



TEST.

MUTEK REF10 NANO

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The topic of master clock has been on my mind for some time now. It's fascinating to see what sonic improvements can still be teased with it out of a digital chain. The brand new REF10 NANO from MUTEK is a variant of the outstanding REF10 that concentrates on the essentials at half the price.

That's quite an announcement and makes the subject of clocking even more interesting as it already is. I've had two cascaded MUTEK MC3+ USB re-clockers in my inventory for many years and am always amazed at how good a digital chain can sound with them. And since my two tests of the REF10 and REF10 SE120 master clocks, I also know that it can be much better. However, I've always had a certain stomach rumble when a clock that's at least four times as expensive "only" clocks the MC3+ USB. To help you better understand what I mean, I need to expand a little. A master clock, such as the REF10 NANO, generates an extremely low phase noise 10 MHz clock signal. But we can't do anything with that at first. Modern DACs work with clock frequencies of 22.5792MHz or 24.5760 MHz, which are integer multiples of the standard audio sampling rates 44.1, 88.2, 176.4kHz and 48.0, 96.0, 192.0 kHz. With USB2.0 we have a clock frequency of 48 MHz and typical Ethernet clock frequencies are 25 MHz, 125 MHz and 156.25 MHz. Nowhere do we find 10 MHz.

Thus, we need a converter that synthesizes the required audio clock frequencies from the 10 MHz clock. The magic formula is called a "digital frequency synthesis". The task of such a process is to generate any clock frequency on the basis of a reference clock of 10 MHz. It is obvious that the clock provided on this basis depends not only on the precision of the clock itself, but also on the quality of this synthesis. A prerequisite for the use of a master clock is therefore that the device to be clocked has such a frequency synthesizer and a connec-



REF10 NANO Front view

tion for an external 10 MHz clock. Unfortunately, there are currently not too many manufacturers and devices in the high-end sector that take this, admittedly complex, approach. MUTEC has compiled a list of currently available 10 MHz-compatible audio devices on its website. But there are still more hurdles to overcome: there is no consensus among manufacturers as to whether the reference clock is provided in the form of a sine wave signal or a square wave signal. Accordingly, it cannot be ruled out that the built-in frequency synthesizer will cope better or worse with one or other signal form. To make matters worse, there are also two standards for interface and cable termination: 50 ohms on the one side and 75 ohms on the other. In the high-end sector, we encounter both standards.

But back to the REF10 NANO. As far as termination is concerned, we are on the safe side. It has four outputs on the rear: two 50 Ohm and two 75 Ohm. Correct termination also requires the right cable and the right connec-



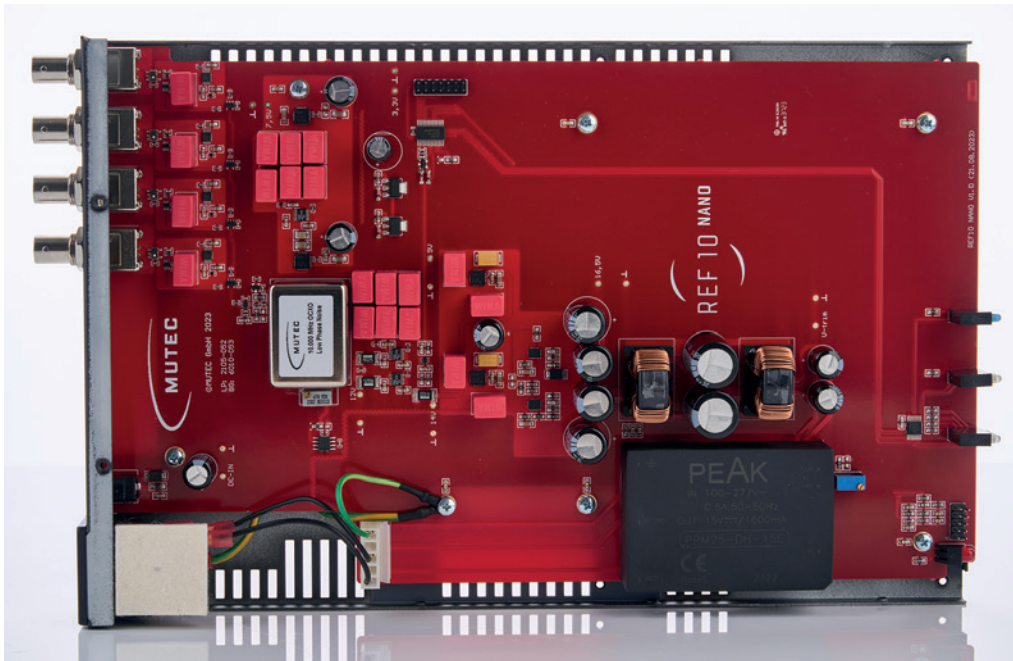
The black rotary knob is used to switch the outputs on or off. The blue LED lights up continuously when the oscillator's warm-up process is complete

tors. With a clock rate of 10 MHz, clean termination across the entire signal path is extremely important - I can't emphasize this enough! Mismatches here can ruin the signal quality to such an extent you might as well do without a master clock altogether. I tried switching between 50 and 75 ohms and the difference is clearly audible. You lose sharpness and precision. At the outputs of the REF10 NANO, a square-wave signal with extremely high edge steepness is output in contrast to the usual sine wave signals of other clock generators available on the market. The steep edge of the square-wave clock signal should lead to significantly faster and more stable synchronization of the connected devices, which in turn should result in less jitter induction in the receiver circuit. According to MUTECH, this is one of the main reasons for the sound improvement achieved by the REF10 NANO. The heart of every master clock is, of course, the oscillator used. Here we are primarily interested in the frequency stability of the generated signal. A distinction is made between long-term and short-term stability. Long-term stability refers to the amount by which the absolute clock frequency drifts over a longer period of time, such as days, weeks or months. At MUTECH, they believe that short-term stability, i.e. the accuracy in the extremely short time interval between samples, is the decisive factor for the sound quality of digital audio material. Changes in the short-term stability are described metrologically with phase noise and jitter. The short-term stability of an oscillator depends significantly on the ambient temperature. MUTECH therefore uses OCXO oscillators in all REF10 variants, which are manufactured in Germany. OCXO stands for "Oven Controlled Crystal Oscillator". The quartz crystal and all other components of the oscillator are located in a heated chamber, which is always kept at a constant temperature, even if the temperature outside changes. The temperature in the chamber is individually set to the turn-over temperature of the quartz material used, i.e. to the temperature at which the quartz exhibits the least frequency changes and therefore provides the highest frequency stability.

The REF10 NANO uses the same oscillator module as its larger siblings. The difference lies in the degree of selection. With the help of highly specialized and cost-intensive measurement technology, individual oscillators are selected from larger production quantities for the highest quality level, the REF10 SE120, which have extremely low phase noise values of at least -120 dBc measured at a 1-Hertz distance from the carrier frequency of 10 MHz. The REF10 achieves values of at least -116dBc in this central metrological aspect, while the REF10 NANO has to make do with values better than -112dBc. Sounds a lot worse at first. But as Mr. Peters, CEO of MUTECH GmbH, told me, in practice the measured values of many REF10 NANO are closer to the REF10 than to the guaranteed, lower minimum value. Extremely low-noise clock distribution and amplification circuits are intended to ensure that the reference signal of the OCXO is really available at the four outputs of the REF10 NANO with virtually no loss. All output stages of the REF10 NANO are galvanically isolated to prevent hum



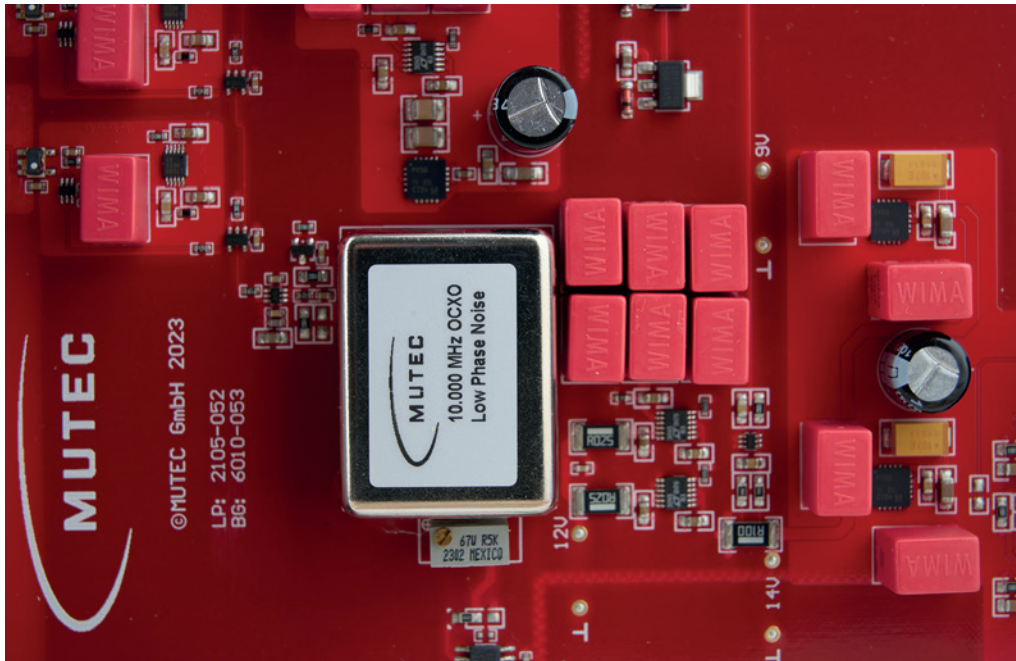
The clock outputs of the REF 10 NANO: 2 x BNC 50 Ohm, and 2 x BNC 75 Ohm. If you look closely, you can see that the inner part of the 50 Ohm and 75 Ohm connectors (white insulation) is different



The inner workings of the REF10 NANO from right to left: switching power supply module (black), complex, multiple cascaded voltage stabilization, OCXO oscillator and output section

interference from ground loops. The REF10 NANO uses virtually the same sophisticated circuitry as its larger siblings. Just as important as the quality of the oscillator is the quality of the power supply for digital audio signal processing. Here, the REF10 NANO has to make do without the toroidal transformer and the generous filter capacities of its big siblings and instead uses an off-the-shelf switching power supply module in the first stage. But what comes next is quite something and hardly differs from the REF10. We find extremely low-noise, multi-cascaded voltage regulators of the latest generation, which are said to be optimized down to the sub-Hertz range. The highly sensitive OCXO oscillator receives its supply voltage isolated from the rest of the circuit to prevent mutual interference, and each of the four outputs also has its own voltage regulation. All the electronics are neatly arranged on a large circuit board and housed in a simple steel casing. At this point, the steel housing has the advantage over the often used aluminum housings that the shielding against external, high-frequency interference is considerably better.

The REF10 NANO is easy to operate. The device is switched on and off using the power switch at the rear. After switching on, the red LED on the outer left lights up. In addition, a blue LED flashes until the heater has warmed the oscillator to its operating temperature; it then lights up continuously. Even if the heating process is completed after about one minute, MUTEC recommends giving the REF10 NANO about 20 to 30 minutes before listening to music so the entire oscillator is completely warmed up and the highest frequency stability is achieved. The outputs are selected using the rotary switch on the front panel and switched on or off by pressing it. Four white LEDs indicate which outputs are active. On the rear, in addition to the four outputs, there is also an input labeled "DC" for connecting an external power supply unit with 15 volts/1 ampere. If an external power supply unit is connected, the REF10 NANO must be disconnected from the mains using the mains switch or, even better, the mains cable must be unplugged immediately. Two LEDs on the front panel visualize which type of power supply is currently active. Unfortunately, MUTEC has installed a socket at this point, I'm guessing Lumberg, which is not compatible with the usual hollow plugs. MUTEC does include a suitable plug, but it might not be everyone's cup of tea to solder a suitable cable. I quickly came up with an adapter. For the listening test, my two cascaded MUTEC MC3+ USB are the "natural" playing partners for the REF10 NANO. From my PS Audio DirectStream DAC it goes via S/P-DIF to the MUTECs and from there via USB to the Diretta Lucia Piccolo Bridge, which receives the music data via Ethernet from my Windows server with JPLAY. The two unused 50 Ohm clock outputs - the MUTECs work with 75 Ohm termination - are switched off with the rotary switch on the front panel to reduce unnecessary interference emissions as far as possible. My two MUTEC MC3+ USB are set to "externally referenced re-clocking mode". The two green LEDs "EXTERN" and "RE-CLK" therefore light



The heart of the REF 10 NANO: the super low-noise OCXO oscillator

up below "Mode" and the two upper blue LEDs "MAIN REF" and "RE-CLK REF" light up below "STATUS". The REF10 NANO leaves a clear, easily audible "footprint" in my chain in the categories of spatiality, musical flow and transparency. The first thing I hear is how the spatial impression improves with the REF10 NANO. In the "Intermezzo from Goyescas" by Enrique Granados with the New Philharmonia Orchestra conducted by Rafael Frübeck des Burgos (Decca Legacy Volume One - FIM UHD), the wind instruments no longer sound so diffuse and oversized, overwhelming everything from the depths of the room, but are better defined in terms of their size and placement in the orchestra, which lends clarity and conciseness to the spatiality of the recording. In the "Simple Symphony, op 4 - Boisterous Bourree" by Benjamin Britten with the TrondheimSolistene (The Nordic Sound - 2L audiophile reference recordings - 24/352), the minimal reverberation of the recording location, a church, is now even better emphasized, giving the spatial expression unmistakable depth. In addition, there is significantly more airiness, from which the fine details of this recording, such as the filigree pizzicato of the individual string groups, benefit in particular and which simply allows us to participate even more intensively in the special atmosphere of this recording.

As I then listen to Otmar Liebert's album Dune, the musical flow and smoothness are particularly striking. In "On the Road to Shiraz", Otmar Liebert's guitar has more volume, the handclaps are more realistic and the accordion, which has always been somewhat nebulous, can now suddenly be heard with fine definition. The electric bass anchors the melody more firmly and drives the piece forward with verve. Here, too, the stage is deeper and the overall impression is more vivid and energetic. Another immediately noticeable feature is the increased transparency in the mids and highs. In "Tarantella" by Sarasate (The Chasing Dragon - Audiophile Recordings), the solo violin chases through the entire sound space at breakneck speed and with the highest degree of difficulty. Soft tones alternate with passages played extremely strong, high harmonics with medium and low registers. This par force ride can quickly become exhausting, especially in the high registers, and the pleasure is then lost. With the REF10 NANO, the solo violin sounds smoother and far less coarse-grained. But that's not all: the overall sound is calmer and less agitated. This makes subtleties in the other instruments audible that were previously masked by the solo violin pushing to the fore. This transparency is continued in the mid-range and gives human voices more naturalness. On "The very thought of you" with Emilie-Claire Barlow (Jazz Ballads - 2xHD 24/44.1), I was impressed by how naturally and clearly outlined the singer now stands between my speakers. The nice thing about this is that the proportions are maintained and the singer and accompanying instruments are not simply shown larger, as when you zoom in on an object with a camera. A warning at this point: anyone listening to a REF10 NANO in combination with a MUTECH MC3+ USB for the first time may initially find the sonic improvements less than spectacular. The aha-effect moment comes at the

latest when the REF10 NANO is removed from the chain. You don't really want to have that, i.e. hear it. Until now, I've always been of the opinion that two MUTEK MC3+ USBs are better than one. I still think that, but I would change the order of purchase. Before buying a second MUTEK MC3+ USB, I would now advise you to invest in a REF10 NANO first. With one MUTEK MC3+ USB, which derives its clock from a REF10 NANO, you will come much closer to the listening impressions just described as with two MUTEK MC3+ USB alone. And I would probably add another purchase in between: a good linear power supply. I know I'm biased when it comes to switching power supplies. But when you hear how even an affordable SBooster BOTW Power & Precision ECO power supply brings even more calm and flow to the musical performance, you'll understand my point. With a good linear power supply, the REF10 NANO comes a good deal closer to the big REF10. But when it comes to the purchase price of such a power supply, keep things in proportion, otherwise you might as well invest in a REF10. Against the background of the experiences just described, the question arises as to whether more is possible? What if the REF10 NANO could make even more devices in my digital chain happy with its 10 MHz reference clock? To examine this question, I am now using a server from SOTM, in which all essential components such as the motherboard, Ethernet module and USB module can be clocked externally, and I am also adding the SOTM switch sNH-10Gi - also with an external clock input - to my chain. I experience the "Spanish Overture No. 1: Capriccio brillante on "La Jota Aragonesa" by Mikhail Glinka with Vladimir Jurowski and the London Philharmonic Orchestra (Valdimir Jurowski: 10 years) with a degree of transparency and resolution that I have hardly heard before: every instrument has its rock-solid, immovable place on the stage and the proportions of the instruments to each other are simply perfect. The whole thing is particularly impressive when groups of instruments at the back, such as the timpani, have already reached fortissimo and do not obscure the violins, which are still playing softly pizzicato and sitting further forward. Following the different musical levels in this piece changes from concentrated listening to relaxed enjoyment! This experiment impressively demonstrates the potential of a REF10 NANO if we allow its 10 MHz reference clock to supply as many as possible or even all devices in a digital chain.

STATEMENT

MUTEK has created a real winner with the REF10 NANO! It is the congenial playing partner for the MUTEK MC3+ USB and the perfect introduction to audiophile clocking. You can't get that much master clock for the money anywhere else at the moment.

LISTENED WITH

Computer	Intel Xeon E3-1225 3,2 GHz, 4 GB RAM, Windows Server 2012R2 and 2019 with AudiophileOptimizer 3.0, JPLAY USB Card, HDPLEX 400W ATX Linear PSU and HDPLEX 200W Linear PSU, Diretta Lucia Piccolo Bridge, LattePanda Alpha 864s with Intel 8th m3--8100y with Diretta Target Bridge or Volumio with HDPLEX 200W Linear PSU
Software	JPLAY Femto, JPLAY femtoServer, JPLAY iOS App, Upplay, JRiver Media Center 24, MinimServer, Roon Server, Volumio
LAN Switch	Silent Angel Switch Bonn NX, SotM sNH-10G i
10-MHz-Clock	Silent Angel Clock Genesis GX, SotM SCLK-OCX10
USB	MUTEC MC-3+ USB, SotM USB Hub tX-USUltra
DA converter	PS Audio DirectStream DAC MK1
Turntable	Platine Verdier
Tonearm	Souther TRIBEAM
Cartridge	Clearaudio Veritas
Preamp	Erno Borbely, Omtec Anturion
Power Amp	Stax DA-80m, Omtec CA 25
Loudspeakers	Børresen 01 Cryo Edition, 2 x Velodyne Subwoofer DD-10+, Audioplan Kontrapunkt IV
Cables and Accessories	Van den Hul, JCAT Reference USB, JCAT Reference LAN, Analysis Plus Digital Oval Yellow, AudioQuest Eagle Eye Digital Cable, SotM dBCL-BNC, Audioquest Niagara 5000, Ansuz Sortz RCA, LAN und BNC

MANUFACTURER'S SPECIFICATIONS

MUTEC REF10 NANO

Interfaces	2 x BNC-Ausgang für 10 MHz-Referenztaktsignale, 50 Ω-Terminierung unsymmetrisch, 2 x BNC-Ausgang für 10 MHz-Referenztaktsignale, 75 Ω-Terminierung unsymmetrisch
Signal Format of all Clock Outputs	Square wave, 10.000 MHz, 2 Vpp, 50:50 duty cycle
Phase Noise	≤ -112 dBc/Hz at 1 Hz, ≤ -142 dBc/Hz at 10 Hz; ≤ -158 dBc/Hz at 100 Hz, ≤ -164 dBc/Hz at 1000 Hz; ≤ -167 dB Noise floor
Jitter	≈ 30 fs (1-100 Hz)
Weight	2070 g without packaging
Case size	196 x 44 x 300 mm (WxHxD, without connectors and case feet)
Price	2000 euros

MANUFACTURER

MUTEC

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