HF SDR S/H Sample and Hold Receiver with possibility to receive 3 bands harmonically related with single oscillator – DR3X is going from 30 KHz to 35 MHz-Make it Simple as Possible with Outstanding Performances

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

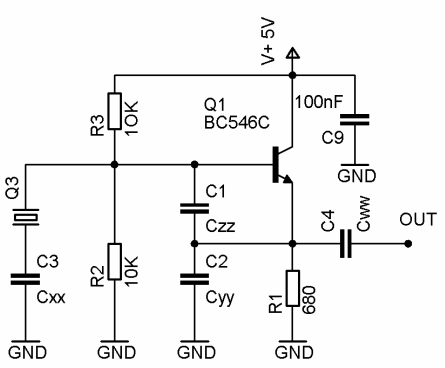
Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. you can see some photos on my sites and I can noticed that they are all mainly satisfied with results . Simple constructions with cheap classic components working really very well. Also I find at INTERNET that some solutions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

I made some local demonstrations of my SDR projects in Belgrade also. Presentation was for KKE club in YU1EXY club Audience was very surprised with very good received/ demodulated sound quality, crisp and clear sound like HI-FI (high fidelity) not common for the most commercial RIGs. SDR possibilities such as adjustable selectivity, noise reduction, NB noise blanker; waterfall… was discovery for most of them..But HAMs first excitements with new SDR techniques ware replaced with some disappointment because most HAMs like to tune LO (local oscillator) all over the working band or bands and they are not satisfied with +/- 20 KHz with fixed LO. Also some easy obtainable XTAL quartz or OSC are not in very interesting parts of HF HAM bands.. I decided to change this situation if it is possible. In meanwhile I made some experiments how to simplify my simple SDR construction with even simpler and cheaper design. Result is HF SDR S/H receivers DR2C and new DR3X which with ones single LO or XTAL enable 3 bands harmonically related receiving. Lets back to the past. I didn't experimenting with 74HC4053 at the beginning because 74HC4053 has higher Rds ON than 74HC4066. ON resistance for 74HC4053 is in range from 60-90 OHms. Also Leif SM5BSZ in his articles wrote that is not good IC like 74HC4052. My bad experience with 74HC4052 and his frequency limit as I explained in my articles on this site presentation previously stoped me to think about 74HC4053 as some possible IC for SDR design. Experimenting with DR2C receiver I noticed that 74HC4053 is very good IC little worse compared to the 74 HC4066 but still with very well and respectively performances. Also RX IC connections are much simpler than with 74HC4066 IC and it is necessary only 2 (two) 90 DEG square signals for driving switches.

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. In this situation give us that we have 4 times higher LO (local oscillator) frequency than receiving 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.

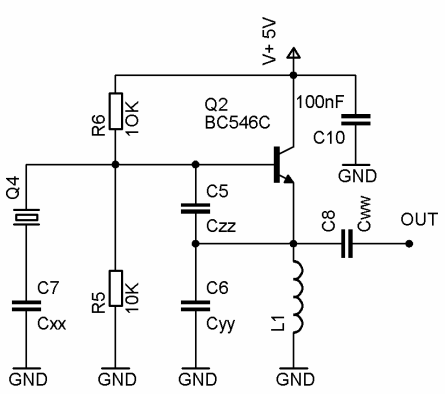
. This mean that is possible satisfactory receiving with relative good image rejection almost in all HAM bands to the 35 MHz .Input frequency 35 MHz is very close to the upper limit for 74HC4053 IC around 55-60 MHz .In oscillator schematic down with tables I proposed some

values for oscillators which are working in fundamental or overtone mode. Components placement are done for all 3 possibilities first for fundamental XTAL quartz OSC, than overtone XTAL quartz OSC and external LO connection. In schematic for fundamental mode oscillator XTAL quartz will oscillate to the 30 MHz . In schematic with coil Lxx oscillator will work with overtone quartz to the max frequencies 100-120 MHz!



FUNDAMENTAL MODE OSCILLATOR

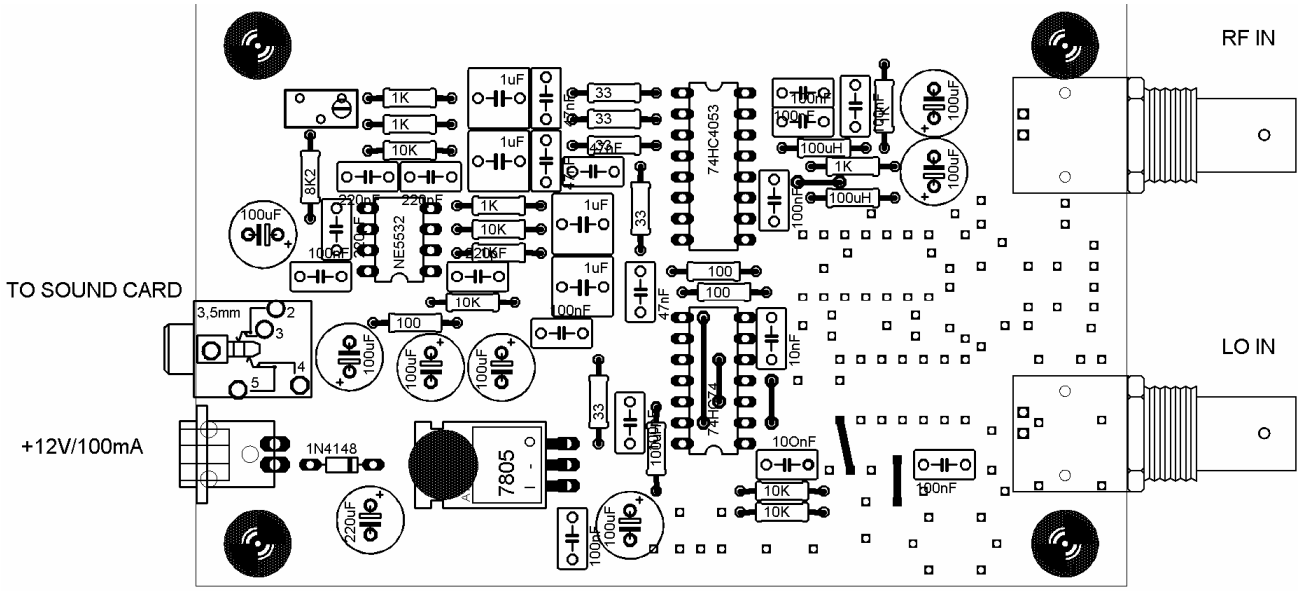
F [MHz]	Cxx [pF]	Cyy [pF]	Czz [pF]	Cww [pF]
2-4	0-33	330	680	220
2-15	0-33	220	470	100
10-30	0-33	100	220	56



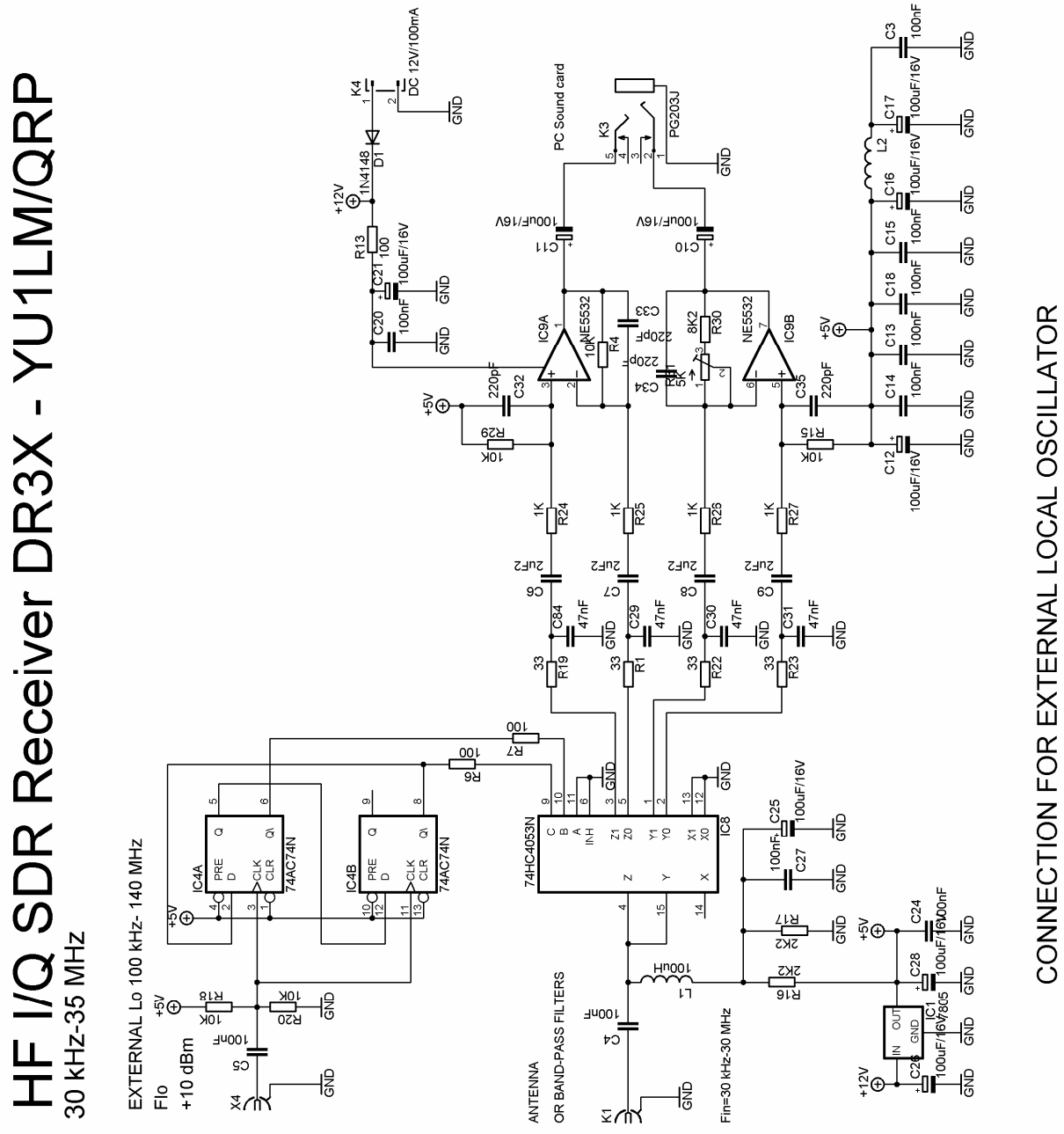
OVERTONE MODE OSCILLATOR

F [MHz]	Cxx [pF]	Cyy [pF]	Czz [pF]	Cww [pF]	Lxx [nH]
28-60	0-33	22	47	22	~330
40-80	0-33	18	33	18	~220
70-110	0-33	15	33	15	~100

BC546C is possible substitute with any other TUN transistor with fT>=150 MHz. All values in tables are only for orientation especially Lxx which is for fine tune.

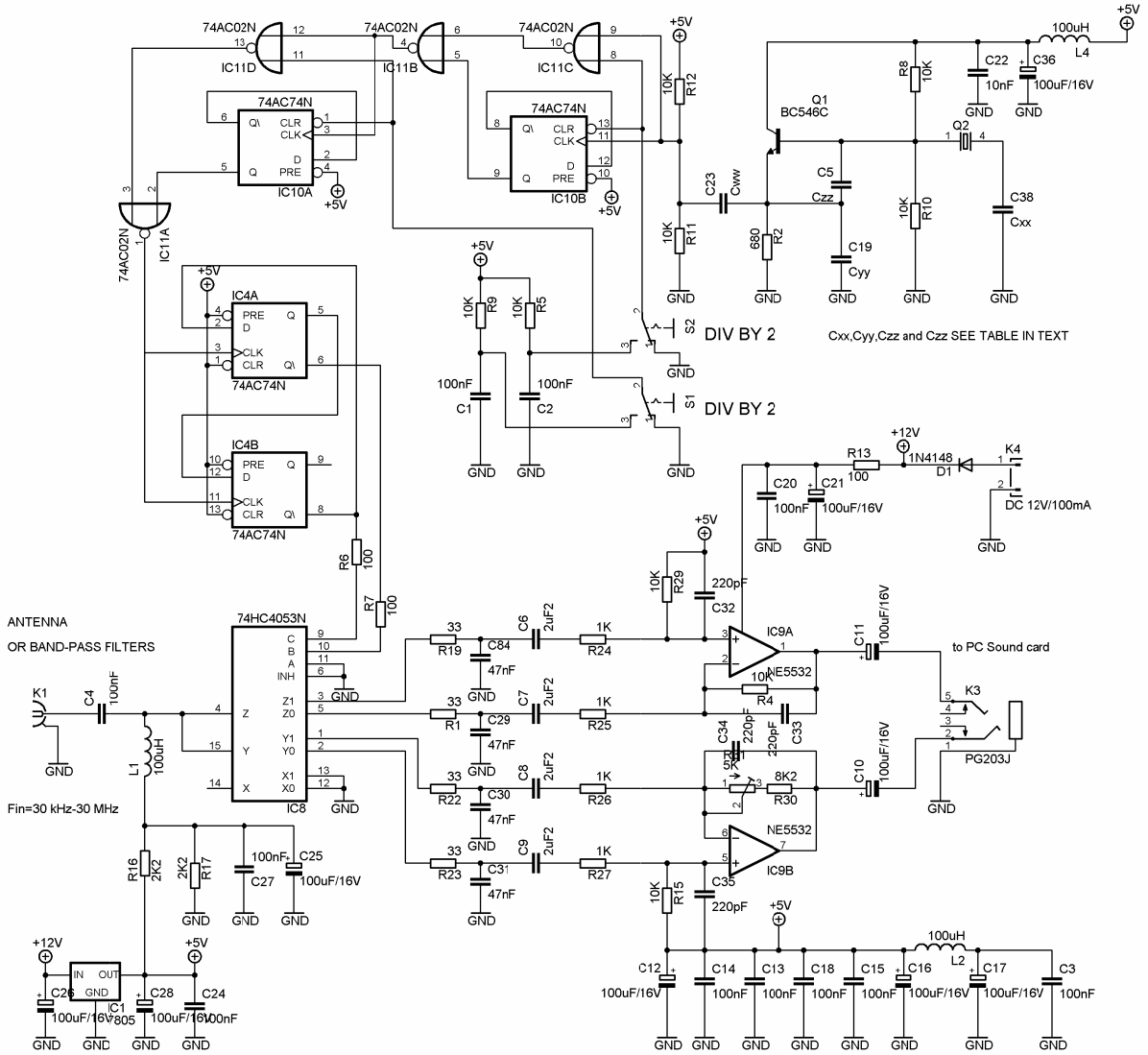


DR3X part placement for external local oscillator connection to 140 MHz with Vcc=+6V and 74AC74

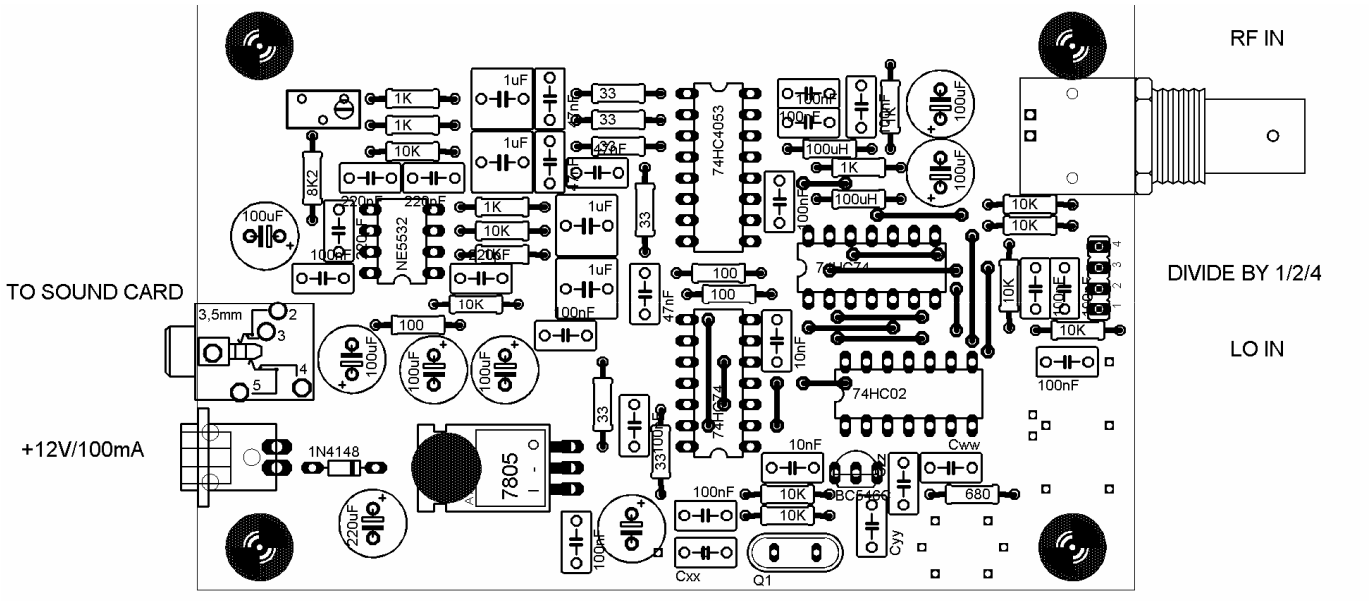


HF I/Q SDR Receiver DR3X - YU1LM/QRP

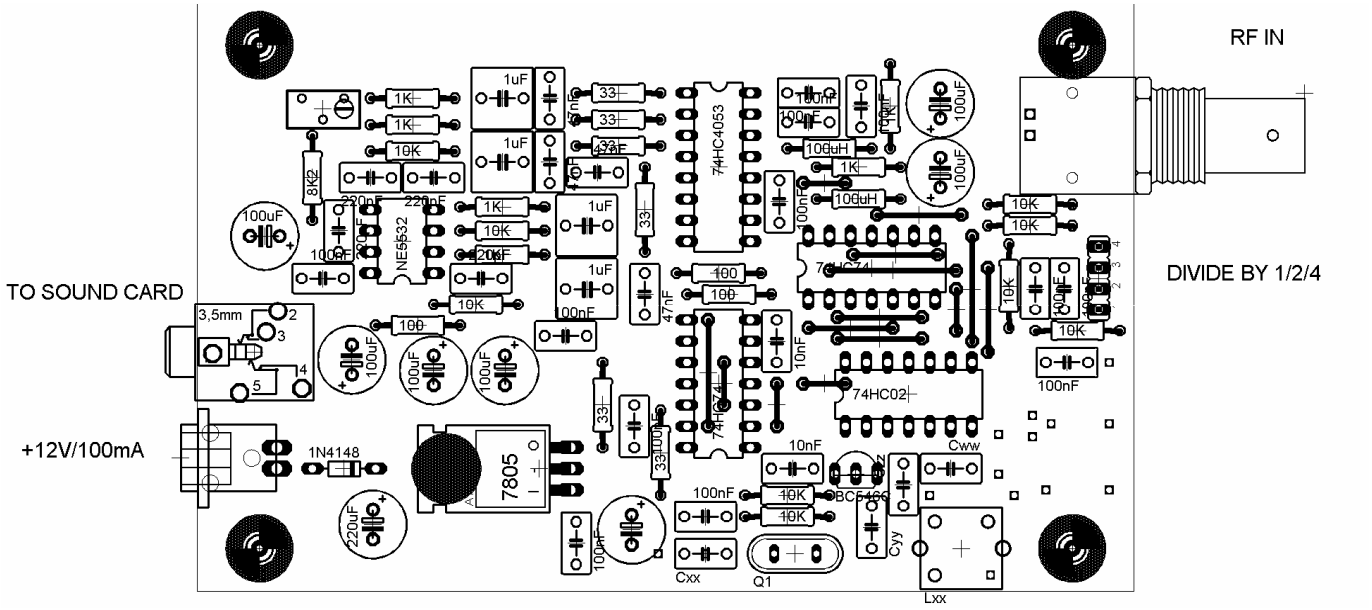
30 kHz-30MHz



CONNECTION FOR FUNDAMENTAL OSCILLATOR MODE TO 30 MHz



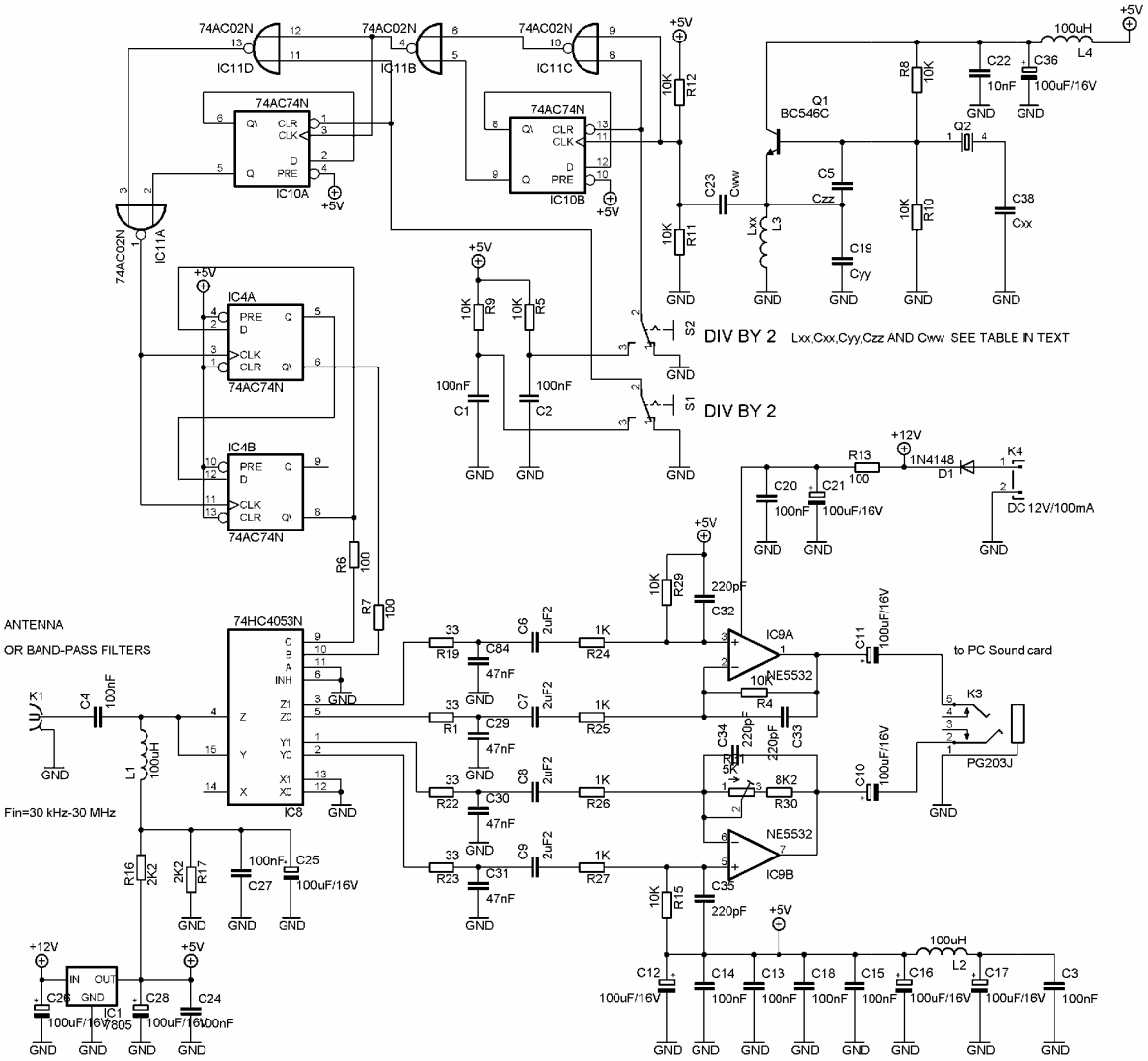
DR3X parts placement for fundamental mode oscillator to 30 MHz



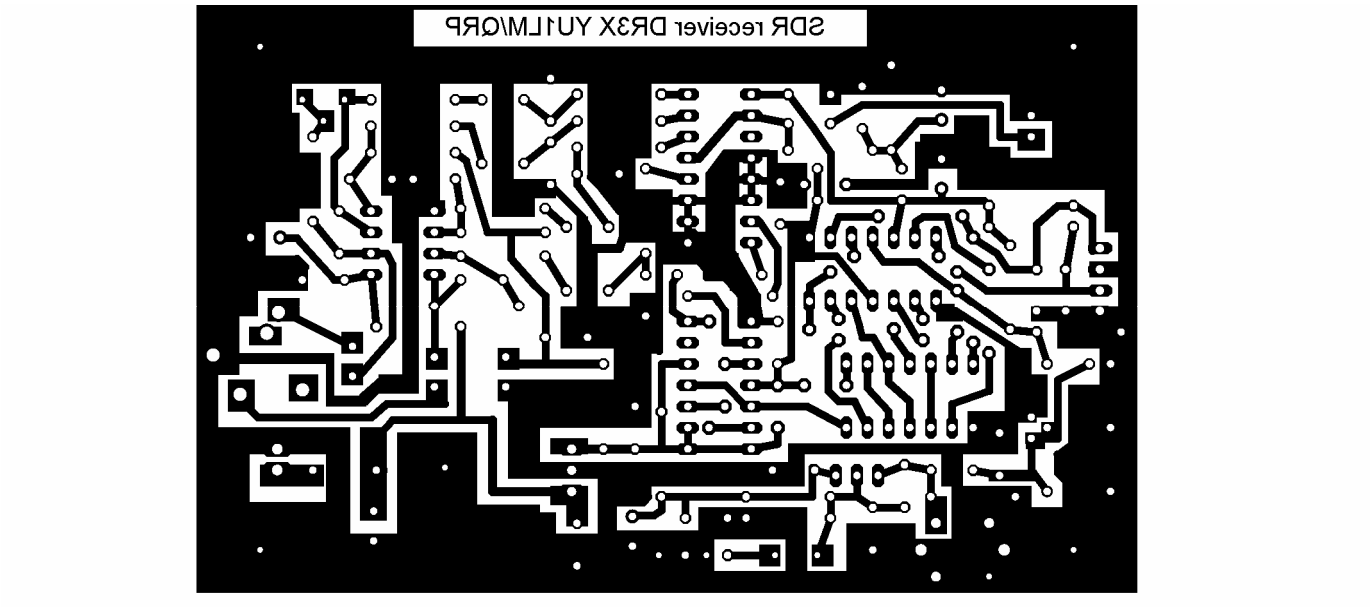
DR3X parts placement for overtone mode oscillator to 110 MHz with 74AC74

HF I/Q SDR Receiver DR3X - YU1LM/QRP

30 kHz-30MHz



CONNECTION FOR OVERTONE OSCILLATOR MODE



Single side PCB size is 112.5 x 70 mm

Measuring results which I made with HF S/H SDR receiver DR3X

1. Receiving range from 30 kHz to 35 MHz (with Q unit oscillator it is limited to the 30 MHz). With one XTAL 56.1 MHz it is possible to receive +/- 20 kHz around next frequencies 14.025 MHz, 7.0125 MHz and 3.507 MHz Bands are harmonically related. Max receiving frequency is achiving with external LO and Vcc=+6 V for digital ICs.
2. IIP3 27-29 dBm and it depends from setting and used programs (all with 16 bit sound cards).
3. MDS -102-105 dBm also with 16 bit SB card Realtek AC97
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 DR3X to lower F (noise figure) of receiver.
6. 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.

Some excellent performances with 3-5 IC are not without other side:

1. First and very big disadvantage is 4 times higher LO
2. Image rejection is changing through receiving bands and results are done for frequencies 12 kHz from central frequency
3. Harmonically bands are not always good choice. For example if we are using very frequent computer quarz 14.312 MHz we can receive +/- 20 kHz around 3.578 MHz,

1.789 MHz and 894.5 kHz middle frequency only touch beginning 160 m band and last one is out of any amateur bands.

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)!!!Simple test that 74HC4053 is working is to measure with DMM(dugital multimeter) Vcc/2 or 2.5 V +/-0.5 V at control pins 9 or 10. If it is not true we have a problem with input LO level or input ICs 74AC74 or 74AC02.

DR3X adjustments are simple and done in two steps:

1. Adjust with universal instruments DMM (digital multimeter) 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 from signal generator to the input of DR3X and with 5 kOhm potentiometer adjust min unwanted image signal in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exist function such as skew in Alberto I2PHD programs.

I wish you successful DR3X 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
tasa@imtel-mikrotalasi.co.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/

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*
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*