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LP-PAN Sound Card Info

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Intro:

The following sound cards have been tested with LP-PAN. The table will give you a basis for comparison. Some of these cards are no longer in production, although they may still be available. Also, not all of these have Windows 7 drivers, and of the ones which do, they aren't all 100% compatible. In general, we recommend either XP or Windows 7 for any OS which is intended mostly for ham applications (virtually all ham apps are 32-bit native). In general, the best performance with PowerSDR/IF or NaP3 is provided by the E-MU 1212m PCIe card, and the best mix of performance, price, compatibility and ease of use is provided by the E-MU 0204. The Infrasonic Quartet works well and is bargain priced these days, and the M-Audio Audiophile 2496 PCI works very well at 96kHz. WARNING: The 1212m is tricky to configure, and has compatibility issues with software which cannot use the ASIO driver. The E-MU 0204 has some issue with these programs as well, but using the Windows mixer for older programs seems to be a reasonable solution in this case.

Detailed tests and discussion:

The table details sound cards that have been tested by me with LP-PAN. It is recommended that you read the table and all notes before deciding on a sound card. Note: I do not endorse these cards as being foolproof to install in all systems. I just pass this information along to indicate that these cards tested well with my system, to the extent of the tests. Site specific issues like PC radiation, and radiation from PC internals in the case of PCI cards, can cause spurious blips in the display. Using high quality, shielded USB and serial cables is strongly recommended. Check the footnotes just after the table for applicable comments. Also, if you plan to use the board simultaneously with another application like CW Skimmer, read the section on sound card sharing.

Following this section is a discussion of sound card issues for those interested in reading it. The following measurements were made at 14 MHz, with the K3 ATTEN OFF and K3 PREAMP ON. The tests were done using a K3 with the N8LP buffer mod as detailed in the LP-100 Yahoo Group site in the Files section, http://groups.yahoo.com/group/LP-PAN/files. The Elecraft buffer mod will provide similar results. All K3s made in the last year or so come with the Elecraft buffer mod. A stock older K3 will have about 10dB higher noise floor, but otherwise be the same. The LP-PAN used in these tests did not have the optional preamp installed.

Audio cables used were Radio Shack part #42-2433 (1/8" mono to 1/4" mono) for EMU-0202, Radio Shack part #42-2616 balanced 1/4" cables plus adapters for 1212m, FA-66 and Delta 44, and Radio Shack part # 15-3031 plus adapters for the M-Audio cards.

The following are parameters which vary from card to card. I have assigned relative "grades" for some categories.

	Noise Floor: Display Center	Noise Floor: Display Edges	Approx CPU Usage (%)	App Sharing	Cost New	Production Status	Windows 7 Compatibility
Up to 192 kHz							

Creative Labs E-MU 0202 USB	-130dBm	-125dBm	C	B	$100	Replaced by E-MU 0204	Compatible for ASIO with beta driver, not MME compatible except thru WIndows Mixer.
Creative Labs E-MU 0204 USB	-130dBm	-125dBm	C	B	$140	In production	Compatible with beta driver. Not fully MME compatible except thru Windows Mixer.
Roland Edirol FA-66 Firewire	-129dBm	-119dBm	B	B	$300-$400	In production	Not tested
Creative Labs E-MU 1212m PCI E-MU 1212m PCIe	-138dBm	-138dBm	B	A	$140	PCIe version in production	Compatible for ASIO and MME, but many users report difficulty with MME.
Infrasonic Quartet PCI	-133dBm	-125dBm	B	A	$140	Out of production	Compatible for ASIO, compatible for MME.
Up to 96 kHz							
M-Audio Firewire Audiophile	-131dBm	-131dBm	A	A	$80 Used	Out of production	Not tested
M-Audio Delta44 PCI	-129dBm	-129dBm	A	A	$150	Out of production	Not tested
M-Audio Audiophile 2496 PCI	-131dBm	-131dBm	A	A	$90	In production	Seems compatible for ASIO and MME in limited testing

Sound card setup and configurations:

Infrasonic Quartet
E-MU 0202
M-Audio Audiophile 2496
E-MU 1212m

Ayatem 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 XP. Vista Tuning for LP-PAN.pdf

Eliminating Images

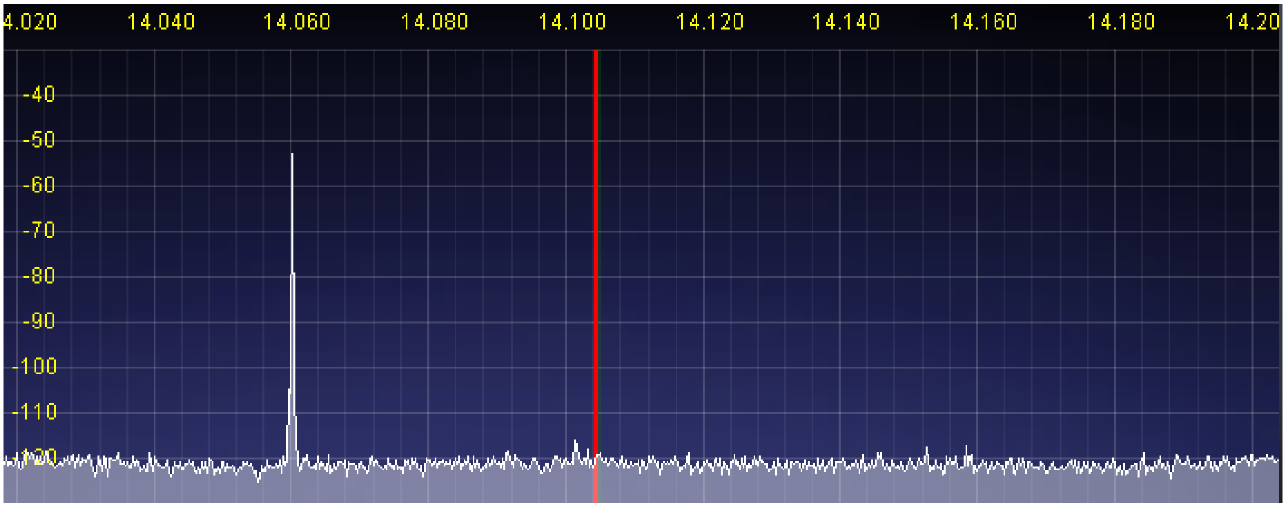
SDRs work on the same principle as the original "phasing" type of SSB generation. Two wideband audio signals are created in LP-PAN, which are identical in every way except that they differ in phase by 90 degrees at every frequency. This is referred to as quadrature phasing. The outputs of LP-PAN are 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 on the left side of the display will appear on the right side of the display (and vice versa). 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.

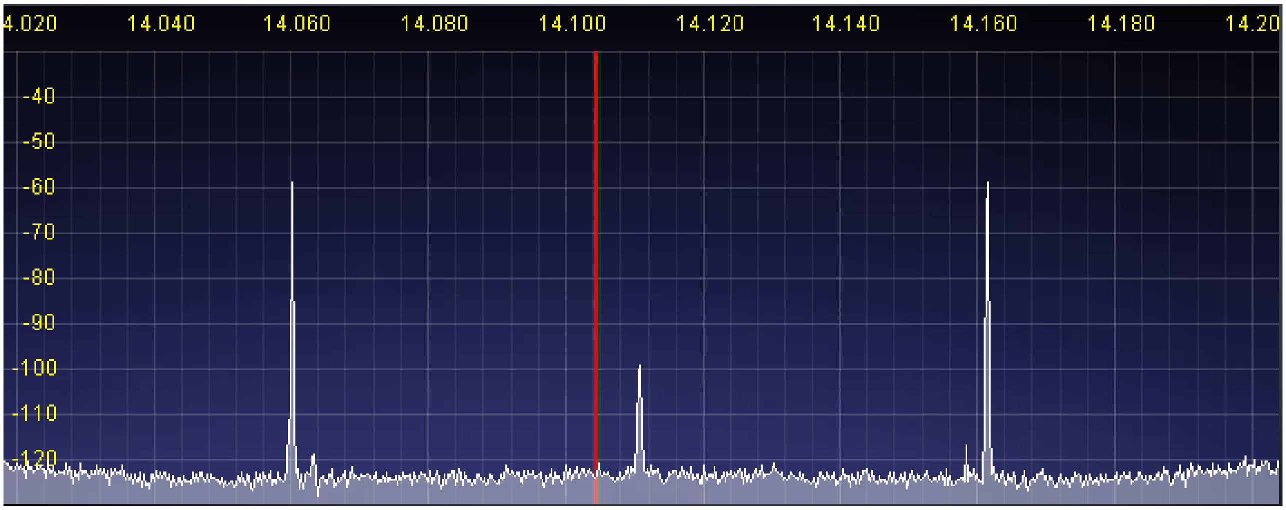
In both PowerSDR/IF and NaP3, which are based on the open source PowerSDR™ program from FlexRadio Systems, an algorithm called Wide Band Image Rejection (WBIR) automatically corrects for any imbalances in the sound card channels, and eliminates the images. But WBIR requires certain conditions to "learn" 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 at all. NOTE: There is one difference between PowerSDR/IF and NaP3... NaP3 saves the current WBIR seed values when it closes, and uses those as the starting point the next time the program is started. This is an advantage for band swith weak signals, but of course it still takes strong signals for the algorithm to imitially learn. PowerSDR/IF always starts from scratch, so it always needs strong signals to come up with a solution.

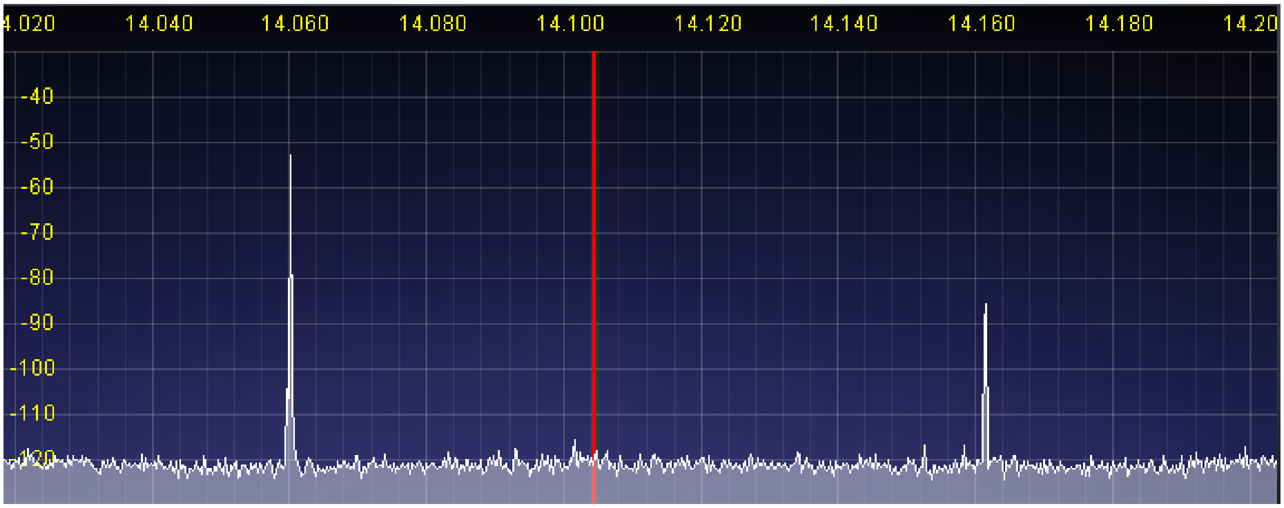
Below is a screen capture from the SDR showing what the display looks like with a single signal and proper image cancellation...



The image signal would appear at 14.161 in this example (equidistant from the IF center, but on the other side). Note 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...

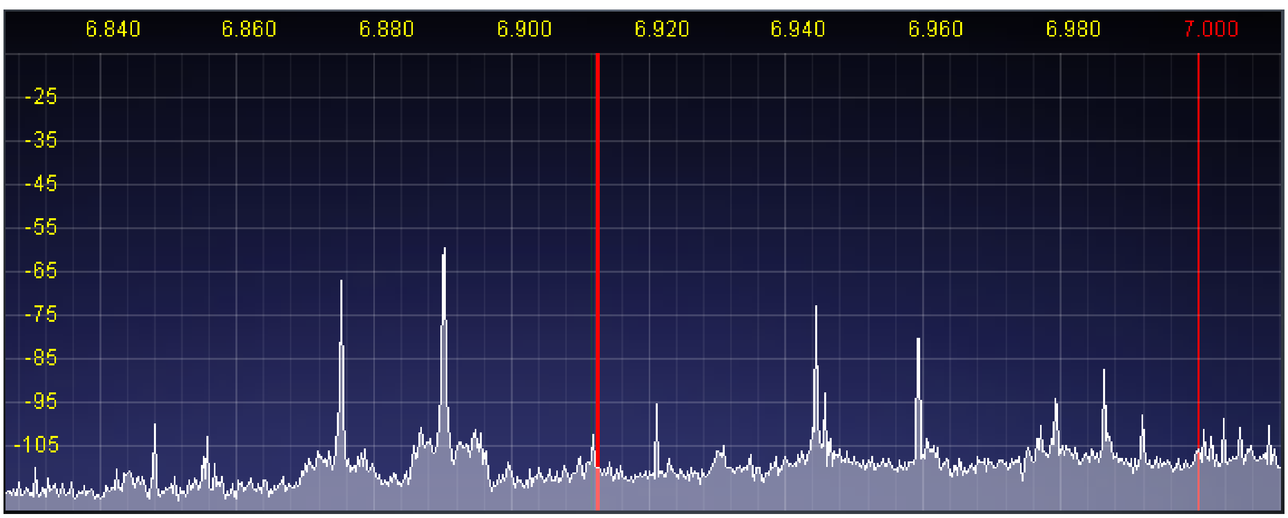


The blip in the IF center respresents hum due to the unterminated cable. The display will look the same with either channel unplugged. If it doesn't, then there is a problem with one of the LP-PAN outputs, or cabling, that must be corrected before proper operation can be attempted. Below is a capture 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.

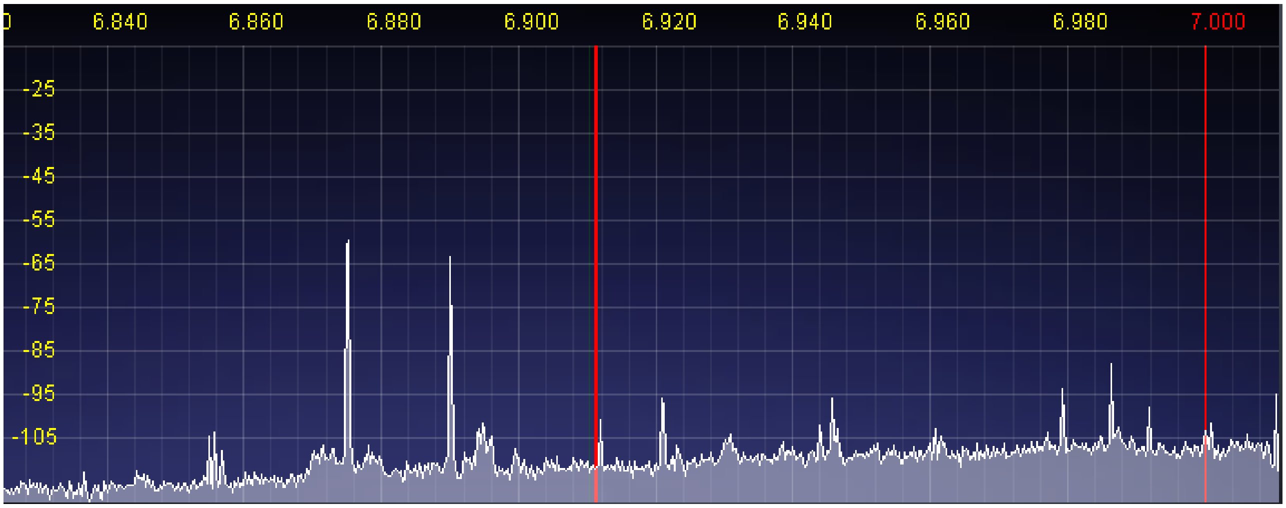


As well as WBIR works, the trick is getting it to initially learn. To repeat, WBIR works best when there is at least one strong signal in the 196kHz passband, meaning at least 50dB above the noise floor. For comparison, signals 50dB above the noise floor will take about 3 minutes for learning. Signals 70dB or more above the noise floor will require about 15 seconds.

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 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 defaulty settings and not learn. With NaP3, it will start with the last good settings, so it will be better.

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 aufio 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.