AURORA STANDARDS CONVERTER WITH RF MODULATOR

A review by Jeffrey Borinsky FIEE C.Eng.

At the end of 2004 I reviewed the original Aurora standards converter. This unique design could take PAL or NTSC and convert to any standard from 819 lines right down to 30 line mechanical. The only thing it lacked was a modulator.

The new Aurora converter has a multichannel modulator but sacrifices multistandard operation. If you thought the original Aurora was small you will be amazed at this tiny package. Just over 2.5" (66mm) square and 1" (25mm) high!

A NOTE ABOUT PRICES

In all my previous reviews of standards converters I have always had to include a note to explain the comparatively high price. Something like this: *Prices of £300 to £400 may seem high but the economics of small scale production make it inevitable*. Darryl Hock, the designer of both Aurora converters has now achieved what seems impossible and made his new design available for just $260, about £150. He has done this with a mixture of modern technology and a keen sense of value engineering. I still don't really know how he has managed it.

DIFFERENT VERSIONS

The new Aurora is available in several different versions. My review sample delivers 405 line output and has a system A modulator covering all 13 channels. Other versions are for European 50Hz standards on 441, 455 and 819 lines, also US 60Hz standards on 343 and 441 lines. Each version has a modulator that covers all the channels appropriate to the standard. All versions have almost identical hardware and rely on different programming of the FPGA.

TECHNOLOGY

Like the original Aurora, this converter uses a Xilinx FPGA. Part of the secret of the low cost is using the very new ultra low cost Spartan 3E series. This contains all the logic and video memory. A new and better decoder replaces the SAA7113 and a standard SPI serial flash memory holds the Xilinx boot data. Another flash device holds a stationary test picture which can be acquired from the video input. There is not much more than that! A few power regulators, a novel discrete DAC and that's it. The modulator is also a new design. David Robinson pioneered the Freescale (was Motorola) MC44BS373CA as a System A modulator. Darryl has used two of these devices to make a flexible multichannel modulator.

POWER SUPPLY

This is not supplied. The new Aurora requires an external power supply of around 9V at 250mA. A low cost "wall wart" is entirely adequate. The design is fully protected against reverse polarity. The decision not to include a power supply saves shipping costs. I used an old wall wart from my junk box which was supposedly regulated and delivered about 9V on load.

VIDEO PERFORMANCE

Just like its older brother, it is hard to fault the video performance of the new Aurora . It has excellent high frequency response, performs well with all sorts of input signals and has excellent interpolation. Each output line is interpolated from 3 input lines. This gives interpolation quality which is theoretically better than anything except the BBC CO6/509 which used four lines. Although it does not use a framestore, the output line sync is always continuous and stable. This is kind to your vintage TVs.

It has switchable equalising pulses. You can turn EQ pulses on for best interlace or off for complete authenticity. The original 405 standard did not have equalising pulses. Although this should not be a problem with good receiver design the fact remains that many sets suffered from poor interlace.

The comb filter decoder ensures that maximum monochrome resolution can be obtained from any video input. In this respect it improves on the earlier Aurora.

The built-in test pattern generator can capture frames of still video to use as test patterns. These are acquired via the analogue video input. I would have like to have seen some digitally derived test patterns pre-programmed in the flash memory but this is really me being a bit too fussy.

SOUND

Unlike its predecessor, the new Aurora does not use a framestore. As a result the video delay is minimal so there can never be any lipsync errors due to the converter. The sound modulator can accept a wide range of input voltages. Modulation depth is controlled by a small preset potentiometer. I don't have facilities to measure the performance of the sound modulator but there's no obvious distortion or other problems.

MODULATOR PERFORMANCE

The modulator can be switched any of the 13 System A channels. Other versions have a full set of channels appropriate to the output standard. Most conventional modulators have had a very high output. This is useful when restoring a deaf old set but could also overload many TVs and required an attenuator in most situations. The Aurora's modulator output is specified as 76dB with respect to 1uV. This is about 6mV, enough to feed one or two sets but not enough to cause overload. There is no VSB filter. This is not important since all sets should be equally happy with a double sideband signal. The output has a lot of harmonics. On channel 1 the 3rd harmonic is 11dB down while the 5th is 18dB down with further harmonics visible all the way up to the 500MHz limit of my spectrum analyser. There is also a low frequency spurious on the modulator output around 1.3MHz, about 27dB below peak vision carrier. This should not cause any trouble but a very simple high pass filter would remove it. The harmonics don't matter for most users but you really must respect the warning in the manual and not connect the modulator output to an antenna as you could cause significant interference to non-vintage radio and TV reception. If you intend to use multiple modulators in an ambitious vintage system you will need to use decent filters before combining their outputs.

I don't have access to a monitoring grade receiver so it was sometimes difficult to distinguish between modulator performance and receiver performance. I was able to try the converter with a number of receivers ranging from pre-war to 1960s dual standard. I am satisfied that there is minimal intermodulation between sound and vision, any buzz on sound was due to the receiver. I am not entirely happy about patterning on vision and the cause is difficult to establish. Channels 1-3 were clean but higher channels suffered variable amounts of patterning. The patterning was worse if I attenuated the signal which suggests external interference. However I could not find any obvious sources of interference across most of Band 3. Winding the aerial cable a few times through a ferrite ring had little effect which means there is unlikely to be a common mode or earthing problem with unwanted signals travelling on the outer of the co-ax cable. I cannot find any in-band spurious signals and the harmonics are unlikely to cause this sort of patterning. For all channels it was possible to get a clean or almost clean picture using good quality co-ax cable and taking care with the connections. Channel 4, which is important because it was used on a number of single channel sets, is easy enough to get clean. Some of the higher channels, especially 10 and above, are not so easy.

This is the only significant criticism I have made of the new Aurora. For most users, who are likely to use channel 1, there is no problem at all.

The 75R output matching is satisfactory. This aspect of RF equipment is usually specified as Voltage Standing Wave Ratio (VSWR) which varies between 1.1 and 1.4 over the frequency range.

A word of caution when working on vintage TVs generally. A failed aerial isolator could put live mains on the inner and/or the outer of the aerial socket. This will not do any good to you or the Aurora. Until you are sure about a receiver it's a good idea to connect an extra aerial isolator to the output of the converter or run the receiver via an isolating transformer.

RADIO INTERFERENCE

The converter contains high speed digital circuitry which is a potent source of RF interference. The plastic case does not inspire confidence but the use of a multilayer PCB with continuous ground plane should help. I do not have facilities for proper EMC tests but I did not notice any obvious problems while testing. It also contains a modulator which is a deliberate source of RF and has many harmonics. If you connect this to an antenna of any kind you may interfere with other services. In the UK this could include DAB which is broadcast on some of the old Band 3 channels and UHF TV services.

POOR QUALITY INPUTS

While I cannot test the unit with all possible poor quality signals I can state that the input AGC copes well with low amplitude down to at least –10dB. Note that the input video and sync amplitudes must be in the correct 7:3 ratio since the AGC measures the sync amplitude. Slightly noisy off air and ordinary VHS replay are fine too. It is always possible that *really* bad VHS replay could cause tearing or other effects but I have not seen this happen.

SOME MINOR PROBLEMS

DC offset

This is a very minor criticism and is of no real importance to users. In professional practice the black level of a video signal is at 0V with the sync tips at –300mV. This cannot be achieved without split +/- voltage supplies. In this design the sync tips are at about +0.2V which will not cause any practical problems. Please note that the absolute DC offset of the signal will not cause the displayed picture to have incorrect black level because the signal will always be AC coupled and DC restored or clamped in a monitor or modulator.

Modulator sync tip level

System A specifies that the sync tips should be at zero carrier. The Aurora's modulator puts them at 10%. This will affect the black level slightly on many sets but is not serious as you can easily adjust the brightness control.

Video input and output impedance

This is a bit technical but please bear with me. Video and RF are normally carried on co-ax cables which have a defined impedance. For video this is always 75R. Video inputs and outputs should both be accurately matched to the cable. This prevents too much signal being reflected from a video input or output. In the RF world this parameter is measured as VSWR but in video it's customary to use return loss. This is simply the ratio of useful voltage to reflected voltage. If return loss is too low, the reflections can cause ghost images or frequency response errors.

The output return loss is around 15dB and it did not vary much with frequency. This would not be acceptable in professional equipment but it's perfectly adequate here. Responsibility lies with the simple emitter follower output stage. This is a good example of how Darryl has employed value engineering to reduce cost while not affecting practical performance. The input return loss on my review sample was poor, between 5dB and 10dB at higher frequencies, depending on whether the converter was in bypass mode. This is bad enough to cause picture quality problems which might not be immediately obvious. Darryl has now modified the design and the input return loss will be satisfactory on all future units.

Connectors

Maybe I'm in a minority but I have never liked using phono (RCA) connectors for video. The review sample had phono connectors for video but buyers are offered the choice of phono or BNC.

The modulated output is an F connector, commonly used for satellite feeds, so UK users will need an adapter from this to Belling and Lee co-ax plug. This is a minor inconvenience. For very early sets there was no standard aerial connector and the unit is intended to be used in several countries, each with its own standards, so I suppose an F connector is as good a choice as any. Inevitably I would have suggested a BNC here too.

ALTERNATIVES

What are the alternatives to the new Aurora? There are several possibilities. The Domino is still a very fine piece of equipment and I stand by my original review. It may no longer be available by the time this review is published because its price tag of about £400 means that it cannot really compete with the new Aurora. Also its modulator is fixed to a single Band I channel. The original Aurora still gives ultimate multistandard flexibility but does not have a modulator. At the time of writing Darius's analogue design has now progressed to a kit with PCB. It probably won't be any cheaper than the new Aurora but it could be interesting to those who are keen on a DIY approach. A very different DIY method has been developed by Kat Manton. Her innovative PC based solution requires very little hardware construction and may appeal to Linux enthusiasts and those with a spare PC doing nothing. At the time of writing she has announced her intention to make an easily installed distro (sorry about the Linux jargon!) called *Fool on the Hill TV Linux*. David Robinson's design, the only one so far to produce 405 NTSC colour, remains as a single prototype with no intention to make it available either as a kit or a complete unit.

CONCLUSIONS

The new Aurora stands alone as the only 405 converter which has a modulator with switchable channels. It works very well and the price is a bargain. Most of the criticisms I have made are of little practical importance users. The only real cause for concern is the possibility of patterning on the higher channels which can usually be minimised. If you need full multistandard capability then you should buy the earlier Aurora. Otherwise this new product can be highly recommended.

THANKS

I would like to thank Gerry Wells, Graham Davis and John Thompson who provided TV receivers and generally helped and encouraged me to do this review.

The Aurora is only available directly from its designer:
Darryl Hock
http://www.auroravideosys.com/converter/
darryl@auroravideosys.com
There are further pictures on the web site. The full Aurora manual can also be downloaded from the web site

Price $260 including delivery to the UK and Europe. This is about £150 at the time of writing. The sterling price will vary with exchange rates. You can pay by Paypal or credit card. My review unit was charged almost £30 by UK Customs and Excise which is VAT on the declared value plus a handling charge. You may have better luck!

CAPTIONS FOR PHOTOS

FILE	CAPTION
internals.jpg	Internal view of Aurora converter
overall.jpg	Aurora converter