LP-PAN Sound Card Info

Updated January 13, 2018

192kHz cards...

The winners in terms of performace are the Asus Xonar U5 & U7, but they have been plagued by failures at the 1 year mark. These appear to be driver/firmware related. Asus recently released a U7 MKII, but the jury's out on it's reliability, and some users have reported difficulty installing the drivers. I plan to purchase one to work out the installation issues and post a procedure.

A close 2nd is the Behringer UMC202HD USB sound card. It currently costs $56 at Amazon. It has a lot of good things going for it. Solid construction, all metal case, excellent drivers and easy setup, although the instruction manual is not very useful. It is inexpensive and has a great warranty (on paper, anyway). The noise floor is a few dB worse than the Asus cards, but from a practical standpoint, that's a minor issue. I plan to post installation and setup instructions for this soon.

96kHz cards...

Don't count out 96kHz cards. Most band segments fit within this bandwidth. They are a little cheaper than the Asus USB cards if you prefer an internal card. They typically use fewer PC resources as well. The best choices here are the Asus Xonar DSX PCIe and the M-Audio Audiophile 2496 PCI. The AP2496 may be hard to find.

I recently tested an M-Audio M-Track 2x2 C-Series USB card. It tested well and was easy to install. It's well built and M-Audio has a solid reputration in the pro-audio world. The inputs are a little unorthodox for our use because you have to use a line input for one channel and an instrument input for the other, but they use the same connectors (1/4" mono).

Sound card table:
This table shows cards which have been tested here. All tests were run with an HP-8657A signal generator feeding a K3 with preamp ON. The K3 IF output is fed to LP-PAN w/preamp (similar to LP-PAN 2). All measurements are made through Windows Mixer (MME driver) except the additional numbers for the 1212m with ASIO driver. In general, MME provides the best OS compatibility and allows sharing of the audio stream with multiple apps at the same time.

With this setup, the maximum signal from the generator is approx. -12dBm (S9 + 60dB) before LP-PAN and sound card clipping using the Windows Mixer settings in the ballpark levels table further down this page. The dynamic range is the difference between the noise floor and -12dBm.

Green... recommended and in production.
Gray... recommended with caveats. In production.
Yellow... recommended, but out of production. Check eBay.
Red... not recommended

	Noise Floor: Center / Edges	Dynamic Range	Cost New	Production Status	Windows 7 64-bit Compatibility
Up to 192 kHz					
Behringer UMC202HD USB **See Note 14**	-130 / -128 dBm	112 dB	$56 (Amazon)	In Production	Drivers for all Windows up thru 10.
Asus Xonar U7 USB **See note 11.**	-131 / -126 dBm	118 dB	$80	In production	Driver support for all modern Windows thru

					10.
Asus Xonar U5 USB **See note 11**	-130 / -126 dBm	119 dB	$65	In production	Driver support for all modern Windows thru 10. **Does not support XP.**
Realtek ALC8xx or 11xx 8ch HD Audio motherboard sound system	-128 / -118 dBm	116 dB	Built in	In Production	Compatible with MME / WDM. No ASIO driver
AimPro AS372N USB (Sewell SoundBox Pro) (SIIG CE-S70011-S1) **See note 12.** .	-134 / -126 dBm SoundBox Pro tested, but all three appear to be the AS372N.	118dB	$65 - $75	In Production	Driver support for all modern Windows OS
Creative Labs E-MU 0202 USB	-130 / -120 dBm	118dB	NA	Out of production	See E-MU 0204 Comments.
Creative Labs E-MU 0204 USB **See note 1 Comments / Links**	-132 / -122 dBm	120dB	$115	Out of production	Compatible with ASIO & MME drivers. Must set up Windows Mixer when using MME driver. **See note 1.**
Creative Labs E-MU 0404 USB **See note 7.**	-130 / -120 dBm	118dB	$150	Out of production	See E-MU 0204 Comments.
Creative Labs E-MU 1212m PCI E-MU 1212m PCIe **See note 8 Comments / Links**	-135dBm ASIO -130dBm MME No edge falloff	123 dB ASIO 118 dB MME	NA	Out of production	Great performance with ASIO, OK with MME.
Infrasonic Quartet PCI **See note 9 Comments / Links.**	-132 / -120 dBm	120 dB	NA	Out of production	Compatible for ASIO. Not compatible with MME.
Steinberg UR22 USB - **See note 6**	-125dBm center -135dBm@150kHz -145dBm@192kHz	115 dB	$150	In Production	Excellent drivers for W7/W8
Tascam US-366 USB Not recommended	-130 / -130 dBm	112 dB	$150 w/ rebate	In production	Driver nightmare in my testing
Up to 96 kHz					
Asus Xonar DSX PCIe See Note 13	-130dBm / -130dBm	119 dB	$45 w/ rebate	In production	Drivers are OK with Win7
M-Audio Firewire Audiophile	-133dBm	121 dB	~$80 Used	Out of production	Not tested with Win7
M-Audio Audiophile 2496 PCI **See note 10 Comments / Links.**	-133dBm	121 dB	$90	In production, but hard to find.	Excellent for ASIO and MME.
Syba (VIA) USB Sound Card SD-AUD20101 **See note 3.**	-125dBm	113 dB	$12	In production	Works with win 7 32 & 64-bit
Sound Blaster HD USB **See note 4.**	-130dBm	118 dB	$85	In production	Works well with win 7 64b using MME drivers
Sound Blaster X-Fi Surround 5.1 Pro USB **See note 5.**	-132dBm	120 dB	$60	In production	Not tested with win 7, but they have drivers up to Windows 8.1.

Note 1: Some users have reported an issue when using E-MU 0204 with win7 64-bit and more tha 4GB RAM. Click here for details and workarounds. Specific config data for this car can be found here, E-MU 0202 / 0204

Note 2: Built into some newer motherboards. This card also has a spur at the center of the spectrum about 30dB above the noise floor. On the lower bands, this will probably disappear into the noise, but will be visible on higher bands.

Note 3: This card requires you to set a sample offset between channels. NaP3, Skimmer and HDSDR provide this feature. The setting is +1 for NaP3 and HDSDR, -1 for CW Skimmer (with IQ set to Q/I).For some reason, Skimmer uses a different convention for assigning left and right channels. Note: There is a bug in NaP3 v4.0 RC1 which requires the user to reenter the sample offset each time the program is run. This is easy to do, just a bit of an annoyance. This appears to be related to v4.0 only, so earlier versions could be used. This card also has a spur at the center of the spectrum about 20dB above the noise floor. This is typical of sound cards built into motherboard ones. VIA provides many of the motherboard chipsets these days.The DC Block in NaP3 takes the spike down to about 5dB. On most bands, this spur will disappear into the noise. The display is flat and almost spur free, with dynamic range within 5-10dB of the best cards. Especially for laptops, you can't do any better price/performance wise than $10 for a clean 96kHz.

Note 4: This card also has a spur at the center of the spectrum about 20dB above the noise floor. On the lower bands, this will probably disappear into the noise, but will be visible on higher bands. NaP3's DC Block reduces this about 10dB.

Note 5: This card also has a spur at the center of the spectrum, but on the tested card the spur was about 15dB above the noise floor. On the lower bands, this will undoubtedly disappear into the noise, but may be visible on higher bands.

Note 6: This card is extremely well built, with a solid metal case. It has a great set of drivers and allows simultaneous use of ASIO and MME/ WDM. It has a spur in the center of the display at about 35dB above the noise floor. It also has smaller spurs at plus/minus 67kHz. When properly set up, this card gradually rolls of to -10dB at + / - 80 kHz, but rolls off dramatically above that. While most cards have rising noise floor at the edges, this one has falling gain.

Note 7: This card is larger than the 0202 / 0204 and uses an external 5V power supply (supplied with international plug adapters).

Note 8: Specific config data for this card can be found here, E-MU 1212m

Note 9: Specific config data for this card can be found here, Infrasonic Quartet

Note 10: Specific config data for this card can be found here, M-Audio Audiophile 2496

Note 11: Easy to install (be patient, the installer takes awhile and doesn't update often) and have a full set of drivers for any modern OS. They have no center spike with MME. They have a small one with ASIO but the DC Block in NaP3 easily takes care of it. The noise floor is about 10dB higher at the edges when viewing the entire 192kHz, but this is typical. They have straightforward control panels for most of the setup. Leave all the special features OFF. See below charts for control panel and Windows Mixer settings. Specific config data can be found here for the U5 & U7, ASUS Xonar U5 / U7 The U5 does not support XP, but the U7 does.
BEWARE EARLY FAILURES OF SOME U7s REPORTED BY USERS.

Note 12: Very similar performance to the Asus since it uses a similar (if not the same) CMedia chipset. The implementation isn't quite as robust, with a noise floor that rises as signal levels increase. Packaging and documentation is not nearly as professional as the Asus. Installation and setup is similar to Asus, but the control panel skins (colors) are slightly different. All in all, not a bad card for the price, but I prefer the Asus for very little more $$$.

Note 13. Has small spike in the center (10dB with record level set to 20%). Otherwise, very clean and no spurs.

Note 14. This card was very easy to install and set up. The Windows Mixer level for flatest noise floor was at around 20%, with the front panel pots set to about 10 o'clock.This card works a lot like the EMU-0204 as far as cabling goes (separate L and R cables with 1/8" to 1/4" plugs. Has a small center spike unless DC Block is turned on in NaP3. It appears to be very rugged and well built, with a professional feeling metal case. Dynamic range can be improved by 10 dB by setting the input pots lower, but then the noise floor increases at the edges. Not as flat frequency response as the EMU or the Asus cards, but close. Wouldn't be noticed except on the quieter bands. The card comes with a 3 year warranty on everything except mechanical parts, which are 1 year.

Generic LP-PAN Sound Card Installation & Checkout for any SDR

The following section will describe a procedure to allow you to check out your sound card using the Windows Mixer and MME driver. This has the advantage of allowing the card to be shared with the SDR and other apps, like CW SKimmer. It also makes for a consistent interface and procedure for configuring sound cards. MME has more latency than ASIO, but this is not a major issue for most users.

We will be using a little app called Digital Level Meter to help set the optimum levels and channel balance. It also quickly identifies any cabling or other hardware issues ahead of the sound card. This is all done completely independent of the SDR app to eliminate confusion and problems before they develop.

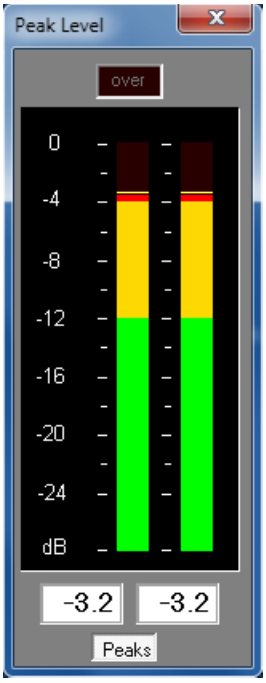
Installing and configuring Digital Level Meter

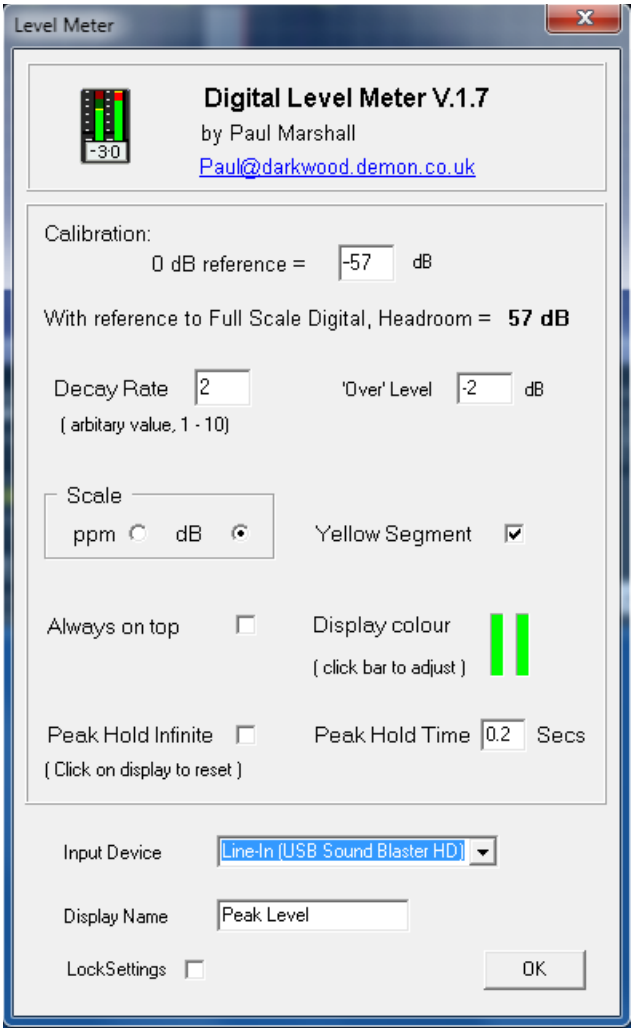
In order to facilitate this you will need to download and install a little program called Digital Level Meter. Click on this link to install the program,

http://www.darkwooddesigns.co.uk/downloads/SetupDigitalLevelMeter170.zip

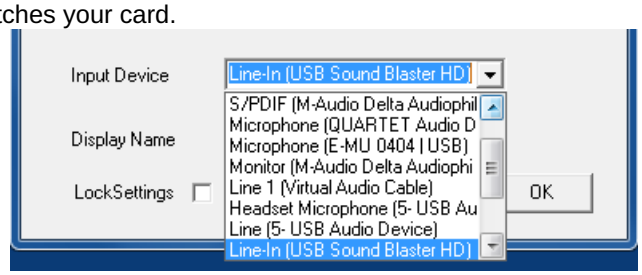
Here's what the program looks like (with S9 signal being received), and what the setup panel looks like when set to display an S9 signal at the edge of yellow and red. You get to the setup panel by right clicking in any gray area of the main window. The reason for the the 0dB reference of -57 is to align the start of the red zone with a level of S9. That

provides 60dB of headroom above S9. If you prefer to have a different amount of headroom, you can use a different reference setting, or you can just set the level in Windows Mixer to a lower or higher value while watching the bargraph levels, or the numerical readouts below the bargraphs.





Here's a closeup of what the sound card input enumeration list might look like. You won't have nearly as many cards listed. Just pick the one that matches your card.



The level control should be adjusted so that the bargraph level is on the edge of yellow and red, and the digital value reading approx. -3dB. The two channels should be close to the same level. WBIR will take over from there when running NaP3. You may need to tweak the balance between channels if you are using a card with physical gain pots.

To obtain an S9 signal for this setting, feed a signal generator set to -73dBm, or an Elecraft XG2 set to the high output level to the rcv ant input of your radio. If you don't have a suitable signal generator, tune in a stable carrier that is close to S9 on the rig's S-meter. You can also generate a carrier using a second transmitter or antenna analyzer connected to a different antenna or a short piece of wire. Never connect an antenna analyzer to the ANT jack of a rcvr!

Tune the carrier in on the radio so that you hear a convenient tone.This should be done in SSB mode, even if the carrier is from an AM broadcast station. It is best that the signal be the only strong signal on the band, or at least the only one within +/- 25kHz of the tuned frequency. Use the rig's preamp and attenuator if need be to get close to S9.

When the sound card is calibrated for S9 as described, it should handle peak signals of S9 +60dB without clipping, and provide low noise floor and maximum dynamic range. If you want a little more or less headroom, just adjust the Windows Mixer levels accordingly, using the digital readouts in Digital Level Meter to determine the change in gain., or change the 0dB Reference level in Digital Level Meter to a different value.

Note: When the sound card is adjusted according to this procedure, S9 will appear properly in the S-Meter and panadapter legend of most SDRs. The exception is NaP3 where the legend can be off, depending on sound card. This is because NaP3 does not offer a way to adjust the legend or S-Meter reading independent of the sound card levels. This is done in order to optimize the working range of the WBIR system.

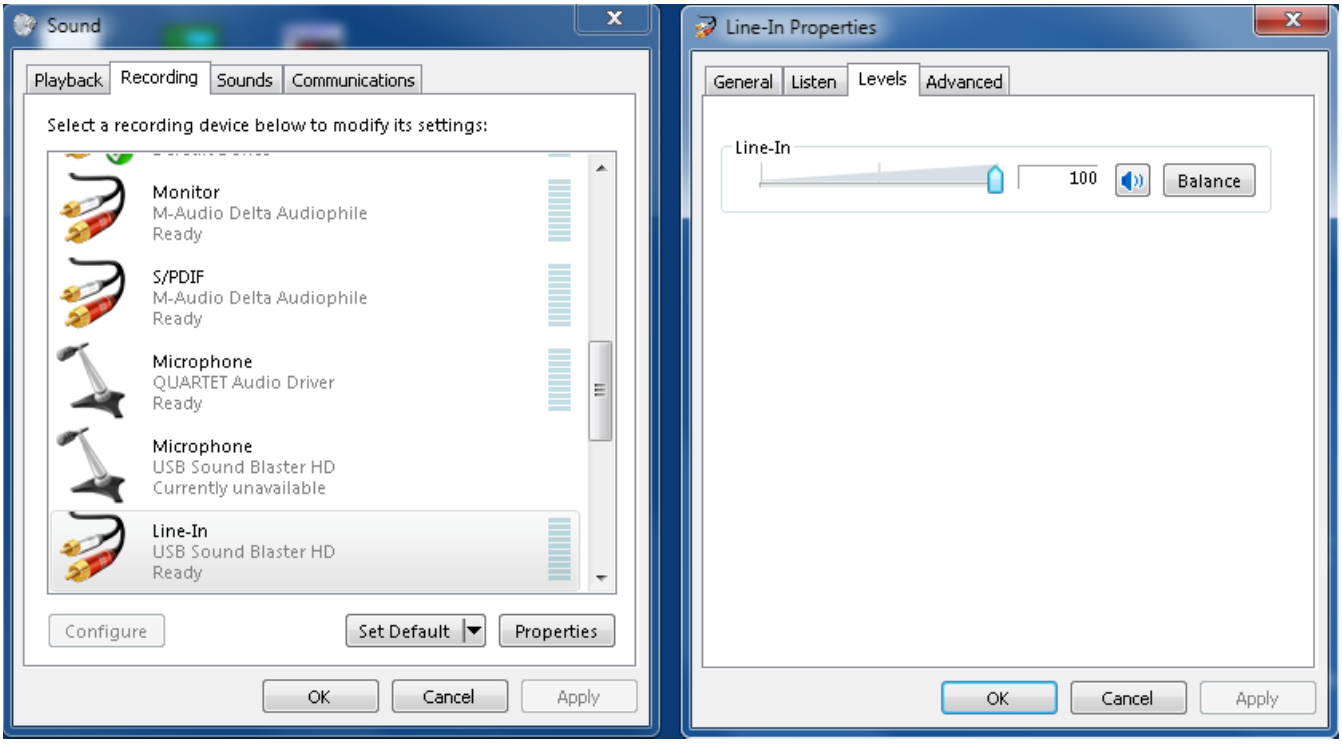
If you like this little program, consider a small donation to https://www.paypal.com/cgi-bin/webscr?cmd=_s-xclick&hosted_button_id=BE3ARET7UEVZU

Note: TelePost has no financial interest in this program. It's just a handy program I found searching the Internet, and I'd like to help the author.

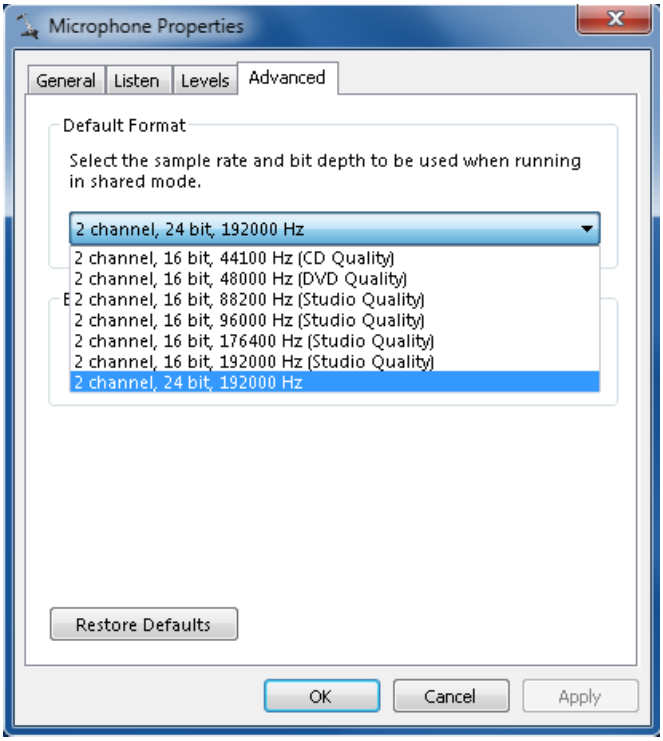
Using Windows Mixer

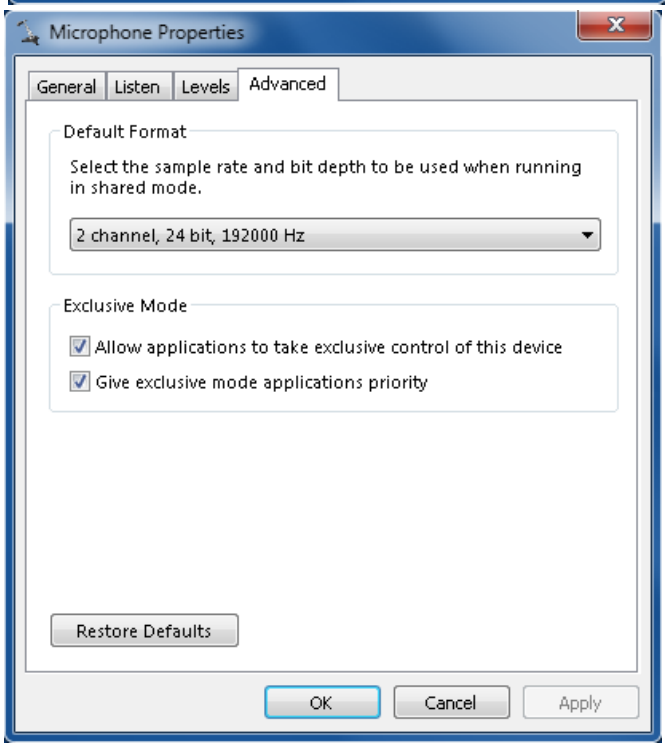
The mixer panel on the left is accessed by right clicking on the little speaker icon in the toolbar at the bottom of the Windows screen. You will be given several choices after clicking. Choose the one labeled Recoeding Devices. Scroll up and down until you get to the correct sound card and input selection. Don't be alarmed by some of the names. Sometimes they will be reported as MIc when it's Line, etc. In general, if both Mic and Line are reported by a sound card, choose Line. But if only Mic is reported, that's OK, it will only affect the level setting, not the headroom nor dynamic range.

Click on the selection, and then click on the Properties button to open up the screen on the right. Click on the Levels tab and use the slider to adjust the audio input level to set the proper bargraph height in Digital Level Meter. Right clicking on the little speaker icon to the right of the level value will allow you to choose between percentage gain (shown) or dB. Right clicking on the Balance button will allow you to adjust the left and right levels, but normally they will be with 1% of each other and well within the range of the SDR image canceling system.



The advanced tab allows you to set the maximum sample rate for your sound card. It's not required in order to use the Digital Level Meter, but will probably be required to make sure that the mixer works at the full bandwidth of your sound card. Lower left is what it looks like when choosing the setting, and lower right after it has been chosen...





Here are some ballpark Windows Mixer levels that I found experimentally on my system for the indicated sound cards, along with some notes.

Except as noted, NaP3 Gain control is set to 0dB for older versions and -30dB for v2.7. Don't be alarmed by low level settings for some cards. This has nothing to do with dynamic range nor headroom. The reason for the "Percentage / dB" values is that Windows Mixer can be set to display either one. The gain values are derived from the sound card driver, and vary from card to card depending on driver methodology and the overall gain of the card. Note: When the sound card is adjusted according to this procedure, S9 will appear properly in the S-Meter and panadapter legend of most SDRs. The exception is NaP3 where the legend can be off, depending on sound card. This is because NaP3 does not offer a way to adjust the legend or S-Meter reading independent of the sound card levels. This is done in order to optimize the working range of the WBIR system.

Sound card	Windows Mixer Level Setting for Optimum	Notes / Suggestions

	Dynamic Range Percentage / dB	
Realtek ALC882 "HD Audio"	60 (+7.6dB)	Use 1/8" (3.5mm) stereo Y adapter and Blue LINE IN jack
E-MU 0202 / 0204 / 0404 USB	3 (-0.4dB)	Front panel pots at 10 o'clock
M-Audio Audiophile 2496	100 (0.0dB)	Set NaP3 Gain to +6
USB SoundBlaster HD (SB1240)	100 (0.0dB)	Set NaP3 Gain to +3, turn on DC Block.
USB SoundBlaster XFi (SB1090)	66 (+8.5dB)	Turn on DC Block for NaP3
Steinberg UR22	100 (0.0dB)	Front panel pots at 9 o'clock, turn on DC Block for NaP3
Syba (VIA) USB SD-AUD20101	0 (0.0dB)	Set Sample Offset to +1, turn on DC Block in NaP3, set CAL to +8.0.
E-MU 1212m PCIe	100 (0.0dB)	PatchMix level set to +7dB. ASIO works a bit better than MME
Infrasonic Quartet	----	Use ASIO driver and manufacturer's control panel
Asus Xonar U7 USB card	10-20 (-26 to -20dB)	Set NaP3 Gain to +10.0. Use Xonar Control Panel to set this card up rather than Windows Mixer.
Asus Xonar U5 USB card	0-2 (-16 to -12.5dB)	Set NaP3 Gain to +10.0.
Sewell SoundBox Pro USB	20 (-8dB)	Set NaP3 Gain to +10.0.
Asus Xonar DSX PCIe	20 (-14.9dB)	Set NaP3 gain to +10. Set this card up in Windows Mixer
Behringer UMC202HD USB	20-30 (-24 to -18 dB)	Set this card up in Windows Mixer. Front panel pots fully CCW with INST inputs selected using the front panel switches, 12 o'clock with LINE inputs selected.

Eliminating Images (needs to be updated)

SDRs work on the same principle as the original "phasing" type of SSB generation. Two wideband audio signals are created in LP-PAN, which are identical in every way except that they differ in phase by 90 degrees at every frequency. This is referred to as quadrature phasing. The outputs of LP-PAN are labeled as I (In-Phase) and Q (Quadrature) for this reason. They are passed to the SDR software through a high quality sound card. The SDR app mathematically derives the desired sideband by manipulating these two signals to produce a sum and difference result. The sum is the desired sideband and the difference is the undesired sideband. Sidebands in this context refer to the signals above and below the center point in the display. If the difference signal isn't a perfect null, a reduced level mirror image of the signals will appear on the opposite side of the display. When tuning the rig, the image will move in the opposite direction of the signal. This is how you can generally differentiate an image from a spur. See Note 1 for a discussion of spurs.

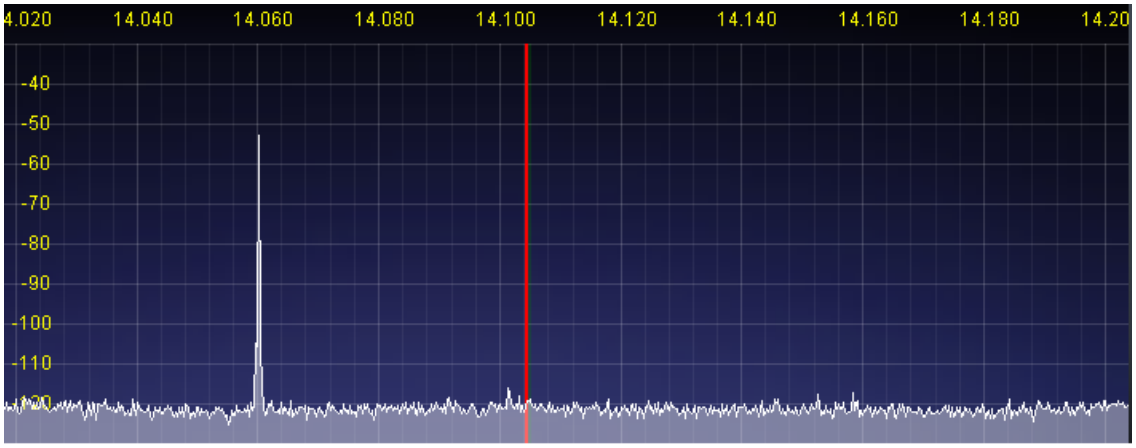
In order for the cancellation to be perfect, both the levels and phase difference of the two sound card channels must be matched. The stream also has to be clean, with no distortion caused by improper sound card synching. To minimize the chance of distortion, the user should generally use the largest buffer size in the SDR app (4096), and the proper buffer latency setting... 5 to 10ms for the ASIO driver choice, 25ms or more for the MME driver choice. These can be found in the sound card setup section of the SDR app.

In both PowerSDR/IF and NaP3, which are based on the open source PowerSDR™ program from FlexRadio Systems, an algorithm called Wide Band Image Rejection (WBIR) automatically corrects for any imbalances in the sound card channels, and eliminates the images. But WBIR requires certain conditions to "learn" where the images are. Once learned, WBIR will constantly adjust to keep the images nulled. It will try to relearn anytime a major change is made... like powering down LP-PAN while the program is running. For this reason, you should always start the SDR app last and close it before turning equipment off.

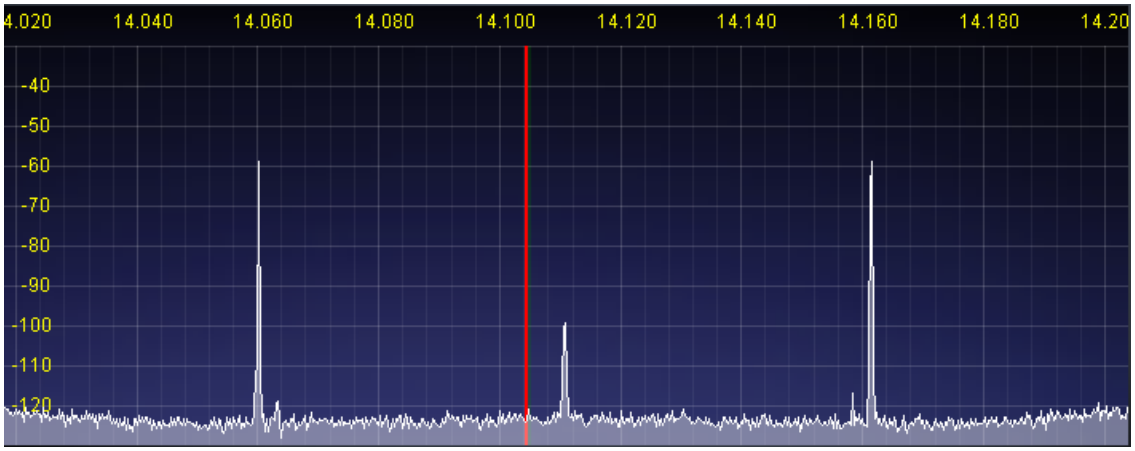
WBIR looks for the strongest signal, and nulls its image. It is assumed that this setting will work for other signals in the region. This generally provides 50-60dB rejection of all signals, and greater than that for strong signals. The effect is to reduce the images to the noise floor. WBIR works faster as signal strength increases. It takes 3 minutes to null images in the S9 range, and a few seconds for signals in the S9+20dB range. If your setup is not displaying at least some signals at

least 50dB above the noise floor, it will take a long time for WBIR to work. If the band is quiet, WBIR will not learn. The latest NaP3 offers a manual setting which locks in the WBIR values and prevents updating. This prevents the system from nulling the worst image, but provides a good null of all images. More on this later.

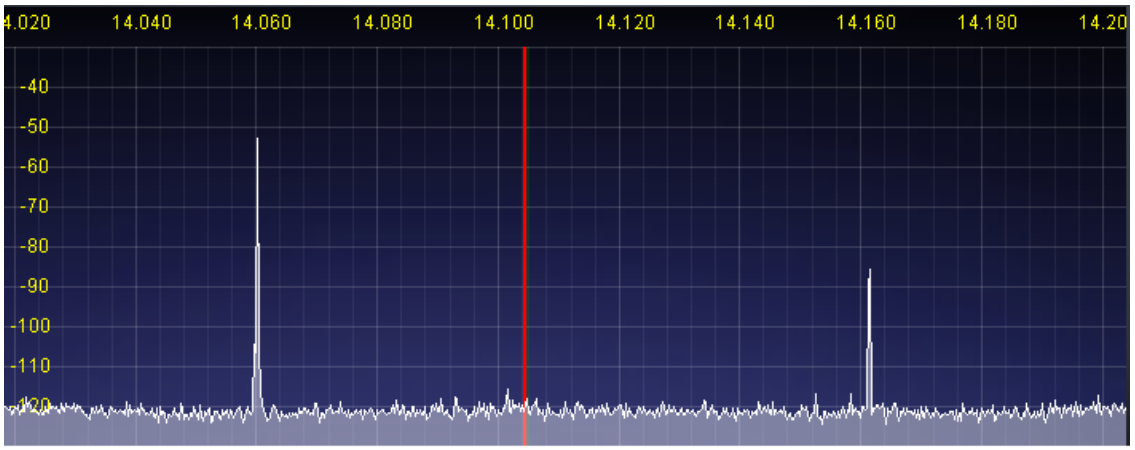
Below is a screen capture from the SDR showing what the display looks like with a single signal and proper image cancellation...



The image signal would appear at 14.161 in this example (equidistant from the IF center, but on the other side). Note that the center red line is 6kHz to the left of the IF center due to the Global Offset setting in the SDR app. No image is seen because it is being properly nulled. Below is another screen shot of the same signal with one channel unplugged on the back of LP-PAN...



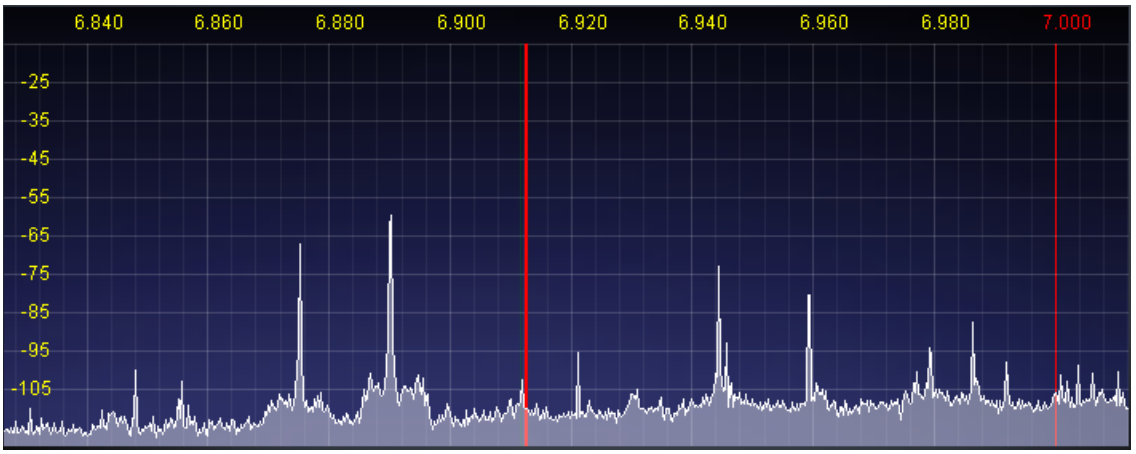
The blip in the IF center respresents hum due to the unterminated cable. The display will look the same with either channel unplugged. If it doesn't, then there is a problem with one of the LP-PAN outputs, or cabling, that must be corrected before proper operation can be attempted. Below is a capture of what the display might look like with both channels plugged in but before the WBIR has learned. Note that the signal is a few dB stronger due to the addition of the two channels, and the image is weaker due to partial cancellation.



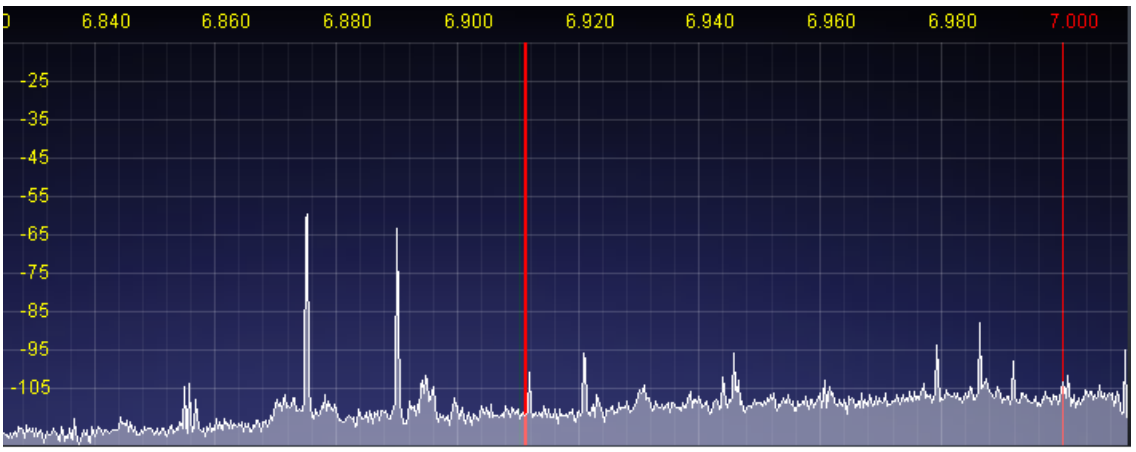
As well as WBIR works, the trick is getting it to initially learn. To repeat, WBIR works best when there is at least one strong signal in the 192kHz passband, meaning at least 50dB above the noise floor. For comparison, signals 50dB above the noise floor will take about 3 minutes for learning. Signals 70dB or more above the noise floor will require about 15

seconds. NaP3 includes a WBIR setup section on the DSP tab in SETUP. The user can select Auto or Manual settings, and there is a "Seed" button to quickly determine the best null settings. After seeding, the user can switch to manual to stop learning if he wishes. This will provide reasonable image rejection (60-80dB) without further intervention. The user can also log the Gain and Phase settings to enter manually in the future if necessary. As long as the sound card levels and cabling don't change, the manual setting will provide reliable image rejection regardless of band conditions.

At my location I find that the AM broadcast band provides lots of strong signals with the correct charactersistics, but not all rigs can tune this band. Below is a picture of 40m in the evening with a couple strong shortwave broadcast stations just below the band. The picture clearly shows images at 6.944 and 6.960 before WBIR has learned.



After a couple minutes of learning, the images will be almost gone...



Once this is done, no further adjustment is needed, because the WBIR will readjust as new strong signals appear, providing the deepest nulls for the strongest signals, and adequate rejection to hide the weaker ones in the noise. Remember, though, that when all signals are weak there will be a problem with PowerSDR/IF because it will start with faulty settings and not learn. With NaP3, it will start with the last good settings, so it will be better, and you can obtain a quick null using the WBIR section in the Config>DSP setup tab. Again, NaP3 also provides a Manual WBIR mode, which you can adjust manually with the Gain and Phase controls, or automaticall by using the "Seed" button.

Note 1 - A discussion of spurs can be found in the Performance section of the LP-PAN detailed specs page, http://www.telepostinc.com/LP-PAN_detail.html Note: Spurs can be the result of synthesizer and mixer anomalies in the rig. They can tune in the same direction as the signal, or in different directions, and even at a different rate, but they are generally quite weak in comparison to an image created by poor sound card balance. Note also that a high FFT setting in NaP3 can reveal small spurs from the rig's synhesizer that would otherwise be invisible (and audibly suppressed by DSP trickery in the rig's audio output). Remember, the rig's IF output comes ahead of any DSP processing in the rig, and is affected by anomalies in the rig's synthesizer and 1st mixer.

System Tuning for Best Audio Streaming

Note: Do not attempt these suggestions unless you have some familiarity with computers, as some of the recommended tricks alter basic Windows operation. All tricks are reversible if you don't like the results, I believe.

Here is a link to Dave, W8FGU's paper on tuning a Vista system for best sound card performance. It also applies in many cases to all versions of Windows. Vista Tuning for LP-PAN.pdf