# HF SDR S/H Sample and Hold Receivers DR2A+ and DR2A++ From 30 KHz to 35(52) MHz Improved Version of DR2A - Make Them Simple as Possible With Outstanding Performances

**Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP**



I read carefully discussion and comments about my SDR designs (especially at Russian SDR forum ***http://forum.cqham.ru***). The discussions gave me some new ideas how to improve my SDR designs. I made big effort to make something new and better and I didn't spent to much time in practical testing my SDR designs in the air. My free time at last time was filled with articles writing and CAD calculation. I had pretty big feedback to the mine work I received a lot of E-mails. But I had to admit that there aren't big number practical suggestion and proposals how to do something or how to improve something in SDR designs from users.

DR2A SDR receiver is my best design if we are talking about IMD (inter-modulation) free DR (dynamic range) IP3 in and 1 dB compression point (please read article about additional measurements done by Norbert DG1GPN and me at site). I decided to improve DR2A design with next features:

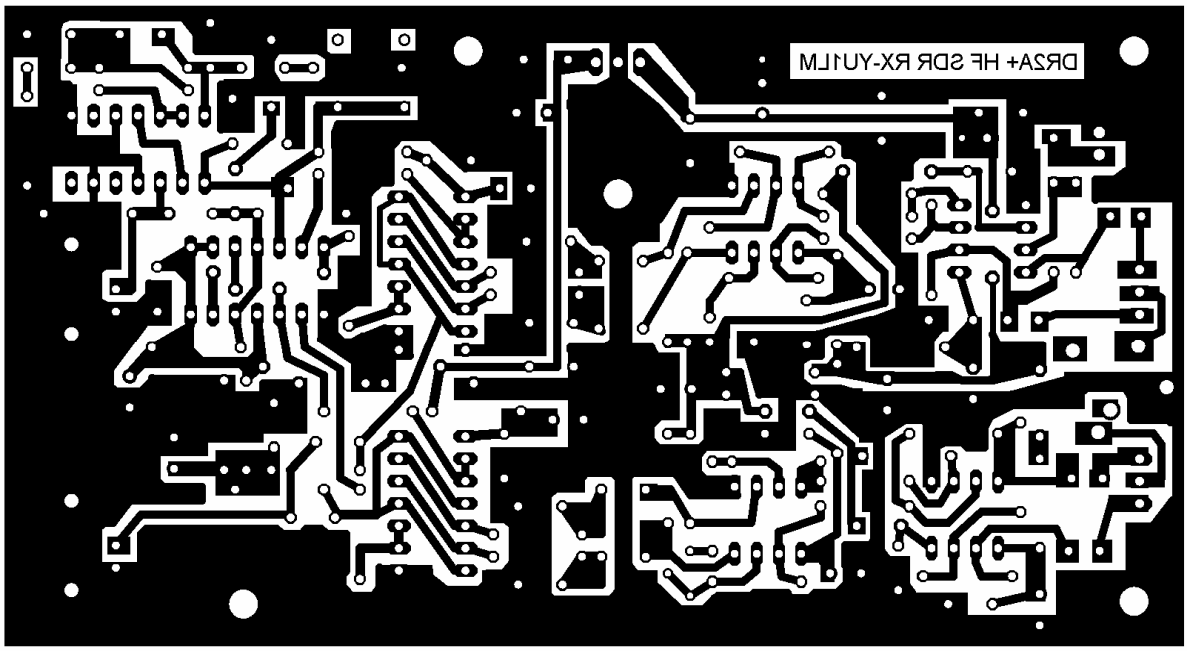
1. Usage instrumental OP AMP as post detector audio amplifier to improve overall NF (please read article about HF/VHF/UHF receivers at site) and CMRR performances also.

2. To build in local oscillator on board (in fundamental or overtone mode) to enable easy use SDR receiver with existing RIG-s at IF. My idea was also to enable newcomers to easy build SDR RX all on one board with all receiver components.

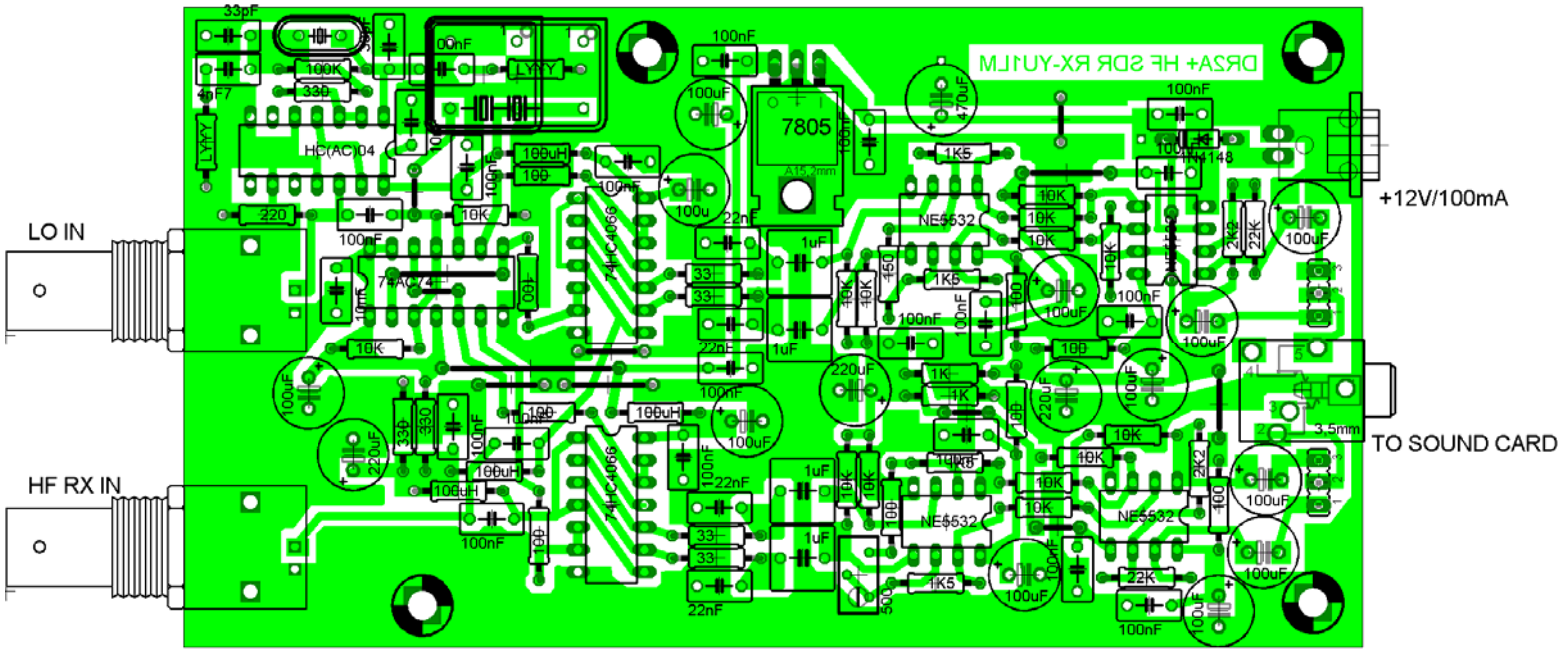
3. All my designs ware with single power supply until now. This solution limited some performances like IMD free DR. Dual +/- power supply improved DR for 4-5 dB and now it is close to the magic numbers 97-100 dB!!!!!!

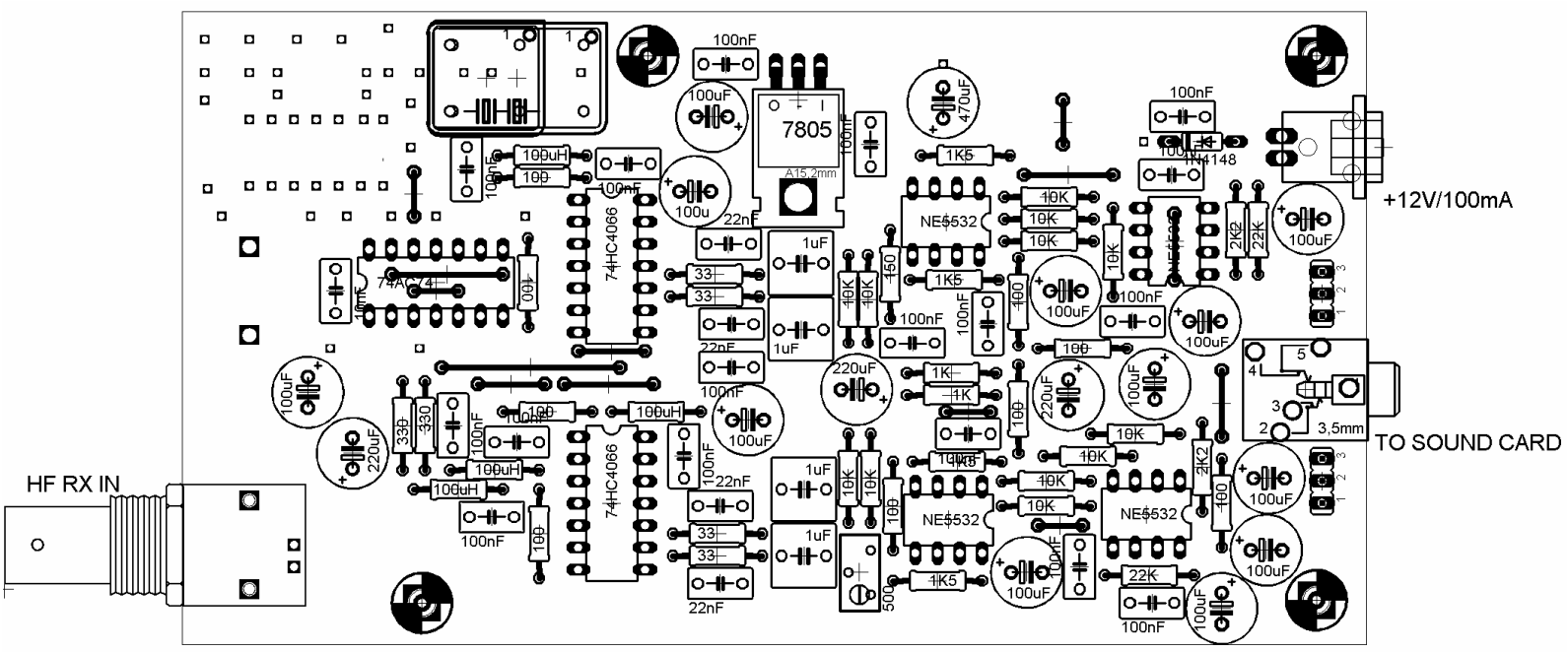
4. I made also proposal how in all my design use better modern technology components as substitute for classic DIL (through hole) components as source for performances improvement with small adapter PCBs placed at top side! New modern components have wider useful bandwidth and they will enable SDR receiving up to the 52 MHz minimum.

5. I changed bandwidth S/H demodulators to wider it and enable better specifications for +/- 48 kHz bandwidth in receiving with 96 kHz SB sample rate. S/H capacitors 47nF are decreased to 22nF. This action is possible to do in all my previously designs!

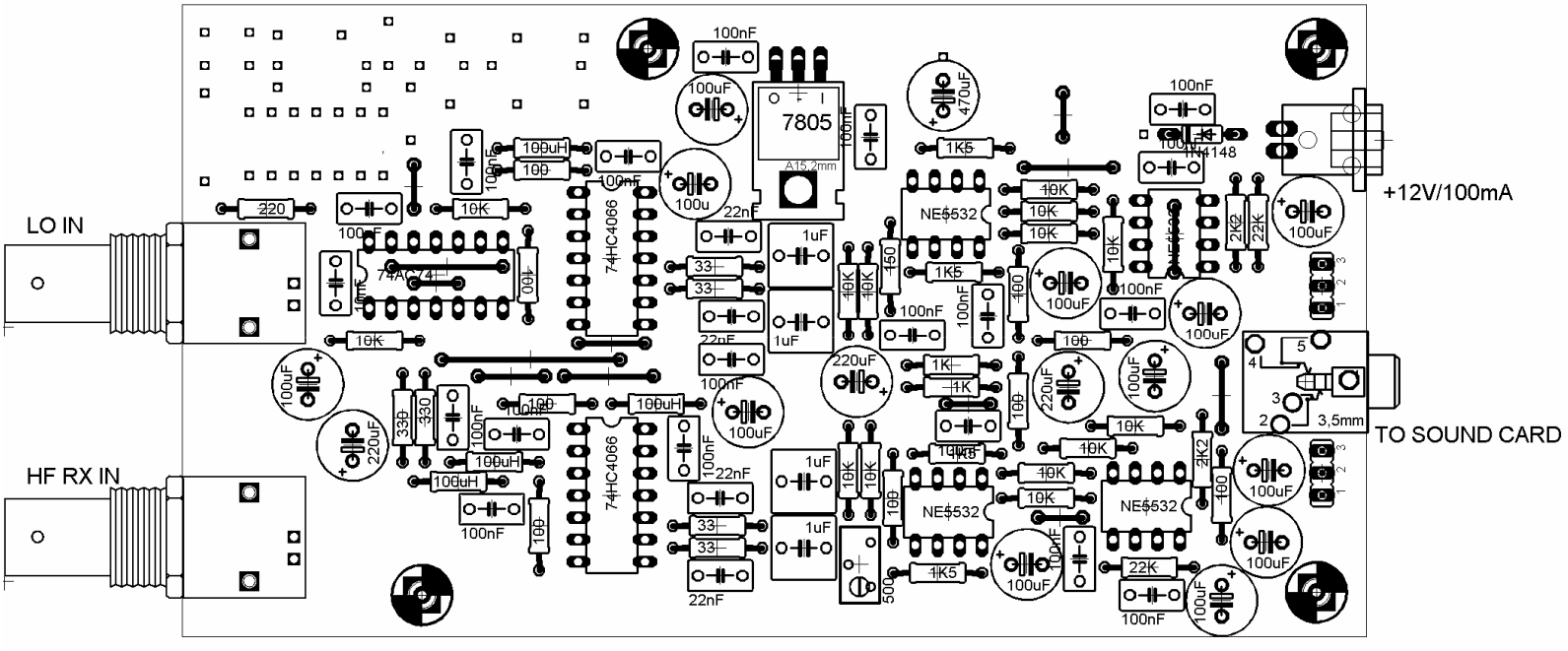



DR2A+ Single side PCB dimensions 135 x 72.5 mm

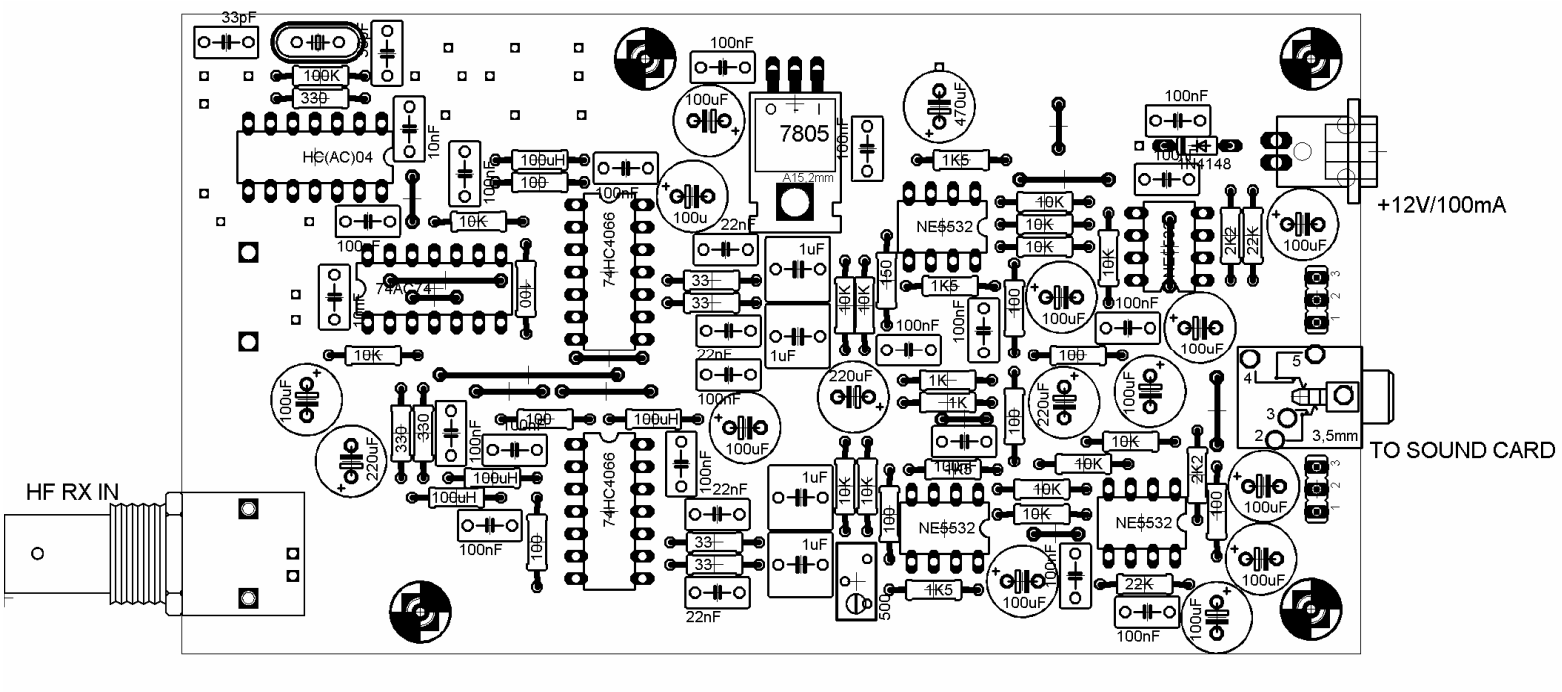




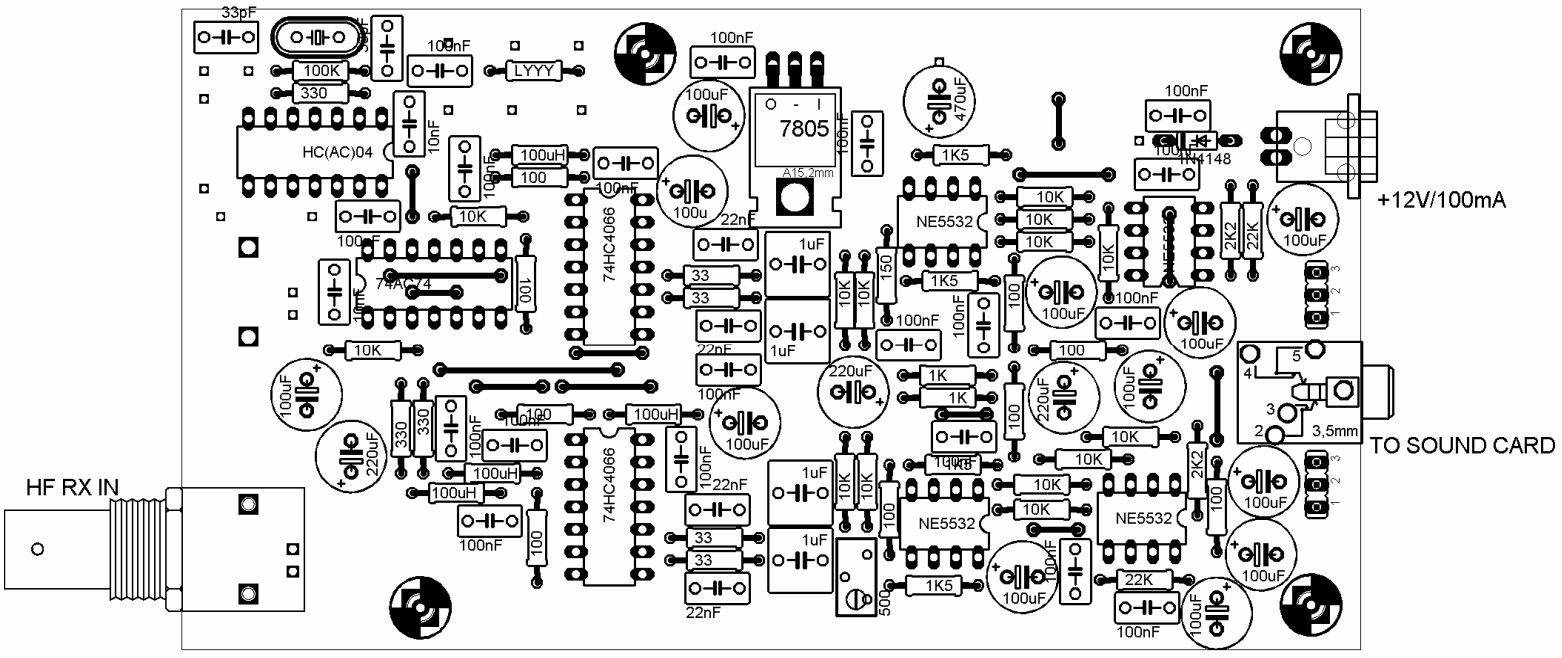

DR2A+ parts placement for block oscillator




DR2A+ parts placement for external oscillator




DR2A+ parts placement for crystal oscillator in fundamental mode (for 3 overtone reduce 100K to 4K7)

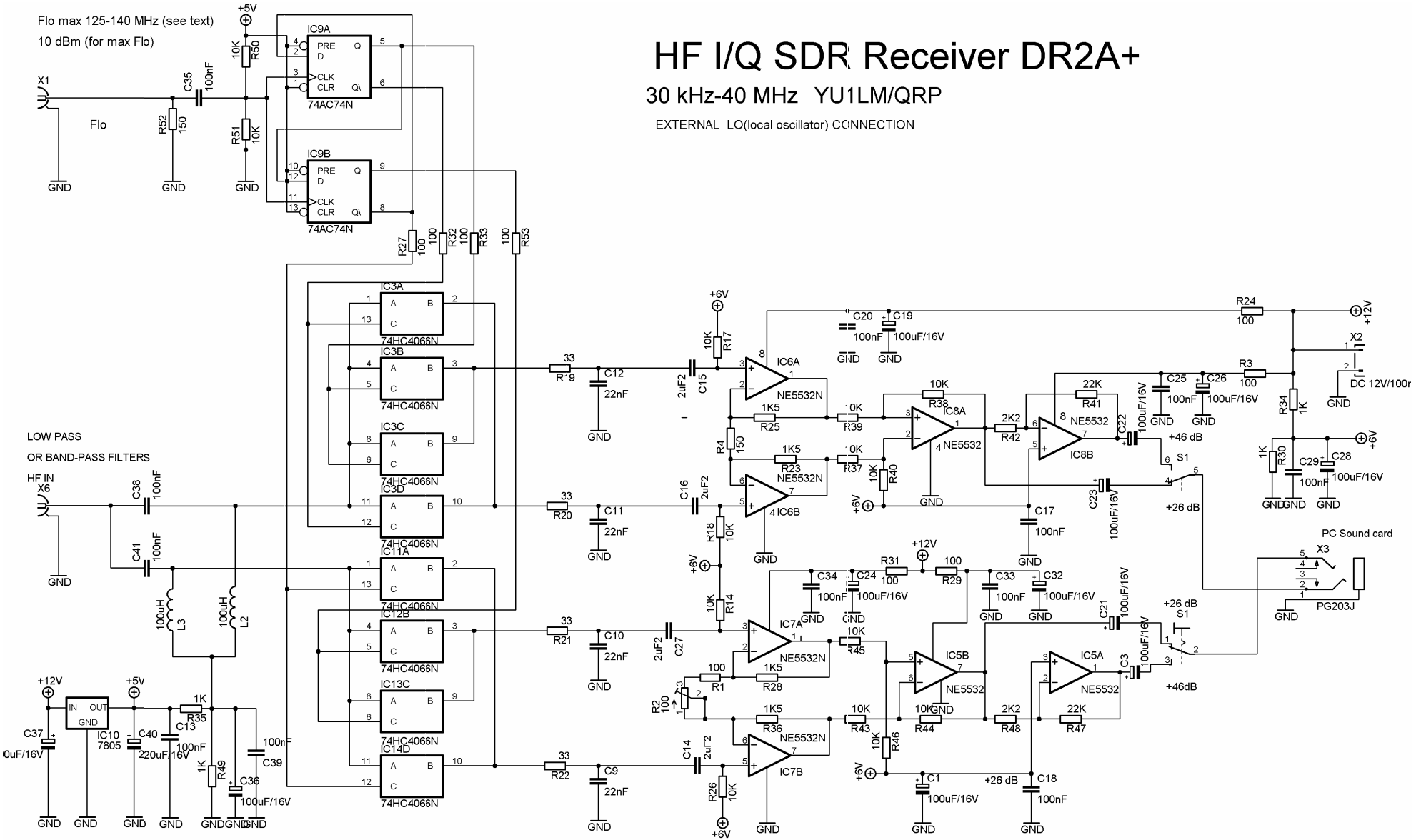


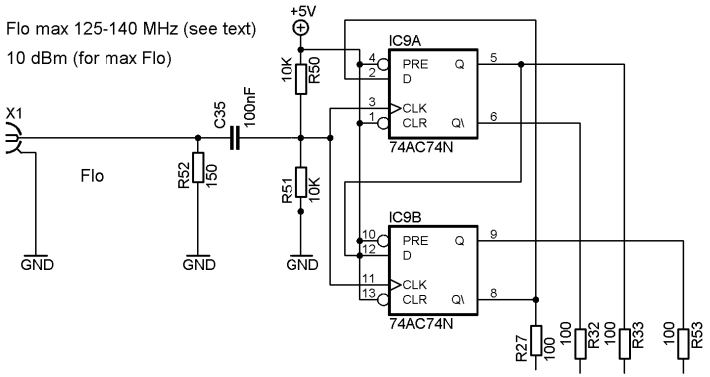

DR2A+ parts placement for crystal oscillator in overtone mode (one of two possible connections)

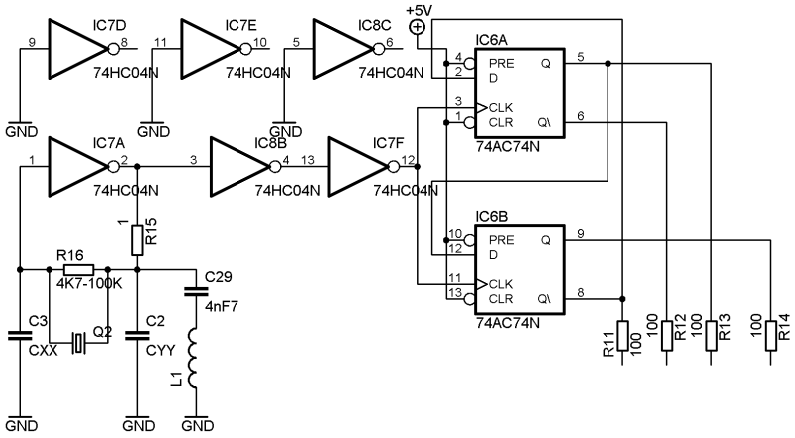
# HF I/Q SDR Receiver DR2A+

## 30 kHz-40 MHz  YU1LM/QRP

EXTERNAL  LO(local oscillator) CONNECTION

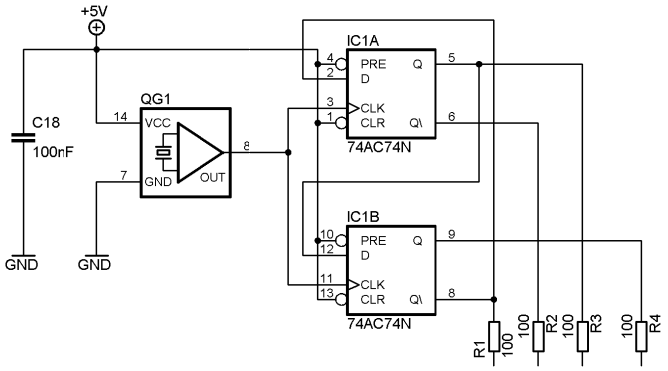


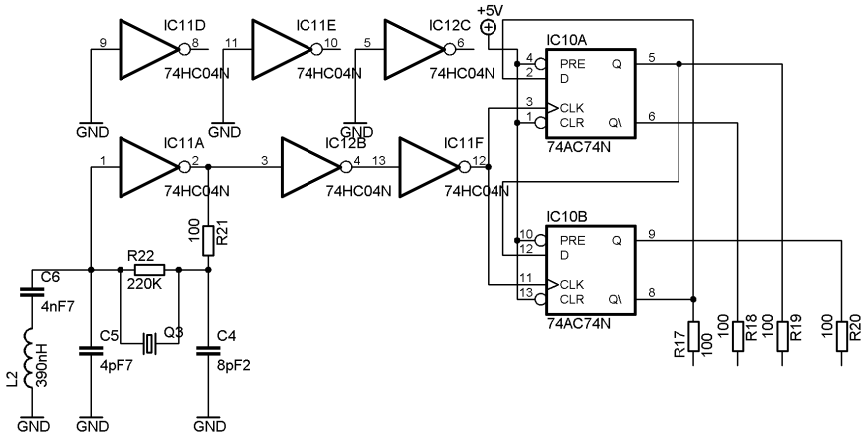


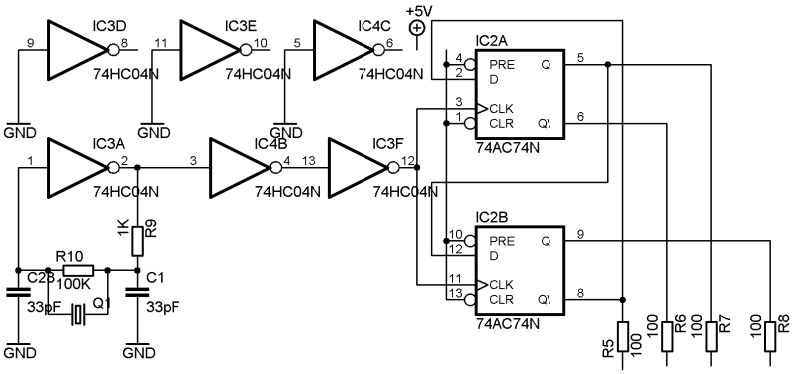

Q UP TO THE 130 MHz OVERTONE MODE
WITH IC 74AC04

F=39MHz CXX=10pF,CYY=27pF L1=1500nHR=4K7
F=56MHz CXX=8.2pF,CYY=12pF L1=820nHR=4K7



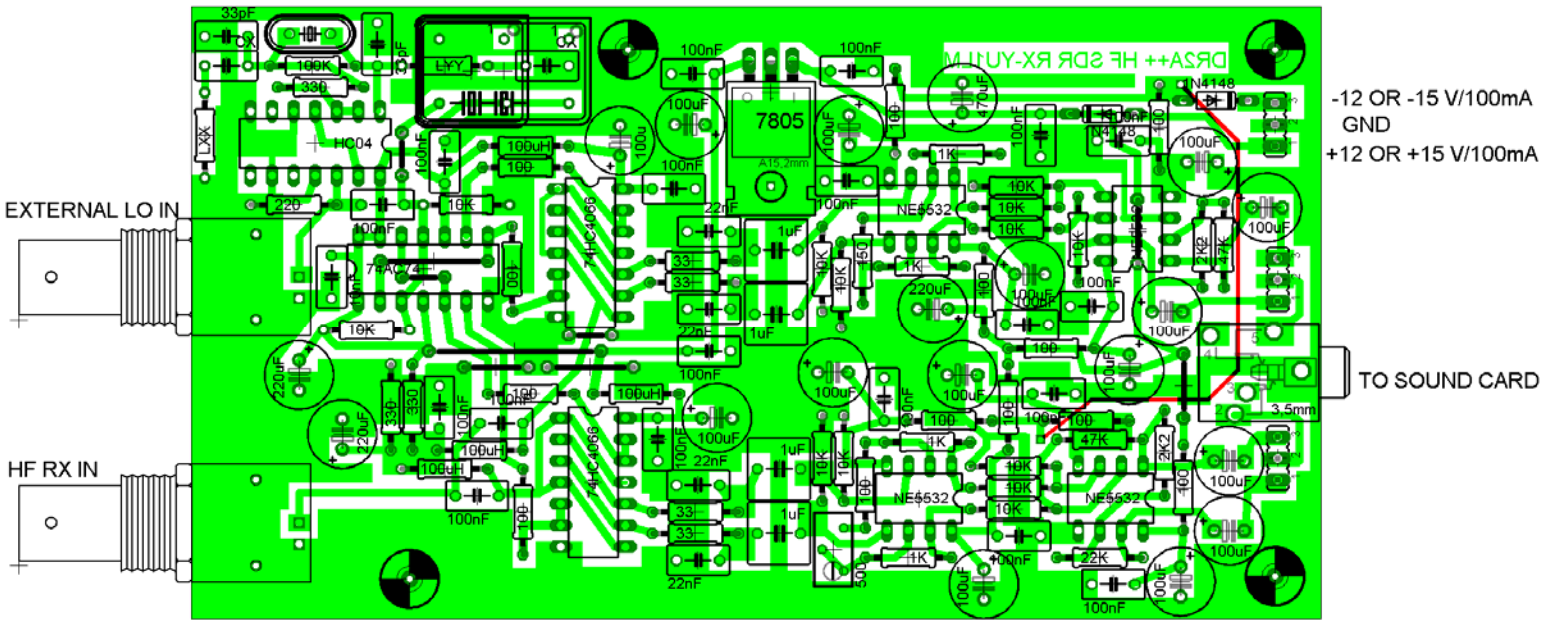

Q UP TO THE 130 MHz OVERTONE MODE
WITH IC 74AC04
VALUES FOR 5 th OVERTONE 115-120 MHz



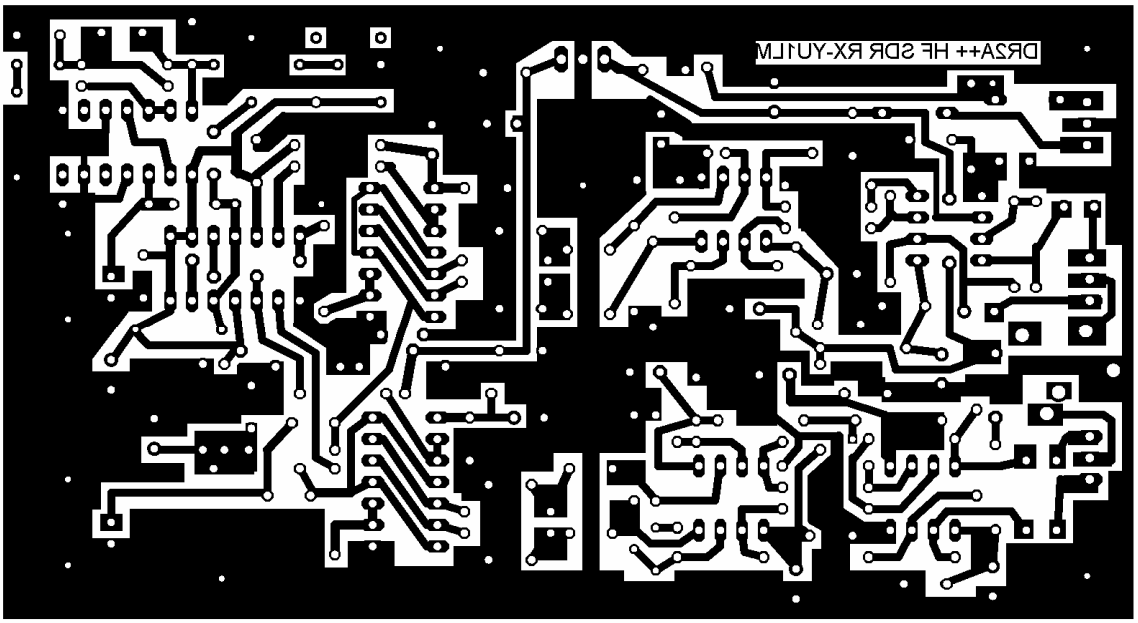

Q UP TO THE 30 MHz FUNDAMENTAL MODE

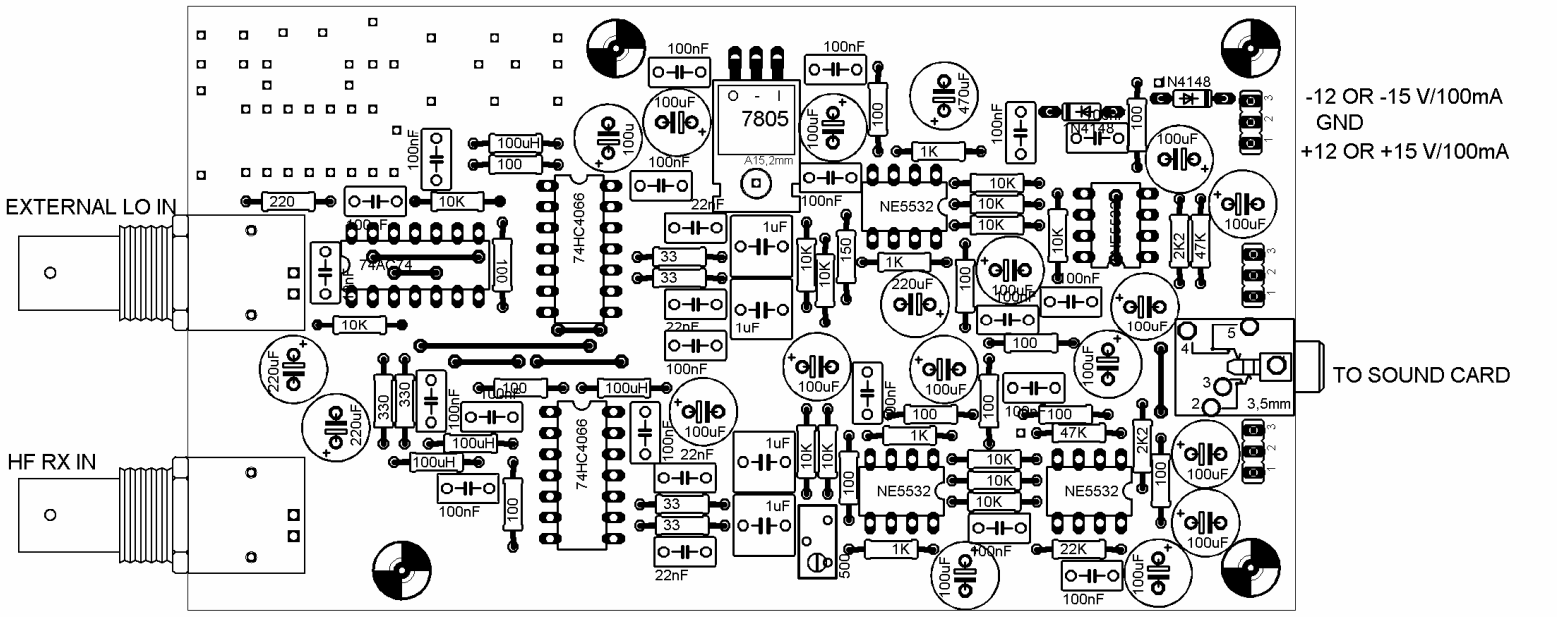
# DIFFERENT OSCILLATORS FOR AVALA-01 ,DR2A+ AND DR2A++ -YU1LM

Dynamic range (DR) limitation in case RXs DR2A and DR2A+ are not cased by S/H 74HC4066 detector but it is determined with post detector OPAMP limitation. As I wrote in past that S/H detector is capable to receive signal levels more than +10dBm without noticeable IMDs. This remarkable S/H detector performance is enabling me realization SDR or DC RXs without input band-pass BP filters. 1dB point compression with Vcc +5V is around +15-+16dBm. With some new IC like 74VHC4066 (SMT) Vcc max= +10V even more. In case RXs DR2A and DR2A+ OPAMP was going to the clipping with output swing +/- 4-5 V. I realized new SDR RX called DR2A++ DR2A+ version with positive and negative power supply for OPAMP. New realization enabled me to overcome situation that OPAMP is going in saturation before this is happening in S/H detector. Now output swing is now +/-10 V or even more. DR improvement is from 4-6 dB and it is noticeable. With new modern SMT components like 74LVC4066 are new SDR RX DR2A++ has SFDR close to the 100 dB.

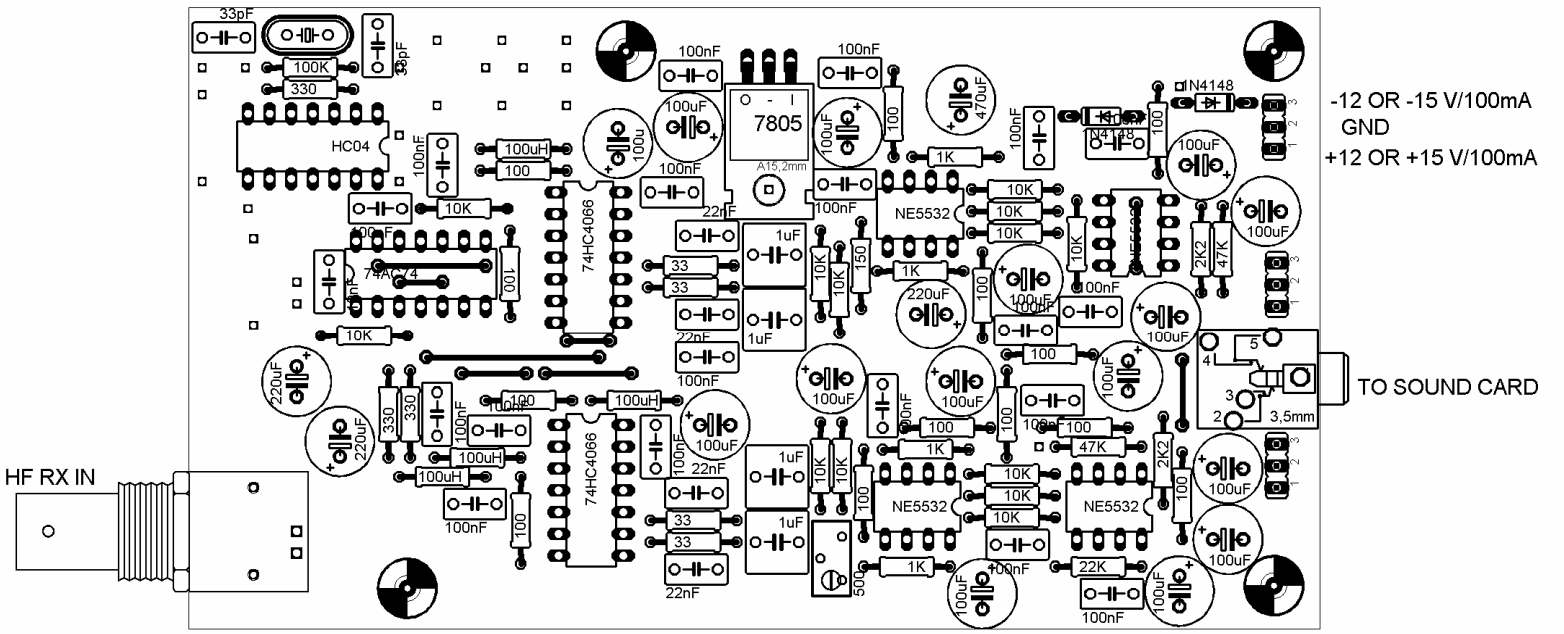



DR2A++ Single side PCB size is 133 x 73 mm, red wire at bottom side is –Vcc power connection

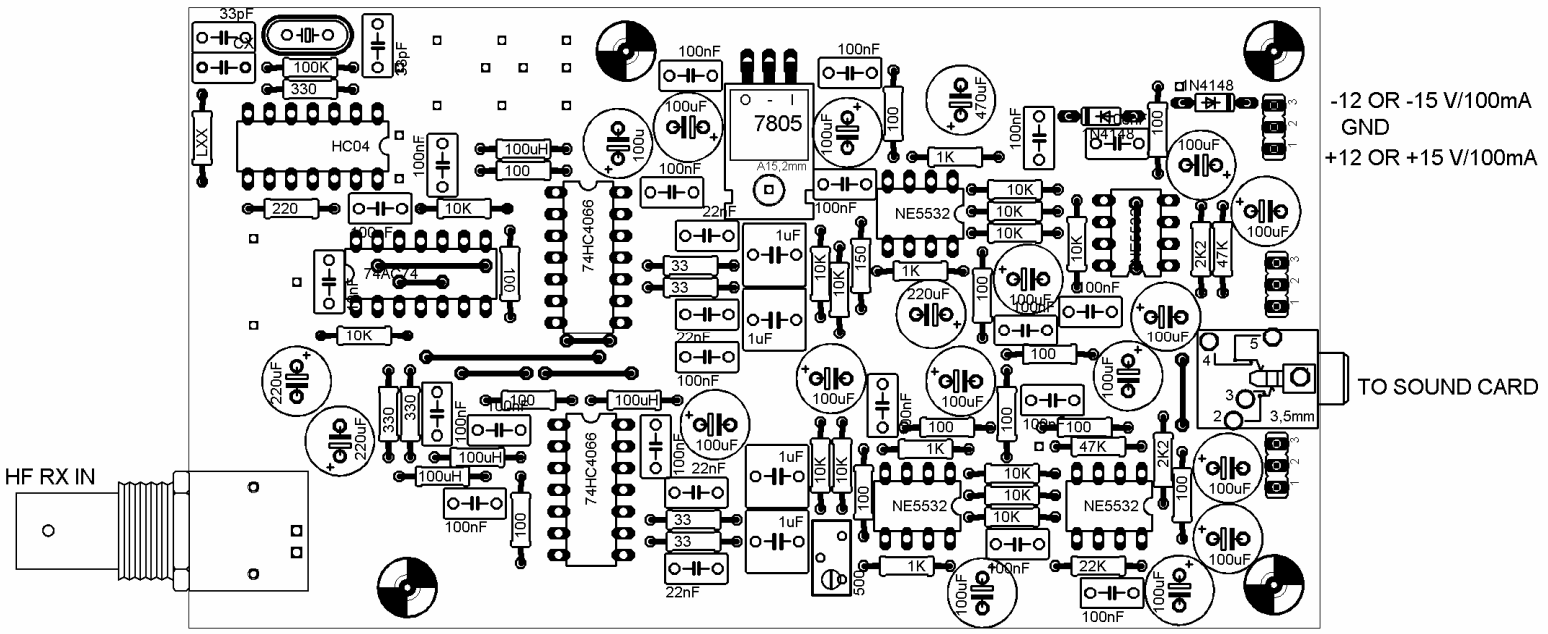




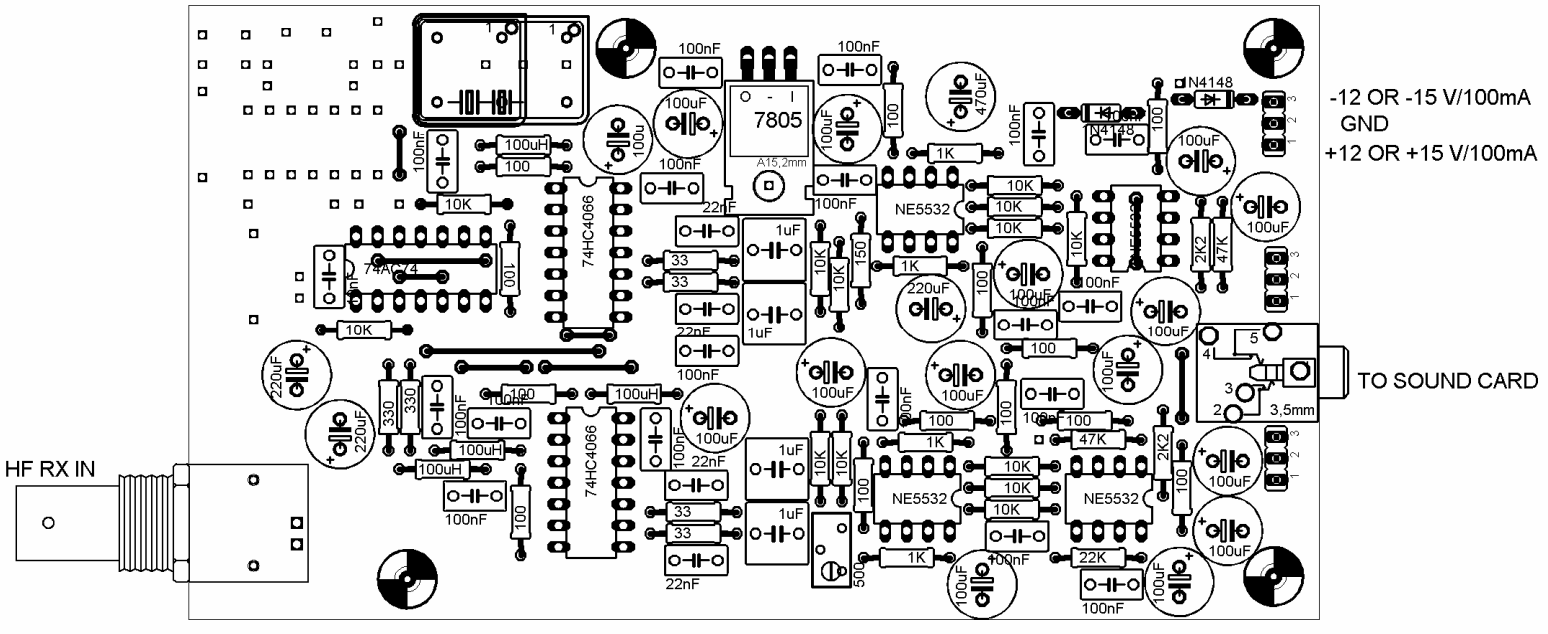

DR2A++ parts placement for external LO case



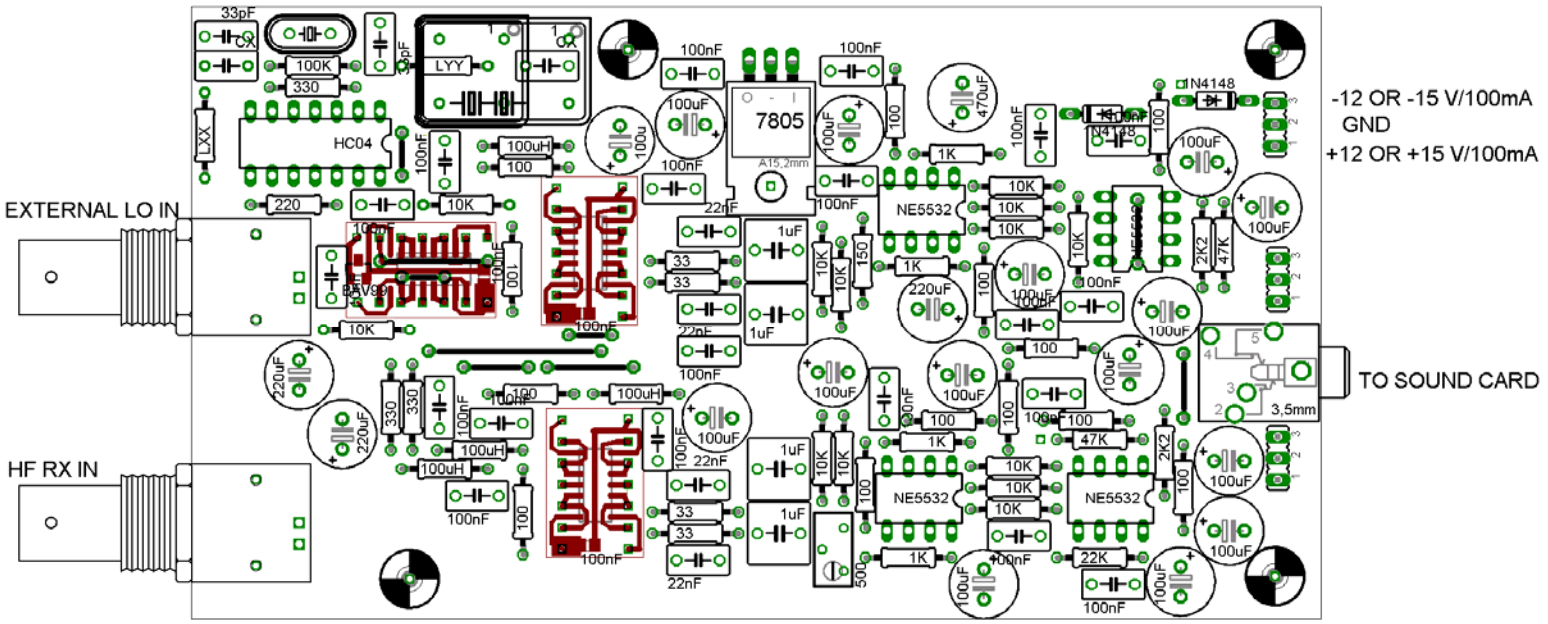

DR2A++ parts placement for internal crystal fundamental mode oscillator to 30 MHz or 3 overtone mode oscillator typical case Q=28322kHz (reduce 100K in HC04 feedback to 4k7)




DR2A+ parts placement for crystal oscillator in overtone mode to 80-120 MHz with AC04 (one of two possible connections)

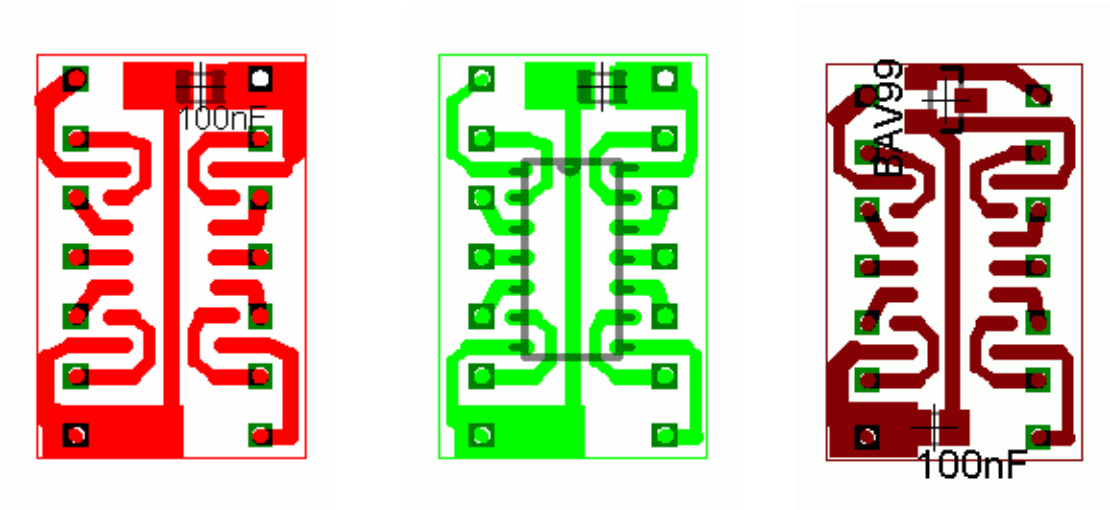



DR2A++ parts placement for the block oscillator




DR2A++ top side parts placement with SMT adapter boards.

SMT adapter for 74LVC40066 IC solder at top DR2A++ (DR2A+) side (add 10nF SMT for better HF RF decoupling). Solder with resistor leads through holes PCB to the DR2A++ PCB bottom side first. After first SMT adapter had been soldered than solder SMT chip 74LVC4066. Vccmax = + 5V!!!!!!




Single side SMT adapter PCBs (for 74LVC4066 and 74LVC74 right) top view dimensions are 21 x 11.5 mm

SMT adapter single side PCB size is 11.4 x 20.7 mm for 74LVC74 (Vcc max is 3.6 V for Fin max 300 MHz )Vcc max = + 5V with adapter PCB we will enable work up to 52 MHz!!!!!! I didn't made this test I checked combination 74LVC4066 + 74AC74 only and they worked very well to the 35 MHz with 74LVC74 according to the data sheet it will not be problem work to 52 MHz. In case that we use

74LVC4066 change resistors R19,20, 21, 22 values from 33Ohms to 82 Ohms. Similar improvements is possible also in all my previously designs with SMT adapter PCBs.

Measuring results which I made with HF S/H SDR receiver DR2A+

1. Receiving range is going from 30 kHz to 35 MHz for DIL ICs version .With built in last modern technology like 74LVC74 and 74LVC4066 and external LO to 52 MHz.
2. IIP3 32-35dBm and it depends from setting and used programs. I changed RX amplification distribution. For first stage I increased gain to the 26 dB and decrease gain to 20 dB for the second stage (all measurements done with 24 bit sound card).
3. MDS -116 to -122dBm also with 24 bit external USB SB card Audigy NX2
4. Image rejection is from 35 -65 dB with hardware realization only
5. Sensitivity 0.6-0.9uV for 10 dB S/N ratio, max S/N ratio I measured was 72dB.
6. SFDR (Spurious free dynamic range) is 92-94 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(with new modern SMT ICs 74LVC4066 SFRD is 95- 97dB).

Measuring results which I made with HF S/H SDR receiver DR2A++:

1. Receiving range from 30 kHz to 35 MHz for DIL ICs version .With built in last modern technology like 74LVC74 and 74LVC4066 and external LO to 52 MHz.2.
2. IIP3 32-36dBm and it depends from setting and used programs. I changed RX amplification distribution. For first stage I increased gain to the 26 dB and decrease gain to 20 dB for the second stage (all measurements done with 24 bit sound card).
3. MDS -117 to -123dBm also with 24 bit external USB SB card Audigy NX2.
4. Image rejection is from 35 -60 dB(at some frequencies rejection was over 65 dB)
5. Sensitivity 0.6-0.8uV for 10 dB S/N ratio, max S/N ratio I measured was 72dB.
6. SFDR (Spurious free dynamic range) is 94-96 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 (with new modern SMT ICs 74LVC4066 SFRD is 97- 100dB)

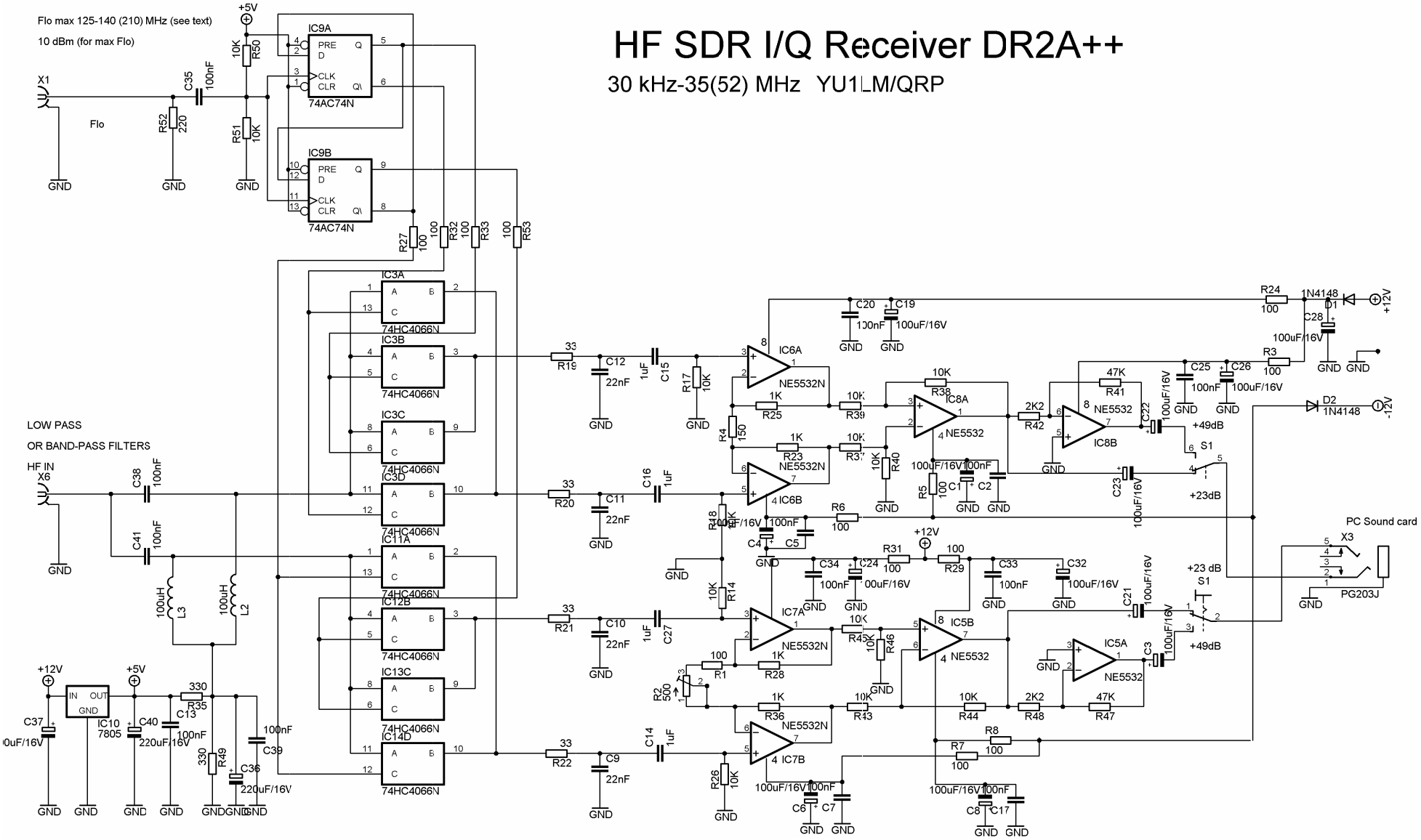
Some excellent performances aren’t without other side:

1. First and very big disadvantage is 4 times higher LO. For 52 MHz maximum input frequency LO frequency is 208 MHz.
2. Image rejection is changing through receiving bands and results are done for frequencies 12 kHz from central receiving frequency. There is also degradation in image rejection as frequencies are increasing.

For external LO it is necessary input level to be around 1 Vp-p min for safe operation (for lower LO drive operations are not sure especially for higher LO frequencies)!!!Simple test for 74HC4066(74LVC4066) correct operation is when we measure with DMM (digital multi meter) Vcc/2 or 2.5 V +/-0.5 V at control pins 12, 13 and 5, 6 If it isn’t true we have a problem with input LO level or input ICs 74AC74 or 74HC4066 (74LVC4066).

# HF SDR I/Q Receiver DR2A++

30 kHz-35(52) MHz  YU1LM/QRP



DR2A+ / DR2A++ adjustments are simple and done in two steps:

1.Adjust with universal instruments DMM (digital multi meter) that is resistance in feedback potentiometer 56 +100 = 150 Ohms
2.Find some strong signal in the air 12 kHz away from zero or connect signal from signal generator to the input of DR2A++ and with 100(500)Ohm potentiometer adjust the minimum unwanted image signal in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.

I wish you successful DR2A+ and DR2A++ 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.

**VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP**

**New E-mail address tasa@insimtel.com April 2007**
**stasic@eunet.yu**

***References:***

***1.*** ***www.qsl.net/yu1lm/homebrew***
***2.*** ***http://forum.cqham.ru/viewforum.php ?f=28***
***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***
***www.analog.com/en/prod/0,,770_843_AD9850,00.html***

***http://www.qsl.net/pa3ckr/signalgenerator/***

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

***7.*** ***Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53***
***1.*** ***RF Design 6/1995***
***2.*** ***Philips- Application note AN97090( IC gate overtone oscillator design)***

***Software LINK for SDR radio receiving and transmitting***

**1.** ***http://digilander.libero.it/i2phd/ SDRadio software ver 1.0***

*www.qsl.net/i2phd Alberto I2PHDhttp://gpsdo.i2phd.com/*

2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
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