The Digital Gearbox

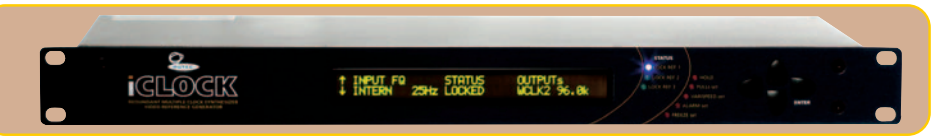
While testing various A/D and D/A converters for the review in the previous issue of Xound, we found that systems such as the ProTools HD 192 or the MotU HD 192 showed a noticeable sonic improvement when operated in connection with a quality external clock (in that case, the Apogee Big Ben of the AD-16 X). This phenomenon was to become the subject of another practical test performed in Peter Weihe's studio. Peter and me were assisted by Phillip Schulz, an audio engineer versed in classical-music recording, and assistant engineer Lutz Krahwinkel. First we want to introduce the individual systems to be tested:

Mutec iCLOCK

Mutec's iCLOCK is not only a clock generator but also a highly flexible audio and video synchronizer. The system is capable of automatically syncing to three external sources, which allows for implementing redundant configurations as favored in broadcasting and networked environments. When it comes to setting up the clock output routing, its flexibility is ideal and state of the art.

The Features in Detail

The iCLOCK does not only generate a master clock but can also use one of three external clock signals. Sample rates of up to 192 KHz are supported. Two BNC terminals are used for applying video-reference signals or clock signals while an additional AES/EBU port is provided for a third external source. Whenever the current source fails, the iCLOCK will immediately sync to the next source, or to the internal generator, without affecting the output signals. The source sequence to be used (i.e. the order in which the signals are selected as master) in case of failure can be adjusted in the setup. All combinations of the configured clock rates can be synchronized to the internal or each of the external sources. The iCLOCK isolates the input-signal clock, thus avoiding jitter at the synchronizer inputs. It has four video outputs that can be set up in pairs and four pairs of word-clock terminals (BNC) that can be scaled and clocked separately from the input signal and from one another. A total of 36 different word-clock rates between 8 KHz and 24.576 MHz are available for selection. The digitally implemented Varispeed function allows for an output-rate variation of ±20%. In addition to the word-clock outputs, there are four AES/EBU outputs to be configured in pairs plus an S/PDIF output in RCA format.



Operation

The iCLOCK is the most easy-to-operate generator unit in this test. It provides the largest number of features appealing to post-production and system facilities. The 2-line display shows all necessary settings at the same time, thus considerably simplifying operation. Four cursor buttons allow for navigating the menus, selecting various parameters, and changing their respective settings. In addition, the iCLOCK provides extensive and highly flexible options for the output configuration (for example, terminator emulation).

Special Features

Two versions of the iCLOCK are available: iCLOCK and iCLOCK dp. The dp version that is 500 EUR more than the basic version rather targets at the broadcasting market and features a secondary power supply. Therefore, it has two IEC power-cable terminals on the rear panel. If the first power supply fails during operation, the second one will take over seamlessly, ensuring continuous clocking. In combination with the auto-sync and the clock-input monitoring features, the iCLOCK is the perfect solution for redundant clock distribution in system houses. We explicitly want to point out the possibility of simultaneously generating two video reference clocks even for different image standards (provided that a secondary optional video-sync generator is installed). The rear panel also has an RJ45 port; in the future, this RS485 interface will be used for firmware updates or for controlling the system from a computer. Last but not least, an ALARM interface indicating failure of the external clock, one of the two internal power supplies, or the internal clock oscillator is optionally available.

Apogee Big Ben

The Apogee Big Ben is not only a classic clock generator but also a versatile format converter that understands - and speaks - a number of digital "languages".

The Features of the Big Ben

The core of the Big Ben is the C777 digital clock which supports sample rates of up to 192 KHz - this should eliminate any jittering problems. In addition, clock timing is optimized using the Adaptive Loop Filtering technology (ALF). This method is based on an intelligent low-pass filter used for minimizing jitter. The unit features the following inputs: 2 fk AES/EBU (XLR), S/PDIF (optical and RCA coaxial), ADAT/SMUX II and IV (optical), and word clock plus PAL/NTSC video (BNC). On the output side, there are two AES/EBU ports (XLR), an S/PDIF jack (RCA coaxial), an optical output supporting the S/PIDF, ADAT, and SMUX II/IV formats, and six BNC terminals producing the normal word clock. (Two of these BNC ports are capable of outputting word-clock signals with multiplier rates of 256, 4, 2, 0.5, and 0.25.) Apogee also offers an optional Firewire I/O board. As already mentioned, the Big Ben can even convert formats: S/PDIF to AES/EBU, ADAT to S/PDIF or AES/EBU, etc. Thanks to the supported sample rates (44.1, 48-88.2, 96-176, and 192kHz), the unit seamlessly integrates into any setup - even with high-end systems.

Operation

Similar to the Mutec iCLOCK, the Big Ben is reasonably easy to operate. Though the display shows only the sample rate currently in use, a number of LEDs indicate the sync statuses and the output configuration in a comprehensive way. Four cursor buttons are provided on the front panel for navigating the setup. Lock Indication LEDs show the lock status of the Big Ben - a clever feature providing information on the quality of the applied reference clock. For example, a lit green arrow indicates that the Big Ben has been unable to lock; if the arrow lights in combination with the Wide Lock indicator, the Big Ben has actually locked but the quality of the applied signal is problematic, etc. In addition, the front-panel LEDs inform on the configuration of the optical outputs (whether these are run in S/PDIF, ADAT, S/MUX II, or S/MUX IV mode) or the AES/EBU ports (single/double-wire mode). Two extra columns show the divisor or multiplier of the sample rate on the word-clock outputs 5 and 6.

Special Features

Two expansion cards are available as options for the Big Ben. First, there is a Firewire board allowing for syncing other Firewire-enabled devices such as keyboards or digital mixing consoles. The other card is the Video Expansion board which allows the Big Ben for generating a video-sync signal in black-burst format (PAL or NTSC). The price of the Firewire board is 405 EUR while the Video Expansion board is 511 EUR. The Big Ben, too, has a fallback function; the difference to the iCLOCK is that the Big Ben is not able to "jump" onto an external reference but continues generating the failed reference clock internally. Several power-supply modes can be set up on the Big Ben, too. The power switch can be disabled, and there is a "wake-up" function triggered by an applied supply voltage.

Rosendahl Nanoclocks

Rosendahl call the Nanoclocks a "digital audio-clock server" - and this is truly an appropriate designation. The Nanoclocks can distribute an applied word clock to 12 outputs without affecting the signal, or it can generate its own audio clock and send it via all outputs. And that's not all.

Nanoclocks Configuration

The Nanoclocks provides two BNC ports as inputs to be fed with external clock signals in audio word-clock format. Input A is capable of handling all clock rates between 32 and 100 KHz while input B accepts all rates between 32 and 200 KHz and the Super Clock format of Digidesign ProTools (Fs fk 256). The Nanoclocks has 12 BNC outputs; the outputs 1 to 4 send word clock or Super Clock while the remaining ones are limited to the word clock format.

Nanoclocks Operating Modes

The Nanoclocks provides three operating modes. In distributor mode, the input signals A and B can routed individually to one or more of the twelve outputs. In generator mode, Nanoclocks becomes an audio master-clock generator with twelve programmable outputs; supported sampling rates include 44.1, 48, 88.2, 96, 176.4, and 192 KHz. Here, too, the outputs 1 to 4 can be used as Super Clock outputs. The outputs 5 to 12 cannot be programmed individually but share a single configuration and support only 2 and 4 as multipliers.

Operation

Basically, operating Rosendahl's Nanoclocks is not as convenient as with the units previously described; this is because it provides only two buttons for configuring the inputs and outputs. Each press of the Menu button proceeds to the next input or output while the Select button changes the parameter. In distributor mode, the LEDs indicate which signals are or are not routed to the word-clock outputs (signal A: LED is off; signal B: LED is lit). In generator mode, only the outputs 1 to 4 are interesting as these show whether or not they produce Super Clock signals.

www.iclock-net.de
iCLOCK: 1,550 EUR (retail price)

www.apogeedigital.com
BigBen: 1,537 EUR (retail price)

www.nanosyncs.de
Nanoclocks: 1,044 EUR (retail price)

www.nanosyncs.de
Nanosyncs: 1,392 EUR (retail price)

Special Features

The failsafe mode is a broadcasting application where input A is constantly monitored. At signal failure at input A, the Nanoclocks syncs to the reference signal present at input B. In failsafe mode, the power switch is disabled. Since input A supports only sample rates between 32 and 100 KHz, a rate of more than 96 KHz cannot be achieved in this mode.

Rosendahl Nanosyncs

The Nanosyncs is more than an AV synchronizer - it is a black-burst generator and distributor as well as a wordclock and Super Clock generator and distributor. The Nanosyncs supports clock rates of 44.1, 48, 88.1, 96, 176.4, and 192 KHz plus Fs fk 256 (Super Clock for ProTools).

Input and Output

PAL and NTSC signals can be used as external reference, and word clock can be applied for synchronization, too. Further, a pair of BNC ports (LTC Input and Through) where LTC can be applied is present on the rear panel. The rear panel also has four BNC terminals for use as black-burst outputs. When the Nanosyncs is in internal-sync mode, an internal distributor sends the internally generated black-burst signal to the four outputs; in any other mode, the signal present at the video input is routed to the distributor. The Nanosyncs also has six word-clock outputs all of which are implemented as BNC ports. In addition, an AES/EBU and an S/PDIF output are available, too.

Operation

Similar to the Nanoclocks, Nanosyncs has a less sophisticated user interface. Here, too, the front panel provides just one Menu button and one Select button for laboring through the setup process. Further, the individual outputs are hard-programmed and limited to an integer multiple of the input sample rates. On the other hand, the Nanosyncs is the only device in this test capable of synchronizing to LTC - in fact, even with the usual frame rates (24, 25, 29.97, or 30 fps).

Special Features

There are four setups for configuring the word-clock outputs. With the first (default) setup, the S/PDIF and AES/EBU outputs follow the word-clock outputs 1 and 2. The second setup is where the outputs are routed with twice the input sample rates. With the third mode, all word-clock outputs offer Super Clock. Finally, in mode 4, Super Clock is sent only from outputs 4 to 6 while the outputs 1 to 3 carry the double clock rates.

Hands-on Test

All of the clock devices reviewed are capable of generating multiple clocks. We disregarded the various synchronization features of the individual units (at least in this test) but were rather interested in questions such as the following: Do the devices actually improve the sound of A/D and D/A converter systems? Are the effects more obvious in A/D or D/A conversion? And last but not least: Are there sonic discrepancies between the individual units?

We have been digging deeply in a number of forums and been discussing with numerous experts, and everybody agreed in at least one point: With the best converter systems featuring a quality internal clock, internal synchronization always achieves better results than synchronization to external clocks. Further, if separate A/D and D/A converters are used, the A/D converter should always act as master. To verify these statements and to get a feeling for what can actually be achieved, we borrowed two top-quality converters: the PrismSound ADA-8 and the Genex GXA8. (Thanks again to SDI!) The setup also included a ProTools HD system equipped with the HD192 interface - definitely a system that many professionals would call a standard setup still today. Live recorded electric and acoustic guitars, live vocals, drum recordings by Curt Cress made to a 24-track Studer analog machine, and various ProTools sessions containing recordings from Rock 'n Roll to orchestral

material from the Abbey Road Studios were used as test signals. All tests were made using a sample rate of 96 KHz, and the external clocks were synced via word clock. To eliminate the chance that the testers hear what they expect to hear, we all took turns reconfiguring and changing the setup while the other ones never knew which device they were actually listening to just then.

Test No. 1

In this trial, we initially tested - using the internal clock - the PrismSound converter in comparison with the ProTools HD192. All signals applied to the A/D-converter input were directly monitored after an immediate D/A conversion and were compared to the original signals. As the Genex is just an A/D converter, we ignored it at first.

Even if the analog original has slightly more details, we all agreed that none of us had ever listened to a converter of such a high quality like the PrismSound ADA-8; we had not expected this even in view of the very high price of 10,000 EUR.

Afterwards, we ran the systems synced by external clocks. The finding was that the sound of the PrismSound does, in fact, deteriorate; with the internal clock, all signals were reproduced much more naturally - a confirmation of what the above-mentioned experts said (namely that an internal clock is always to be preferred provided that it is good enough). Therefore, the concept of the new Apogee AD-16X and DA-16X 16-channel converters makes sense as they integrate the C777 Big Ben clock as a standard component. The ProTools HD192 which is known to be a good system shows sonic improvements with each of the tested clocks. All in all, when synced externally, the ProTools interface produces a more open sound with better resolution.

Test No. 2

The objective of the following test was to examine the impact exerted by A/D conversion on the external clock. For this purpose, various Logic and ProTools sessions replayed from the computer were monitored directly via the ProTools HD192 and via the PrismSound D/A converter. In this setup, the ADA-8 was digitally connected to the ProTools system via AES/EBU. Here, one of the two interfaces must be master - we have tried both of them. We also inserted the Benchmark DAC1 D/A converter for listening to a variety of sessions; the DAC1, too, was hooked up via AES/EBU.

The aural comparison between the ProTools and the PrismSound systems showed that the ProTools interface apparently benefits from the high-quality PrismSound clock while the ADA-8 spiraled downward as soon as the ProTools became the master. The Benchmark DAC-1 achieved amazingly good results: depending on the material being played back, it sometimes produced an even more open and dynamic sound than the PrismSound A/D converter. Generally speaking, the differences between using the internal or external clocks appear to be significantly smaller than in the first test. This means that D/A conversion seems to be much less susceptible.

Test No. 3

Finally, we used the available A/D converters for recording a variety of signals - guitars, vocals, and drums - to the ProTools HD system. All of them were recorded using both the internal and one of the external clocks and were later played using the same clock applied for recording. This situation is quite similar to what happens day by day in a typical studio. In order to compare the A/D conversions, we reproduced the results using the Benchmark (which - as already mentioned - did a perfect job).

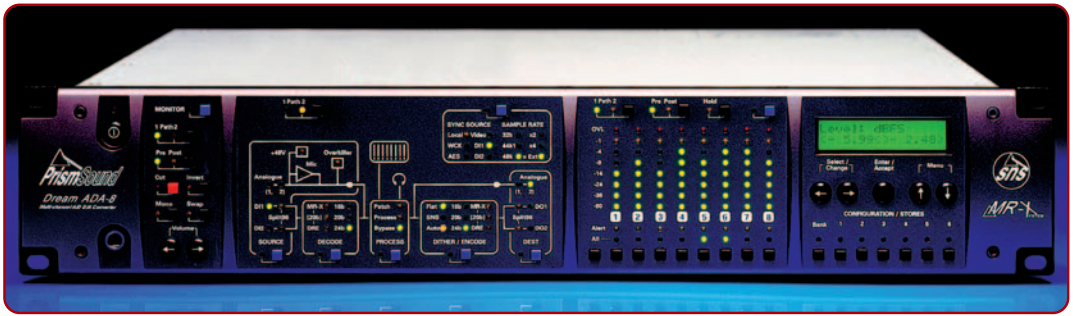
Here, too, the findings from the first test were confirmed. While the PrismSound ADA-8 did worse when an external clock was applied, the ProTools HD 192 improved its performance. The Genex, too, sounded slightly better with internal synchronization though the difference is not as evident as with the PrismSound.

Clock Synchronization
By Heinz Peter Reykers (WDR)

Since the introduction of digital technology into broadcasting, clock synchronization has become an important aspect of both planning and operation. At the beginning, digital studio environments emerged like islands in the broadcasting center, and only the internal components were synchronized to a shared clock. This studio master clock was usually derived from the console clock and was then distributed as word clock to DAT recorders, multi-track machines, and other peripherals. Signals were exchanged as analog audio between separate complexes, which did not cause any problems. These became apparent only by and by when the broadcasting center was gradually being transferred to the digital domain and a demand for a digital infrastructure for audio exchange arose. Suddenly, there was a strong need for action. First, the use of sample-rate converters was considered for interconnecting separate digital studios but this would have been a significant expense factor; also, using such components would have noticeably affected the signal quality. As an alternative, it was decided to install a centralized, fully redundant in-house clock interconnecting all internal digital complexes; this allows for implementing an seamless internal audio exchange - the same way it had previously been achieved on the analog domain. This in-house clock is generated by a quality quartz oscillator that is superior to the generators in mixing consoles or converters in terms of frequency accuracy, stability, and electrical signal properties, e.g. clock jitter. Thus, not only the signal exchange benefits from such a central clock but the remote-clocked peripherals in the studio are also greatly enhanced.

Summary

Differences between the several clocks were, in fact, noticeable in the aural comparisons; they are, however, minimal and vary depending on the audio material. Thus, it would not be legitimate saying that one of the clocks sounded better than the others. All in all, we can confirm that a converter system that does not implement an optimum internal clock and sync design (and this should be the case with all affordable converters) is considerable improved by the use of an external clock - especially when it comes to A/D conversion. We later repeated this test with a MotU HD 192 and the RME Fireface, and our findings were confirmed once more. If you are among the lucky ones who do not need to care about the money, one of the high-end converters should be your choice. There are, however, down-to-earth solutions. A setup including an external clock and a cheaper converter might even perform better than a more expensive converter. Don't hesitate finding out - an advice not only to the professionals.



PrismSound ADA-8

The PrismSound ADA-8 was used as one of the reference converters in the clock test. We used the STD-AES version of the unit; this version which has the AES/EBU board installed and provides digital I/Os (XLR, balanced) for each of the eight A/D-D/A converters. This high-end converter (19", 2U) made in Britain supports clock rates of up to 96 KHz and a resolution of up to 24 bits. It targets at the mastering and broadcasting markets and is, of course, also suitable for surround mixing and mobile recording. In the configuration described, the price of the PrismSound ADA-8 is 11,156 EUR.

Genex GXA8

The Genex GXA8 is an 8-channel A/D converter. It is an upscale high-end product, too, and was likewise used as reference converter. The retail price of the 8-channel version is currently 4,303 EUR. All standard rates between 44.1 and 192 KHz and word widths of 16, 20, and 24 bits are supported. The converters are free of DSPs, and the analog stages have a rather purist design. Available options include a ProTools interface with metadata support, so the sample rate and the bit width can be controlled from ProTools. Similar to the PrismSound, the GXA8 is suitable for all professional applications.