



AmberFin White Paper

Maximising quality for 720p delivery

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EXECUTIVE SUMMARY

Converting existing SD content to HD is a fast growing business worldwide.

Right now, there is a very specific need Europe and parts of Asia to make high quality 720P up conversions of original interlaced 625 SD images.

Broadcasters need to incorporate SD segments into HD programs (for example archive material in a documentary or sport program) or to transmit full length high quality SD programs.

Bad quality up conversion to HD can cause problems for Broadcasters who are claiming to offer a high quality high definition service.

Good quality up conversion allows HD broadcasters to cost effectively exploit the vast amounts of quality SD content as part of their service.

AmberFin iCR conversion technology includes unique algorithms from Snell and Wilcox Emmy award winning products, as well as new AmberFin developments. This white paper shows how AmberFin iCR can help you deliver the best quality SD up conversions to 720p HD.



Background

In April 2004, the European Broadcast Union Technical Committee recommended the use of progressive rather than interlaced scanning, for High Definition broadcasting. There has been lively debate in Europe and elsewhere on the relative merits of two technically different and competing HD standards:

- 1080i (1080 vertical lines, each with 1920 pixels horizontally, interlaced)
- 720p (720 vertical lines, each with 1280 pixels horizontally, progressive)

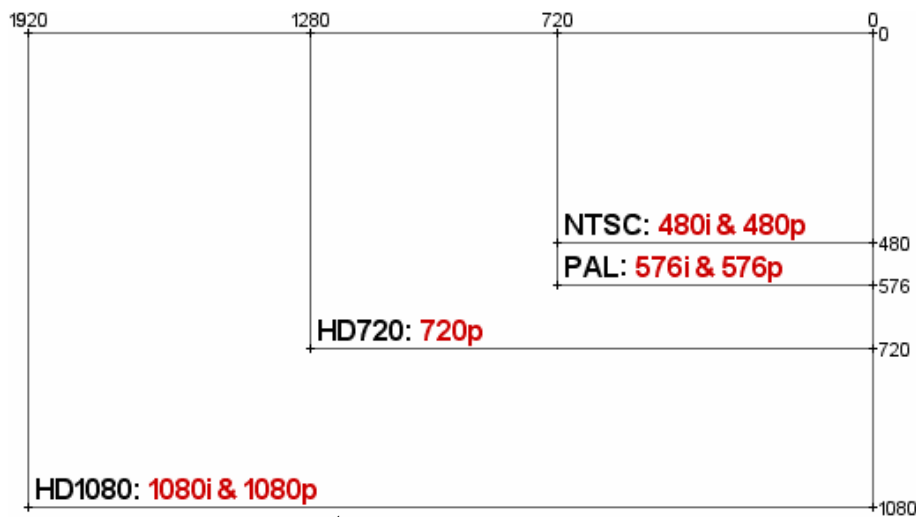
In the US, both standards are already in use

- 1080i is used by USA, TBS, Hallmark, TNT, Nick at Nite, NBC, Lifetime
- 720p is used by ESPN, Disney Channel, Fox News, ABC Family

Web HD content is also often 720p.

As well as these current competing formats, the European DVB suite of broadcasting standards includes provision for future 1080P. The US ATSC high definition standards also allow for future 1080p delivery and number of consumer devices already support 1080p.

So, including standard definition services, which will likely continue indefinitely, there are many possible current and future delivery formats.



Transcoding material created in one size format for delivery in another, poses one set of technical quality challenges. Transcoding interlaced material for progressive display poses another.

AmberFin have addressed both these challenges with unique high quality algorithms that produce outstanding results. To understand the issues and how they have been solved, we first need to explore the technical differences between the formats.

¹ <http://www.hdtvfaq.org/hdtv-formats.html>

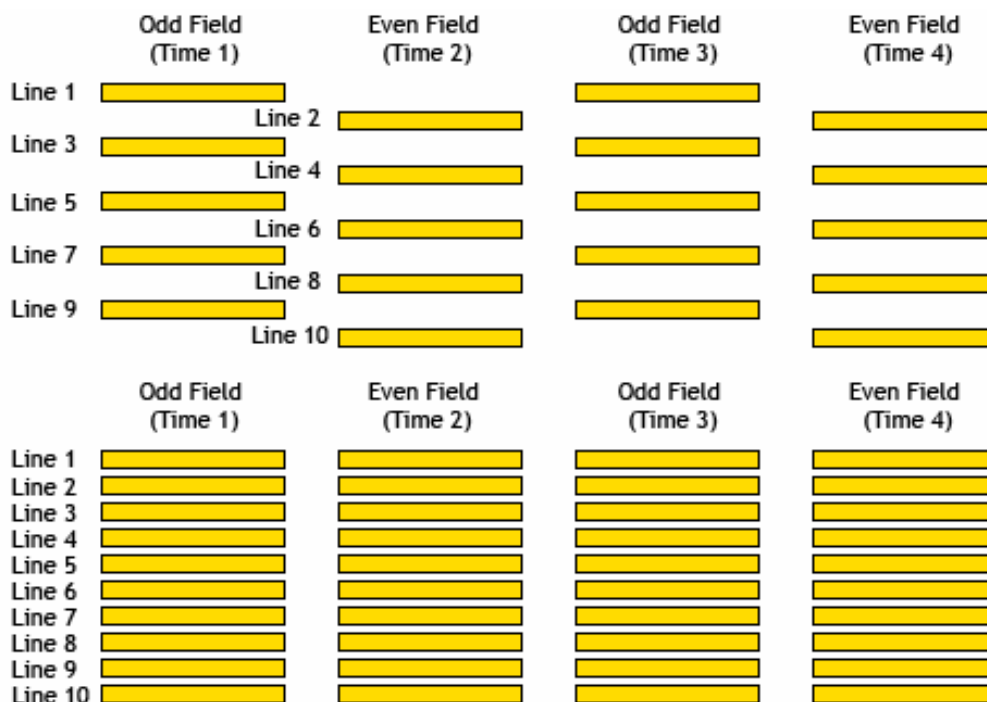
Interlaced vs. progressive

Most modern display devices, including flat screen TV's, PC screens and mobile phones are progressive. Most legacy content however is interlaced.

In interlaced broadcasting, each frame of picture is divided into odd and even lines which are alternately shown as fields.

One picture frame consists of two fields, shown one after the other. In a PAL broadcast, which has 25 frames per second, there are 50 fields.

There is a small delay between the odd and even line which causes slightly jagged images, especially on fast motion.



*The difference between interlaced and progressive*²

Interlaced came about for historic reasons, because of the way early analogue cameras, Telecines and Cathode Ray Tube (CRT) televisions worked.

In progressive broadcasting, such as 720p/50 or 720p/60,³ the whole frame is shown.

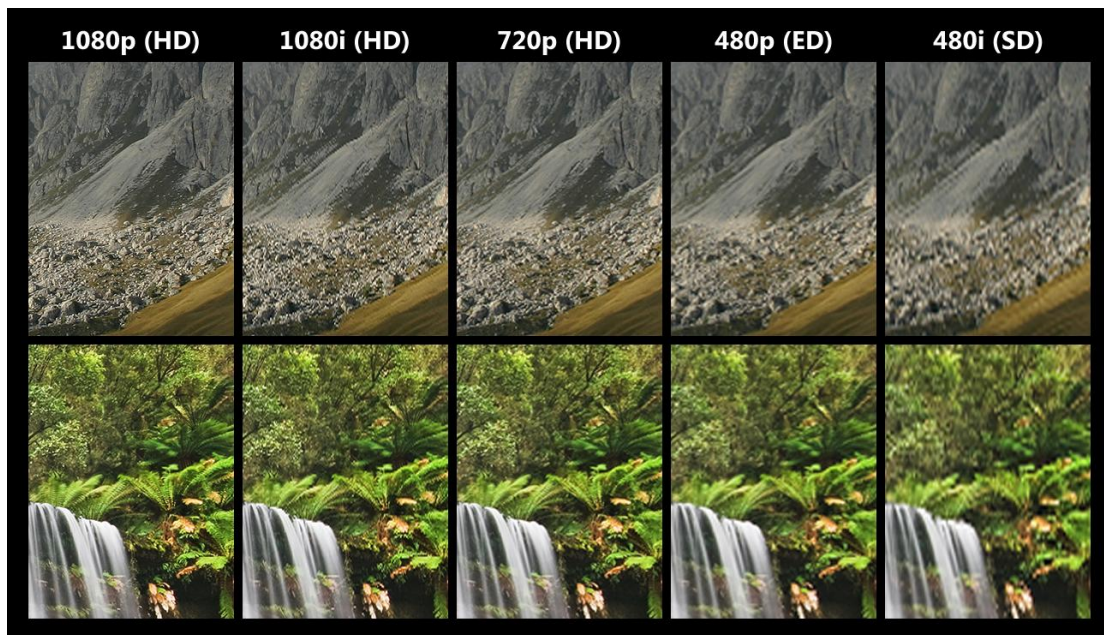
² findtechno.com/1080p-hdtv

³ There is no 720i at present.



Some benefits claimed for 720p include:

- Progressive images are easier to compress than interlaced, saving money on bandwidth.
- Modern cameras and modern displays are progressive. So keeping everything progressive keeps things simple and cost effective. It's relatively straightforward process convert progressive images to interlaced but it's harder to convert interlaced images to progressive, especially with fast motion.
- Since interlacing shows half resolution per field rather than full resolution per frame, 720p subjective resolution is argued to be close to 1080i.



Comparisons of static images. Note the increasing sharpness towards the left⁴.

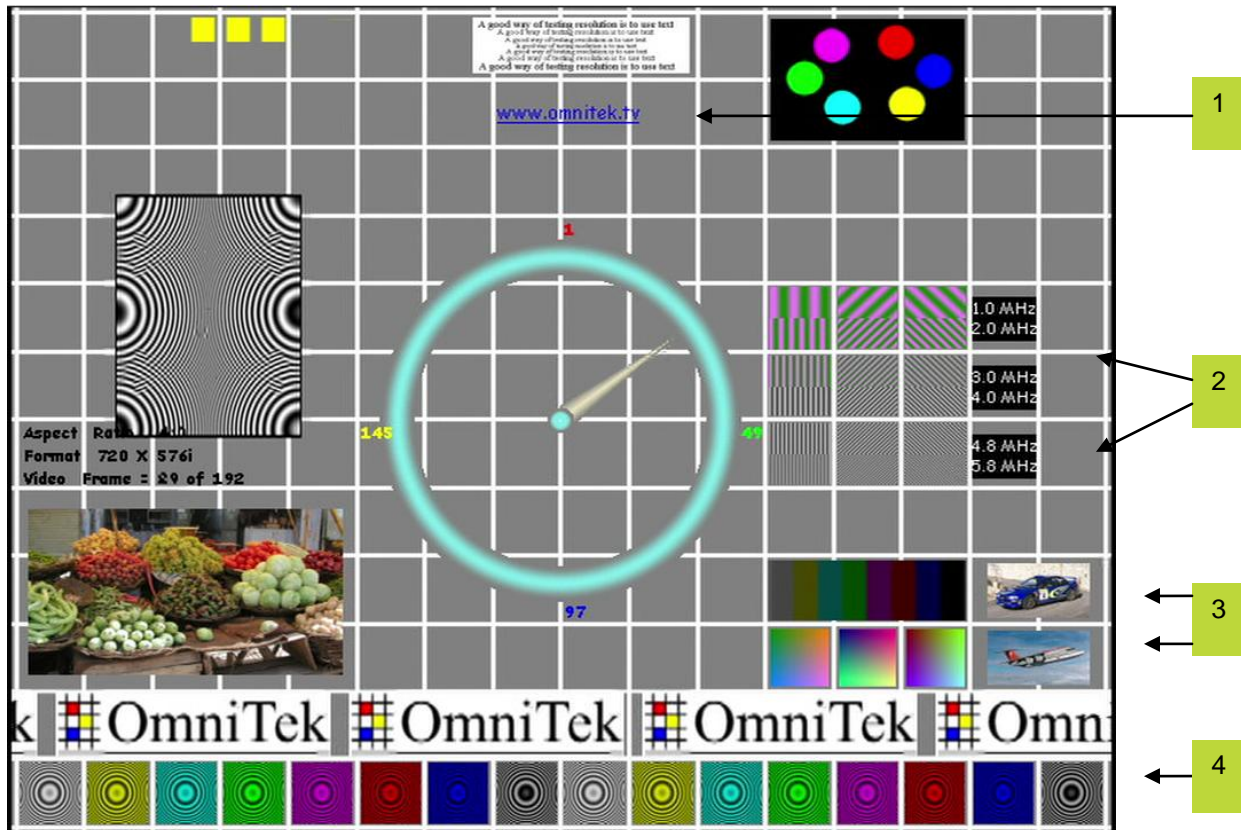
Whatever conclusions individuals might draw from the technical arguments⁵, the two specific challenges for SD interlaced to HD progressive transcoding are:

- How to scale up pixels to give the sharpest results
- How to remap interlaced pixels onto a progressive display without artifacts

The image below shows the results of using AmberFin iCR to up convert an interlaced standard definition signal (576i) to 720p:

⁴ From http://upload.wikimedia.org/wikipedia/commons/e/e0/HD_vs_SD_resolutions.png

⁵ There is also debate about 720p vs. 1080p. Those in favour of 720P say that at an average viewing distance in a European home, 720p would provide more than enough detail and that the added resolution of 1080p would not significantly enhance the viewing experience.



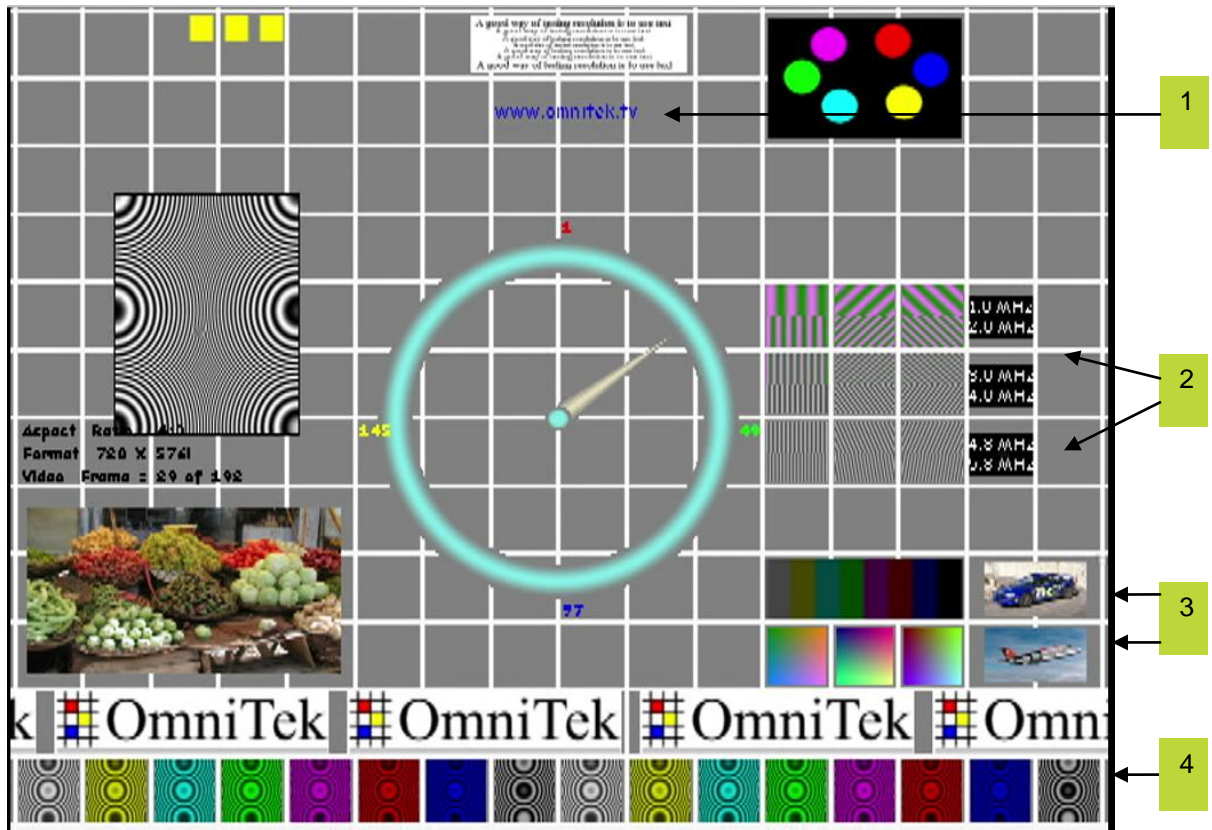
AmberFin iCR up convert

Note:

1. The blue lettering is crisp.
2. The white text can be read.
3. The car and plane do not show aliasing
4. The test signals show one set of rings (the correct number).

Now look at the next image using a conventional Transcode process on the same standard definition test signal (576i) and the same 720p result:





Typical conventional up convert

The overall image is much less sharp. Note especially:

1. The blue lettering is blurred and has lost the underline.
2. The white text is virtually illegible.
3. The jagged edges on the small pictures of the car and plane.
4. The patterns on the test signals in the bottom row show three sets of rings.

Looking at print images like these rather than moving pictures on a screen doesn't tell the whole story, for example they can't show any real time playback artifacts like 'twittering' (lines flickering between frames) which some systems suffer from. However, what should be clear is that iCR is producing far better results.

We'll now explore why that is.



Maximizing quality with iCR

There are millions of hours of European legacy interlaced standard definition content. iCR format conversion is based on a technical heritage of 30 years in image processing.

iCR produces best in class results in a range of up convert applications

- 576i to 720p/50 up convert (720p HD transmission of 625 line SD content)
- 576i to 1080p/50 up convert (1080p HD transmission of 625 line SD content)
- 480i to 720p/60 up convert (720p HD transmission of 525 line SD content)⁶
- 480i to 1080p/60 up convert (1080p HD transmission of 525 line SD content)

There are also more exotic requirements⁷ the iCR can handle:

- 1080i to 720p down convert
- 1080p to 720p down convert
- 1080i to 1080p cross convert
- 720p/50 to 576p down convert (simulcast SD transmission of 720p HD)
- 1080p/50 to 576p down convert (simulcast SD transmission of 1080p HD)
- 720p/60 to 480p down convert (simulcast SD transmission of 720p HD)
- 1080p/60 to 480p down convert (simulcast SD transmission of 1080p HD)
- 720p to 1080p up convert

Custom scaling operations, for example Web or Mobile are also possible.

Up converting images requires scaling the image - i.e. reading a lower number of input pixels and writing a higher number of output pixels. Interpolation is needed. Furthermore, if the input video signal is interlaced, while the output is progressive, special processes are needed to avoid unpleasant artefacts.

Down conversion also requires more sophistication than simply dropping pixels. iCR format conversion is based on EmmyTM award winning technology.

Up and down converts use adaptive multi-tap polyphase interpolation filters. Rather than simple pixel repetition or decimation, the iCR scaler calculates intermediate points using filters optimised for the needs of the particular conversion process. The filters have been optimised by AmberFin, for example for low-ring, producing 'best in class' results.

⁶ Note that the jump between 480 and 720 or 1080 is bigger than 576 to 720 or 576 to 1080, so up conversions will not necessarily be of the same quality.

⁷ iCR is acting as a format convertor, not a standards convertor, so the frame rate must be the same.



Practical Examples

This scaling method preserves detail in the image without introducing new artefacts. Other approaches will either produce a softer result, or render fine details with ghost second images (ringing), produces jagged edges on diagonals (jaggies), introduce motion artefacts between seemingly good pictures or rapid alternation between adjacent lines (twittering).



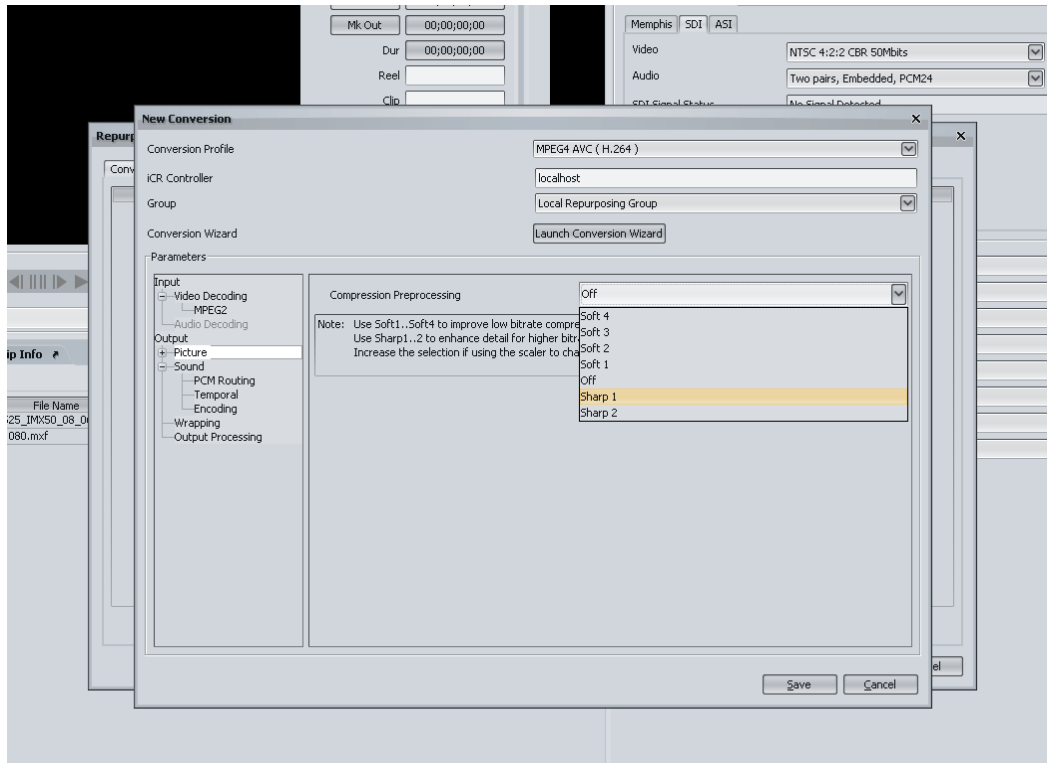
Unpleasant edge aliasing called 'jaggies' can occur with some algorithms. Compare the standard Transcode on the left with the AmberFin Transcode on the right.

Poor scaling is especially objectionable on text and is a major problem for sponsoring advertisers, using posters or logos on equipment and clothing at sports events, where the messaging may be illegible.



Double imaging on interlaced material is a typical problem with poor quality systems. Compare the standard processes on the left with the AmberFin on the right. AmberFin produces clean results.

With AmberFin technology, multi-stage process are used whereby adaptive de-interlacing handles mixed sources such as film, video and mixes of interlaced and progressive, for example progressive graphics over an interlaced background.



iCR pre processing controls

While most processes are pre set for best results, the iCR includes adjustable softening and sharpening pre-processing controls for matching especially difficult shots into other sequences.

Architecture

iCR is software and runs on standard PC hardware. Unlike traditional hardware based format converters customers can supply their own hardware. Therefore:

- iCR offers users a lower cost of entry.
- Support costs are kept to a minimum.
- Customers can benefit from latest computer hardware developments, rather than being tied to a single vendor's hardware product roadmap.
- Customers who only need the iCR for occasional use can choose to run it on a generic PC which has other applications, so they are not investing in a single use device which may be idle for much of the time.
- When required, format conversion can take place as file-in, file-out, without the need to go via baseband video, tying up external devices.

Combining these and other techniques, allows iCR to handle both the full spatial and temporal resolution as permitted by the source and produce optimum results.

Conclusion

Consumers expect HD services to be high quality. Whenever SD content is shown on HD channels it's important that quality is kept high, to avoid viewer dissatisfaction.

Using inferior conversion methods is risky. Leaving conversion to broadcast time (or set top boxes) is riskier still and will inevitably lead to lower quality.

European and Asian Broadcasters and their suppliers need a high quality, cost effective answer for 576i to 720p format conversion today. Around the world there are many other format conversion requirements where quality matters. AmberFin iCR produces best-in-class results, using unique software technology based on 30 years experience in image processing.

To find out more, contact

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