

LinkRF



UADC4

4-ch Universal Analog to Digital Converter

User Manual v2.0

Jan. 2019

INTRODUCTION

Congratulations on purchasing a new dedicated ADC for ZERO IF receiver.

The UADC4 is the result of a long period of research and testing, as a dedicated ADC was needed to replace the obsolete PC Audio Cards used for years as a pseudo ADC. It combines state-of-the-art components and design, extensive hours of simulations, several prototypes and hundreds of tests to reach peak performance.

For years, ZERO IF receivers used, with acceptable results, PC sound cards to do the ADC conversion. However, audio cards have limitations in this use. This limitation slowed down the development of better IQ mixers due to the fact that PC sound cards had extraordinary performance (from the SDR perspective) in just 20KHz of BW -- the limiting BW of our ears.

With the UADC4, improvements in IQ mixer performance will be possible.

The big advantage to using the UADC4 is its extremely low noise floor, when most of the audio cards combined with IQ mixers produce a combination with a noise floor near -140dBc/Hz (@ 1KHz BW) or worse. The integration of the IQ+ and the UADC4 moves the noise floor to an outstanding -163.0dBc/Hz (@1KHz BW) in EXT mode.

I don't need to explain you the advantages of having a lower noise floor in your receiver chain, especially today where day-by-day our ham bands are polluted by manmade noise.

Just to give you an example, again with the IQ+ (properly modified to host the UADC4) your saturation point will move from -26dBm to a -8.8dBm. This means the IQ+ will be able to tolerate signals 17dB stronger than the previous systems based on PC sound cards. Unfortunately, the laws of physics do not allow us to claim the full theoretical 17dB. Mitigating factors such as phase noise in the local oscillator and the intrinsic characteristics of the LT5517 IQ demodulator limit this improvement to a 12dB! The UADC4 highlights the limitations of existing IQ mixers, and in the near future, when better designs appear in the market, we will be able to claim another 8 to 10dBs more in performance.

For the moment, the UADC4 is increasing your RX performance considerably, but keep in mind it has embedded more room for improvement because now the limiting factor is no longer the ADC conversion, it is the mixer and your LO, and we are working on that.

I want to extend my public gratitude to Leif Asbrink SM5BSZ and George Boudreau from Yoyodyne Consulting. Both dedicated hundreds of hours to test, criticize and improve our design and concepts. Without their valuable collaboration, the UADC4 will not exist.

73 de Alex, HB9DRI

! WARNING!

***DO NOT PLUG YOUR UADC4 BEFORE
INSTALLING THE WINDOWS DRIVER***

(ignore for Linux and OS)

***IF YOU PLUG YOUR UADC4
BEFORE THE WINDOWS DRIVER
IS INSTALLED, YOU MUST REPAIR
THE SET-UP PROCESS IN A VERY
TEDIOUS AND COMPLICATE PROCESS.***

***READ THE MANUAL AND
DON'T PLUG YOUR UADC4 IN
A WINDOWS BOX IF THE
DRIVER IS NOT SET UP FIRST!!***

!WARNING!

TOPICS

- 1.- Architecture description
- 2.- Specifications
- 3.- Configuring your UADC for optimal input level
- 4.- Electrical installation, base band cables, DC and Ground
- 5.- Interface the IQ+ revA and revB, modifications needed
- 6.- Interface a Softrock, LP-PAN, modifications needed
- 7.- Interface WSE units, modifications needed
- 8.- Setup Drivers for Windows 7, 8, 8.1 and 10
- 9.- Setup for Linux and OS

1. ARCHITECTURE DESCRIPTION

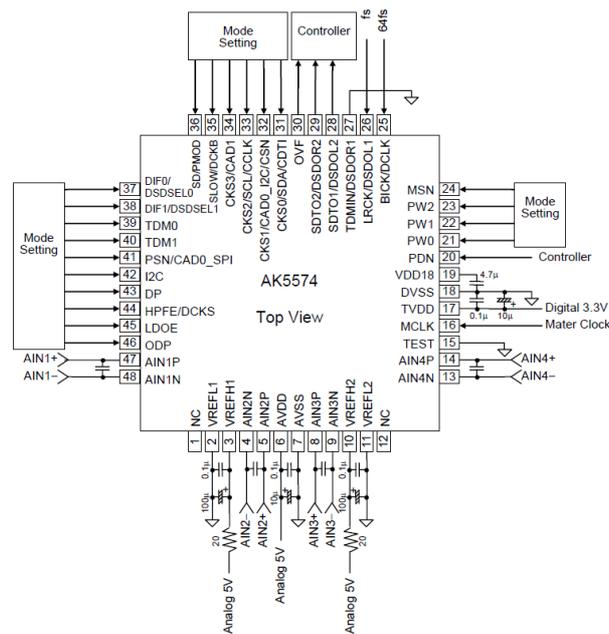
As I cannot build ADC chips, I was forced to evaluate what the market can deliver and select the best one for our purposes.

The use of FPGA chips was discharged due the complexity and cost.

I reduced the number of candidates to the following four companies:

- Analog Devices
- Texas Instruments
- Linear Technologies
- Asahi Kasei Microdevices

I choose Asahi Kasei Microdevices (AKM), who has proven experience in ADC chips with outstanding audio performance. The selected chip, the core of the UADC4, is the AK5574: 4-channel, differential input, 32bits $\Delta\Sigma$ ADC up to 768 KHz sampling capable of deliver up to 121dB DNR in the single channel mode and up to 127dB in 4-to-1 configuration.



I decided to use the AK5574 based on its flat response above 20 KHz (where most of the audio chips have a terrible rollup in the noise floor). Compared with other ADCs, the AK5574 has a good flat response above 40 KHz up to 96 KHz. After that increase, the noise floor rolls up fast to 192 KHz. Above 192 KHz, the chip suffers the same flaws as other brands, which means that the noise floor is no flatter.

Certainly, the use of a preamp in front of your SDR receiver and the proper Linrad calibration will compensate for lifting of the noise floor at the extreme ends, but I was looking for a device with better characteristics in its native configuration.

The AK5574 can select the sampling speed without any special programming. The chip locks its sampling speed according to the software request you are using to open the data stream. In my example, Linrad opens different sampling speeds up to 192 KHz with no problems; also MAP65 opens data stream at 96 KHz with no programming intervention, HSDR in the same way. The output data format supports in PCM mode 24/32-bit MSB, justified, I²S or TDM; in DSD mode, it supports DSD native 64, 128, 256.

Additionally, the AK5574 has internal anti-alias filters. Compared with other chips, those filters have a good response. You can configure the PCM roll-off filter response with one jumper between sharp and slow roll-off and you can configure the PCM digital filter delay between short and normal. In the best configuration, at $f_s=96$ KHz, the passband is selected at 48.8 KHz with -82dB Stopband attenuation @55.7 KHz.

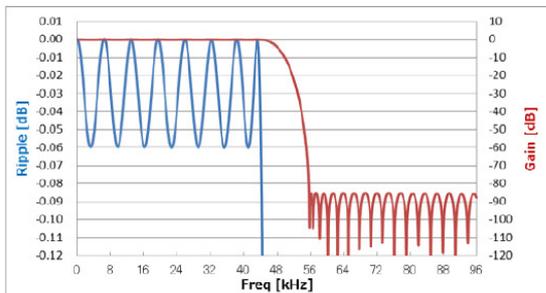


Figure 7. SHARP ROLL-OFF ($f_s= 96$ kHz)

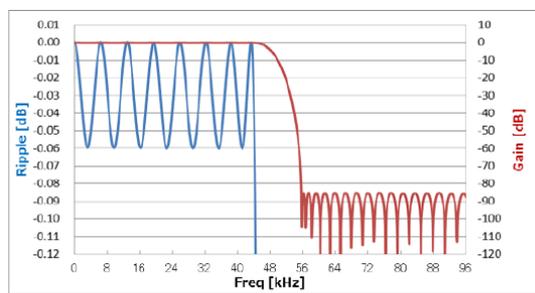


Figure 9. SHORT DELAY SHARP ROLL-OFF ($f_s= 96$ kHz)

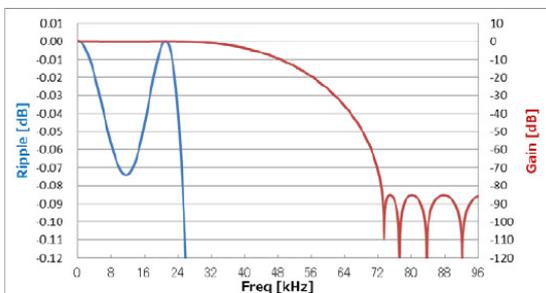


Figure 8. SLOW ROLL-OFF ($f_s= 96$ kHz)

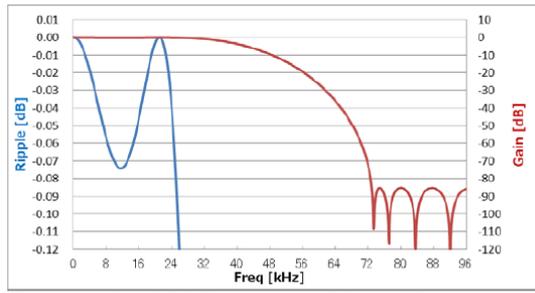


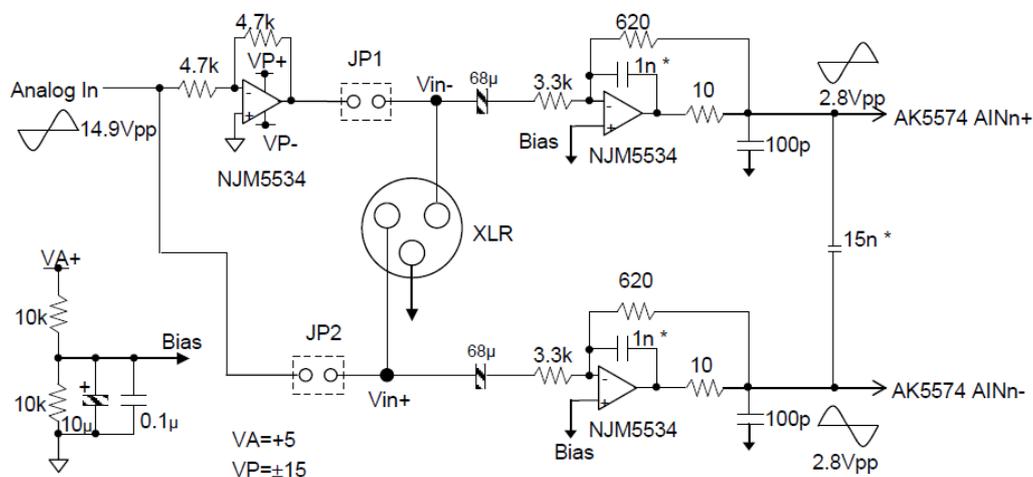
Figure 10. SHORT DELAY SLOW ROLL-OFF ($f_s= 96$ kHz)

1.1 THE BUFFER STAGE by THE MANUFACTURER

After the ADC chip was selected, I tried to understand why almost all ADC chips available for that frequency suffer from asymmetrical noise floor. I did measurements in many audio cards with different ADC's and I discovered peculiar buffer stages in the input.

Independent of the internal configuration of those chips, where they concentrate on perfect response in just 20 KHz, the buffer stage has a lot to do with the final performance.

Looking into the manufacturer's documentation, this is the buffer stage proposed for the AK5574 in the data sheet:



This buffer stage is not suitable for our purposes. It is okay for audio and music but has many pitfalls for SDR applications.

- The NJM5534 is an opamp with an input noise voltage of $3.3\text{nV}/\sqrt{\text{Hz}}$; this can be improved with a better opamp.
- The AK5574 needs differential input but this buffer is not really a differential amplifier. I did hundreds of hours of simulations in LTSpice, and the output amplitude of this configuration has asymmetric amplitude in the range of 80 mV when measuring pins AIN+ and AIN-. To properly feed the ADC, both signals need to have the same amplitude; no differences are accepted in this respect.
- The first opamp causes a delay in the signal. As you see, when JP1 and JP2 are in place, the output of the first opamp goes to the input of the AIN+ opamp, the third opamp receives the signal without any active device, direct from the input source. Even if the first opamp has its source and feedback resistors in a ratio of 1:1, there will exist a delay in the signal, something unacceptable for a SDR application.
- The values proposed for the source and feedback resistors are too high. The higher the values, the higher the noise caused by the resistor (thermal noise), but it looks like the noise produced there is still within the parameters of what is acceptable for audio applications, but not for SDR.

- Last but not least, this pseudo single-end input to differential buffer has no limiting control in the input. It is assumed the designers would add some kind of potentiometer or digital resistor in the input to control the amplitude from the front panel or via software. The +/-15vdc supply to the opamps allows a rail-to-rail output swing that will damage or destroy the ADC. You can add an amplitude control at the input, but this will add more noise to this already noisy buffer.

1.2 THE UADC4 BUFFER STAGE

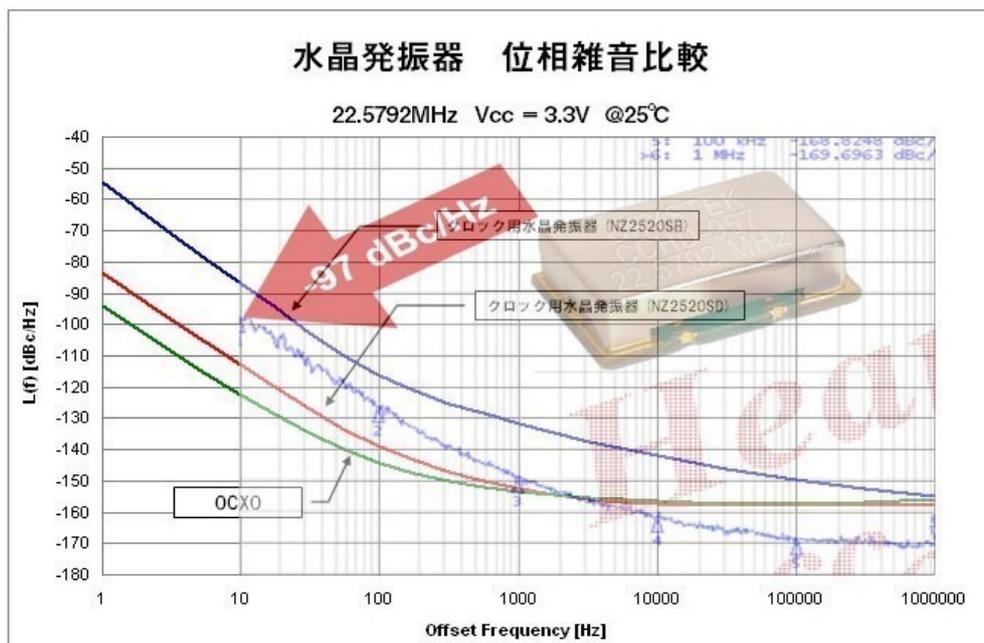
To correct the problems in the buffer stage I decided to build a completely new buffer suitable for our SDR demands:

- I discarded the NJM5534 opamp and selected two new devices from Linear Technologies with an input noise voltage of just $1.0\text{nV}/\sqrt{\text{Hz}}$
- The first device works as a limiter to avoid any possible ADC destruction due to an excess of amplitude level.
- For the second opamp I selected a "real" differential amplifier to correct the asymmetric output and incorporated an LPF in the design to reduce frequencies above 100 KHz
- Feedback resistors and source resistors are **selected** to reduce the noise caused by those resistors.
- The resistors are high-quality parts with tolerances expressed in ppm; the tolerances here are better than 0.2%
- Avoid the use of any kind of potentiometer or digital resistor to control the input amplitude. Instead of those noisy elements (very common in PC audio cards), I deployed a very simple set of jumper matrix to accommodate input values from 0 to 14 Vpp in 6 steps.
- To set up the proper input gain, the user will hardwire the input using jumpers and close the unit. For example, with the jumper in position 1, the maximum input will be 3.5 Vpp, producing 2.8 Vpp in the output buffer. If more level is applied in that configuration, the first opamp will saturate. The signal will be distorted, but the amplitude introduced to the ADC will never exceed the 2.81 Vpp, preserving the ADC from any damage.

1.3 THE USB I2S CLOCK

The USB interface uses a very precise and low jitter clock to generate the I2S signals. One common problem with PC soundcards is the clock quality. Normally the clock units are very cheap oscillators with very high phase noise and poor stability -- not so critical for music, but very critical to keep the reciprocal mixing as low as possible in your SDR. Everything with a phase noise high than -130dBc/Hz @ 1KHz is not good enough to keep reciprocal mixing as low as possible.

The DIYINHK XMOS card uses the NDK NZ21520SD Ultra low phase noise oscillator.



1.4 The ADC

The selection was rigorous, and different candidates were tested. The AK5574 from AsahiKASEI met all my expectations, especially with respect to the flat response, beyond the traditional 20KHz umbral, up to 96KHz. The noise floor response is very flat with and small increase up to 192KHz. At the beginning of this document, I noted the most relevant information.

If you want to read detailed information about the AK5574, here is the link:

<https://www.akm.com/akm/en/file/datasheet/AK5574EN.pdf>

1.5 Internal power supplies

The UADC needs different voltages to work properly. The unit is fed with 11 to 14.5VDC, but internally, different voltages are fed to the different stages. Linear regulators were not in consideration due the high noise they produce at different frequencies.

The voltage regulators are switching style and based in very well tested circuits in ADC conversion by "Linear Technologies". The use of switching regulation is not easy, but when it is well implemented, they deliver good level of current with almost no noise. ADC systems are sensitive to ripple and high oscillation noise coming normally via the DC path. That condition demands the use of high-quality capacitors with extremely low ESR and properly inductors on the switching oscillators. Additionally, each DC path is decoupled to the respective ground plane to avoid artifacts via the DC path.

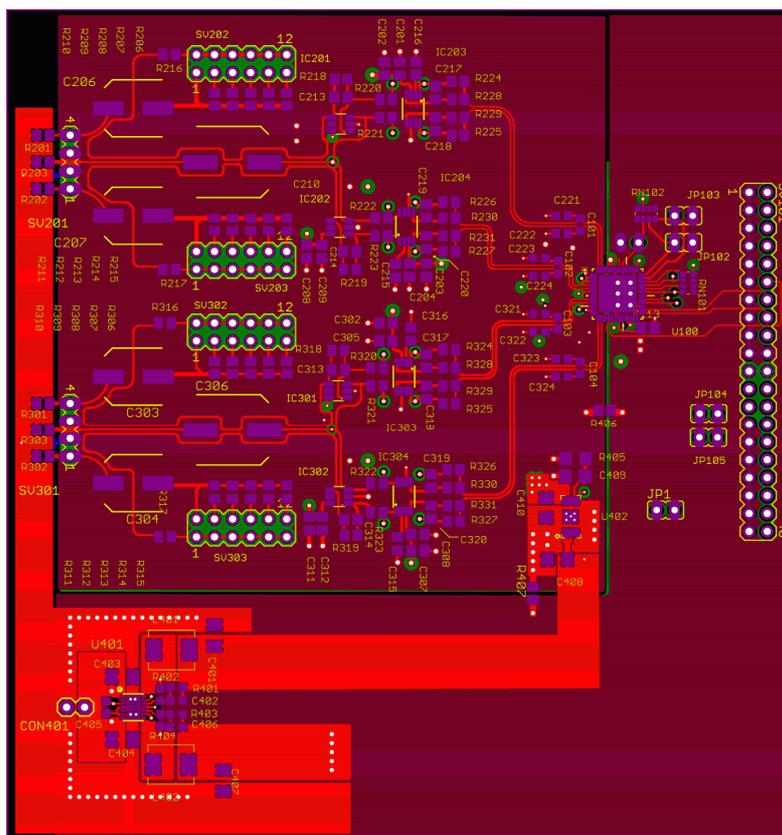
The DC decoupling demands a rigorous separation between the different grounds planes to avoid mixing the digital ground with the analog ground. This separation translated into a mandatory separate ground on the PCB, and the result is a pcb design with four layers and not two, as most of the consumer audio cards are using.

1.6 The PCB layout

Creating a PCB is as much an art as it is a science. Designing a data acquisition card with low noise requires extra attention be paid to layout as well as component choices. At the heart of the UADC4 is the AK5574. Starting with the manufacturers recommendations, the design evolved as performance roadblocks were tackled. Paramount was the separation of low voltage analog signals and fast rise time digital clocks. This mandated separate power and ground planes for analog and digital signals. The ground planes were connected at single point at the switching supply. As a point of interest, 3 connection points were placed on the PCB. Between these points there was almost 2dB reduction in the noise floor.

One of the most difficult problems to resolve was the "magnetic" interaction between traces. Poor isolation will cause crosstalk between traces, reducing the channel separation and increasing dramatically the reciprocal mixing in the SDR. This is one of the most common problems with PC audio cards and why they don't reach high level of performance.

This magnetic induction is very sensitive and complicated to reduce, especially in the input buffer. Just moving a capacitor a few millimeters in one direction could change for better or worse the performance by several dBs.

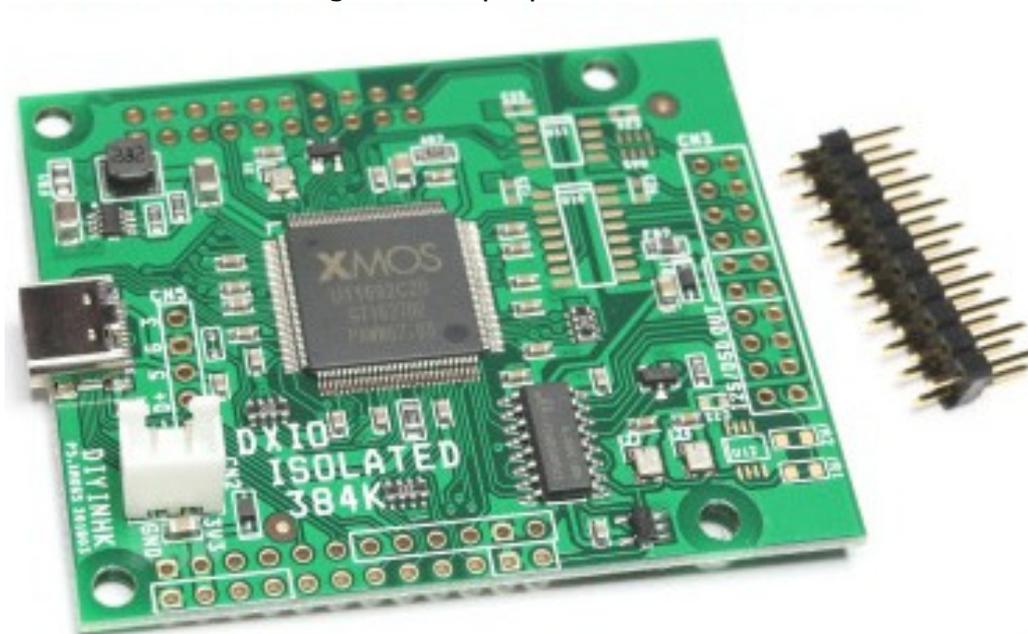


1.7 The XMOS USB interface

The XMOS USB UAC2 card by DIYINHK was a convenient interface and reduced the amount of development time by focusing on the acquisition and not spreading resources on the ADC and the USB interface.

The DXIO32ch produced by DIYINHK is based on the XMOS XU216-512, with 2000MIPS in dual-tile mode. It can work up to 384KHz with an incredible performance and "ZERO" impact on the signal quality. Just request USB.2.0 and the driver delivers, with the board allowing up to 4 analog channels up to 384KHz, 6 channels up to 384KHz in I2C, and up to 8 analog channels with the properly firmware.

We just plugged the XMOS board into our prototypes and the digital stream from the ADC was introduced in the PC without investing time and money in a proprietary design. The board is delivering with the proper ASIO driver.



2. SPECIFICATIONS

I will give the UADC4 specifications working with IQ+ revA, revB, revC, WSE front-end units and the UADC4 working with a popular M-Audio Quad Track PC sound card.

For the IQ+, I provide 3 levels of specifications --Standard (STD), Extended (EXT) and no modifications at all -- that helps to compare and understand how much some parameters are affected under the presence of the front-end unit and how optimization is a hard trade-off between all parameters.

Understanding some terms:

A) **-1dBFS:** The signal is placed at -1dB BEFORE saturation happens; at 0dBFS the ADC clip abruptly. Mixers respond different. They saturate, gradually destroying the linearity of the RX chain and affecting the overtone response, especially the 3th overtone and the IQ image rejection. This is the most difficult part: where to place the maximum signal input level to obtain maximum performance without entering into compression.

B) **Noise floor (@1KHz BW and -1dBFS):** After calibrating the power meter to read 0dBm at -1dBFS and switching off the carrier, the noise floor is obtained without considering the reciprocal mixing in a BW of 1KHz. Some people prefer to adjust the reference level at the same saturation level, then when the carrier is off, they subtract from the value obtained the saturation level to obtain the noise floor with the front end unit connected. This is an indirect method and introduces some distortions in the numbers, because people try to round numbers, sometimes a little up, sometimes a little less. I prefer to adjust my gear at -1dBFS, as a ZERO on my power meter; then my readings are direct without any deviation.

C) **MDS --Minimum Discernible Signal:** According to the ARRL specifications: MDS is the level of the signal input to the receiver that will produce an audio output where the power in the signal is equal to the power in the noise ($S + N = N + 3dB$) in a BW of 500Hz. It is also known as a noise floor but at that BW (500Hz).

D) **Reciprocal mixing:** I obtained readings of the noise floor increment at a 20KHz separation from the carrier adjusted at -1dBFS with a BW of 1KHz. The increment on the noise floor at that point with respect to the noise floor without a carrier is the reciprocal mixing at 20KHz separation from the carrier in @1KHz BW. My signal generator (Marconi 2040) and most signal generators have too much phase noise. Instead, I used a W6PQL Xtal oscillator at 144.1 MHz. This oscillator has a very good phase noise, probably not ultra-low noise, but enough for my test. To have the cleanest signal possible, I passed the output through an 8-pole Xtal notch filter. The notch has 70dB attenuation and just 1KHz BW. That allowed me to see the real noise-floor increment.

E) Effective Dynamic range is the available dynamic range after removing the increment of noise floor produced by the reciprocal mixing 20KHz away from the carrier in a BW of 1KHz. Many people confuse Dynamic range with the amount of dBs available when you switch on/off the carrier, and this is wrong. Phase noise in local oscillators and poor engineering will make the noise floor increase several decibels, reducing the theoretical dynamic range available. The better your RX system, the less reciprocal mixing masking your effective dynamic range.

F) Overtones and IQ image rejection are inevitable. Normally, the third overtone is the most aggressive. After that, overtones roll down gradually until they disappear.

Overtone levels are a good indicator of how linear our system is working, especially the IQ mixer. It will show a gradual increase and at certain point an abrupt increment, making evident the non-linearity. The IQ image rejection is greatly affected by overtone levels. Thus, a good practice for limiting the saturation point is to place the image signal below the third overtone. Otherwise, any IQ image rejection calibration will fail, with the consequence of poor response and dirty passband.

UADC4 PERFORMANCE WITH SOME FRONT-END MIXERS

(UADC4 Noise floor without Front-end mixer = -133.4dBm or -163.4dBc/Hz @1KHz BW and -1dBFS)

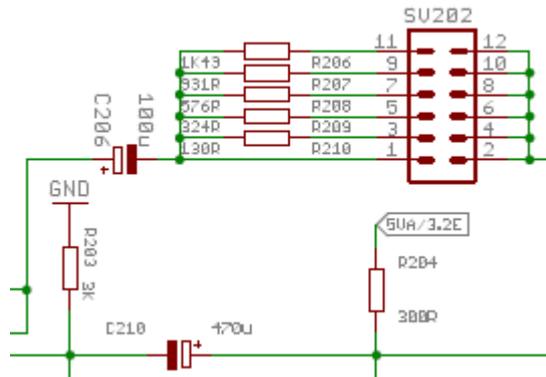
Order of Merit	Front-End + ADC	Saturation @-1dBFS (dBm)	Noise Floor @1KHZ BW -1dBFS (dBm)	MDS @500 Hz BW -1dBFS (dBm)	NF (dB)	Reciprocal mixing @20Khz from carrier BW 1KHz -1dBFS (dBm)	Effective Dynamic Range (dB)	3th overtone (dB) or better	Image rejection (dB) or better	OBSERVATIONS
1	WSE+UADC4	-9.0	-126.0 (156.0 dBc/Hz)	-129.0	18.0	2.3	123.7	-80	-80	With 10dB attenuator in the RX2500 input
2	IQ+revA,B,C (EXT) + UADC4	-8.8	-124.8 (154.8 dBc/Hz)	-127.8	19.2	5.0	119.8	-53	-43	Very good noise floor and EffDynRange but bad overtone and Image rejection response
3	IQ+revC (STD) + UADC4	-16.2	-120.5 (150.5 dBc/Hz)	-123.5	23.5	5.0	115.5	-63	-63	Mixer still lineal. Better noise floor than WSE+Delta44, or other sound cards
4	IQ+revA,B + UADC4	-26.0	-112.0 (142.0 dBc/Hz)	-115.0	32.0	5.0	107.0	-55	-55	IQ+ UADC4 same as a combo with a good PC sound card (EMU1616PCie)
5	IQ+revA,B + M-Audio-QuadTrack	-26.0	-109.3 (139.3 dBc/Hz)	-112.3	34.7	5.5	103.8	-50	-50	Suffer from asymmetric gain and Image rejection cal. is poor, also some glitches with strong signals.

Jan.2019

3. CONFIGURE THE UADC4 FOR OPTIMAL INPUT LEVEL

The UADC4 has no variable input level controls, no VGA, potentiometers or digital resistors. The reason for that is those elements introduce thermal noise -- very useful in sound cards but not at all for ADC in SDR applications.

Nevertheless, we must control the input level to avoid saturations in the ADC. For that, the UADC4 has internally a "jumper matrix" with 6 different positions. This allows us to match base band sources from 0 to 14Vpp in 6 steps. There are 4 "jumper matrix", one per channel, each IQ pair need to be setup at the same input level.



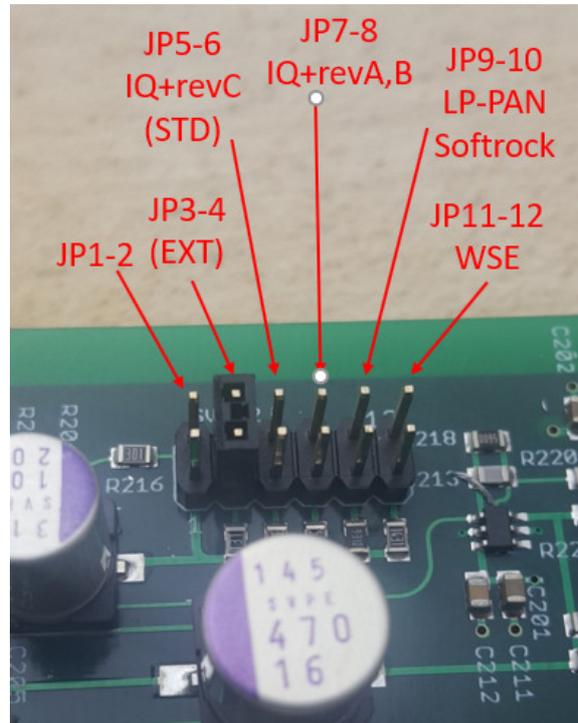
In the diagram, you can see the jumper matrix has 6 positions. Each position adds a resistor with different values to fit different levels. The following table summarizes the optimal jumper selection for a number of front-end units.

Jumper positions	Resistor value (ohms)	Front-end	Obs.
1 – 2	0R	customized	Read Note 2
3 – 4	130R	IQ+revA, B, C	Extended mod.
5 – 6	324R	IQ+ revC	Standard mod
7 – 8	576R	IQ+ revA, B	No mod.
9 – 10	931R	LP-PAN, Softrock	
11 – 12	1.43K	WSE	Read Note2

Note 2: For WSE converters, the jumper position (11–12) provides excellent performance. Post testing demonstrates that the 1.43K ohms resistor can be increased up to 2K ohms, which will improve the noise floor with the WSE units by 1.5dB. If the user wants to claim that extra performance, they can build a small inverse jumper with a 2K ohm resistor solder on the opposite pins and install that "jumper resistor" in position (1–2)



In the next photo, you can see how the jumper matrix looks. Follow that photo and the previous table to jumper your UADC4 according to your front-end.



NOTE: The position JP1-2 has no limiting resistor. It's used for very low input voltages (1.0Vpp or less) or to install a custom jumper with specific values (like for WSE) to fit your requirements. If you select position one and over-drive the input, you could damage the UADC4

To properly set up your UADC4, remove the 4 black screws in the back plate. The back plate attached to the pcb will glide off the case. Take care and follow standard anti-static proceeds. All active elements inside, especially the ADC chip, are sensitive to static discharge. Jumper the 4-jumper matrix according to your requirements and reassembled the UADC4. Nothing else is required. Your UADC4 now is ready for your front-end mixer.

4. ELECTRICAL INSTALLATION, BASE BAND CABLES, DC AND GROUND

The UADC4 must be installed in a place as near as possible to your front-end mixer (IQ+, WSE, Softrock etc.). Avoid a long run for the base band cables.

Power Supply: 10 to 14VDC (250ma). The normal current consumption is approximately 110ma, but the switching voltage regulators inside require a peak of high current to start and then stabilize to the fixed voltage. For that reason, it's good practice to double the size of the maximum consume. Avoid the use of DC wall adapters due to the bad filtering and low stability they have.

It's very important to run a ground cable from the UADC4 to the case of your front-end mixer. If both devices share the same DC power supply, maybe they are sharing the ground via, the negative line. BUT even if they share, it's recommended to add a dedicated ground cable from the chassis of your front-end mixer to the ground connection in the UADC4. That connection will lower the noise floor and eliminate some hum (50/60Hz) coming from the AC home network.

Do not install your unit near a switching power supply, wireless cameras, LED lamps and computer monitors. The chances that you will receive interference from such devices are very high. In some case, you will need some ferrite in the DC cables.

Do not ground the shield of your based band cables. They are floating respect to ground.

For optimal work, limit the distance of the based band cables to 1.5 meters. But if you can run short cables, do it. Then the opportunity to pick up interference will be reduced drastically. The longer the cables, the higher the chances are to pick up magnetic noise, even with good cables.

Note about Ground Loops: They are present everywhere and they are difficult to identify and cure. A ground loop will create hum noise, bumps, and even higher noise floor in your pass band. Ground loops can occur when an electrical system is connected more than one way to the electrical ground. Follow the best practice of grounding in your station and avoid/eliminate ground loops and current flows for a much quieter pass band.

5. SETUP THE IQ+ revA, B, MODIFICATIONS NEEDED

Interfacing an unmodified IQ+revA or B to the UADC4 will produce a small increment in performance (see performance table). This setup will work almost at the same level as an IQ+ and a PC sound card. The reason for the minimal change is the UADC4 has a much lower noise floor while PC sound cards have much higher noise floor.

To overcome the high noise floor in PC sound cards, the IQ+ revA, B gain was set very high. With the quieter UADC4, this excess gain is unnecessary. The modification we are looking for is to reduce the excess of analog gain in the output Opamp in your IQ+. I will present two modifications, **Standard** and **Extended**, (see performance table to see differences).

Standard Modification: This will convert your IQ+revA, B in a revC. New shipments of the IQ+ will be at the revC level. The standard modifications are a good balance and trade-off in the different parameters creating a balance front-end - ADC.

Extended Modification: This can be applied to any revision level of the IQ+. It creates a superb performance response in the noise floor and dynamic range, BUT the cost an inferior overtone response and image rejection.

You must decide what is more suitable for you. I would recommend keeping your IQ+ as a revC, meaning "Standard". In that configuration, you will have a reduced noise floor and greater effective dynamic range than your previous configuration without risking overloads and bad overtones resulting in reduced image rejection.

If you decide to go for the "Extended" modification, you must accept worse third overtone response and mediocre Image rejection. The Extended modification is only suitable for extremely quiet antenna locations. That system will be very sensitive to overloads. If a strong signal reaches your pass band, it will have extraordinary sensitivity.

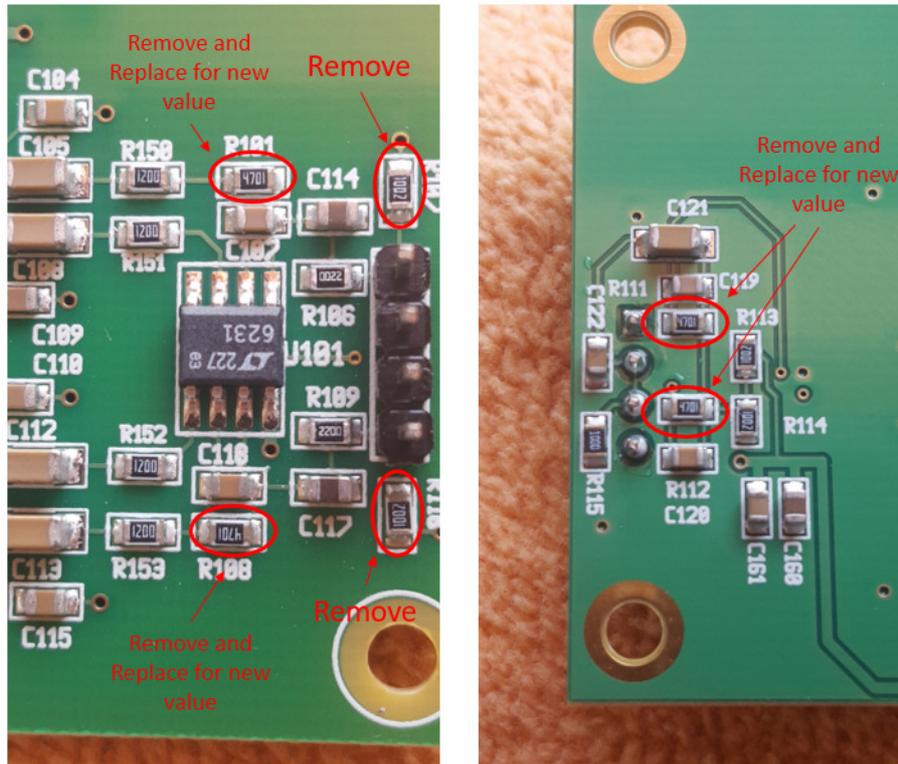
Performance is a trade-off. I give you the options with pros and cons; you decide! The IQ+revA and B have a voltage ratio of 39 equivalent to a 32dB gain in the analog amplifier. We must reduce that gain to claim more performance from the UADC4.

To modify your exiting IQ+revA, B, you must do the following steps:

- Remove R107 and R110 (10K) resistor and leave empty
- Remove R101, R108, R111 and R112 (4.7K) and replace for new values according the next table:

Modification	R101, R108 R111, R112	New Voltage Ration	New analog Gain in (dB)
IQ+revA,B to revC "Standard"	1.8Kohms	15	23.5
IQ+revA, B, C to "Extended"	560 ohms	4.6	13.3

In the next pictures, you can see both sides of the RX PCB with clear indications about the resistors needed to be removed and/or replaced.



When you dismantle your IQ+, you MUST take note of the correct position for the cables going into the RX boards. The boards have no reverse polarity protection. If you swap the small connectors, you will irreversibly damage the RX boards. Take a note about the position of the output connector. If you swap, your I and Q output will be reversed.

The resistors are SMD type with a 0805 size. They are available in low quantity. Price will depend on the precision. 1% is ideal, but 5% will work. Digi-key, Mouser, Reichelt, etc., are fully stocked and they sell it by the unit. This modification takes just 15 minutes.

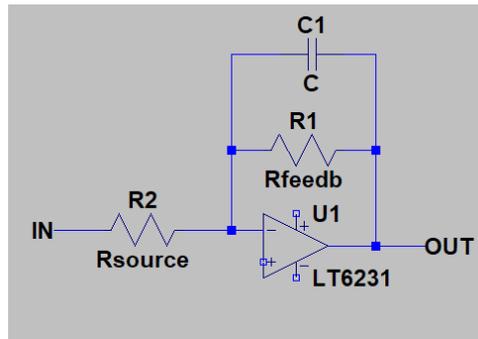
IQ Image Rejection and Noise Blanker Calibrations:

You must do both calibrations. You cannot use old files from your previous IQ+ setup; you must do a complete calibration.

Starting for the IQ image rejection with Linrad, move to 64 segments (not 32) and use steps of 1.5KHz (96KHz BW). For example, if your center frequency is 144.1, the swap will be from 144.052 to 144.148. Start a little low and finish a little high to avoid jump in to the center notch; for example, start sweep at 144.0512 and finish at 144.148.4 will be okay. To do the IQ image rejection with Linrad, I recommend (for revC or Standard) a signal level of 60%; for Extended modification just use 20 to 25%, max. The smart NB can be calibrated in Linrad using a PRF from 470 to 600. Find your optimal value following the normal smart NB calibration in Linrad.

6. SETUP Softrock, LP-PAN, MODIFICATIONS NEEDED

As with the IQ+, Softrock and LP-PAN and any other similar front-end mixer need to reduce their analog gain to work properly with the UADC4. The analog amplifier after the mixer could look like this:



The voltage gain is established by $R1/R2$. Normally in Softrocks, the R_{source} is approximately 10 ohms and the $R_{feedback}$ is around 5K ohms. That means $5000/10 = 500$ voltage gain, and that is equivalent to 54dB. To interface the UADC4, we must decrease the gain by 10dB resulting in a final gain of 44dB. That is equivalent to a voltage ratio of 158. R_{source} is not changed, only $R_{feedback}$:

$$R_{feedback} = (R_{source}) \times (158) = 1.58Kohms$$

The same criteria apply to the LP-PAN. You must find the optimal value of amplification and that will depend on the level of the mixer. Reducing the gain in the analog stage will move the saturation point higher. You must decrease the gain until a point where the mixer start compression affecting overtones and Image rejection.

7. INTERFACING WSE UNITS, MODIFICATIONS NEEDED

Leif SM5BSZ published a YouTube video where he tests the UADC4 with his famous WSE converters. In the video, you can see the performance reached and the possible modifications in the audio stages to reduce the gain. He concludes than a simple 5 to 10dB attenuator installed in the RX2500 "Inputs" will do the job. Nevertheless, the modification in the audio stages could give you another 2dB decrease in the noise floor without affecting the overtones and image rejection. In the performance table, I tested my WSE units with a 10dB attenuator, and I was satisfied with the results. I didn't modify any audio stage.

Watch Leif video in this link: <https://www.youtube.com/watch?v=YGF8dofRW08>

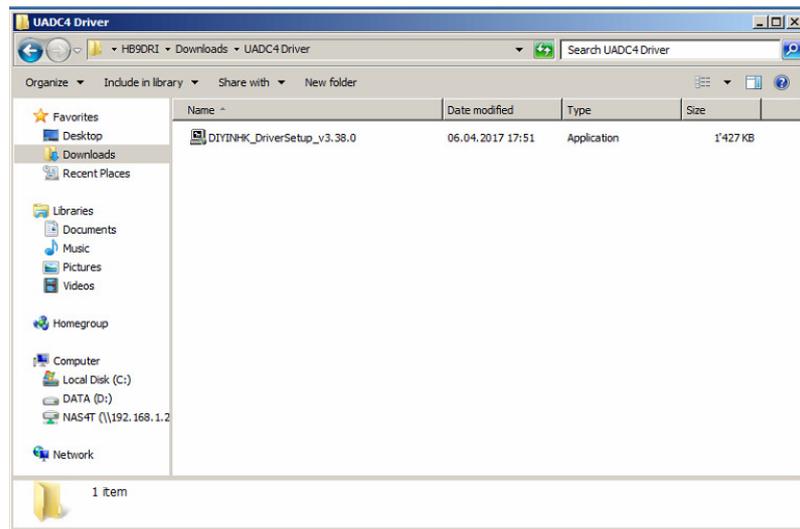
8. SETUP DRIVERS FOR WINDOWS (7 to 10)

As I mentioned in the 2nd page of this manual, the driver **MUST** be installed before plugging the UADC4 into the PC. If you plug the UADC4 without a driver, Windows will install a driver via Windows Update, and this driver will never work. De-installing that Driver and correcting all the problems would be a tedious and complicated job.

The Windows driver is a proprietary driver from DIYINHK. You will receive a link from Yoyodyne Consulting, where you can download the driver.

Follow the next steps to install the drivers:

8.1) Double click in the driver v3.38.0

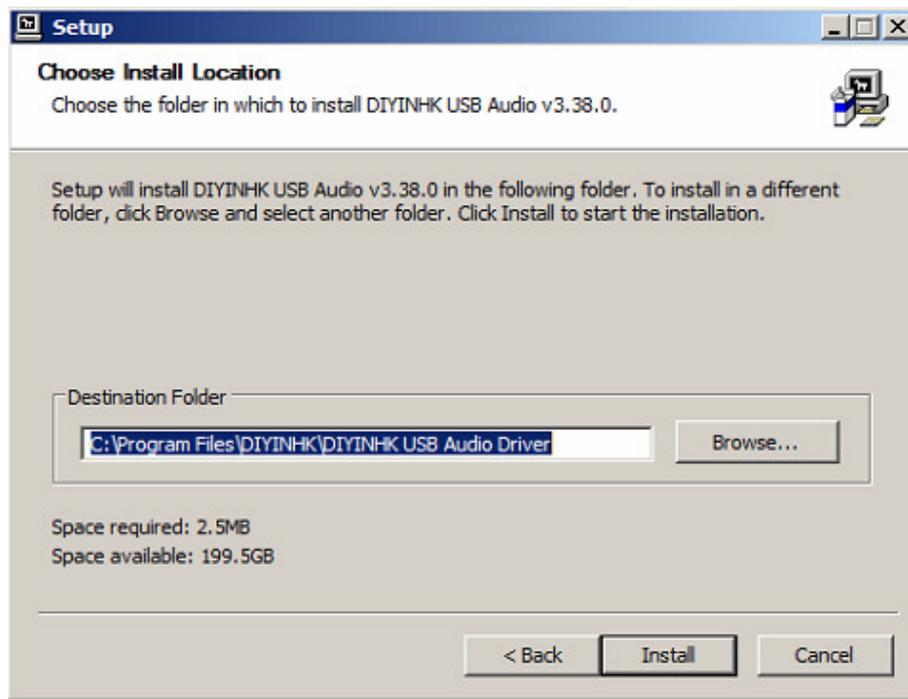


8.2)



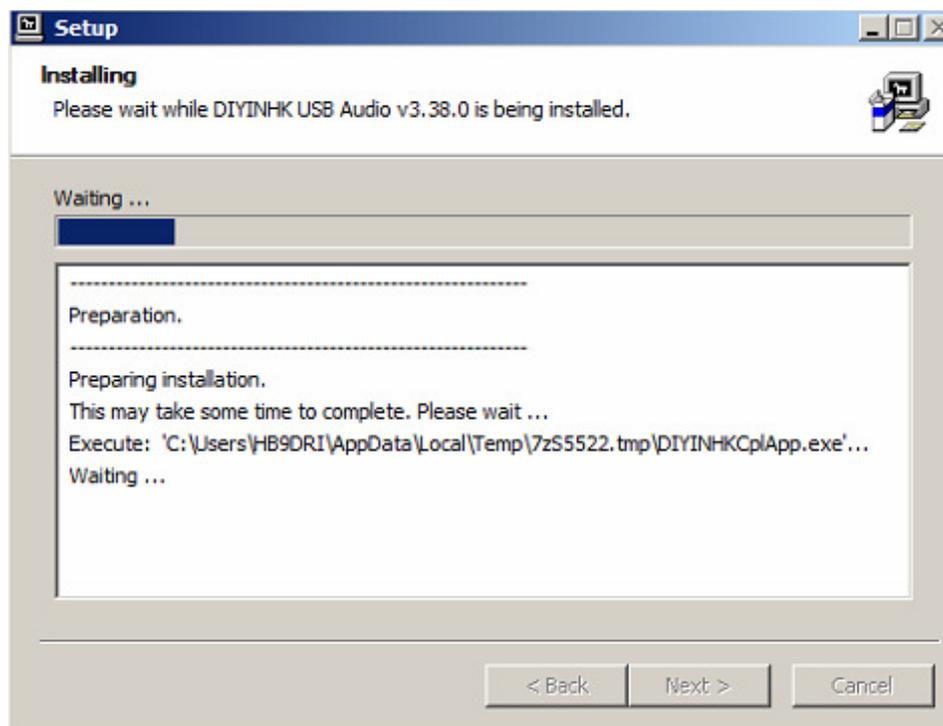
Click Next in the Welcome page

8.3)



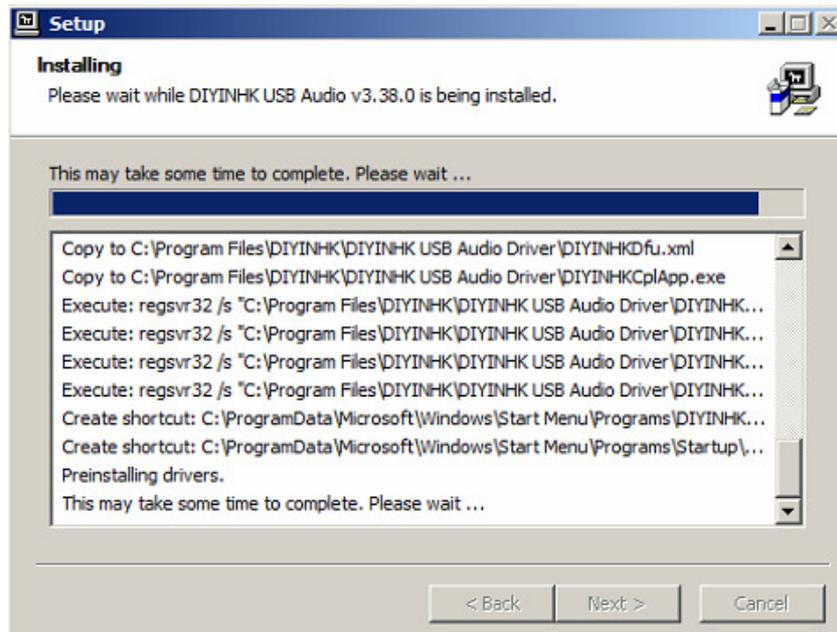
Accept default location and click "Install"

8.4)



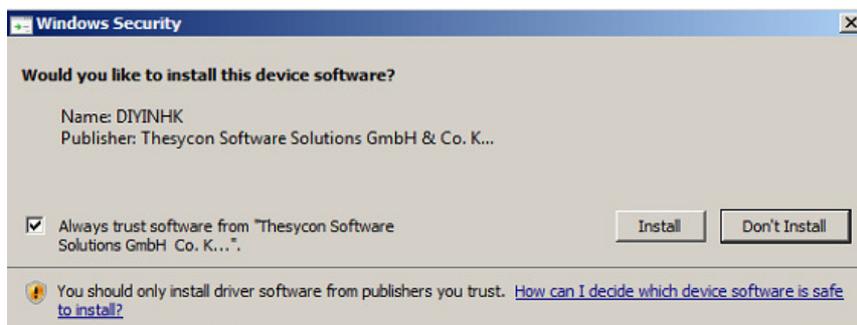
The set up starts, and you can follow the progress.

8.5)



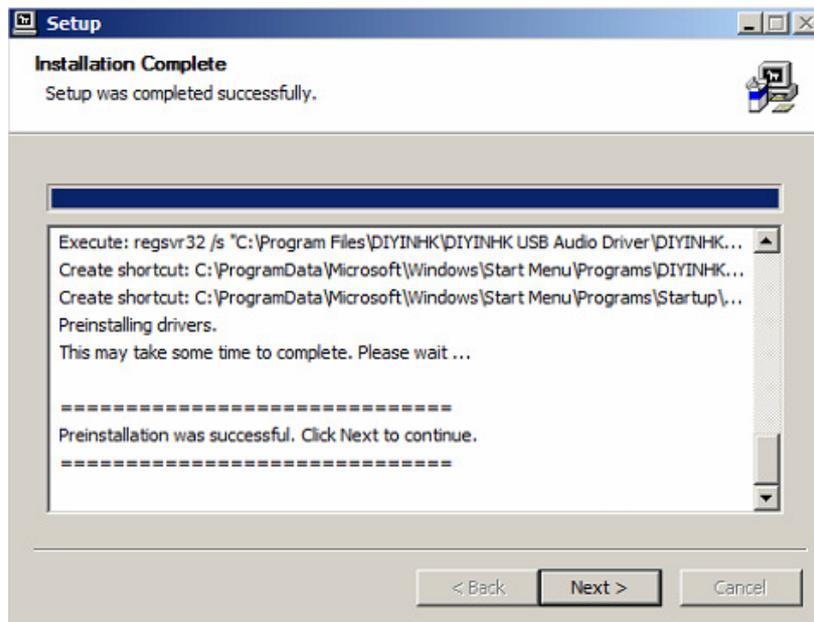
When it's almost done, Windows Security will present the next question. You must select "Always trust software from "Theyscon Software...." And click "Install."

A few second later, Windows Security will ask again:



you must select "Always trust software from "Theyscon Software...." And click "Install" again.

8.6)

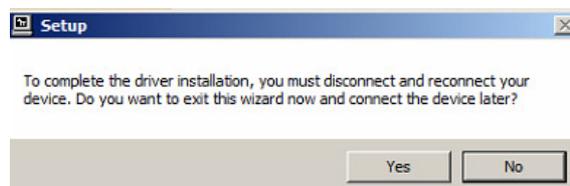


When the Installation reports "Setup was complete successfully", click "Next"



And then click "Finish" to close the wizard.

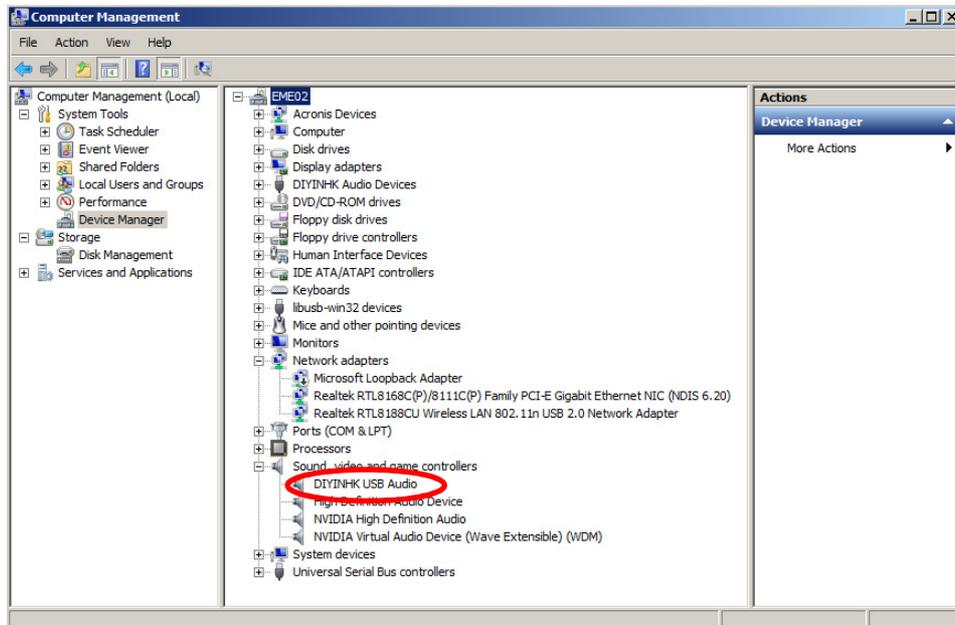
8.6)



Now is the crucial moment. Click "YES" to exit the wizard, and now plug DC in your UADC4, plug the USB cable from the UADC4 to the PC and turn on the UADC4

8.7)

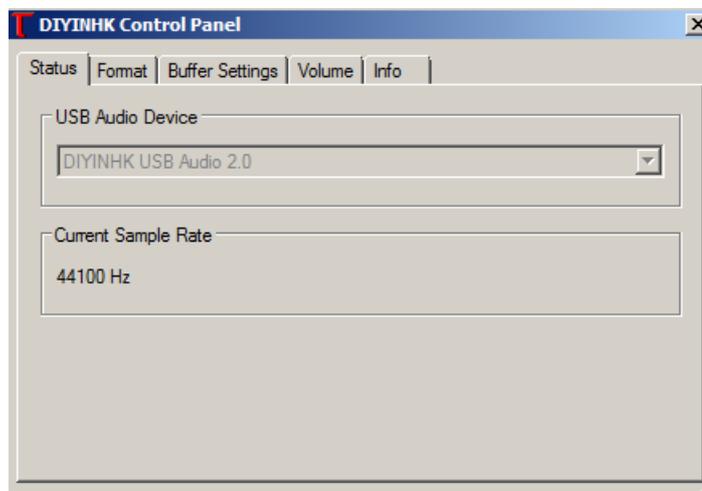
Open the Device manager in Windows and you will see the DIYINHK USB Audio under Sound, video and game controllers



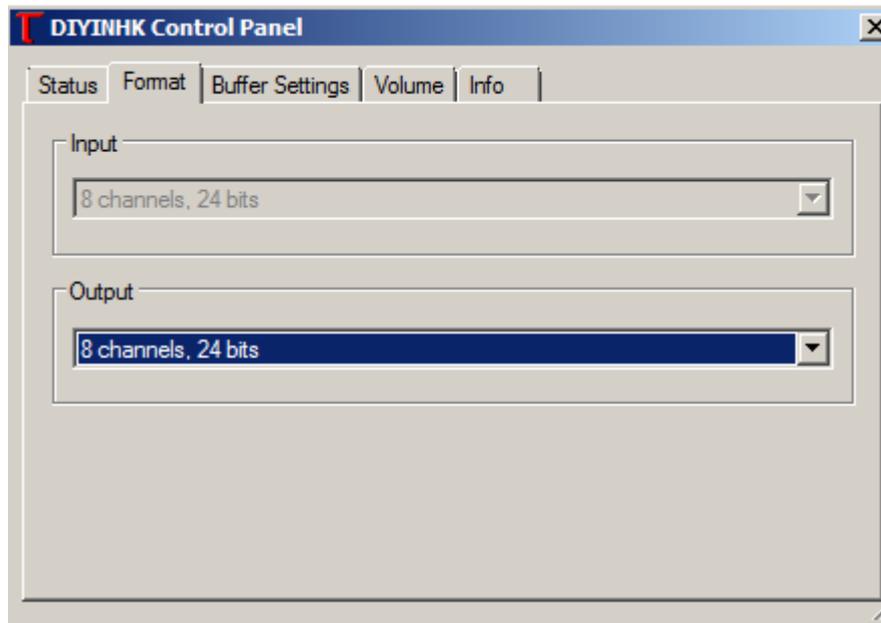
Your UADC4 Driver is correctly setup

8.8) Configure the DIYINHK XMOS control panel por optimum performance:

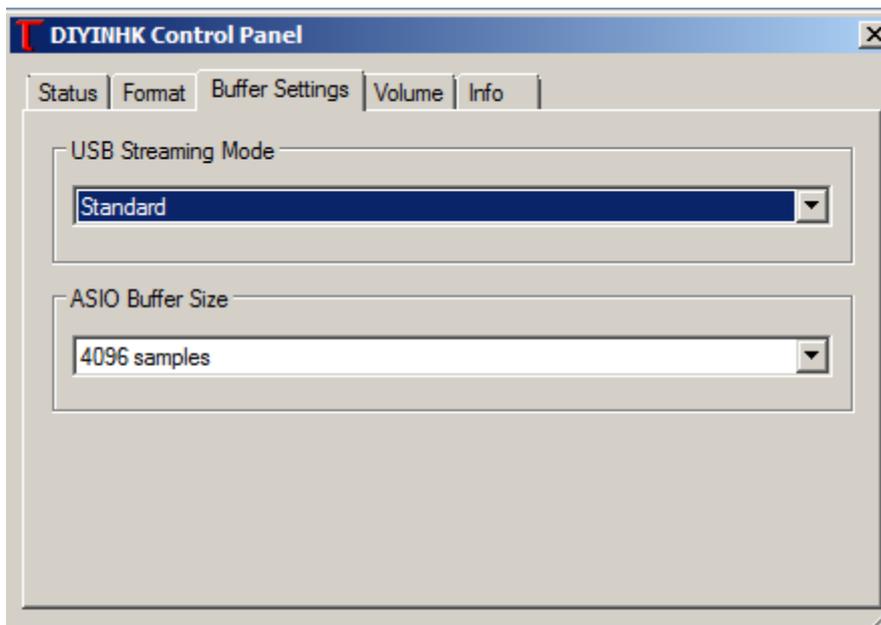
Open the DIYINHK control panel, and you will find the icon in the lower right of your screen



When no application is using the driver, under Status label, the sample rate is always 44100Hz. IT will change to the Sampling rate you select in your software. For example, if you select Linrad to work at 96KHz, here it will show 96000 Hz

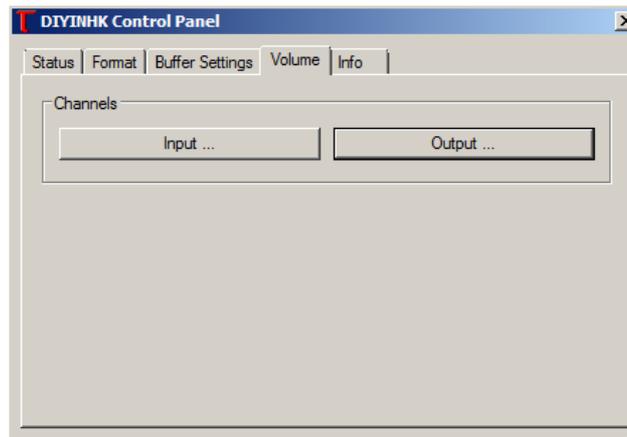


Under Format label, there is nothing to select. The output can change from 16 to 24 bits, BUT we don't have outputs implemented in the XMOS board.

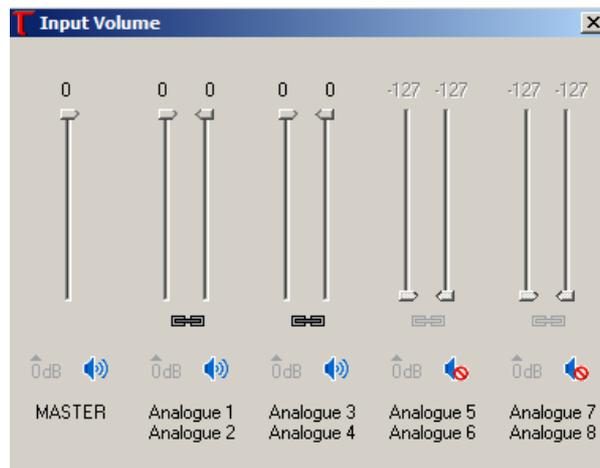


Under Buffer label, configure the "USB Streaming Mode" to Standard and place the "ASIO Buffer Size" in 4096 samples. This configuration allows Linrad 4.13 running in an old Pentium Quad Core 2.4GHz. You can explore different combinations to avoid glitches and freezing in Linrad.

8.9) Configure levels for INPUT

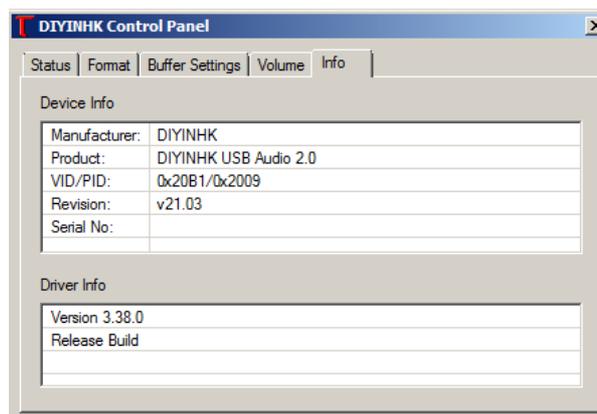


Again, there is nothing to configure for the Output. Click on "Input" and configure the levels like in the next figure:



The MASTER and Analog 1 to 4 MUST be at 0dB, MUTE Analog 5 to 8. They are not used. Any lower gain than 0dB will produce and unbalance system. The UADC4 is designed to work at 0dB.

As a reference, this is the Info panel:



9. SETUP FOR LINUX AND OS

The XMOS USB interface supports "Audio Class 2". Linux and MAC OS will not need any special driver because they are integrated by default. You just plug your UADC4 into the computer and the DIYINHK board will be recognized automatically.