HF-VHF SDR S/H Sample and Hold Receivers DR2I+ and DR2I++ From 30 KHz to 72(110) MHz - Make Them Simple as Possible With Outstanding Performances

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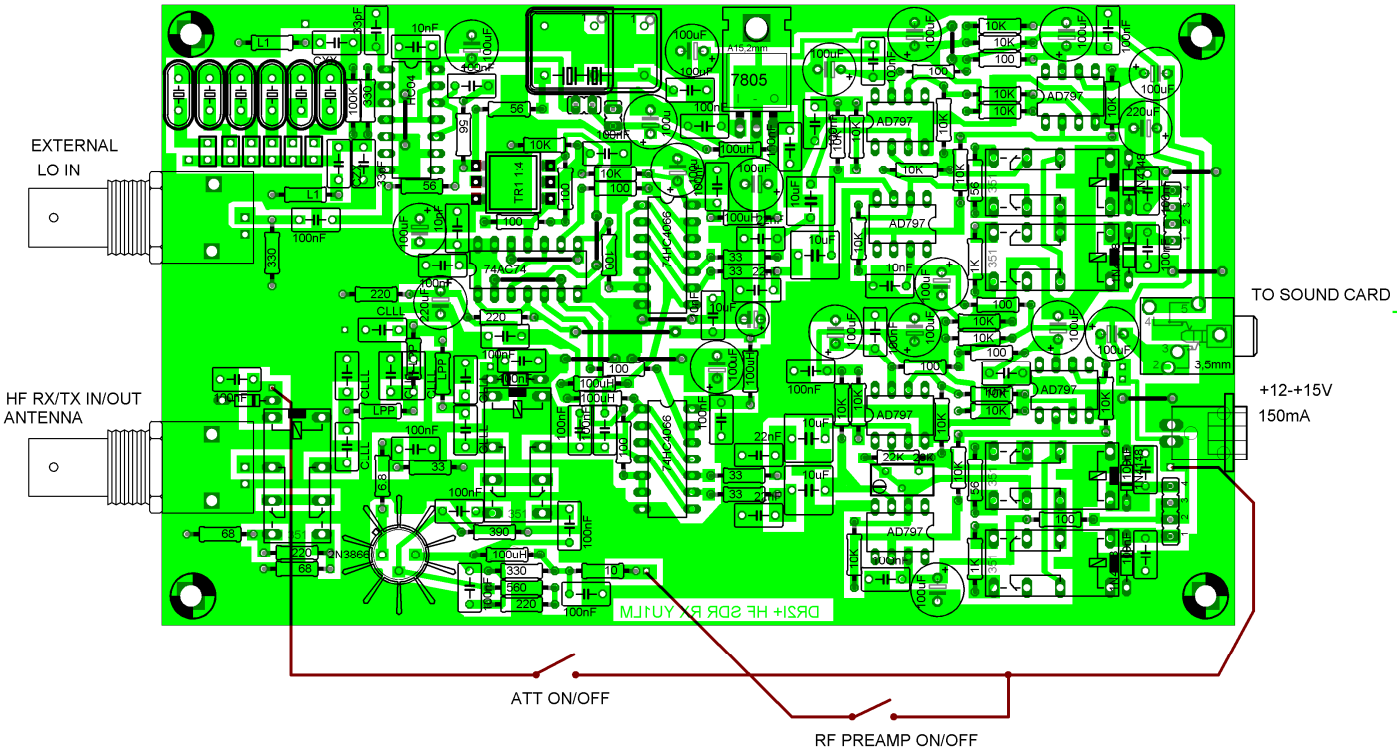
After I made DR2F+ receiver I decided to use realized solution with improved RX sensitivity together with biggest frequency bandwidth than DR2H+ receiver has in new design name DR2I+. Read those articles please and I shall not repeat here. I shall give realization and measuring results only. DR2I+ specifications are:

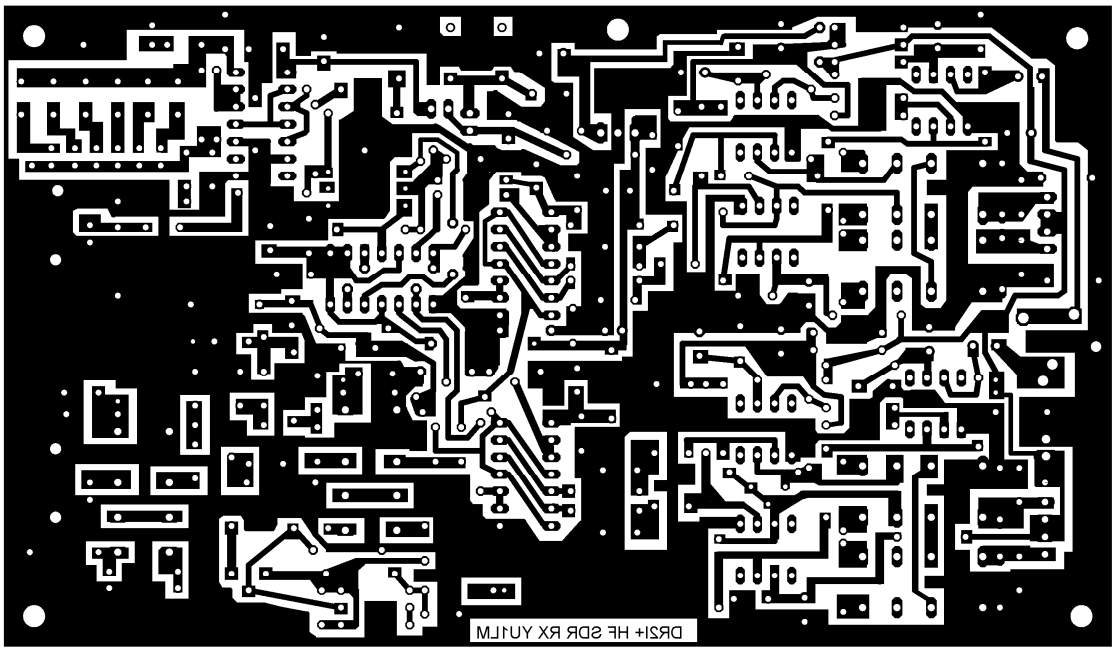
1. Receiving range is going from 30 kHz to **72 MHz for DIL ICs version**!!! With built in last modern technology components like 74LVC74 and 74LVC4066 are and with external LO to **110MHz!!**
2. IIP3 32-35dBm and it depends from setting and used programs. MDS -120 to -125dBm also with 24 bit external USB SB card Audigy NX2. With RF preamplifier MDS is -135 to -137dBm.
3. Receiver image rejection is from 65 -30 dB with hardware realization only
4. Sensitivity 0.1-0.16uV for 10 dB S/N ratio, max S/N ratio I measured was 70dB.
5. SFDR (Spurious free dynamic range) is 93-94 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).
6. RX 1 dB compression point is + 15dBm!!!
7. Receiver has built in 6 channel CMOS oscillator

I left possibility to build in some kind of input filter LP or BP type if we want to achieve max specifications and reduce odd harmonic receiving especially. Practically experience is that harmonic receiving is reduced. The results measured are lower RX sensitivity around -35 to -10 dB for third harmonic than fundamental is. These results are not looking so good but my practical experiences are that even with my big antenna like 84m delta loop is harmonic receiving is not problem for most HF bands. In the evening hours I can notice only weak presents of strong carriers from 7 MHz broadcast band during receiving weak HAM signals at 1.8MHz.My practical experience is that RX can work without any kind of input filter. The filter place can be substitute with shorts with jumpers see article devoted to DR2H** RXs. Different samples of DIL D FF 74AC74 were working to 160MHz and upper frequency limit for DR2I+ is determined by 74HC4066 DIL to 72-78MHz. All about LP or BP filters you can read in additional articles published at this site and they are not subject of this article. All types are possible assembled at the same RX PCB layout. Gain distribution is the same as DR2F+(DR2F++) has see article about DR2F.

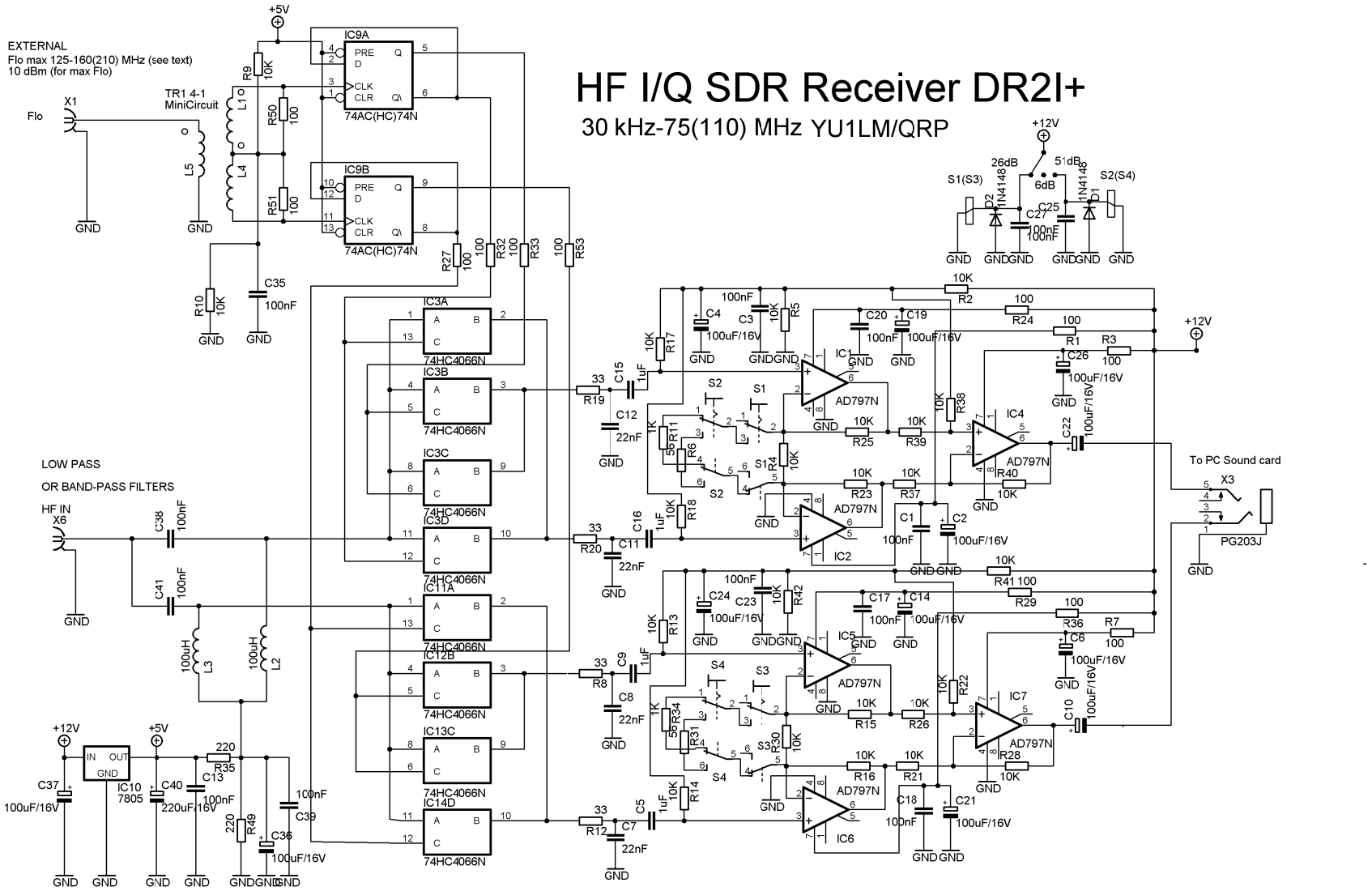
The DR2I++ is receiver with improved DR with SMT 74LVC4066 this receiver has DR over 100dB and it is my receiver with very good performances . Few dB improvements over DR2I+ is achieved with double positive and negative power supply.

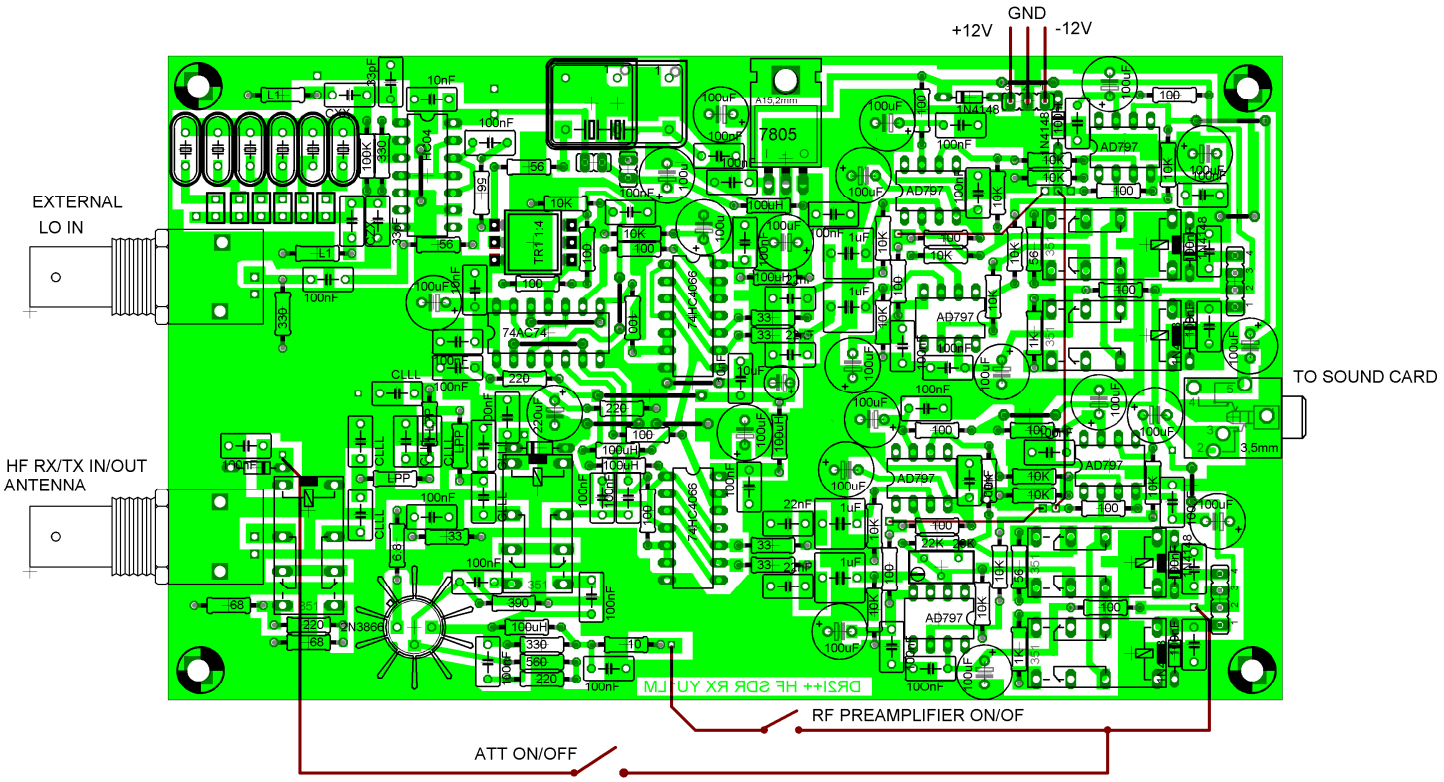


DR2I+ components placement

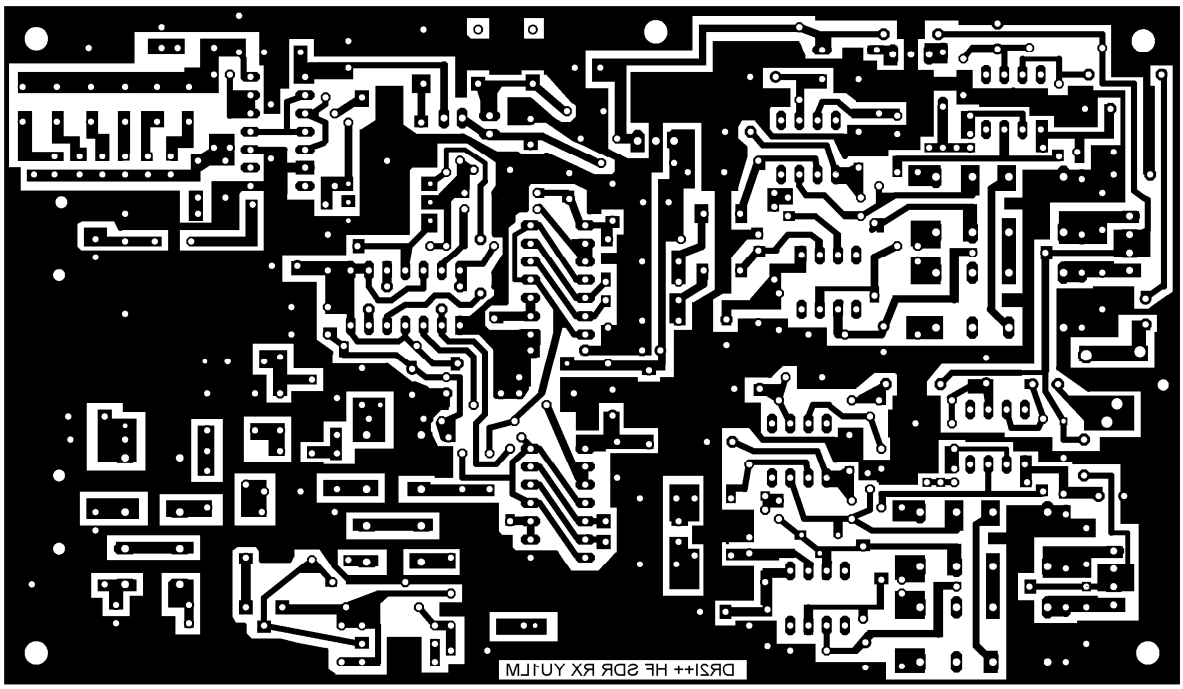


DR2I++ Single side PCB dimensions 164 x 94.5 mm


HF I/Q SDR Receiver DR2I+
30 kHz-75(110) MHz YU1LM/QRP
EXTERNAL
Flo max 125-160(210) MHz (see text)
10 dBm (for max Flo)
Flo
X1
TR1 4-1
MiniCircuit
L1
L4
L5
+5V
IC9A
IC9B
74AC(HC)74N
R9 10K
R50 100
R51 100
R10 10K
C35 100nF
GND
R27 100
R32 100
R33 100
R53 100
IC3A
IC3B
IC3C
IC3D
IC11A
IC12B
IC13C
IC14D
74HC4066N
LOW PASS
OR BAND-PASS FILTERS
HF IN
X6
C38 100nF
C41 100nF
100uH L3
100uH L2
+12V
IC10
7805
IN OUT GND
C37 100uF/16V
C40 220uF/16V
C13 100nF
R35 220
R49 220
C36 100uF/16V
C39 100nF
R19 33
R20 33
R8 33
R12 33
C15 1uF
C16 1uF
C9 1uF
C5 1uF
C12 22nF
C11 22nF
C8 22nF
C7 22nF
R17 10K
R18 10K
R13 10K
R14 10K
R11 1K
R6 56
R4 10K
R34 1K
R31 56
R30 10K
S1
S2
S3
S4
IC1
IC2
IC5
IC6
AD797N
C4 100nF
C3 10K
R5
100uF/16V
C20 100nF
C19 100uF/16V
C24 100nF
C23 10K
R42
C17 100nF
C14 100uF/16V
R25 10K
R39 10K
R23 10K
R37 10K
R15 10K
R26 10K
R16 10K
R21 10K
C18 100nF
C21 100uF/16V
R2 10K
R24 100
R1 100
R3 100
C26 100uF/16V
R38 10K
IC4
C22 100uF/16V
R40 10K
C1 100nF
C2 100uF/16V
R41 10K
R29 100
R36 100
R7 100
C6 100uF/16V
R22 10K
IC7
C10 100uF/16V
R28 10K
S1(S3)
S2(S4)
26dB
6dB
D2 1N4148
D1 1N4148
C25 100nF
C27 100nF
To PC Sound card
X3
PG203J



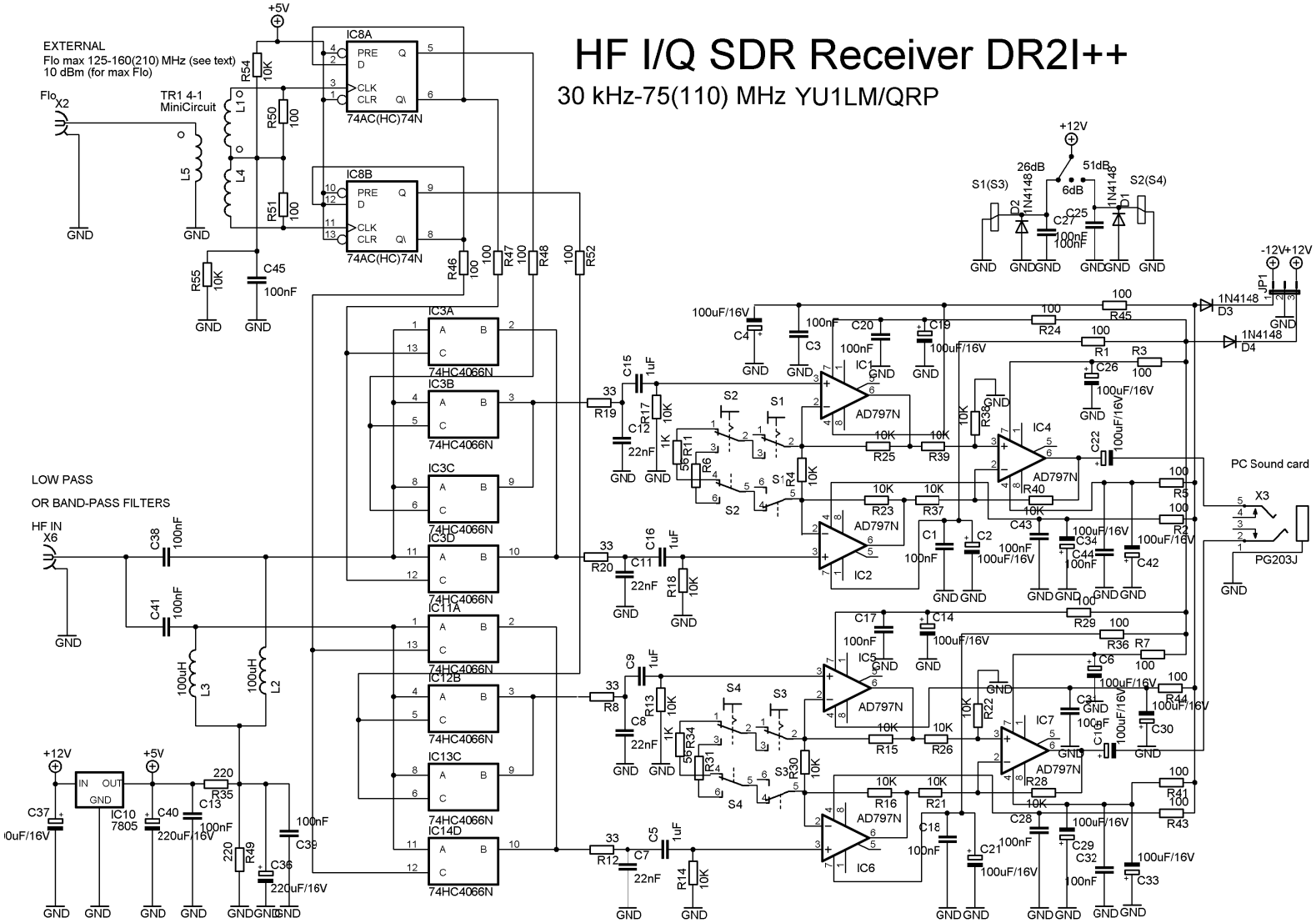
DR2I++ components placement

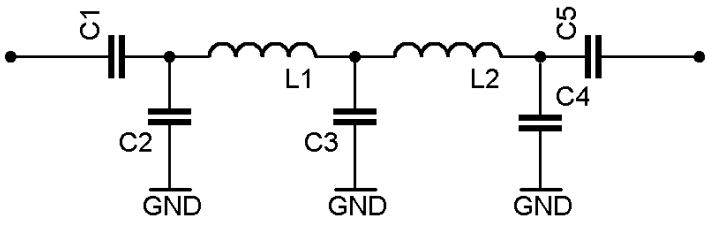


DR2I++ Single side PCB dimensions 164 x 94.5 mm

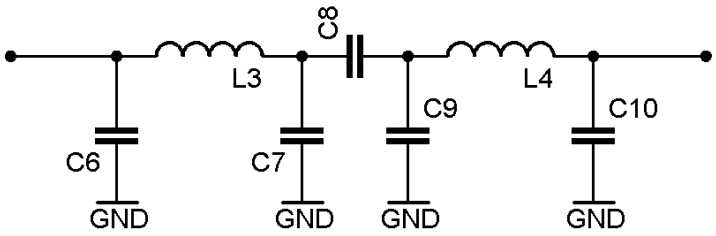
HF I/Q SDR Receiver DR2I++

30 kHz-75(110) MHz YU1LM/QRP

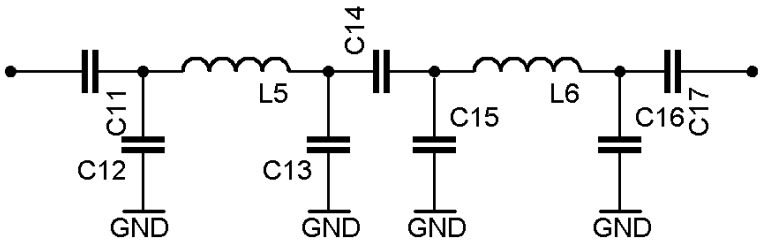




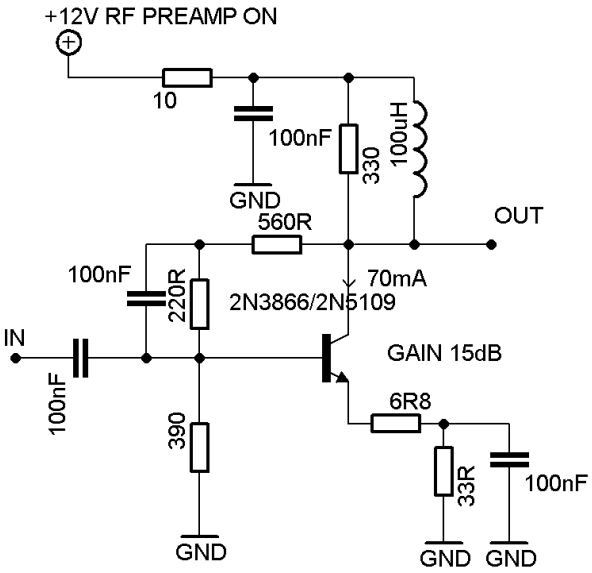
BAND PASS 2 COILS VER1



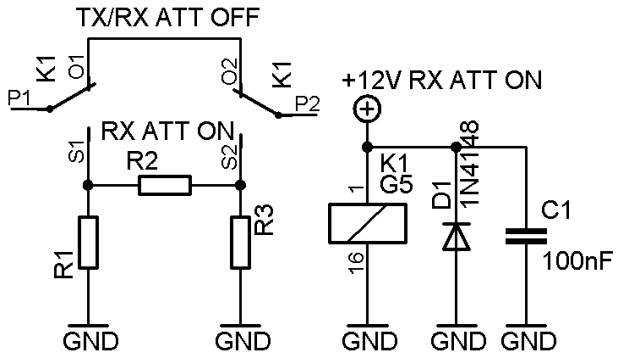
BAND PASS 2 COILS VER2



BAND PASS 2 COILS VER3



BJT RF PREAMPLIFIER - YU1LM



Pi attenuator at DR2I+ and DR2I++ input

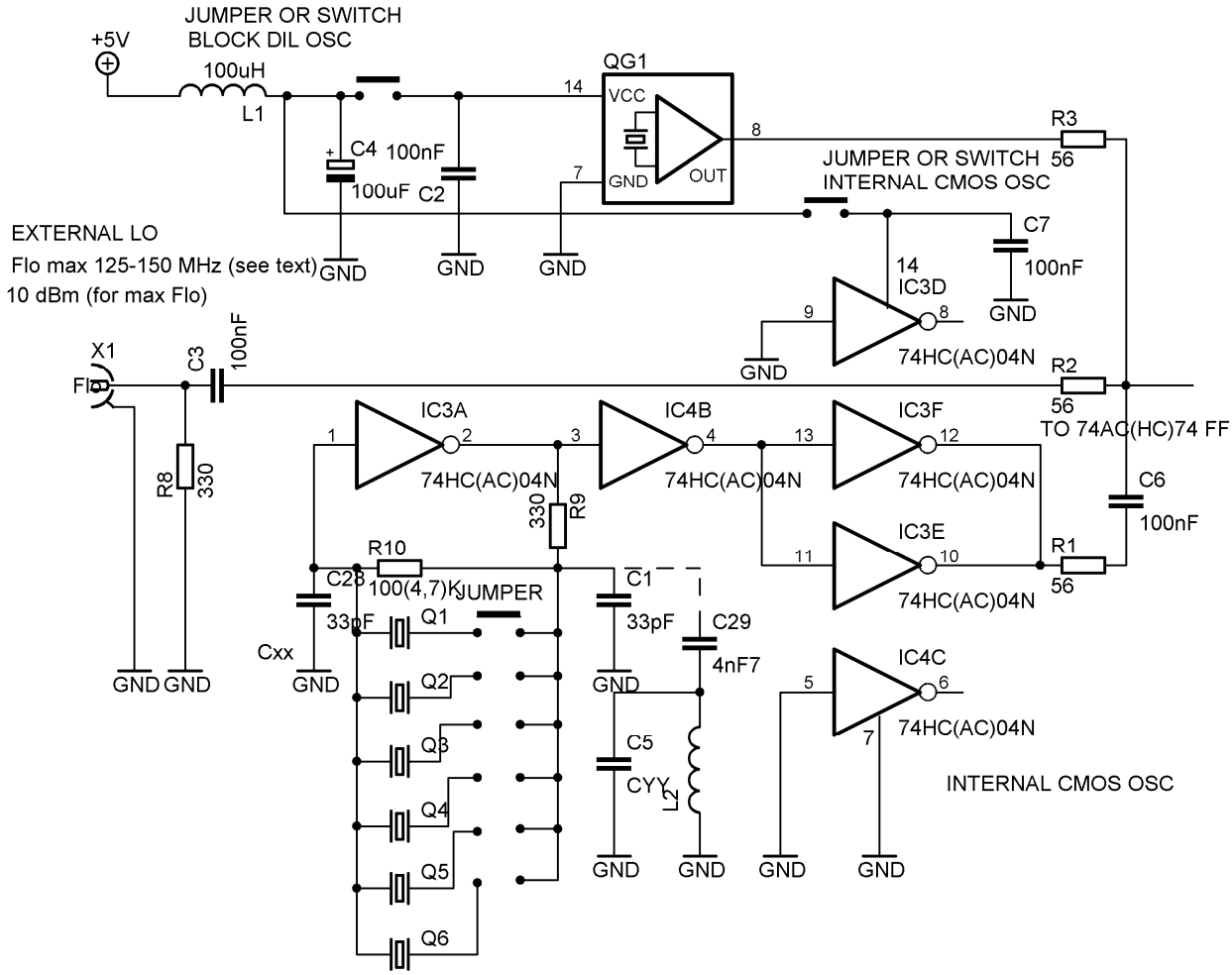
Attenuation [dB]	R1[Ohm]	R2[Ohm]	R3[Ohm]
-6	150	39	150
-10	91(100)	68	91(100)
-15	75	150	75
-17	68	180	68
-18	68	220	68
-20	56	220	56

Table is with standard resistor values for different attenuator attenuation.

DR2I+ and DR2I+ + receivers have RF preamplifier at input realized with CATV BJT transistor and ATT to optimize DR of receiver. Attenuatror is in Pi schematics and attenuation can be from 6dB to 18-20 dB . I am suggesting 15db (2x 82R and once 180R). After input attenuator I left possibility for some LP/BP according articles in Filter section to eliminate harmonic receiving to min !!

DR2I++ measured performances are:

8. Receiving range is going from 30 kHz to 35 MHz for DIL ICs version!!! With built in last modern technology components like 74LVC74 and 74LVC4066 are and with external LO to 55MHz!!
9. IIP3 34-37dBm and it depends from setting and used programs. MDS -120 to -125dBm also with 24 bit external USB SB card Audigy NX2. With RF preamplifier MDS is -135 to -137dBm.
10. Receiver image rejection is from 65 -35 dB with hardware realization only
11. Sensitivity 0.1-0.12uV for 10 dB S/N ratio, max S/N ratio I measured was 70dB.
12. SFDR (Spurious free dynamic range) is 95-97 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 98- 101dB!!!).
13. RX 1 dB compression point is 18dBm!!!
14. Receiver has built in 6 channel CMOS oscillator

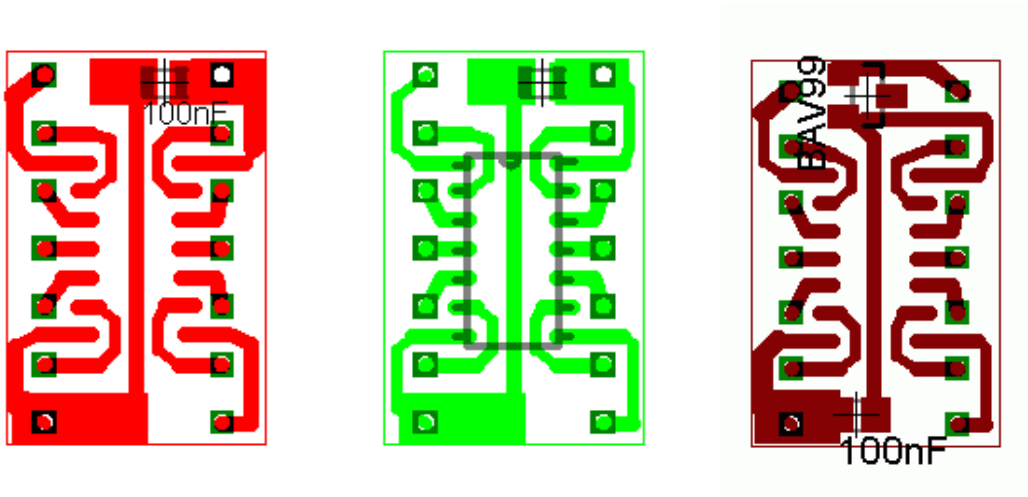


WITH IC 74AC04 UP TO THE 130 MHz OVERTONE MODE
F=56-62MHz CXX=8.2pF,CYY=12pF L1=470nH IC HC04

OSCILLATORS CONNECTION DR2F+, DR2H++ ,DR2I+ AND DR2I++ - YU1LM

Oscillator section is realized to be external or internal. This solution is similar to oscillator section into previously designs. With jumper or toggle switch with neutral position we can make choice between 3 different LO sources. Internal CMOS oscillator can be fundamental or overtone mode oscillator.

For max useful bandwidth it is necessary to use smt 74LVC** ICs. SMT adapter for 74LVC40066 IC is soldering at top DR2I++ (DR2I+) 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 was soldered than solder SMT chip 74LVC4066. Vcc max = + 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 is size 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 110 MHz!!!!!! . In case that we use 74LVC4066 change values for resistors R19, 12, 08, 20 from 33Ohms to 82 Ohms.

Some excellent performances aren't without other side:

1. First and very big disadvantage is 2 times higher LO
2. Image rejection is changing through receiving bands and results are done for frequencies 12 kHz from central frequency
3. 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)!!!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).
4. RF preamplifier isn't good enough if we like to receive max frequency 110MHz. It is very god for frequencies to 30MHz and satisfying for frequencies up to 50MHz. The preamplifier gain is only ~9dB or less at 110MHz and NF is over 8-9dB. It will be better use some IMD inferior component like MMIC MAV11(MSA1105) with lower constant gain +12dB but much better noise performances NF~3.5dB IP3out +33dBm. Possible solution for improvement is substitution 2N3866 (2N5109) with BFR96 or some better and similar transistor with Ft>5GHz.

DR2I+ / DR2I++ adjustments are simple and done in two steps:

1. Adjust with universal instruments DMM (digital multi meter) that is resistance in feedback potentiometer parallel connection 22K and potentiometer = 10kOhm.
2. Find some strong signal in the air 12 kHz away from zero or connect signal from signal generator to the input of DR2I** and with 20KOhm potentiometer adjust the minimum unwanted image signal in some SDR program for max receiver gain. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.

I wish you successful DR2I+ and DR2I++ 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.

July 2008

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

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References:

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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/

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

http://ham.kiev.ua/pic/dds_ham2.html

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/

http://members.aol.com/Dl4JAL/DDS.html

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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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***