The use of Ultimate Quality Composite Decoding

The Snell & Wilcox IQDAMDA and IQDAMDD

by Richard Schiller

The television broadcast world is changing its infrastructure from an analog base to a digital one. This is happening more rapidly in some areas than others but the unrelenting progress is clear. Therefore in most television stations there is a mix of analog and digital technologies and a need to interface between them. In many cases this will involve the use of decoders from composite analog to digital component domains. When selecting the decoder required for a given application there are two factors that need to be considered:

- **What demands is the source going to place on the decoder? The nature of the content will determine the best decoding process to use.**
- **How the output is going to be used within the station and at its final destination.**

Most modular product systems for the broadcast industry support some kind of composite decoding capability. The IQ Modular system from Snell & Wilcox is unusual in that it supports not only excellent quality decoders at a variety of price points but also supports the ultimate quality of Golden Gate technology in the IQDAMDD and IQDAMDA decoders. Because of the extremely powerful adaptive algorithms used by these decoders, they will deal with every composite decoding challenge. They are in that respect a safe choice.

Not every decoding application requires ultimate performance however, so this paper is designed to explain how to decide when you need to make the decision to use ultimate quality decoding.

The paper is in three parts. Part one explains why, just as composite signals are declining in popularity for many broadcast applications, their decoding is becoming more crucial than ever before. Part two explains the basis on which decisions to adopt ultimate quality decoding are made, using examples from the IQ Modular range. The third and final part of this white paper gives an overview of decoding technologies, and is especially useful for those new to the subject. In fact, you might want to read this section first if you are unfamiliar with terms used in decoding technology.

Why is decoding now more important than ever?

This section describes the factors that are driving the business case for quality in the decoding arena. One of the most common processes in the broadcast arena - composite decoding - is now an essential operation. Many do not realise however just how critical the quality of the composite decoding process can be to the success of operations up-stream and therefore to revenue. There is quite literally more to composite decoding than meets the eye.

More critical audiences

Viewers can now watch from portable equipment, such as hand-held televisions and even, one day, their mobile phones. The breadth of equipment available for viewing also encompasses higher quality platforms with high-resolution displays of a much greater size than previously available. As displays increase in size, the viewer is getting relatively closer to the picture detail. All this combines to create a more critical audience at a time when content providers are facing more competition. Broadcasters now compete with other delivery systems such as the Internet, DVDs and tape rental for the same viewing audience. For all methods of delivery, audiences are more able and therefore more likely to switch away to another provider if they detect sub-standard quality. In short, they are more aware and critical of technical quality than ever before.

Component delivery

Modern delivery systems have improved the technical quality of the pictures that can be received by viewers in many ways but the increase in color performance has been spectacular. Composite video was invented as a form of analog compression to fit color signals into monochrome transmission bandwidth and had to put narrow limits on color bandwidth. This was compounded by the ubiquitous VHS system. Today, digital compression schemes work with component video and reduce data by eliminating redundant information – not bandwidth - and allow component delivery right through to the viewer. Digital transmission, DVDs and Internet delivery all work in the component domain. The overall effect is that the audience are now seeing color artefacts that were previously insignificant – even in those cases where, theoretically, the system is not rated overall as better than previous technology.

Spatial frequencies
In the past, the poor performance of analog transmission channels hardly mattered, as consumer viewing equipment could not reproduce high spatial frequencies. That has now changed. Viewers can now use their greatly improved televisions – and even computers equipped with receivers – to watch television piped through digital delivery systems that no longer have difficulty maintaining high spatial frequencies. Therefore, when these high spatial frequencies are missing from the picture, because of poor decoding within the originating broadcast or post production process, it is now noticeable to viewers. As a result, maintaining resolution has become a priority for decoding composite signals.

Compression
Compressed digital video systems use component color channels. Therefore any composite source material has to be decoded prior to the digital compression process. Unfortunately, artefacts from composite coding that affect the picture quality also affect the compression process. Even though a decoder may reduce cross-color or cross-luminance to to a virtually invisible level, minute residual levels can still waste compressed bandwidth. The compression system may have to sacrifice genuine picture detail in order to pass residual signals not completely removed in the decoding process.

Compression users need 'ultimate quality' decoding in order to gain maximum compression efficiency. Achieving this can lead to both better quality pictures for the viewers, improved viewer loyalty and more channels in the same data space; in short, a better business model.

When decoding quality really counts

The decision to use any particular quality of decoder is, not surprisingly, dependent on two elements: the source and the destination of the content.

The IQDAMDA and IQDAMDD composite decoders from Snell & Wilcox are adaptive. This is an over-used phrase which can mean many different things. In this context however, powerful specialized algorithms mean that these decoders will select the best performance regardless of signal type. Although no signal is too poor to be properly decoded by, and benefit from, these units, some signals will benefit more. In short, the better the source or the more demanding the destination, the greater the need for ultimate quality decoding.

This section explains how to select composite decoders through the use of the Snell & Wilcox modular decoder line.

The demands of the source
The source of composite video can be either internal to the current location such as composite origination equipment or composite tape formats or it may be an external feed from a remote location.

Internal sources
Typically these feeds will be from older equipment, such as analog cameras or broadcast quality VTRs, or the analog distribution system for the station. These types of signal will be clean, noise free, timed into the system and synchronized to station reference. Therefore the decoder used will need to have a good range of high quality filters able to deal with a wide range of program content but they will not need either synchronization or noise reduction.

Project Brief	Decoder type	What this decoder offers this application
Best performance	IQDAMDD – Golden Gate decoding quality in a module	Picture quality approaching un-encoded
Excellent performance within average budgets	IQDMSDD – high quality multi-filter decoder	Excellent picture quality

Some programs need to use video that has been recorded on color-under VTRs (VHS, S-VHS, Hi8 or U-matic). These sources can exhibit a far greater degree of instability, as for example in the case of a viewer's contribution that has been shot on S-VHS or a Hi8 camcorder. In this case the decoder will not need the same high quality filters, since the material will not have high end detail anyway, but it will need to be able to handle unstable signals. A choice of Y/C input can help maintain the quality if the VTR is equipped with an S-VHS connector or equivalent Y/C feed.

Project Brief	Decoder type	What this decoder offers this application
Best performance	IQDAMDA – Golden Gate decoding quality in a module with built-in agile synchronization	The IQDAMDA is guaranteed to extract the most from any signal. Particularly useful when the configuration has to cope with this and other source types. Can be used with the IQDANR for the ultimate noise reduction performance
Excellent performance	IQDMSDP – line comb decoder with synchronizer	For high performance decoding where the original signal quality warrants it. Built-in noise reduction will help extract the most from the signal
Quality to match requirements at a value price	IQDMSDL – line comb decoder with Y/C input, a synchroniser and noise reducer	For the majority of cases this solution is appropriate. It is also a very compact package with built-in noise reduction and Y/C input.

External Feeds

There are normally three varieties of external feeds into a typical TV station/facility:contribution feeds from a region or another broadcaster, electronic news gathering and outside broadcast for sport etc.

Contribution Feeds
Typically, contribution feeds have traditionally been analog composite but are slowly changing over to digital SDI or MPEG-2. The analog feeds will be high quality video that need to

be decoded using the optimum quality decoder. However, they will also need to be timed into the system. Therefore the decoder used will require a good range of high quality filters, able to deal with a wide range of program content and a frame synchronizer to time the source to the station reference.

Project Brief	Decoder type	What this decoder offers this application
Best performance	IQDAMDA – Golden Gate decoding quality in a module with built-in agile synchronization	Near un-encoded performance can be achieved from a composite link using this decoder.
Excellent performance	IQDMSDA – high quality multi filter decoder with synchroniser	For situations where the performance has to be excellent but where the use of the signals does not demand ultimate quality.
Good performance within average budgets	IQDMSDL - line comb decoder with a synchroniser and noise reducer	The IQDMSDL is a compact solution offering both synchronization and decoding.

ENG Feeds

Typically ENG feeds have traditionally been analog composite via satellite but they are also changing over to digital, MPEG-2. Because of the nature of news, analog ENG feeds can have variable quality depending on the conditions of the shoot. The decoder used will therefore need to be able to handle video of less than optimum quality. It will also need to be timed into the system and able to reduce any noise in the video caused by the 'gain up' setting on the cameras. The choice of decoder for such applications therefore will be one with a good range of high quality filters able to deal with a wide range of program content and with frame synchronization to time the source to the station reference.

Project Brief	Decoder type	What this decoder offers this application
Best performance	IQDAMDA – Golden Gate decoding quality in a module with built-in agile synchronization	For ENG applications where occasional excellent source material can occur
Excellent performance where quality matters	IQDMSDA – high quality multi filter decoder with synchroniser	A solution that copes well with a broad spectrum of ENG material.
Good performance for real-life ENG sources	IQDMSDL - line comb decoder with a synchroniser and noise reducer	A realistic solution for the bulk of ENG material.

Sport

Sport offers its own challenges. Although it is generally higher quality than the worst that ENG feeds can throw up, it still shares a need to synchronize the incoming video.

Project Brief	Decoder type	What this decoder offers this application
Best performance	IQDAMDA – Golden Gate decoding quality in a module with built-in agile synchronization	Sport combines fast action with a need to view detail. If it is worth watching it will probably be worth the ultimate quality decoder.
Excellent performance for a value based solution	IQDMSDA – high quality multi filter decoder with synchroniser	Suitable for many sports feeds

The use of the decoded output

In many cases the source will determine the decoder required for a particular application. However, in some cases it is the quality requirements of the final destination of the video material that will dictate your choice of decoder.

Post production

Post production is normally done in component video, (analog in older facilities and digital in later ones). Any picture manipulation, such as digital video effects or aspect ratio conversion requires a component input, so any composite material must be decoded before processing. Post production always needs the highest quality signal at the input. Any leftover decoding artefacts will tend to be exaggerated by the effects manipulation making them even more visible and where composite originated material has to be combined with component the boundary can become intrusive. This could limit the creative use of poorly decoded archive material and directly increase the costs of productions. Post production therefore requires a general purpose decoder, one that can tackle any job at peak performance.

Project Brief	Decoder type	What this decoder offers this application
Post production of original composite assets solution	IQDAMDD – Golden Gate decoding quality in a module	Seamless integration between composite and component origination with no exaggerated composite decoding artefacts to mar the outcome

Transcoding and upconversion

One of the most delicate broadcast operations is transcoding. Taking material from one coding system to another concatenates the causes of coding artefacts. Worse than this however, the artefacts of the first system can interact with the second coding system and lead to a combined performance which is below acceptable levels. There are two common transcoding operations that challenge composite decoders: decoding PAL to be coded to SECAM and decoding any composite signal prior to compression encoding, principally MPEG.

For making the best transcoding operation there is only one strategy - use the best possible decoder in order to get as close to un-

encoded signals as can be achieved. Then, the encoding process will be as unaffacted by artefacts from the original encoding scheme.

Upconversion to high definition is really a special version of transcoding, which by its nature can cruelly expose any quality defects in the original material. The constraints are therefore as tight as any use of material which was previously composite.

Project Brief	Decoder type	What this decoder offers this application
To get the most from the encoding process	IQDAMDD – Golden Gate decoding quality in a module	The ultimate in re-encoding performance, eliminating the risk of degredation caused by residual decoding artefacts.

Archive

In past years, program owners have pondered whether to archive their original composite content or a decoded component version of their assets. As time goes by, more archive material is component-originated. What is more, component archive systems are the only viable alternative. Therefore, less and less material is kept in original composite form. Hence, the imperative is to decode the material at its best possible quality before archiving. If there is only one chance to decode valuable media assets, who would want to compromise its future revenue earning potential? However, it is still the case that the archive will contain material on a variety of tape formats and the older these are, the more difficult it will be to extract the quality.

Project Brief	Decoder type	What this decoder offers this application
Where the brief is 'Archive this composite material'	IQDAMDD – Golden Gate decoding quality in a module	The ultimate in re-encoding performance, eliminating the risk of degredation caused by residual decoding artefacts.

Composite Decoding technologies

Composite video decoding is still one of the most difficult video processing tasks in the media environment. In essence, it requires that the chrominance and luminance information are separated and that the chrominance information must then be processed to separate the two colour-difference signals. Finally, for a component output such as SDI, the color difference values are re-scaled. The quality of decoders is mainly determined by the degree of separation of the chrominance and luminance signals.

In practical terms, perfect decoding is possible but only on certain types of input material. Overall there is no perfect solution but, with more than ten years R&D effort, Snell & Wilcox has probably come closest to providing the ideal, with a top-of-the-range solution for the most demanding applications and a range of other models to meet the need of every other real-life application.

Simple decoding

The simplest method of luminance/chrominance separation consists of low-pass filtering of the composite signal to remove the chrominance from the luminance and high-pass filtering to produce the complementary chrominance. However, this type of crude filtering cannot produce a 100% separation. It also loses any high frequency luminance information. The chrominance signal will contain contamination from the luminance – known as cross-color. The luminance will also be affected by residual chrominance information, known as cross-luma.

Notch filtering

This type of filter uses a notch filter to separate the chrominance from the luminance signal and to provide a luminance output with some of its original high frequencies. Otherwise, this configuration is similar in performance to the simple decoding using high-pass and low-pass filters.

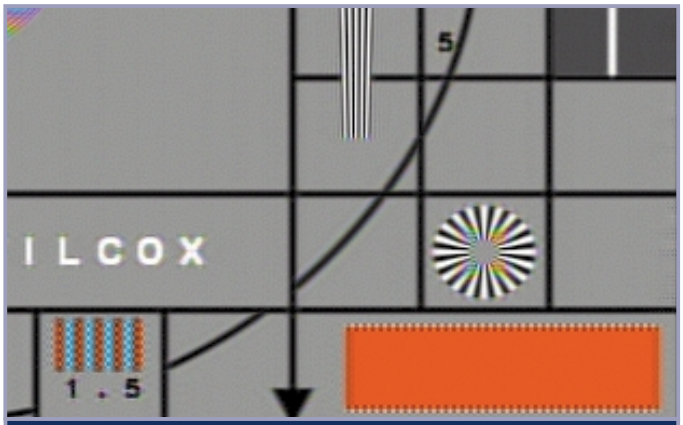
Source Picture

Field comb decoded NTSC composite

The test charts above illustrate the effects caused by the use of simple decoding techniques. Note that all luminance information 1 MHz either side of the sub-carrier is decoded as cross-color. Also notice the low chrominance bandwidth.

Line comb filtering

Line comb filters offer improved performance for separating the two basic parts of the signal. They work by correlating information in adjacent lines within video fields and are, therefore, implemented in the vertical picture axis. Compared with the simplest separation, they offer significantly improved performance, reducing both cross-color and cross-luma effects. However, these filters are still not perfect and vertical transitions in the picture can cause artefacts such as 'hanging dots'.



Hanging dots shown above and below the red block on the vertical chrominance transition

As line comb filtering only needs simultaneous access to two lines at once, there is very little delay through the decoder. Also, as it is only dependent on a relatively small area of a picture, two lines, it works equally well where there is fast action such as sports coverage, as with relatively static video, such as most drama.

Temporal comb filtering

Both frame and field-based filters are known as temporal filters. These use information from successive video fields (gathered over time) hence the term 'temporal'.

Source Picture

The two pictures above and at the top of the next column show the effect of a field based decoder. Using a field comb decoder on the same test chart as before, it can be seen that all the benefits of the line comb are maintained and the spread of cross luminance on vertical color transitions (hanging dots) is reduced. It can also be seen that the cross color on diagonals is reduced in amplitude. Field comb decoding is superior to line combs on these static test cards.

Output from a simple NTSC notch

With the best performance of all the filter types on static pictures, frame-comb filtering can actually provide perfect decoding but only if there is no movement between the fields. Like the simpler line comb filters, field and frame temporal filtering can be included as part of an adaptive decoding process.

Adaptive filtering

Adaptive filter systems are selective in their use of filters. In their most basic form, adaptive decoders attempt to use the best type of filter available whilst allowing for the limitations of the individual filter systems. Despite their perfect performance, temporal-comb filters need to be switched off if there is movement. The alternative would be to use line comb filters. If the line-comb filter has a problem, typically in the case of sharp, vertical changes in color, then a simpler low-pass filter can be used. This is a simple explanation, but in reality a more complex set of rules define the detail of the adaptive process.

By its nature, the quality of adaptive decoding is highly dependent on the detail of the decision-making processes it uses in deciding when to adapt to which filter. While the best quality decoders use adaptive systems, adaptive decoding on its own is far from a guarantee of quality.

The adaptive touch

Snell & Wilcox understands how to make adaptive decisions and has applied years of experience in building world-best composite decoders to create compact versions of these for the IQ Modular range.

The techniques use a unique adaptive algorithm based on Golden Gate: the world's leading composite decoder technology. Here, multiple filters simultaneously output their values for the decoded picture in parallel. Each pixel is then individually considered and the best of the filter strategies are used according to a set of adaptive rules. It is this rule-set that forms the decoder's 'intelligence'. The resulting series of highly intelligent decoders including the IQDAMDD and IQDAMDA incorporate intricate adaptive algorithms to provide the very highest decoding performance for real-world picture content.

International Sales Offices:

UK

Snell & Wilcox Ltd., 6 Old Lodge Place, St Margaret's,

Twickenham, TW1 1RQ

Tel: +44 (0)20 8917 4300 Fax: +44 (0)20 8607 9466

E-mail: info@snellwilcox.com

USA and Latin America

Snell & Wilcox Inc., 2225-I Martin Avenue,

Santa Clara, CA 95050

Tel: +1 408 260 1000 Fax: +1 408 260 2800

E-mail: info@snellamerica.com

China

Tel: +86 (0)10 6528 2761 Fax: +86 (0)10 6528 7635

E-mail: swchina@snellwilcox.com

France

Tel: +33 (0)1 45 28 1000 Fax: +33 (0)1 45 28 6452

E-mail: swfrance@snellwilcox.com

Germany

Tel: +49 (0)6122 9843 0 Fax: +49 (0)6122 9843 55

E-mail: swgermany@snellwilcox.com

Hong Kong

Tel: +852 2356 1660 Fax: +852 2356 1603

E-mail: swhk@snellwilcox.com

India (liaison)

Tel: +91 (0)11 641 2609/622 8014 Fax: +91 (0)11 621 8777

E-mail: swindia@snellwilcox.com

Japan

Tel: +81 (0)3 3446 3996 Fax: +81 (0)3 5449 7392

E-mail: swjapan@snellwilcox.com

Lebanon (liaison)

Tel: +961 (0)380 9995 Fax: +961 (0)121 6854

E-mail: swlebanon@snellwilcox.com

Malaysia

Tel: +60 (0)3 2732 5557 Fax: +60 (0)3 2732 8669

E-mail: swmalaysia@snellwilcox.com

Russian Federation

Tel: +7 095 248 3443 Fax: +7 095 248 1104

E-mail: swrussia@snellwilcox.com

www.snellwilcox.com

SNELL & WILCOX

0150/06/02