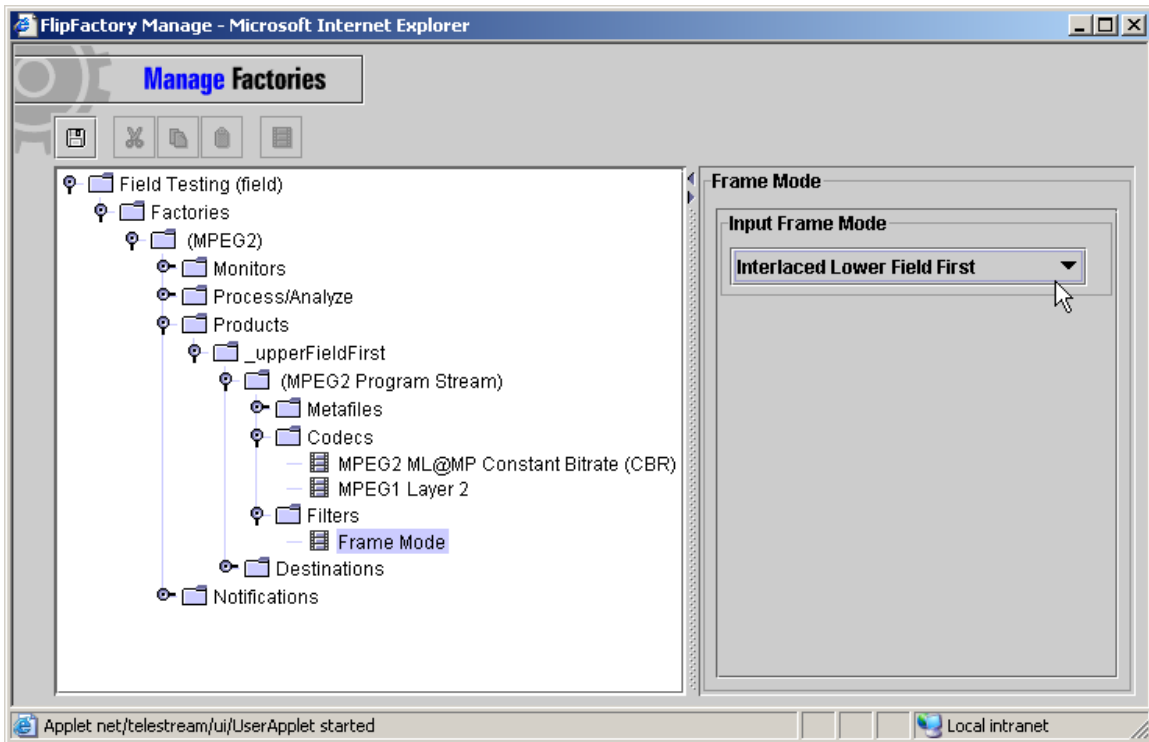
This is most likely caused by FlipFactory not knowing the specific characteristics of the input video. FlipFactory assumes that video with a frame rate of 29.97 fps and frame height of 480 or 512 is interlaced upper field first. FlipFactory assumes that video with a frame rate of 25 fps and a frame height of 576 or 608 is interlaced lower field first.

If FlipFactory is not aware of the true characteristics of the input video (i.e. either the assumption it made was incorrect, or it was given incorrect information), the output video will not be reconstructed properly. This will immediately be evident when played on an interlaced monitor (such as a television monitor). This problem will be more difficult to detect on a progressive computer monitor because both fields of video will be displayed at the same time (in 1 frame).

To correct this problem, it is essential to inform FlipFactory when the particular characteristics of the input video do not conform to the assumptions that are automatically made. For example, if your input source is DV video (which is almost always bottom field dominant - lower field first), FlipFactory must be made aware of this. Otherwise, your output will not look proper; in particular, video rendered on an interlaced monitor will appear jerky, shaky or jumpy. (All of these are indications of field inversion problems).

If however, you properly inform FlipFactory of the field characteristics of the input video, the output will appear smooth and consistent.

The following screenshot illustrates the proper product filter setting to indicate the lower field first video will be supplied to a factory.

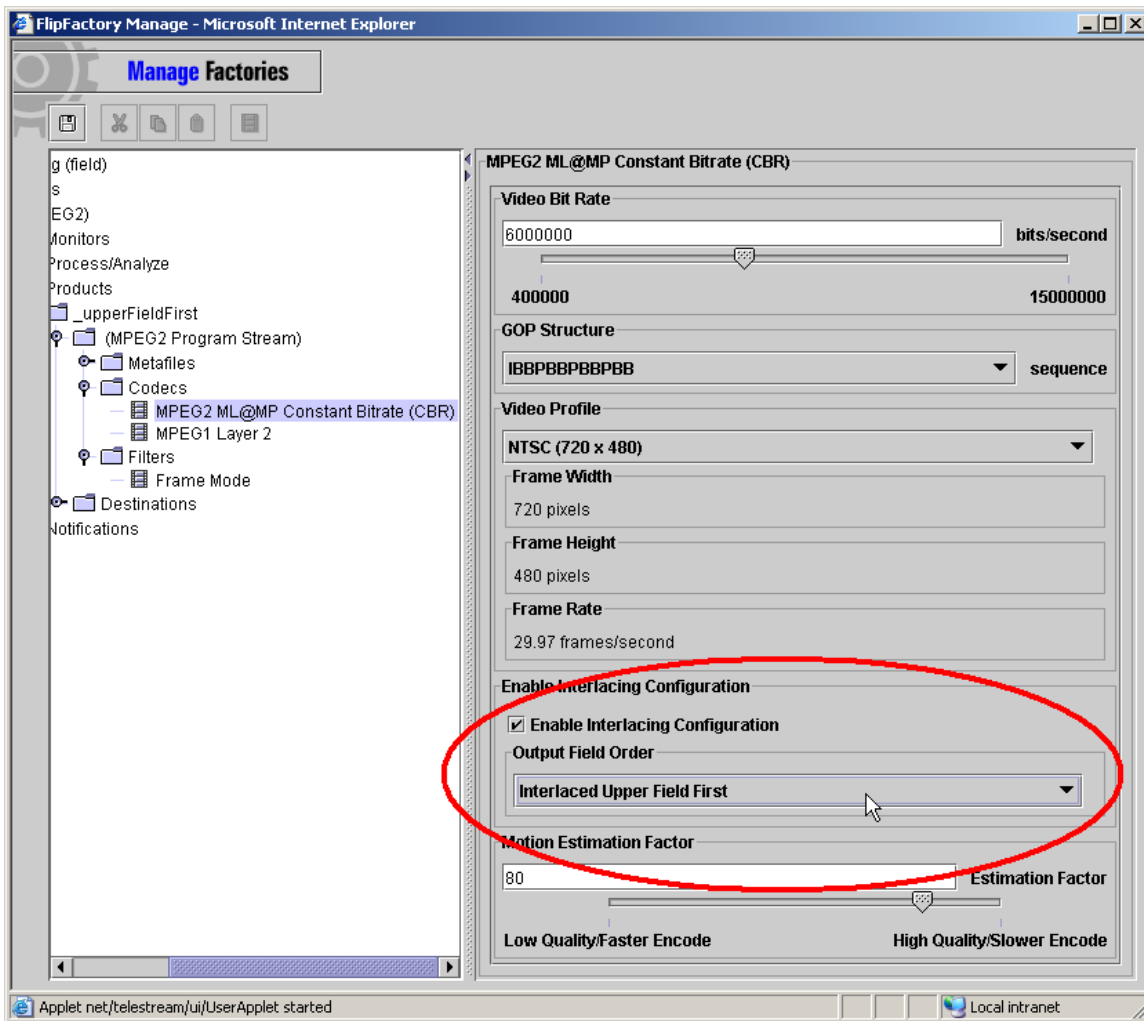


As a result of this setting, the underlying video manipulation routines within the FlipFactory software will properly handle the processing of the input video.



As a part of each encoding session, FlipFactory will attempt to determine or be told the specific characteristics of the input video. Also, and just as important, the specific characteristics of the output video are specified. In general, when creating MPEG-based NTSC output video, the default interlacing scheme on the output will be upper field first. When creating MPEG-based PAL output video, the default interlacing scheme will be lower field first. Certain encoders allow a specific output interlacing pattern to be specified.

Below is a screenshot of the option that is available in the Program Stream CBR codec:



This specification will cause the output MPEG video to be interlaced upper field first. Certain hardware devices demand that video be interlaced one way or another, but the primary rationale behind this option was to allow the best possible video to be created.

When video with one interlacing characteristic is specified as the source, and video of a different interlacing characteristic is specified as the output (as is the case in the two example screenshots above (input = lower field first, output = upper field first), an effect called interpolation is performed.



In this case, FlipFactory is aware of the exact characteristics of both the input and the output video. It is also aware that in order to properly create the output video, the characteristics of the input video must be altered during the conversion process – in this case, specifically changing the lower field first video input into upper field first video output. This is done by resampling each specific field of input video and creating a new field with different spatial characteristics. Lower field lines are interpolated to create upper field lines and upper field lines are interpolated to generate lower field lines.

As a result of this process, the output video will be correctly field ordered; however, “softness” will be apparent in the overall image quality. This leads to the second common problem associated with interlaced video.

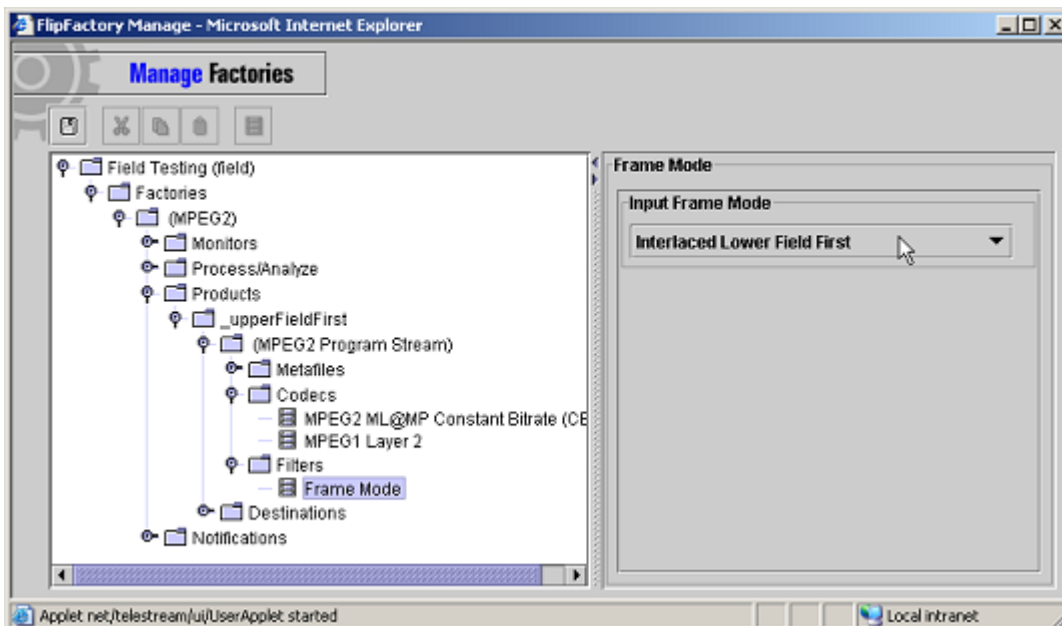
If your video is “soft” or has a loss of sharpness when transcoded from one format to another.

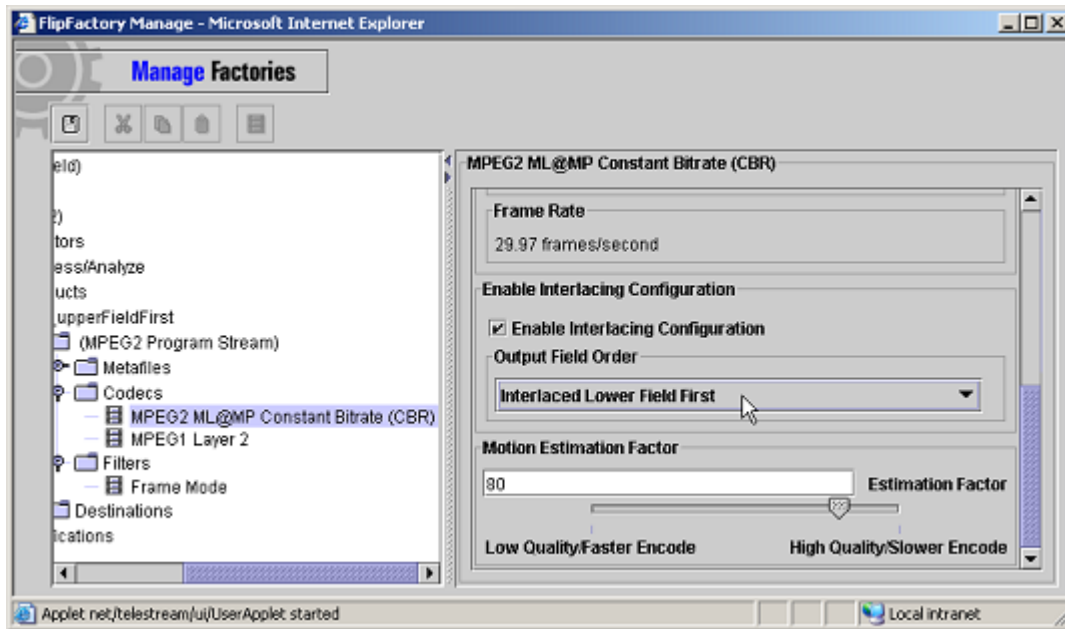
As mentioned above, this “softness” is most often the result of spatially interpolating between input frames with one interlacing characteristic to create output frames of a different interlacing characteristic.

With this in mind, it is obvious that the way to achieve the “cleanest” or highest quality output would be to have the output field dominance match the input field dominance. That is, if your input video is interlaced upper field first, your output video should be interlaced upper field first (or vice versa).

FlipFactory has several encoders (primarily MPEG based) that allow the interlacing characteristic of the output video to be specified. When this feature is used in conjunction with the “Frame Mode” input filter, the output (prior to compression) will have the highest quality possible (i.e. the most amount of original material preserved).

This being said, the following screenshots illustrate the proper factory settings for an input source of lower field first DV video to preserve the greatest amount of original video data prior to the compression phase:





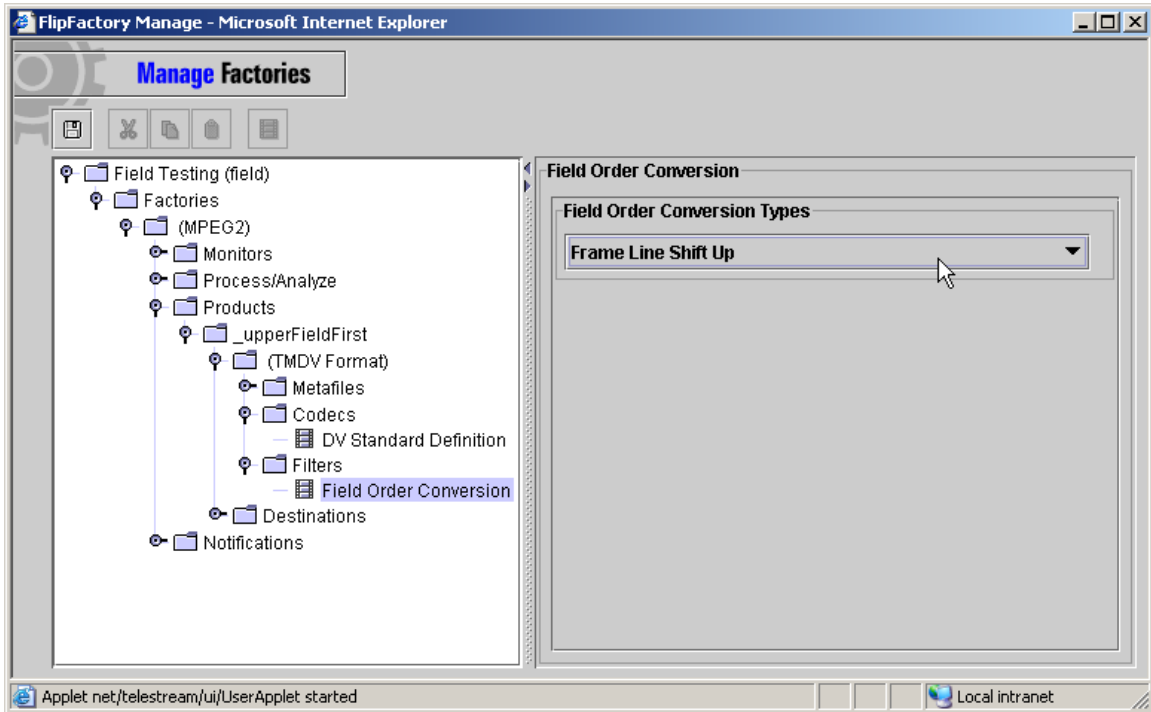
With this configuration, no spatial interpolation will be performed because the field order characteristics of the input match those specified for the output. This allows the greatest amount of original video to be preserved and passed to the underlying video compressor (MPEG-2 in this case).

There will be situations or scenarios when the luxury of being able to specify the field ordering of the output video will not be available. A hardware restriction or codec limitation may require that the output video be interlaced in a certain manner.

As an example, consider the converse of the above example, submitting upper field first MPEG video to a DV based factory. DV video produced by FlipFactory will always be interlaced lower field first. There will never be an option within a DV codec to allow the interlacing order to be specified. In this case, one might assume that the output video must suffer the effects of being spatially interpolated in order to properly produce the required field ordering.

Fortunately, FlipFactory was designed so that this is not the case. If desired, the video processing algorithms can be informed to adjust the input video to compensate for the difference in the field order characteristics.

The following screenshot illustrates the specification of the Field Order Conversion filter:



In this example (upper field first MPEG source file, output is a lower field first DV video), knowing that the factory will be creating DV video (the DV Standard Definition codec has been selected), and further knowing that FlipFactory produces only lower-field-first video when creating DV; the Field Order Conversion filter has been specified.

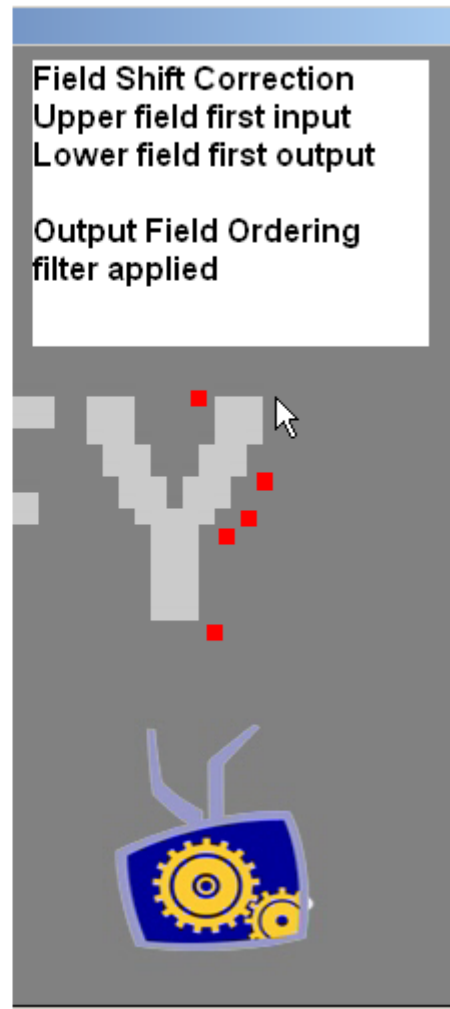
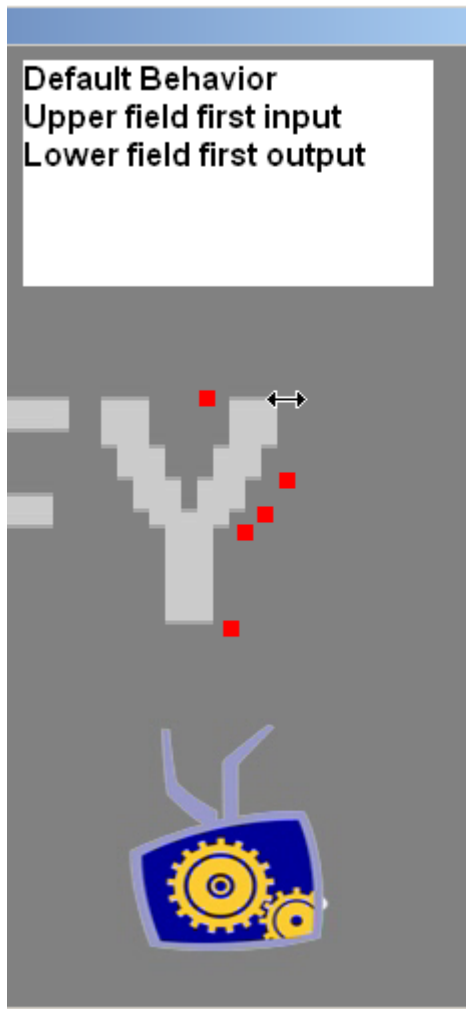
NOTE: FlipFactory will assume that any input into this factory will be upper field first using the rules mentioned earlier. It was not necessary to specify the Frame Mode filter with a value of "Upper Field First".

The "Field Order Conversion" filter will alter the input video by either shifting the video 1 line up or 1 line down in order to change an upper field to a lower (or vice versa). This has the effect of negating the need for spatial interpolation (and consequently preserving a much, much larger portion of the input video).

It is important to note that the cost of this operation is the loss of one line of video. This loss of one line must be weighed against the "softness" effect that accompanies the spatial interpolation phase when considering the desired output video characteristic.

The following image illustrates a comparison of the output when using the Field Order Conversion filter to compensate for the different field order characteristics of the input and output video. In this case, both images were created using the identical factory setup (with the exception of the "Field Order Conversion" filter). Of primary importance is that in each case the output was specified to be lower field first while the input video has a field-ordering characteristic of upper field first.

Please note the difference in the images around the points indicated by the **RED** squares. The image rendered using the default spatial characteristic shows a noticeable "softness" due to the effects of the spatial interpolation. The image on the right (which was created utilizing the "Field Order Conversion", is noticeably much sharper around the areas indicated by the **RED** squares.



Knowing ahead of time the particular characteristics (in particular the field ordering characteristics) of the video being processed will allow video of the optimal quality to be created by FlipFactory. In addition to the field ordering assumptions specified earlier (NTSC with a height of 480 or 512 will be assumed to be interlaced upper field first; PAL with a height of 576 or 608 will be assumed to be interlaced lower field first), the following list shows the specific cases when FlipFactory should be informed of the characteristics of the input video (i.e. these formats would not automatically be processed correctly by FlipFactory unless the necessary filters are specified):

NOTE: Unless specifically mentioned, the ordering below refers to both NTSC and PAL video.

Media Source

- Avid Meridian Interlaced Codecs
- Pinnacle MediaStream PAL MPEG
- Avid AVBV/NuVista Interlaced Codecs
- DV video (regardless of the source)

Field Ordering for FlipFactory

- Lower field first
- Upper field first
- Upper field first
- Lower field first



Also note that if you create video with a specific field ordering characteristic that is different than the field ordering that FlipFactory will assume, then you will need to provide a Frame Mode filter with the appropriate setting to properly render the video. For example, if you create NTSC MPEG output that is interlaced lower field first, you would need to specify a frame mode filter set to Lower Field First on any factory that in which this file is provided as an input.

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