Get the most out of a transport + DAC couple

SPDIF Reclocking made easy

[Italian version]

Product: SPDIF Reclocking for CD Player and Transports
Producer: DIY project, no component made available
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Introduction

The topic of this article is how to optimize the use of a very high quality clock in the transport or in a CD player **used as transport**, which is the most frequent case with low to medium class external DACs, to achieve the best results not in terms of sound from the local converters but in terms of precision and cleanliness of the generated S/PDIF flow.

The solution

The idea is very simple: instead of wasting clock precision by loading it with all the original circuitry, the best clock is to be reserved exclusively for cleaning up as much as possible the S/PDIF output flow, while a "rough copy" of the clock is used to achieve a perfect synchronism in the rest of the unit, without any special care for jitter and precision.

In facts, an advantage of synchronous digital systems, like our transport unit, versus the asynchronous ones is that the digital signal level cannot change at any time, but only in specific moments. So, if you have a signal affected by jitter, and you have a jitter-free clock which the signal is synchronous to, it is possible to build a slightly delayed but jitter-free copy of the original signal just by reclocking it, that is, re-sampling it with the jitter-free clock.

The application is rather simple too. In practice, there are two issue to address.

First, you need a very high quality, jitter-free clock, and must synchronize all the transport with this clock. If your unit is very high quality, it is possible that the clock is already at an acceptable level. Anything in the consumer area has for sure a low quality clock.

In this case, the best solution is the most radical: eliminate the clock generation system (normally just a quartz with a couple of capacitors and an inverter gate, and install one of the many super clocks available on the market (e.g. LC Audio, NET, Tent, ...) in place of the standard clock.

Second issue, you obviously need to install a reclocking circuit. You need to identify on the board the S/PDIF data flow at CMOS/TTL logical level (very roughly 0/+5V). This can be not easy , unless you have the schematic, and can also be plainly not possible, because the S/PDIF signal might be not available at all on the board.

The simplest case to address, and the one we will describe in detail, is when an optical digital output is already available.

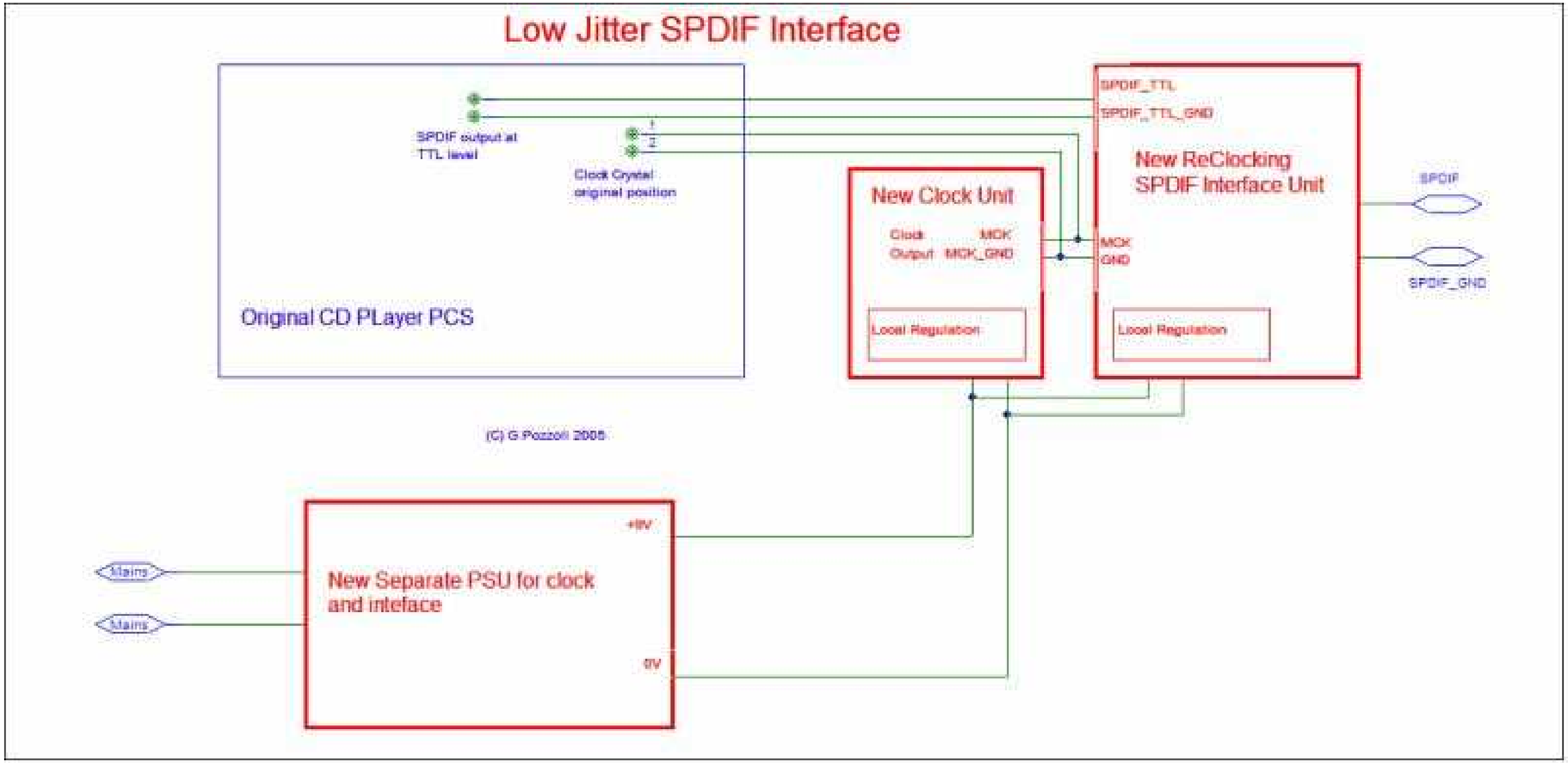
In this case the required signal is present on one of the connection pins of the optical interface (TOTX). The other ones are normally connected to +5V or ground, and therefore the hot pin (that is the one with the signal) should be easy to detect by measuring the resistance between ground and +5V and each pin using a normal tester as ohmmeter.

In case of doubt, anyway, you can also refer to the interesting document by Tomi Engdhal available on the Internet, that contains really a lot of information regarding SPDIF and digital audio interfaces, and also TOTX references and pinout.

We need now to bring the reclocked data to the standard S/PDIF level and take it to the output connector. If the transport already has a digital out, one is strongly tempted to use the original circuits and connector. This is however not a good idea, especially where the cost reductions have been heavier. The simplest solution, and the one that allows to get the best results, at this point, is to build a completely new electrical output.

Finally, no high quality circuit can give his best if its power supply is dirty, noisy, not perfectly stable. Therefore a clean power supply, independent as far as possible from the general one of the transport unit, is required to achieve the best results.

Further care must be taken to make the power supply of the clock and of the reclocking circuit as independent and uncorrelated as possible. For this reason local filtering and regulation should better be present.



The design

In the following is detailed a possible very low cost implementation. It is far from absolutel optimal, but it works and works fine. The design was tested in a Pioneer PD-S505 CD player.

The clock and reclocking units are separate. This is due essentially to the need I have to be able to compare different clocks, and to the fact that these clock are normally complete, stand-alone units, with their own power supply: if you are designing your own clock, there is no reason for you not to put both circuits in the same board provided you use separate regulators to drive the two circuits and keep the clock a little apart in order to avoid or at least reduce disturbs propagation.

For the same reason, it is mandatory to use a ground plane: it is a very powerful method for reducing any sort of bad mutual effects between the different components.

For the clock, you can choose any special low jitter clock on the market. If you already have one, you can just use it. If it really is such an high quality, it should already have a local regulation and filtering in place. If it has not, add one.

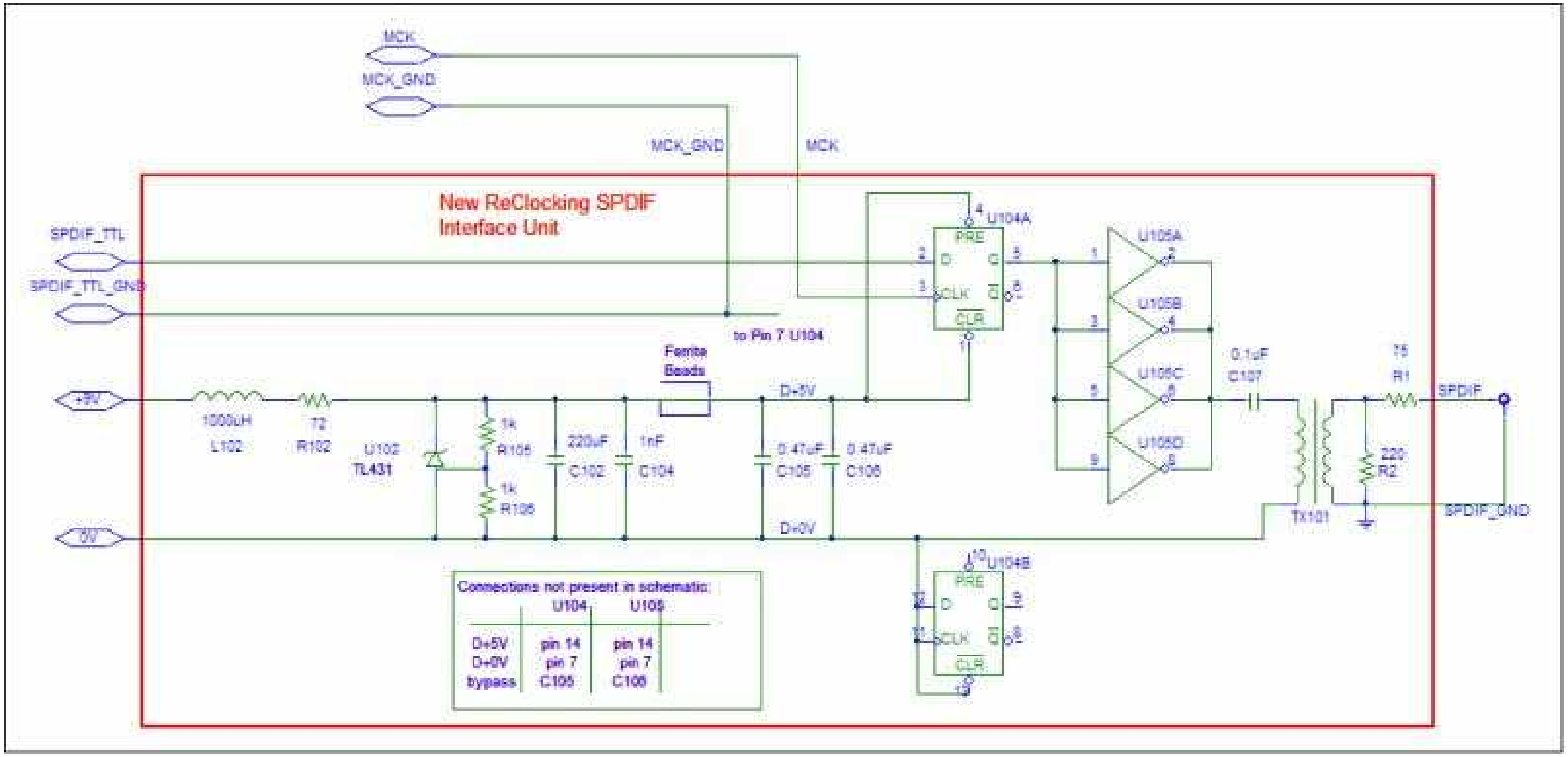
The clock must be placed as near as possible to the reclocking unit, which should be as near as possible to the output connector; the distance from the original clock position is far less relevant.

In any case, DO NOT use the spare inverters available in U105 for clock buffering. It is for sure better to add another hex inverter for the sake of clock precision and cleanness, but especially for SPDIF signal cleanness. The power supply too should come from the clock branch and adequate de-coupling is required.

The reclocking and line drive unit is rather straightforward. The reclocking is simply obtained with a D type flip flop, which samples the input value on the rising edge of the clock, and keeps the output stable to this value up to the next clock rising edge. That's really all.

The output driver has been inspired by (better say taken from..) the interesting document by Tomi Engdhal named before and was originally published by Elektor. It has enough power to drive the 75ohm line and enough speed to keep the signal edges as sharp as possible, which helps a lot in reducing jitter. An RS-485 line driver would have been a more proper choice, but it is not so easy to find and more expensive.

The output transformer is home made. I used a ferrite toroid from RS Components as a core, part number 212-0831, and just wound up both primary and secondary coils with enameled copper solid core wire (the one used for normal power transformers secondary coils). Unfortunately the original ferrite toroid is no longer available; try finding something similar of small dimensions. The primary winding has 15 turns, and the secondary 3.



The installation

First of all the original clock must be eliminated. Please refer to the instruction of your clock (or of any other clock: they are all quite similar; the instruction for the LClock XO used to be very complete and detailed and were available for a number of different units, but the site has benn changed...) to find the clock components, and eliminate them.

Next, you need to install a new SPDIF connector. The connector must be insulated from the cabinet, and can be either an RCA or a BNC. I prefer the BNC, because is available with a precise 75ohm impedance, but the best digital interconnects I have listened to are RCA terminated... so do not worry too much in taking such a decision.

Now you have to prepare the wiring. As said, first priority is to keep the wiring between the clock and the reclocking unit, and between this last and the SPDIF output connector, as short as possible, no longer than very few centimeters. Then lower priorities are to keep short the connections between the new boards and the new power supply, and from the clock board to the original clock position.

For all the signal and low voltage power connections, a solid core twisted couple, taken for example from a UTP Cat.5 network wire, can be used. Finally, you need to connect the new power supply unit to the transport input mains connector or soldering points. Use a wire that can cope with the high voltage involved: do NOT use cat.5 wires here!!! Keep the wire as far as possible from digital and audio circuits to prevent mains noise to be picked up.

At this point you have just to switch the unit on, and hope everything works fine...