Convert your standard ReVox B77/PR99 into a well performing 'Tape Project' machine (Rev 2).

Arian Jansen. **Updated: March 31, 2008 (PR99 mkII and PR99 mkIII temporarily removed from this document.)**

Last year Paul Stubblebine, Dan Schmalle and Michael Romanowski, all gentlemen with a good reputation in the recording industry started an initiative called 'The Tape Project'. The purpose of this initiative is to make second generation very high quality reel to reel tape copies of great analog recordings available to the public. For more details on the initiative and the available titles visit the website of 'The Tape Project' (www.tapeproject.com).

The albums made available by the Tape Project come on two 10.5" reels of 1⁄4" tape that are recorded in 2 tracks at 15ips using an IEC (CCIR) equalization curve. These parameters were purely chosen to get the very best audio performance possible. I have to say that the result is absolutely stunning and these Tape Project albums really constitute the 'ultimate analog' when played on a high end reel to reel play back system.

Although the last consumer reel to reel recorder came off the production lines years ago, there are still plenty of them around. However, since the reel size that the tape deck must be able to handle has to be 10.5", the majority of those decks are not suitable. The requirement for 2 tracks instead of the more common 4 tracks again takes away the majority of the available decks. 15ips reduces the number of candidates even further and finally the requirement for an IEC EQ cuts most of the candidates that were left. If after this deduction you still have some enthusiasm left, let me add that most of the candidate decks left were made in the late 70's and early 80's which was a pretty sad era for high end audio, mainly because of the questionable design philosophies of the electronics at that time. That means that many of the reel to reels from those days sound pretty disappointing.

So does that mean that the Tape Project is a waste of time? No, because there are options, albeit not all of them necessarily easy or cheap. With respect to the cost, keep in mind that we are talking about the 'ultimate analog' here. Some people spend tens of thousands of dollars on vinyl playback. With the Tape Project tapes you can match or exceed the performance of the best vinyl for a significantly lower cost. You can pick up professional studio tape decks from Studer, Telefunken or Ampex for reasonable prices. Furthermore there are places that sell custom electronics for consumer/ semi professional tape decks that can match or exceed the performance of the professional studio decks.

This article will describe a method to convert two of the more easily available consumer/semi professional reel to reel recorders into a remarkably good playback deck for Tape Project tapes. I am talking about the standard ReVox B77 and its professional cousin the ReVox PR99.

ReVox B77 MKII ReVox PR99

The standard B77 comes with two speeds, 3¾ ips and 7½ ips and has NAB EQ. There is also a 7½ / 15 ips version available but that one is harder to find and almost always has a NAB EQ. The PR99 is about equally available in the 3¾ / 7½ ips version as in the 7½ / 15 ips version but also almost always with a NAB EQ.

There are two good reasons to look at the B77/PR99. First, the availability is pretty good for very reasonable prices. Many people may even have a standard B77 sitting around. But more important, the play back electronics, albeit based on 70's design philosophy, is well designed and makes use of high quality components. That is a significant advantage over pretty much every other consumer deck from that era.

In this article I will describe how to easily **convert a standard 3¾ / 7½ ips NAB B77 or PR99 into a 7½ / 15 ips playback only version with an IEC(CCIR) EQ for 15ips and a NAB EQ for 7½ ips.** All (eight) components necessary to make this conversion are already present in the machine, so no new components need to be procured. On the flip side, the recording function will no longer be available.

First some important general
remarks:

- If you do **not** live in North America you can stop reading this because the speed change won't work. - This modification requires the ability to desolder, remove, and resolder components from and to circuit
boards without damaging the parts or the circuit boards. You can view a tutorial on how to do this at http://tangentsoft.net/elec/movies/ . Practice on a circuit board from an old component or computer until you are confident that you have the skill to work on your tape machine circuit boards without damaging them. - An obvious one: There are no resistors you can change to convert a 4 track machine into a 2 track
machine, so you need to start from a 2 track machine. - The record function will only be disabled if you strip the necessary components from the record circuit
boards as described in this article. It is not necessary to disable the record function if you put in

new components, but the record EQs will not match with the new playback EQs. - This modification is valid for the ReVox B77, B77 mkII and the PR99. - **Some of the PR99 mkII and all of the PR99 mkIII versions use a different reproduce board. Modifications for those machines will be published later.** - This modification is also possible on the 'PR99 reproduce only', but only with new components

because there are no record circuit boards to strip the components off. Furthermore, the tape speed calibration as described in this article can not be carried out that way. - A very similar modification can also be done on the ReVox A77 mkIV, but not on the earlier revisions. Details for that modification will not be discussed here. - If you have one of these decks available for this conversion, just use it. However, if you still have to buy one, go for the B77 mkII version. The main reason is that ReVox changed component suppliers around that time and has been using high performance Beyschlag and Philips components in those later revisions. The improvement in audio performance is considerable because of that. - The exact appearance of the components on the boards can differ from unit to unit because over time different component manufacturers have been used. The values of the components and the placement on the boards will be the same, though. The pictures used here are of a B77mkII and a PR99 (mkI). The pictures of the boards are coming from either the B77mkII or the PR99 so the exact appearance of the components may not always link up in the pictures. - **Do not buy a PR99 over a B77 because of the balanced outputs !!** The balanced outputs do not

sound very good and will need to be by-passed for the best result, which fortunately is very easy as you'll see at the end.

**The
modification.**

Before starting the actual modification it is necessary to make a reference tape that will be used to recalibrate the tape speed after the modification is carried out. To make the test tape you need to have a

tone generator of some sort that can generate a stable and repeatable tone of preferably 1000Hz. Any frequency between 200Hz and 1000Hz will be OK as long as it is a stable and repeatable source. This can be in the form of a CD with test signals, for instance, or even better a tone generator for a PC. A very convenient and easy to use tone generator that runs on pretty much any PC can be downloaded as a free trial from the NCH Swift Sound Software website www.nch.com.au/tonegen .

**To make the reference
tape:**

- Before making the reference tape, make sure the machine has been switched on for about an hour so

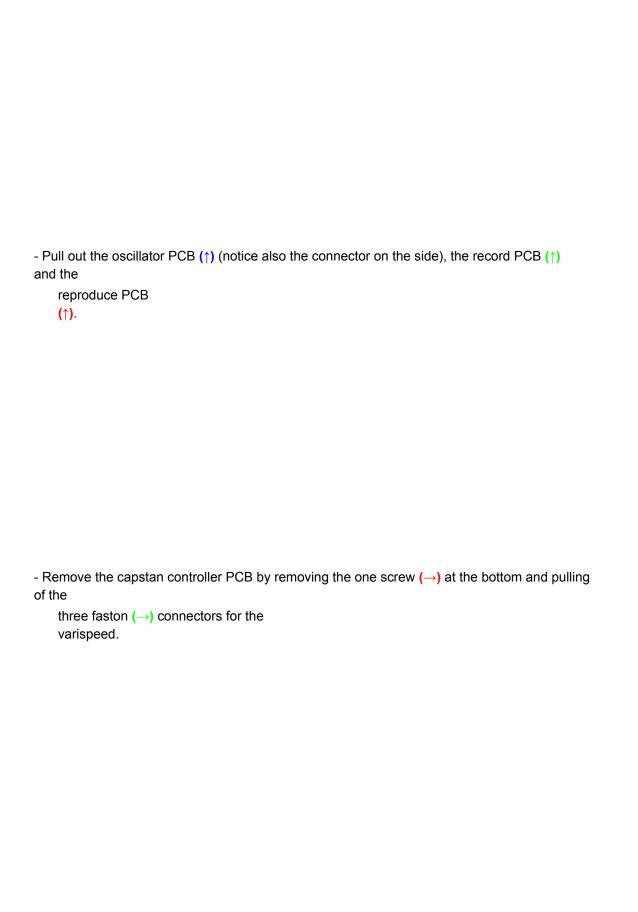that it has reached its normal operating temperature. - Set your B77/PR99 for a tape speed of 7 1⁄2 ips. (Make sure the varispeed is switched off for mkII and

III versions.) - Load a tape on the recorder. Preferably on 10.5" reels for better stability. - Record a 1000Hz tone on both channels at approx. –6dB. - Run the recording for at least 5 or 10 minutes, so you have enough time to do the speed re-calibration

later on. - Take the tape of the recorder and put it aside until the modification is carried out.

Now it is time to remove the cover of the deck and heat up your soldering iron.

- To remove the back cover put the deck face down on a soft surface. The carpet for instance. - Remove the four screws **(0)** from the back and lift the back cover/cage off the machine.

- Remove the bottom cover by removing the two screws **(0)** in the corner.

- Pull out the oscillator PCB **(↑)** (notice also the connector on the side), the record PCB **(↑)** and the

    reproduce PCB
    (↑).

- Remove the capstan controller PCB by removing the one screw **(→)** at the bottom and pulling of the

    three faston **(→)** connectors for the
    varispeed.

We will now do the modification for the tape speed. The capstan speed controller uses a so called Phase Locked Loop (PLL) circuit that locks the capstan motor rotation speed to a reference frequency. The reference frequency in this case is 800Hz. If we increase that reference frequency to 1600Hz, both tape speeds of the recorder will be doubled, changing it from a 3¾ / 7½ ips machine to a 7½ / 15 ips machine.

- In order to change the reference frequency to 1600Hz we have to remove the 4700pF timing capacitor

(0) and replace it with a 1600pF capacitor. - There is no 1600pF capacitor available in the record electronics of the B77/PR99, but there are two

> 3300pF **(0)** capacitors available on the record PCB **(↑)**. If we put them in series we get a 1650pF capacitor. That's close enough. The pictures below show where to find the 3300pF capacitors and how to put them in series on the correct location on the capstan controller board.

- Now plug the capstan controller board back in the machine and screw it back down to the chassis. - The speed modification is now done, but still needs to be adjusted using the reference tape you made

before ripping the machine apart (You did make it, didn't
you.)

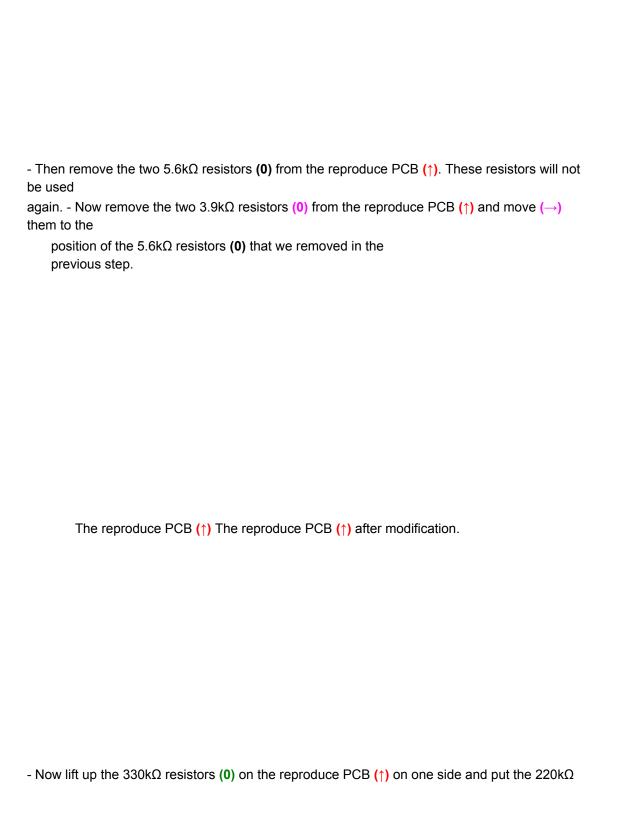We will now change the playback EQ on the reproduce amplifier
board.

- First we will remove some components from the record PCB **(↑)**. These components will be used on
the reproduce PCB **(↑)** to modify the EQ. - Remove the two 1kΩ resistors **(0)**, the two 680Ω resistors **(0)** and the two 220kΩ resistors **(0)** from the

record PCB
(↑).
    The record PCB **(↑)**. The modified capstan controller board.

- Then remove the two 5.6kΩ resistors **(0)** from the reproduce PCB **(↑)**. These resistors will not be used

again. - Now remove the two 3.9kΩ resistors **(0)** from the reproduce PCB **(↑)** and move **(→)** them to the

position of the 5.6kΩ resistors **(0)** that we removed in the previous step.

The reproduce PCB **(↑)** The reproduce PCB **(↑)** after modification.

- Now lift up the 330kΩ resistors **(0)** on the reproduce PCB **(↑)** on one side and put the 220kΩ

resistors

(0) we pulled from the record PCB **(↑)** in series with the 330kΩ resistors **(0)**. - Then take the 1kΩ resistors **(0)** and the 680Ω resistors **(0)** from the record PCB **(↑)** and put them in series to form 1680Ω resistors. Put these in the former location of the two 3.9kΩ resistors **(0)** on the reproduce PCB **(↑)**. - This completes the modification of the EQ.

Now a small modification will be done to improve the audio performance of the playback electronics. As mentioned earlier, the circuit design of the playback electronics of the B77/PR99 is quite good. However, the component choice of at least two capacitors in the playback circuitry is quite poor. Fortunately we can replace these two capacitors by two real good quality capacitors found on the oscillator PCB **(↑)**.

- Remove the two 220pF polystyrene capacitors **(0)** from the oscillator PCB **(↑)**. - Remove the two 100pF ceramic capacitors **(0)** from the reproduce PCB **(↑)**.

- After removing the two 100pF ceramic capacitors **(0)**, replace them with the two 220pF polystyrene

capacitors **(0)** from the oscillator PCB **(↑)**. Since the two 220pF polystyrene capacitors **(0)** are quite a bit bigger, it is easier to solder them on the bottom of the PCB. *(The function of the two 100pF ceramic capacitors **(0)**, is to keep the output amplifiers stable. Replacing them by 220pF will reduce the maximum frequency of the output amplifiers from 1.4MHz to 630kHz. Still way higher than you'll ever need, since the maximum frequency via the tape will be around 30kHz at 15ips (24kHz at 7½ips).)* - An additional improvement to the audio performance can be achieved by removing two transistors **(0)** . These transistors are used to mute the output signal during 'fast forward' and 'rewind' or when the

- Now it is time to put the reproduce PCB **(↑)** back into the machine. Be careful to put the pins in the correct sockets. (It is very easy to put the PCB in the sockets with all the pins one position shifted.) - Since the oscillator PCB **(↑)** and the record PCB **(↑)** are no longer functional and to protect your tapes

against accidental erasure, do not put these two PCBs back in the machine. - Put the bottom cover back in place and reassemble the two screws. (The plug-in PCBs all have to fall into the respective notches in the bottom cover to keep them in place. You may have to wiggle the PCBs a little to make them fall in place.) - Do not put the back cover on yet, because the tape speed still has to be calibrated.

Tape speed
re-calibration.

The capstan motor of the B77/PR99 is a synchronous AC motor. That means that the maximum motor speed is determined by the frequency of the AC power from the wall. In the US where the AC frequency is 60Hz, the maximum tape speed you can achieve with a standard B77/PR99 is approximately 16ips. Just enough to meet the 15ips we are looking for. In pretty much the rest of the world, the AC frequency is 50Hz, which corresponds with a maximum tape speed for a standard B77/PR99 of 13.3ips. So, no chance there to ever get to 15ips.

Lower speeds than the maximum speed are achieved by allowing the motor to magnetically (not mechanically) slip from that maximum speed determined by the AC power frequency. Since 15ips is not much lower than 15.5ips it would be beneficial to have as much power available to regulate the speed reliably to 15ips. The AC voltage in the US normally lies in between 110Vac and 120Vac. The voltage selector of the B77/PR99 is normally set for 120Vac, which means that it runs below nominal voltage in most cases. For reliable 15ips operation I would strongly recommend to put the voltage selector of the B77/PR99 at 100Vac. Even at AC voltages as high

as 125Vac, there is no risk in setting it for 100Vac.

- Move the voltage selector at the back of the machine from 120Vac to 100Vac. (Unplug the power cord
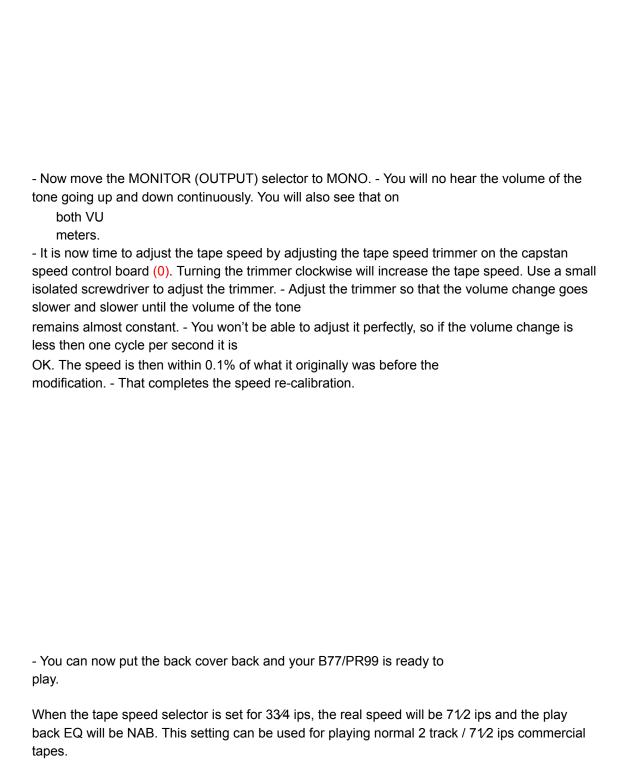   before changing the voltage
    selector !!)
    tape is stopped. By removing these transistors you will hear sound during 'fast forward' and 'rewind', but since the tape is lifted from the heads in that case the residual sound is not very loud.

The speed re-calibration will be done by mixing the recorded test tone together with the original tone coming from the tone generator. When two tones of slightly different frequency are mixed together, the result will be a tone that goes up and down in volume in a continuous wave. The closer the two frequencies are, the slower the interference wave.

- Now plug the AC cord in and switch the machine on. (It is again better to run the machine for an hour
or so to bring it up to normal operating temperature.) - Set the tape speed selector on 3¾ ips. Because of the modification the machine should now actually
run at 7½ ips. - Connect your 1000Hz generator to the AUX (LINE) inputs of
your B77 (PR99). - Put the test tape you made earlier on the recorder. - Set
the MONITOR (OUTPUT) selector at STEREO. - Set the MONITOR
(OUTPUT) switch to INPUT (INPUT/SYNC). - Set the RECORD LEFT
(INPUT CH1) at AUX (LINE). - Set the RECORD RIGHT (INPUT CH2) at
L→R (CH1→CH2). - For PR99 only, switch the UNCAL on (red) - Adjust the
LEFT (CH1) INPUT LEVEL knob to –6dB on the left VU meter. - Now start
the test tape. - Adjust the RIGHT (CH2) INPUT LEVEL knob to –6dB on the
right VU meter.

- Now move the MONITOR (OUTPUT) selector to MONO. - You will no hear the volume of the tone going up and down continuously. You will also see that on

    both VU

    meters.

- It is now time to adjust the tape speed by adjusting the tape speed trimmer on the capstan speed control board (0). Turning the trimmer clockwise will increase the tape speed. Use a small isolated screwdriver to adjust the trimmer. - Adjust the trimmer so that the volume change goes slower and slower until the volume of the tone

remains almost constant. - You won't be able to adjust it perfectly, so if the volume change is less then one cycle per second it is

OK. The speed is then within 0.1% of what it originally was before the

modification. - That completes the speed re-calibration.

- You can now put the back cover back and your B77/PR99 is ready to
play.

When the tape speed selector is set for 33⁄4 ips, the real speed will be 71⁄2 ips and the play back EQ will be NAB. This setting can be used for playing normal 2 track / 71⁄2 ips commercial tapes.

When the tape speed selector is set for 7½ ips, the real speed will be 15ips and the play back EQ will be CCIR. This setting can be used for playing the Tape Project tapes.

Just one more important remark with respect to the PR99. Where in the B77 the signal from the reproduce amplifier goes almost immediately to the output RCAs, in the PR99 the signal first goes through several opamps, potmeters, relays, transistors and transformers before ending up at the output XLRs. All those components have a negative effect on the sound quality that is quite audible in the form of typical semiconductor and transformer colorations.

The good news is that the signals that come straight from the reproduce amplifier are available at the MONITOR output connector of the PR99. At that point you will get the same sound quality as from de B77. Even though the MONITOR connector is a 7-pin DIN, you can use a normal 5-pin DIN because of the pin out of the MONITOR connector.

GN
D

Right

Left

So how does it sound?

As mentioned earlier the stock electronics of the B77/PR99 and especially those of the later MKII and MKIII revisions are about the best you can get in semi-professional tape decks from that era (late 70's until the early 90's). The two modifications (the polystyrene caps and the muting transistors) will bring the playback performance up to an even higher level.

Listening to the TP tapes, it immediately becomes clear that the coloration, or better the lack thereof, reaches a level that is almost unmatched by any digital (CD,SACD,DVDA) or analog (Vinyl) medium. Also the dynamics immediately stand out as exceptional. The large three dimensional soundstage reminds me of the best vinyl playback I've heard but without the restless background noise and the filthy colorations at the sides of the soundstage that are virtually unavoidable with the vinyl medium.

When compared to my Studer A810 with fully custom tube playback electronics, it becomes clear that the modified B77/PR99 is still not completely clear from solid state coloration. And even though the soundstage on the A810 is not much larger than on the B77/PR99, the focus and

stability of the instruments and the air around them are still noticeably better on the A810.

So for those of us that do not have a $20,000 CD player or a $30,000 vinyl playback system, these Tape Project tapes on the modified B77 or PR99 as described in this article will provide a whole new level of audio performance for a very reasonable price. The modified B77 or PR99 will also be able to get close to the maximum out of your 7½ ips 2 track pre-recorded R2R tapes.