HF SDR (Software Defined Radio) S/H Sample and Hold Transceiver ADTRX1 from 30 KHz to 35 MHz - Make it Simple as Possible with Outstanding Performances Part 1

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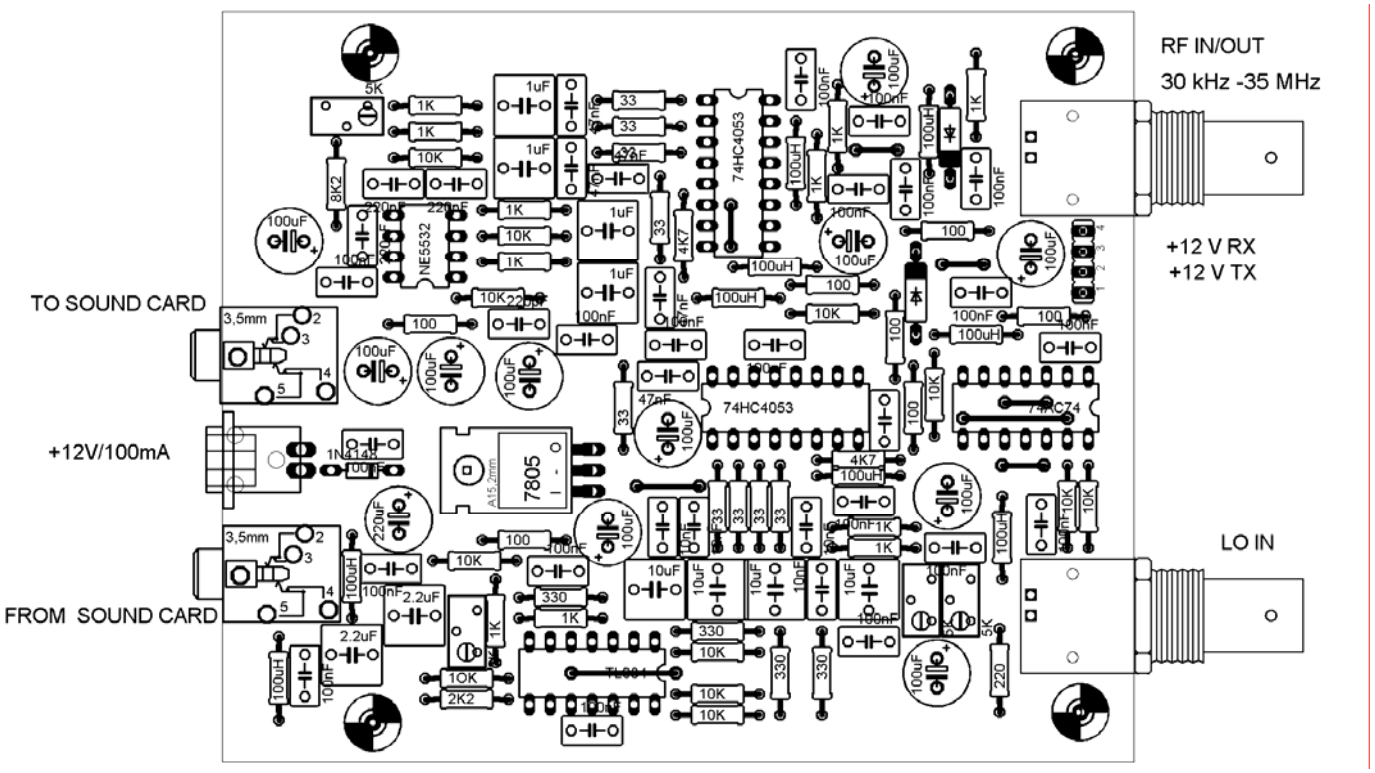
As I wrote before many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. and some built my transmission design DT1, DT2 and DT2A you can see some photos on my sites. I can notice that they are all mainly satisfied with results. Simple constructions with cheap classic size components working really very well. Also I find at INTERNET that some solutions from my receivers/transmitters are used in some new SDR projects.

I made my new SDR projects receivers DR2C, DR2B and DR3X with 74HC4053 IC. You can read articles related to these designs. My final goal is and it was to design SDR transceiver contest grade quality. I was waiting long time to obtain some freeware SB (sound blaster) software for SDR transceiver but still stay only hope. Some OMs like Alberto I2PHD made really fantastic job with his SDR receiving software thank you very much for them. But still we haven't free transmission programs for SSB which Alberto promised us some time ago but probably he couldn't find free time to do it... Because of that I made HF SDR transceiver called ADTRX1 (analog + digital). ADTRX1 is working to the 35 MHz and it is compilation of the results previously published design. Experimenting with DR2C receiver I noticed that 74HC4053 is very good IC little worse compared to the74 HC4066 but still with very well and respectively performances. Also RX/TX IC connections are much simpler than with 74HC4066. It is necessary only 2 (two) 90 DEG square signals for driving switches. Transmission part from DT2 and DT2A design I had been redesigned to the new IC 74HC4053.

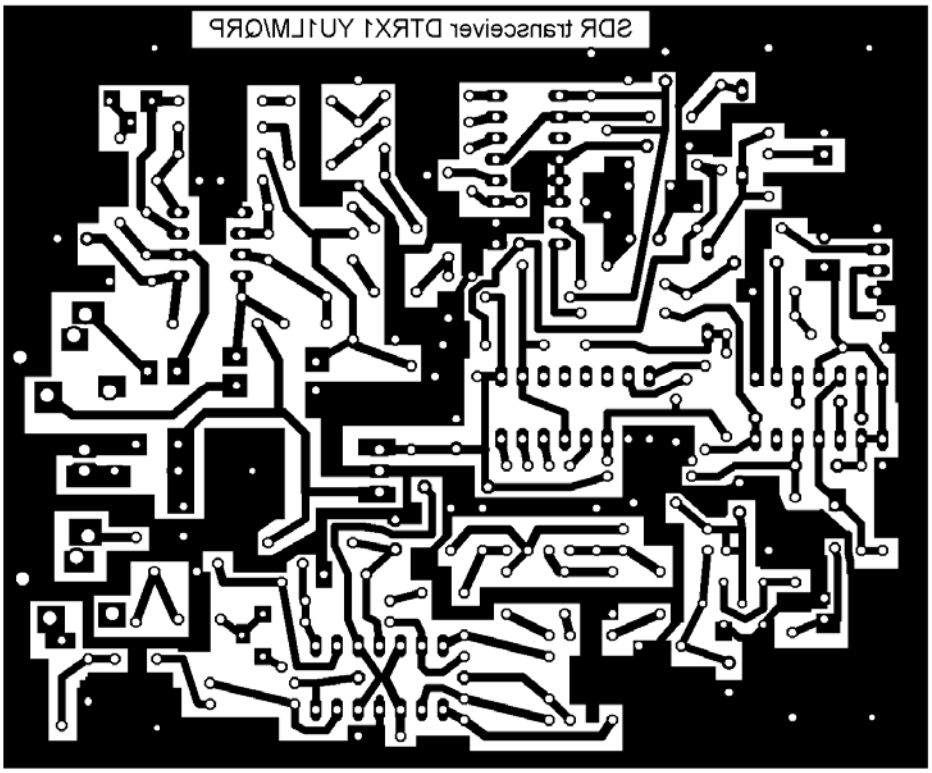
I made successfully CW and PSK transmission some details about that I explain later in part 2. For SSB or some other operation transceiver ADTRX1 is ready but operation is not easy possible in this moment reason leak of adequate SDR software program. In meanwhile I successive to perform SSB operation also see down diagram how I made it. It is little complicating for practical use but with adequate uC support instead PC use only. SSB operation is possible with change some parts on B2 board. I change bandwidth fmin/fmax for AF 90 deg all pass network to perform SSB operation.

I am using optimum technique to obtaining I/Q 90 DEG branches for driving CMOS switches with double D FF 74AC74 for max input frequency of 74HC4053.This solution dictate that we have 4 times higher LO (local oscillator) frequency than receiving/transmitting frequency is. Advantage of using 50/50 % duty cycle technique I explained in previously articles. Advantage is evident very much in my SDR transmission projects DT1, DT2 and DT2A and new SDR low power transceiver ADTRX1. In receivers this 50/50 % ratio is not so important like for the transmission. 50/50 % driving LO signals will increase max input frequencies with used ICs hardware realization and it will clear output spectrum.

Miss software support for SDR transmission I solved with 2 control board ADTRX1-B1 and ADTRX1-B2 connected in sandwich style like SDR1000 do. Here I shall describe main

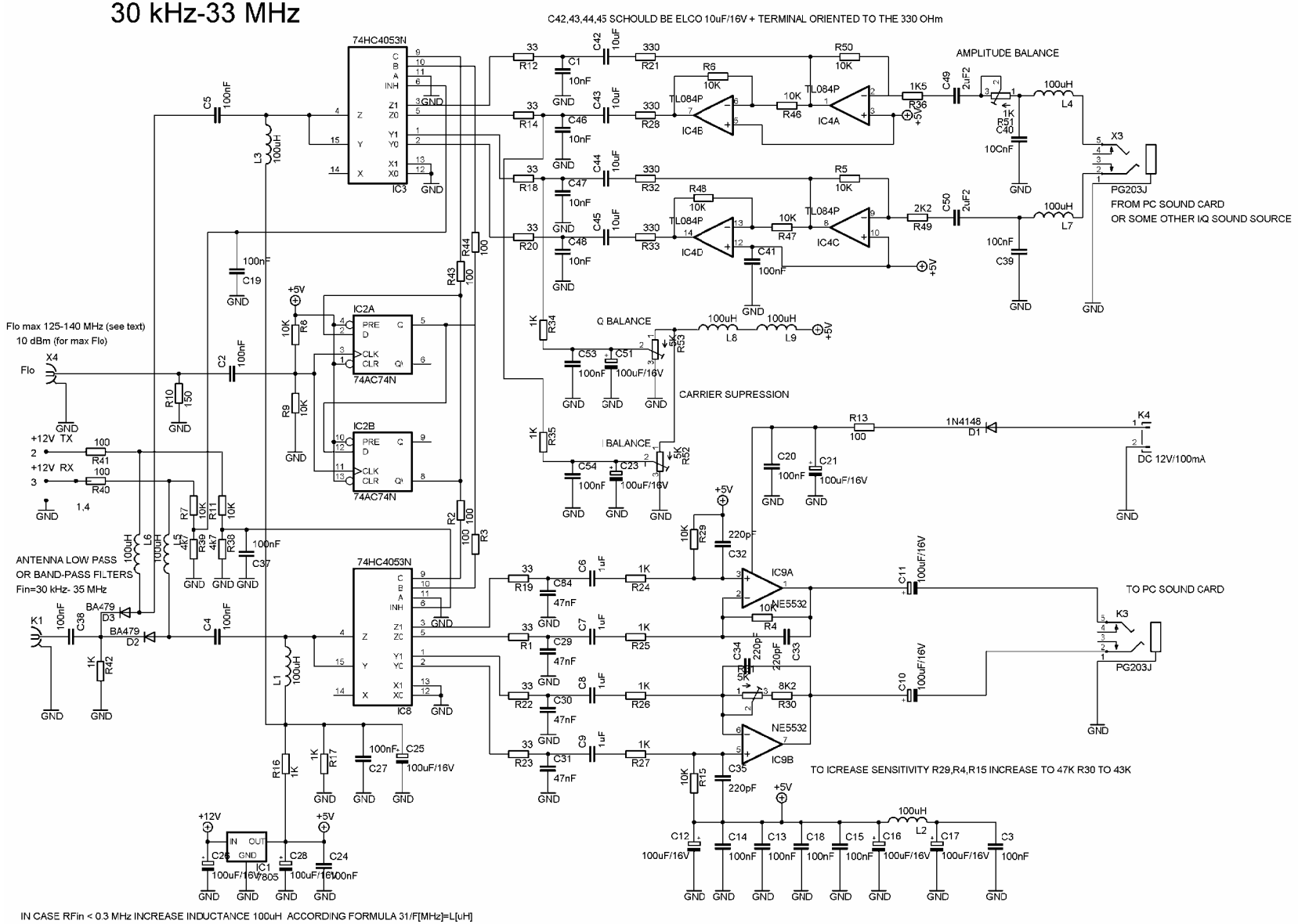


Single side PCB size is 110 x 92 mm



HF SDR Transceiver ADTRX1- YU1LM/QRP

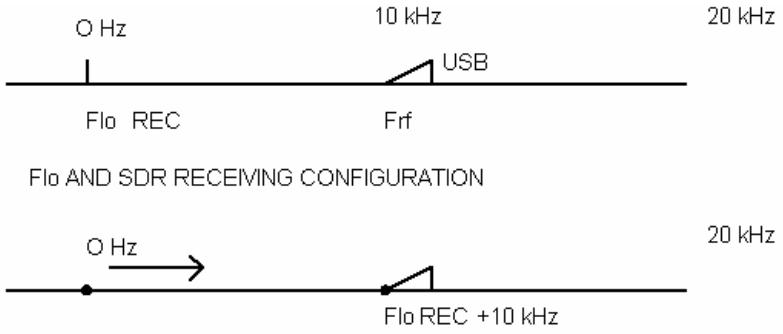
30 kHz-33 MHz



MAIN BOARD DTRX1

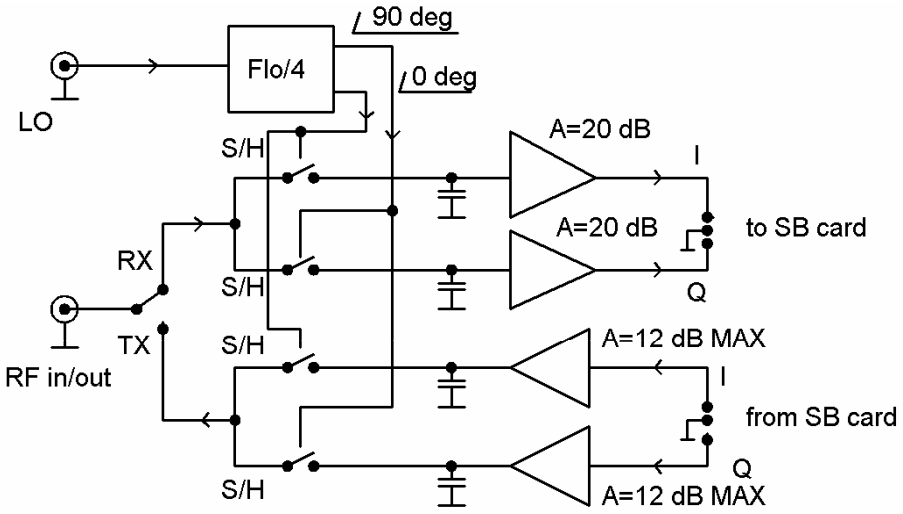
board and block diagram for control board B1 and B2. Schematics and PCBs for control boards I shall publish later in part 2. I shall not write too much about main board because main thing including results had been written in previously articles.

Here is only realization and how to use it... Operation is possible on all HF HAM bands up to the 35 MHz limited with 74AC74.Used 74AC74 frequency limit is 140 MHz with VCC=+6V. Instead PIN diodes BA479 it is possible some other PIN diodes or 1N4007 as substitute.



ADTRX1 CONFIGURATION FOR SSB TRANSMISSION

CONBINATION CLASSIC PHASE TRANSMISSION AND SDR RECEIVING



SIMPLIFIED SDR TRANSCEIVER ADTRX1 MAIN BOARD BLOCK DIAGRAM

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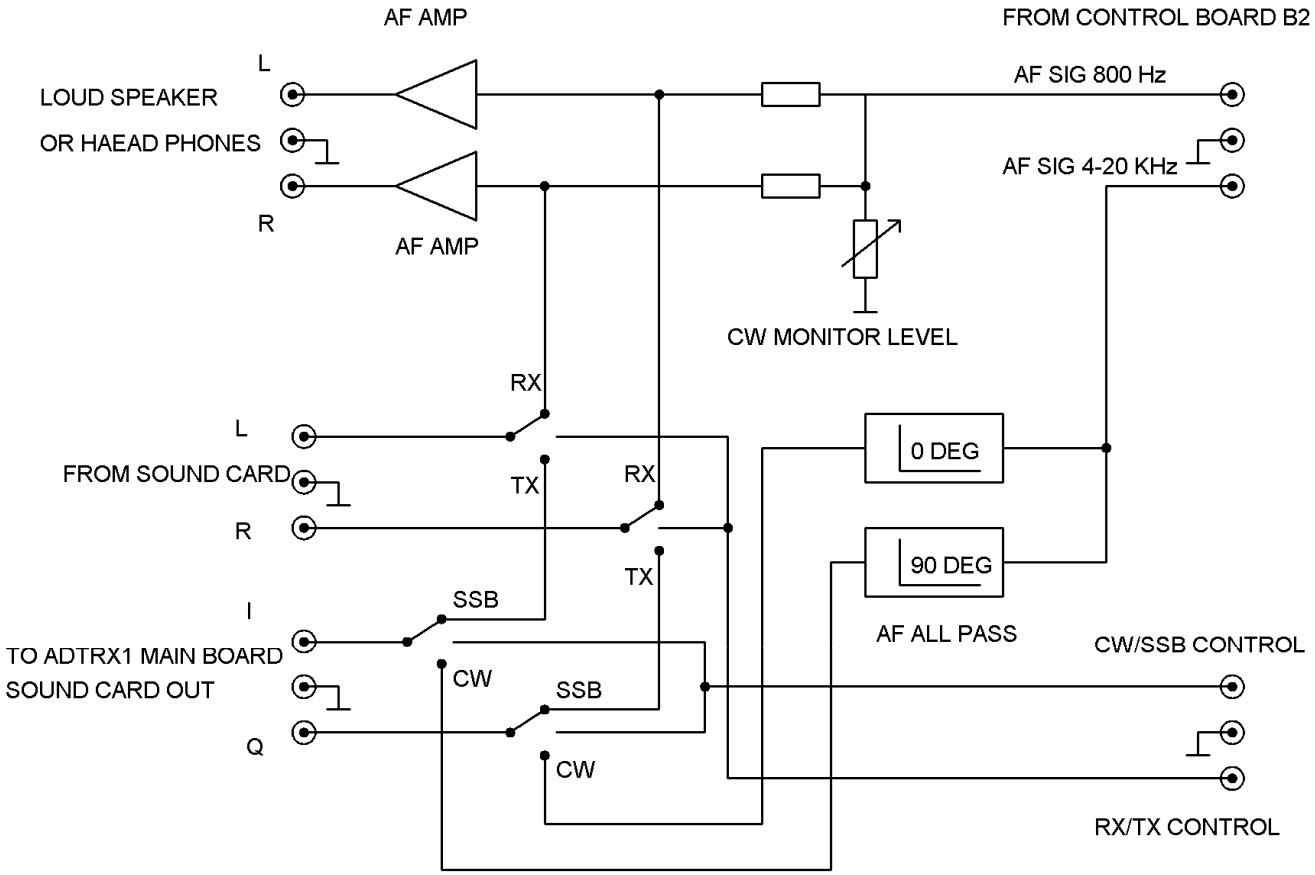
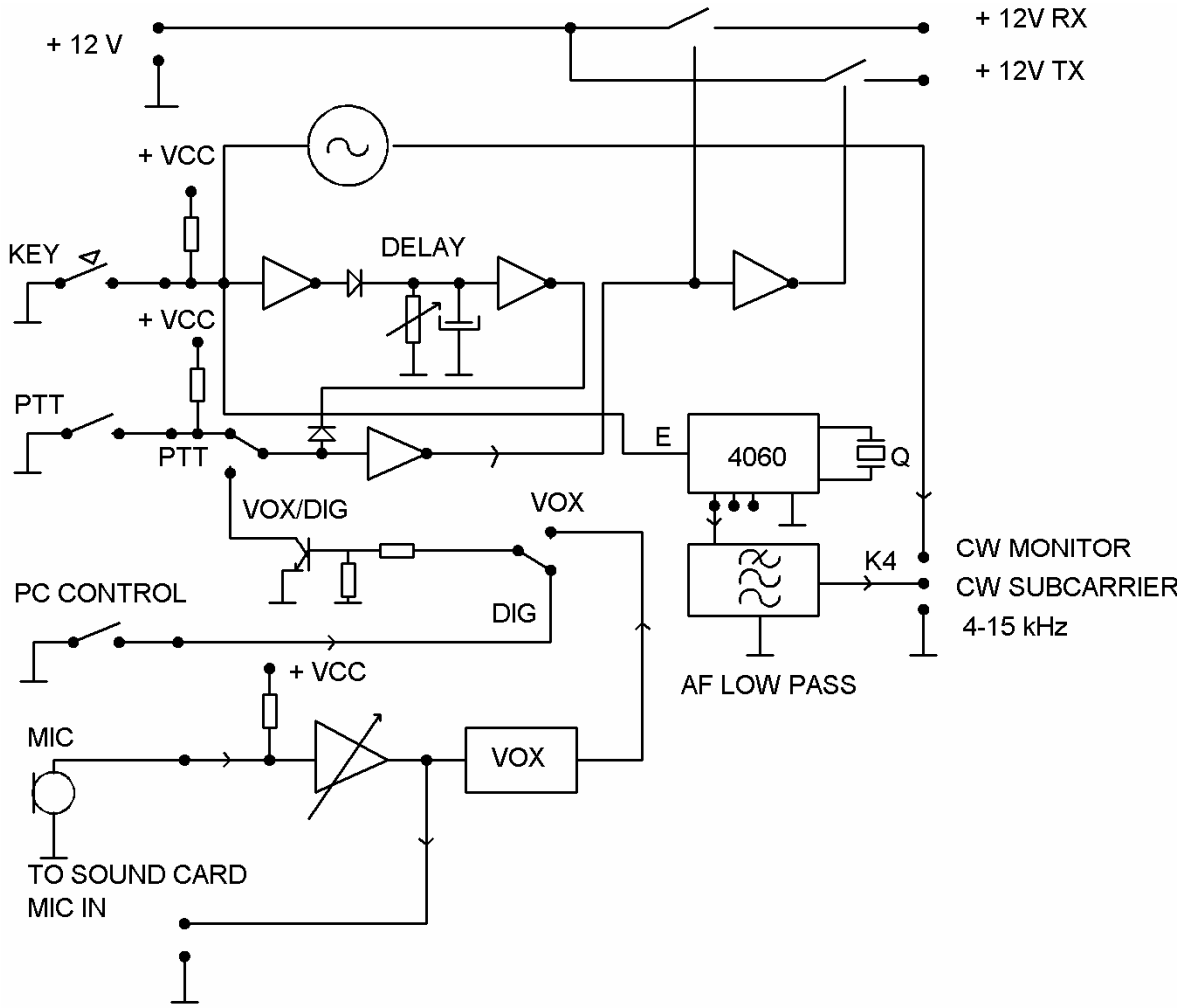


BLOCK DIAGRAM - CONTROL BOARD B1 ADTRX1

In table is my proposals for high pass [HP] and low pass [LP] filters which will enable ADTRX1 receive /transmit on HAM radio bands. How to realized this filters are individual solution for every builder. I had been use, during testing ADTRX1, some my previously design and realization for HP and LP filters. Power amplifier is broad band HF amplifier and input power in it is in region from -4 to -6 dBm. On Internet you will find easy a lot of designs for this kind of amplifier.

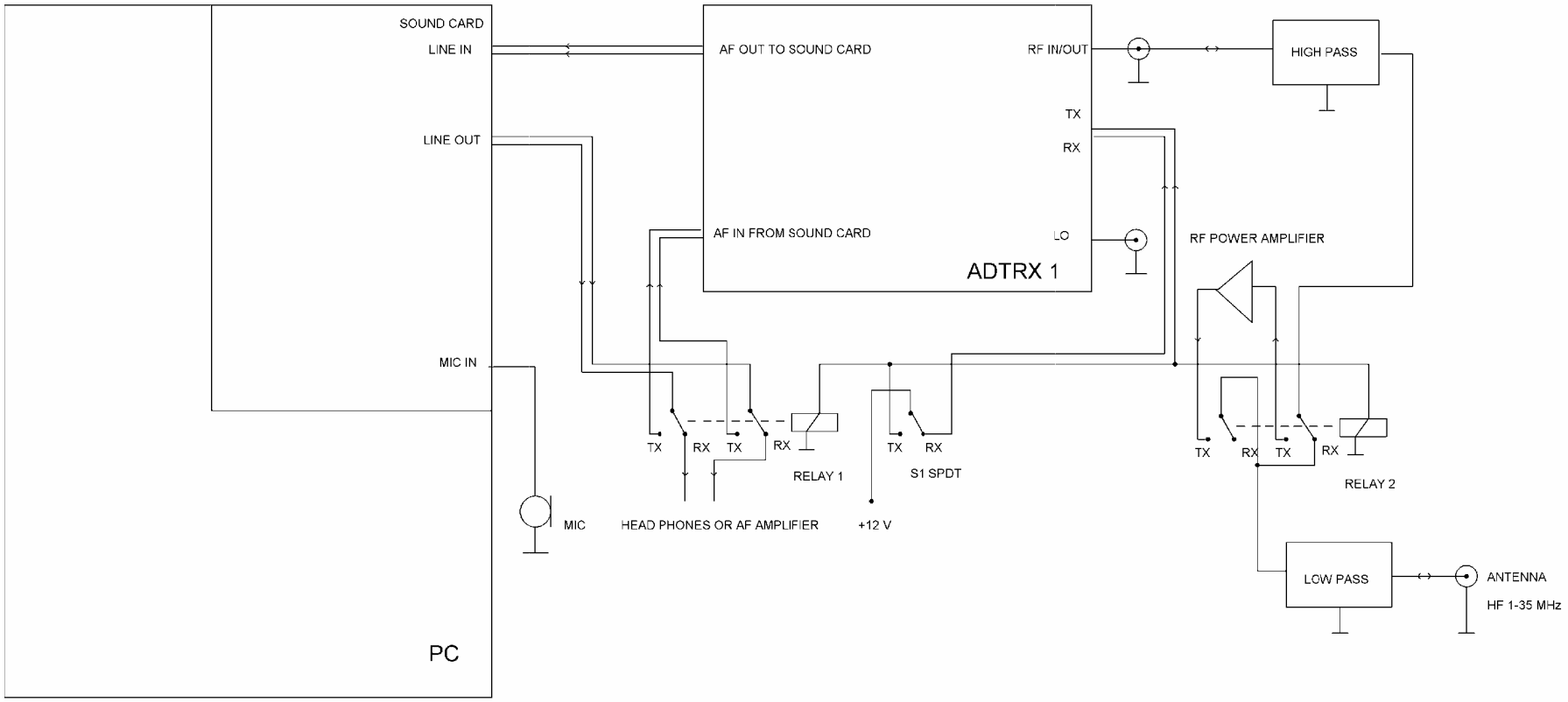
HAM Bands [MHz]	High Pass [MHz]	Low Pass [MHz]
1.8	1.5	2.5
3.5	3	4.7
7	6.5	7.5
10,14	9.7	16
18,21	17.5	24
24,28	24	31



CONTROL BOARD B2 BLOCK DIAGRAM

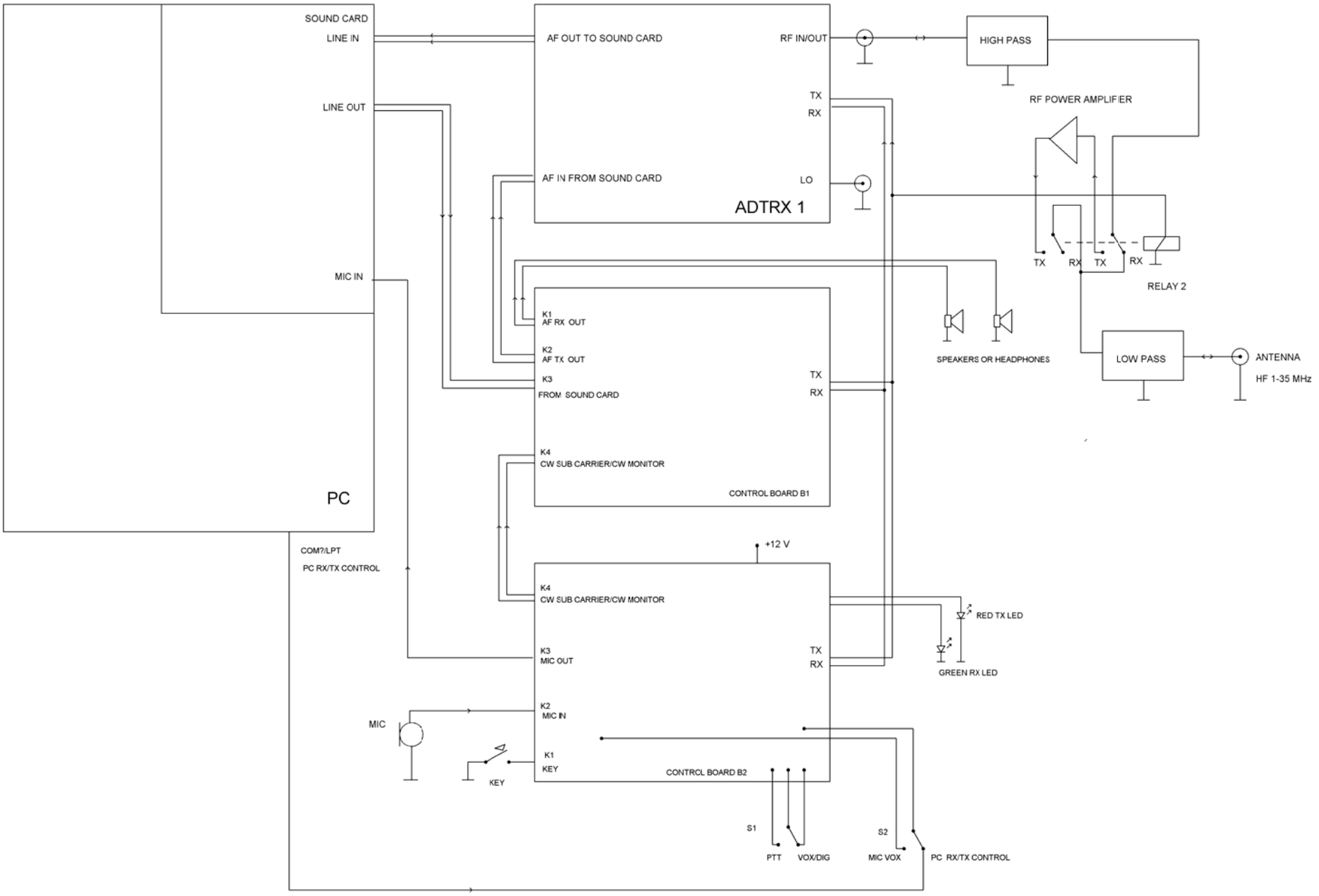
Down in text there are two basic ADTRX1 connections with and without additional control boards B1 and B2. There is possible also some new connection with ADTRX1 board control boards B1 and B2 and use 2 sound cards but this I shall describe in part 2 The simplest connection is with only ADTRX1 board and 2 relays and one SPDT switch. In this moment the problem is software support for this basic configuration. I hope that we shall have it in future soon maybe SDR transceiver software from Alberto I2PHD as he promised some times ago.

HF SDR S/H SAMPLE AND HOLD TRANSCEIVER ADTRX 1



BASIC ADTRX TRANSMIT/RECEIVE CONNECTION WITH PC SOUND CARD , 2 RELAYS AND 1 SPDT SWITCH

HF SDR S/H SAMPLE AND HOLD TRANSCEIVER ADTRX 1



BASIC ADTRX TRANSMIT/RECEIVE CONNECTION WITH PC SOUND CARD , CONTROL BOARD B1,B2 RELAY AND 2 SPDT SWITCH

I like CW very much and I like to take part in contests .For good CW operation it is very important to have very small delay in SDR processing between receiving and transmitting. Except good PC with high clock frequency and a lot of RAM very important is how signal in SB (sound blaster) DSP processing is done. Even an excellent SDR 1000 is not good as CW contest RIG. This I had been read on some forums devoted to SDR1000 some time ago. I can see that this demand for better CW operation is improving in every new version of FLEX software. I hadn't chance to test SDR 1000 personally to conclude this practically. Transmitting CW with SB card isn't easy task because it is necessary to decrease time delay between receiving / transmitting for good CW operation to really small values in msec region. To much time delay is making confusion in our brain we aren't learn to make CW keying with echo. Also our correspondent is starting transmission before we are starting receiving. To overcome this situation I made 2 control boards B1 and B2. With help boards B1 and B2 delay is long as it is for receiving process and delay time is in acceptable time border limits with good PC.

Measuring results which I made with HF S/H SDR transceiver ADTRX1

1. Receiving/transmitting range from 30 kHz to 35 MHz (with HP and LP filters limited to HAM bands 1.8……..28 MHz)
2. RX IIP3 27-29 dBm and it depends from setting and used programs (all with 16 bit sound cards).
3. RX MDS is -102-105 dBm also with 16 bit SB card Realtek AC97(with better SB card it is possible very easy to improve this value for 10 dB and more)
4. Image rejection is possible adjust to 35-60 dB 12 kHz from center frequency.
5. Sensitivity 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 70 dB. This sensitivity is more than enough for frequency near to 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain (10 Kohms increase to max 100 Kohms R4,R29,R30 and R15) or putting some RF preamplifier in front of ADTRX1 to lower F (noise figure) of receiver.
6. RX SFDR (Spurious free dynamic range) is 86-92 dB, this results are with signals spaced 5 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more. All measurements are done by use HP8662 signal generators and HP 70000 series spectrum analyzer.
7. In transmission carrier suppressions going from 30-60 dB , results depend from working frequency and adjustment
8. Unwanted side band suppression 30-50 dB
9. TX output power is in range from -5 to -2 dBm
10. Isolation between RX/TX is min 45 dB typical value is 55 dB

Some excellent performances with 5 IC are not without other side:

1. First and very big disadvantage is 4 times higher LO

2. RX image rejection and opposite TX sideband rejection are changing with receiving/transmitting band and results are for frequencies 10 kHz from central frequency
3. There is delay when we are going from transmission to receiving. Reason for that is delay in SB card and PC signal processing. With slower PC (lower clock) delay time is big even 1 sec close to make practically impossible transceiver operation...
4. For external LO it is necessary input level around 1 Vp-p min for safe operation (for lower LO drive operations are not sure especially for higher LO frequencies!!!

Lower power S/H SDR transceiver ADTRX1 adjustments are simple and done in few steps:

1. Receiver adjustment: Adjust with universal instruments DMM (digital multi meter) that is resistance in feedback potentiometer 5k +8K2 = 10 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal with signal generator to the input of DR3X and with 5 kOhm potentiometer adjust min unwanted image in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.
3. Transmission part adjustment is done in 2 iteration. Chose some high working frequency like 21 or 24 MHz. With help R52 and R53 adjust minimum carrier at working frequency monitoring on some receiver or better on spectrum analyzer. Next step is to adjust min of unwanted side band with help of R51. This procedure repeat once more for the best results and that is all

I wish you successful AFTRX1 realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

In part 2 I shall describe B1 and B2 PCB board and how to perform SSB, CW, and Digital (RTTY, PSK….) operation with used hardware. I shall describe how to adjust B1 and B2 boards for best results.

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References:

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3. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
4. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
5. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
6. ***http://www.njqrp.org/mbrproj/9850dds.html***

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http://www.k6ese.com/DDS_Project.htm

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http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

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http://hem.passagen.se/communication/dds.html

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6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

1. ***http://digilander.libero.it/i2phd/ SDRadio software ver 0.99***

   www.qsl.net/i2phd Alberto I2PHDhttp://gpsdo.i2phd.com/
2. ***ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio***
3. ***www.weaksignals.com WINRAD***
4. ***www.ciaoradio.com***
5. ***www.m0kgk.co.uk/sdr***
6. ***www.g8jcf.dyndns.org Peter G8JCF***
7. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
8. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
9. ***dl6iak.ba-karlsruhe.de***