PMSDR

Software-Defined-Radio

for **HF** **a**nd **VHF**

PMSDR

Software-Defined Radio for HF and VHF
v1.0 - Apr. 2011

"From Factory to Field Usage"

Contents

Introduction

The PMSDR is an example of a QSD-SDR Receiver (**Q**uadrature - **S**ample-**D**etector; **S**oftware-**D**efined-**R**adio). The concepts applied here produce a clean output spectrum, very low phase noise, and an almost unbeatable cost/capability ratio. This way, one may produce a small but capable SDR receiver with a general suitability over the complete shortwave domain. The control connection to the PC, as well as the DC power, takes place through a USB connection. The I/Q outputs are connected to the stereo line input of the PC's soundcard. Audio is available via either headphones or loudspeaker.
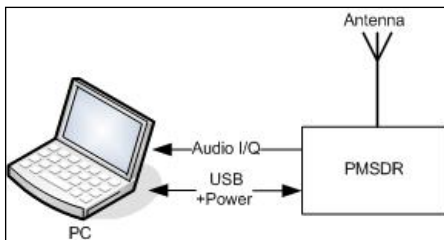

Fig. 1: PC-PMSDR Connections

This offers a simple and capable solution for all conceivable options for long and shortwave reception.

A novel use of oscillator overtones makes even VHF reception possible, with only a small loss of sensitivity. Reception is also possible in the 2m amateur band (144MHz), without an additional converter.

If there is concern over restrictions imposed by this method, an optional down-converter is available.

■ Free Software

Ultimately, reception takes place on the PC via free software.

The connecting link between the hardware and the control software is a so-called DLL (**D**ynamic **L**ink **L**ibrary). This DLL contains program code used by both the PMSDR and the PC control software.

With this DLL, PMSDR possesses wide ranging capabilities. Among others, it will function as a b**idirectional**, tunable Panadapter.

There are many additional options, interconnection possibilities, and CAT-Interfaces to other programs as well, including several transceivers that are already available, or being continuously adapted and further developed.

PMSDR works optimally and with support of all the capabilities offered by the DLL mentioned above, with the outstanding software program "Winrad." Winrad was first developed for Windows by Alberto (I2PHD), but unfortunately this software was not further developed by its author. Alberto graciously placed the source code in the public domain. Capable individuals are continuously developing these programs.

On the accompanying CD you will find the most current **Winrad** version in its original form [3] as well as its extension as **HDSDR** [8] (previously **WinradHD**), and **WRplus** [10].

There has been a further very significant development in a program called **WinradF** [9]. Unfortunately the link to the home page of this author is inactive, and at present no one knows if this important beginning will be followed further...

With a loss of a bit of operator convenience, PMSDR can also operate with PowerSDR-IQ, with G8JCFSDR Software, as well as with the SDR Shell for Linux.

All modes can be received with this software. Virtual interfaces (additional software, for example: VAC, Com0Com, VSPE; on the CD) make possible operation with other software, for example that for digital modes.

■ The Receiver

The receiver in the PMSDR is designed to be a highly capable all-band receiver for the frequency range 0.1-55 MHz. Thanks to the excellent properties of the mixer, supported by automatically switched preselection filters, the large signal behavior is unusually good.

Experiments with the large 40m full-size loop from the QRP-Project [5] have demonstrated that the PMSDR shows that it can, even in the evening hours, and without a preselector, receive the weakest amateur signals. Therefore, PMSDR is an ideal tool for monitoring for the amateur radio operator as well as for the shortwave listener. Even friends of the "magic band" can listen in on the activity of the 50 MHz band without difficulty.

■ Requirements on the PC

The requirements on the capabilities of the PC are not severe. Even running the system on a netbook causes no problems with PMSDR.

■Further Development

PMSDR is continuously in development. Please visit the developer's web site on a regular basis [1]. You will probably find a current DLL, or also new Firmware which can be quickly installed in PMSDR over the USB connection.

☞ You will find detailed technical information in an Appendix.

Construction Notes

This kit is tailored to meet your particular requirements. All parts that are really difficult to handle (surface mount devices) have been installed on the circuit boards by professional circuit board producers using automatic positioning devices.

To complete the kit, only the installation of the uncritical, larger components (such as LEDs, headers, sockets, crystals, and so forth) remains. This requires no experience soldering SMD components, greatly facilitating the mounting process. One estimates the necessary time for assembly of the main circuit board and enclosure to be approximately one hour!

With a suitable antenna, you are quickly on target to hear your first stations.

■ The Kits

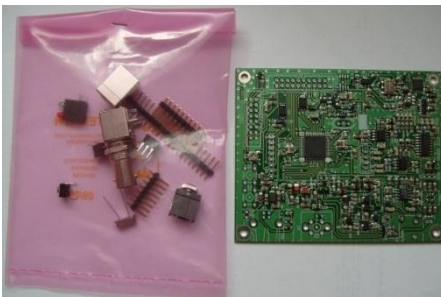The scope of delivery varies considerably, according to your needs.

Fig. 2: PMSDR Kit

Figure 2 shows only the PMSDR Kit, which can be expanded at any time by adding Display, Enclosure, T/R Switch (Switchboard) and Down-Converter.
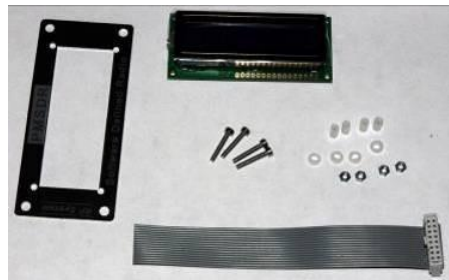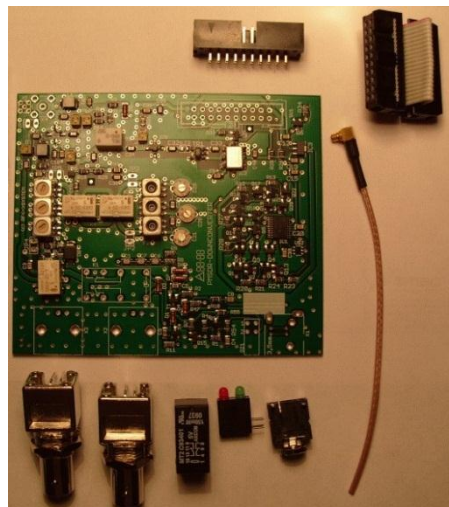

Fig. 3: Enclosure Kit

Fig. 4: Display Kit
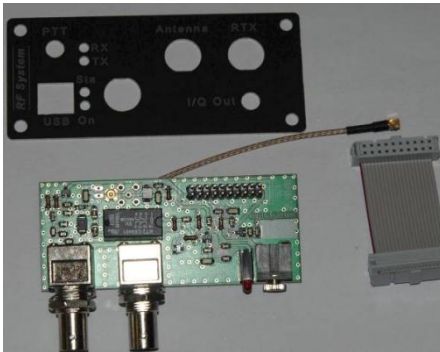

Fig. 5: Down-Converter Kit

Fig. 6: Switchboard T/R Kit

■ Tools needed:
You will find the following set of tools to be adequate:

-Solder: ca. 0.5 to 0.7mm

-Desoldering braid: 2.5mm

-Soldering iron: ca. 30 to 50 watt, best if temperature regulated and with a narrow chisel tip.

-A small electronics sidecutter and various screwdrivers will be useful.

-A particularly useful device is a "third hand," which greatly facilitates the work. Circuit board holders of various types are available (vide [6] or [7]).

Fig. 7: Third Hand

■ Protect against Static Electricity!

During soldering and when handling the boards, one must be certain to provide full protection against static electricity.

Electrostatic discharge can easily destroy the chips on the circuit boards. Such damage can cause later difficulty in troubleshooting and in localizing problems. A grounding strap or wrist band is not absolutely necessary, but if you have one, use it. Touching a grounded surface, such as a nearby radiator or the exterior of your soldering station is sufficient. IF you should feel a static discharge (a "shock"), regard this as "**Level Red**" and look for the reason. Are you perhaps standing on a carpet? If so, use a different workplace. If you are wearing felt or fur slippers, immediately change to other shoes (or work barefoot). Components that are particularly static-sensitive are marked in the parts list and specifically pointed out in the assembly instructions. Be sure to leave these parts in their antistatic packaging until you are actually ready to use them. The packaging consists either of an antistatic plastic bag, or conductive plastic foam into which the leads of the parts are inserted.

■ Soldering
If this is your first experience with soldering on circuit boards, please definitely read further. The experienced among you can skip this section without further ado.

All circuit boards are double sided, and all holes are plated through. This means that one does not have to (and should not!) solder on the component side of the boards. In a few cases (changes in the enclosure originating with the vendor), it may become necessary to place a component on the conductor side of the board. Always work with a preheated soldering iron. If you are able to set the temperature of the iron, use 350°C to 400°C. Use a minimal soldering time! Beginners, particularly, have a tendency to stay on a solder point too long, detaching a conductor trace and applying an excess of solder. One should never use any additional soldering aids such as liquid flux, soldering paste. Modern-day solder for electronics use contains a core of flux that already serves this purpose.

■ Lead-Free, If You Please!

At present, there are solders of various compositions. The high toxic lead content makes it necessary to comply with the provisions of EHS! During soldering, do not place your nose directly in the smoke coming from the operation! Commercially-available so-called "environmentally friendly" solder has not been proven in practice. The cheapest and most widely used alloy, called Sn64Pb36, consists of 64% tin and 36% lead. Compositions with 2% copper or silver have a lower melting point, which makes the soldering somewhat easier, and the joints are noticeably shiny.

The latter has of course no particular electrical significance, but pleases many hobbyists. Whether you use silver or copper based solder makes no real difference except to your wallet!

■ 30-50 Watt Soldering Station

A soldering station that works with low voltage and potential equalization is optimum. Please do not use one of the old soldering iron models, in which the tip is inserted into the core and held in place by a screw. In this old style iron, the tip is often poorly held in the heating element and has, on this account, very poor heat transfer. If you need to buy a new iron, please buy a modern one. These irons have a plated tip and are pre-tinned.

Keep the soldering iron tip clean as you work. Use a damp sponge or a damp cloth to clean the tip regularly. An 0.8 to 1.0 mm tip is ideal for normal circuit board traces. For large-area surfaces, this kind of tip is not really suitable, and a somewhat broader tip (so-called chisel point) is advantageous because of the improved heat transfer. At least these two tip types are useful. They can be interchanged when it becomes necessary to solder, e.g., some large flat surface. Only heat the point being soldered just sufficiently to give a good connection.

A small circuit board holder makes working on the board easier.

In cross-section, correct and incorrect solder joints appear as shown below:

Fig. 8: Solder joints
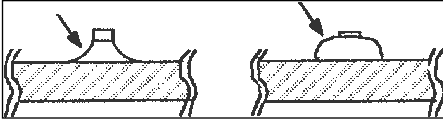
Good: The solder joint is concave in shape.

Poor: The joint is lumpy and saturated with solder.

Touch the board trace and the component connection at the same time with the soldering tip. Apply the solder within one or two seconds. First take away the solder, and then the tip of the iron. Be sparing with the solder; too much solder may cause solder bridges to neighboring components. If you don't notice such a bridge while soldering, it can be very difficult to find at a later time. If a solder bridge occurs, remove it carefully with desoldering braid. This is described in the next section.

All components should, in so far as possible, be in contact with the board surface. This has nothing to do with aesthetics, but is a necessity in high frequency technique. Accordingly, resistors lie with their body flat on the circuit board unless of course they are to be installed vertically. Capacitors are likewise installed against the board. In other words, there are no components with long legs. (These are to be found elsewhere ... ☺)

■ Desoldering

When desoldering, only apply heat for a minimal time, to avoid detaching the circuit trace from the board. If you need to completely remove a component again, cut it with the side cutter in such a way that each lead is individually left. In the case of a resistor for example, cut both leads close to the body. In the case of transistors, 3 leads are left, and on an IC, cut all the leads, close to the body of the IC. There are now two ways to proceed: If you have a helper (Wife, son daughter, friend; not necessarily an expert) the rest is quite simple: your helper pulls the free leads one after another on your command with a tweezer as the soldering iron is applied on the opposite side with just enough heat to melt it free;. If you don't have someone to assist, both heating and extraction must be cleverly executed at the same time.

This works best with the aid of a stable board holder, as mentioned above. When the leads have been removed, then the component hole(s) can be cleaned with desoldering braid. Use braid with a width of 2.5 mm, and always work with a clean, fresh piece. Cut and discard used pieces of the braid before using it anew. Put a small surface of the braid on the solder point, then put your soldering iron lightly against the braid, until the solder is sucked up into the copper. The component can then be easily removed, replaced, and soldered cleanly in place. Use a circuit board holder, as we have mentioned several times already. This frees both hands, and also makes the re-soldering go much more simply!

Since soldering is a general part of electronics assembly, we give here a URL containing videos dealing with a wide variety of situations:

www.solder.net/technical/tips.asp

■ Filling the PMSDR Board

Let's start with the installation of a few of the remaining additional components. Refer to the color-coded diagram, Fig. 9. Take care that the BNC jacks lie flat on the board. If this is done, their leading edge is exactly parallel to the PCB edge.
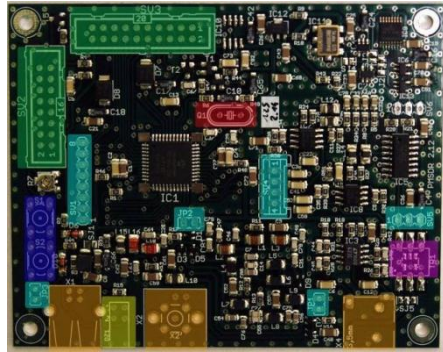

Fig. 9: Insertion Diagram, PMSDR-Board

Parts / Locations:

[ ] **Red**: Crystal
[ ] **Orange**: 3x USB/BNC Jacks
[ ] **Green:** 2x 2-rowed headers
[ ] **Yellow:** LED Block
[ ] **Violet:** HF-Transformer
[ ] **Bright Blue:** 3x 1-rowed headers
[ ] **Dark Blue:** 2x Buttons

Check the box when each component type is installed.

Crystal: The orientation of the crystal is immaterial.

[ ] Crystal

Headers: (vide also Page 14!)

☞ Headers are always mounted with the short ends inserted into the circuit board. Make sure that they sit flat on the board surface.

[ ] 2-Rowed Header (2x10 PIN's)
[ ] 2-Rowed Header (2x 8 PIN's)

The double LED block must also sit squarely and parallel, aligned with the front edge of the board.

[ ] Double LED Block

Some of the row headers must be cut from a longer header with a sharp sidecutter. Place the headers so that they sit perpendicular to the board surface.

[ ] 1 Row, 8 Pin Header (SV1)
[ ] 2 ditto. 1 Row, 2 Pin (JP2/JP3)

☞ **Nothing is to be installed at positions SV4, SV5, SV6, and JP1.**

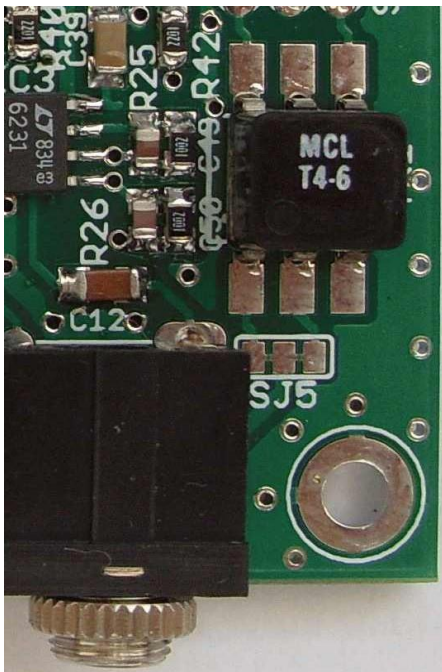The small six-legged component in the components package is a prefabricated HF transformer.

Fig. 10 HF Transformer

[ ] Trafo MCL T4-6

It is marked: **MCL T4-6**.

Place it on the pads so that the label is readable viewing from the side with the jacks. Solder as usual from the solder side of the board.
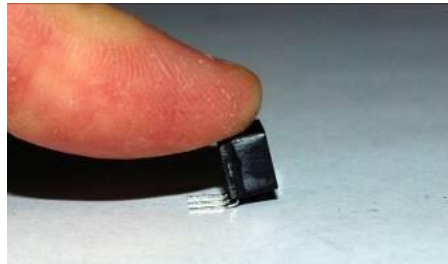

Fig. 11: Positioning the Leads

If the pins do not fit straight into the holes, bend them using gentle pressure on a hard surface, as in Fig. 11 above..
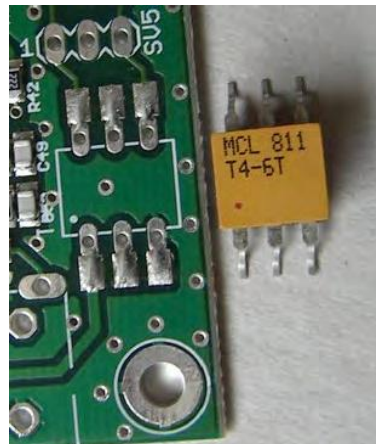

Fig. 12: Alternative Conformation

Another supplier may provide a component with legs clearly bent to the sides. As an exception, solder this component **from the upper side** of the circuit board. The solder pads are ready for this case.

Jacks and Buttons:

Again, note that these sit level on the board, and are aligned parallel to the front board edge. On the ground pins of the BNC plugs, use a suitably-hot iron with a broad tip to avoid damage to the board by overheating as a result of heating too long. Even if the buttons have a square shape, the solder tails are not arranged in a square but rectangular form. Don't use force on the solder eyelets; insure that the solder tails sit exactly over the solder eyelets. Press the buttons carefully against the board. The leads snap into place when they are properly positioned.

[ ] Stereo Jack for 3.5 mm plug.
[ ] USB Jack
[ ] 2x pushbuttons
[ ] **BNC Jack**
[ ] **Antenna**
        Do not install if installing the Switchboard option!

■ Option: Display

If you didn't order the display option, skip to the section on installation of the PMSDR in the enclosure…

☞ There are displays on the market that produce very significant interference, and which therefore have a severe influence on the sensitivity of reception with the PMSDR. The display we deliver was chosen for its minimal interference, and its power supply is also decoupled.
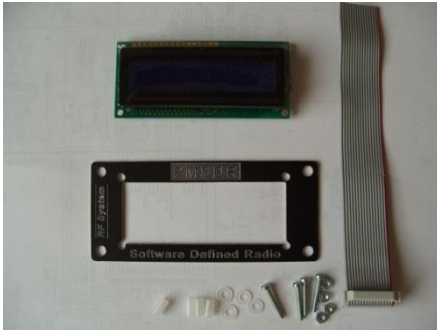

Insert Spacers Here

Fig. 14: Display Assembly

At this point, prepare the ribbon cable for connection to the display.

Fig. 13: Display Kit

The display unit, with adhesive and frame, is delivered ready to use.
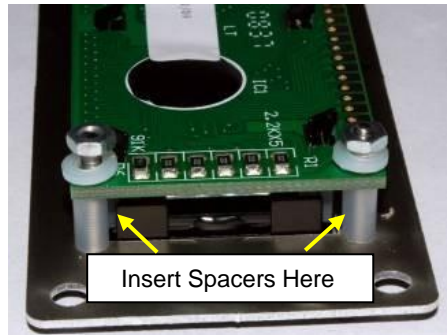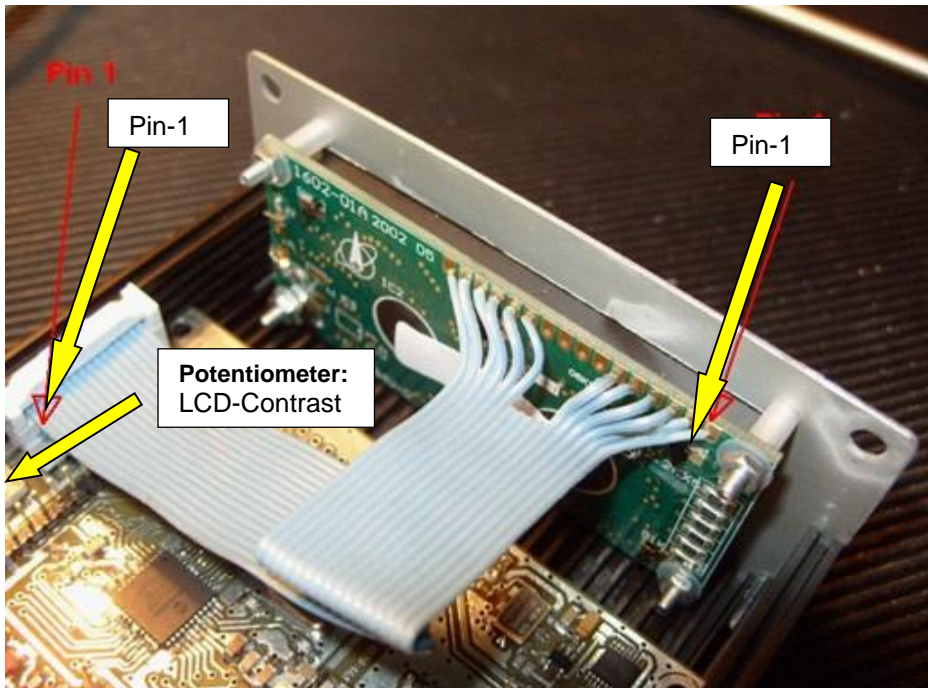Examine Figs. 14 and 15 for placement of screws and plastic spacer.

Fig. 15: Display in place and connected

Split the cable end opposite from the connector as follows. Begin with wire number 1 (with the red tracer). If your cable has no red tracer, see Fig. 15.
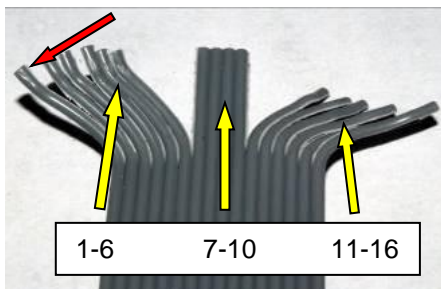
Fig. 16: Prepared Ribbon Cable

This shows how to identify wire 1 via the connector if the color tracer is

missing. If possible, use your fingernail rather than a tool. Divide the ribbon cable between the 6th and 7th wire for 3 to 5 cm. Count further to the 10th wire and divide the cable again between wires 10 and 11.

Cut away about 2 cm of the free section (wires 7-10). Now, again using your fingernail, separate the individual wires 1 through 6 and 11 through 16 so that the ends are each ca. 2 cm long.

Strip off about 3 mm of the insulation. Here again do not use a sidecutter, as in so doing, it is highly probable that you will damage the thin wires and make breaks in them. A good wire stripper, however, will work very well. Especially good are the automatic versions, with a relatively wide "mouth." These types can strip the ribbon cable, several wires at once. The insulation on the ribbon cable supplied can, however, be easily nicked and removed with the thumb nail. Check the resulting strands. If they are fanned out, then carefully use two fingers to twist them together. Tin the wire ends very lightly, so that there are no loose strands.



Fig. 17: Solder Ribbon Cable

Subsequent soldering of the ribbon cable is greatly simplified if the display is placed in a suitable holder or clamps.

In what follows, pay close attention that the wires are soldered exactly in the order 1-6 and 11-16. Nowhere do two wires cross! The ribbon cable is inserted strand by strand into the corresponding pads of the display board. Examine Fig. 15 and 17.

Begin on the right with wire 1 and solder 1-6. Eyelets 7-10 remain open, corresponding to the fact that you earlier cut back the wires on the ribbon cable. Finish by soldering wires 11-16. At this point the display can be fastened to the front panel. Use the 2mm nuts and bushings supplied. Follow Fig. 14; the nuts are on the innermost position inside the housing.

Addendum for headers and header connectors.
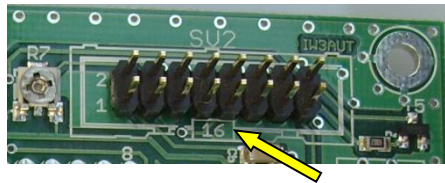
If your kit was supplied with mounted pins instead of bare ones, the printing 16 (or 20, respectively) shows the position of the notch on the board. Be careful to follow this orientation.

■ Option: Enclosure

Installation using the optional enclosure is quite simple. Remove the nut and lock washer from the BNC jack, as well as the nut from the stereo jack. Insert the back panel right side up on the board edge bearing these jacks, and install the nut and lock washer on the BNC jack and the nut onto the stereo jack, leaving them loose.
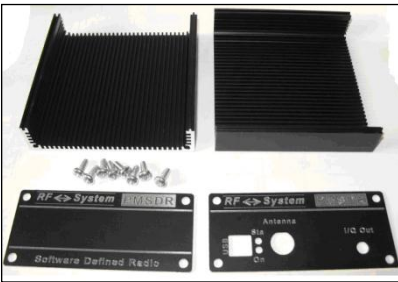

Fig. 18: Enclosure (Housing) Kit

Tighten these nuts before installing the upper part of the housing...
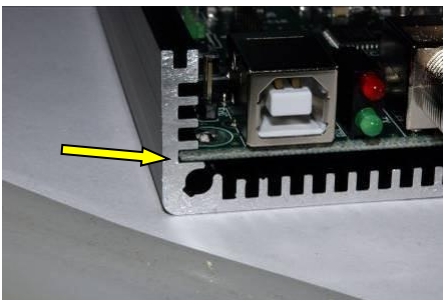

Fig. 19: Insert Circuit Board Here

Slide the circuit board into the U-shaped lower section, using the first (lowest) slot.
Now attach the rear panel at the bottom with 2 of the 8 self-tapping enclosure screws. The screws will be a bit hard to turn, as on first insertion they have to cut their own threads.

When the back panel is attached, the front panel (with or without the display) can be screwed to the front side.

☞ **If you have the display, don't attach the cover, since the contrast potentiometer may need to be adjusted**.

If you don't have the display, the upper cover can now be mounted.

Best Wishes

We're about finished, and not far from receiving the first signals.

☞ If you did not order any options, skip directly to the Start-up Chapter on page 25.
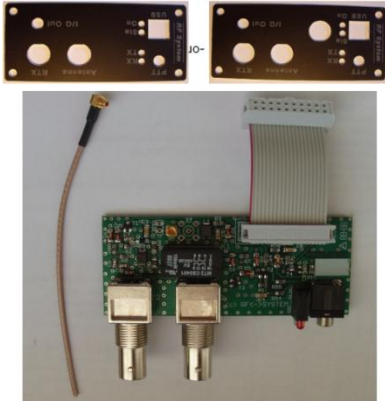
■ Option: T/R Switch (Switchboard)

Fig. 20: T/R Switch Option

Fig. 23: Switch Circuit Board

This board is, like the PMSDR board, delivered with SMD in place.

The switch is available in two variants, which differ only in the cutouts of the rear panel. If you ordered your kit including the switch, you received rear panel Type 2.
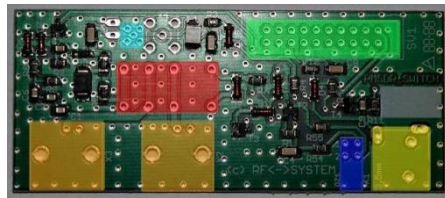
Fig. 24: Switch Layout

Populate the board with the 7 components as follows:

Fig. 21: Type 2 Rear Panel; In this case, do not install the antenna jack on the PMSDR circuit board!

Placement of Components:

[ ] **Rd**: Relay
[ ] **Orange**: 2x BNC Jacks
[ ] **Green:** 2-Rowed Header
[ ] **Yellow:** LED Block
[ ] **Light Blue:** MMCX/SMA-Jack
[ ] **Dark Blue:** LED Block
[ ] **Coax Cable with** MMCX Plug

In the other case, i.e. when retrofitting, you receive a rear panel of Type 1.

Install the individual components according to their corresponding colors.

Fig. 22 Type 1 Rear Panel

You should first attach both BNC jacks to the rear panel, and then solder the result to the circuit board If you try to first mount the jacks to the board and then mount the rear panel, the panel will not be exactly parallel to the board (because the BNC jacks have a little "play.").

Fig. 25: Finished Circuit Board

Now it is only a matter of connecting the supplied coaxial cable to the PMSDR, putting on the pin header to connect the two boards, and screwing the board to the back panel. But first things first:

Fig. 26: Prepared Coax Cable

The task now is to solder the coax cable so that the shield connects to the right lead, and the center conductor connects to the left lead of JP2 Orient the cable so that you have the BNC jack directly in front of you. Remove about 1 cm from the sheath of the coax, using a sharp knife, but being careful not to damage the shield beneath it. Dress the shield back away from the center conductor (and insulation) and remove about 5 mm of the center conductor's insulation. Lightly tin the center conductor, as well as that part of the shield you bent back away from the tip. Tinning the shield should be done in small stages. Work stepwise, until you have tinned completely around the rim. By working in stages, you avoid melting the center insulation by over-heating.

The cable is now ready to install. The location is labeled JP2 on the main circuit board. It is between the BNC jack and IC1.

Fig. 27: Detail around JP2

Be sure to check carefully for a short-circuit between the pins of JP2.

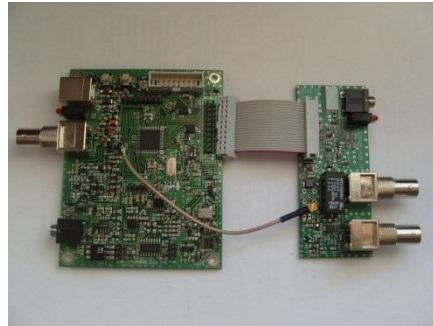The two units will finally be connected as follows.
.

Fig. 29: Interconnected Units

■ **Interconnection of the Units**

Now screw the switchboard down to the back panel. This secures the small board via the 3 screws on the jack.
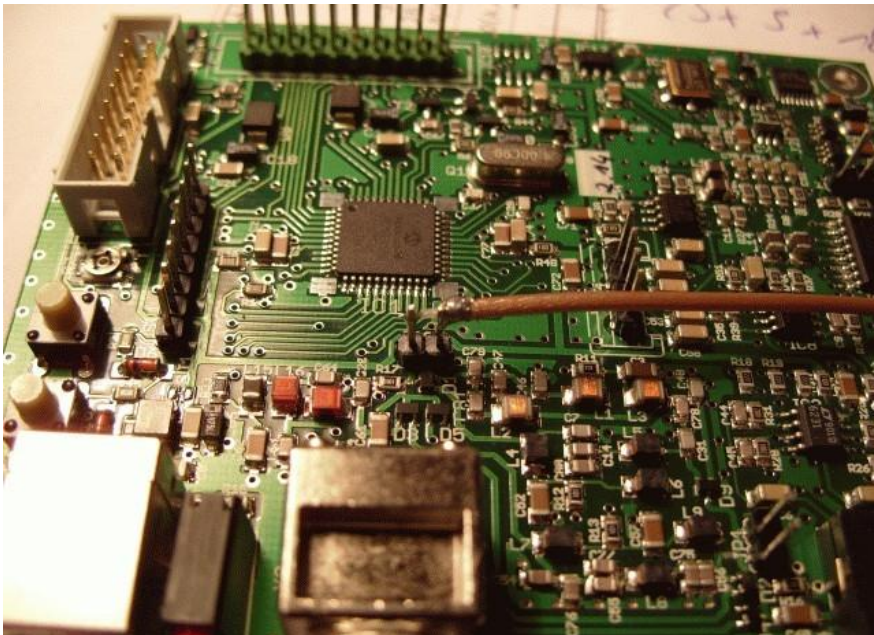
Fig. 28: Connection to JP2

Plug one side of the ribbon cable on the board, as shown here.

Fig. 30: Ribbon Cable connected

Put the small coax MMCX/SMA plug carefully in its socket.

Fig. 31: Detail, MMCX plug

Screw the rear panel to the enclosure, and finally connect the other end of the ribbon cable to the row of pins SV3 on the PMSDR board.

The cable runs directly linearly from the upper board to the lower board.

Finally, put the enclosure cover on, and you're finished.

Fig. 32: T/R Switch Installed

The PMSDR with the T/R switch installed corresponds to one or the other of these figures:

Fig. 33: Rear, Type 2; Completed

Fig. 34: Rear, Type 1; Completed

■ Alternative T/R-Switch Modification

Fig. 35: Detail from Circuit Diagram

To install this, you only need to remove the upper part of the housing. The board is then already in the correct orientation. The two eyelets may easily be soldered from the side turned toward you.
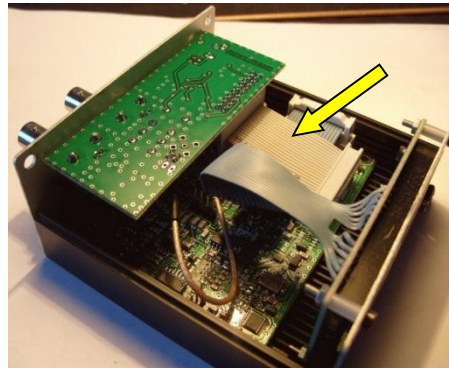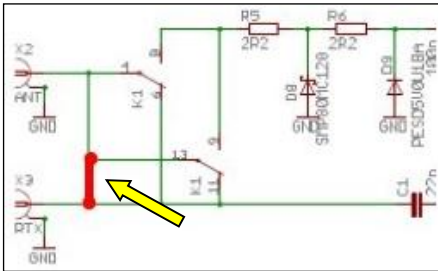
Important Notice: This modification carries with it a risk of damage for the switch board: If, for whatever reason the RF vox fails or does not respond, the full RF power of the transmitter will go into the receiver channel and in all probability damage
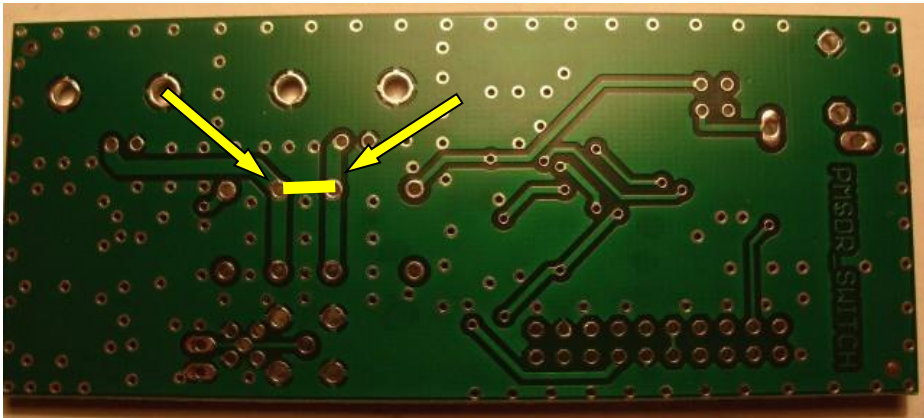
Fig. 36: Additional Bridge

There is a small additional modification that we want to share with you. It allows simultaneous reception via RX/TX and PMSDR. This allows good comparisons to be made between methods. You lose only about 3 dB in sensitivity with the two receiver inputs. Fig. 36 shows the added connection. Use a short piece of insulated wire as a bridge on the underside of the board between the two eyelets shown.

it. We therefore recommend that the switchboard, when modified in this way, not be used with the internal RF vox, but that it be controlled by the PTT output of the transceiver.

■ Option: VHF/UHF Down-Converter
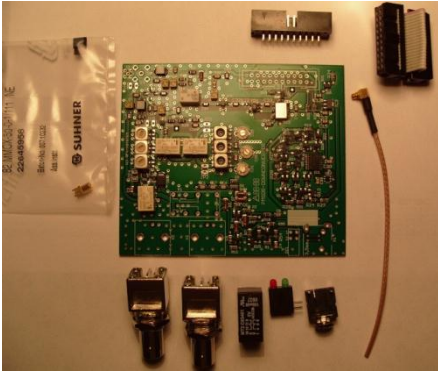
Fig. 37: Kit

The T/R switch function is built into the down-converter. That is, there is only an either/or installation option in the existing PMSDR housing; either the switch function or the down-converter with built-in switching function.

Both the construction and the installation in the PMSDR enclosure run very similarly to the installation already described for the switch. Which of the two rear panels is appropriate depends on your situation. If you are upgrading a currently existing PMSDR, it is this:

Fig. 38: Type 1 Rear Panel

If you are building from scratch, it is this rear panel:

Fig. 39: Type 2 Rear Panel

Fig. 40: Component Placement

We have adapted the kit to the state of the art, and now provide a fully tested and calibrated board. (Fig. 37 still shows the old version). There are three components to be installed:

[ ] BNC Jack
[ ] Double LED Block
[ ] 3,5mm plug jack

Figs. 40 and 41 show clearly the positions of the parts to be used.

The filters that are on the module are already set up. (They are Filter F2, C21, C28, und C29 for the 2m Band, as well as Filter F1 for the 70cm Band.) For experts: Jumper JP4/JP5 allows the connection of a network analyzer for the extended filter range for filter F2, (or for filter F1 at JP2/JP3.)

After mounting these few parts, the board is ready for installation.
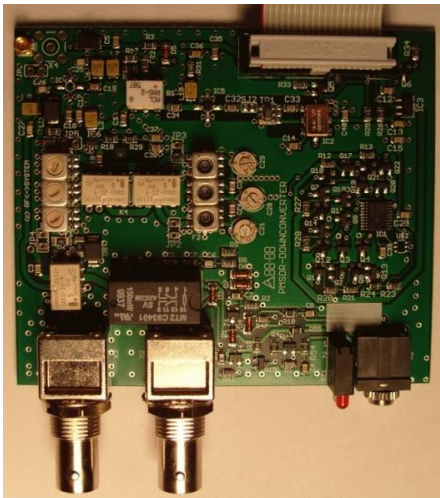
Fig. 41: The fully populated board

As in the case of the switchboard (above), strip the short piece of coax and connect it to JP2 on the main board. The process is identical.

Now attach the rear panel in the same way as before, and screw the unit onto the housing.

Connect the ribbon cable and the coax to the down-converter board and to the corresponding points on the PMSDR board.
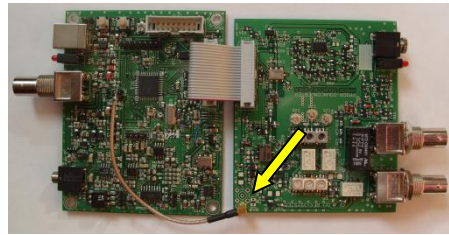
Fig. 42: Units Interconnected

Please pay careful attention to the short coax connection to JP2 on the board PMSDR. It should not be twisted.

Fig. 43: Circuit board installed

Screw the rear panel to the bottom part of the housing.

As the final step, install the front plate and display panel, and close up the enclosure with the upper half.

The fully assembled PMSDR with down-converter again corresponds to one of these two figures.

Fig. 44: Type 2 Rear Panel

Fig. 45: Type 1 Rear Panel

The same modification that was mentioned for the T/R switch may be made here, to allow simultaneous reception with both apparatuses.

In contrast to the T/R switch, you will not need to use a piece of wire here. It is sufficient to make a solder bridge between the two points with **a bit of** excess solder.

Fig. 46: Bridge with solder

Fig. 47: Positioning the bridge

■ The fully-populated PMSDR circuit board

Fig. 48: Circuit Board fully populated

Fig. 49: In Operation

Fig. 50: Power Supply Connected

■ Setting up the PMSDR

■ Overview

1. Connect PMSDR to the computer via USB cable and audio cable.
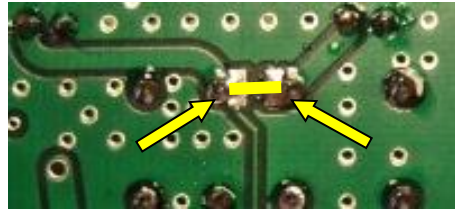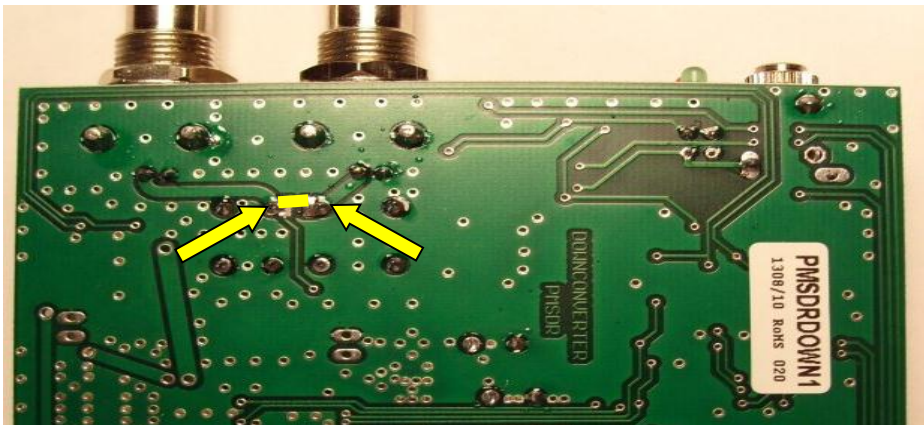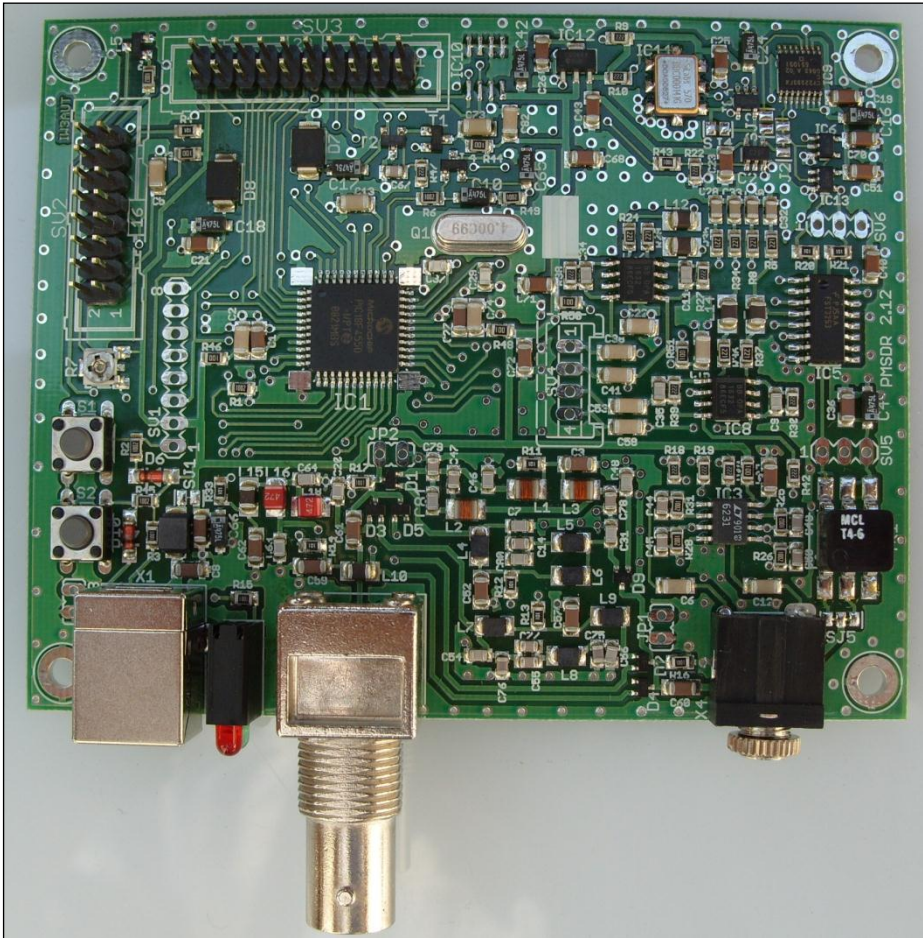2. Install USB driver
3. Install HDSDR software.
4. Copy DLLs contained in the HDSDR directory.
5. Set up and ready the PC sound card.
6. Make necessary settings in HDSDR.
7. Connect antenna and
8. Start HDSDR.

■In Detail:

■ 1.) USB and Audio Cable

Connect your USB and audio cable to your computer.

■ 2.) Install USB Driver

The PMSDR is both powered and controlled through the USB Port.

The necessary drivers should already be present (automatically installed) in Windows XP, Windows Vista and Windows 7. In case they are not, install them by hand as described below.

Windows automatically signals that it has found new hardware when a USB cable is connected. If the system recognizes the necessary driver, then a subsequent call to the Device Manager shows a screen similar to:

Fig. 51: USB Driver Properly Installed

If the highlighted line shows the same or similar, everything is OK. In this case, proceed to Step 3. If the driver is not found automatically, the Device Manager shows:
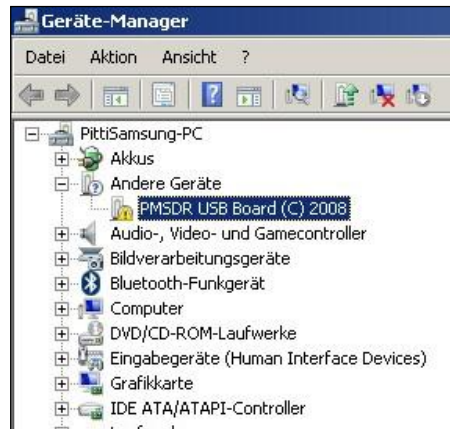

Fig. 52: USB Driver not recognized

In this case, you must intervene by hand. Right-click on the line in Device Manager with the yellow alarm labeled „PMSDR USB Board", in order to open the context menu.

We proceed with a question & answer game. Answer the question about "automatic updating" with "No, not this time," and click on „Proceed" In the next Dialog click on the buttons "Search the following sources" and "Search." Now select the path to your CD drive (containing the CD we provided). On the CD, find the folder **PMSDR_MCHPUSB driver,** click on it, and answer OK. This will locate the driver and install it. Device Manager should now show "Microchip Custom USB Device" as it appears in Fig. 51.

As soon as the driver is installed, the green LED on the rear panel of the PMSDR should come on, and if you have the display installed, it will light up in a blue color.

If you have the display option installed, the trim-pot R7 next to the display cable plug should be used to adjust the contrast according to your taste. The upper half of the enclosure can now be replaced and attached with the self-tapping screws provided

■ 3.) Installing Software

You should now install appropriate software for your PMSDR. The Winrad series from Alberto (I2PHD) is ideal, capable, and simple to operate.

The following example was created with the use of the very advanced program suite HDSDR, from DG0JBJ. Use Windows Explorer to access the DLL directory. Copy the 3 DLLs contained there, and also the package **HDSDR**, from DG0JBJ.

Other programs, such as the often-recommended "PowerSDR-IQ" are harder to configure and use. These non-Winrad based programs do not support the above-mentioned DLLs very well, which consequently significantly limits their utility.

If you wish to run Winrad with HDSDR on a netbook, you are better off with this version, which can compensate for the limited vertical resolution of the netbook. The program can be called up with a tag (**-wv**), which fully utilizes the available resolution in each case. Of this, more later.

Pick out the installation file for HDSDR from the **PC-Software** folder on the CD, and start the installation program. The best choice for the requested parameters is to leave them with their default values. HDSDR will then be put in the folder "**c:/Programme/HDSDR**" (WinXP) ("**Program Files**" for Win7).

■ 4.) Copy DLLs

The DLL files mentioned above must also be put into this folder, so that PMSDR can talk to HDSDR. Using Windows Explorer, call up the folder on the CD that contains the DLL files

and copy the 3 DLL files into the program folder of HDSDR. They are "**cc3260.dll**," "**ExtIO_PMSDR.dll**," "**mpusbapi.dll**".

☞   **Update the DLLs**

We have already mentioned earlier that these DLL are continuously under development. Therefore it is appropriate to look for new versions on the web site of the developer from time to time. With new versions, you simply proceed as usual. The DLL are presented in "zip" format. That is, these files are compressed to save space, and must be unpacked to recover the original form. Double clicking opens the archive. The 3 files inside should be copied to the HDSDR folder. Answer with "yes" to overwrite the prior versions.

■ **5.) Prepare the Sound Card (XP)**

PMSDR puts out two 90-degree phase shifted audio signals. These are the so-called I/Q signals, which are worked up to an audible signal in the sound card. These signals must be processed in parallel.

Your sound card must have a stereo input!

Unfortunately this is not the case with some sound cards. Check your available sound card for stereo capability. We proceed assuming that your computer is outfitted with a stereo input. Connect the computer to the PMSDR with a stereo cable.

Audio Connection

In most usual cases you will need a cable with a 3.5 mm stereo plug on both ends. To avoid distracting influences, it is useful also to connect headphones to the headphone output jack.
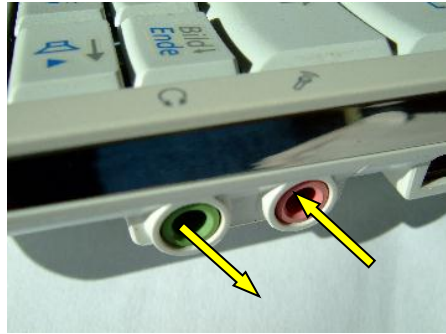

Fig. 53: The Samsung NC10 (Microphone Input = Pink; Line Output = green)

Figs. 53-55 show typical sound card inputs for various computers. (NC10 *vide* P. 37)
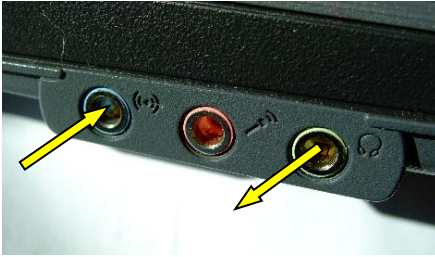
Fig. 54: Standard Laptop Line-In
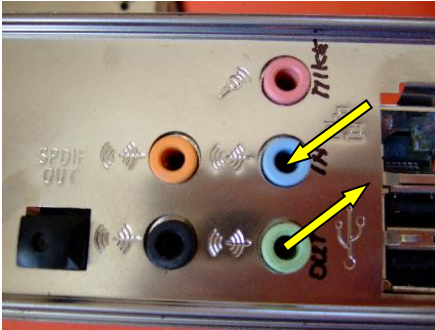
Fig. 55: Standard PC Line-In (Blue)

For making the following settings on the PC only minimal computer skills are needed.

Make the settings as you see them in the following pictures.
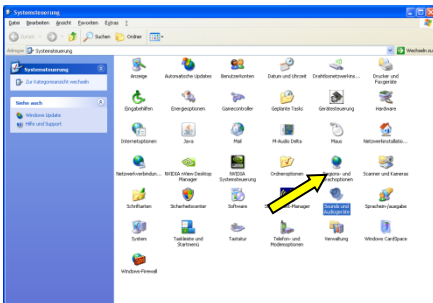
Fig. 56: Sounds and Audio
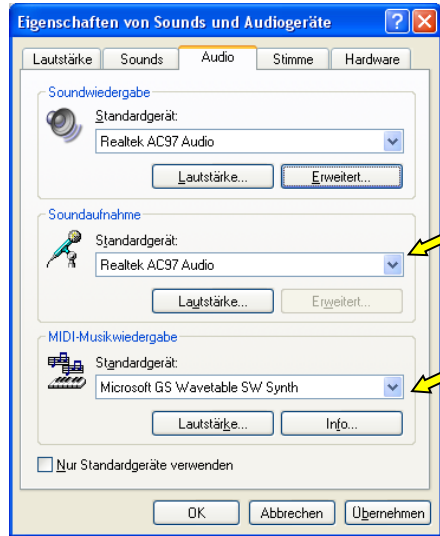
Fig. 57: Audio Properties

The following examples are taken from Windows XP, with a Realtek **AC97 Audio** sound card, which is standard in most notebooks.

A short series of pictures subsequently shows the calls for Windows 7 (*vide* Appendix).

Bring up Control Panel from the Start menu and double click "Sounds."

Make the settings as you see them in the following pictures.

Click sequentially the fields for Sound Reproduction and Sound Recording. Choose AC97 as the default.

In the Advanced box, set the speaker output to headphone output.

Fig. 58: Choose Earphones
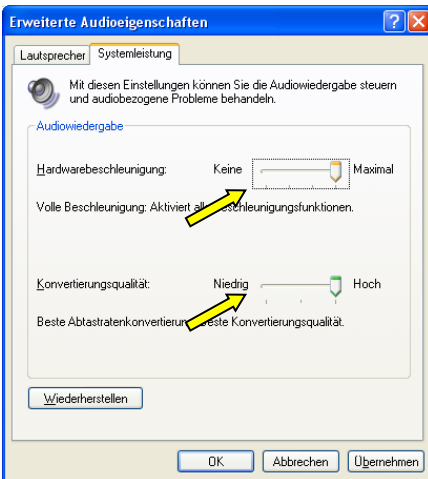
Fig. 59: System Capability

Set the sliders for system capability to maximum.

(Separately for recording and playback) You want everything not absolutely necessary to be off, so that only the necessary control fields remain.

Fig. 60: Volume Setting
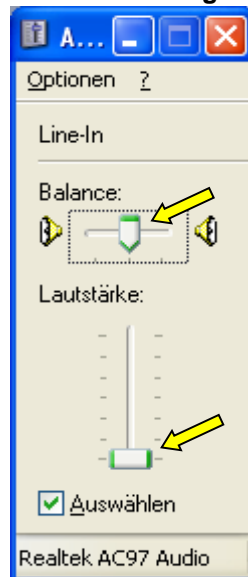
Fig. 61: Line-In to Minimum

☞ The slider for the Line-In input is deliberately close to the lower limit,

The levels at the I/Q output of the PMSDR are relatively high, so use

the least input amplification possible. Be sure that all the **balance** sliders are in the middle!
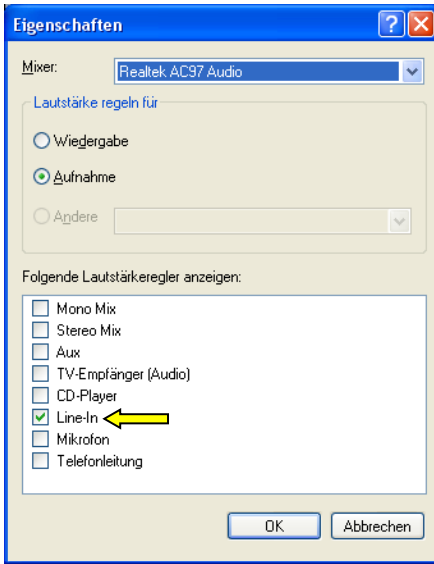
Fig. 62: Recording Choices

At this point, using "options" and "properties," you have deactivated everything not in use.

☞ **The following Playback settings active:** Only Loudness and Wave!
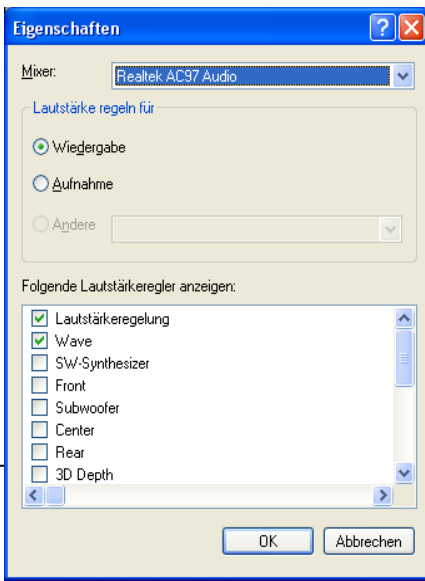
The following Recording settings active: Only Line-In!

The adjustments now showing up have been reduced to a minimum.

The only input appearing on your notebook or PC **MUST** be a stereo input.

Your PC manual should answer the question in this case.
Fig. 63: Playback Choices

Fig. 64: Additional functions
If this is not the case, use the microphone input, not the line in jack, but please note that
:

☞ **Mic-Boost** must not be switched on!

31

In the advanced installation, there is a check box for "Mic Boost."
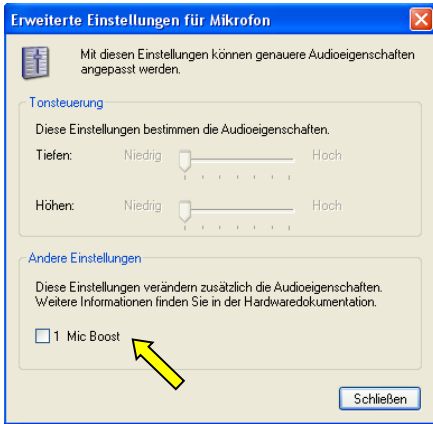
Fig. 65: Do not check Mic-Boost.

Nothing should be activated here, otherwise everything will be hopelessly overloaded! If your microphone input is also not a stereo input, you must first get an appropriate USB sound card*, then proceed as usual.

As a rule, all line inputs are stereo, so it is likely that there is no real problem here.

☞ *** Suitable models are listed in an Appendix.**

5a.) Win7 Sound Cards. See Appendix II

Procedures for WIN 7 run in an analogous way to those given for XP. A short series of pictures offers the necessary assistance, should you require it.

A left mouse click on the WIN 7 Start symbol opens a dialog box, in which you simply enter "sound card."
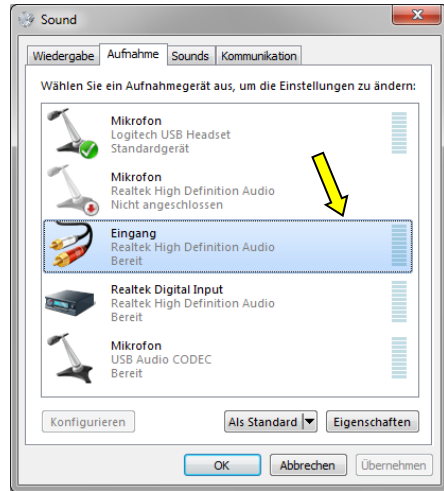
Normally this opens a selection box with fairly obvious choices:

Fig. 66: Keywords "Sound Card"

Simply click on "Change Sound Card Installation," if this choice appears.

Fig. 67: Recording

The new window shows you a summary of all installation possibilities for Recording and Play-Back.

It is unfortunately the case that computers offer a large range of possibilities for setting up sound cards. Some computers come with built-in sound. Some users choose to replace the built-in sound with a sound card, which will usually come with a software management package that offers different-appearing control applets. A general principle to remember is that the basic on-off control of built-in sound hardware is available through the system setup utility (usually by pressing F2 at boot time).

32

There is some uniformity amongs manufacturers with regard to the color-coding of the analog line-level input jack that is used with the PMSDR…it is **light blue**. If there is a rear-panel L/R microphone input jack, it will usually be **pink** in color. See Fig. 55-2 in Appendix II.

Fig. 68: Repeat
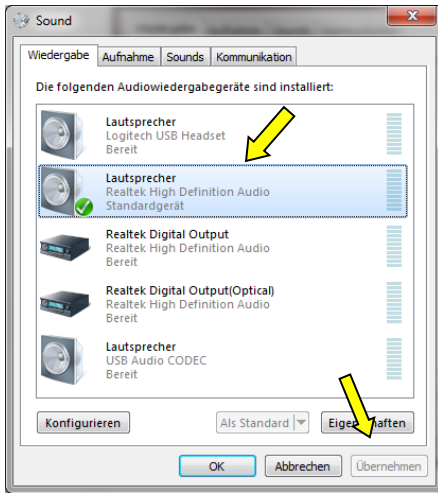
Fig. 69: Enhancements Off!
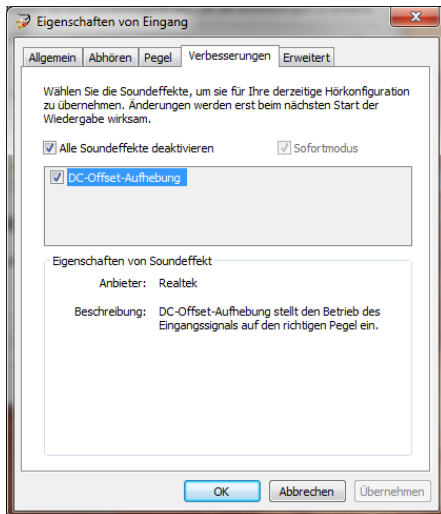
At this point, and particularly with add-in sound cards, look under "Properties" to see if there are enhancements that can be turned off. Among these would be "Equalizers," "Power Saving," as well as all sorts of other functions that distort sounds (Reverb, Echo, 3D, etc.)

■ 6.) Settings for HDSDR

Boot HDSDR, but do not press "Start."

Enter the following choices on the HDSDR screen:

Sound-Card Button:

Fig. 70: Sound-Card Selections

Make the choices for Input/Output here.. Definitely use headphones for listening to signals.

Otherwise it is difficult to avoid unpleasant cross-talk effects.

Soundcard Sampling Rate Button:

Fig. 71: Choosing the sampling frequency

Fix the sampling rate (48 KHz, 96 KHz, 192 KHz).

The AC97 only allows a sampling rate of 48 kHz. (see PC manual for information.). The rate showing on the right is set automatically by the program.

Sound-Card Options Button:
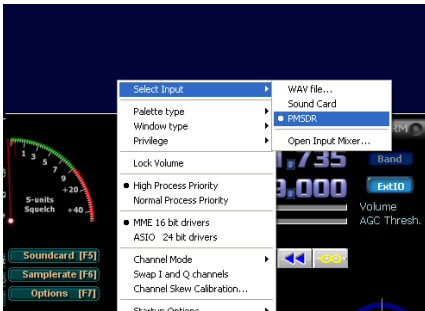
Fig. 72: PMSDR Data Input

→ Choose **Select Input**
→ Choose **PMSDR**
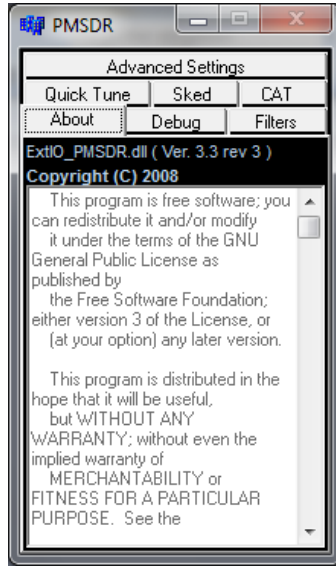
Fig. 73: DLL GUI

Choosing "PMSDR" causes the GUI to appear at once: The I/O window of the DLL. (**GUI** stands, by the way, for Graphical User Interface, namely the operator service window.)

Fig. 74: Sound-Card Driver Choices

Be sure that the **MME** 16 Bit drivers are activated, as in the picture.
Choose the **Channel Mode**, and be sure that the **I/Q Mode** is activated.

34
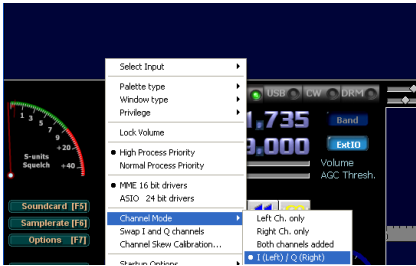
Fig. 75: I/Q-Output

■ **Adapting Screen Size:**

Previously mentioned options for matching the screen resolution are found under **Options→Startup Options** (called "**Window View**"; abbreviated **wv**).

For a netbook with its decreased vertical resolution, these settings are probably not available. In this case, start the program with the tag "**-wv**".

Go to the desktop of your computer, and call up the connection to the program path with a right mouse click on the HDSDR icon, under **Properties.** This should now read:

"C:\Program\HDSDR**HDSDR.exe –wv**" (For WIN 7: "C:\Program Files\HDSDR\ HDSDR.exe **–wv**")

There is one further setting for reception:
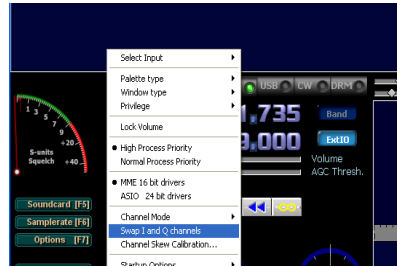
Fig. 76: Inverting I/Q Input

If, during SSB reception in lower or upper sideband, the signals are not decoded, (speech sounds strangely distorted), use **Swap I/Q Channels** to invert the signal.
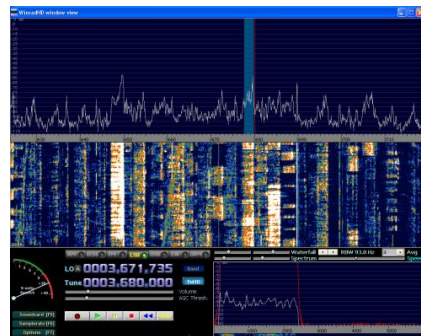
Fig. 77: 80m Band Reception

■ **7.) and 8.)   Connect Antenna and click START Button**

Clicking START should now show a picture similar to that in Fig. 77!

Listen using earphones.

If you don't see noise in the baseline, move the Line-In slider up a small amount. This should lead to the desired image.

Procedure:

First pull the slider all the way down, leave the cursor on the slider, and then use the arrow button „increase" to move further up, step by step, until a signal is seen.

In Win7 a more elaborate window may show up as a result of this call. Don't be put off by it.

Fig. 78: Input Sensitivity
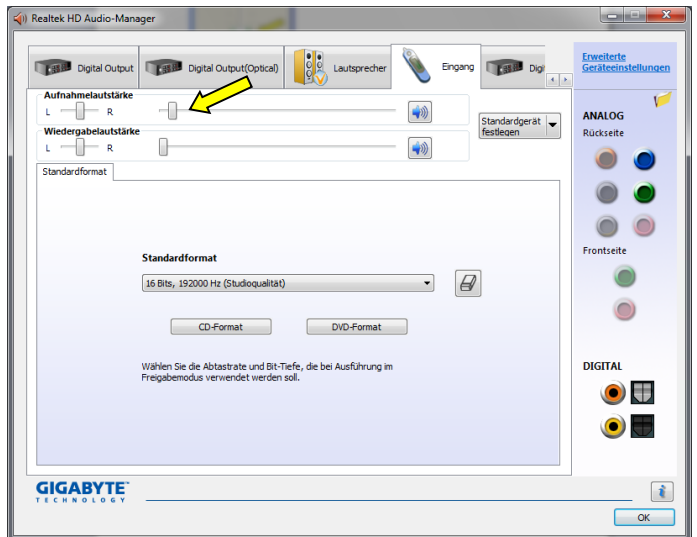
Fig. 79: Input Sens. Win7

Sound Card Selection

Initial Comment:

The quality of what comes out of the SDR stands or falls with the quality of the sound card! Unfortunately one cannot use the same criteria that a music enthusiast would apply. For the same reason, the various reviews which one finds in HIFI magazines are misleading and not usable; consider that we are using the sound card as a high-quality 2-channel A/D converter, not as a music reproduction device!

Practical considerations:

For our purposes it is therefore important to consider some completely different things of a more technical nature, such as:

- Outstanding A / D converter?
- Excellent dynamic range?
- Equipped with stereo input?
- Full duplex signal processing?
- Built-in anti-aliasing filter?
- Low-pass filter available?
- Uniform noise floor over the entire frequency range?
- Internal DC-DC run-out close to zero? Etc. Etc....

Unfortunately, these details are not in most manuals, so that either one is dependent on the experience of others, or one has adequate test capabilities at hand to be able to see the card itself behind the scenes! This is the basis for the table given below. The bandwidth capability of our sound card is directly dependent on the so-called sample rate. For SDR applications, this is the same bandwidth as shown on the waterfall or spectrum. There are cards that can yield 48, 96, even 192 kHz. Be sure you purchase a card with 24 bit resolution, not one with 16 bit resolution! The 24 bit choice will already do everything that the 16 bit choice will. There is no question which is the better!

At this point, a word about 16 vs. 24 bits. On one hand, one talks of 16 or 24 bit **drivers**, and on the other, of 16- or 24 bit **resolution**. These really have nothing to do with one another. Window's own WMME interface generally operates with 16 bits, the ASIO driver with 24. (ASIO stands for **A**udio-**S**tream-**I**nput-**O**utput). The latter driver will usually produce be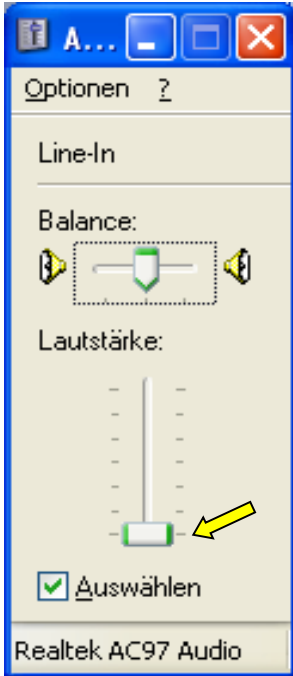tter timing with the "run" behavior of the signals. This is the so-called latency period. Windows native drivers are usually sufficient for us. But it is, from our experience, **not** reasonable to first buy a 48 kHz card, only to replace it later with a 192 kHz one. The price difference is minimal!

The following list is not intended to be comprehensive, but merely offers something for every budget. The internet provides technical details and current prices in abundance!

One final comment: First try what you have available before you spend a lot of money for something new! The built-in sound cards in computers or notebooks are usually adequate, as long as they provide stereo inputs.

Always use the LINE-input! (Only this input is usually set up as the stereo input needed by PMSDR.)

The tried and true **SAMSUNG NC10** is an exception. This small computer has no line-in input on its high quality built-in sound card, only usually a microphone input and a headphone output. Nevertheless, the microphone input is stereo, and can therefore be used for our purposes! One limitation: this card can only produce a 48 kHz resolution.

The boxed text to the right may be of some help in finding a sound card. The prices shown are *only approximate*, and will vary from vendor to vendor, sometimes over a large range. Some of the cards labeled "discontinued" show up used in places like eBay, or even new in Amazon. **Shop around!**

The following cards are well suited to our applications, not only for the PMSDR, but also for every SDR.

ESI JULI@PCI, PCI, to 192 KHz, (discontinued, hard to find)
ESI MAYA44e, PCIe, to 96 kHz, (discontinued, hard to find)

Infrasonic Quartet, PCI, to 192 KHz**,** ca. US$ 100 (discontinued, available)

Creative EMU-1820, PCI with external connection box, to 192 kHz, ca. US $ 200-300
Creative EMU-1212, PCIe with external connection board, to 192 kHz,, ca. US$ 160-260
Creative EMU-1616, to 192 kHz, various forms: PCI, PCIe, with ext. Interface, ca. US$ 350 to 450
Creative EMU-0404 USB to 192 kHz, ca. US$ 175
Creative EMU-0202 USB to 192 kHz, ca. US$ 90
Creative EMU-0204 USB to 192 kHz**,** ca. US$ 130

M-Audio Audiophile to 192 kHz PCI ca. US$ 200

The bold-face suggestions are especially suited and recommended for 192 kHz use.

Fig. 80: Selection of Proven Cards.

Sound Card Test

Extremely helpful for this is a test device with which you can see at a glance what is going on, and from which you can judge suitability or non-suitability.

Fig. 81: Soundcard-Tester

This small test circuit is driven from a battery pack, and costs only a few Euros. It generates test signals which are fed into the sound card to be tested. The screen image from HDSDR then gives information on the suitability or non-suitability. If nothing seems to go, and nobody knows why, this little device can quickly provide insight. You can get the completed tester from [11].

The circuit is relatively simple. A time, NE555, is used as a tone generator. Two RC elements, as phase shifters, emulate the I / Q signals. The phase difference of 90 degrees is only true for the fundamental. The output frequency of this device is somewhat dependent on power supply voltage. For 6V one gets ca. 15 KHz; for 9V ca. 17 KHz.

Such a test device can be built up quickly and without problems, using a small project board.
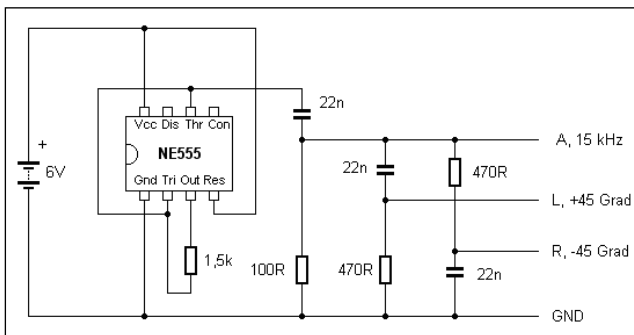
Fig. 82: Phase shifter built from a NE555
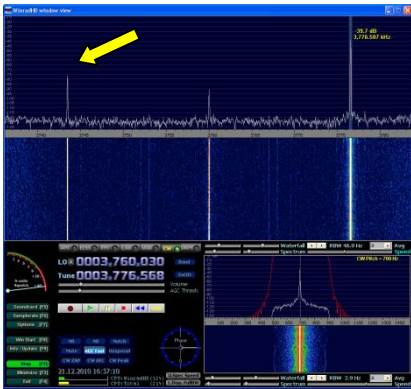
Fig. 83: Carrier and Image Signal

When a connection is made to the soundcard input, the result should look something like Fig. 83.
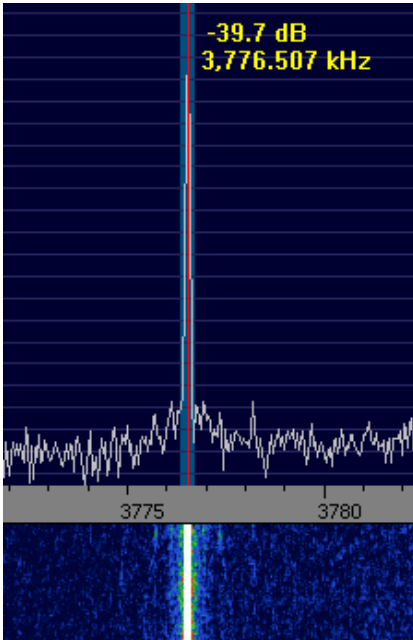
Fig. 84: Carrier Signal

The original signal is clearly seen on the right at ca. 17 kHz, while the image appears, significantly suppressed, at left. The difference in these values shows an excellent innate image suppression of about 70 dB.
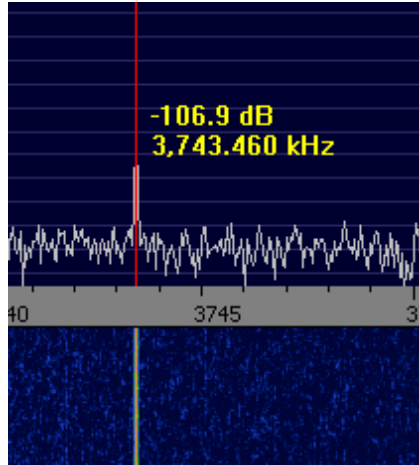
Fig. 85: Image Signal

The scale shows a center frequency of 3760 kHz. Also seen here is the signal frequency, 16.5 kHz.

The image signal appears at -16.5 KHz, which with the help of the channel skew calibration, can be further significantly reduced.

■ Image Frequency Suppression

Use the **Options** button to open the calibration window.
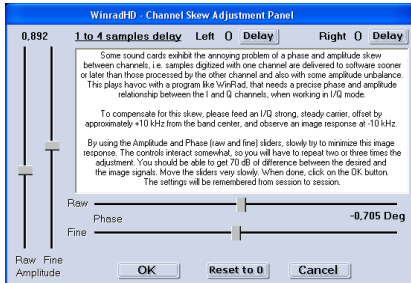
Fig. 86: Channel Skew Calib.

Setting the slides requires a lot of care! It does not matter at first whether you start with the amplitude or phase. Start with the **Coarse** slider, and move it VERY slowly, while watching the image signal. The point is to minimize the image signal by mutual adjustment of the two pairs of controls.

When the **Coarse** slider produces no further result, then turn to the **Fine** slider. These settings are somewhat interdependent. Set to work carefully with both controls until you have succeeded in minimizing the image signal. With careful handling, you can nearly null out the image, as shown in Fig. 87. At this point the suppression of the image frequency produces a suppression of a whole 85 dB! We do have to point out that (unfortunately) this is an "average" setting. That is, the result you obtain actually pertains precisely only for this single frequency.
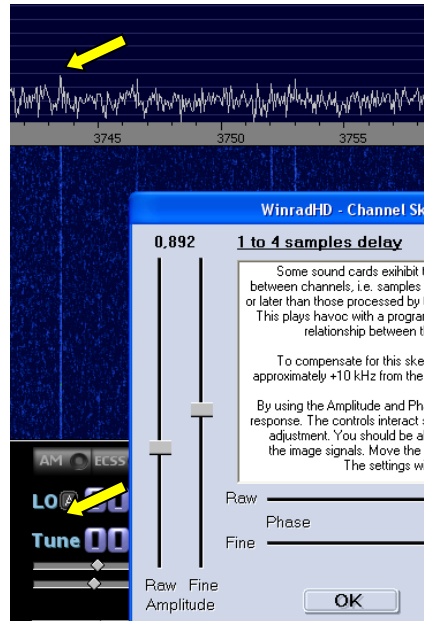
Reception frequencies that lie markedly right or left of this one, show less image suppression.

Fig. 87: Resulting Suppression

An automatic, constantly re-adjusting determination of the correction value would be extremely useful. (Keyword phrase: **WBIR**; **W**ide-**B**and-**I**mage-**R**ejection). In some software suites (PowerSDR, Rocky [14]) something like this is already implemented, but unfortunately not yet in HDSDR.

Soundcard Control

It should look like:

Requirements:

- The PMSDR is fully connected, but NOT turned on (USB plug removed).
- For this test, it does not matter whether an antenna is connected or not.
- In HDSDR, all settings have been made as indicated above.
- HDSDR has been started using START
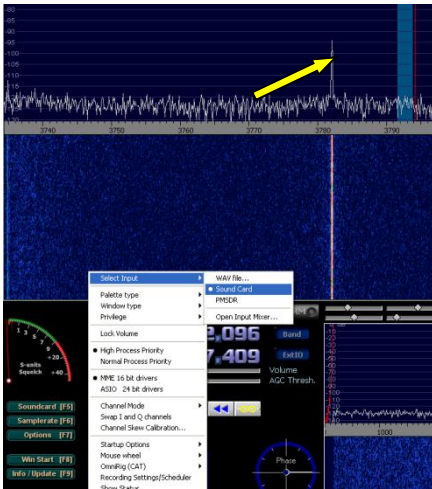
Fig. 88: Soundcard selected.

For **Select Input**, you currently have only **Sound Card** to select. **PMSDR** is grayed out, since it is not connected. Choose **Sound Card**. The result is a more or less narrow line in the center of the frequency scale.

If one looks further into this matter, one finds the following causes:
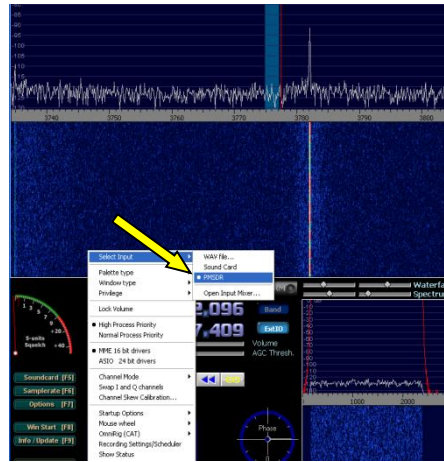
Fig. 89: PMSDR Chosen

- A signal at the LO frequency produced a DC signal by mixing effects,.
- Many sound cards are AC coupled. If this is the case, you will see a black stripe and no line!
- If the sound card is DC coupled, then a few mV of DC offset will produce a strong signal at the center frequency. A little DC offset will produce a gigantic center peak.

But that is only the beginning! There are many totally-different signal-paths in a sound card, and at least as many (or mutually incompatible) ways to connect them with each other.

These pathways are directly influenced by the various links in the relevant software.

What sounds like an unsolvable Gordian knot fortunately usually works well enough in practice. The problem is that one can spend many frustrating hours working at this. In this case, alternative activation of the ASIO driver (instead of the Windows WMME driver) may help! The broadest meaning of that line is that it shows the sum of all non-linearities of your sound card.

To work around this user-side problem, market oriented manufacturers are striving to integrate the corresponding audio chips into their SDR products. Assuming the hardware of your device to be OK, different images illustrate problems with the settings of your sound card!
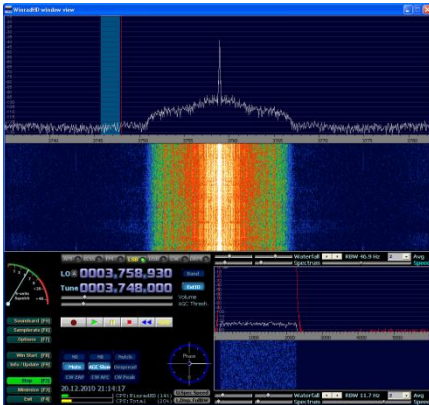
Fig. 90: It should not be this way!

Fig. 90 shows an open and totally saturated microphone input.

■ Setting up the Input Controller for good dynamic range.

We have already pointed out above the very sensitive setting of the "input potentiometer."

Nevertheless, the question arises, how far do I have to "turn it up" here, on the one hand to get the full dynamic range of my card, and on the other hand not to go into the region of saturation? This question is difficult to answer, but experience will help us.

Do exactly as before, as indicated above for the sound card control, and note the level of the noise floor. Use a ruler laid across the noise floor, and read the noise floor for HDSDR on the left scale.

Now close your PMSDR (without antenna!), and set the slider to a value that corresponds to an increase of about 6 dB in the noise floor.
Assuming the noise floor was -103 dB, then at about the correct setting, the noise floor will now be at about 97dB.

The DLL and its Settings
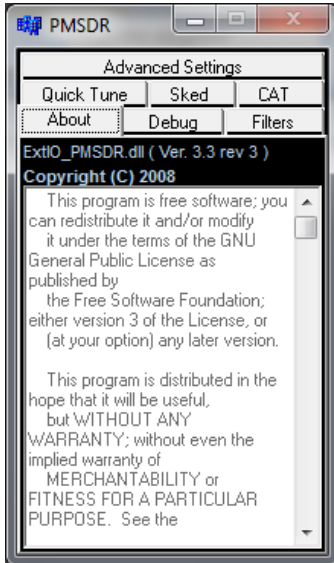
Fig. 91: "About" Tab
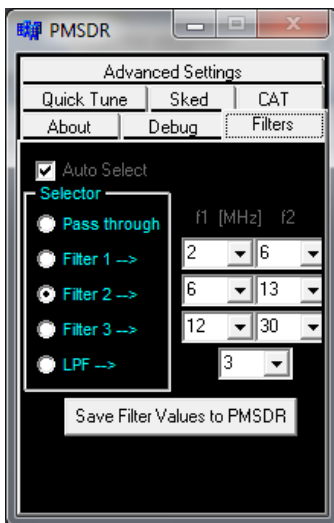
Fig. 92: "Filters" Tab

The "**About**" tab merely notes the version of the DLL, the copyright, and a general GNU GPL (General Public License) release.

Do not change anything on the **"Filter"** tab. The settings are optimized for your PMSDR.

A comparison of the default values with those of your DLL can not hurt!

Differences are to be revised and then saved with the **"Save Filter Values"** button!

Leave **Auto Select** switched on!

for routine use of the system are given.
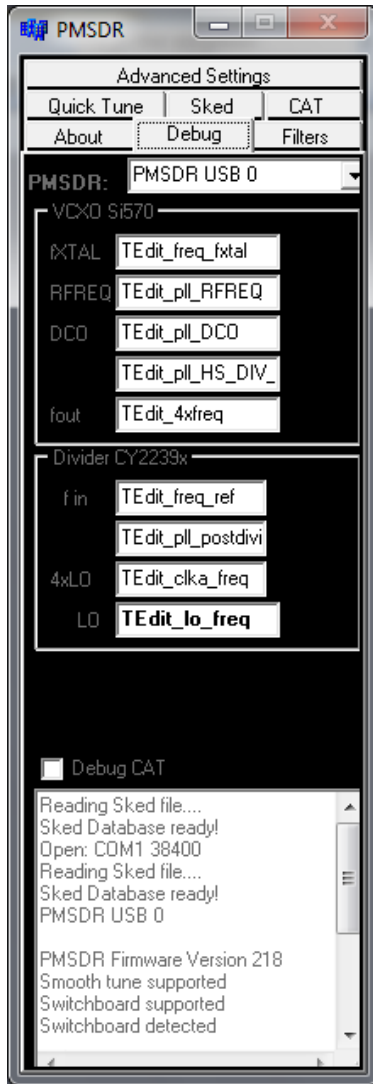
Fig. 93: "Debug" tab

The Debug window is used primarily by developers to detect errors. Don't change anything here!

It is of interest to open the **Quick Tune** window; various possibilities
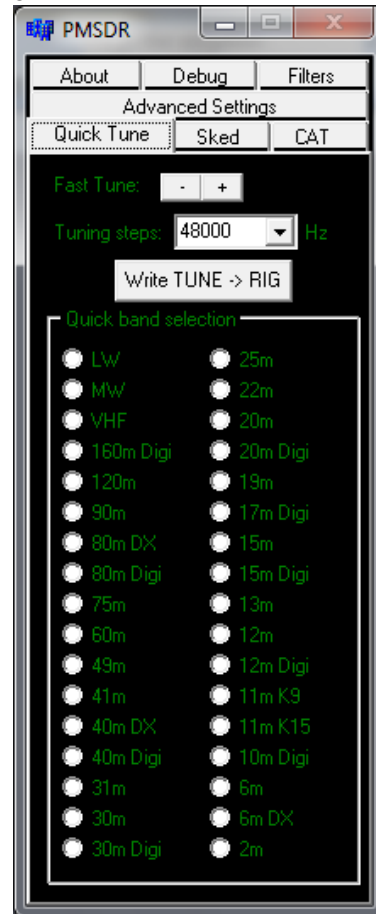
Fig. 94: Quick Tune Tab

For example, here you can set the possible speed-dial settings to your own taste. More on that later, in the section dealing with the initialization file (*. INI) of the DLL. The **± Fast Tune** button places the preset **Tuning Steps** values on the frequency bar. The button "**Write TUNE ➔ RIG"** transfers the selected frequencies to the TRX.

in various formats. Use those ending in *.**csv** for updating purposes. Copy the current file into the HDSDR program directory.

You can select the *.csv file and bring it into the DLL for display, using the **"Open Database"** button. Installation under the **Filters** tab permits, using the **Language** and **target** options, all possible filter combinations for the selection of stored radio stations. One click on this list sets the PMSDR on both the right frequency and the correct mode. Position the slider on the right side of the lower border in order to see the extended fields.

Those of you who use this display should put a check in the "Show Station" box in the **LCD** field. If this is done, the name of the station chosen appears in the PMSDR display!

Under the tab **Advanced Settings** you will find a similar display setting.

Fig. 95: Sked Tab

Radio listeners will find **Sked** very useful. (by the way, "sked" is shorthand from the world of amateur radio. It refers to a contact with a certain specific station. Here we are using it for radio listeners in general!)

A world-wide variety of HF broadcast stations is listed for direct access. One mouse click on your choice, and it is instantly tuned in. The station list comes from the freely available **EIBI** of Eike Bierwirth [13], on whose website you will find Up-to-date files

Fig. 96: Advanced Settings Tab

A check in **Show Frequency on LCD** puts the tuning frequency on the display.

Mute turns off the mixer from the QSD, and is therefore reserved for testing.

☞ **A secondary effect from the lab, and good to know:**

Activation or deactivation trips the T/R switch relay.

Bias/Slider and **Bias-voltage:** You should not change these settings. Leave the bias voltage set to its proper value of 2.5 V.

Si570 Frequency Calibration:
The PMSDR frequency display can be set precisely with the aid of a frequency standard (beacon, time-signal transmitter). For this purpose, tune to a known signal and change the display value until it shows the known carrier frequency of the source. Do this using the small button by the display.

External Down-Converter:
For activation of an external down-converter.

PMSDR Down-Converter:
The DLL automatically detects the possible presence of its own down-converter. Until it does so, the **Use PMSDR Downconverter** choice is blocked. A grayed out legend "Use PMSDR Downconverter" indicates that the native down-converter is not built in or that it has not been recognized.

👉   💥 **Simultaneous Converters:**

In the presence of the native PMSDR down-converter, you should never try to also activate an external converter. This also applies to the 3rd harmonic mode. If you intend to use this mode, do not activate the external converter.

IF-Panadapter:
In reading the next paragraph, where the example illustrates how to deal with the PMSDR as a panadapter you will find an extensive explanation of the subject of **IF Pan-Adapters**. (See panadapter settings).

Mixer inv.:
Is a function that you select depending on RX/TX status as well as sometimes with an IF board, since a few IF boards invert the signal layer. This occurs, for example, with the Elecraft K3 and requires use of **"Mixer Inv."**

Switchboard:
If this option is in operation, it allows one to set a PTT drop-out delay, in ms. "**Only SSB/CW**" should preferably be used with the internal RF VOX of the switchboard.

Use of this switch is only meaningful when hardware PTT-control is **not** used. If you use the **PTT control output** of your TRX**,** set the delay value to zero**.**

3th Harmonic Mode:
Another section is dedicated to the experimental mode called 3rd harmonic mode

.
Reception up into the VHF range (to 165 MHz) is possible, using the 3rd overtone of the local oscillator. There is some loss in sensitivity, but operation in this way does not require addition of a down-converter!

Auto-Select This mode switches in automatically, when a frequency over 55 MHz is specified.

Save Current Frequency as Default:

This does exactly what it says: The current frequency is used each time the PMSDR is brought up.

👉   The special significance of this application becomes clear, for example, when using the PMSDR as a WEB SDR receiver [16,17]. Here, the USB interface only serves as a power supply. This setting insures that the PMSDR comes up with the default frequency every time it boots!

You will better understand the **CAT** settings under the final tab, when you read the explanation in the subsequent paragraphs concerning "daily usage."

Fig. 97: CAT Tab

All these settings control the data direction and data flow when used with a transceiver.

Enable CAT:
Enables firstly the bidirectional data flow ←→ between PMSDR and the TRX. Specifically here we mean the flow of data from TRX → to the PC software.

Send CAT commands to Rig:
Contrariwise this influences data flow in the reverse direction, namely from the PC-Software → to TRX. You use this function specifically in panadapter mode. The following section elaborates on this.

Use RTS:
when activated, sets a voltage on the RTS line of the RS232 port of your PC. This option may be needed to supply power for an interface converter or interface. The various offset settings provide a very precise synchronization between the RX / TRX-VFO frequency and the display of the PMSDR in panadapter mode. If you don't work in panadapter mode (but rather in direct receive mode) then use **Enable Offsets** to turn this off.

Write Tune to RIG:
Transfers the selected frequency to a TRX if one is to be used, as already described above under **Quick Tune**. The two functions are the same.

Everyday Use

The use of PMSDR as a panoramic receiver is surely one of the goodies of this fine technology. In principle, any SDR offers the possibility of using the device as a stand-alone receiver, or to use the IF output of an existing transceiver to run the SDR as a panoramic receiver. The bandwidth that can be displayed depends on the sound card used! **The greatest advantage of PMSDR is that it can be set to any IF within the frequency limits of the local oscillator.**
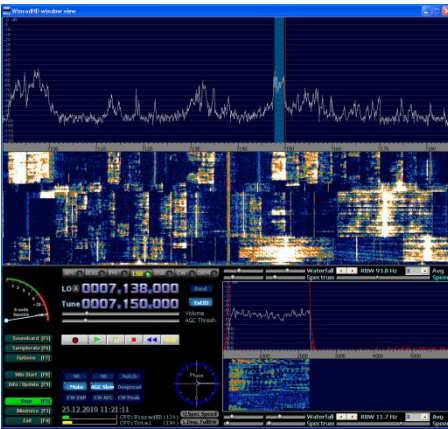
Fig. 98: Running In Panadapter Mode

This permits easy panadapter operation with a variety of rigs.

The panadapter operation which is possible with this little box is really quite excellent, and affords considerable entertainment!

The possibilities by which the DLL and HDSDR can be exploited are here essentially complete!

Anyone who has already used the luxury of "Click and Tune" in this new tuning technology won't want to be without it. You will see a relatively large band section in front of you, and will immediately recognize the emergence of a new station. With a single mouse click, the bars for decoding and listening are set immediately to the new frequency. Is it the DX you sought? One more click, and the TRX is already immediately available.

Through this function, one may use a second or even third receiver, depending on what you already have at hand.

The control mechanisms needed for this are already present in the DLL. That means considerable freedom from installed programs, regardless of the specific one (i.e. Winrad, HDSDR, WRplus, WinradF, PowerSDR) used as an interface. In this form, this freedom is unprecedented!

HDSDR is the appropriate program for controlling the PMSDR. It is 100% integrated with the DLL.

PowerSDR-IQ, in contrast, offers only a very limited integration with the DLL.

In what follows, you will see a description of the use of a FT950-2000 in this regard. For all other transceivers, see below for a summary and for the information needed to convert a FT-950/2000 to this functionality.

What is described here is naturally, mutatis mutandis, as much for normal HF reception as for stand-alone mode.

■ IF Connection to a FT-950

Here we use the IF-2000, an IF interface board from the firm RFSPACE [2]. This is a proven solution.

The board will be installed at the location allocated for the DMU2000 unit in this device. The amateur radio market has the relevant boards in stock. On behalf of all others, we mention [4] here.

.
Installation is very simple and only takes a few minutes. It does not void the guarantee. One needs nothing more than a screwdriver and a small cable tie. Installation should not be a concern.

Fig. 99: IF Connection

The Installation Guide that is delivered with the IF board explains everything very clearly.

The vents on the rear of the unit are used to route the supplied coax cable to the PMSDR. A small cable tie is

■ Tandem Mode Hookup with the FT-950

This is only protected against damage to the input stage when you use the optional T/R (switchboard)

PMSDR & Switchboard Option im Tandem - Mode
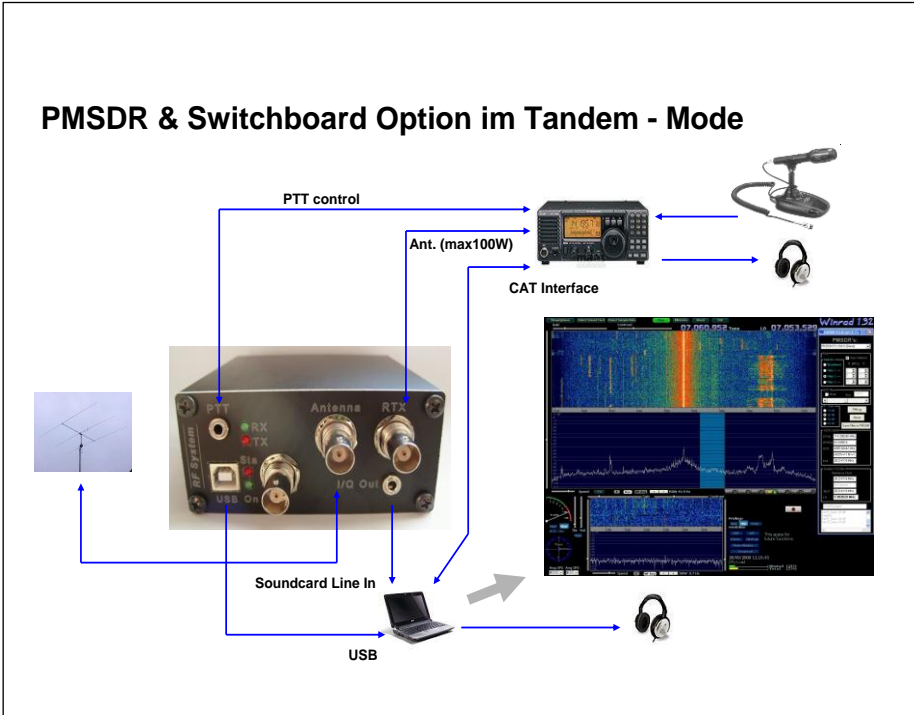
Fig. 100: Tandem-Mode

used to attach the coax to the vent fins. In addition to connecting to the IF port, it is also possible to use the PMSDR as a separate receiver at the same time. We refer to this as "Tandem" mode. It is illustrated in Fig. 100.

Connect the IF cable to the antenna input of your PMSDR per Figs. 99 and 100.

switch. The antenna signal (for sending and receiving) is routed via this board. In this case, a max. 100W output power (up to 50 MHz) is allowed. The PTT line of the TRX takes over secure control of the circuit board.

Do not confuse PTT In and PTT out!

☞ 💣 Do not become confused by the normal PTT jack on your transceiver (PTT-**In**), sometimes used with a foot switch.

This is a **jack for an input signal** (switch-contact to GND), and is not suitable as a control input for PTT control of the switchboard.

Remedy:
Use the hardware control signal that is present, for example, in the control socket for an external power amplifier (PTT-**Out**).

Alternative:
Equip your foot switch with a second microswitch, and use it for hardware control of the switchboard.

■ CAT-Connection

In both cases, we need a CAT connection between the PC and the TRX. A simple 1-to-1 cable will be sufficient. The cable must not be crossed internally at the plugs, and each end needs a 9-pin female RS232 connector! (This is **NOT** a null modem cable!)

A USB-RS232 converter [1] may of course also be used here.

■ Configuring HDSDR

All the information in the following applies equally for both modes, tandem, or IF configuration. Boot HDSDR [9], but do not press START

yet. Now we will configure the software so that the interaction between hardware and software works smoothly. Essentially, it is only the DLL that needs to be processed, in graphical form on your screen when you start HDSDR. You will recognize the picture from the above material. Please verify, by comparison with the website [1], that the current DLL is loaded.

■ Interdependencies: Send/Receive Direction (of the CAT signal)

For a better understanding of the following, note that "**ENABLE-CAT**" is meant to activate the CAT connection in general, as well as here specifically to direct the data flow from the transceiver to the PC software!

Figs. 101 and 102 clarify this.
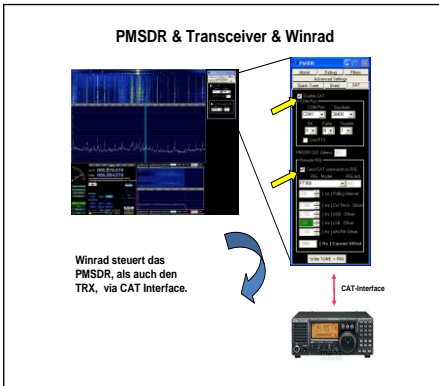
Fig. 101: Enable CAT **ON**
Remote RIG **OFF**
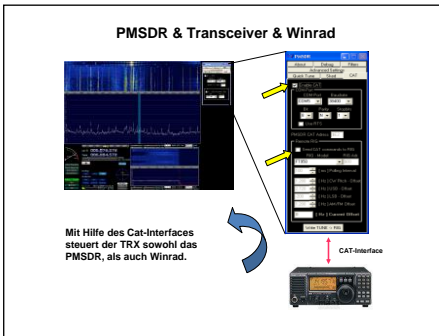
Fig. 102: Enable CAT **ON**
Remote RIG **ON**

Please note the entries marked with the yellow arrows!

Activation of **"Send CAT-Commands to RIG"** however, opens the transfer direction for all the commands in the direction of the TRX, for example for writing a frequency to the VFO of the TRX.

You will learn below just what we can accomplish by clever activation or clearing of this check box,! (The Appendix contains a description of the entire operation in telegram style. Best to print it out and keep it handy.)

■ CAT Settings

All settings described here refer to the DLL v3.3 Rev2. Check the web site [1] for the list of supported TRX and for new versions.

The necessary parameters for control of the interfaces to and from the RIG, as well as the data for Frequency Offset (described later) are initially entered under the **CAT** tab.

Before you can use ADVANCED SETTINGS to switch on the panadapter, you must set up CAT control fully.

If **ENABLE-CAT** is checked, uncheck it, otherwise you will not be able to make the necessary changes.

Replace the COM port number shown in the box by the COM port number you are using for the TRX.
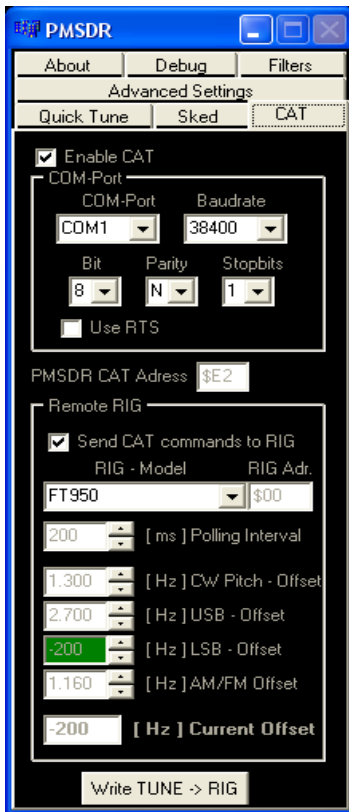
Fig. 103: CAT Settings

Use the menu in your TRX to set the baud rate and handshaking (RTS=Off) to the values visible in the CAT settings. For the FT-950, use positions #26 and #28, which correspond to these settings. (If you use a CAT interface or a USB-RS232 converter instead of an RS232 cable, you may have to turn on **USE RTS** to provide power to the adapter. Check in the manual of your CAT interface.)

Using the **Write TUNE ➜ RIG** button, pass the selected frequency on from the waterfall to the TRX with a mouse click.

This always works in the usual way, even with the "Remote Rig" flag switched off (meaning ➜ „Send CAT commands to RIG".)

If you leave this function switched on, and press "Write Tune To RIG," although the frequency will transfer to the VFO, the spectrum displayed will simultaneously change, which we don't desire to happen (read further under ■ **Initial Operation**)
For „normal" "Click and Tune" operation, the statement reading: **Send CAT commands to RIG** should be left switched off!

The currently used offset value is shown in green, and again explicitly specified in the box CURRENT OFFSET. We will go into "Offsets" again later.

So, now set ENABLE-CAT to on again, and go to the ADVANCED SETTINGS tab.

Now on to the panadapter configuration.

■ Panadapter Settings

In the Box **IF Pan-Adapter** under the Advanced-Settings tab, select, under **RIG,** the IF-Board **IF2000**. The required IF of 10.55 MHz should be selected automatically, appearing in the adjacent field.
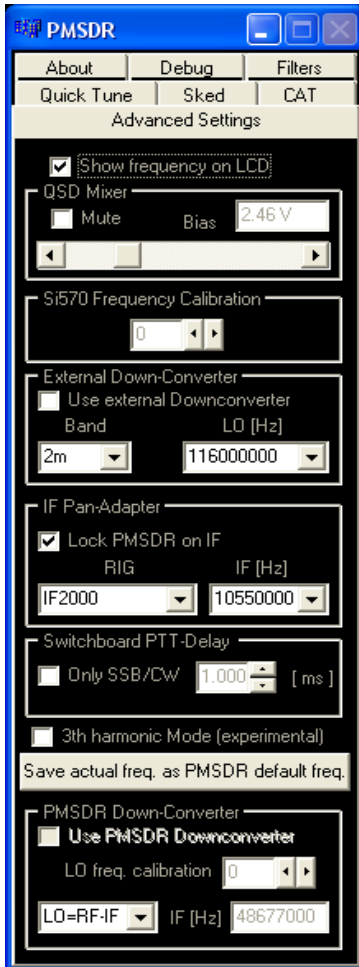
Fig. 104: Advanced Settings

(If the entry for IF2000 does not appear, go briefly to the section on manipulating the DLL. This explains

how to make the entry quickly and easily.

Now check **LOCK PMSDR ON IF.** This locks the local oscillator of the PMSDR to the IF of the FT-950/2000.

SHOW FREQUENCY ON LCD should also be enabled. If so, the TUNE FREQUENCY for HDSDR is also shown on the PMSDR LCD display, if the display option is present.

If you now press **START** in **HDSDR**, you should already have a spectrum, or see a waterfall with information, provided all your basic settings for HDSDR are OK.

■Initial Operation
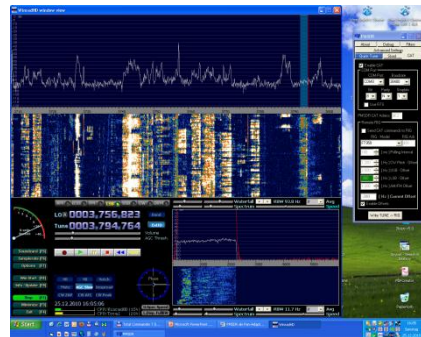
Fig. 105: Active 80m Band

You can now use HDSDR to decode stations that you see in the waterfall by clicking on them.

There is one important difference to the stand-alone mode, in which the PMSDR up to now has been used

as a stand-alone receiver.

In this mode, you simply put the light-blue tuning bar, hereinafter abbreviated cursor, on the station to be decoded, then the next, etc. etc. Here, the LO correctly follows the tuned frequency.
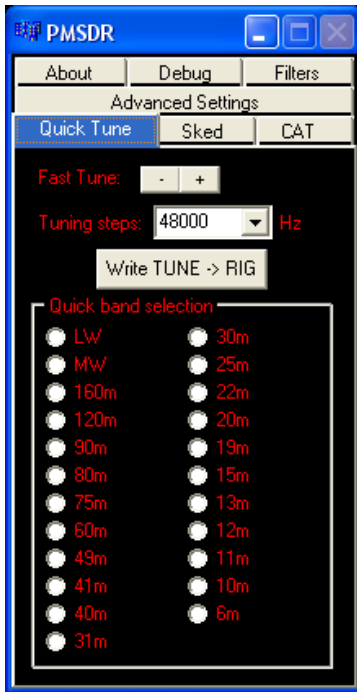
Fig. 106: Remote RIG OFF

If the previous settings were done correctly, you will see that HDSDR always transfers the new frequency to the RIG, and that the waterfall and the spectrum also change in appearance with every click.

Of course this is not so useful, nor really intended, and because of this, we now have to turn off the CAT connection **from Program ➔ to RIG**, as we have already mentioned above!

## ■ Listening to Stations

Now return to the **CAT** tab, and **deactivate** the check box for: **SEND CAT COMMANDS TO RIG. (**This switch is found in **Remote Rig**. Because of the shorter spelling, this term is hereinafter to be used as a synonym. **"Remote RIG OFF"** thus means that **"Send CAT commands to RIG"** is NOT activated!) This prevents the continual alteration of the spectrum when the cursor is moved.

In the display area, you can now click around at will, seeking out stations to decode and to click on for listening.

The TRX is temporarily possibly tuned to a different station, until a new frequency is written into the VFO using **Write TUNE ➔ RIG**.

The presently **blue**-backgrounded **QUICK TUNE** tab is an indication, that functions there are no longer accessible. Switch to the **QUICK TUNE** tab provisionally. The whole internal field is now displayed in red to show that these functions are disabled.

Now is the time to explain the next step for applications, namely what to do if you want to want to leave or change the display area.

■ Changing the Display- or Frequency-Range

There are various possibilities:

I.) If you simply turn the VFO knob without changing any of the settings, you will see that the light blue frequency bar changes, and the spectrum in the display frame changes as well. Pick out new stations as usual, just by clicking on them.

II.) Use the **TUNING STEPS/ FAST TUNE,** along with the **± Button** under the **QUICK TUNE** tab**.**

III.) Select the bright blue frequency bar with the left mouse button, hold it depressed, and **slide the tuning bar** to the right or left to a frequency range of your choice. Do this as many times as you please, by releasing and pressing the frequency bar to a new position, etc. etc.

The latter two versions will obviously require the reactivation of the function **SEND CAT COMMANDS ➔ RIG.** How else would the TRX else know that it has to adjust the VFO?

Re-check the box for RIG control, that is: RemoteRIG ON.

When you do this, the blue field in QUICK TUNE simultaneously disappears, and the same interior legend changes color to green.
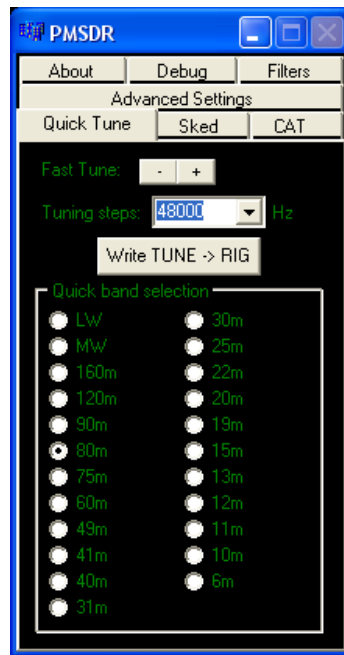
Fig. 107: Remote RIG ON

Access to the control is released again!

Please try out options **II** and **III**! The proof is in the pudding here!

The operation sequence is logical and will become familiar to you very quickly.

Reading this description makes things sound much more complicated than they are in practice.

So please, no hesitation. Operation will quickly become "duck soup." The fact that here in Quick-Tune a single click also allows you to change bands, is surely clear to you and requires no further mention?

Incidentally, the built-in ability of HDSDR to change bands (BAND button) works the same way, and allows either/or/simultaneous use of the DLL-functions!

Along with band change, the mode (USB, LSB, AM, CW, etc.) also automatically switches over.

Which modes are used for each band is stored in the INI to the DLL. You can use an editor to make as changes as required.

■ Setting Mode-Offsets

We come now to a most interesting part of this manual, namely the precise transfer of the selected frequency to the VFO of your TRX by mouse click.

At this point you have to know that the IF generated by the FT-950/2000 is not carved in stone, but that it changes with the selected operating modes (USB, LSB, CW ...) and possibly the programmed carrier offset. These expected changes lie in the range of ± 3 kHz. This is not a negligible change. Without a correction factor in PMSDR which gets passed to the VFO, the frequency would deviate by this amount from the receive frequency of the HDSDR spectrum.

As a consequence, one would simply not hear/find the expected station and therefore also not be able to communicate!

This is the reason for the presence of mode offsets.

These values only need to be determined once, and written into the Mode Offset boxes using the small up / down buttons.

This process ultimately calibrates the frequency display in HDSDR to the VFO of the RIG! We will explain how to do this in a moment. If you wish, at this point you can just use the pre-determined correction values for the FT-950:

CW	+ 1.300 Hz
USB	+ 2.700 Hz
LSB	- 200 Hz
AM/FM	+ 1.160 Hz

Fig. 108: Offset Values for the FT-950

These numbers will not be badly wrong, at least for a FT-950.

The precision of the renewal of these numbers on HDSDR re-launch is quite good.

One ends up so near the VFO frequency that the signal set in HDSDR is easy to identify in the VFO.

There will possibly be (small) corrections to be made with the VFO knob, so that one, by ear, gets the same pitch as in HDSDR. These will be of the order of magnitude of a few Hertz.

■ Determining Correction Factors

How do you determine the best correction factors? This is also very easy and quick to understand, and will be explained in steps. The goal is to match the HDSDR frequency to the VFO frequency of your RX/TX!

The simplest of these cases is the equalization for AM and CW, because both can be matched to the existing transmitted carrier itself. An example based on the Deutsche-Welle can be used to illustrate this:

■ AM Correction Factor

Frequencies of 6075 kHz and 6190 kHz almost always offer good AM reception. We begin with the AM case; tune your VFO to one of these frequencies with the CAT and REMOTE RIG on. The following figure shows a piece of the spectrum around the frequency 6075 kHz, as it comes from a display width of 96 kHz and RBW = 93.8 Hz.
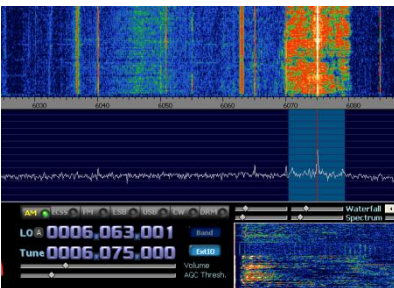

Fig. 109: Display for 6.075 MHz AM

The match is almost perfect, when using the correction values. If, however, you start with zero entries, the evident differences are of course much larger.

In this case, you want a resolution sufficient to allow the precise positioning of the cursor on the carrier frequency.
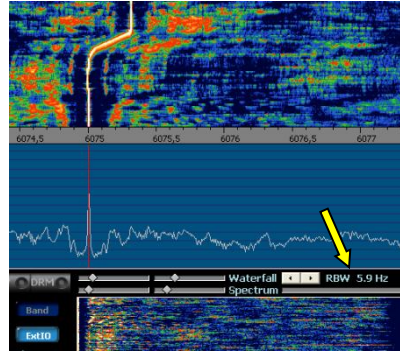
Fig. 110: Centering (RBW 5,9Hz)

Just choose the maximum resolution of RBW = 5.9 Hz (for each screen pixel (2)). Press and hold the corresponding Up/Down button until the center peak of the carrier matches the desired frequency.

The waterfall picture shows clearly how the carrier slowly but surely moves in the direction of the desired frequency. Center the peak with the Up/Down buttons as precisely as you can. If the whine of the carrier bothers you, just shut it off with MUTE.

Done! that's it for AM! That was not really so hard, right?

■ CW Correction Factor

Because it was just so simple, we repeat the whole sequence now for CW.

We use one of the available standard frequency and time signal transmitters. These are either the WWV transmitter (U.S., Fort Collins), or the best station in Europe to record, the RWV chain of stations, (Moscow, Russia).

RWM sends, for example, on 4996, 9996 and 14996 kHz in a time-dependent sequence, and in various different modes. The best place to get the actual sequence is from the internet [8].
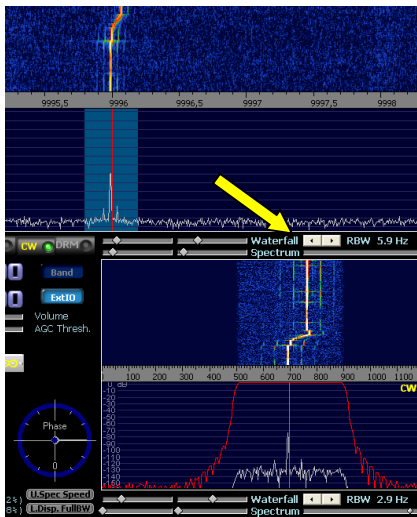

Fig. 111: CW Carrier Centered

Of most interest for our purposes, are the transmissions from 0 to 7:55 and 30 to 37:55 minutes, every hour.

During these roughly eight minute intervals, we see a carrier without any modulation, which can be very easy to use. If you don't hear anything, wait a few minutes. The transmitters are each turned off in the minutes 8 to 9, also 38 to 39! Proceed analogously as above, and adjust the Up / Down keys until the carrier is centered.

Done! That's it, this time for CW!

■   LSB/USB   Correction Factor

The two remaining modes to be adjusted, LSB and USB, are just as simple to treat, in principle. In practice, it is not quite as easy as for AM and CW, since one has to adjust to one side of the signal, or to the other, both in the welter of other existing signals. It may not be so simple to locate these points.

To locate these points, a little "trial and error" is not out of place. The procedure is the same for both modes, with the single difference that for LSB one is calibrating on the right edge, and in USB on the left edge.

For this process, seek out a quiet (sparsely-occupied) portion of the spectrum somewhere in any amateur radio band.
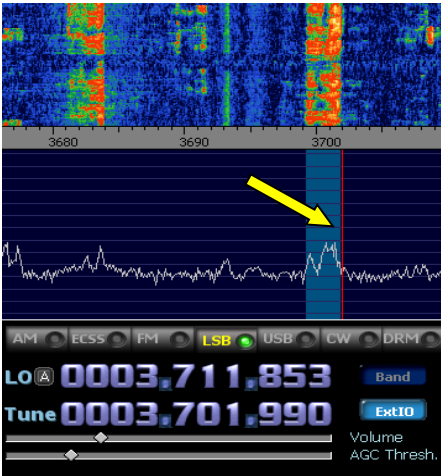
Fig. 112: LSB Calibration

Tune the VFO so that the received speech sounds natural to your ears. IF we now set the HDSDR Frequency to the VFO Frequency, we are using as an indicator one of the best measuring instruments that we have as radio amateurs, namely our ears.!
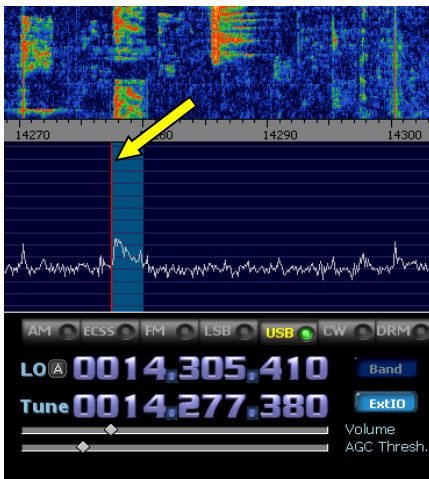

Fig. 113: USB Calibration

Set the audio from the rig and HDSDR to a comfortable level, and, analogous to the above, use the Up/Down buttons until the two audio signals are as nearly as possible identical.

It is naturally not a question of „zero beat, but the process is very similar, and every technolog immediately understands what is meant here!

You don't need to use the highest possible resolution here, as the adjustment by ear has a somewhat subjective character.

In the future, for everyday use try to set the cursor (more precisely, **the red line** next to the tuning bar) on the corresponding signal flank as you are now doing, and remember this as long as possible.

This ensures that every time you click, you will get a correct VFO frequency for the transmitting station!

However, if you are not quite on the VFO frequency, this is not the end, because you always end up at least pretty close. (As described above, always somewhere in the range of a few Hz)

A small turn of the VFO knob if necessary, and you have the right frequency!

That's it! With this, you have set all the offsets!

■ Storing the Values

An important point must not be overlooked, namely saving (storing) the above-determined values!

There is, unfortunately, no extra button for this in the DLL; you just have to remember, that writing / saving the values to the INI of the DLL happens at the moment when you press the STOP button in HDSDR!

You should therefore not get used to terminating the program with the Red Windows Close Box in the top right corner of the screen. Always terminate the program properly by using "STOP and EXIT." Now you know why ...!

Possible Ways to Manipulate the DLL

The DLL file itself cannot be modified. Influence over the various parameters associated with the DLL is only allowed via the so-called INI file. The parameters in this file are read at startup of HDSDR in the DLL.

The result will appear as a service window next to HDSDR, in the graphic form you already know.

The INI file is called **EXTIO_PMSDR.INI**, and is a purely text file, which you can work on using an appropriate text editor. The term "manipulation" is chosen with care and intention. **Warning:** When one enters something here, he must understand clearly that he is "manipulating" the file!, After all, this is the control file for the EXTIO_PMSDR.DLL, the heart of the software interplay between PMSDR and HDSDR, as well as the rig that is connected!
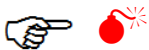
☞ 💣 **Backing up the file BEFORE changing it is strongly recommended!**

Use a suitable text-editor for editing. **Notepad2** [15] is available as Freeware, and is excellent! Below, we specify sections for changing or supplementation in the *.INI file. These sections are also found enclosed in square

brackets in the original file. After saving changes and executing a cold restart, any changes are automatically transferred to the DLL.

■ IF Entry for use as a Panadapter:

The relevant original entries look like this:

[PAN_RIG]
ELEKRAFT K2=4915000
ELEKRAFT K3=8215000
IF2000=10550000

In this example, you will note an entry for the IF-2000 interface board from RF-Space mentioned above.. This is an IF interface for the Yaesu FT-950/2000, which down-mixes the IF of the two devices to the level that PMSDR can use without problems. (In this case, to 10,55 MHz) This saves one from the outrageously expensive DMU unit.

For your own entries, copy this example.

■ Target for Changing Quick Tune entries:

[BANDBUTTONS_FREQ]
LW=150000
MW=500000
160m=2000000
120m=2300000
90m=3200000
80m=3800000
75m=3900000

You can cleverly arrange things so that a click on the 80 meter band jumps you immediately to the (hopefully DX-loaded) upper band edge. From there, the band lies in the direction of lower frequencies. If you are more interested instead in CW or digital modes, you can accordingly naturally set up the corresponding... etc. etc.

■ Changing the way QUICK TUNE works...
                    &
■ Creating Additional QUICK TUNE ENTRIES...

The adjacent QUICK-TUNE window clearly illustrates how to get to your favorite bands and areas by mouse.

☞ One must, however, make absolutely sure now that the same name is used in all three of the areas:

[BANDBUTTONS_FREQ],
[BANDBUTTONS_TUNESTEP],
[BANDBUTTONS_MODE],

Very clearly you can do this with the help of an Excel file.

One can see at a glance if something is wrong somewhere! Compare Fig. 115!

■ 3rd Harmonic Mode Automatically...:

Fig. 114: Quick Tune Entries

When one keys VHF/2m into the auto-select function, the unit automatically switches to the 3rd harmonic mode (SS67)!

Remember that all three areas need the same name; otherwise nothing will come of your project! The figure below shows in a row, for example, the name **80m Digi** 3x. This name must be the same in all three columns!

FREQ	TUNESTEP	MODE
LW=150000	LW=9000	LW=AM
MW=500000	MW=9000	MW=AM
VHF=90000000	VHF=9000	VHF=FM
160m Digi=1840000	160m Digi=48000	160m Digi=LSB
120m=2300000	120m=5000	120m=AM
90m=3200000	90m=5000	90m=AM
80m DX=3800000	80m DX=48000	80m DX=LSB
80m Digi=3582000	80m Digi=48000	80m Digi=LSB
75m=3900000	75m=5000	75m=AM
60m=4750000	60m=5000	60m=AM
49m=5900000	49m=5000	49m=AM
41m=7100000	41m=5000	41m=AM
40m DX=7200000	40m DX=48000	40m DX=LSB
40m Digi=7036000	40m Digi=48000	40m Digi=LSB
31m=9400000	31m=5000	31m=AM
30m=10112000	30m=48000	30m=LSB
30m Digi=10141000	30m Digi=48000	30m Digi=LSB
25m=11600000	25m=5000	25m=AM
22m=13560000	22m=5000	22m=AM
20m=14350000	20m=48000	20m=USB
20m Digi=14072000	20m Digi=48000	20m Digi=USB
19m=18168000	19m=5000	19m=USB
17m Digi=18102000	17m Digi=5000	17m Digi=USB
15m=21450000	15m=48000	15m=USB
15m Digi=21072000	15m Digi=48000	15m Digi=USB
13m=21440000	13m=5000	13m=AM
12m=24990000	12m=48000	12m=USB
12m Digi=24920000	12m Digi=48000	12m Digi=USB
11m K9=27065000	11m K9=5000	11m K9=AM
11m K15=27135000	11m K15=5000	11m K15=USB
10m Digi=28120000	10m Digi=48000	10m Digi=USB
6m=50000000	6m=48000	6m=USB
2m=145000000	2m=48000	2m=FM

Fig. 115: Entries for Editing Quick Tune

■ Sked Entries adapted to your needs:

[SKED]
FILENAME=**beliebig.csv**
SHOW_LCD=1
LANGUAGE=All

The original entry **sked-a09.csv** contains a text file (it is a pure text file, even though its name doesn't carry the extension *.txt!) with pretty much all short-wave radio stations, which can then be received under SKED, only requiring a mouse click. The unchangeable default mode here is set to be AM. **Eike Bierwirth** (evidently the source of the name "**EiBi "**), from Leipzig, is the author of this nice addition.

You can find the newest *.csv file on his webpage [13]. Just copy it as needed into the HDSDR program directory.

Use the **Open Database** function to make the file selection you desire.

Fig. 116: Installing your own „Sked"

The structure of this file is somewhat complicated. Nevertheless, you can pretty much adapt it to your own needs.

An example:

The following text is entered under the file name oe8mcq.csv, which is then called through **Open Database** in the DLL:
The accompanying text is shown, reproduced line by line.

1:kHz:75;Time(UTC):93;Days:59;ITU:49;
Station:201;Lng:49;Target:62;Remarks:1
35;P:35;Start:60;Stop:60;U1018-RUS
2:14070;;;;20m PSK-31;x;AFU;;;
3:27065;;;;CB-Ch.9;x;CB;;;
4:29670;;;;10m DF0MOT;x;AFU;;;
5:50110;;;;6m SSB-CALL;x;AFU;;;

There is a total of five lines, the structure of which must be exactly as listed here, otherwise the DLL will not function properly.
Line 1 is especially important, and must not be changed in any case!
Do not use bold-face numbers 1-5 when you type them.
Line 1: Your own entry via the editor begins with "kHz" and ends with "-RUS".
Line 2: starts with "14070" and ends with "AFU ;;;\", etc.
The number of semicolons is important! Their exact number and arrangement is important!

By the way, all the example files mentioned in this manual are to be found in the appropriate sub-directories on the enclosed CD as well.

As selection criteria in this example, the terms amateur radio and CB are installed. Other additional words are possible, after using the **Language** and **Target** filters to make a filtered version of the original language.
The mode is, as already indicated, limited to AM.

If necessary, simply switch the required operating mode by hand.

The illustration Fig. 116 ends with **Lang**. Everything else is hidden on the right. Using the slider at the bottom of the screen, scroll to the desired display area.

■ External Down-Converter

[DOWNCONVERTER]
2m=116000000
70cm=404000000

Two entries for 2m and 70cm are already loaded with the LO values of 116 MHz and 404 MHz.
If these values do not correspond to your LO frequencies, you can change them as necessary. You may also like these records kept as they are, and may add your own as long as they conform to the illustration. Your new entries will appear in the drop-down list at the next start-up for you to select!
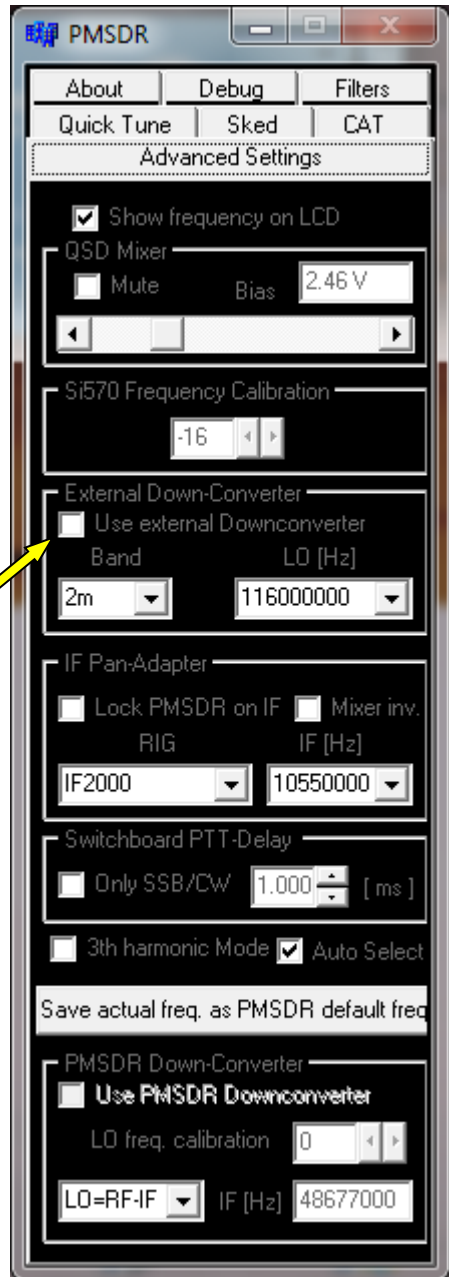

Fig. 117: Ext. Down-Converter

Receiving in 3rd Harmonic Mode

■ FM Reception in General

By activating the 3rd harmonic mode, the FM broadcast band (88-108MHz) can be received with a 192 kHz sound card. The receiver also works with 96 KHz cards but with somewhat limited sound quality. 48 KHz cards however are totally inappropriate for FM radio reception.

Turning on this flag causes the PMSDR to be set exactly to one third of the desired receive frequency. The PMSDR has a lower sensitivity (approximately-108 dBm, in 3rd harmonic mode; that is, 15dB poorer than in normal use), but that is not very significant for reception of the strong channels in the FM broadcast band. Note that the PMSDR after all still has an IP3 of +30 dBm with a dynamic range of 92dB IMD. (These values were determined at 144 MHz.)

This allows one, for example, reception of the aircraft radio band and the 144 MHz amateur radio band. It should be noted that the spectrum of the 3rd overtone is backwards. By inverting with "**SHOW OPTIONS"->"Swap I/Q channels"** the frequency scale is displayed correctly in Winrad.
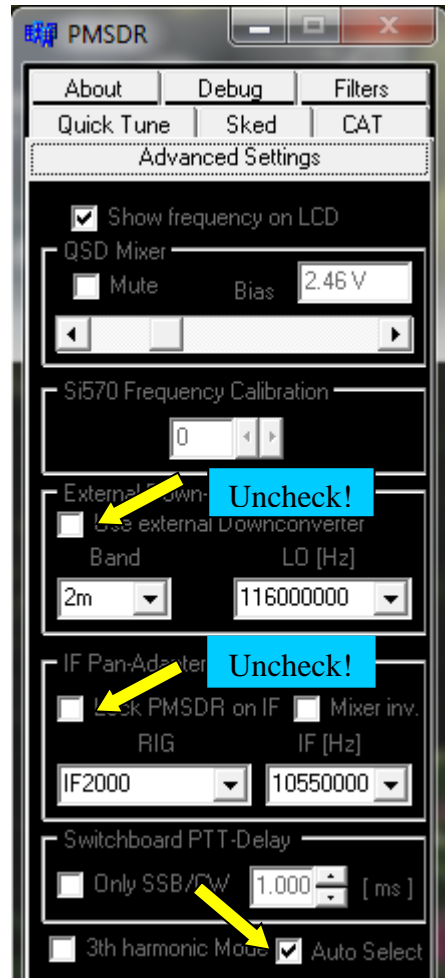

Fig. 118: 3rd Harmonic Mode

This has particular implications in FM narrow band operation (amateur radio to 20 KHz), since the frequency scale will not be precise. For the much broader-band FM radio operation (150 kHz bandwidth), this is almost meaningless.

If the flag in the DLL is set for automatic mode, automatic switching occurs when the LO is set to 55 MHz or higher.

Remember to disable everything that is not needed.

☞ For example, Pan-adapter-off mode, converter off, etc.

Suitability for FM

All Winrad based programs are suitable for narrowband FM use. The special needs of FM broadcast reception are, however, currently only met by **WRplus.** Here, by right clicking on the FM button, all sophisticated functions can be seen, including RDS reception, presented in a separate window! All the following figures therefore only bear on WRplus!

■ FM Radio Reception

Brief Instructions:

- Start **WRplus**,
- **Swap I/Q-Channels** is irrelevant,
- Right Mouse click on FM button,
- Activate broadband FM.
- Possibly switch in RDS...
- Tune in the FM Band (88-108 M Hz).
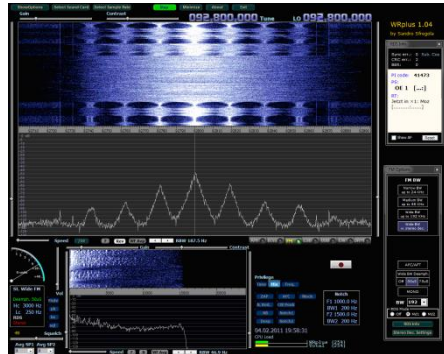
Fig. 119 was made with a 192 kHz soundcard.

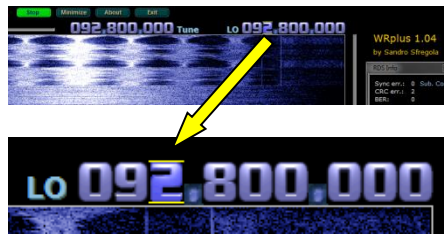**Fig. 119: FM Reception with a 192 kHz Card**

Fig. 120: Tuning using LO

■ Tuning

Click the mouse cursor on the LO-Frequency. This marks it with an overscore or an underline. You now use the mouse wheel to change frequency easily.

Start with the 10th position, and continue with a new mouse click at each less-significant digit. Use the mouse wheel as necessary.
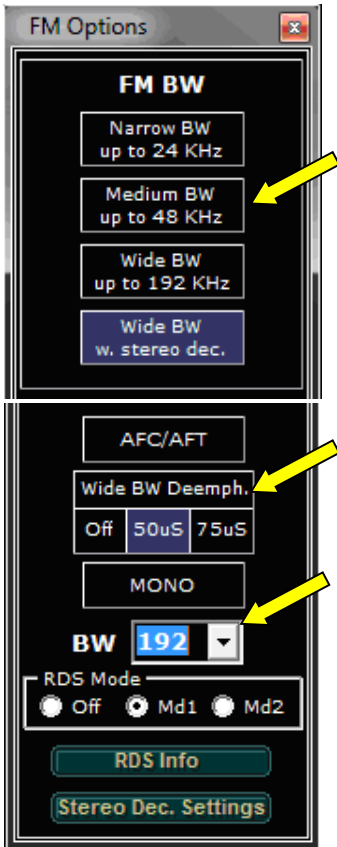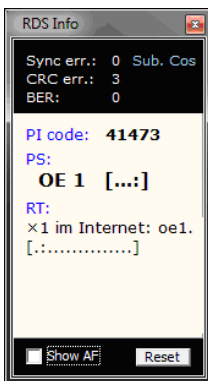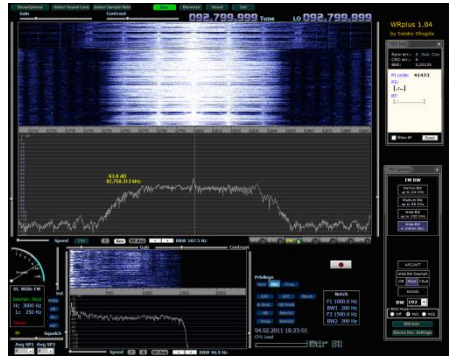
Fig. 121: FM Options

Fig. 123: FM Reception with a 96 kHz card

The sound of FM reception with a 96 KHz spectrum card is no longer quite so strong and full as with a 192 kHz card. However, there are no other restrictions as compared to 192 kHz card.

Fig. 124: FM Reception with a 48 kHz card

A 48 kHz card is unfortunately not suitable for FM reception!

Please refer to the very comprehensive guide supplied with WRplus! It will pay off!

RDS information is displayed in the window.
(± 57 KHz Displacement from FM Carrier)

Fig. 122: RDS Info

■ FM Reception in Amateur Radio

Brief Instructions:

- All Winrad based programs are suitable!
- Start **HDSDR**,
- Switch **Swap I/Q-Channels**,
  (Contrary to your previous Settings for LSB/USB Reception!)-
- Click on **FM** button,
- Tune in the FM portion of the 2m Amateur band (146-148 MHz)
- Work with **LO** in Reception Mode, and tune using **TUNE**.

There is really not much more to say here, as everything has already been explained.

With exception of the bandwidths, the screen pictures are quite similar. This (narrow-band FM) is also the reason for the universal applicability of all Winrad derivatives.

■Air Traffic Radio Reception (AM)

Brief Instructions:

The same situation pertains as in the two examples above, but with one exception:

You must switch to AM mode, as all air traffic takes place using AM!

- All Winrad based programs are suitable!

- Start **HDSDR**,

- Switch **Swap I/Q-Channels**,
  (Contrary to your previous Settings for LSB/USB Reception!)
- Click on the **AM** button,
- Tune in the Air Traffic AM Band (108- 136 MHz),
- Work with **LO** in Reception Mode, and tune using **TUNE**.

Sample Applications

■ DREAM

© 1998 DRM-Association

DRM stands for **D**igital-**R**adio-**M**ondiale, which is most simply understood as "Worldwide Digital Radio.". This public service includes digital radio and data services. The data are encoded for transmission using MPEG-4. DRM works in the shortwave region, with a bandwidth of 10kHz.

The **DRM** mode in the various versions of Winrad does not decode the signals, but just broadens the bandwidth to 12 kHz. If you wish to continue to work with the possibilities that Winrad offers, must provide a decoder. This can be accomplished elegantly today with VAC (Virtual Audio Cable). With the help of VAC [19], Winrad passes the data stream to the desired program. Here we focus on the description of the stand-alone version of the program.

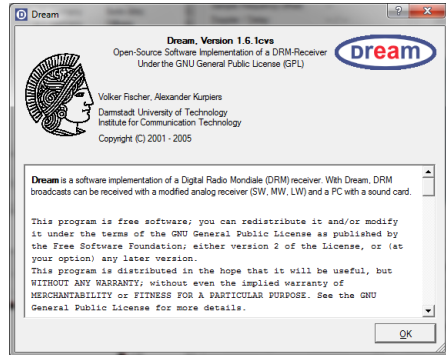An alternative to VAC is to use a special program for decoding the signals.

Fig. 125: Dream

DREAM is an example of such a program, developed at the University of Darmstadt by Volker Fischer and Alexander Kurpiers. This program in in the public domain. [20]

## ■ DREAM as a stand-alone program

On the CD provided, you will find the current version of DREAM (up to the time of printing of this manual), Version ver. 1.61. The program requires no installation, and is started using its program name, dream.exe.

It is best if you install a start-up icon on your desktop.

You will usually have to use the command line tag "**-c5**" when you start the program, in order that Dream runs in I/Q mode. To set this up, open the "**Properties**" menu with a right mouse click on the Dream icon.

One is the so-called Evaluation Dialog, the other the Multimedia-Dialog.

Both windows are from the main program.

Fig. 126: Program start line
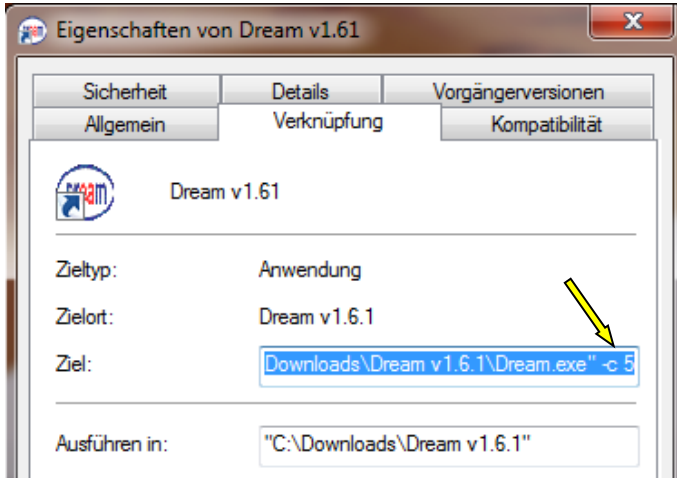
What we need now is a system for setting the frequency.

Somehow we need to tell our PMSDR what frequency we would like to set.

The tag **–c 5** needs to be entered after the exclamation point.

There is a small utility exactly tailored for these applications that allows you direct frequency input using a mini-DLL

Fig. 127: Sound Card Selection

In the root directory of the CD, find **PMSDR-Control_v1.5** and start **pmsdr.exe** from there.

As a result, two windows open up. One allows direct frequency entry by clicking the numeric positions.. The other has a graphic interface already known to you for the DLL. With the numeric input, you already have complete control.
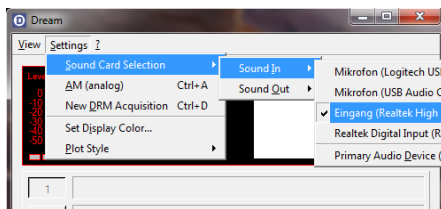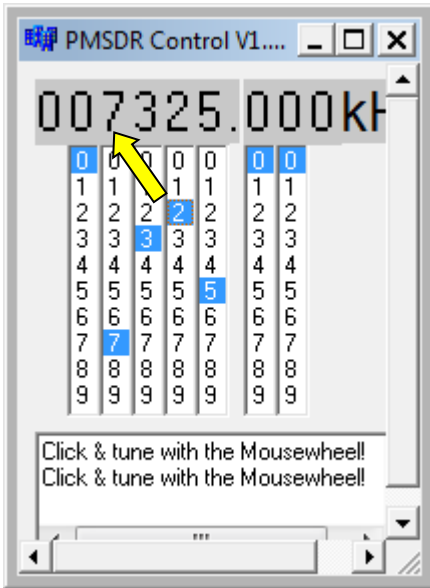
Under **Settings** and **Sound Card Selection,** enter your current data for audio input and output (Sound-In / Sound-Out).
When your program is running bring up two additional windows on the screen by pressing **Ctrl-E** & **Ctrl-U** .

Fig. 128: Frequency Input

Notice what is written in the window: "Click & tune with the Mouse wheel". A click on one of the large grey digits permits quick frequency change/entry with the mouse wheel. The DLL permits convenient direct access to your desired frequencies even with CAT control.

These can be found under the **Quick-Tune** tab, and under **sked.** Entries are of course possible, as already described above in the section on manipulation of the DLL .

The multimedia dialog shows several active DRM frequencies, and among them, **7325 kHz** promises quick reception success.
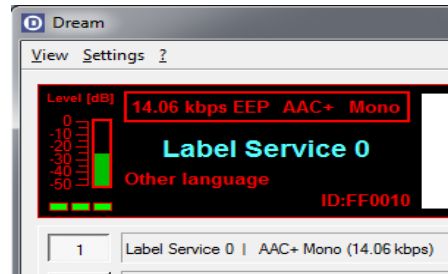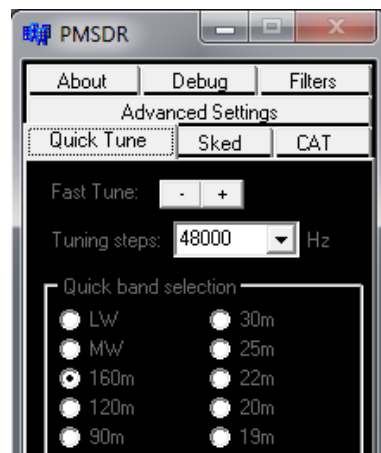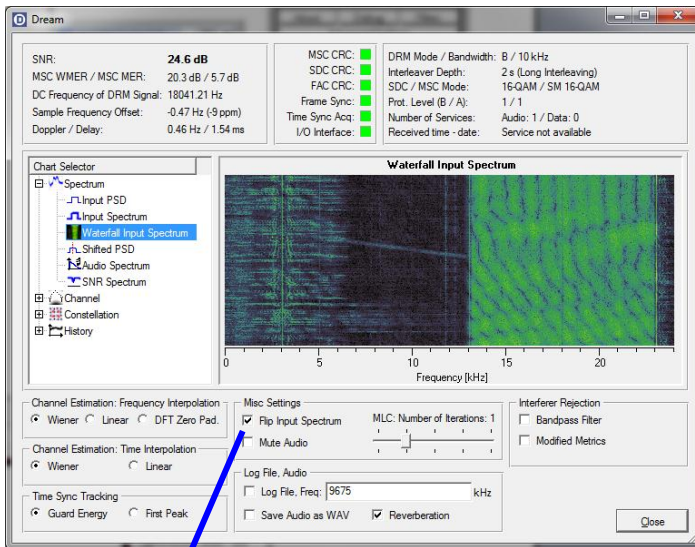

Fig. 129: Decoding OK

Fig. 130: Quick-Tune Window

If your current waterfall shows a strong signal as well defined as the well-defined signal in Fig. 131, but nothing is heard, then it is highly probable that the receive selection must be inverted.

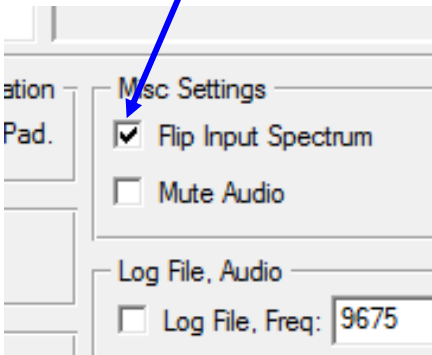It should now be possible to hear a nearly FM-like language or music output!

Fig. 131: Flip Input Spectrum

In this case, check the **Flip Input Spectrum** box. Leave all other settings as they were. If the inversion of the reception sspectrum produces the desired results, put the tag "**-p**" into the previously cited program call. This permanently sets the check in the „Flip Input Spectrum box. In the properties box for program startup, the complete call now reads **"-c5 -p**".

The Disco Palace promises just as easy a reception experience on **6015 kHz.**

The Russian service **Label Service** very often broadcasts in German **on 7325** kHz, and we usually receive it well in Europe.

The program needs a strong input for clean reception. Feel free to experiment a bit with different input levels for your sound card!

Have fun with DRM Reception!

■ PowerSDR-IQ

☞ If you just happened to start reading the manual here: Don't necessarily begin your career with Power SDR-IQ.

It is a very nice program with lots of capabilities, but it is exactly these that make the program less obvious in contrast to the Winrad versions, and somewhat unwieldy to use. In addition, the original PowerSDR was actually specifically designed for Flex Radio equipment, and is exactly tailored to that in operation. Consequently, when used to control PMSDR many buttons are useless because they are inactive.

☞ **Good to know:**

→ **There are several PowerSDR-IQ systems on the internet. On the CD, you will find ver. 1.12.23, which has proven to be stable.**

→ **More recent versions (since v1.19.xx) no longer support the necessary PMSDR DLL functions, and are therefore no longer useful.**

→ **These versions require a particular version of the DLL: ver. 3.2 rev. 9. This supports the PowerSDR-IQ software to version v1.12.xx.**

Installation:

If possible, install the program using all of its "Default" values. Then copy the three necessary DLL files into the newly created program directory.

(If you need the full program path, for XP this is in C:\ Program Files\ Flex Radio\x26 SV1EIA\ PowerSDR v1.12.23-IQ\) For Win7: Instead of "**Program**" use "**Program Files**".)

These are the three files: **c3260.dll, Extio_PMSDR.dll,** and **mpusbapi.dll**.

☞ 💣 Be careful not to use the file Extio_PMSDR.dll accidentally for one of the Winrad derivatives. It won't work!
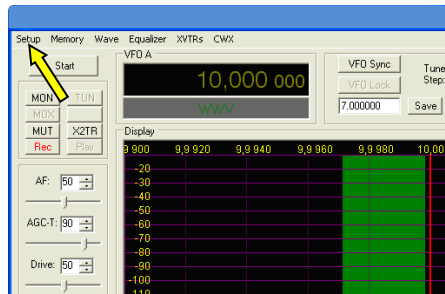
Start the program and click on **Setup**.

Fig. 132: Setup

In the resulting window, put your **general** and **hardware config** in the foreground..

The familiar DLL control window immediately appears on the desktop!

In the next step, the necessary audio installations will be carried out. You find these at **Audio** and **Primary**, as are to be seen in Fig. 135
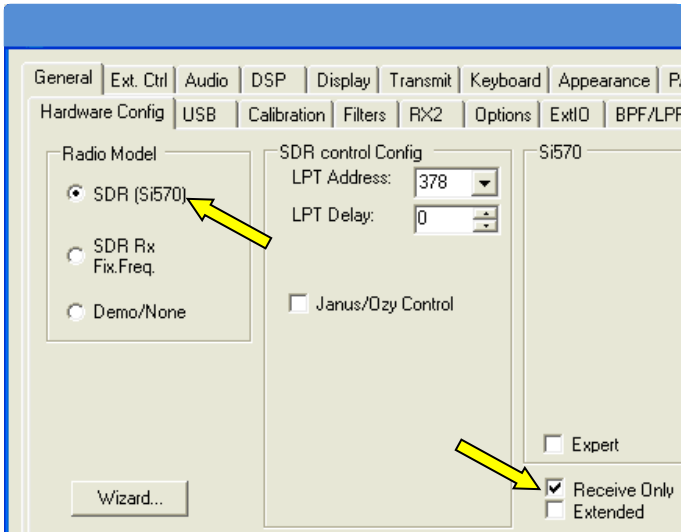
Fig. 133: Radio Model Setup

Activate the radio buttons at 👉 **Radio Model**, and also at **Receive Only**.

If you should happen to find your card entered here, please please do **not** select it!

Now open the tab **General → ExtIO**. In this new field, activate **PMSDR Enable**.

The reason has already been mentioned above: This is a function that necessarily implies the Flex radio hardware! This would therefore definitely lead to problems! So please leave this item set to Unsupported Card!
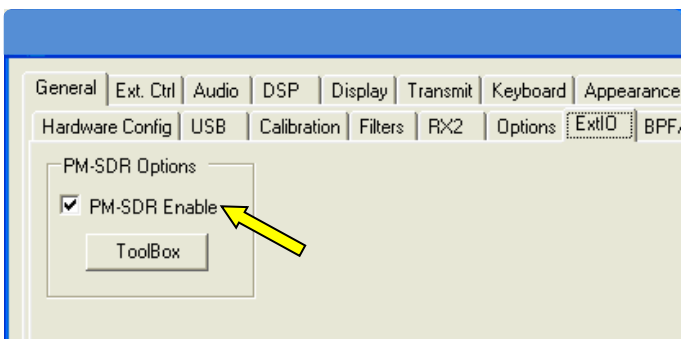

Fig. 134: Enable PMSDR

The CAT control missing from the DLL is done internally by the PowerSDR-IQ software. Only activation of CAT control subsequently then allows the use of the band and mode switches as shown in Fig. 136.
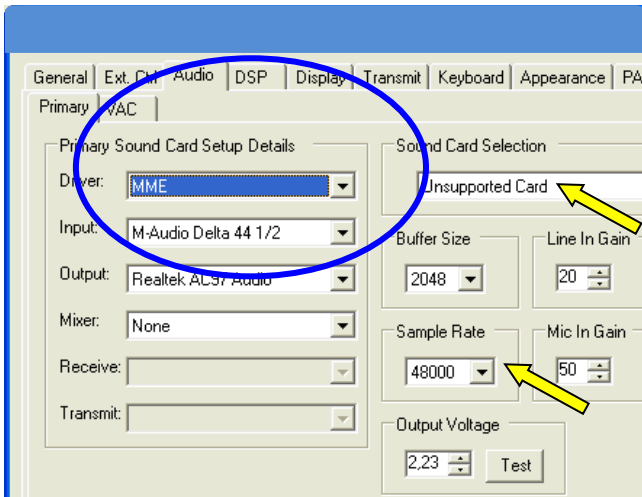
Fig. 135: Audio Settings

Make all the important settings shown here, insofar as your sound card allows..

Various different drivers are concealed behind the **Driver** pull-down menu. First, try the standard driver, **MME**. Move on to others only if you don't see a waterfall in this case.

We have already pointed out:

A special DLL is required here, which offers many possibilities not available in Winrad!

Thus, for example none of the entries Quick-Tune, Sked, CAT will be available.
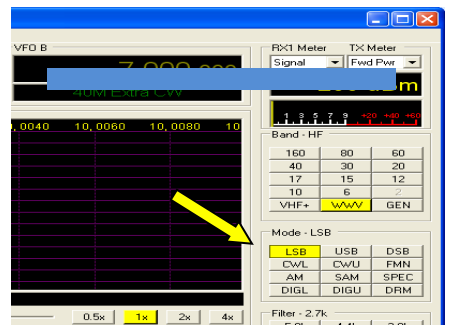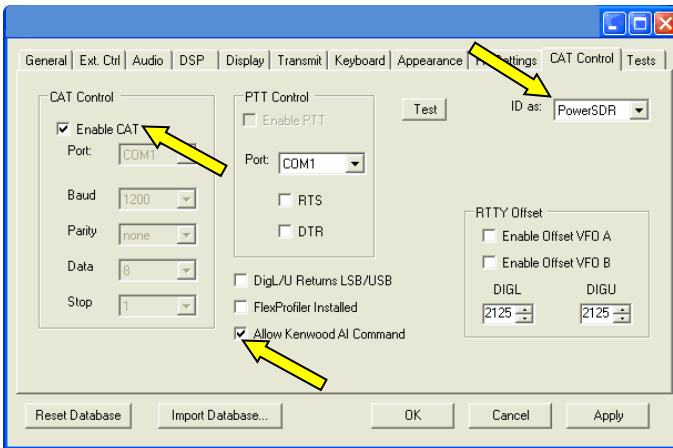

Fig. 136: Band and Mode Button

Please therefore, use the settings that you see in Fig. 137.

Only Enable CAT and **ID as: PowerSDR**.

Everything else is uninteresting, as it is associated with external hardware.

The DLL in Fig. 139 is already familiar. It offers no other special features over what you already know.

Fig. 137: Set Up CAT

The switch "**Allow Kenwood AI Command"** is probably more closely related to other interactive programs (e.g. HRD).
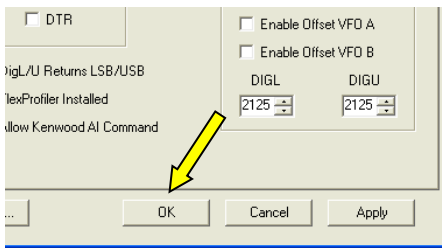

Fig. 138: Store with OK

Click OK to store these settings.
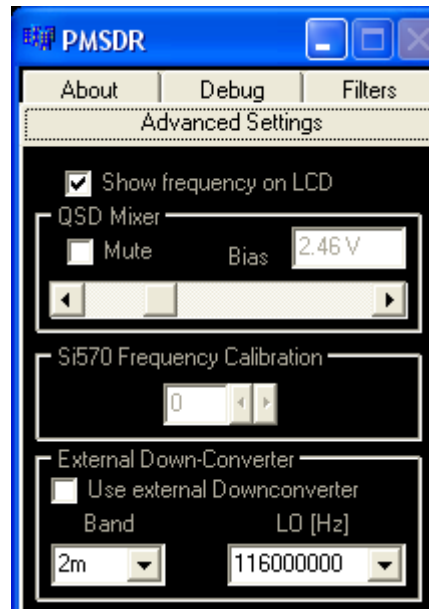
Fig. 139: DLL for PowerSDR-IQ

So, now it's time for the **START** button. If everything is set correctly, you will find a window similar to Fig. 140.
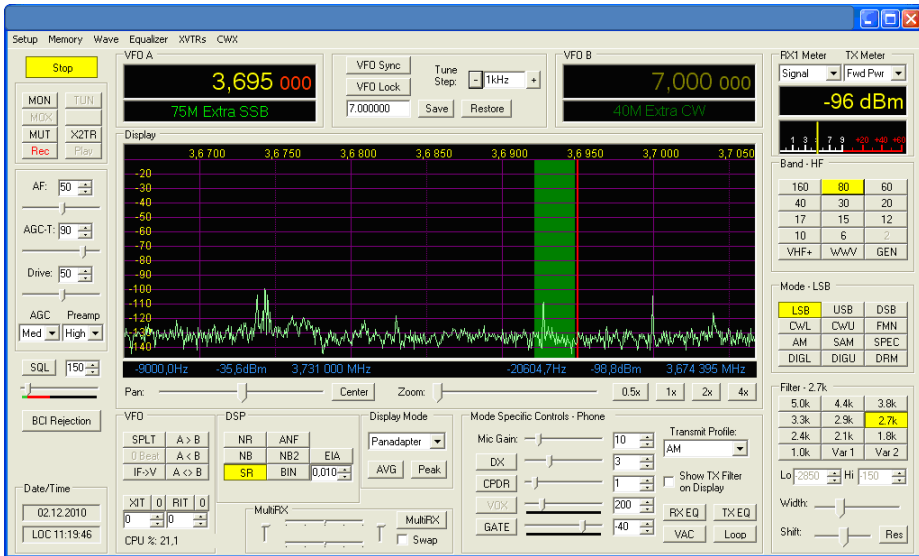
Fig. 140: Receiving Works!

If what you expected to see does not appear, please go back to the audio settings and try different drivers.

☞ **Swap I/Q channels**

The software does not allow inversion of the I / Q signals.

This will ultimately require changing the audio cable, if one has the wrong sideband location.

Wrong Sideband Location:
Despite apparently correct alignment with the signal edge, speech sounds forced, distorted, and clearly squeaky!)

■ Winrad Variants

This section is by no means a complete list of all the Winrad versions and their features. That would significantly exceed the space available.

Instead, we want to briefly mention the key data, as well as an eyeball inspection, to obtain a first impression of how the corresponding programs will look on your PC.

In particular, this may illustrate the important ways that the graphics of the various versions impact use on a netbook.

Thus, for example, none of the previous versions are able to change the horizontal area which is occupied by the waterfall/spectrum area.

A netbook screen may display, therefore, the waterfall/spectrum area as a fairly small section at the top of the screen.

Winrad, in all its versions has the ability to use keyboard shortcuts, e.g. hot-keys.

☞ The appendix contains a summary of commands (to cut out).

■ Winrad Ver. 1.61

The last available version from the original author (Alberto Di Bene; I2PHD) was Winrad Ver. 1.33, Jan. 2009.

Jeffrey Pawlan (WA6KBL) brought his own version (Ver. 1.61) to market in Feb. 2010.

Fig. 141: Winrad Ver. 1.61
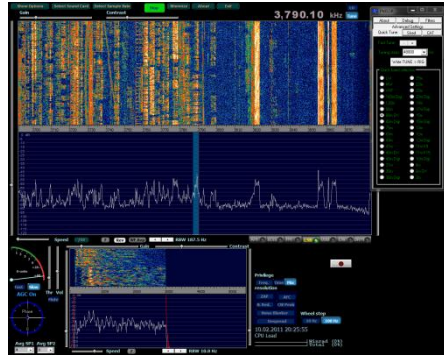
The author's notes about this program can be found in [3].

■ Winrad Variant WRplus

This version provides a complete revision of the so-called DSP Engine, the specially-important part of the program for Digital Signal Processing. Thus, for example, excellent suppression of the phantom signals (anti-aliasing), is one of many distinctive features
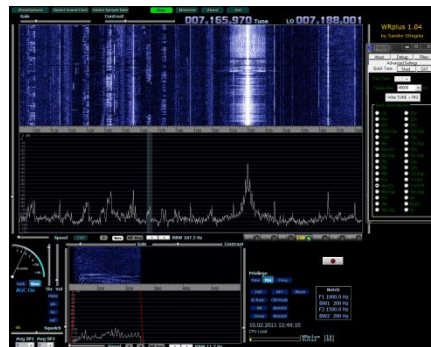

Fig. 142: WRplus Ver. 1.04r4

The website of author Sandro Sfregola [12] provides good opportunities for comparison. The most recent version of his Ver. 1.04r4 was published in January 2011.

Right clicking on the FM button opens up many new opportunities for FM radio reception.

Take the instructions provided to heart! In the application examples above, we offer a glimpse of the sophisticated features of FM reception!

When visiting the websites of the most active developers, you may find yet another new version.

■ Winrad Variant WinradF

Andrea Vigarani presented his open version Ver. 1.5 in Oct. 2010.

Fig. 143: WinradF Ver. 1.5

With the modified graphics user interface, the display on a netbook is a lot better.

Many nice features are implemented here for the first time.

Among the special features of his version, this author develops a new graphics user interface (GUI). Particularly provided for netbooks is the minimal vertical resolution of a 1024x 600 pixel screen.

His website has not been available for some time, for unknown reasons.

■ Winrad Variant HDSDR
  (formerly **WinradHD**

Besides WRplus, another version, by the author Mario Täubel (DG0JBJ) is also actively under development.

Version Ver. 1.0, of Dec. 2010, is the newest at the time of publication of this manual.

This version is ideal for use on note- and net-books. The smallest resolution available is 640x480 pixels!

Here we give a few of the useful command-line start-up tags, without looking in detail into the options for settings. Examples include **-sd** for display on a 2nd display, "**-fs**" for full screen display, "**-wv"** for a complete Windows-specific on-screen display, including free placement on the screen, etc.

The "Release Notes" in the program directory provide more detailed information!

In addition to the sophisticated features for customizing the display, there is a clear focus on the evolution of the DSP Engine.
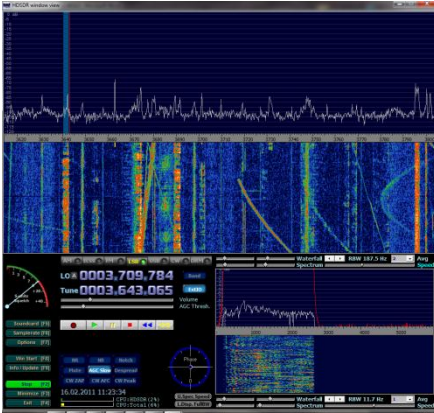

Fig. 144: HDSDR Ver. 1.0

Mario, for example, makes available 10 (!) notch filters, which are able to be arranged freely. Using the mouse wheel, it is even possible to set the filter bandwidth per notch filter to one's taste!

As mentioned, the author is very active, so be alert for new versions! [9].

■ Firmware Updates

Potentially necessary firmware updates can be made both quickly and easily. The version installed in the PMSDR can be read from the LCD display, or from the DEBUG tab (below) in the DLL. In the software folder on the CD, you will find a **"PMSDR Firmware_Upgrade_Tool"** named **PDFSUSB.exe**. This program is directly bootable, and thus requires no installation!

Preparation:

Remove the upper housing, by removing the two upper screws on the front plate as well as the corresponding screws on the rear plate. Now that you can reach both S1 and S2, do so. See Fig. 145!

However, if a switch board, or a down converter is installed, it may be advisable to also remove the lower two screws on the back plate and fold the (switch board or downconverter) unit carefully to the side!

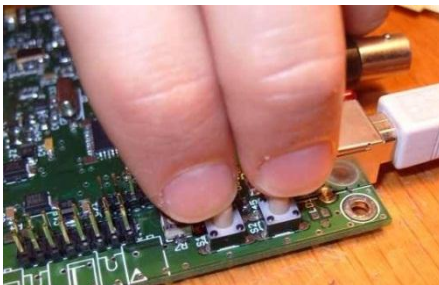We are now ready to carry out the operation shown in Fig. 145.

Fig. 145: Press both buttons...

Short Description of Process:

→ Connect USB Cable,
→ Start Program,
→ Reset,
→ PMSDR is in boot loader mode,
→ Program Firmware,
→ Ignore Error Message,
→ Finished!

In Steps:

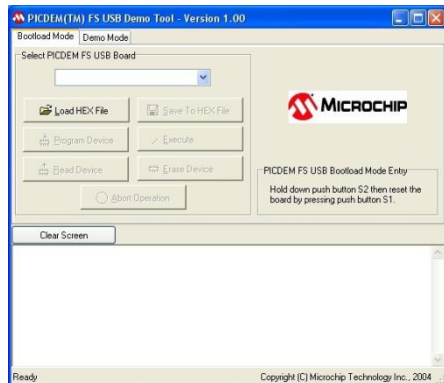Connect your PMSDR to your PC using the USB cable, and start the program.

Fig. 146: Program started

Now press down the two buttons S1 and S2; you will be able to feel the points to press. Hold S2 (Right button) while you let go of S1 (left button). Immediately afterwards, release the button S2.

The board is now in bootloader mode and ready for programming.

The following pictures repeat the operating sequence.
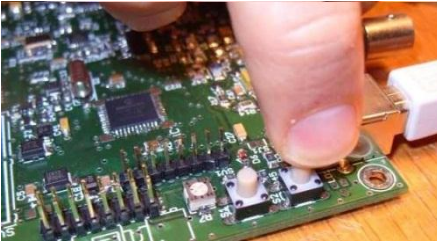
Fig. 147: Release S1 ...
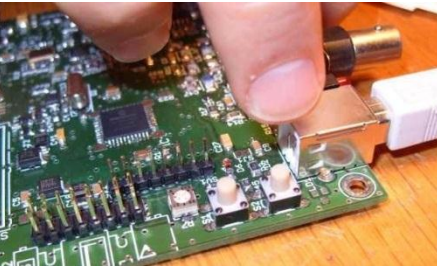
Fig. 148: Then release S2.
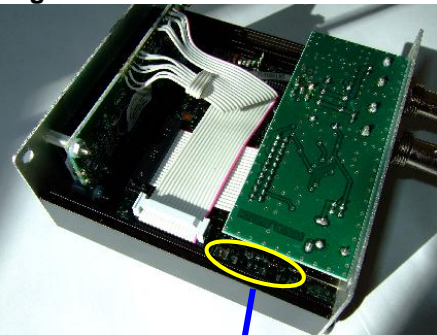
Fig. 149: With accessory present.
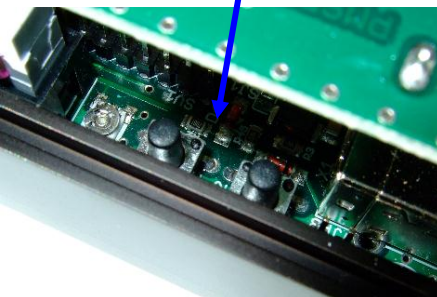
Fig. 150: S1 and S2 ...
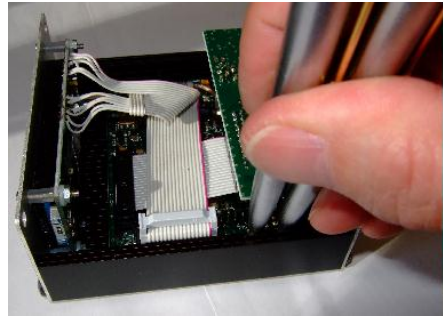
Fig. 151: Using ball point pens...

In principle, these finger acrobatics can be done with two pens. (Don't put points out!). This has the advantage that the device does not have to be taken too far apart.

So let's continue. The last item was: "The device is in boot loader mode."

Check it out!:
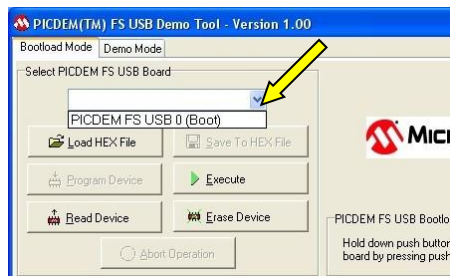
Fig. 152: In Bootloader Mode

In the pull-down menu the following entry must now be available: **PICDEM FS USB 0 (BOOT)**.

Use the button **Load HEX File** to store the current Firmware in the program.
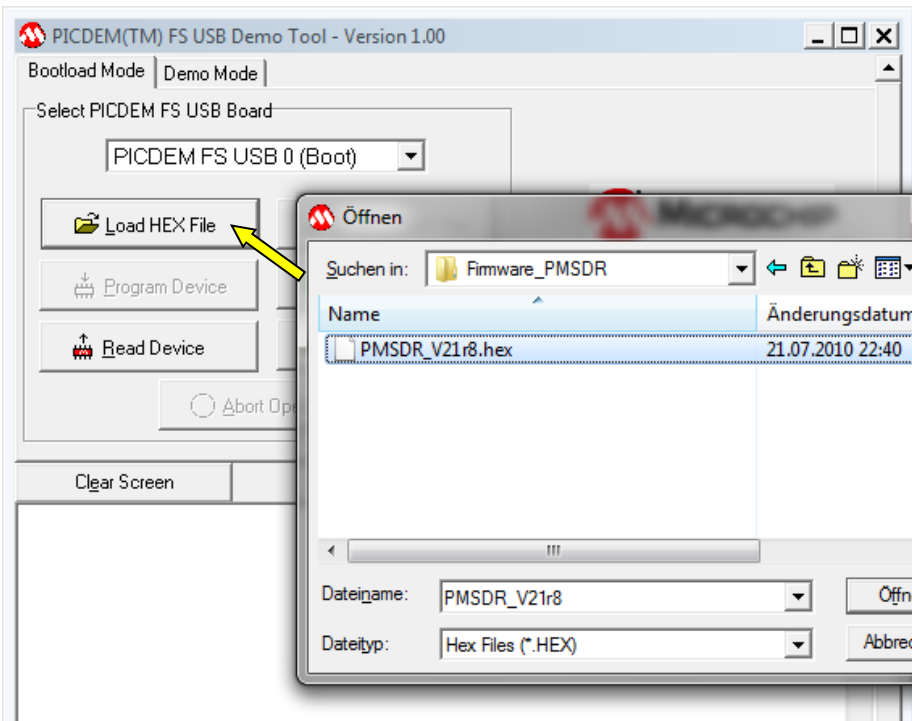
Fig. 153: Load Firmware

Fig. 154: Over-write Warning

Answer the following warning with Yes.

The firmware upgrade to be programmed is now in the internal program memory.
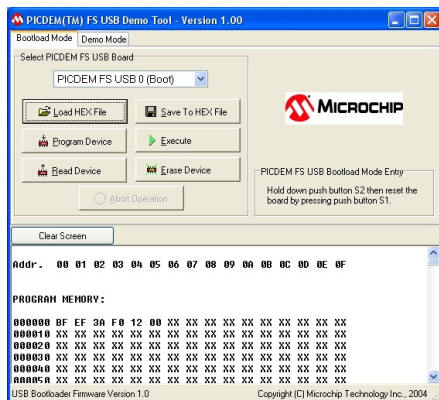
Fig. 155: Firmware Loaded
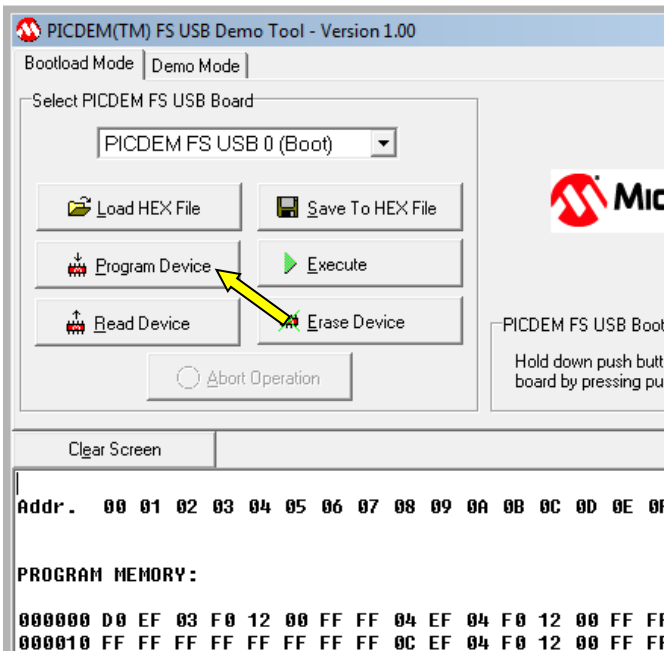
As a result you will see a few messages in the program output field.

Wait for the notification:

MESSAGE- Programming CONFIG DATA Completed

will be displayed.

Fig. 156: Begin Programming
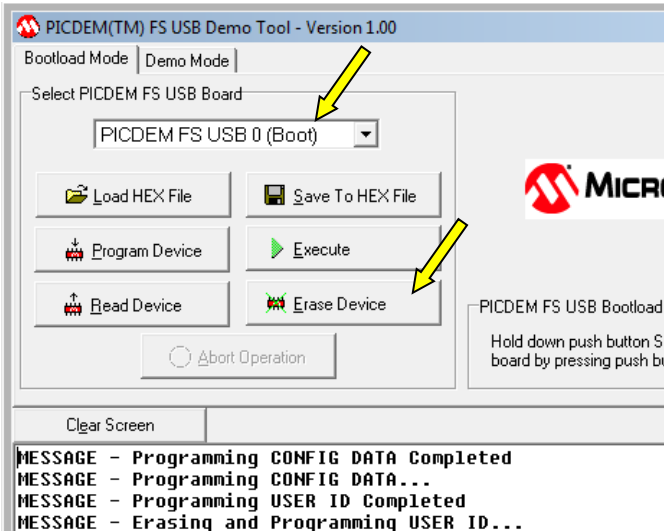
A hearty push on Execute starts the newly written firmware.

More or less as a sign of success, the display lights up again.

Fig. 157: Implement new FW

Now click on **Program Device** to start the actual programming operation.
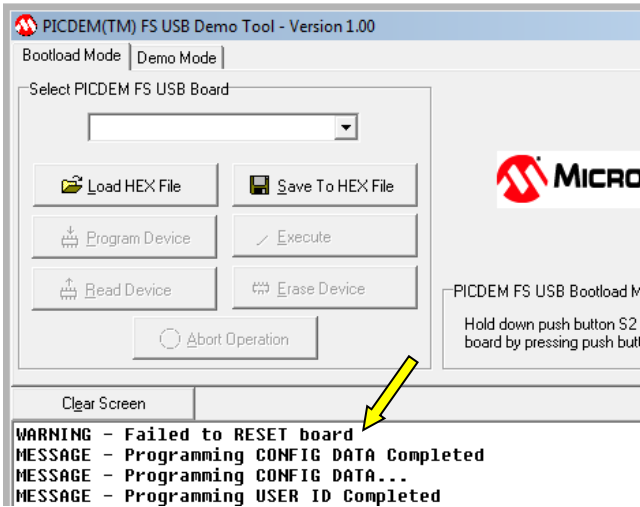
Don't be put off by the apparent error message:

WARNING-Failed to RESET Board

Everything is in order, and your PMSDR is correctly programmed!

Fig. 158: "Error Message"
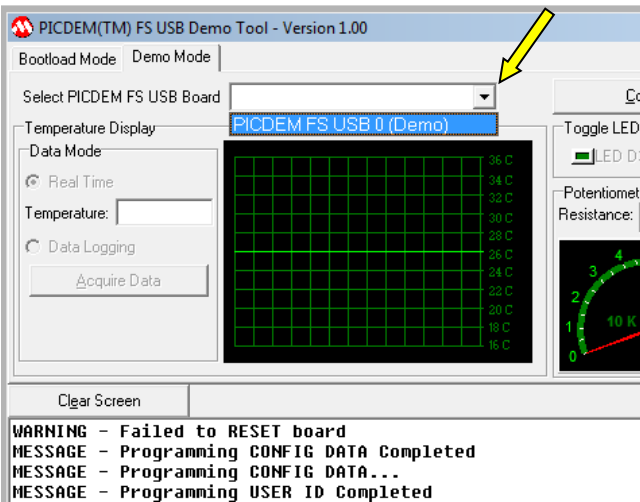
Do you want to convince yourself?

Switch briefly to the tab **Demo mode**. There, on the pull-down menu, you will find:

PICDEM FS USB 0 (Demo),

which wasn't there before!

Fig. 159: Firmware Active

Programming is now complete, and you can close the case again!

■ **Accessories**

■ **The Antenna Isolator**

The resulting line is essentially a mixture of ground-effects and sound card nonlinearities that have become visible.
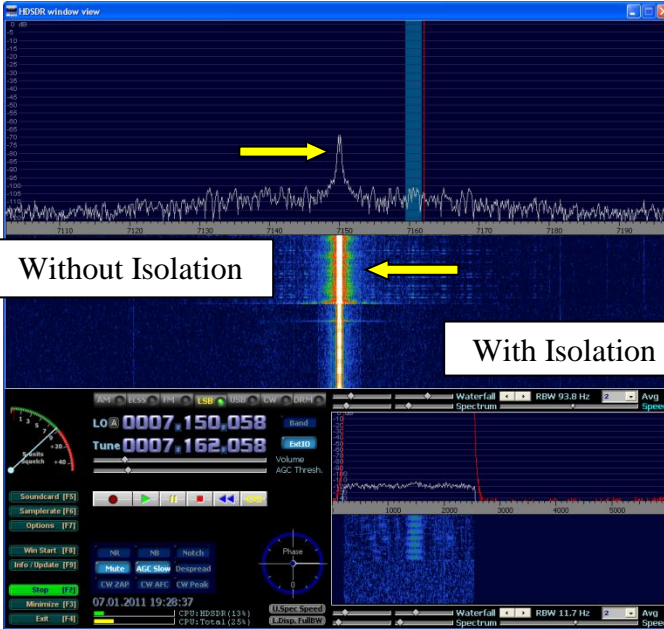
The assembly is really quite simple:

The three components are soldered in place, covered with heat shrink tubing... Fini. Take care when heating the heat shrink tubing not to overheat the little transformer.

.

Fig. 161: The Kit

Fig. 160: The Result of Adding Antenna Isolation

The antenna isolator eliminates ground loops that are caused by the antenna connection!

The small device is basically just a simple 1-1 RF isolation transformer; however, it is a carefully selected component, with excellent broadband transmission characteristics.

Fig. 160 shows the antenna connected to ground potential; in the upper part without, and in the lower part, with antenna isolation inserted.

The positive effect on the waterfall and spectrum is clear!
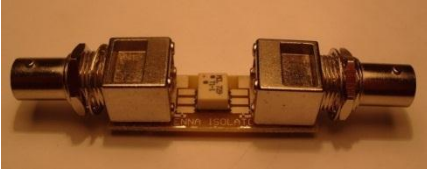
Fig. 162: Assembled Unit

Fig. 163: Covered with Heat-shrink Tubing

If you don't have a hot air gun handy, a butane lighter will work in a pinch. Please take care with the open flame! Turn the unit constantly to avoid localized overheating!

Fig. 164: Ant.-Isolator in Position

Connect the unit directly, using a male BNC on both ends, as shown in the picture, Fig. 164, or use a short piece of coax adapter cable, to avoid mechanical overloading!

☞ 💣 The RF transformer will not tolerate transmitter power! Use the Antenna isolator only for receiving!

Fig. 165: Insertion Loss

Measurements show an insertion loss of Max. 1 dB (2-50 MHz) or ~3 dB (0,15-400 MHz)

Input and output impedance: 50Ω; Power: max. 0.25 W

■ Technical Specifications and Schematics

■ Technical Specifications

Frequency Range	0,1-55 MHz *
Extended Frequency Range	In 3th Harmonic-Mode up to 165 MHz, without additional converter!
LO (Local Oscillator)	Si570; 10-220 MHz
Bandfilter	Three 3rd Order Chebyshev-Filter and 1 Lw-pass Filter
Anti-Aliasing	By means of PC-Software
Demodulation Modes	All; Software dependent
Dynamic Range	90-100 dB; Soundcard dependent
Sensitivity (MDS)	To -125 dBm; Soundcard dependent
IP3	5-25 dBm; Band and Soundcard dependent
Antenna Input	50Ω; BNC Jack
Bandwidth, IQ-Output (IF)	155 kHz @ -6 dB
Saturation Level (IQ Output)	2,45 V pp at -13 dBm HF-levell
Sampling Rate	To 192 KHz; Soundcard dependent
Power Supply Voltage/Current	USB 5V/170mA max.
PC Connection	USB-1.1/2.0
Internal Interfaces	LCD Display, Switchboard, Down-Converter, I/Q quadrature Outputs for professional soundcards.
AGC	Via PC Software

☞   * For receiving below 2 MHz, and also for the 3rd harmonic mode, an external band filter is advisable.

(dBm ➔ Power level reference is 1 mW)

■ Laboratory Measurement Report for PMSDR

Eraldo (I4SBX) conducted detailed laboratory tests on our receiver. Here we pass on the most interesting data with our gratitude. (December 2009 © Eraldo I4SBX)

The unit measured was a PMSDR Ver. 2.12, SN-2.13.0001
Sound Card: **E-MU 1212m**: sampling 192 KHz; Input level –10 dBV.
Sound Max (PC-Internal): sampling 48 KHz; Input level "line".
Measuring Instrumentation:
HF Signal generator: Marconi 2918 and 2919A.
Spectrum Analyzer: Marconi 2380-2383.
Attenuator: HP-355C/D; Voltmeter: RMS HP3400A.
Audio filter: f_C = 3000 Hz passive, vor dem RMSVoltmeter.
Dual-Tone DDS Signal generator: self built.
All calculations were rounded to the precision of the calibration (±1dB). MDS und IMD-Measurements were carried through by the usual methods: (S+N)/N = 3 dB; Setup according to RKE 8-9-10-11/2006.

● **Sound Card: E-MU 1212m**; (Measured with BW 2400Hz (SSB)).

	Filter: Auto-Select	Filter: Pass-Through	Filter: Auto-Select
Band	MDS	3th MDS	3th MDS
MHz	dBm	dBm	dBm
0,136	-120	-112	-112
0,57	-120	-115	-115
1,000	-120	-115	-112
1,850	-121	-116	-94
3,650	-123	-115	-93
7,050	-123	-116	-87
10,130	-121	-111	-72
14,150	-126	-113	-95
18,100	-125	-114	-89
21,200	-124	-113	-84
24,900	-123	-113	-80
28,500	-125	-112	-77
50,100	-124		

(3rd ➜ 3rd Overtone of LO)

MDS? – What is this?
MDS ➜ Minimum Discernable Signal

MDS values are mostly corrected for the noise floor of the unit; some are strongly dependent on the selected filter bandwidth (3).

The mixer of the PMSDR has an attenuation of just 13 dB on the 3rd Harmonic. In general, for QSD mixers one has to take in to account the total attenuation of harmonics in the pre-filter. The quality of these pre-filters is therefore of vital importance!

Fig. 166: Frequency vs. MDS

The **EMU-1212m** sound card produced a very low noise floor of -120 dB, (@ RBW = 187.5 Hz) . In the spectrum, however, some unwanted signals with very low levels are seen (-100 dB, see Fig. 175).

Measurements were carried out in the interference-free sections of the spectrum.

With the "**Sound Max**" the noise level is around -100 dB, (@ RBW = 187.5 Hz), and no spurious signals above this level are seen. The sensitivity is approximately 8 dB lower compared to the EMU-1212m.

● **PMSDR Efficiency in Harmonic Mode**

The MDS measurements were made as previously, but were performed only for the 80m band (BW 2400 Hz).

Band	MDS	2nd MDS	3rd MDS	4th MDS	5th MDS	7th MDS
MHz	dBm	dBm	dBm	dBm	dBm	dBm
3,650	-124	-76	-112	-66	-112	-107

Fig. 167: MDS vers. Harmonic: 2nd to 7th

From the above table, one sees again that the damping of the harmonics by the pre-filter plays a very crucial role.

● **Pre-filter**
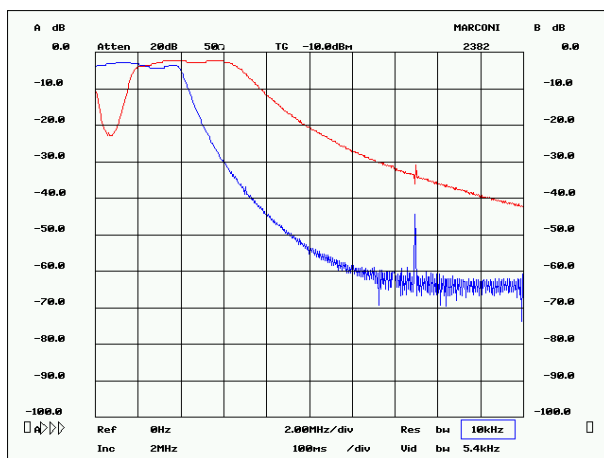
Fig. 168: Plot for the Pre-filters

(Spectrum Analyzer with Sweep Generator: Marconi 2380-2382; High Impendance Probe Marconi 2388).

Upper scale 0 dB; calibrated with "pass through" filter setting.

Blue: LP Filter

Red: 2-6 MHz Filter
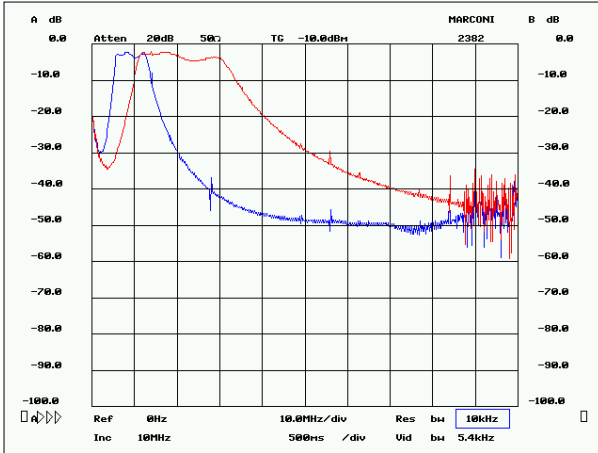
Fig. 169: Plots for Pre-filters

Blue: 6-13 MHz Filter

Red: 12-30 MHz Filter
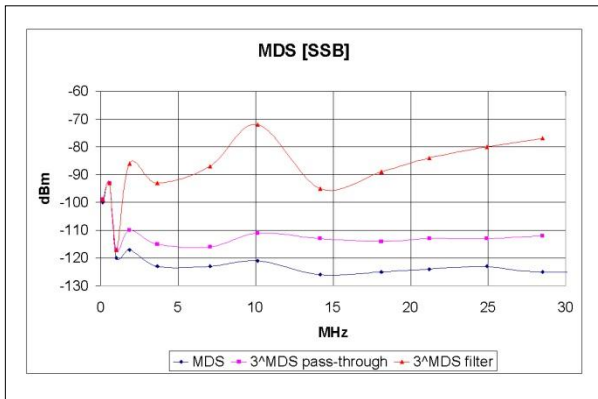
Fig. 170: Graphic representation of the measured MDS values

The differences between the values of the blue line [MDS] and each of the red lines [MDS in 3rd overtone] correspond to the dynamics of the PMSDR receiver.
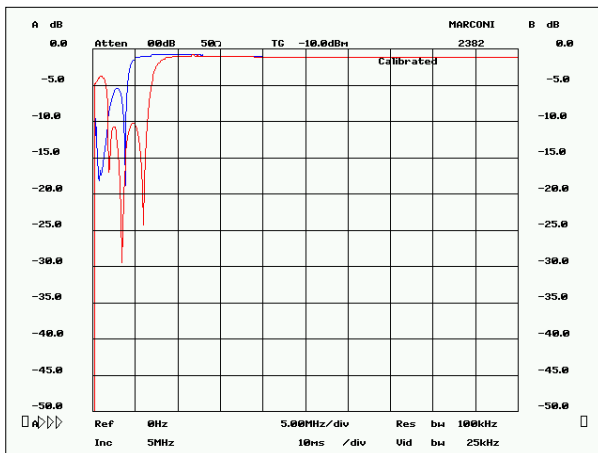
Bild-171: Return-Loss at the Antenna Input of the PMSDR

Blue: LP Filter

Red: 2-6 MHz Filter
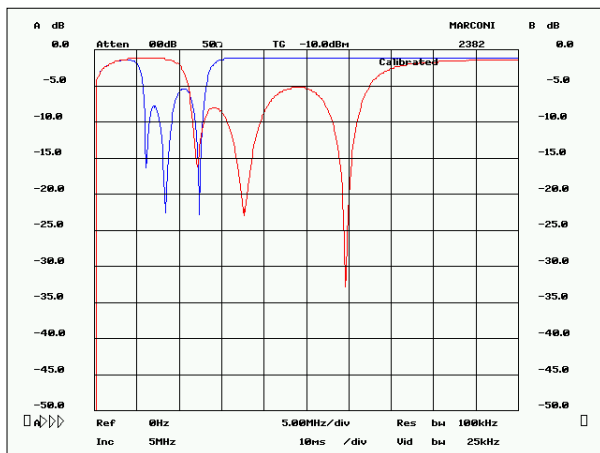
Fig. 172: Return Loss at the Antenna Input of the PMSDR

Blau: Filter 6-13 MHz

Rot: Filter 12-30 MHz.

Fig. 173: Return Loss Input without Prefilter (pass-through)

Note: Each filter shows good matching of the antenna input over the entire spectrum.

● **SFDR (Spurious free dynamic range)**

What is SFDR? – Explanation:

Distortion Free Dynamic Range ➔ Distance of distortion to a reference frequency

With the E-MU 1212m Sound Card , input at -10dBV, the dynamics are better than 110 dB (SSB), with the exception of small band sections in LW / MW, with some unwanted signals. With the Sound Max, input "line", the SFDR is only ca. 87 dB (SSB).

● **Dynamics of IP3.**

The measurements were carried out with a dual-tone DDS signal generator and a home-made Combiner (remaining ~ 50 dBm IP3;. See RKE 11/2006).

The level of the intermodulation product was read and tested with an NFvoltmeter HP 3400A RMS.

The measurements refer to a BW of 2400 Hz (SSB), and a separation of 2 kHz for the two tones.

Band	MDS	IP3	DR-IMD
MHz	dBm	dBm	dB
0,136	-100	8	72
0,567	-93	12	70
1,000	-120	11	87
1,850	-117	18	90
3,650	-123	21	96
7,050	-123	24	98
10,130	-121	24	97
14,150	-126	26	101
18,100	-125	24	99
21,200	-124	23	98
24,900	-123	1*	83*
28,500	-125	-5*	80*
50,100	-124	15	92
Band	MDS	IP3	DR-IMD
MHz	dBm	dBm	dB
24,900	-123	22*	96*
28,500	-125	23*	98*

* Dramatic decrease of IP3, caused by the action of the prefilter.

* Without Prefilter (Pass Through).

Fig. 174: IP3 Dynamics

With a good sound card, the dynamics of the PMSDR are limited only by intermodulation products and image rejection.

In switching mixers, the intermodulation products increase by a factor of 3, if signal peaks reach the supply voltage of the mixer. This effect is called "clipping."

A mixer which is operated with a supply voltage of 5V can therefore process an RF signal of max. 5V pp. This assumes that this is distributed symmetrically around a bias voltage = 2.5V. Therefore, the best setting of the QSD Mixer bias is 2.5 V.

● Image Suppression
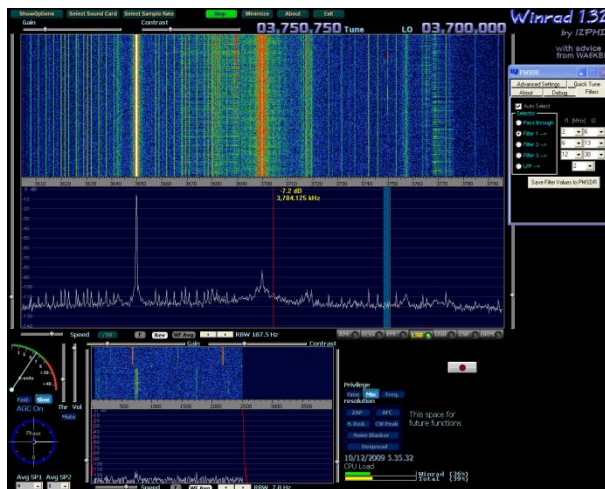
Fig. 175: "Channel Skew Calibration"- adjust for best rejection.

If, for Winrad, optimization is done at an image frequency in one of the two band halves, then image suppression remains at least 50 dB throughout the rest of that band section! In the case of the Rocky SDR program [14], the image rejection remains below 85dB after running the Automatic I / Q Balance function, likewise measured over the entire band!

The unwanted signals are most likely generated by the PC, and are then picked up through the internal sound card. Through use of an external sound card, they should disappear entirely, or at least be greatly weakened.

● Personal assessment by I4SBX

(This is) A good SDR receiver with excellent price / performance ratio, with a dynamic range of ~ 100 dB (SSB). Unfortunately, the attenuation of the prefilters is not very high outside their filter edges. This results in the reception of unwanted harmonics, and therefore affects the dynamics of the overall system.

End of Report; Technical Data

December 2009 © Eraldo, I4SBX

■ Schematics

Fig. 176: PMSDR
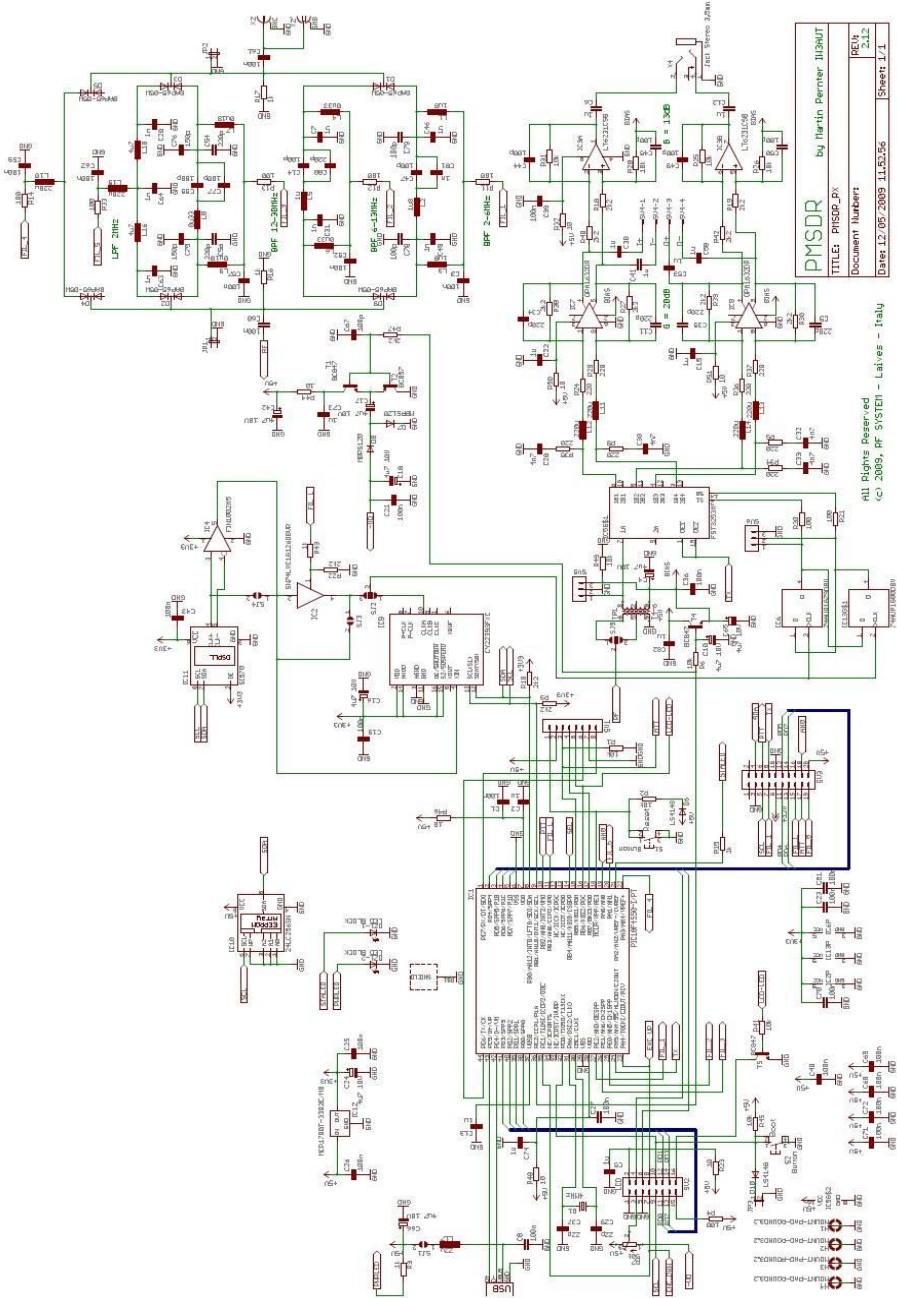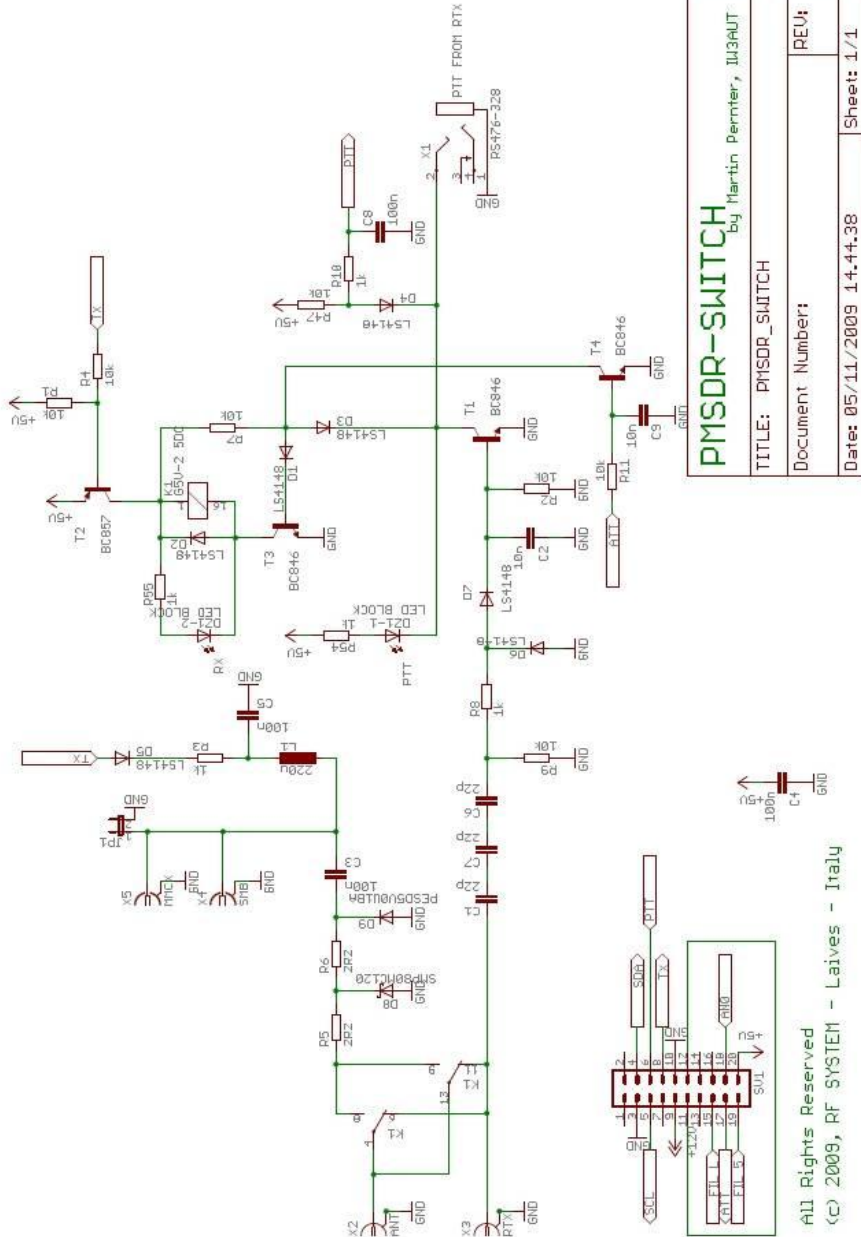
Fig. 177: T/R Switch Board
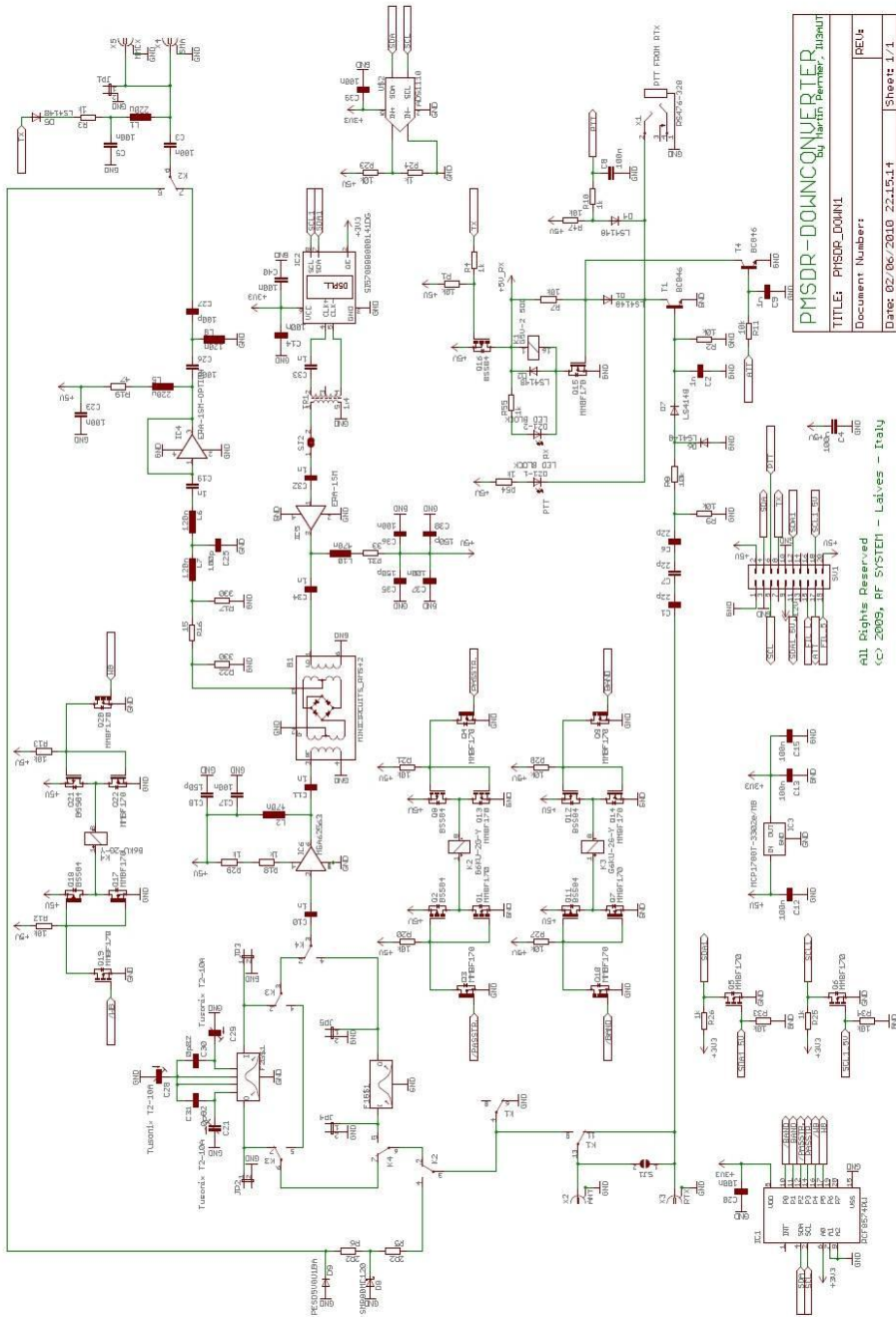
Fig. 178: Down-Converter

■ Troubleshooting / Test Points

To encompass possible malfunctions, the most important test points are shown:
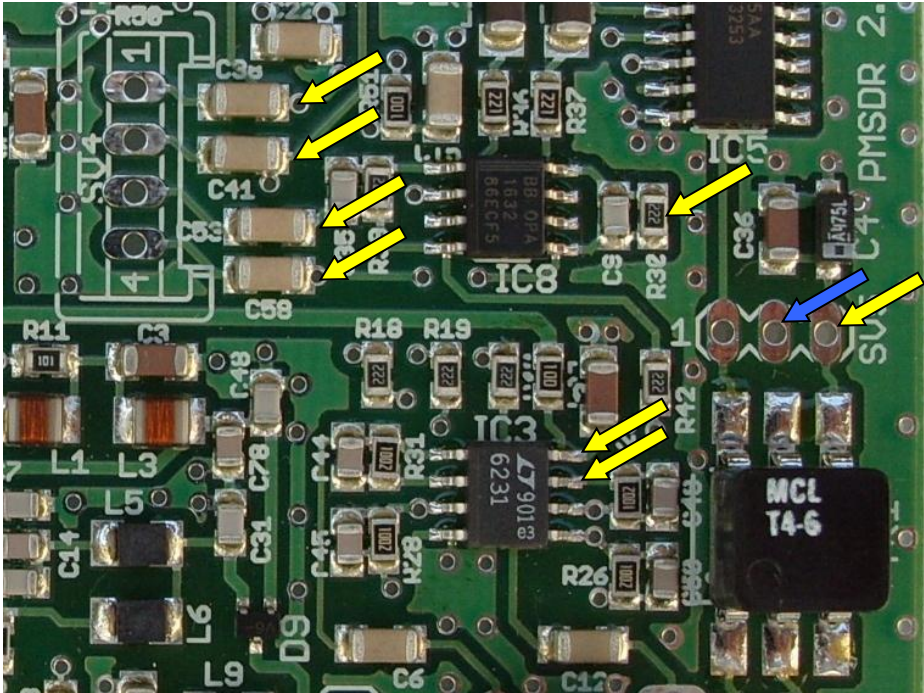
Fig. 179: Test Points

One should use a relatively modern high impedance multimeter. It need not be a relatively expensive instrument of the RMS (Root-Mean-Square) class, but it should possess an input impedance of a few MΩ!

Please measure **across the resistor:** Voltage drop across **R32**: max. **100mV**, (otherwise IC8 is bad.)

The following measurements are all related to ground potential: **GND** at **SV5 Pin2**. All pins should show an equal value of **1.95V**. The differences in measured values with each other should not exceed ± 50mV!

SV5-Pin3,   C41 (On the side connected to IC8),
IC3-Pin7,   C53 (On the side connected to IC8),
IC3-Pin8,   C58 (On the side connected to IC8),
C38 (On the side connected to IC8).
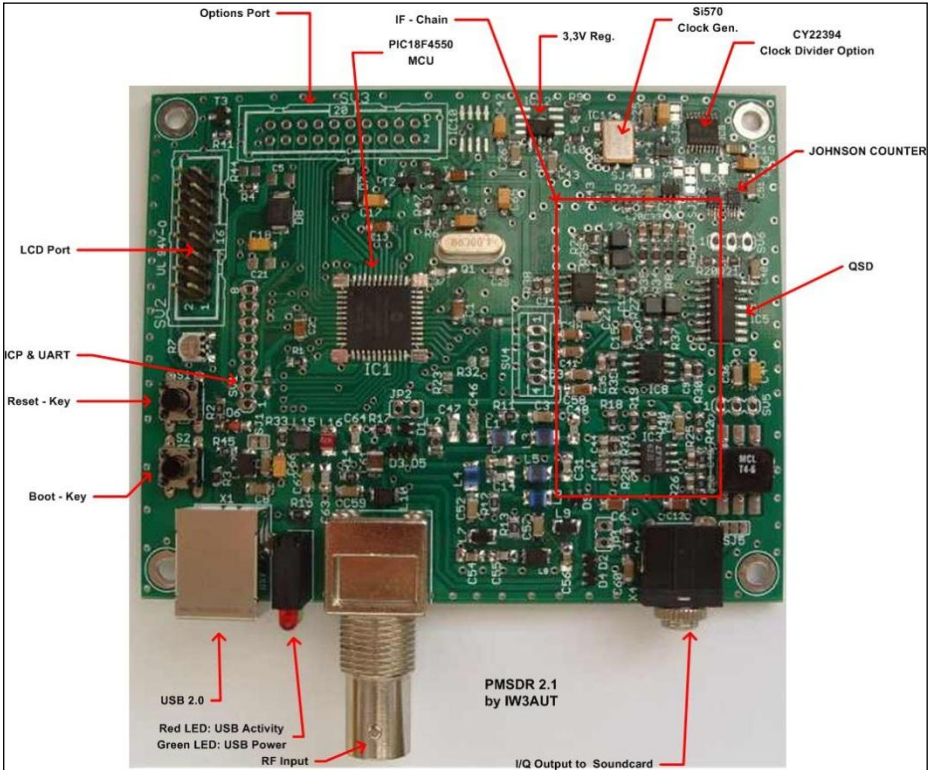
Fig. 180: The most important sites and their positions

Your Measured Values:

Position	Should read		Actually reads
R32	<100mV	➔	
SV5-Pin2	**GND**		
SV5-Pin3	1,95V	➔	
IC3-Pin7	1,95V	➔	
IC3-Pin8	1,95V	➔	
C38	1,95V	➔	
C41	1,95V	➔	
C53	1,95V	➔	
C58	1,95V	➔	

(Deviations from one another not greater than 50 mV!)

■ **Appendix I**

■ **CD Index / Directory**

The CD provided does not contain any self-starting applications. Use Windows Explorer (Button: ⊞-**E**) to aid in looking through the contents.

We ask you to observe the relevant rules of GNU-GPL freeware, which can be found in the appendix.

The documentation and descriptions mentioned in the Manual are to be found under the corresponding rubric of PC-software, not in „Documents.

In **Documents** conversely, one will find further PMSDR Documents, as for example, schematics.

■ Introduction to the Technology of SDR

● What is SDR actually?

There are many highly complicated definitions of this term. They can however be reduced to just what the name says already: "Software Defined Radio." But this definitely does NOT imply a radio receiver (or transceiver) controlled by software, but rather a device in which many **functions** of a normal receiver / transmitter are emulated in software, not by analog circuitry!

● Low hardware complexity

This reduces the remaining circuit complexity to a minimum. A complete digitization of the entire receiver circuitry in software, however, is not (yet) possible. Ideally, a received signal would be fed directly into an A/D converter, and subsequently directly converted to the demodulated signal in bits and bytes for further processing. For sending, just the converse of this process: Speech would be digitized and fed into a D/A-Converter, which sends the signal directly to the antenna. We are not quite to this point with the technology, but are close to it.

● Signal Processing in the PC

The great advantage to this approach is the minimal hardware requirement, combined with the almost unimaginable ability to manipulate the output signal.

This happens in the downstream PC...

Here one can now realize, for example, the sharpest filters that one can imagine! But everything has its downside, which begins here with the subject of the PC. By processing the data (in a computer), we distance ourselves clearly from real-time analog technology.

It is easy to see that processing in a PC takes time. The problems resulting from the (finite) run-time duration cannot be underestimated, and unfortunately this is only the beginning of problems facing the SDR technology.

● The Direct Conversion Receiver

There are several technical approaches to realizing an SDR. The various different methods need not be discussed here; this is completely beyond the scope of this small treatise! A relatively easy to understand technology is applied in the PMSDR QSD method; it promises excellent results, and for the effort involved is predestined to be a price/capability winner. Also, the operating principle is relatively simple to understand.

We can best approach the subject with a step-by-step introduction to the functional principles of a direct conversion receiver.
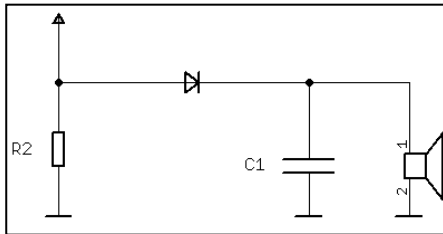
Fig. 183: Direct Conversion Receiver

The principle is actually the same as shown above, and was used in the early days of radio technology for receiving AM radio stations.
This type of receiver needs a so-called detector. Here, a diode is used. This diode acts as a switch, "closed," as it were, during the positive half-cycle of the reception frequency, open during the negative half-cycle. The integrating capacitor downstream from the switch will be charged through this on-off switching in synchrony with the frequency being received, and this charge is audible through the loudspeaker as speech or music.

One can now easily imagine replacing the diode by a switch, and (as in Fig. 184) allowing this switch to open and close in synchrony with the received frequency. During the positive-going half cycle of the radio signal (0° to 180°) the switch might

be open, and during the negative half-cycle (180° to 360°) , closed, etc.

(By the way, this receiving method is still free from image frequencies.)
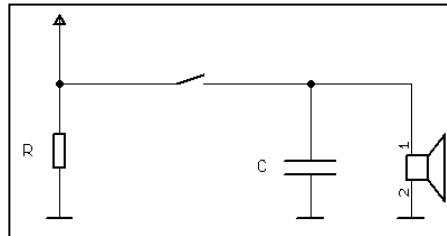
Fig. 184: ... with a switch

With progress in radio technology, the superheterodyne receiver appeared, in which a mixer was used to make the high input frequency easier to process by mixing it to produce lower frequencies. This is unfortunately where the subject of the image frequencies is born.

● **Use of mixers**

Unfortunately, through the mixing process, not only the desired result f1+f2, but also the undesired result f1-f2 appears in every mixer.

● **QSD**

The switch idea of Fig. 184 is also used in our PMSDR. Instead of one switch, however, four are used. These switches cycle every 90 degrees, not just every half-cycle.

(So there are namely four switches, along with four integrating capacitors.) This switch arrangement is called a **Tayloe Mixer**, or QSD. (QSD stands for quadrature sampling detector). During sampling, only one switch is closed per time interval, while the others are open. This gives sampling at phases 0 °, 90 °, 180 ° and 270 °, and one calls this type of sampling "sample and hold."

The resulting voltage values of the four integrating capacitors are now grouped in pairs, and operational amplifiers are used for further processing.

Fig. 185: Four-fold Sample and Hold

Follow along here with a thought experiment: Imagine we want to rotate through the switching process so that we get our 4 phase values. This is illustrated conceptually in Fig. 185. But at what rate should we rotate through the switching process? When we crank through the switches at a leisurely rate, a couple of revolutions per second, speech output is incomprehensible, because it is very "chopped. ". It is easy to see that comprehensibility gets better with increasing sampling speed, because the signal present is
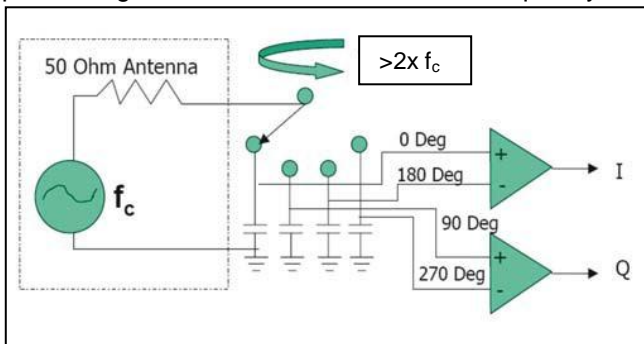
recorded in ever-shorter time intervals. Above a certain speed of rotation, the sampling is so fast that as a result the full intelligibility of the input signal is achieved.

We have now playfully approached the "sampling theorem." Behind it all lies a lot of mathematics, but we will not ask this of you. Only one thing is important:

● **Sampling Theorem**

How high the sampling frequency is, depends directly on the input frequency. The physicists Shannon and Nyquist found that one has to sample at least twice as fast as the highest frequency in the input signal to be able to reproduce that signal. As a formula:

$$f_{sample} > 2 \times f_c$$

Consider that you want to build a receiver that will process input frequencies of up to 60 MHz. At least how high does the sampling frequency have to be? Right! At least 120 MHz!

For completeness sake, it is worth mentioning marginally that in this type of sampling, artifacts exist which have to be suppressed by appropriate measures (analog low pass filters).

A higher sampling rate than $2 \times f_c$ does not lead to further information gain. Nevertheless, it is often used.

● **Oversampling**

The justification:

Extremely high demands are placed on the steepness of the skirts of the low-pass filter used. These filters can only be made with a very considerable effort (The Chebyshev filters used in PMSDR have such an extreme slope). Over-sampling (commonly by factors of M = 2 and M = 4) now allows, on the one hand, a drastic reduction in the requirements required of the analog filters. On the other hand, after sampling, a digital filter needs to be in place for sampling rate reduction. Such filters are referred to as decimation filters. What at first sounds like a great disadvantage, is instead cleverly used in such a way that during the mathematical process of decimation, so-called processing gains arise, by which the dynamic range of the SDR receiver improves quite significantly. For SDR receivers of the DDC* (Direct Down-Conversion) type this is done by hardware in the receiver. Here in the QSD method, the software in the downstream PC is responsible for decimation. This is enough to say at this point. Excessive mathematics lurks behind it again!

*What is **DDC**?
DDC stands for **D**irect **D**own-**C**onversion, and describes a process

in which an HF-Signal is directly down-converted to 0 Hz.

● **I/Q Signals**

This is not the end of it. To pick up the thread again:

From Fig. 185 we know that there are two signals at the output of our QSD mixer, I und Q. "I" stands for In-Phase here, and contains the 0° and 180° signals.
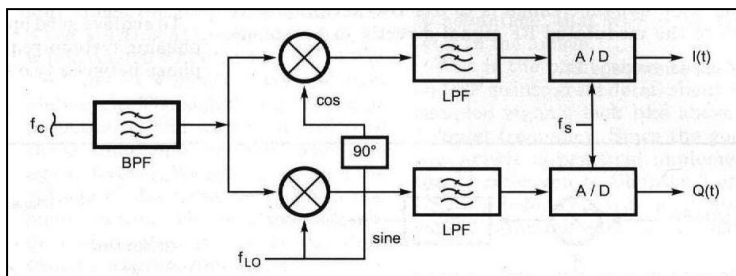

Fig. 186: Principles of a QSD Receiver

"Q" stands for ("in-") Quadrature, and consists of the 90° und 270° components. The phase shift between these two signals corresponds therefore to 90°. The I Signal at the output of the op-amp contains the value 0° minus 180°, while the Q Signal corresponds to the value of 90° minus 270°.

One can also see this in Fig. 184. The two analog signals I and Q thus now contain the entirety of information in the input frequency.
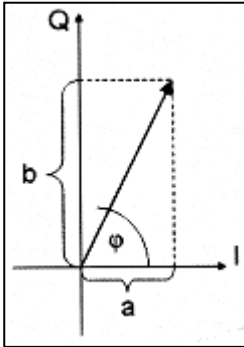

Fig. 187: I/Q Coordinate system

The data content of these complex signals is in an orthogonal coordinate system, from which the PC software can again reconstruct the input signal.

We want to very briefly examine how the original signal is to be reconstructed. Therefore one must first know: The length of the vector contains the original signal amplitude, while the angle with the abscissa (I-axis) contains the instantaneous phase. For the demodulated signal, we then calculate as follows:

AM: Amplitude of the vector = root (a^2+b^2).

FM: Phase=arctan (a/b).

SSB: FFT with several thousand bins. Here, the sideband is converted into the frequency domain, from which one can then calculate the modulation content. You guessed it, certainly: Again, lots of mathematics. But back to the mixer output...

The frequency bandwidth of I / Q, the mixing results, the frequency bandwidth of I / Q, is the so-called "base-band," which could, for example, range between 0 Hz and 96 kHz. (Thinking here of a sampling rate of 192 kHz) If this signal is sent to the right/left inputs of a sound card, one obtains as a final result, a high-quality receiver, whose properties depend essentially on the PC software used for further processing. The sound card now "breaks up" this analog I/Q-Signal, using its A / D converter, into digital snacks for further data processing in the PC.
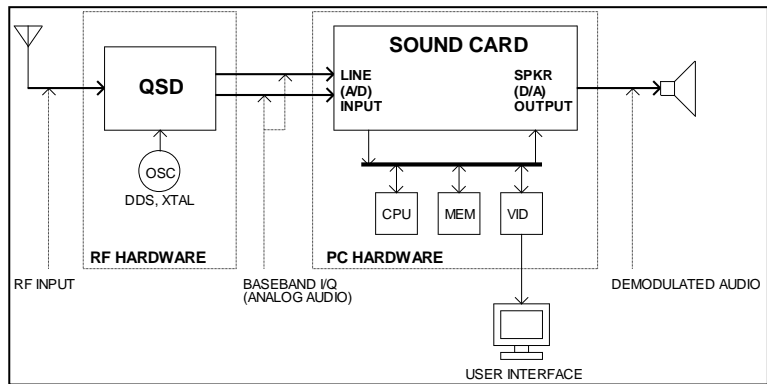
● **Block Diagram**

Fig. 188: SDR Components

An SDR always consists of three parts: mixer, processor, and controller.

The QSD takes care of the mixing.
The PC, together with sound card and software, takes over the processing.
The Control is just a bidirectional link between PC and SDR (responsible for setting frequency and display, control of the LO, AGC, level of amplification, user interface, etc.)
The general idea has by now surely become clear! The complexity of the whole, however, significantly increases, the deeper one looks into the matter! We leave it at this point.

This now makes it possible for you to understand the block diagram in Figure-188 relatively easily. The antenna input on the left provides RF to the SDR hardware. This hardware now uses, as we know, the QSD for mixing / reduction of the input signals to the base-band. The resulting analog I / Q signals are fed to the sound card, and then digitized in the A / D converters ("quantized", as the expert says). The DSP (Digital Signal Processing) follows later in the software used (Winrad, PowerSDR-IQ, etc.).

● **Suppression of Image Signals**

We still want to consider briefly the image signals which originate in the mixer and which are always present. A couple of examples may make this clear once again: Consider a signal of 17 KHz (for example, the test signal from the sound card tester) in the spectrum. Because of the mixing, this signal shows up again, 34 kHz below. We assume that the mid-point of the spectrum is set at 0 Hz. In other words, the image signal would appear left of the center, at -17 kHz.

A station which is at 25 KHz will be found duplicated, 50 kHz below it, etc., etc... We naturally want to suppress these mirror signals, which are undesirable by-products! But how?
The answer to that is already implicit above. The two-fold reduction of the signal to baseband in the process described above must have a reason! As we have seen: One mixes the incoming signal in question not once but twice to baseband, but with a phase shift of 90° in the second conversion.
The image signals are now already significantly suppressed by the operational amplifier acting as an adder. This is the reason for the claim in the literature that the QSD already has, from the outset, good image suppression. The DSP software on the PC then tries (with relatively complex mathematical algorithms), to remove the parts which unfortunately remain.
It is precisely at this point that "Channel-Skew-Calibration" enters in, resulting in the removal of images from a narrow portion of the spectrum. One hopes that the authors of Winrad may at some point implement an automatic form of algorithm (WBIR), that optimizes image suppression over the entire spectral range.

● **Twice the Bandwidth**

As a by-product, so to say, the I / Q technique allows a double-width spectrum display. This increases the total range to twice the (internal) sampling rate of the sound card. Why "Internal? " The answer is simple: We must bear in mind that the sampling

theorem also applies here: A sound card with 96 kHz sampling frequency can internally handle only a 48 kHz wide input signal. The complex I / Q signals in this coordinate system, however, have spectral asymmetry. This means that all the information contained is present in negative as well as positive form. In the mathematical reconstruction of signals using the FFT (Fast Fourier Transform), both positive and negative spectral components arise again. The positive are seen from the origin to the right, while the negatives are located to the left. This results in a total spectrum width of 2 x 48 kHz, or 96 kHz. Despite the limitations of the sampling theorem, a sound card with 96 kHz sample rate can display a 96 kHz wide spectrum.

● Anti-Aliasing Filter (Sound Card)

The A / D converters in the sound card unfortunately react not only to the desired baseband signals, but also to their harmonics, that is, the 2nd, 3rd, 4th, overtones, etc.
These undesirable spectral components should or must be filtered out, so that our spectrum is not distorted by phantom signals. This is effected, at least for the better (read: more expensive) sound cards, by the low-pass filter preceding the A / D converters. These so-called anti-aliasing filters in the real world, of course, turn out to be less than ideal, having a slowly rising bandstop characteristic. As a result, not everything above 48 kHz (as in our example above) is cleanly suppressed, with remaining traces of the harmonics passing through the filter. In practice this means that

strong signals that are just below the filter's rising bandstop edge (and thus that are only slightly attenuated), produce so-called alias frequencies f_a. The results are the same here as in the case of the mixer: $f_a=f_e+f_s$, or $f_a=f_e-f_s$ respectively.

The problem described here is a general one, which serves to emphasize the importance of a good sound card with cleanly functioning anti-aliasing filters.

● Dynamic Range (Sound Card)

For use in the SDR, the dynamic range and sensitivity of a sound card are not quite as important. Even cards in the "low-cost" market reach background noise values between -90 dB and -110 dB. High quality (and then unfortunately very expensive) cards reach values well above -120 dB. For the majority of all SDR application, a card in the range of about -90 dB suffices, since as a rule, the IF signal is so strong that even weak signals easily exceed the threshold of -90 dB and on this account clearly lie over the base noise of the card.

So now the path for signal processing, from antenna to speaker, has hopefully become clearly visible to everyone.

■ PMSDR Block Diagram

With this background, we turn to the block diagram for PMSDR:

The filters pass their signal further along, to the QSD mixer. The mixer produces the two 90-degree phase shifted signals under control of the Johnson-counter.

Fig. 189: PMSDR Block Diagram
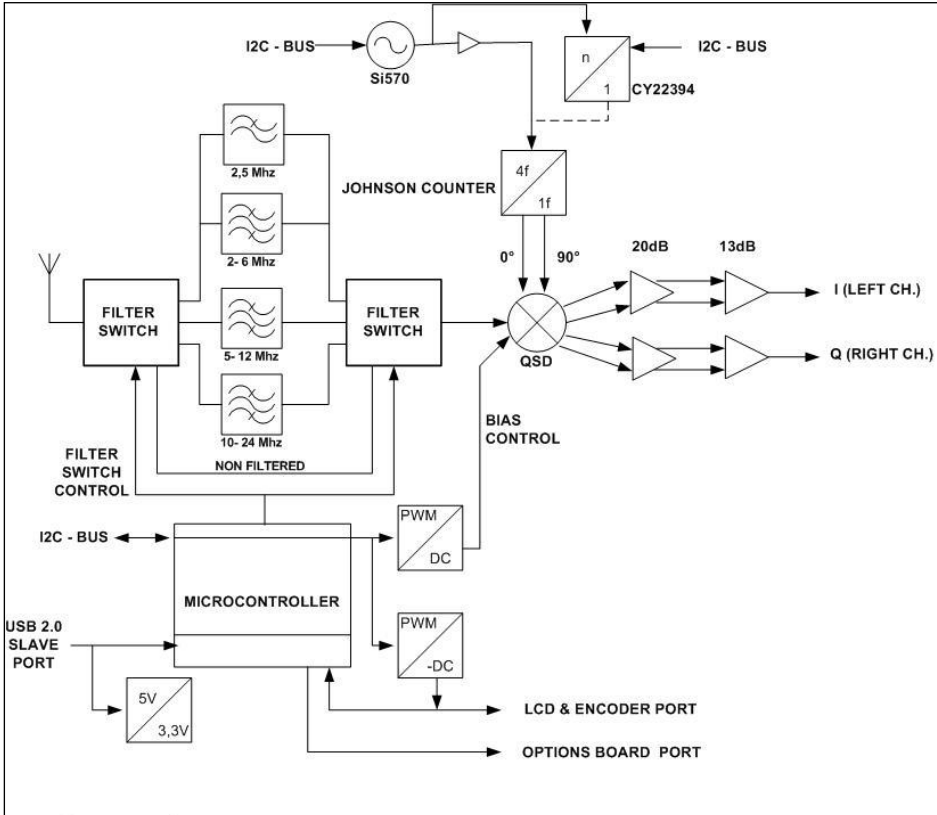
PM-SDR2.1 Circuit block diagram

by Martin Pernter IW3AUT

All the elements of Fig. 188 are easily recognizable here. To the left, above, we see the antenna input, followed by 4 filters. The uppermost is a low-pass filter, while the three beneath it consist of a set of 3 overlapping band-pass filters (3rd Order Chebyshev-Filters.

(This switch element is a (divide by 4) ring-counter. It is tasked with production of the two 90° control signals for the QSD input.)
The signal pairs 0°/180°, and 90°/270° are fed to the two operational amplifiers (right, in the figure) where they are arranged into two sets.

The first-stage amplifiers work as differential amplifiers, and deliver a symmetrical output. The second stage converts this signal into an unsymmetrical form.

The I / Q signals generated here are ready for connection to the sound card.

Only two functional groups have not been discussed so far: The local oscillator (LO), and the microprocessor.

The microcontroller, left under the figure. Center, controls all components of the PMSDR unit. We bypass its discussion. For an understanding of the details of SDR technology, this is not important.

At the top in the middle, you see the local oscillator (LO) module Si570, which in turn feeds the Johnson Counter. The Si570 is a programmable crystal oscillator with very good properties in terms of spectral purity of the output signal, as well as an exceptionally low phase noise!

The LO frequency is passed on to the Johnson counter. QSD uses an oversampling factor M = 2.

For an input frequency "f" of 50 MHz at the antenna input, we have learned: The sampling theorem then requires a sampling frequency of at least 100 MHz. With an oversampling factor of M = 2, this becomes a 200 MHz sampling frequency.

200 MHz is also 4xf. This value of 4xf ("4f"), is shown in the "Johnson-Counter" box. The value of 1f in the same box indicates the operand of the division, here 4 to 1. This finishes the full discussion of the block diagram, and we are at the output of the circuit board.

The I / Q lines to the stereo sound card inputs are connected from here.

■ Epilog

This little trip could only shed superficial light on the theory of SDR technology, of course, but nevertheless should have provided some basic understanding.

We would be delighted if this discourse would be seen as a stimulus for you to delve further into the matter of your own accord.

Commercially available literature on this subject is unfortunately still very rare. The discussion in [22], the book by Dipl. Commercial Bodo J. Krink (DL7BJK) is a well-expounded exception. He takes care to prepare the necessary mathematics for the reader to understand and intuit.

Also, the special CQDL [23] of July 2008 (Title: CQ-DL-Spezial-SDR-und-D-Star) makes especially worthwhile reading!

References and Links

"Notes and references:"

(1) USB-Adapter

If your laptop / PC does not have a RS232C jack, you can also use a USB adapter cable. Caution should be exercised in the selection of this cable, as not all products support the required bi-directionality of the RS232C interface. Make sure that an FTDI Chip is chugging away inside! A proven product is sold under the trade name Digitus DA-70 156, obtainable, for example, from [6].

(2) RBW

The awkward expression "resolution-band-width" is simply a measure of how much "Hz / pixel" of the signal is displayed per screen pixel. In principle, one is dealing not with purely optical zoom capability but with available practical resolution. This can be assessed from the fact that the noise level in the spectrum is smaller with increasing resolution.

(3) MDS

The MDS involves a number of factors. The absolute limiting value for maximum possible receiver sensitivity is its noise floor. The MDS value is directly proportional to the noise floor! For understanding an MDS value, it is good to know, of course, what theoretical value characterizes an ideal receiver. For this, we make a very brief excursion into theory:

An absolutely noise-free receiver (a device that does not exist in practice!) has an MDS value corresponding to (kT). In this expression, "k" is the Boltzmann-Constant*: (1.38066×10^{-23}), and „T" the absolute Temperature (of the resistors).
At 20° C room temperature (293 K) the thermal noise power comes out to: $P = 4.045 \times 10^{-21}$ W = -173.93 dBm, which we round to ~ **-174 dBm**.
This value is relative to a 1 Hz bandwidth. For a filter bandwidth of 2.4 kHz, one calculates ~ -140 dBm.
It follows then that the ultimate relative noise figure of a receiver can be taken to be: NF [dB] = MDS-140.

If you are interested in further details about this issue: The somewhat older but still very readable English article by Leif Åsbrink, SM5BSZ, [15] gives a deeper insight into the topic!

* Here we mean the constant named after that introduced by Max Planck and named for the Austrian physicist Ludwig Boltzmann, not to be confused with the "Stefan-Boltzmann" constant!

Sources and URLs:

[1] http://www.iw3aut.altervista.org/index_de.htm
[2] http://www.rfspace.com/RFSPACE/IF-2000.html
[3] http://www.winrad.org
[4] http://www.wimo.de/framesetp_d.html
[5] http://www.qrp-shop.de
[6] http://www.reichelt.de
[7] http://www.box73.de/catalog/
[8] http://www.irkutsk.com/radio/tis.htm
[9] http://www.hdsdr.de
[10] http://www.webalice.it/andreavigarani
[11] http://www.ak-modul-bus.de/stat/soundkartentester.html
[12] http://www.wrplus.altervista.org
[13] http://www.eibi.de
[14] http://www.dxatlas.com/Rocky
[15] http://www.flos-freeware.ch/notepad2.html
[16] http://www.websdr.at
[17] http://www.websdr.org
[18] http://www.arrl.org/files/file/Technology/tis/info/pdf/030910qex029.pdf
[19] http://software.muzychenko.net/eng/vac.htm
[20] http://sourceforge.net/projects/drm/
[21] Burkhard Kainka:
    "Software Defined Radio"; Deutsch, 2008; Elektor-Verlag
[22] Dipl. Kaufm. Bodo J. Krink:
    "SDR - Software Defined Radio für den Funkamateur", Deutsch, 2009;
    VTH-Verlag.
[23] http://darcverlag.de/CQ-DL-Spezial-SDR-und-D-Star

Symbols:

☞ General Information / Please Note!

💣 Attention! / Possible Problems if not Noted!

■ Quick Outline: Usage in Pan-Adapter Mode

In Spectrum/Waterfall Looking for Stations:

Tab → CAT; Enable CAT → ON; Remote Rig → OFF

Note: Do not move→ Frequency Bar with Remote-Rig OFF, otherwise the frequency displayed in Winrad will not be correct! Should this happen accidentally, a slight turn of the VFO knob will correctly synchronize the VFO with the bar!

Setting the Cursor to the Station:

USB → Use the left mouse button to place the red line on the left edge.
LSB → Use the left mouse button to place the red line on the right edge.
CW → Use the left mouse button to place the red line in the middle.
AM → Use the left mouse button to place the red line in the middle.
Use the mouse wheel for fine adjustment (10 Hz per wheel click)

Transfer of the Frequency to the VFO:

Button → Write Tune to RIG (not necessary to switch on the remote rig!)
VFO → possible slight retuning needed.

Moving the span of the displayed spectrum:

By "cranking:"

→ Turn the VFO to the desired frequency range, Spectrum/Waterfall & Frequency Bar follow.

By sliding the frequency bar:

Tab → CAT; Remote-Rig → ON
Frequency Bar → Grab with the left mouse button.
→ Hold left button depressed, slide right or left; the VFO and Frequency Bar will follow.

By predetermined (48 / 96 KHz) frequency displacements (Quick-Tune):

➔ Is the Quick-Tune tab blue?
      If YES ➔ Tab ➔ CAT: Remote-Rig ➔ ON; Tab ➔
      ➔ Quick-Tune
      If NO ➔ Tab ➔ Quick-Tune
Quick-Tune:
➔ Set Tuning Steps to desired value;
➔ ± Button actuate; VFO and Frequency Bar follow.

Back to searching for stations:

Tab ➔ CAT; Remote-Rig ➔ OFF; place Cursor etc. etc.

Change display resolution (RBW):

➔ Winrad:
➔ Press Right/Left Arrow Bars next to RBW
➔ Max. Resolution is 5.9 Hz per Screen-Pixel
➔ Max. Possible Display Range is 93.8 Hz per Screen-Pixel

      Note: ➔ **Disappearing Cursor:** When changing the resolution, the cursor can travel out of the display area. If this happens, just click anywhere in the spectrum with the left mouse button to get it back.

Band Change (Quick-Tune):

➔ Is the background of the Quick-Tune tab blue?
      If YES ➔ Tab ➔ CAT: Remote-Rig ➔ ON; Tab ➔
      ➔ Quick-Tune
      If NO ➔ Tab ➔ Quick-Tune
Quick-Tune:
➔ Click on desired band.

Appendix II: Setting up the PMSDR in WIN7

The detailed instructions given in the text above (pp. 25-35) were written for Windows XP. This operating system (OS) is excellent, and many users have retained it for home use. But the most recent Microsoft OS family at the present point in time is that of Windows 7 (existing in several forms), and it is almost universally sold as the OS on new computers of the PC type.

Because WIN7 is in active use, this section has been included to help with PMSDR set-up.

The "Device Manager" utility, part of the OS, is very useful. It may be accessed in several ways, the simplest of which is to enter "device manager" in the query window that appears when you click on the Start icon (the Microsoft flag-in-a-blue-sphere at the extreme bottom left of the task bar). A second, easy, way to access Device Manager is through its icon in Control Panel.

■ Overview: This is the same outline as given above.

1. Connect PMSDR to the computer via USB cable and audio cable.
2. Install USB driver.
3. Install HDSDR software.
4. Copy DLLs contained in the HDSDR directory.
5. Set up and ready the PC sound card.
6. Make necessary settings in HDSDR.
7. Connect antenna and
8. Start HDSDR.

■In Detail:

■ 1.) USB and Audio Cable

Connect your USB and audio cable to your computer. The audio input to most WIN7 sound cards is a stereo jack.

■ 2.) Install USB Driver

The PMSDR is powered and controlled through the USB Port. The necessary drivers should already be present (automatically installed) in Windows 7. In case they are not, install them by hand as described below.

Windows automatically signals that it has found new hardware when a USB cable is connected. If the system recognizes the necessary driver, then a subsequent call to the Device Manager shows a screen similar to:

Fig. 51-2: USB Driver Properly Installed

The relevant entry in this screen reads **"Microchip Custom USB Device."** If the highlighted line shows the same or similar, everything is OK. In this case, proceed to Step 3.

If the OS does not find the driver automatically, the Device Manager shows a yellow warning sign:
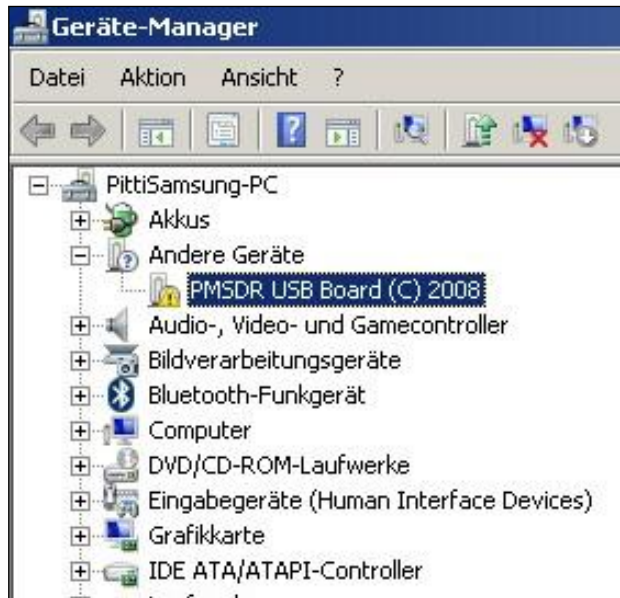
Fig. 52-2: USB Driver Not Available

In this case, a little hand-work is needed. Right-click on the line in Device Manager with the yellow flag (here shown as "PMSDR USB Board"). This opens the context menu. Click on "Update Driver Software." In the next Dialog click on the bar "Browse my computer for driver software," then in the next window, "Search for driver software in this location:" where you need to indicate your CD drive (containing the CD we provided). On the CD, find the folder **PMSDR_MCHPUSB driver,** click on it, and answer OK. This will locate the driver and install it. Device Manager should now show **"Microchip Custom USB Device"** as it appears in Fig. 51-2.

As soon as the driver is installed, the green LED on the rear panel of the PMSDR should come on, and if you have the display installed, it will light up in a blue tint.

If you have the display option installed, the trim pot R7 next to the display cable plug should be used to adjust the contrast according to your taste. The upper half of the enclosure can then be replaced and attached with the self-tapping screws provided

■ **3.) Installing Software**

You should now install appropriate software for your PMSDR. The Winrad series from Alberto (I2PHD) is one such possibility, capable, and simple to operate.

The following example was created with the use of the more advanced program suite **HDSDR**, from DG0JBJ. Use Windows Explorer (Flag-E from the keyboard) to access the DLL directory on the CD. Copy the 3 DLLs contained there, and also the package **HDSDR**, from DG0JBJ. **HDSDR can be obtained from the author's download site, http://www.hdsdr.de/**

If you wish to run using PMSDR on a netbook, you are better off with **HDSDR**, which can compensate for the limited vertical resolution of the netbook. The program can be called up with a tag (**-wv**), which fully utilizes the available resolution in each case. This requires a slight change in the „Properties" box of the program. We will show how to do this below.

Pick out the installation file for HDSDR from the **PC-Software** folder on the CD, and start the installation program. The best choice for the requested parameters is to leave them with their default values. HDSDR will then be put in the folder "**Program Files.**"

■ **4.) Copy DLLs**

The DLL files mentioned above must also be in this folder, so that PMSDR can communicate with HDSDR. Using Windows Explorer, call up the folder on the CD that contains the DLL files and copy the 3 DLL files into the program folder of HDSDR.

The files are "**cc3260.dll,**" "**ExtIO_PMSDR.dll,**" and "**mpusbapi.dll**".

☞ **Update the DLLs! Note also: a copy of LIBUSB0.DLL may have to be put into the HDSDR Program Folder.**

The DLLs are continuously under development. Therefore it is appropriate to look for new versions on the web site of the developer from time to time. With new versions, you simply proceed as usual. The DLLs are presented in "zip"

format, and must be unpacked. Click on the "Extract All Files" at the top of the window, and choose the directory to which they are to be extracted.

■ 5.) Prepare the Sound Card

PMSDR puts out two audio signals, phase shifted by 90-degrees, the so-called I/Q signals, which are worked up to an audible signal in the sound card. These signals must be processed in parallel, and your sound card must therefore have a **stereo** input. **We assume this to be the case.** Connect the computer to the PMSDR with a stereo cable.

Audio Connection

You will need a cable with a 3.5 mm stereo plug on both ends. To avoid distracting influences, it is useful also to connect headphones to the headphone output jack...
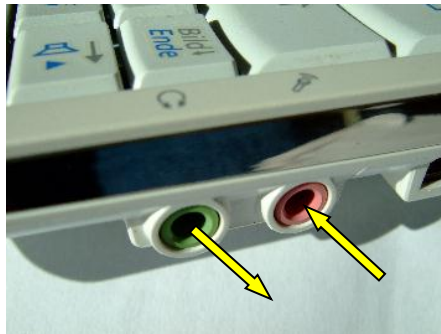
Fig. 53-2: Samsung-NC10 (Mike In)

Figs. 53-2 to 55-2 below show typical sound card inputs for various computers. The **Samsung-NC10** family are small, somewhat-older laptop computers, no longer available new in the US market, but that were popular in their day. It is chosen as a typical example of the genre.

Fig. 54-2: Standard Laptop Line-In
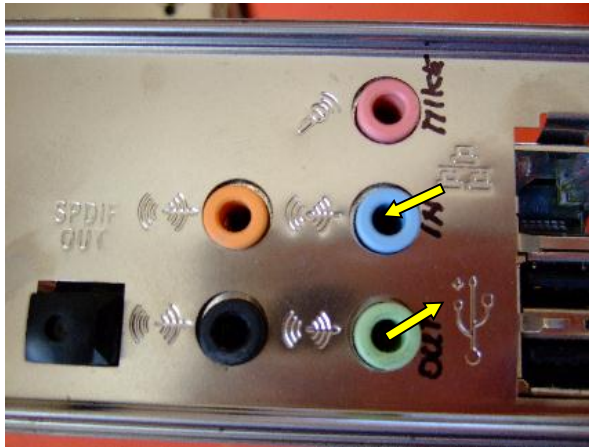
Fig. 55-2: Standard PC Line-In

Make the settings as you see them in the following pictures.

Fig. 56-2 Sound Icon (Control PanelSnippet)

A short series of pictures subsequently shows the calls for Windows 7.

These examples are taken from an small ACER desktop machine running Windows 7 Home Premium (64-bit), with a **Realtek High Definition Audio** sound card. There are major differences in the way that XP and WIN7 **display** audio controls, and unfortunately there are also some differences among machines running WIN7 Home Premium, WIN7 Professional, and WIN7 Ultimate. For your particular machine, some exploration may be needed to work your way through this thicket of check boxes, sliders, and tabs.

Bring up Control Panel from the Start menu and double click "Sounds."

The resulting window is shown as Fig. 57-2.
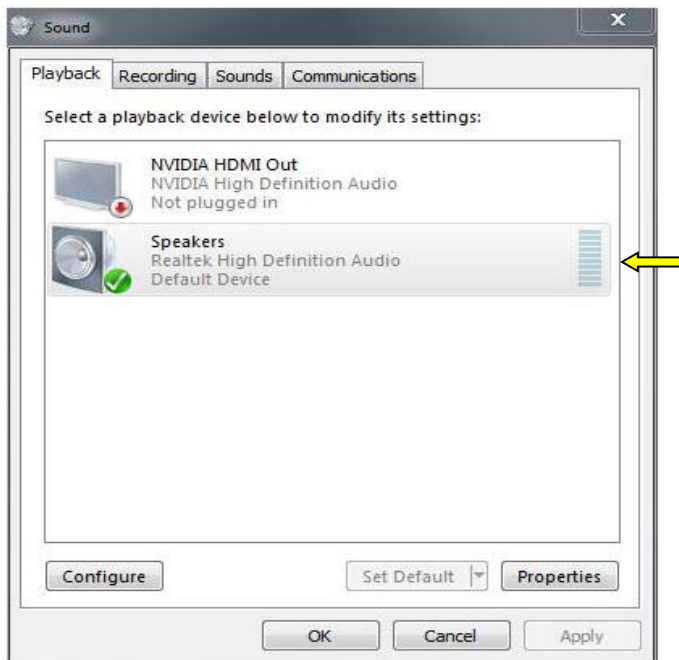
Fig. 57-2 Sound Panel from Control Panel

Click sequentially the fields for **Playback** and **Recording.** Familiarize yourself with the possible settings in each. Click (once) on the large **"Speakers"** area to select it (graying it, as above) then click on **"Properties."**
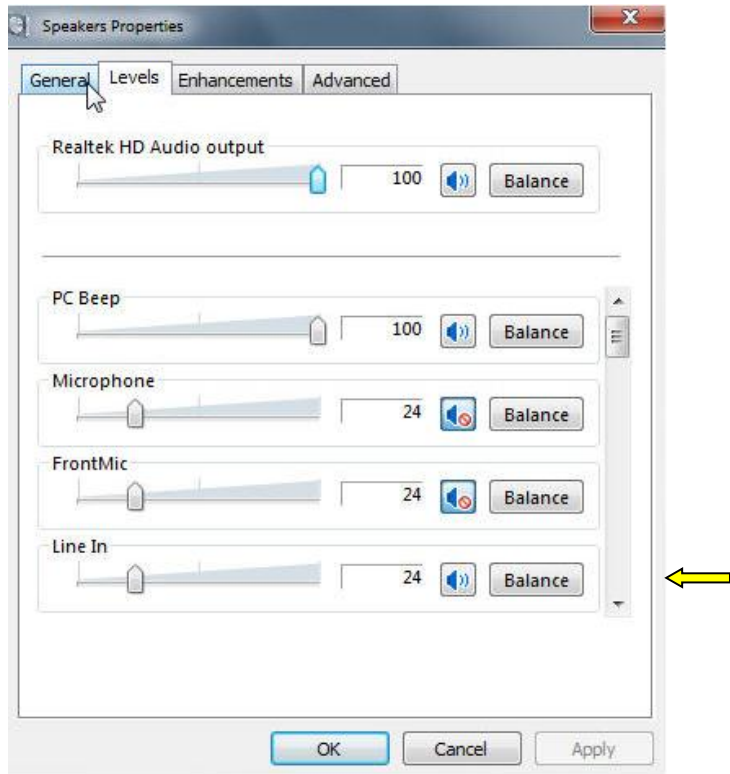
Fig. 58-2 Properties Tab for Speakers; "Levels" Selected. Note "Line In" slider at bottom.

☞ The slider for the Line-In input is deliberately set close to the lower limit. **(You may wonder what the "Line In" slider is doing on the Properties Tab for Speakers – just take it like you find it! Remember this is from the same people who gave you the START button as a place to STOP!)** The levels at the I/Q output of the PMSDR are relatively high, so use the least input amplification possible.

☞ Be sure that any **balance sliders** are set in the **middle**! We repeat that the input that you are using on your notebook or PC **MUST** be a stereo input. If this is not the case, use the microphone input, not the line in jack. Your PC manual should answer the question in this case. If your microphone input is also not a stereo input, you must first get an appropriate USB sound card, then proceed as usual. As a rule, all line inputs are stereo, so it is likely that there is no real problem here.

☞ In the window shown in **Fig. 58-2** there is a tab labelled **"Enhancements."** This has to do with effects such as reverb, echo, etc. If possible, check a box labelled "**DISABLE Enhancements.**"
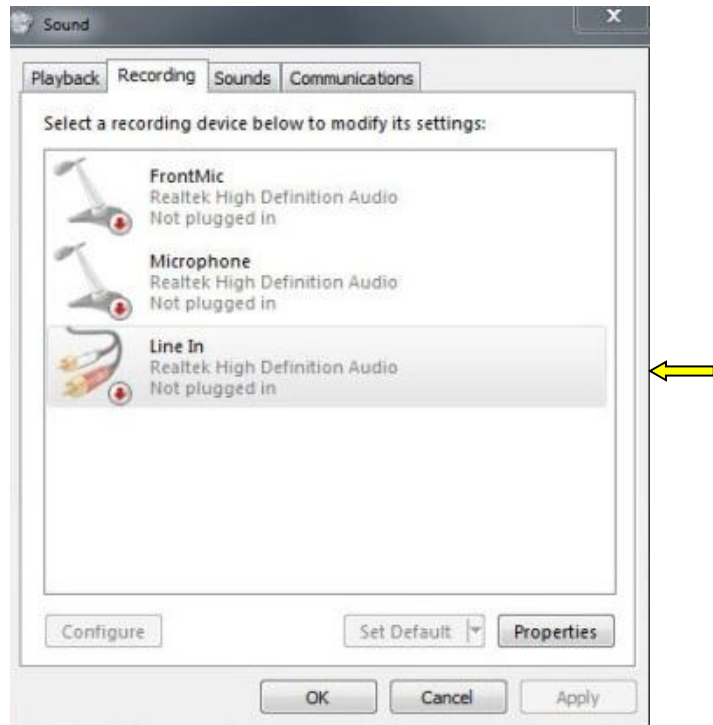
Fig. 62-2: Recording Choices

■ **6.) Set-up choices for HDSDR.**

We have now finished detailing the WIN7 set-up choices. The set-up for HDSDR continues as in the text above, P. 32.

☞ **Remember, if you don't see noise in the baseline, move the Line-In Slider (Fig. 58-2) up a small amount. This should lead to the desired image.**

Winrad: Hot-Keys

Keyboard Input:	Produces Function:
C	Changes the **LO**; Centers receiver range.
H	Opens GUI for external hardware (PMSDR)
U	Toggles through the Units Hz, kHz, MHz
Z	Same as the ZAP key; Enables ZAP Function
CTRL-A	Switch to **AM**
CTRL-B	Identical to the **Noise Blanker** Key
CTRL-C	Switch to **CW**
CTRL-D	Switch to **DRM** (No Demodulation!)
CTRL-E	Switch to **ECSS**
CTRL-F	Switch to **FM**
CTRL-L	Switch to f **LSB**
CTRL-O	Direct **LO Frequency Input** via Keyboard
CTRL-P	Identical to the CW **Peak** Key
CTRL-R	Identical to the Noise **Red.** Key
CTRL-T	Direct **TUNE Frequency Input** via Keyboard
CTRL-U	Switch to **USB**
Up-Arrow	Direct Change of the **TUNE** Frequency by **+0.1 kHz**
Down-Arrow	Direct Change of the **TUNE** Frequency by -**0.1 kHz**
Right-Arrow	Direct Change of the **LO** Frequency by **+10 kHz**
Left-Arrow	Direct Change of the **LO** Frequency by **-10 kHz**
Sh. Up-Ar.	Direct Change of the **TUNE** Frequency by +**1 kHz**
Sh Down-Ar,	Direct Change of the **TUNE** Frequency by -**1 kHz**
Sh. Ar. Right	Direct Change of the **LO** Frequency by **+100 kHz**
Sh. Ar. Left	Direct Change of the L**O** Frequency by -**100 kHz**
Page Up	**Frequency Shift** of the **LO** by **+Entire Spectrum Width** *
Page Down	**Frequency Shift** of the **LO** by **–Entire Spectrum Width** *

(In newer versions of Winrad the Arrow-/Page-keys apparently only work in concert with the CTRL key!)

* ➔ Fast "Step-Through" of the receiver range
Ar. ➔ Arrow
Sh. ➔ Shift

The CD

The accompanying CD contains no self-starting material. Page through the directory using Windows-Explorer (Press ⊞-E).

```
[PMSDR CD zum Buch]
    [Documents]
    [PC-Software]
        [DLL]
            [DLL_PowerSDR-IQ&G8JCFSDR_v3.2r9]
            [DLL_WinRad_v3.3r2]
        [Dream_v1.61]
        [Editor_Notepad2_v4.1.24]
        [EiBi-Database]
        [PowerSDR-IQ_v1.12.23]
        [Virtual_Cabels&Port_Emulators]
            [Com0Com_v2.22]
            [VAC_v4.10]
                [x64]
                [x86]
            [VSPE_v0.938]
        [Winrad&Derivate]
            [HDSDR_v1.0_ex_WinradHD_DG0JBJ]
            [Winrad_v1.33_I2PHD]
            [Winrad_v1.61_WA6KBL]
            [WinradF_v1.5_Andrea_Vigarani]
            [WRplus_v1.04r4_Sandro_sfregola]
    [PMSDR-Control_v1.5]
    [PMSDR-Firmware]
    [PMSDR-Firmware_Upgrade_Tool]
    [PMSDR-MCHPUSB_Driver]
```

Liability Disclaimer

The software is provided "as is" without any kind of express or implied warranty, including but not limited to implied warranties of merchantability and fitness for a particular purpose. "RF System of the Anna Maria Quinto", with "RF System of the Anna Maria Quinto" affiliates, their distributors and dealers, accept no guarantee that the information contained in the software features match your requirements or that the operation corresponding to the Software will meet your requirements or that operation of the Software will be uninterrupted or error free.

The user assumes the entire risk relating to results and performance of computer extensions, programs and products listed in this guide. Neither "RF System of the Anna Maria Quinto", its directors, officers, employees or agents are liable for incidental or consequential damages or indirect damages (including lost profits, business interruption, loss of business information or the like), arising from the use or inability to use the computer extensions, programs and products, which are listed or contained in this Manual, even if the „Anna Maria Quinto RF SYSTEM" has been informed about the possibility of such damages.

Since some countries do not allow the limitation or exclusion of liability for consequential or incidental damages, it may be that the foregoing does not apply to you.

The liability of "RF System of the Anna Maria Quinto" for actual damages" regardless of the cause and the action, whether arising in contract, tort (including negligence), product liability, or otherwise, in no event exceeds the equivalent of 5 €.

Freeware

1. All Freeware Programs offered on the CD or on the web site, which you are allowed to use gratuitously for private purposes, carry the following legal restrictions imposed on the user. The user is hereby expressly informed that all freeware versions available on the web site as well as on the CD are subject to the copyright laws, and are therefore protected. All rights are therefore reserved to the copyright holder alone, hereinafter called the author.

2. All freeware offers are non-binding. The author reserves the right to change parts or the entire offering, or to add to, delete or temporarily or permanently suspend the publication without separate announcement.

3. The author allows the private use and disclosure of the offered freeware software explicitly only under the following conditions, which the user making the download of a freeware program recognizes:

3a) The author of the freeware software offers no guarantee of any kind, either express or implied, for the use of the gratuitously provided freeware for any purpose whatever. He also assumes no obligations and guarantees for the practical value of the freeware software.

3b) In no event shall the author be liable for any damages, consequential damages, including any loss of profits and losses of assets or other direct or indirect damages resulting from the use or inability to use the freeware software and its accompanying documentation. Exceptions apply only if the author's deliberate (intentional) action can be demonstrated. No responsibility is assumed for consequential damages. The use of the freeware software is undertaken at the user's own risk.

3c) Over and above its own use, commercial use of the freeware software and the elements of the software of which it is composed is not allowed. In particular, the following is not allowed:

- copying, storing and using the software or any part thereof for commercial purposes, or the sale, rental or lease to third parties;
- the substantive change or editing of the features in the software program;
- that no change or editing of the entries in the software program takes place (for example, banner ads, push buttons, etc.), with the exception of the entry of the user's own data to the extent necessary to use the freeware program.

Reproduction or transmission of the freeware software offered here is only allowed with the express prior written consent of the Author.

3d) The permissible disclosure of the freeware software is also for private use subject to the following:

- That money is neither requested nor paid;
- That the freeware software is given out faithfully, without any change or editing of the functions and entries in the software program, and
- That a link to the website of the author is included, or at least published.

"If even a single of these conditions is not met, the distribution without the express prior written consent of the Author is nevertheless not permitted.

4. If sections or individual terms of this Legal Notice are not, do no longer, or are not completely suitable, the remaining parts of the document nevertheless retain their validity.

Keyword Directory / Index

Notes

A Lovely Example of an 80m DX Pile-Up!

In Closing, We Wish You
- "Endless Good DX" -
As well as
Many Beautiful Hours With Your
PMSDR!

SOFTWARE DEFINED RADIO

PMSDR

To rediscover the shortwave listening and more ...

www.rfsystem.it