HAM Sample and Hold SDR (Software Defined Radio) Modulator/Transmitter for DSB, SSB, CW, AM, FM, DRM.. On HF (30 kHz to 70 MHz) in Connection With PC Sound Card or Other Audio Source– Make it Simple as Possible –Part 2

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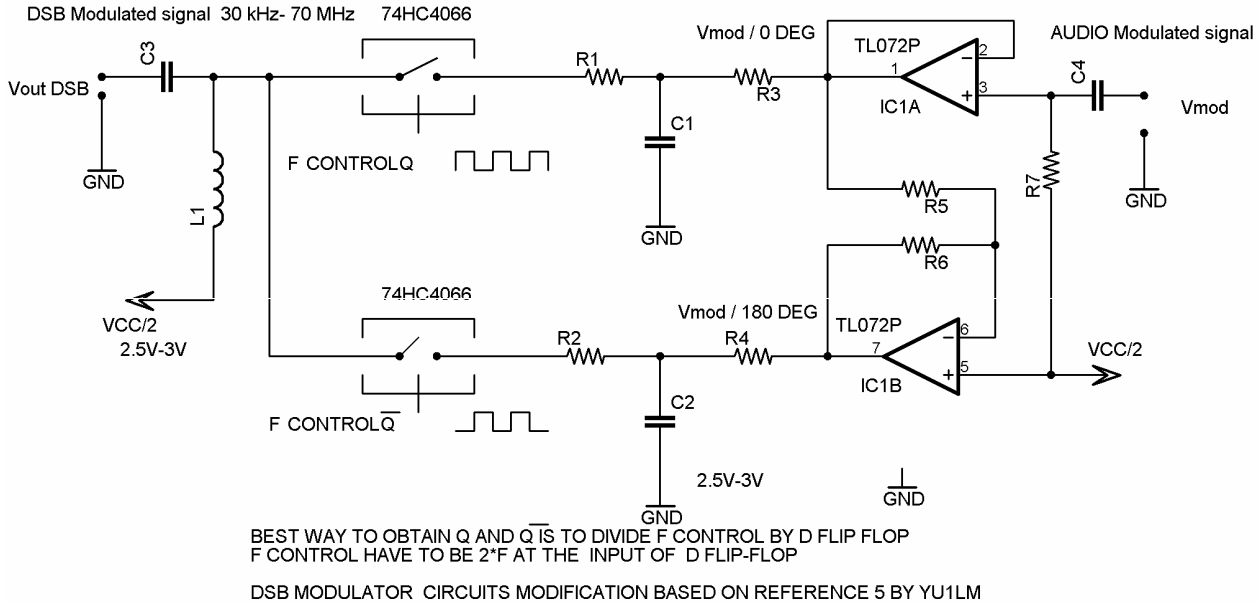
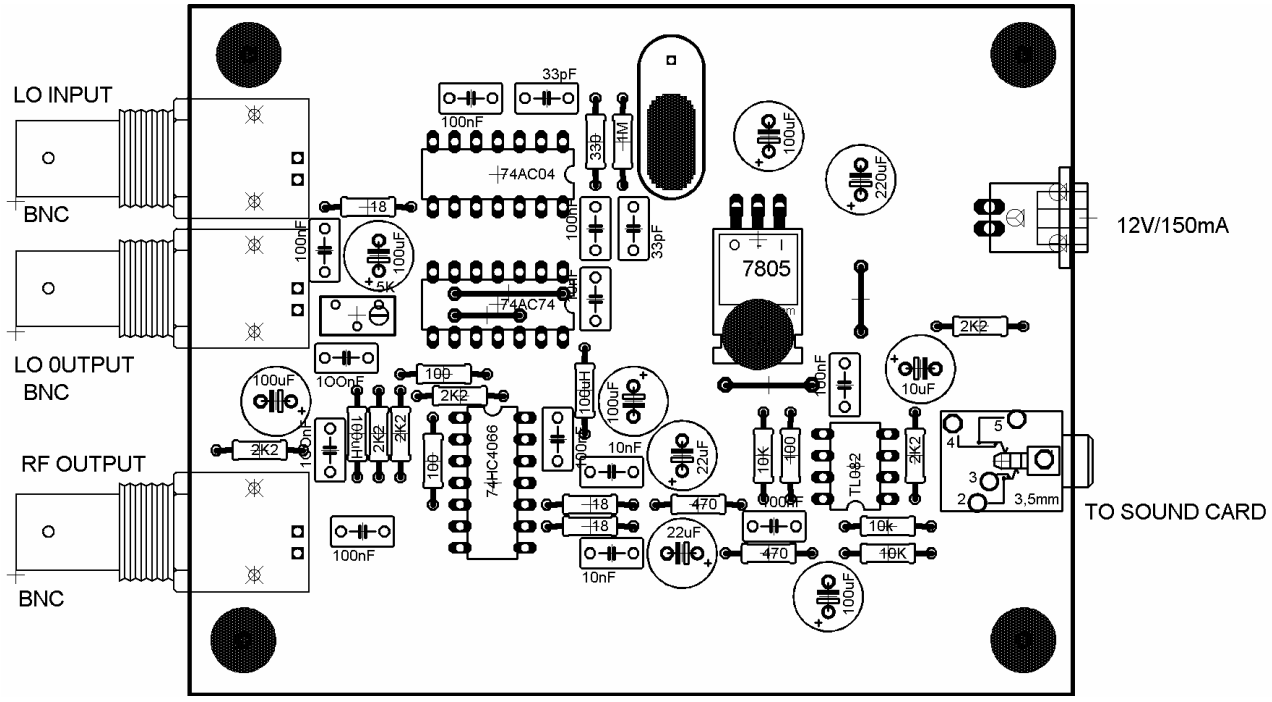
First I made SDR receivers DR1 and DR2 after that I tried to make transmission part of SDR radio. First attempt I made was like as it is done in original Gerald AC5OG SDR1000 article (reference 2). I made it with 74HC4052 1-4 MUX multiplexer but I was disappointed with final results as I explained in receiver's part1. Modulator worked well to maximum 10 MHz but constant degradations performances as frequency increased. During the measurements and testing SDR receivers DR1 and DR2 I connected RX inputs to the AS (spectrum analyzer). All harmonics was suppressed very much including carrier frequency. It is as I explained in first part it is great advantage in driving switches with 50/50 % duty ratio from D FF outputs. I rearranged SDR S/H sample and hold demodulator according to reference 5 by U. Rohde to transmission/modulation see below:

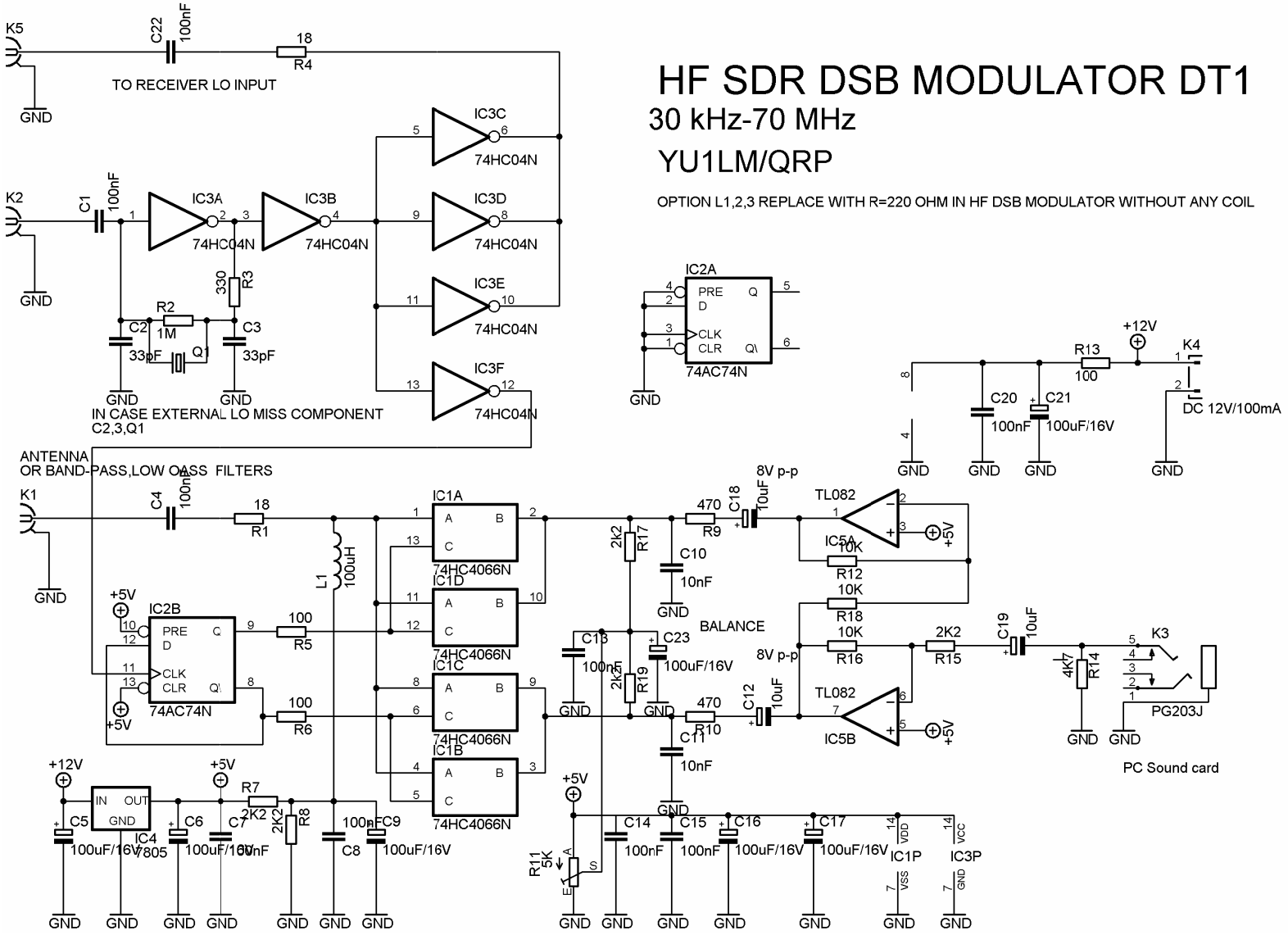


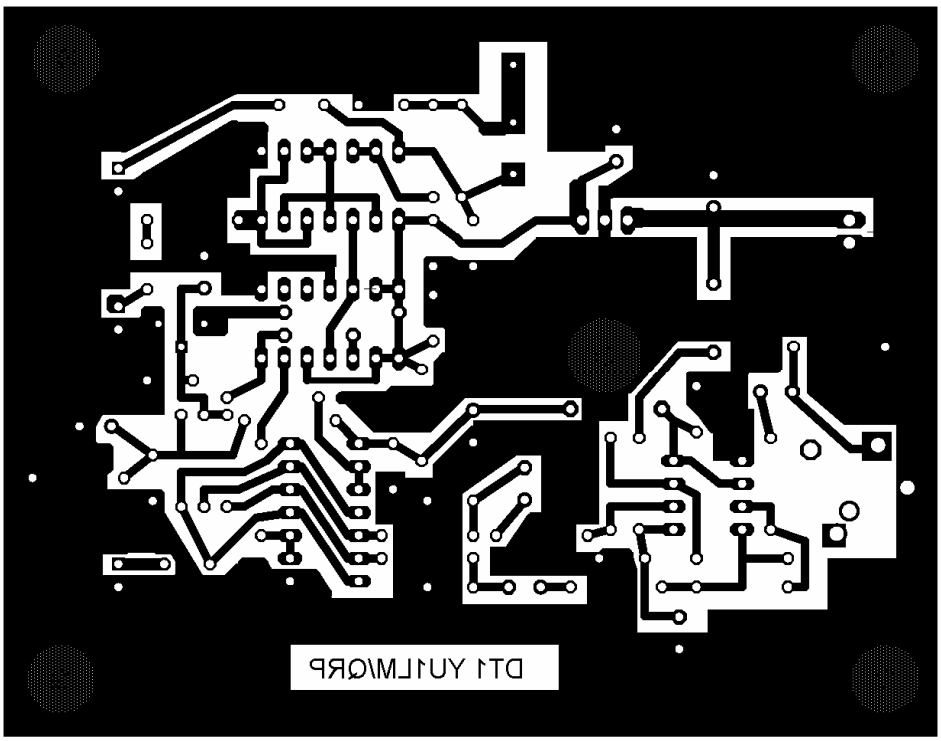
Practical measurements results from DT1 DSB modulator based on upper schematics are:

1. Frequency range from 30 kHz – 70 MHz

2. Carrier suppression without adjustment 35- 42 dB (carrier level outputs from Q and Q complement is 15-17 dBm at 50 Ohms) absolutely carrier level at output was -27 dBm. With careful adjustment with R potentiometer I achieved 55 dB and more carrier suppression and results are not changing so much through the entire frequency range 30 kHz – 70 MHz. Output spectrum is very clear harmonic frequencies are down around 45-50 dB compared to the output DSB level. Output spectrum is very easy cleaning with simple LP (low pass) filter or better with BP (band pass). See some possible solution for BP in the other articles on site or in some other references.
3. Input modulation frequency range is from near 0 Hz to about 40 kHz limited with 10nF. It is possible to increase modulation frequency and made modulator to work as double balanced mixer. I am using similar arrangement in HF front end to the 70 MHz..
4. Output level from DT1 is max to +2-+3 dBm at 50 Ohms with IMD better than -40-50 dB what's mean that it have very good modulation linearity. This result is really very good ,or better I can say excellent. Compare these figures with other commonly used IC DSB modulators like SA612. LM1496….Vcc/2 voltage is necessary to increase linearity. Without it VCC/2 we limit upper useful frequency and we are increasing higher order IMD 5, 7, 9..That is evident in the output spectrum very much .Unwanted products are growing very quickly with increasing output level other way. There isn't so big effect to the linearity of fundamental frequency before it arrives to the 1dB compression point.
5. DT1 adjustment is very easy. Connect AS (spectrum analyzer) or receiver and without modulated AF signal adjust with potentiometer min. That is all!!
6. Disadvantage is that we need to have twice (2 times) higher LO frequency.




HF SDR DSB MODULATOR DT1
30 kHz-70 MHz
YU1LM/QRP
OPTION L1,2,3 REPLACE WITH R=220 OHM IN HF DSB MODULATOR WITHOUT ANY COIL
K5
C22 100nF
18
R4
TO RECEIVER LO INPUT
GND
K2
C1 100nF
IC3A
IC3B
74HC04N
IC3C
IC3D
IC3E
IC3F
330
R3
R2
1M
C2
33pF
Q1
C3
33pF
IN CASE EXTERNAL LO MISS COMPONENT
C2,3,Q1
IC2A
PRE
D
CLK
CLR
Q
Q\
74AC74N
+12V
R13
100
K4
DC 12V/100mA
C20
100nF
C21
100uF/16V
ANTENNA
OR BAND-PASS,LOW OASS FILTERS
K1
C4 100nF
18
R1
L1 100uH
IC1A
IC1B
IC1C
IC1D
74HC4066N
+5V
IC2B
74AC74N
100
R5
R6
8V p-p
470
R9
R10
C18 10uF
C12 10uF
TL082
IC5A
IC5B
10K
R12
R18
R16
2K2
R15
C19 10uF
BALANCE
C10 10nF
C11 10nF
2K2
R17
2K2
R19
C13 100nF
C23 100uF/16V
4K7
R14
K3
PG203J
PC Sound card
+12V
IC4
7805
IN
OUT
GND
C5 100uF/16V
C6 100uF/16V
C7 100nF
R7 2K2
R8 2K2
C8 100nF
C9 100uF/16V
R11 5K
C14 100nF
C15 100nF
C16 100uF/16V
C17 100uF/16V
IC1P
IC3P
VDD
VCC
VSS

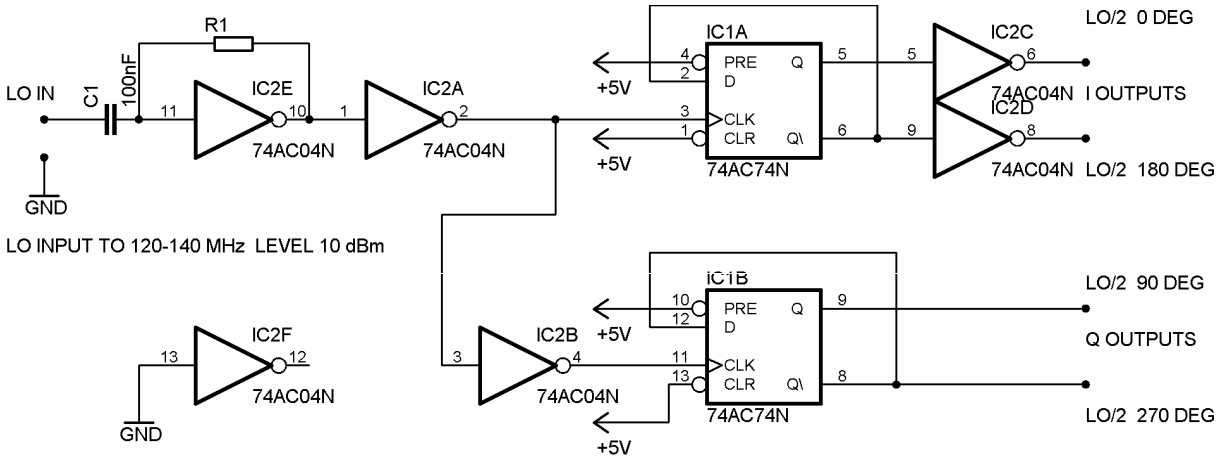


DT1 low power transmitter PCB is single side board dimension are 104 x 80 mm

DT2 is low power transmitter SSB/CW….or some other modulation which is possible make with I/Q barnches.Output level is around 0 dBm with adding simple LP or BP filters and linear amplifier it is very easy to achieve higher output levels QRP 0.5W-5W or higher with very clean output spectrum. I tried to obtain, from few HAMs who are owners of nice sophisticate RIG SDR1000 designed by Gerald AC5OG, how interface board looks like in SDR1000. My initial idea was to make hardware for SDR transceiver compatible in RT/TX command with software for SDR1000. I didn't receive any positive answer because of that I didn't realized SDR transceiver yet. I hope that it will be possible in future with new data. I had some schematics and PCBs design at papers but still not realized. Measurements results with DT2 are very similar to the DT1 except few new data:

1. Unwanted side band suppression is vicinity 30-50 dB. I used very nice program from DL6IAK, see software reference 7, for adjustment and measurements. **All measurements and results in text for SDR radio are related to the carrier suppression at 12 kHz from carrier frequency** this data is valid for both receivers and transmitters PCBs. Carrier suppression is not the same through output audio demodulated frequency band and input modulated band in modulator. It is necessary to have very good RF match between switches inside 74HC4066 (this depend from IC manufactory and frequency) and built in component in audio chain. Because of that I made improved version receivers and transmitter. New SMT components like PIV…FST...CBT with lower Rds-ON enable better match because of that their influence to the unbalance, with adequate design, is small.

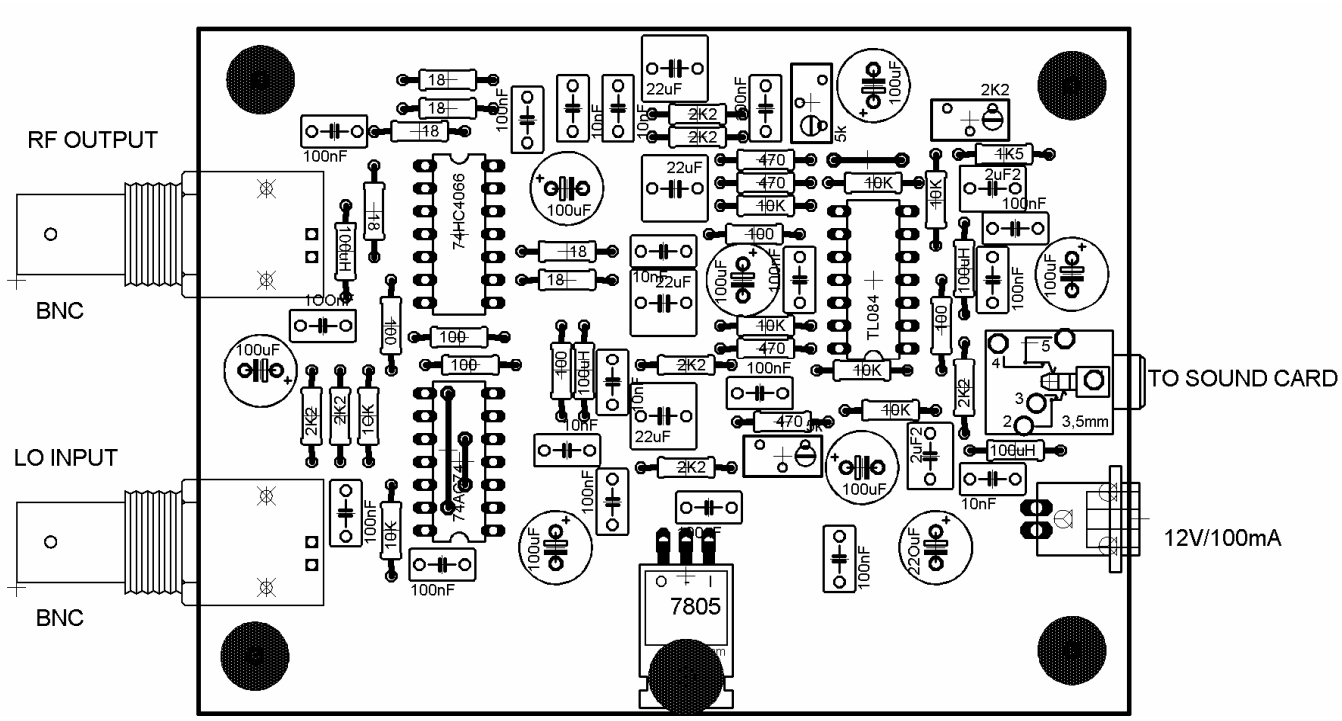
2. Frequency range is from very low 30 KHz to the 30-35 MHz and it is limited with built in components. I have schematics below which enable that we can use only twice (2) higher frequency for LO .If LO input frequency is higher than 10 MHz it is necessary to make compensation phase between D FF outputs. At input frequency 60 MHz differences between I Q outputs are around 2-6 DEG Delay in invertors is 3-5 nsec and also it is important IC slew rate at different frequencies this mean that is not possible easy hardware compensate delay. The phase compensation depend mainly from used 74HC4066 components and PCB layout also this difference or error is very easy compensating in the most softwares but not in the all. Results are not changing in same HAM bands and difference has fixed amount.

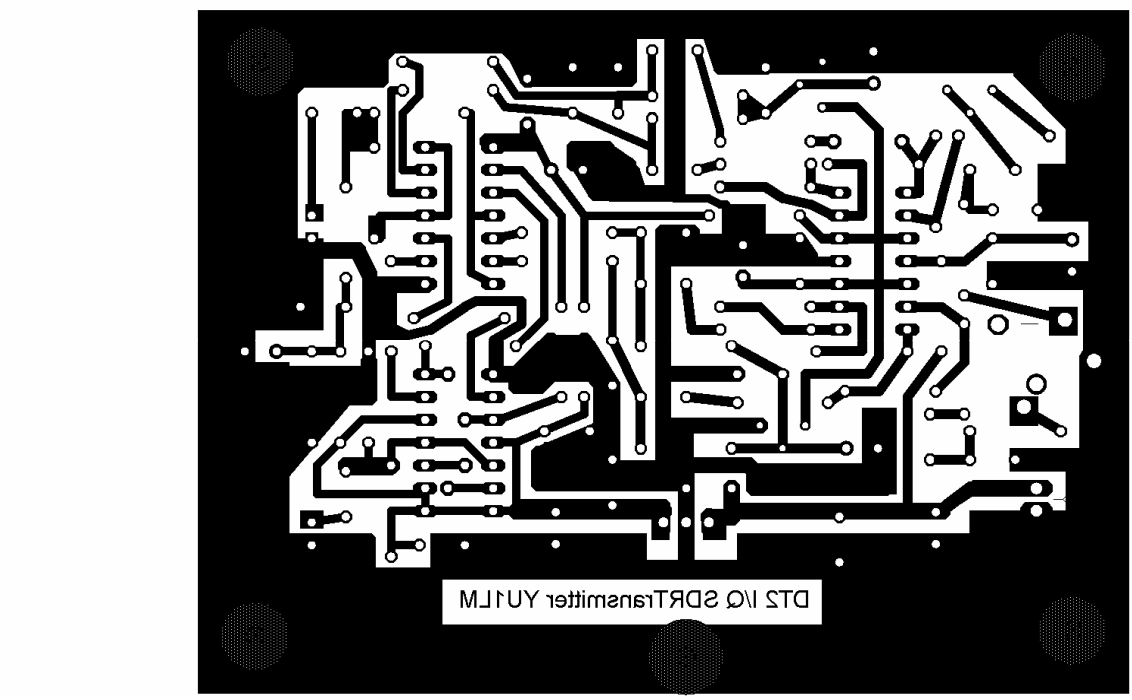


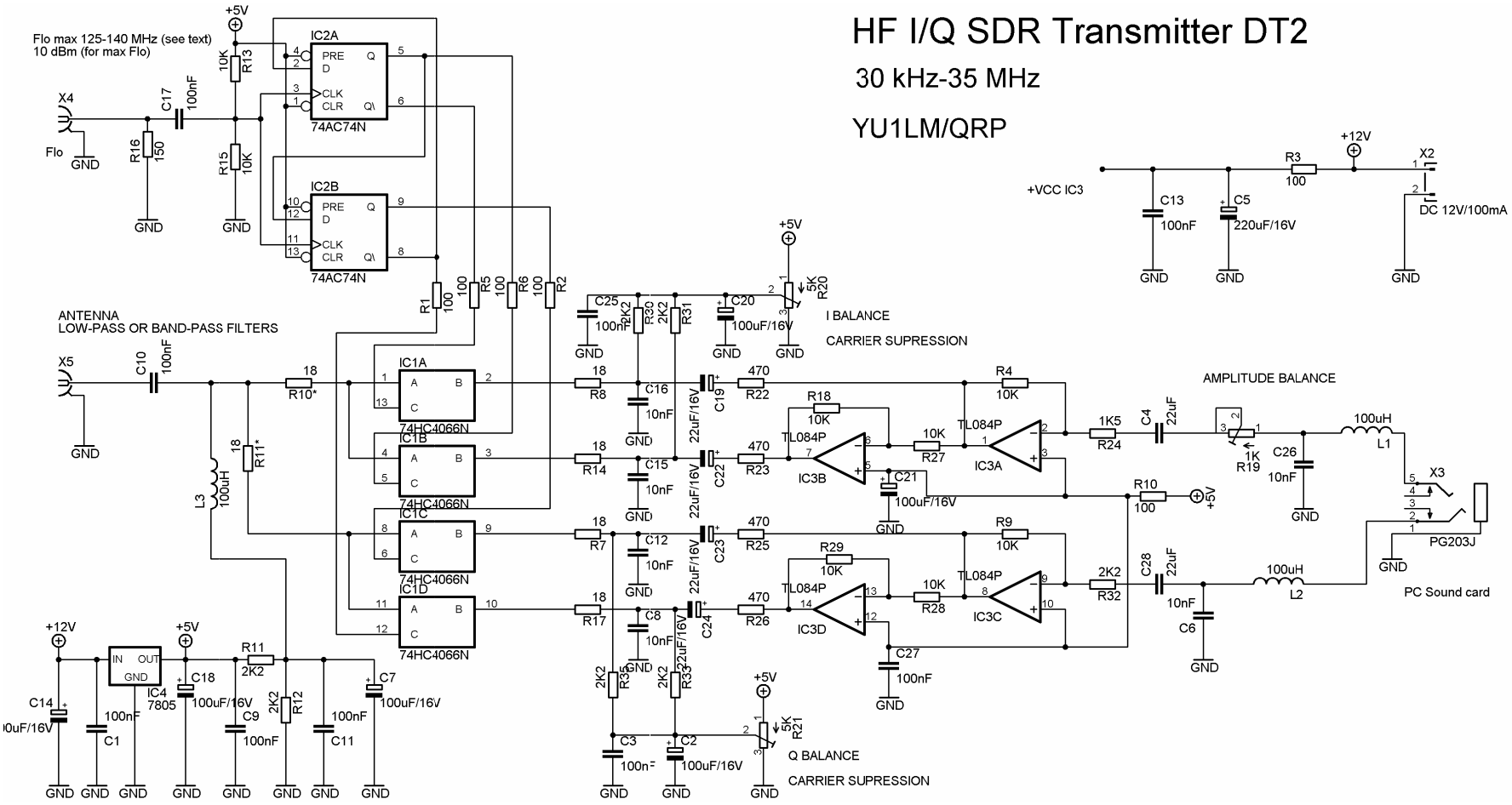
ALTERNATIVE WAY TO OBTAIN I AND Q BRANCHES FOR SDR TRANSMITTER by YU1LM/QRP

3. DT2 adjustment is very easy and it has a 2 steps. First step: connect AS (spectrum analyzer) or receiver and without modulated AF signal adjust with one 5K potentiometer in I branch min and the same procedure with second 5K potentiometer in Q. This procedure is iterative process and it has to be repeat few times to obtain min. After that connect audio modulation signal 12 kHz (best program is from DL6IAK) I and Q branches and with 2K2 potentiometer adjust about 6 Vp-p at the output of OPAMP and max rejection opposite side band at AS or receiver. Optimum frequency for adjustment is close to the end of working frequency for HF it is 26- 27 MHz. That is all!!
4. Disadvantage DT2 is 4 times higher LO frequency and balancing is not the same through the entire input audio bandwidth (20 Hz- 20 kHz)

DT2 is one side PCB and dimensions are 75 x 105 mm






HF I/Q SDR Transmitter DT2
30 kHz-35 MHz
YU1LM/QRP
Flo max 125-140 MHz (see text)
10 dBm (for max Flo)
Flo
ANTENNA
LOW-PASS OR BAND-PASS FILTERS
I BALANCE
CARRIER SUPRESSION
Q BALANCE
CARRIER SUPRESSION
AMPLITUDE BALANCE
+VCC IC3
DC 12V/100mA
PG203J
PC Sound card
74AC74N
74HC4066N
TL084P
IC4 7805
GND
+5V
+12V

I shall keep on with improved versions of SDR receivers DR1 and DR2 and transmitter DT2 in part 3 as my proposal for homebrew builders. I wish you successful DT1 and DT2 realization and send me your comments please.

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References:

1. *Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP*
2. *http://www.nitehawk.com/sm5bsz Leif LINARD*
3. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
4. *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

5. *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 0.95*

   *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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5. *http://www.nitehawk.com/sm5bsz Leif LINARD*
6. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
7. ***dl6iak**.ba-karlsruhe.de*