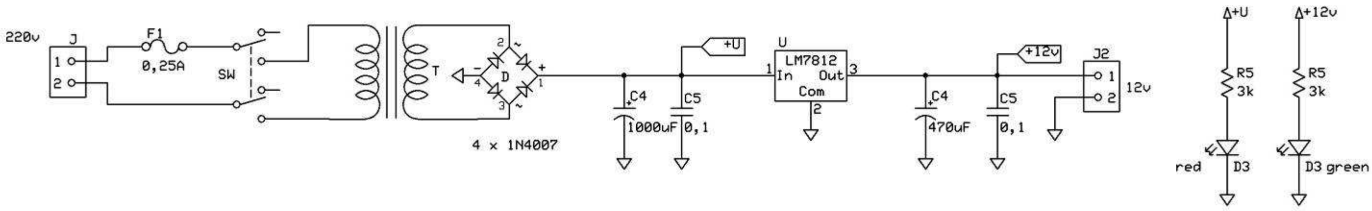
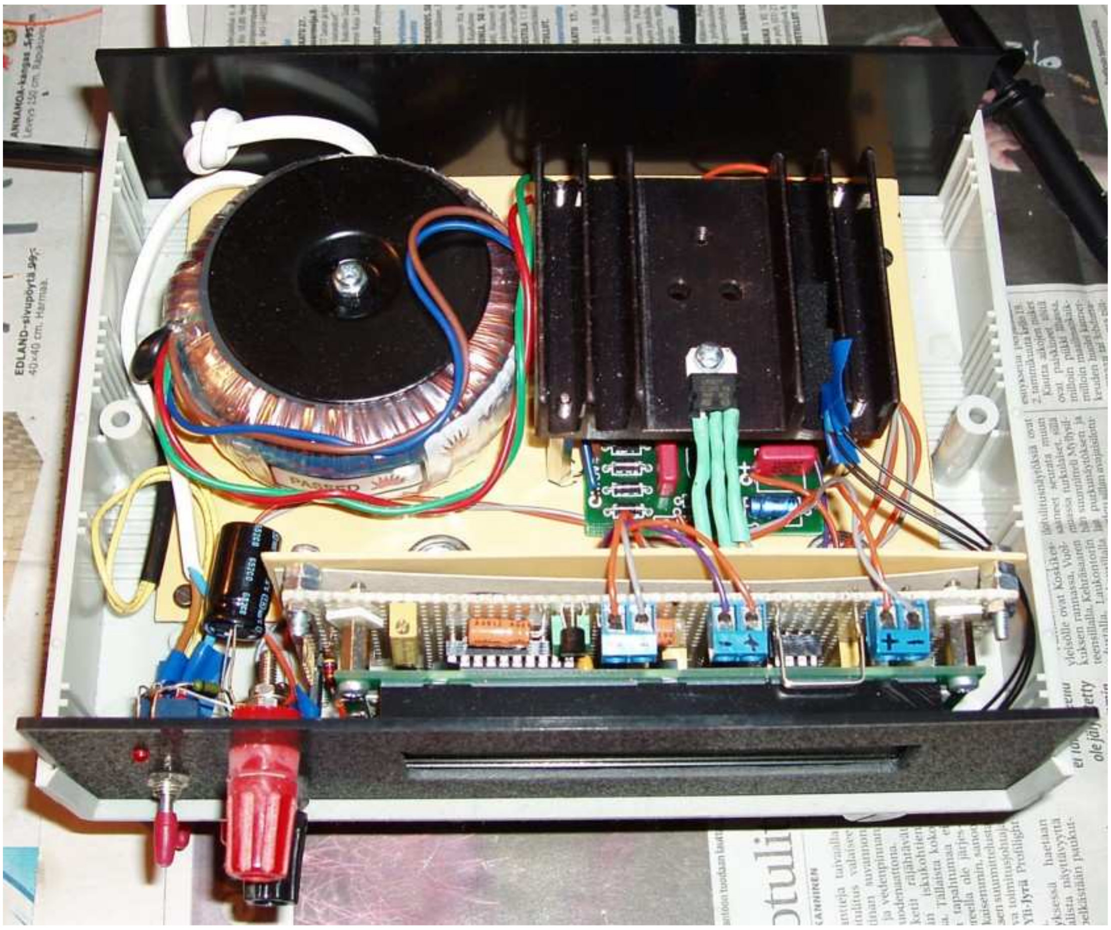
Homebrew Electronics Lab Tools

rev. 1.2
12.05.2012

Contents

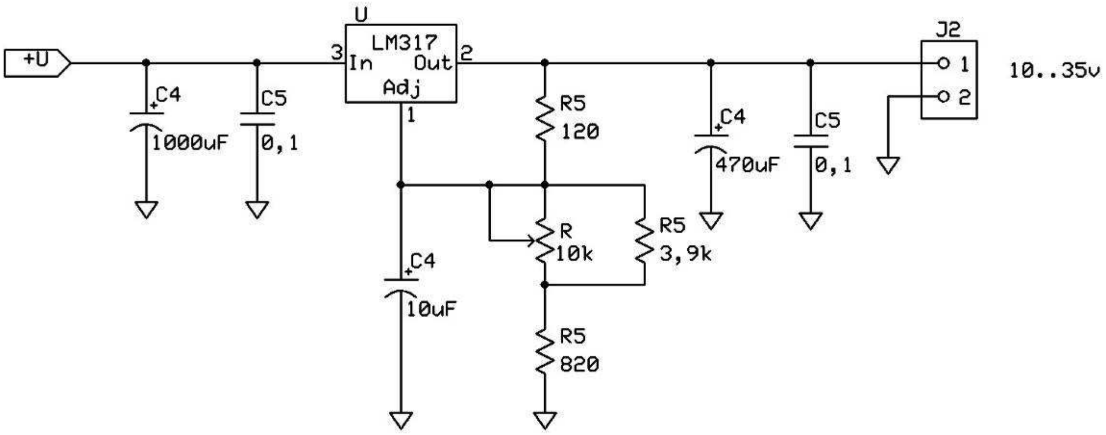
Power supply 12v 1a





pic. 12v PSU and UI indicator

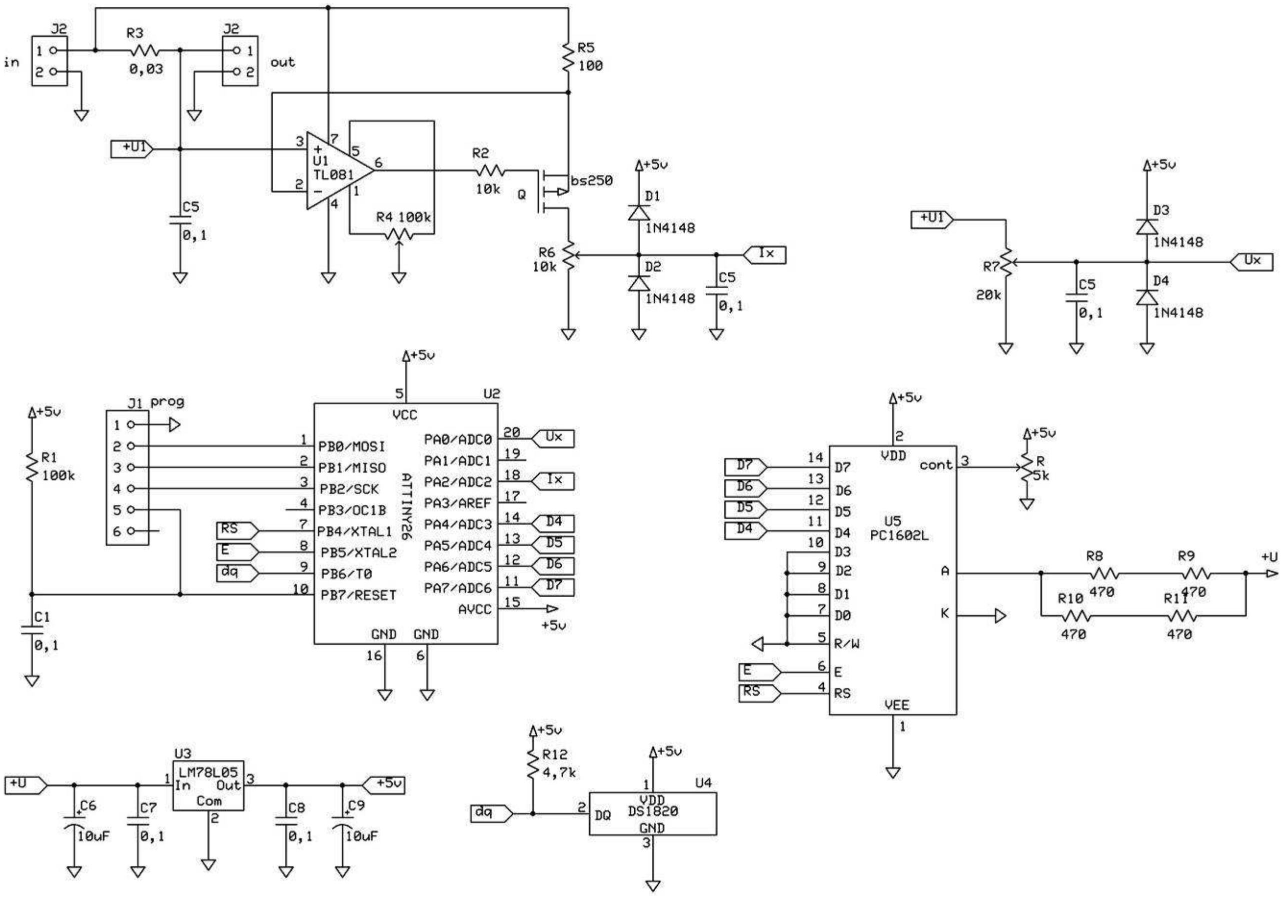
Power supply 8..35v 1a



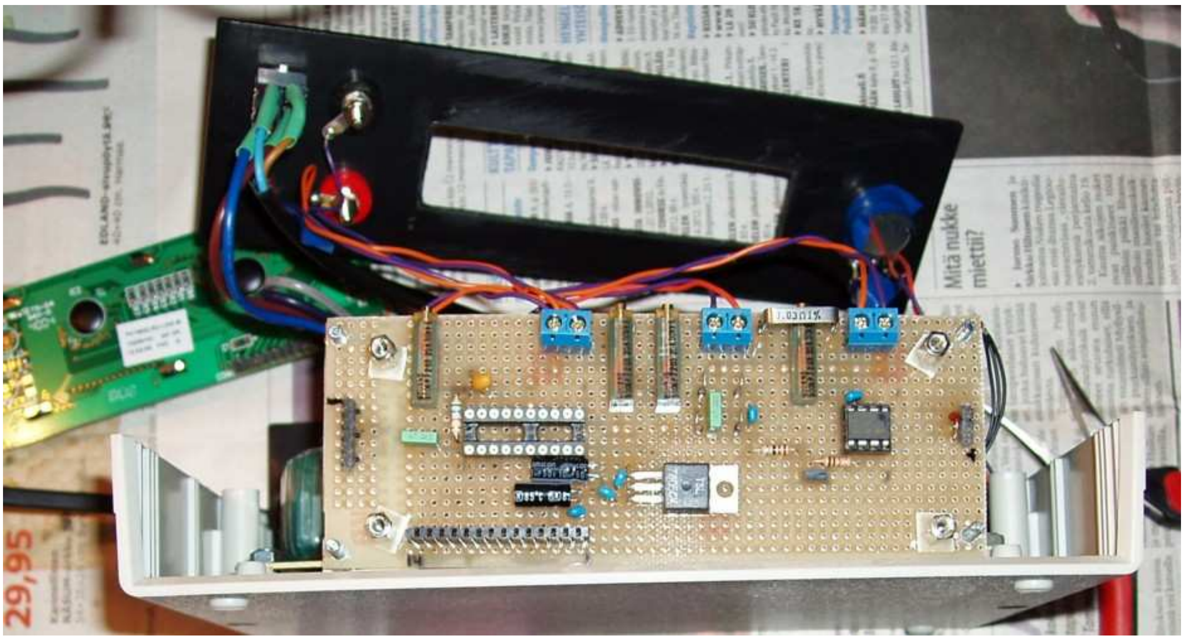
pic. my PSU under construction

UI meter with temperature sensor for power supply

U 0..20v (20mv / div)
I 0..1a (4ma / div)
T 0..85*C (0.5*C / div)



firmware: ui_src.rar (c / winavr)

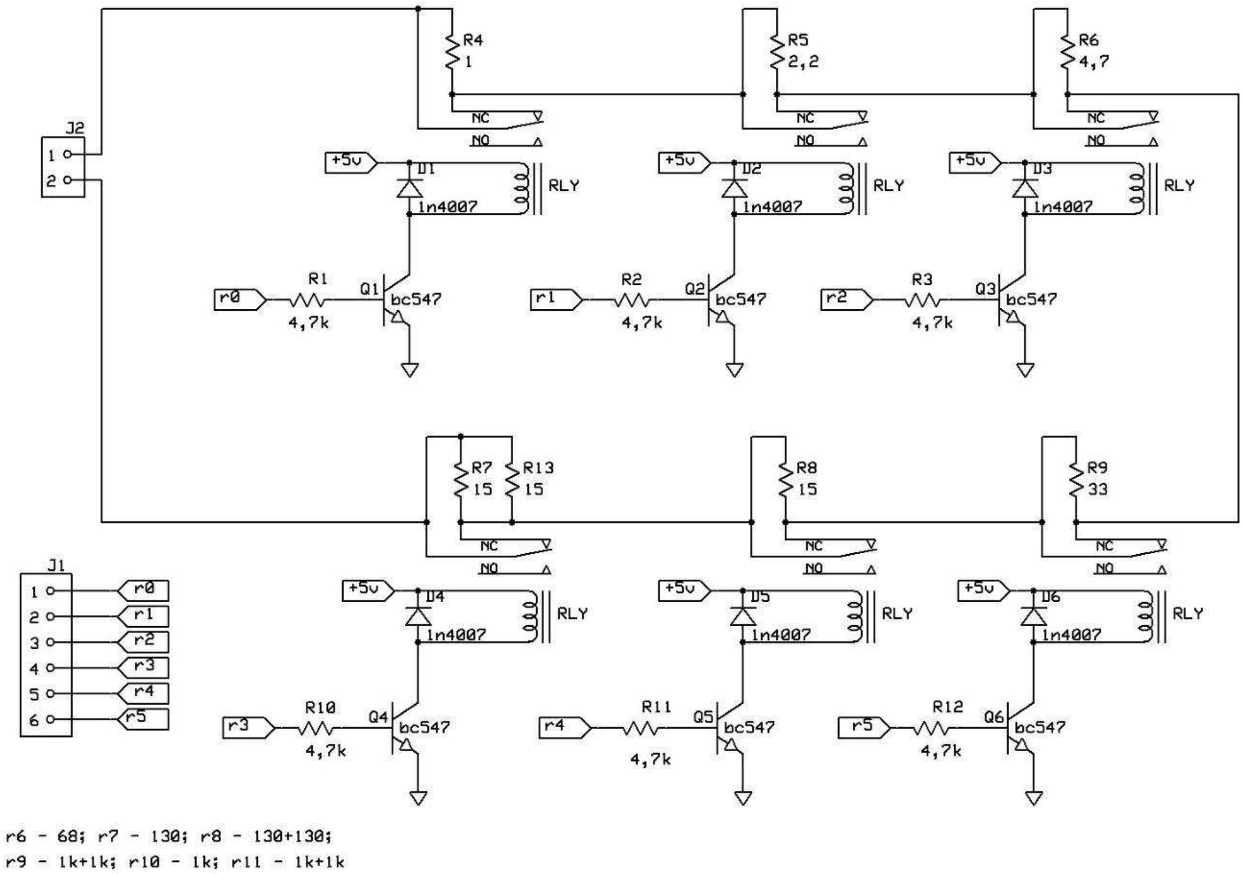


pic. UI meter board in PSU

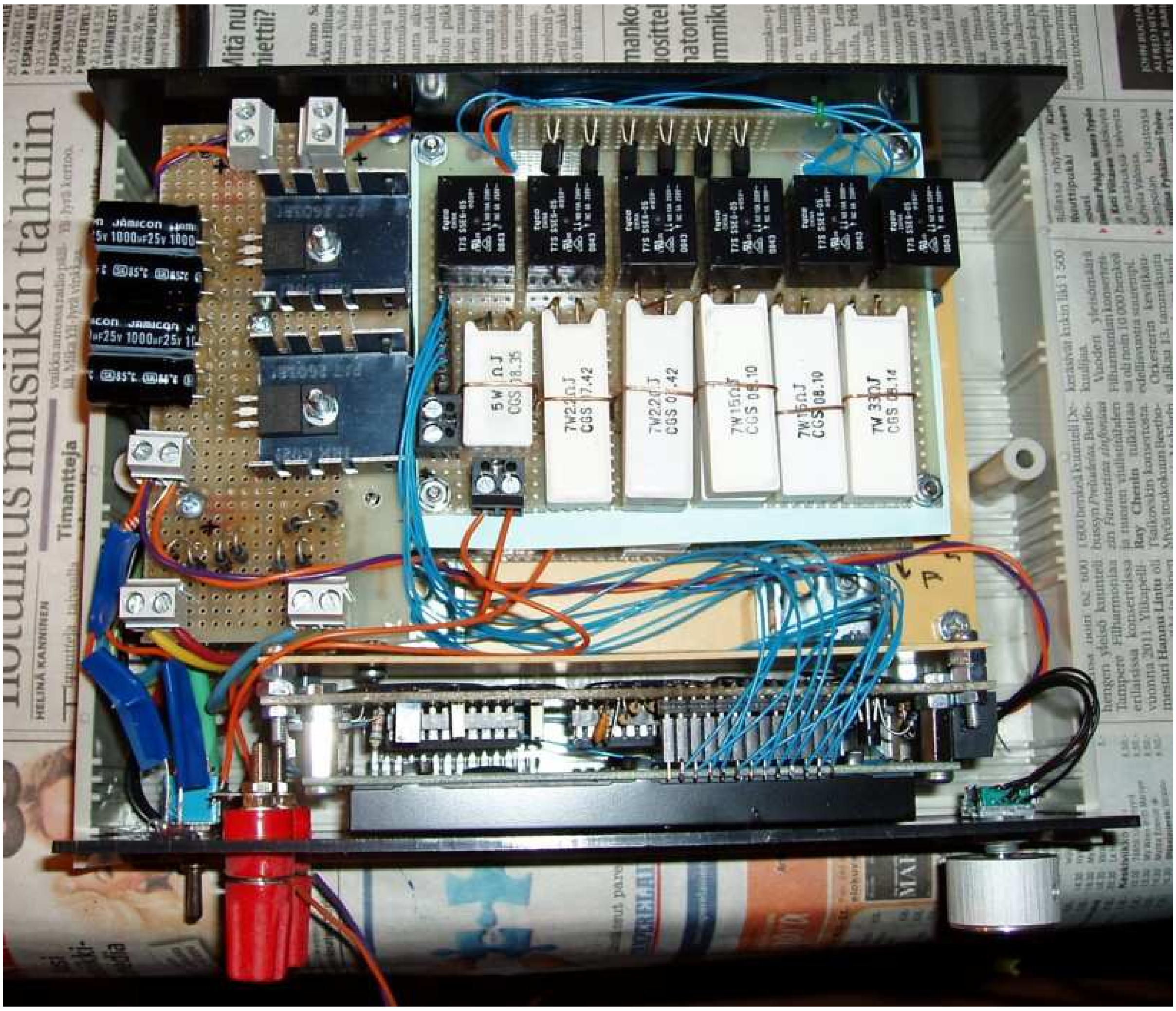
Links:
http://www.elektor.com/magazines/2008/january/versatile-dc-power-meter.367551.lynkx

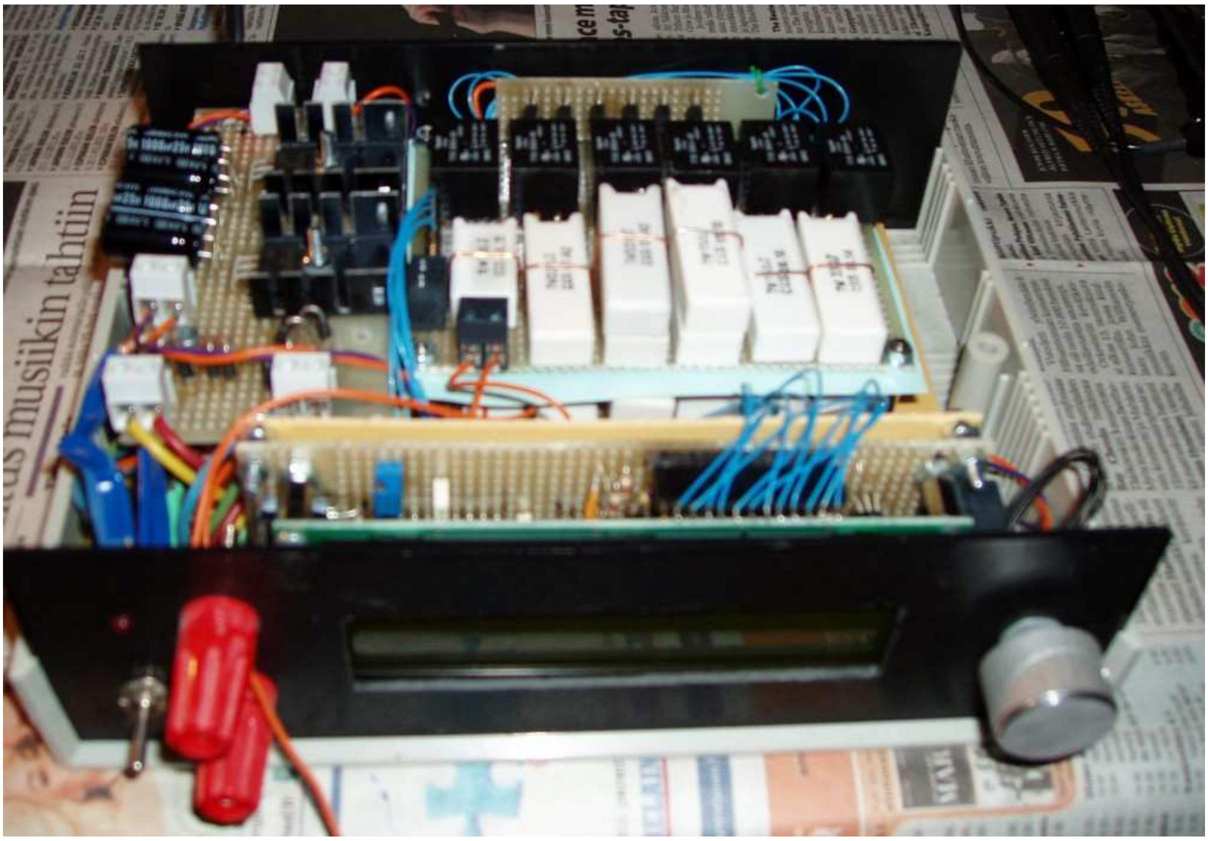
R bank

R 0..4095 ohm (1 ohm / div)

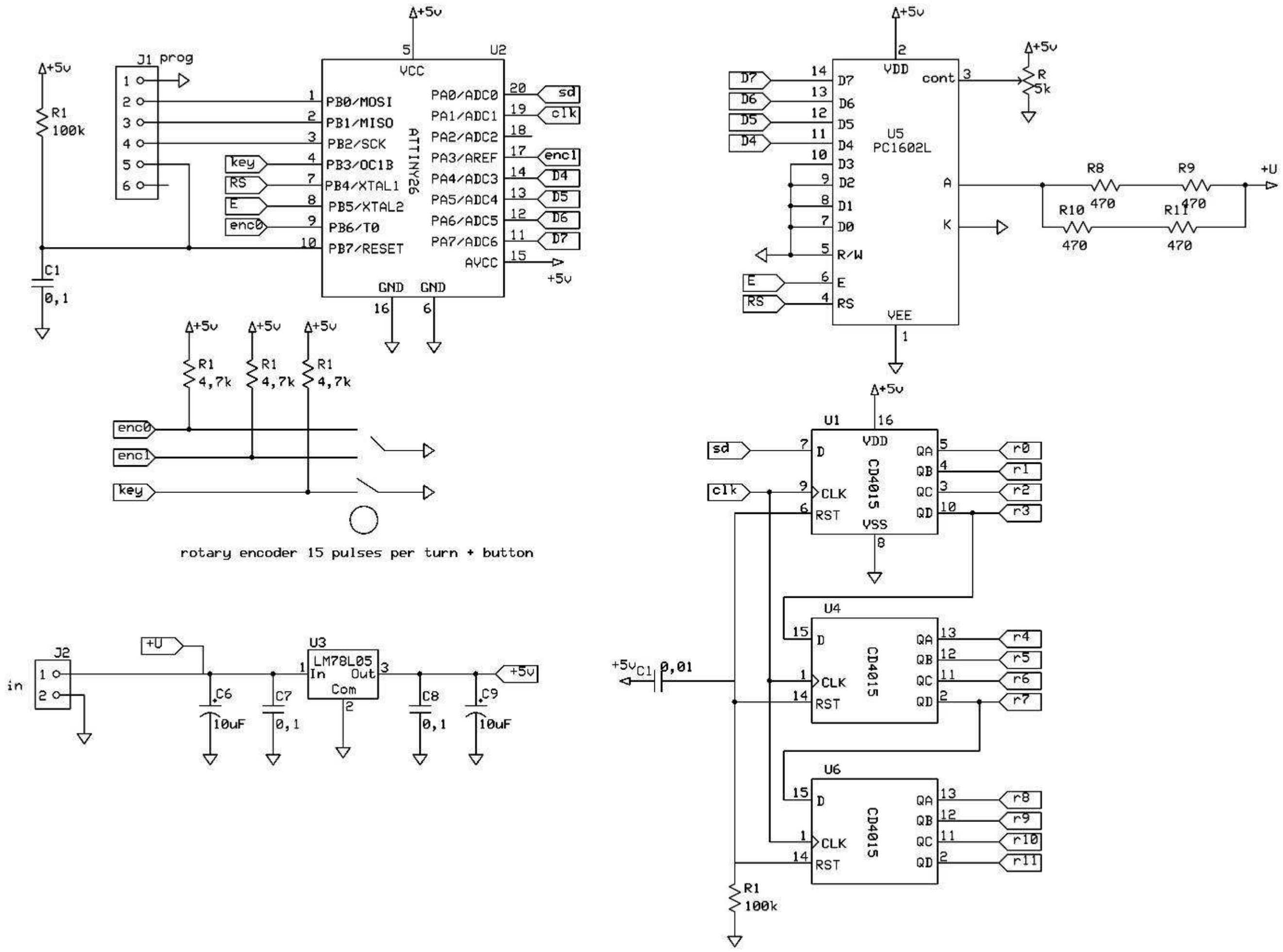


pic. 2 boards, 6 relays each





pic. R bank

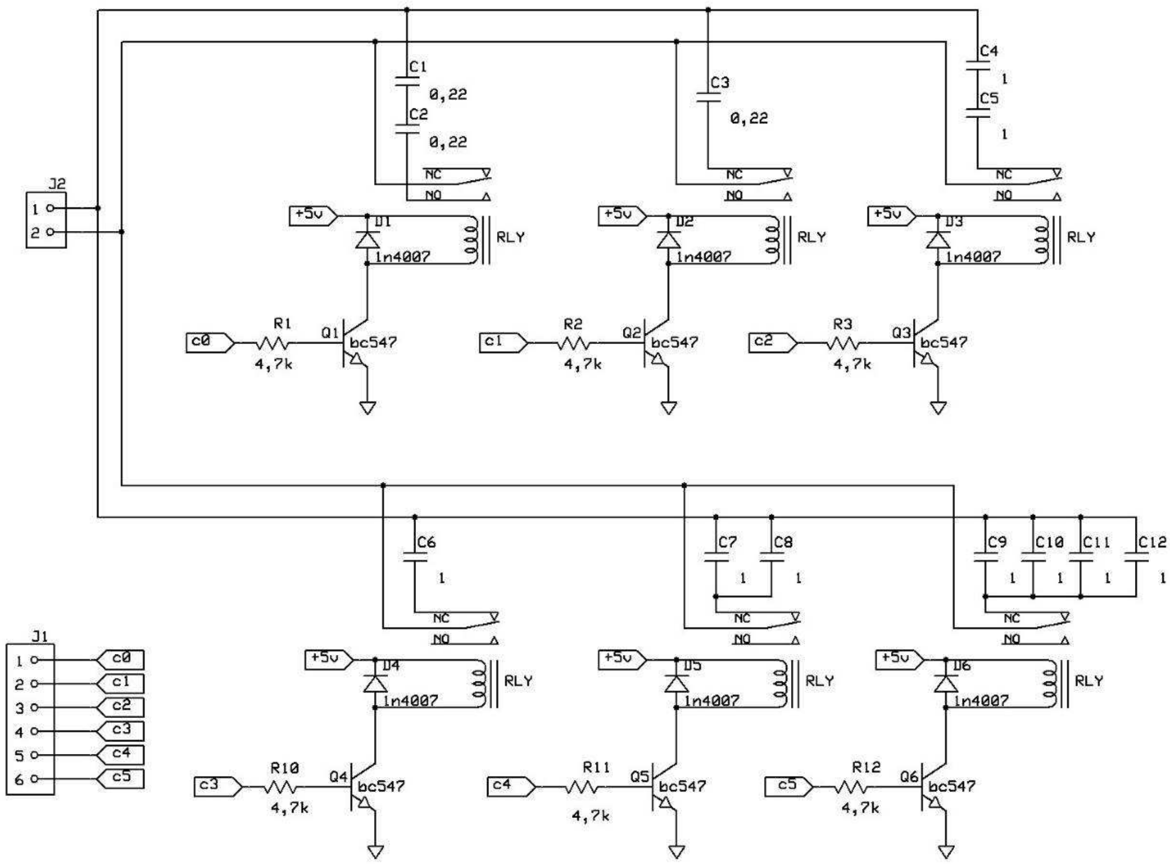


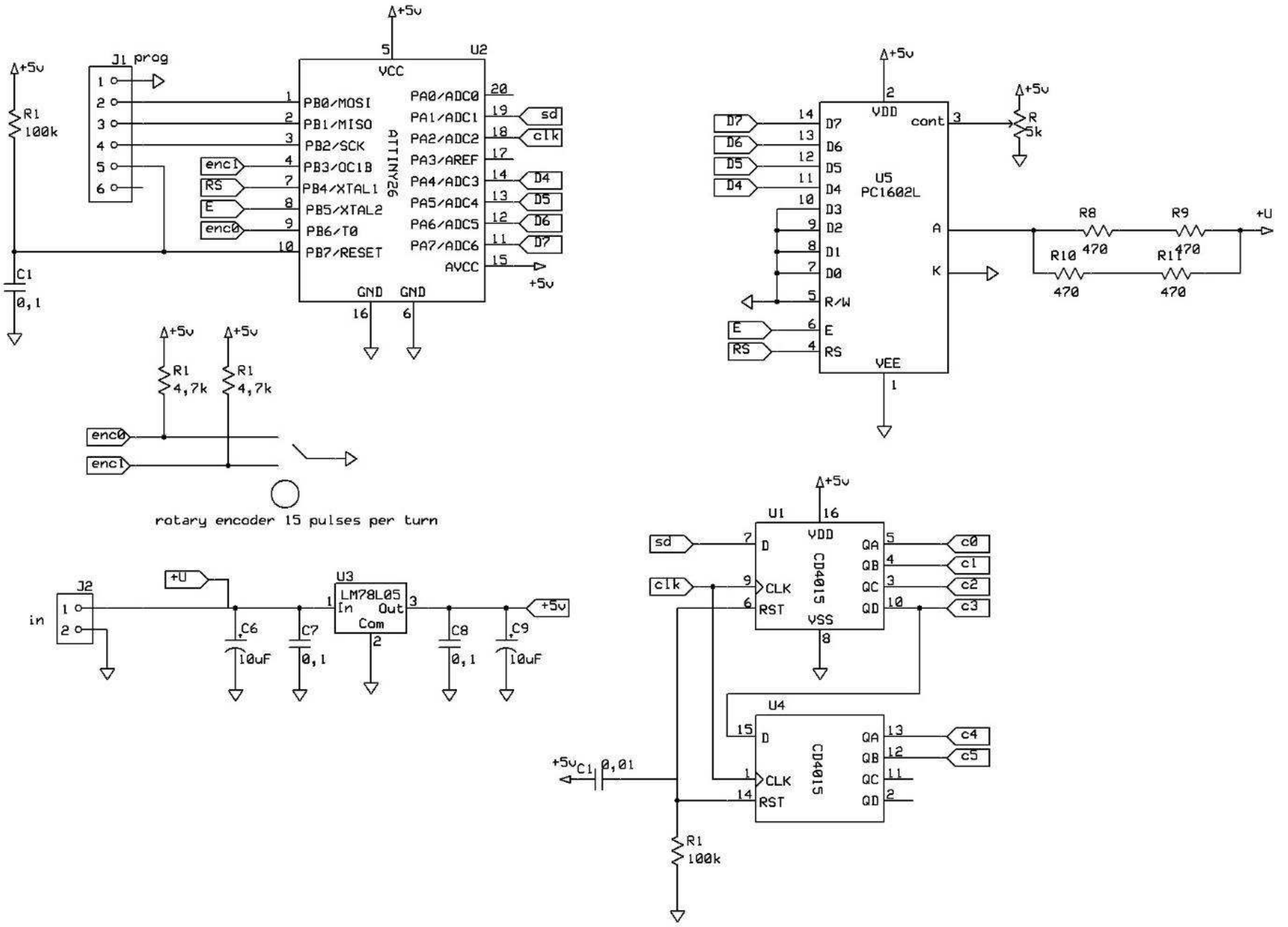
pic. MCU board

firmware: r_bank_src.rar (c / winavr)

C bank

C 0.125 .. 7.5 uF (0.125 uF / div)



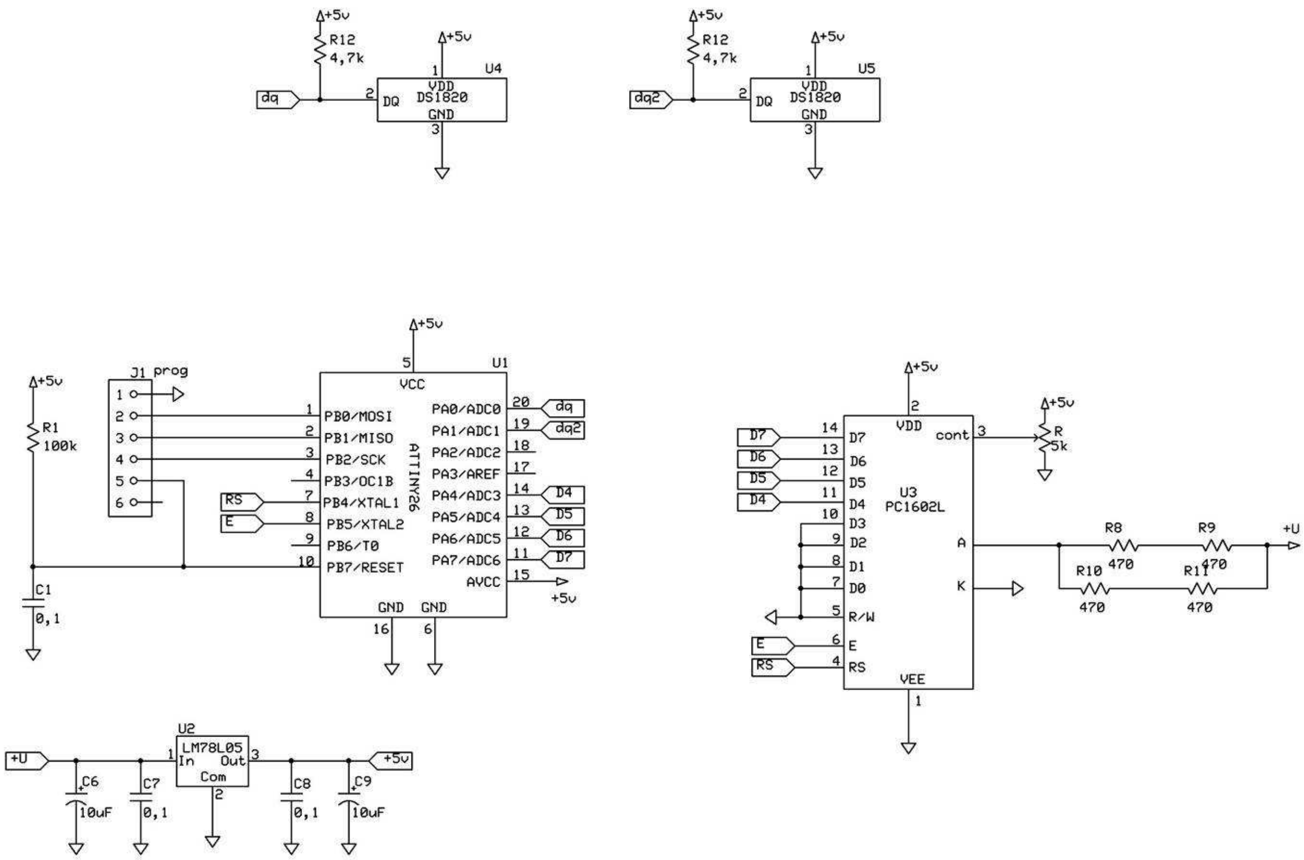


firmware: c_bank_src.rar (c / winavr)

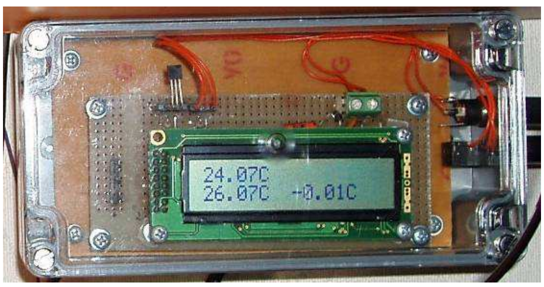
Dual temperature sensor

T 0..85*C (0.1*C / dic)

based on ds1820s



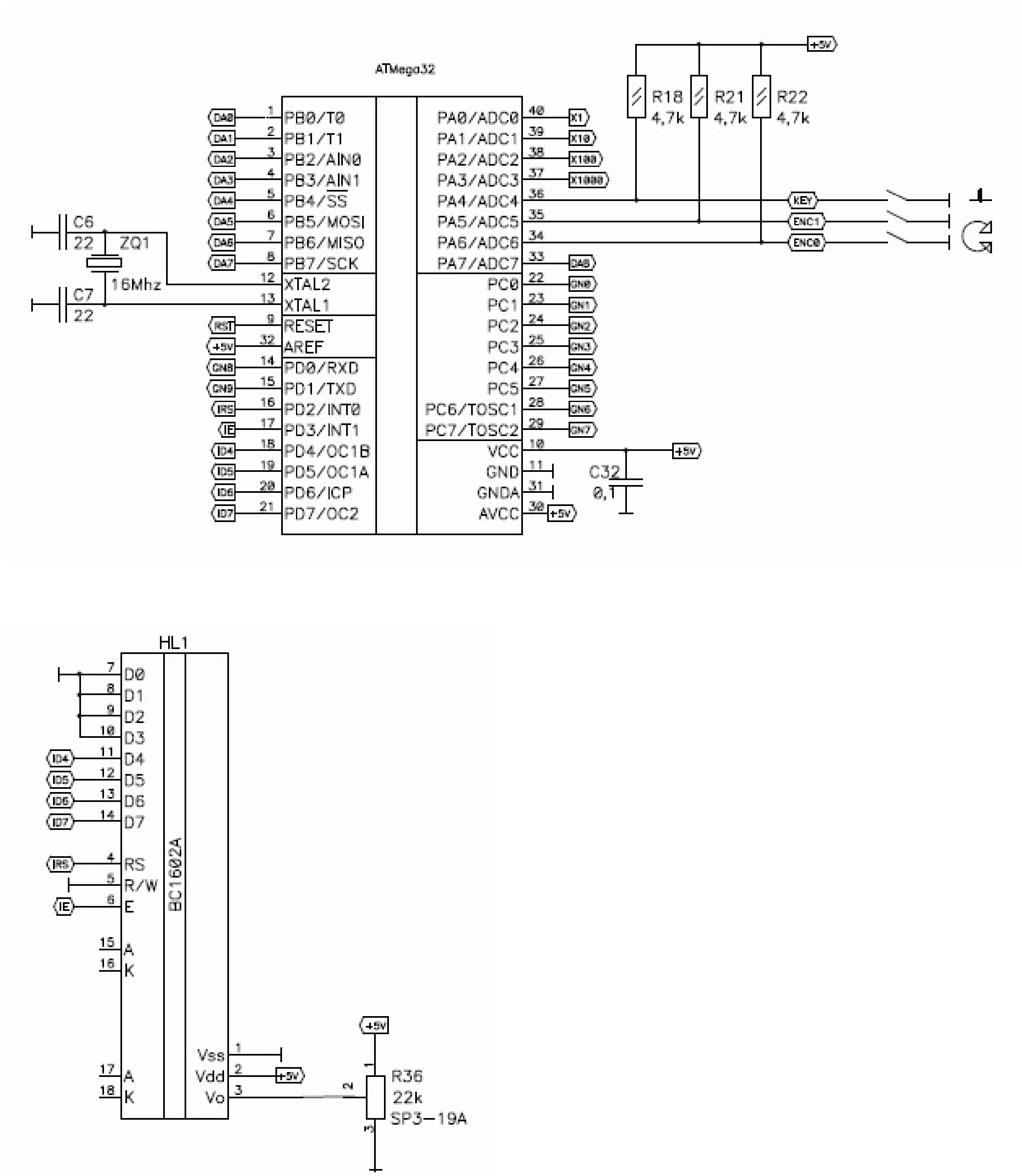
firmware: temp_src.rar (c / iar c avr)



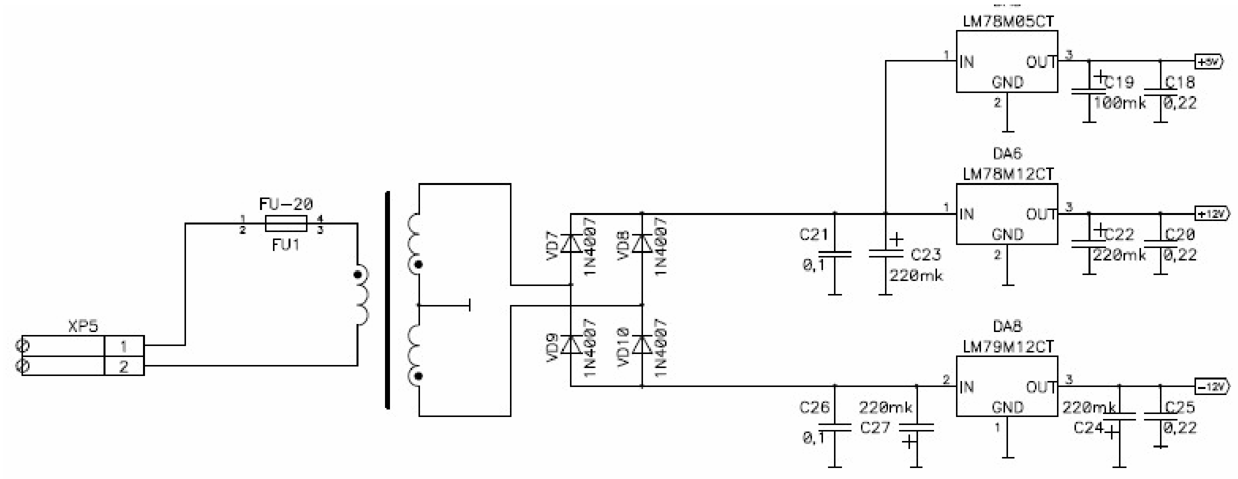
pic. dual temperature sensor in velleman box

Sin DDS

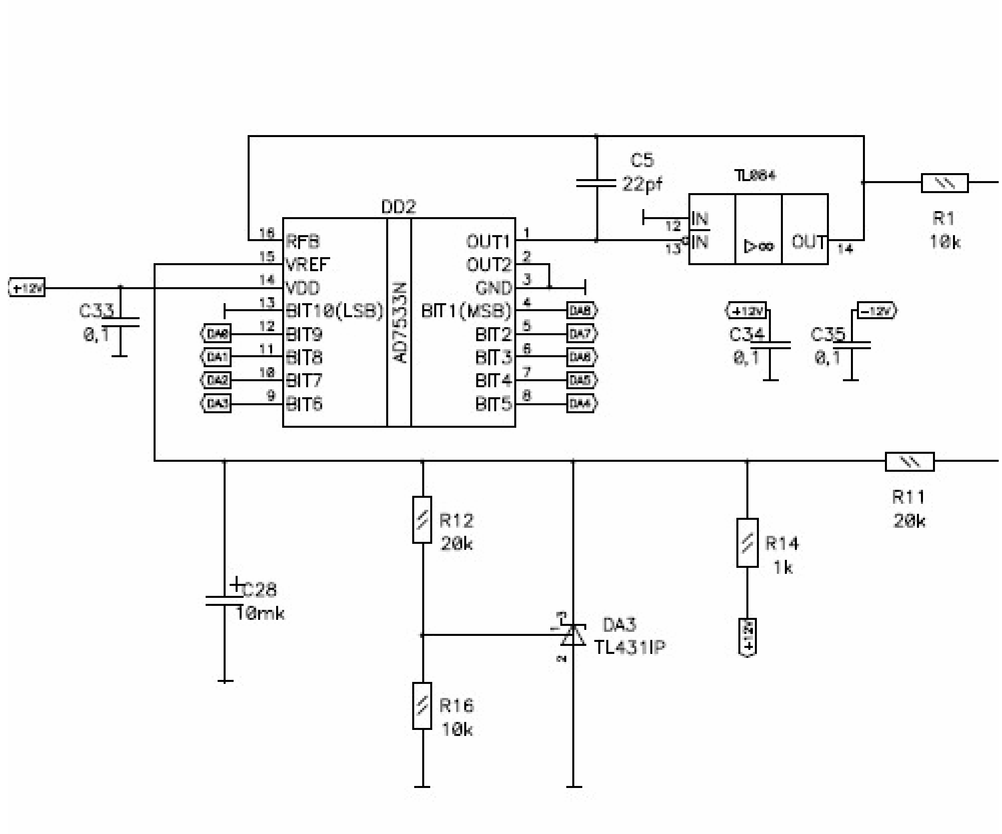
F 1…49999Hz (0.1hz/div)
U 0..10v (10mv/div)
attenuator 0 / -20 / -40 / -60dB



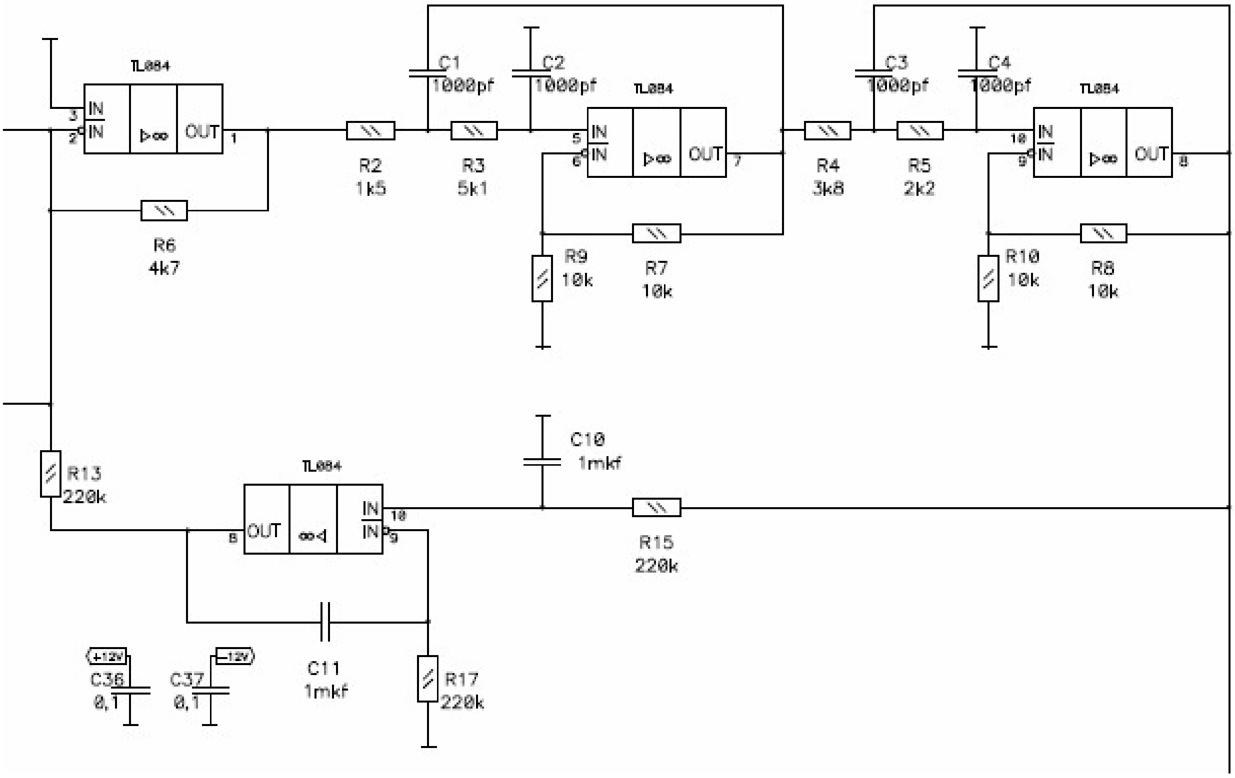
pic. MCU and display



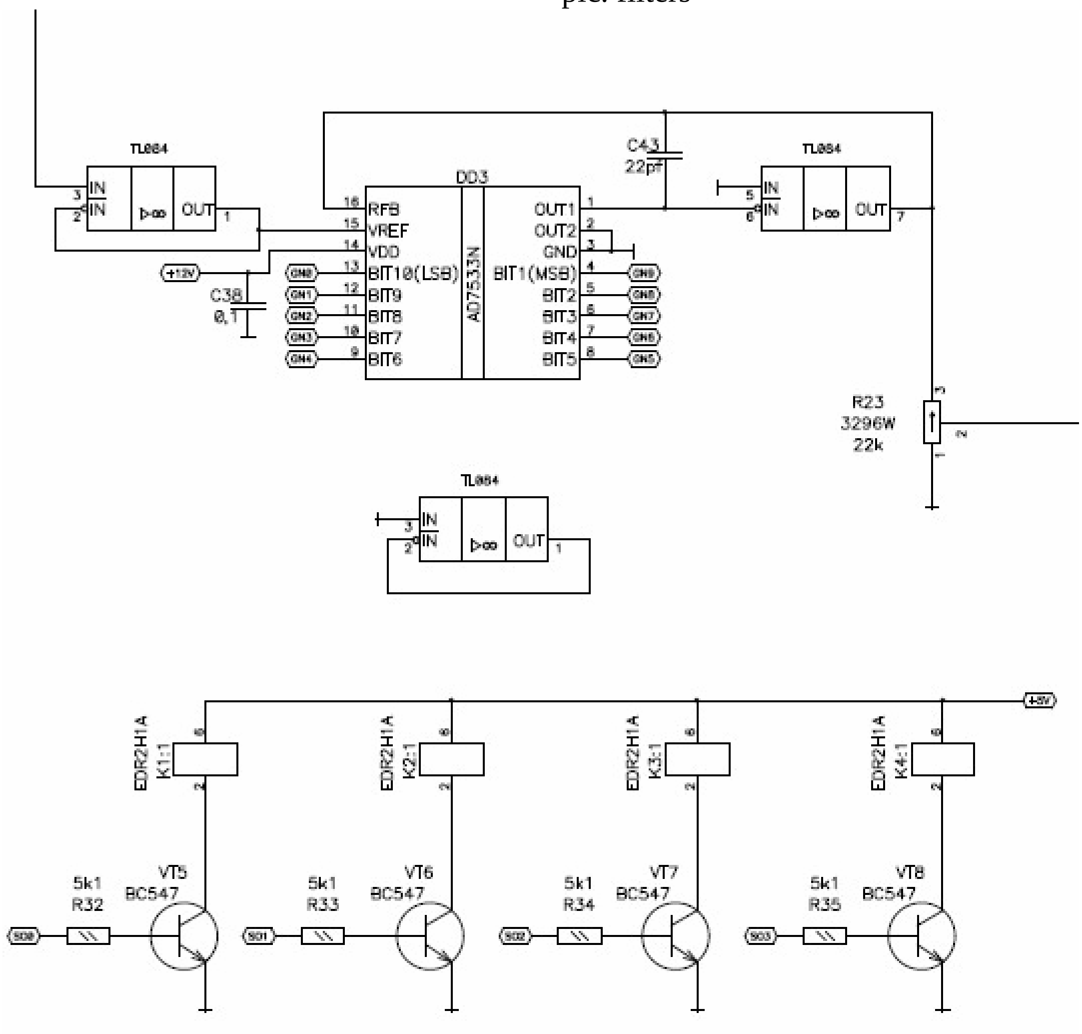
pic. PSU



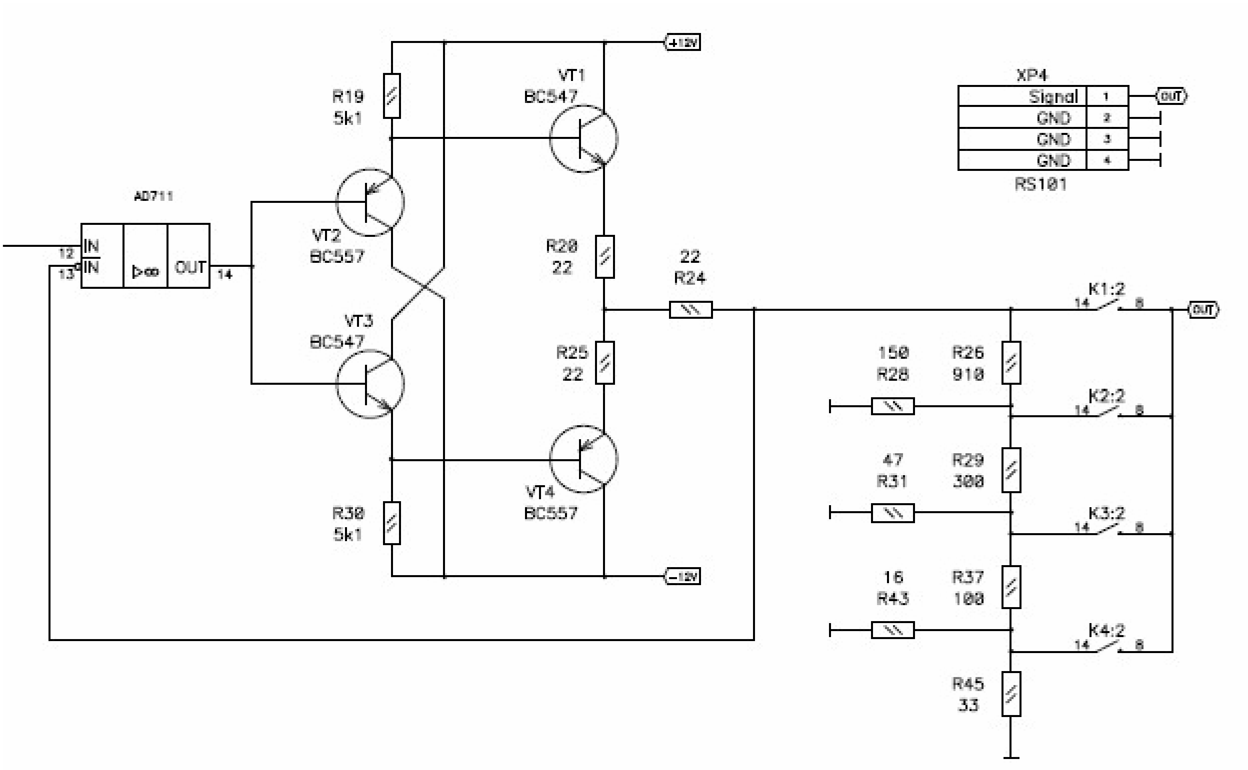
pic. DAC



pic. filters



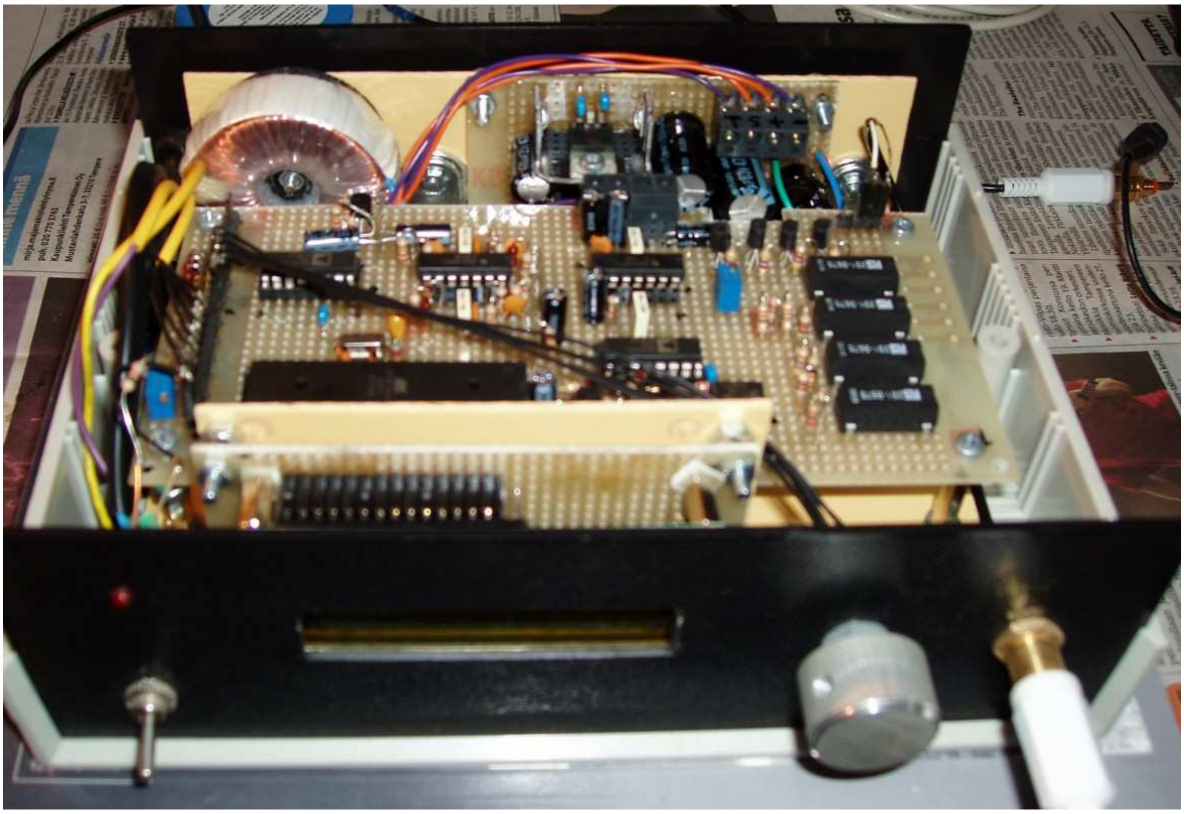
pic. volume and att. control



pic. output amplifier and attenuator

firmware: singen_src.zip (c / winavr)

pic. my DDS front panel view

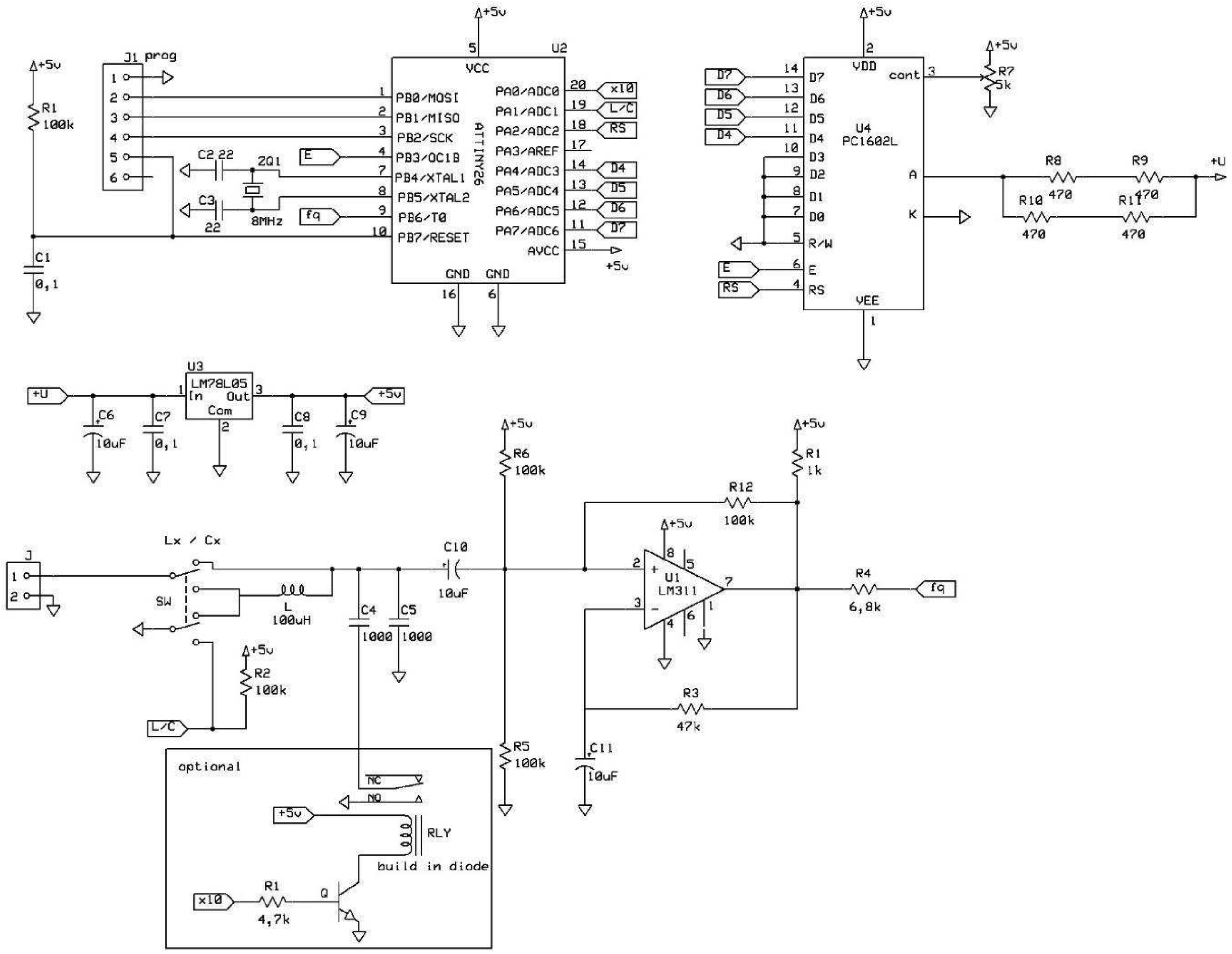


pic. my Sin DDS

Links:
1. http://www.radioland.net.ua/sxemaid-446.html (in Russian)
2. http://www.elektor.com/magazines/2012/march/avr-software-defined-radio-%281%29.2084135.lynkx

L/C meter

L 1uH … 100mH (?)
C 1pF … 100nF   (?)



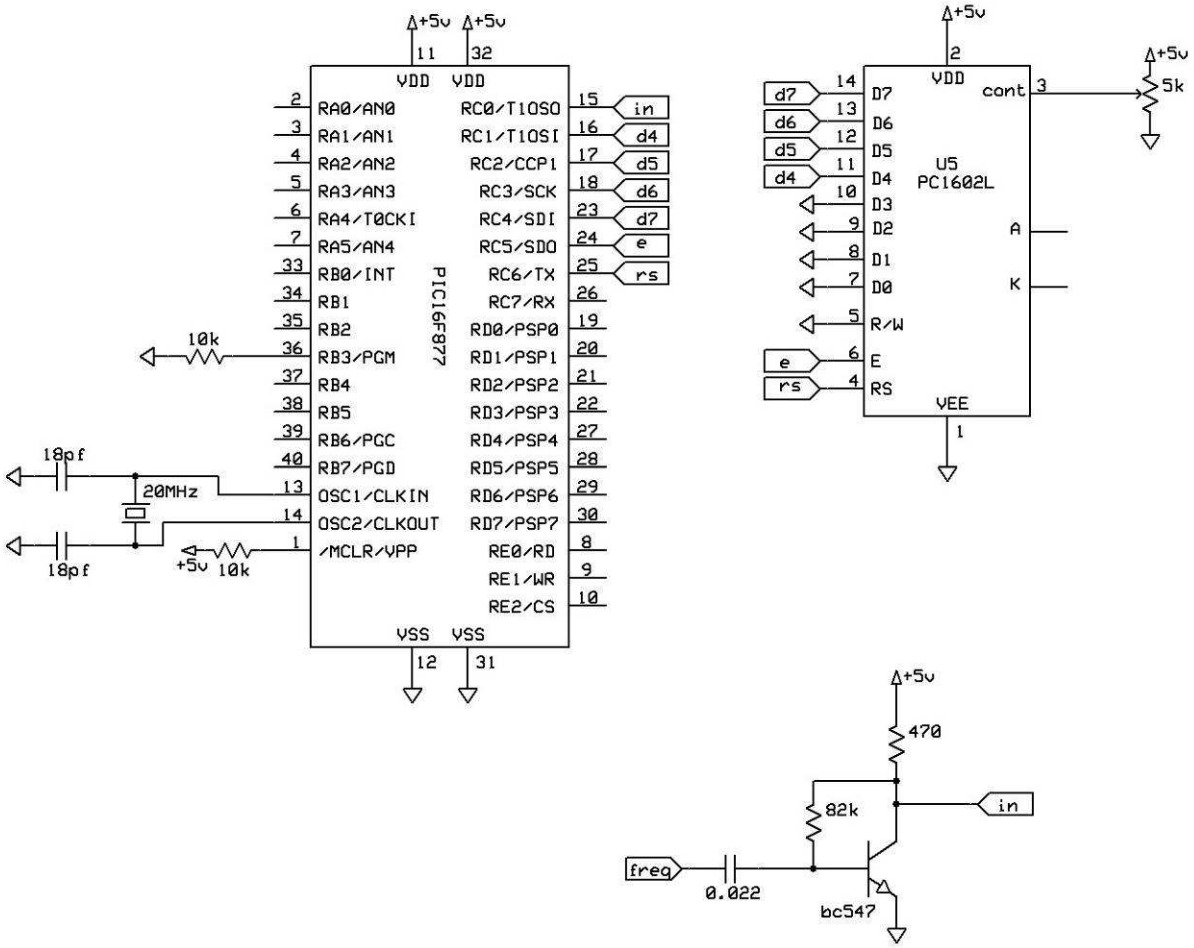
firmware: lcm_src.zip (c / winavr)

pic. my LC meter

Links:
http://electronics-diy.com/lc_meter.php

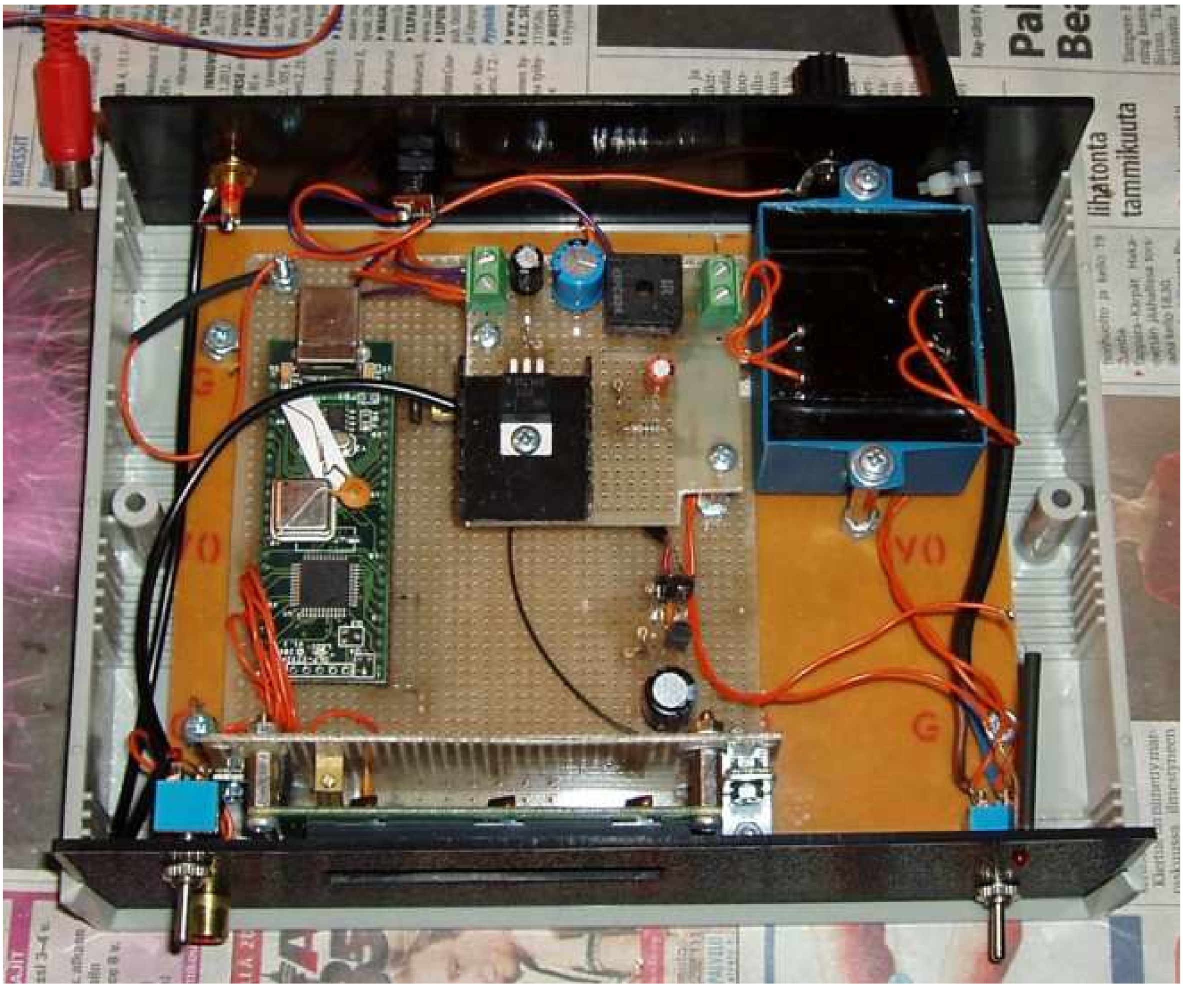
Minimalist frequency meter

F 1Hz ... 30 MHz (1hz / div)
based on DLP-2232PB module from http://www.dlpdesign.com



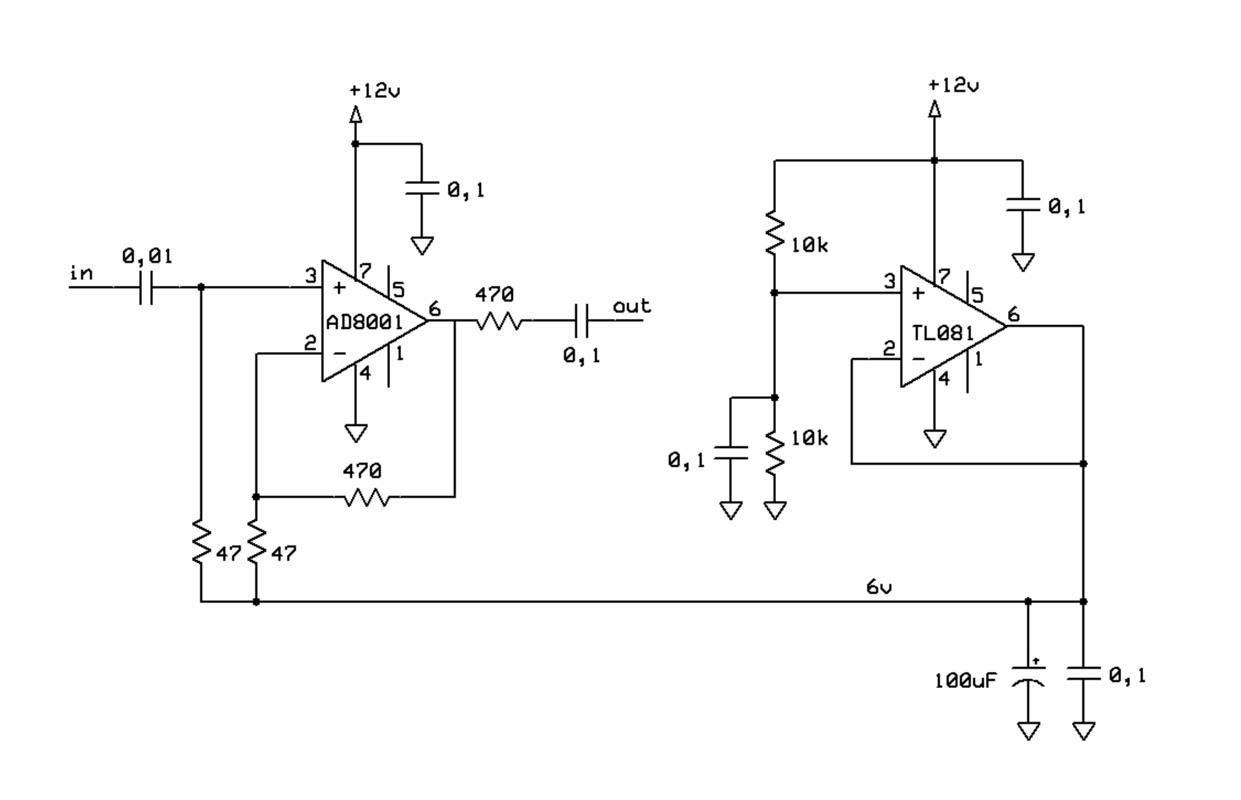
firmware: fm_src.rar (c / hi tech pic c)
see pp877 folder in isp_src.rar for ISP programmer

pic. Frequency meter (on the right) with signal source (on the left)

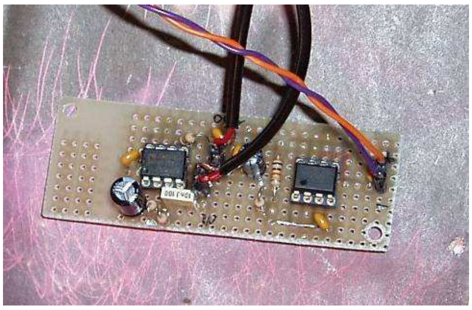

pic. Inside frequency meter

Links:
1. http://www.ar2r.50webs.com/freqmet/freqmet.html
2. http://electronics-diy.com/electronic_schematic.php?id=550

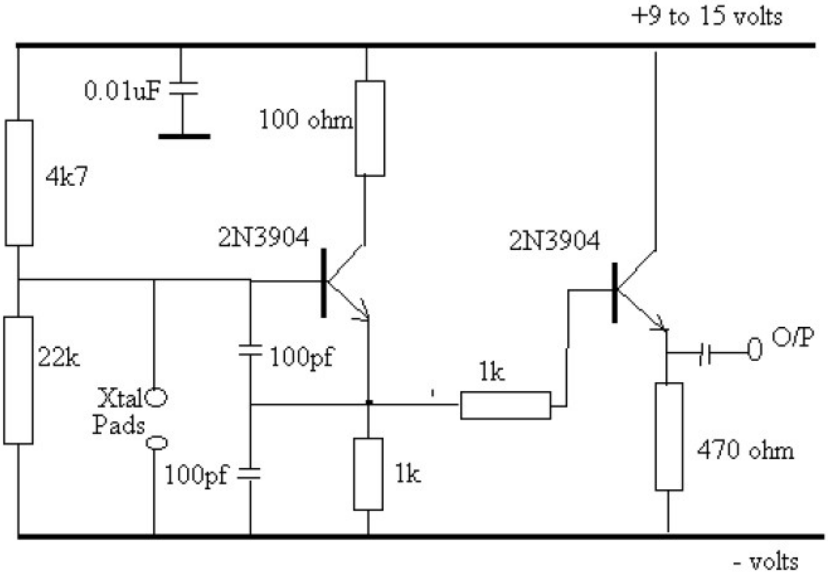
x10 preamplifier for frequency meter



pic. preamplifier

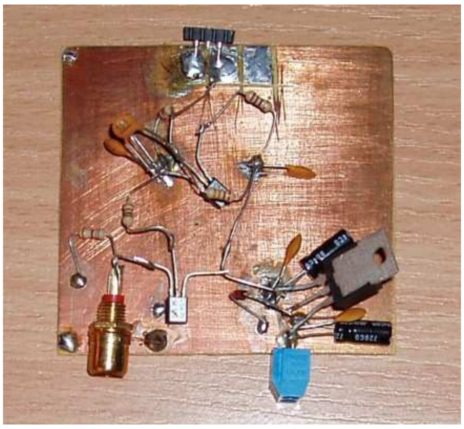


XTAL tester



o/p to freq. meter input

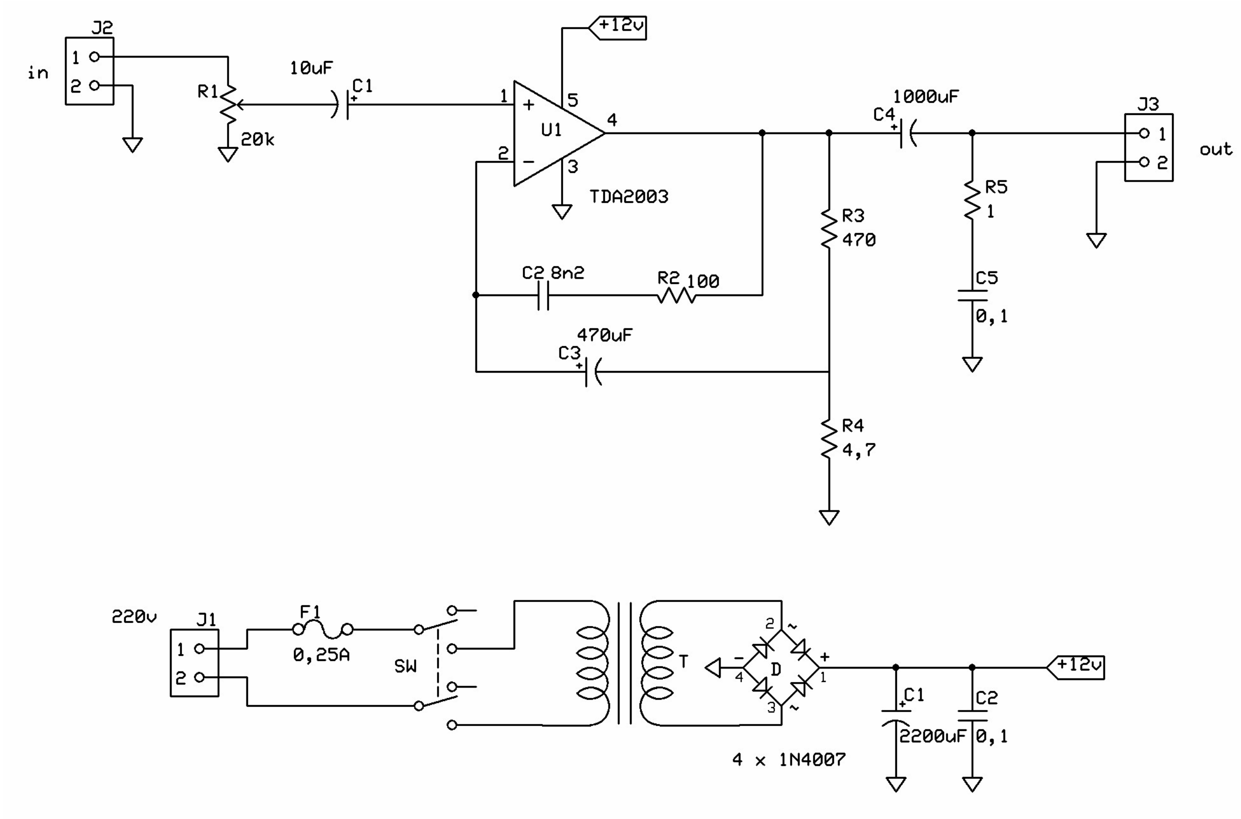
Source http://www.qsl.net/g3pto/xtest.htm



pic. my ugly Xtal tester

Power Amplifier 2w

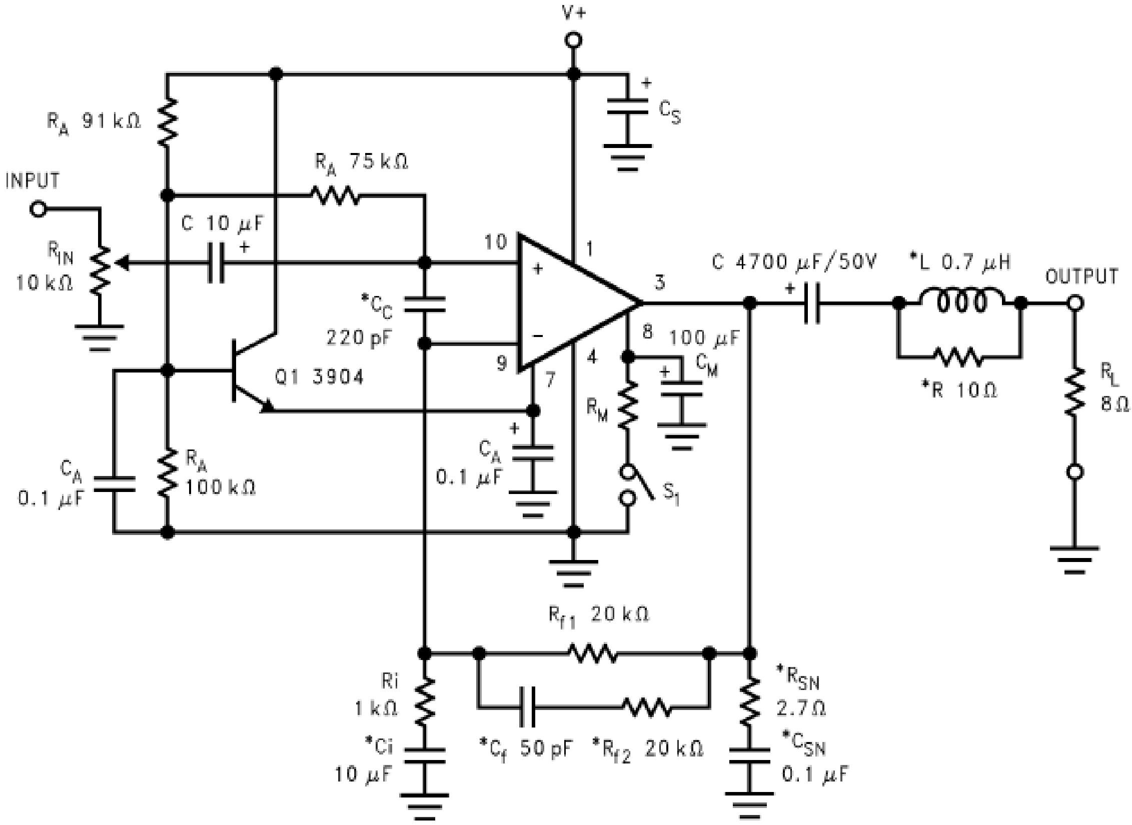
based on TDA2003
veleman kit K4001
+V 8..18v



Power Amplifier 100w

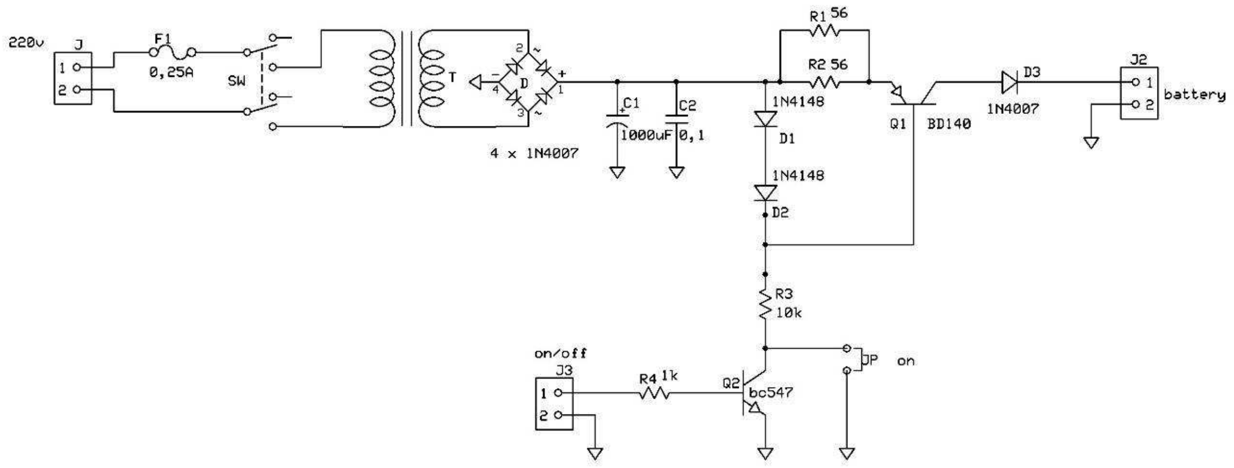
based on LM3886

Cs = 4700uF
V+/- = 30v



L* 30cm 15turms
Rm 15K

Simple Nicad Battery Charger



Adjust charge current by changing R1,R2

Basic high frequency signal source

source: http://www.phonestack.com/farhan/siggen.htm

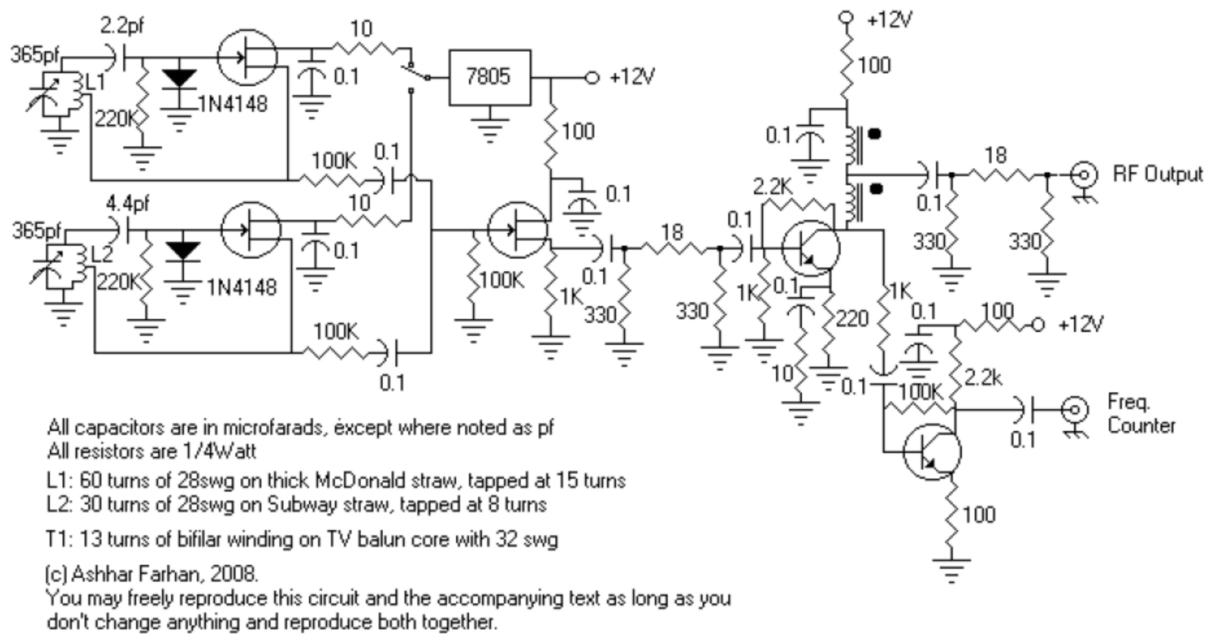
A Signal Generator

Home » A Signal Generator

During the course of designing some bandpass filters, I realized that in order to measure the bandwidths, I could no longer rely on the trusty old crystal oscillator with swappable crystals as the signal generators. The more I investigated, the more important it appeared to me that I needed a signal generator that went beyond just a crystal oscillator. These were the requirements:

1. The generator needs to be tunable from 3 to 30 Mhz in order to be usable to measure everything from Q and bandpass characteristics to antenna SWR and resonance.
2. The generator should provide stable 50 ohms output impedance. My initial attempts at using the crystal oscillator as an RF source were a disaster. It was driving the filter as a 12 ohms source impedance!
3. The generator should have a pure sine wave output. You can translate that into saying it should have no or low harmonic content. If the output looks spikey or flat-topped, it means that apart from the fundamental frequency there is considerable output at other frequencies too (probably at harmonics). This can upset your measurements.

Design

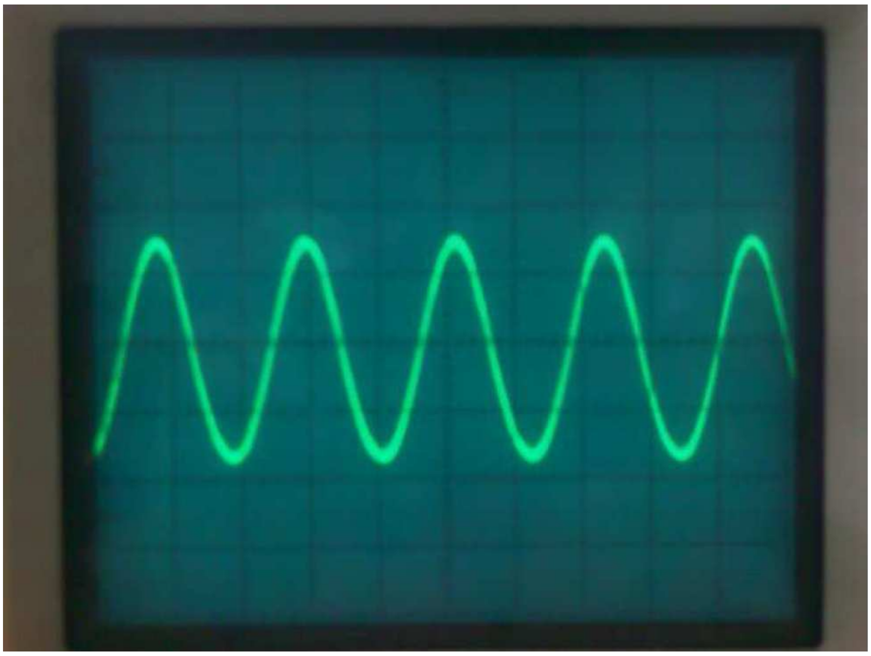


There was an interesting discussion on the BITX list about using computer PSU boxes for homebrew projects. Accordingly, a PSU was ripped out. The back (which is screwed to the back panel of the PC) had it's fan grill ripped out and an unetched copper laminate was bolted on as a panel.
The frequency range of 3-30 MHz could be covered only in two ranges of 3-10MHz and 10-30MHz. Hence, two Hartely oscillators are used, one for each range. The range selection is done with a toggle switch that powers one oscillator or the other. Junk box lacked a Zener diode, and a spare 7805 was used as a regulator. Those wishing to replicate can use a 78L09 or a regular Zener diode with a 100 ohms drop resistor.
In order to preserve the sine wave purity, it was decided to load the VFO as lightly as possible, hence, it is coupled through a 100K resistor and a 0.1 DC blocking capacitor to the buffer FET. Keeping an FET buffer gives fairly high isolation with high impedance input.
The output of the VFO buffer feeds a 6 db attenuation pad that feeds to feedback amp with another 6 db pad in the output. These excessive pads work towards providing a more stable output impedance.
The low output impedance of the FET source follower and the two pads surrounding the output amplifier provide a resilient 50 ohms source impedance at the output jack.
A separate output is provided for the frequency counter to isolate the digital noise from making it back to the signal generator's output.

Construction

An un-etched copper laminate was cut to the size of the bottom of the chassis (of the departed PC). It was affixed to the bottom of the case using the screws salvaged from the power supply. After mounting the tuning capacitor to the front panel (also made out of copper laminate), right angled supports fashioned out of more copper laminate were soldered between the two boards to hold the front panel rigidly as well as provide a low impedance ground return to the tuning capacitor.
The junk box didn't have any 330 ohms resistors required for the attenuators, they were fashioned by putting 100 ohms and 220 ohms resistors in series. The 18 ohms was substituted with a 100 ohms in series with a 22 ohms.
The lower frequency range oscillator was unreliably starting with the a 2.2pf coupling capacitor, another 2.2pf was paralleled to bring up the coupling capacitance to 4.4pf.
The initial decision was to include a small 12V power supply inside the signal generator box. However, potential problems of drift made it undesirable. Instead, the power supply is fed to the signal generator directly from the lab power unit (a converted 12V car battery charger with a 78H12 added to it). This signal generator is on all the time when the lab is powered up, potentially avoiding the startup drift.
As the week's preoccupation was with various types of coils (which is what spurred this generator) a trip to the local Baskin Robbins and MacDonald's (ugh!) with the kids provided with ample straws to wind the coils on. I guess, one can patent 'A method and apparatus to generate RF signals with MacDonald's straws' and sue the some fat corporations (Hi!).

Conclusion

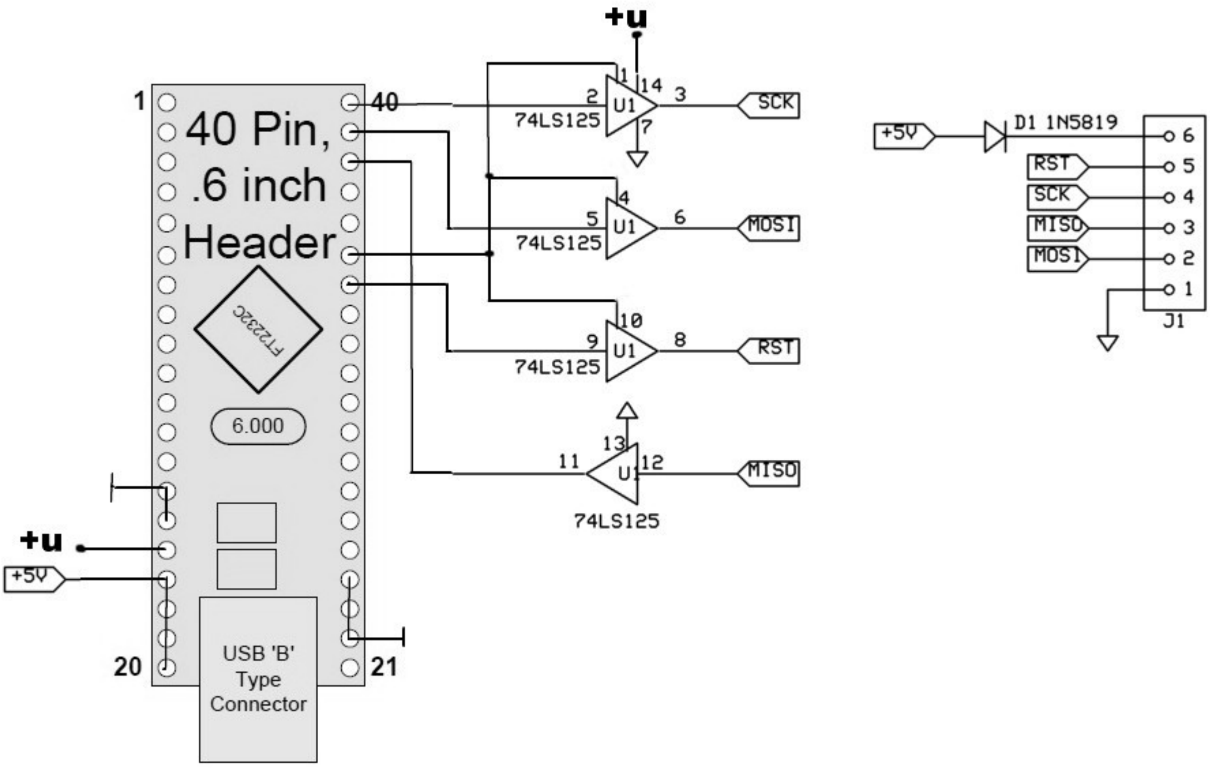


The signal generator took two evenings (and five milkshakes) to make. It is well worth the time invested. The signal levels vary across the spectrum and band. Hence it is not a calibrated instrument, however, almost all our measurements relative power levels. Hence, measuring input
and output levels and their ratios is enough for almost all our work.
This signal generator is surprisingly stable. It uses air wound coils with air spaced capacitors (broadcast capacitors . polyvaricons) which might explain the stability. It drifts less than 10 Hz (unmeasurable on my frequency counter) on 3.5 MHz. But the drift is a few hundred hertz a minute on 14 MHz.
The signal generator is finding more and more use everyday in the shack. Aligning band-pass filters, measuring impedances, finding out filter bandwidths, measuring inductor Qs is all easy and a matter of seconds and minutes. It gives one an additional set of 'eyes' into your projects. Highly recommended.
The frequency counter still contributes slight noise to the RF output when connected. In order to make precise measurements, I have to unplug the frequency counter.

pic. my signal generator

Simple SPI Programmer

Based on DLP-2232M module from
http://www.dlpdesign.com



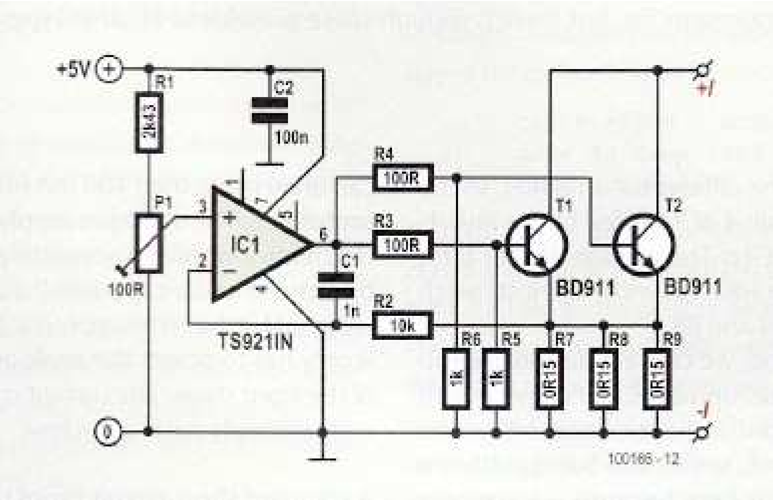
pic. my SPI programmer

host software (command line tool) : isp_src.rar (MS VC 2005)
supported MCUs: ATtiny26, ATmega32, ATmega88, ATtiny861

Links:
1. http://www.dlpdesign.com/usb/2232m.shtml
2. http://www.ftdichip.com/FTDrivers.htm

Current sink (electronic load equivalent)

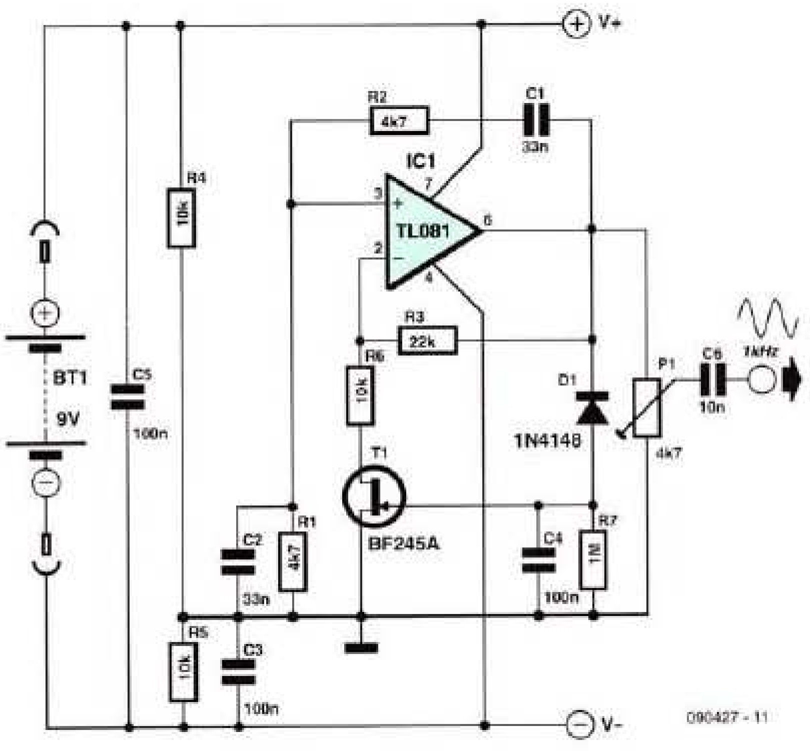
idea from here
http://www.elektor.com/magazines/2010/september/dual-voltage-current-display.1466817.lynkx

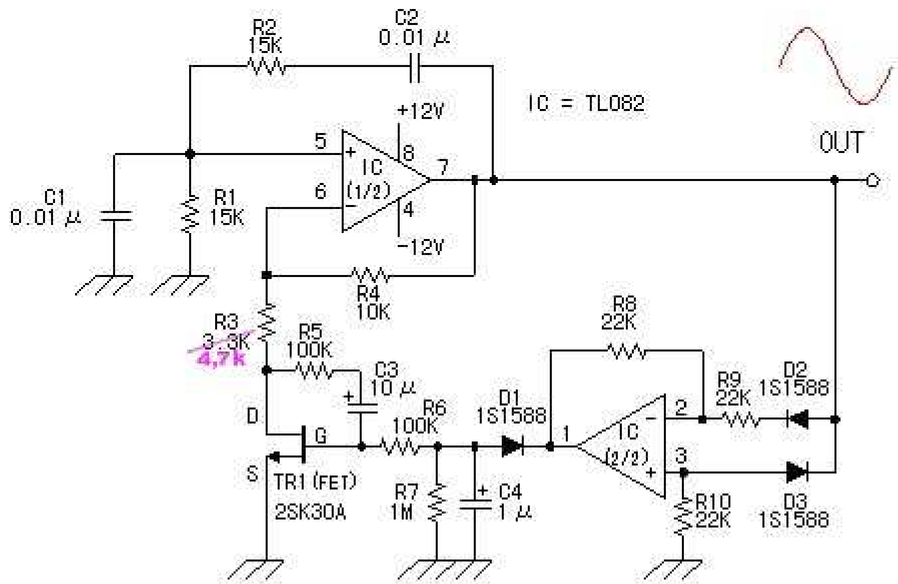


good in combination with UI meter

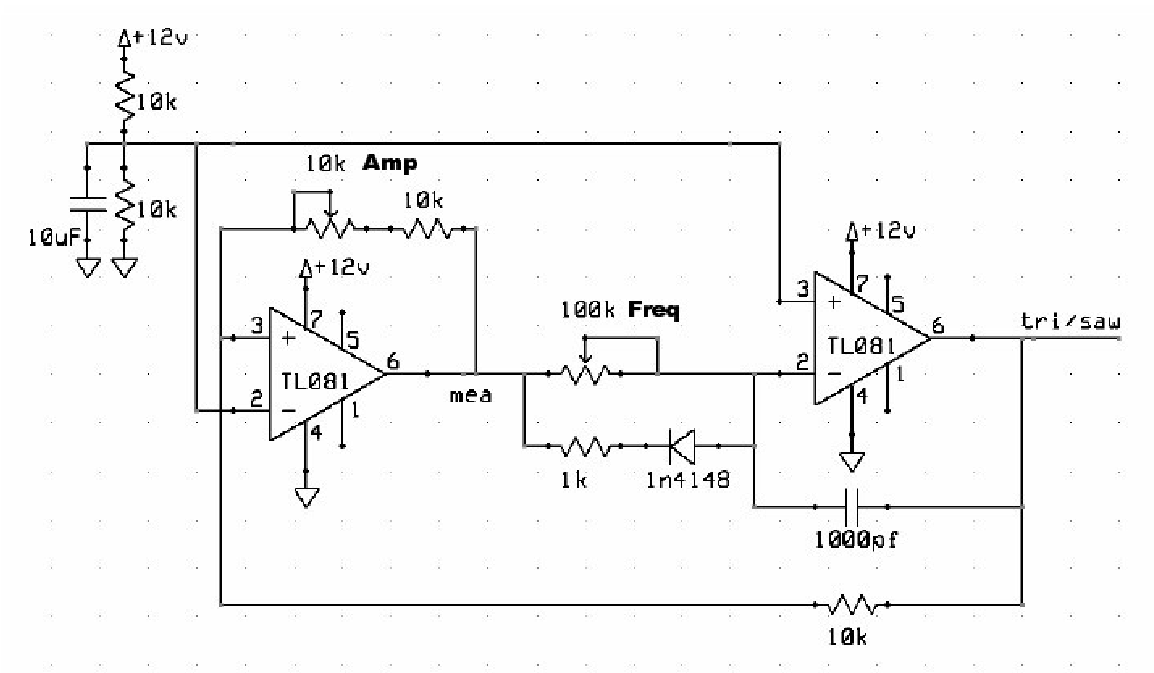
Signal sources with OpAmps

Two sinusoidal signal sources



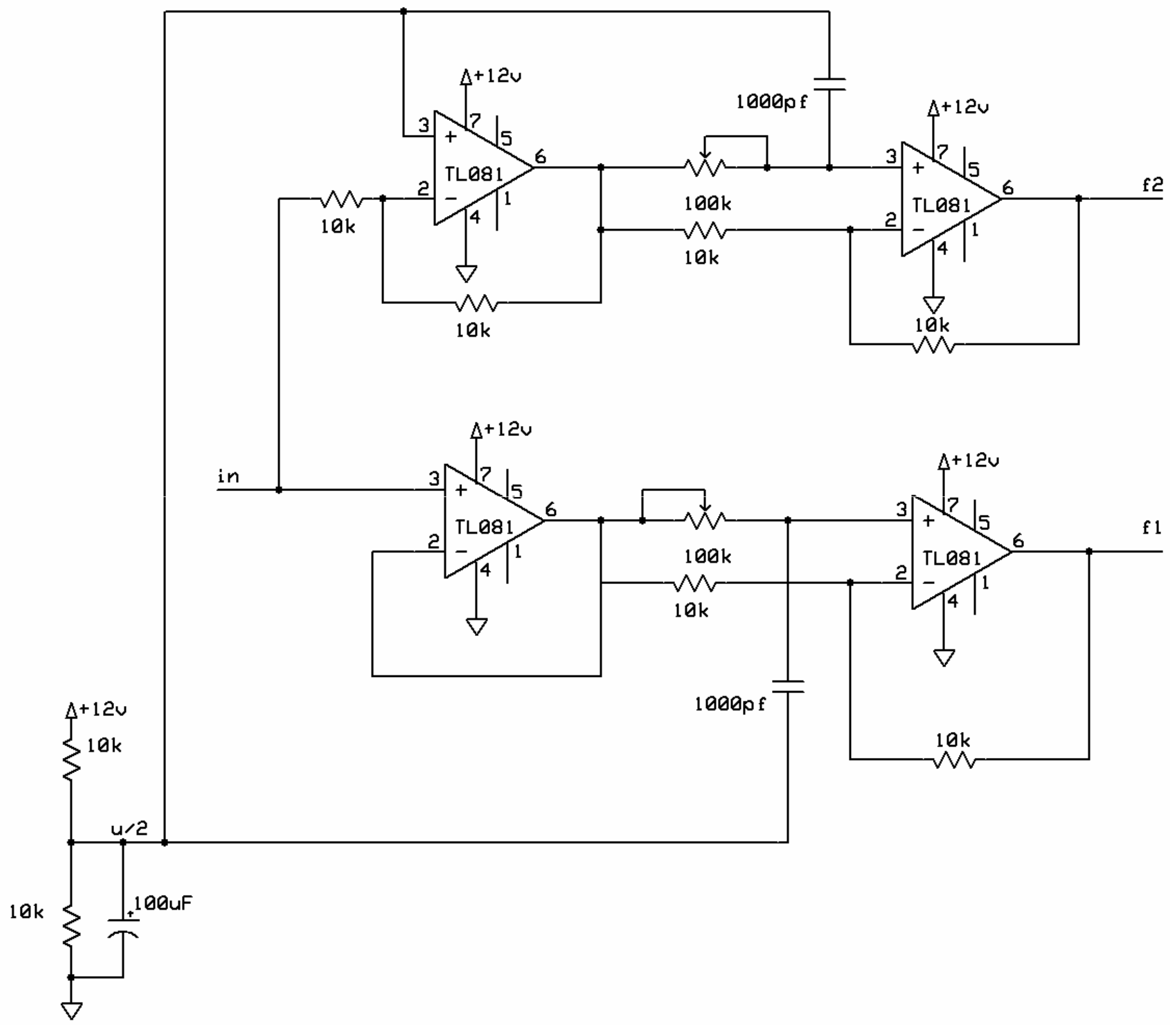


Triangular/saw signal source

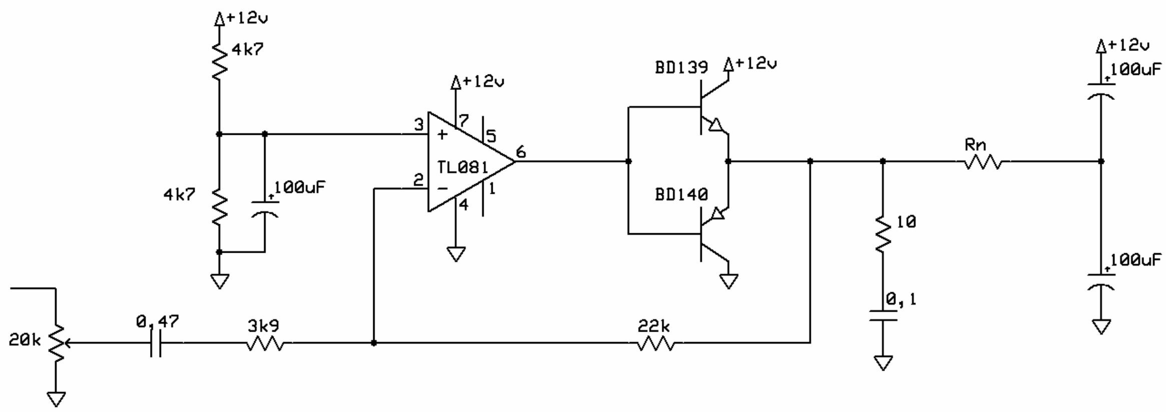


* remove diode and 1k resistor for triangle

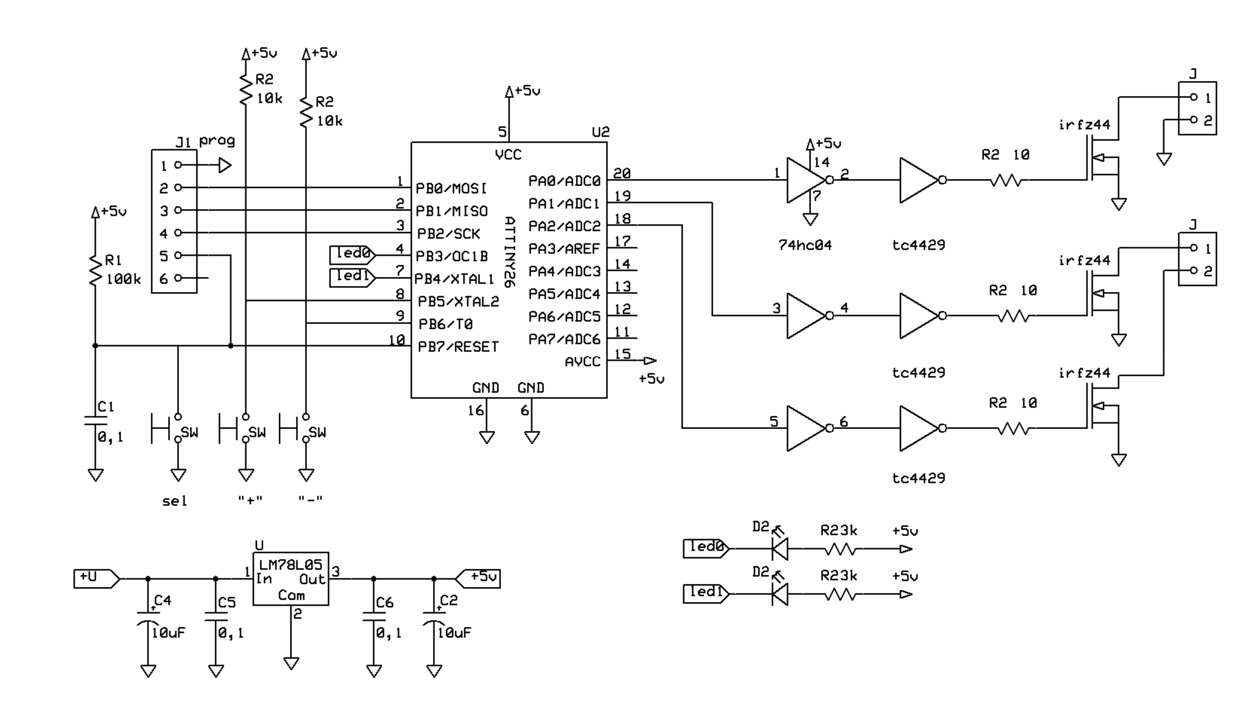
Analogue delay (phase shifter)



Very simple power amplifier

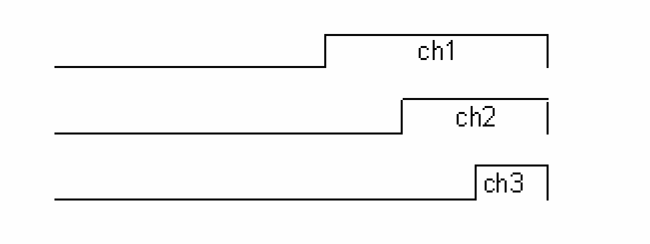


Software pulse generator



firmware: plsgen_src.rar (avrasm)

This firmware will generate output like this

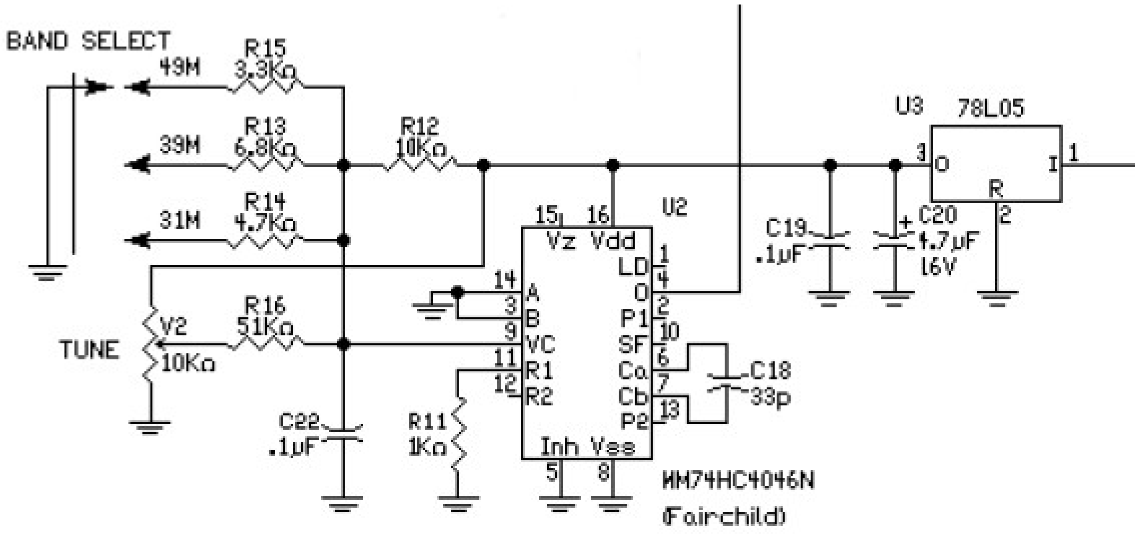


Pattern can be easily changed.

Controls

Led0	Led1	+/- func.
off	off	ch1 pulse width
on	off	ch2 pulse width
off	on	ch3 pulse width
on	on	freq. adjust

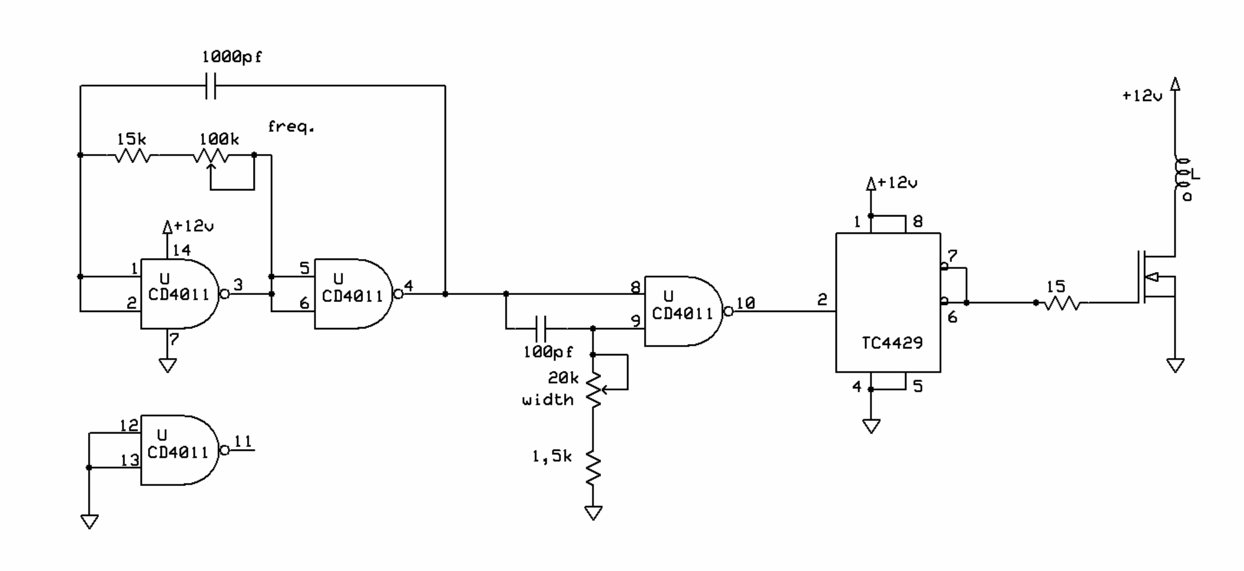
Meander generator with 74hc4046



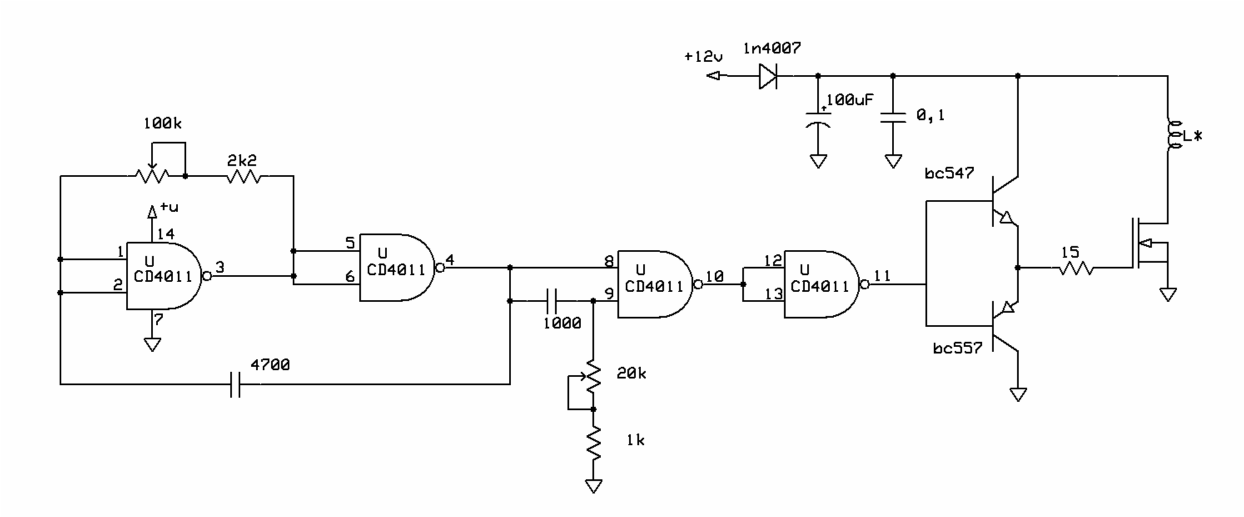
Originally used in SW radio receiver

source: http://kd1jv.qrpradio.com/swbcrx/AMSWBC.HTM

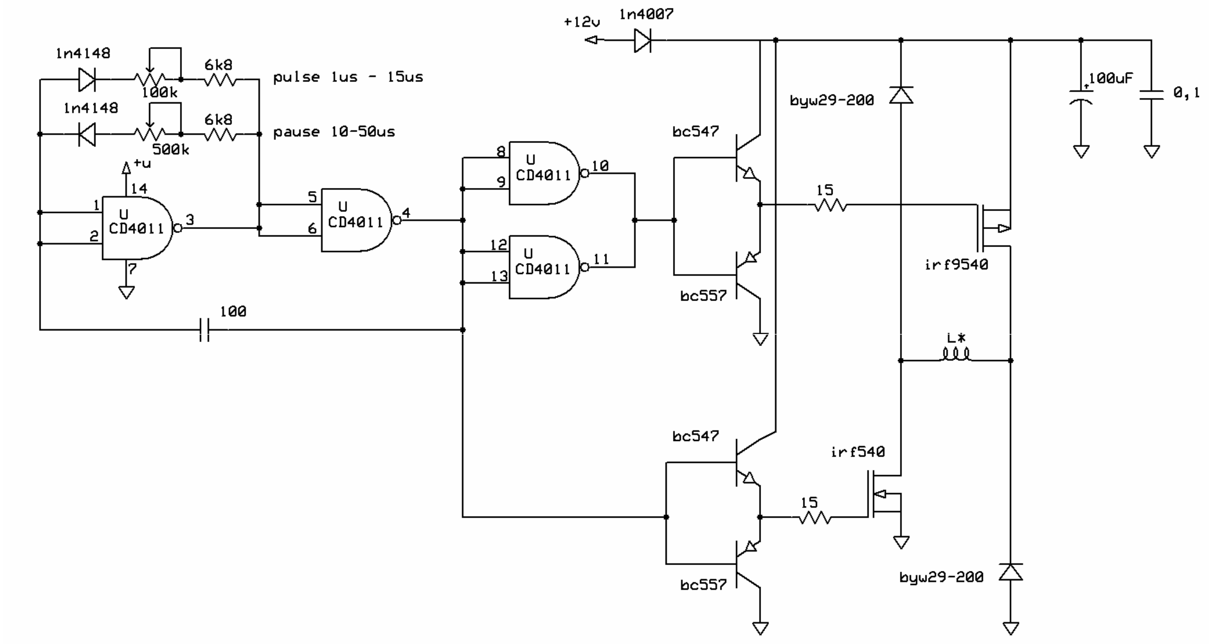
Very simple pulse generators for experiments



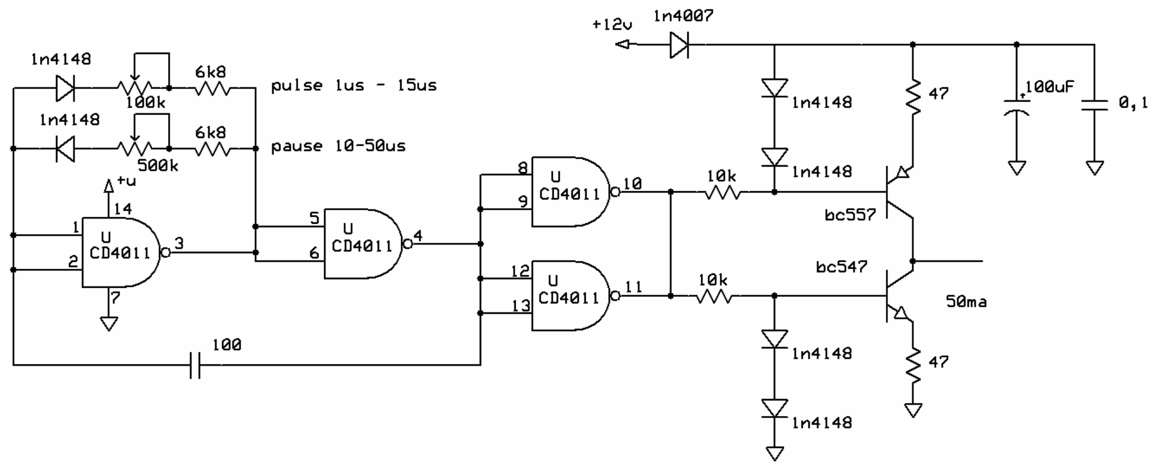
Can provide pulses with 50ns + width and frequency up to 50kHz



pic. Even simpler generator, will not work very well on high frequencies



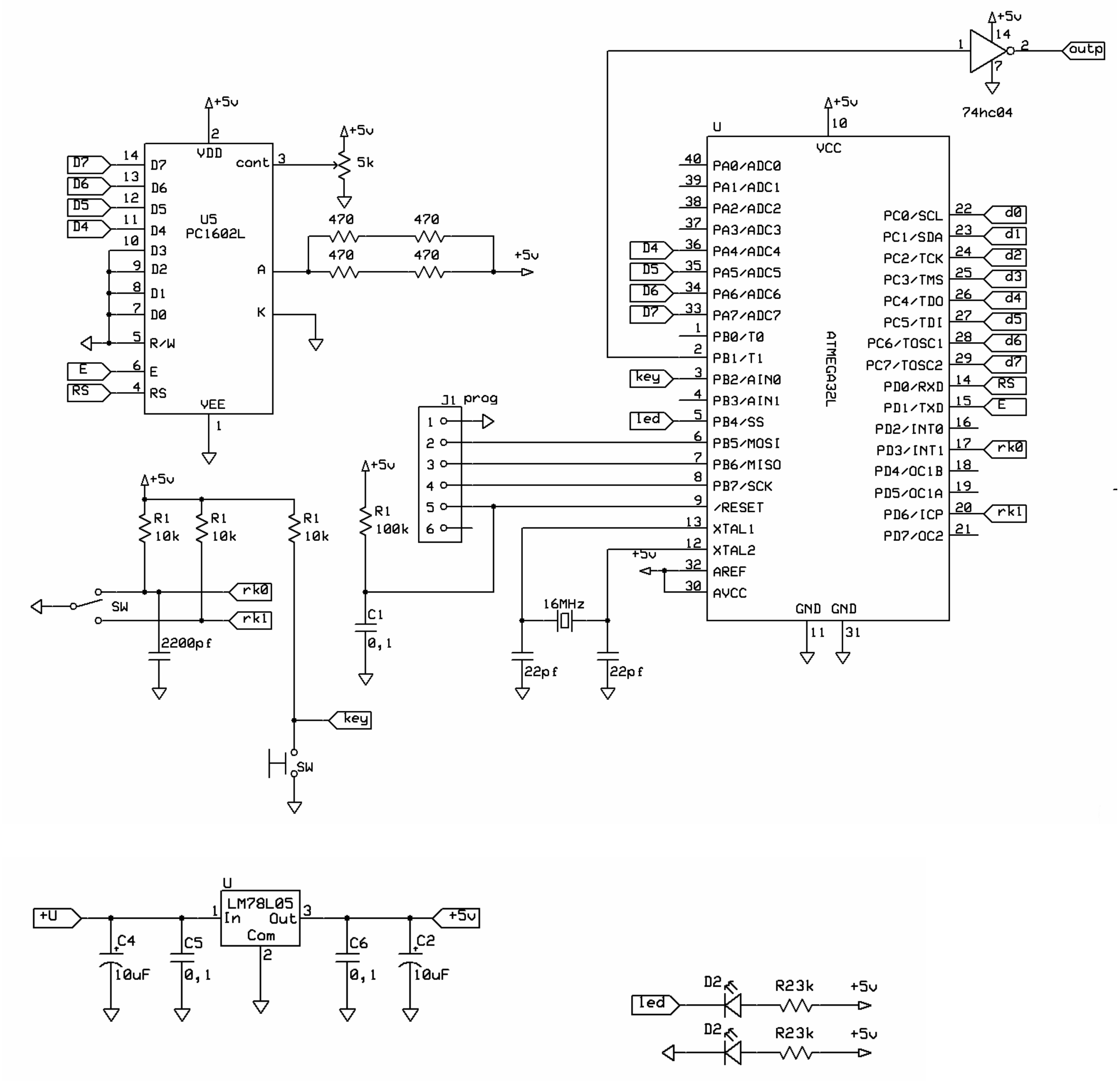
pic. “Skew” half bridge



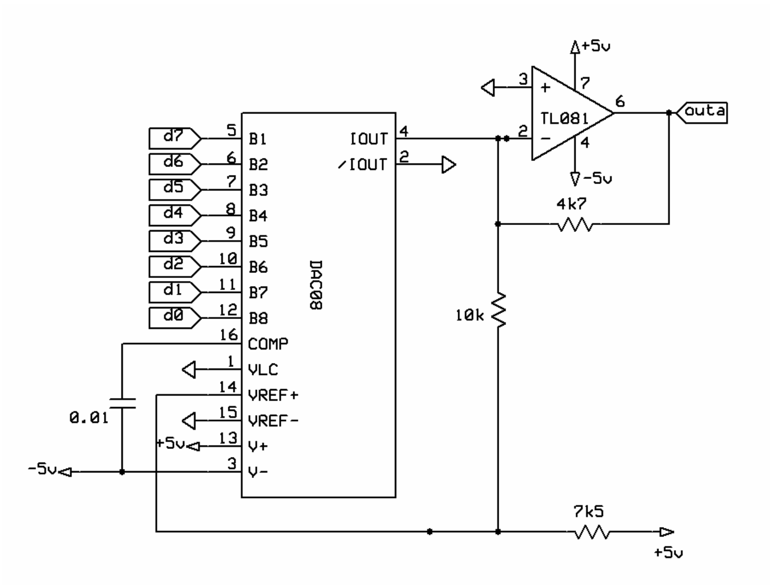
pic. driver with current limiting

More advanced pulse/sin generator

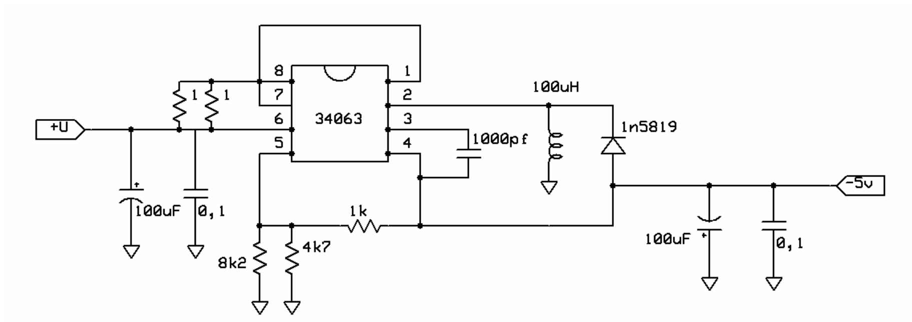
Can produce pulses from 62.5ns to 1s with 62.5ns step, 2 channels (outputs PD4, PD5)
Pulses generated using timer 1.



firmware: pls32_src.rar

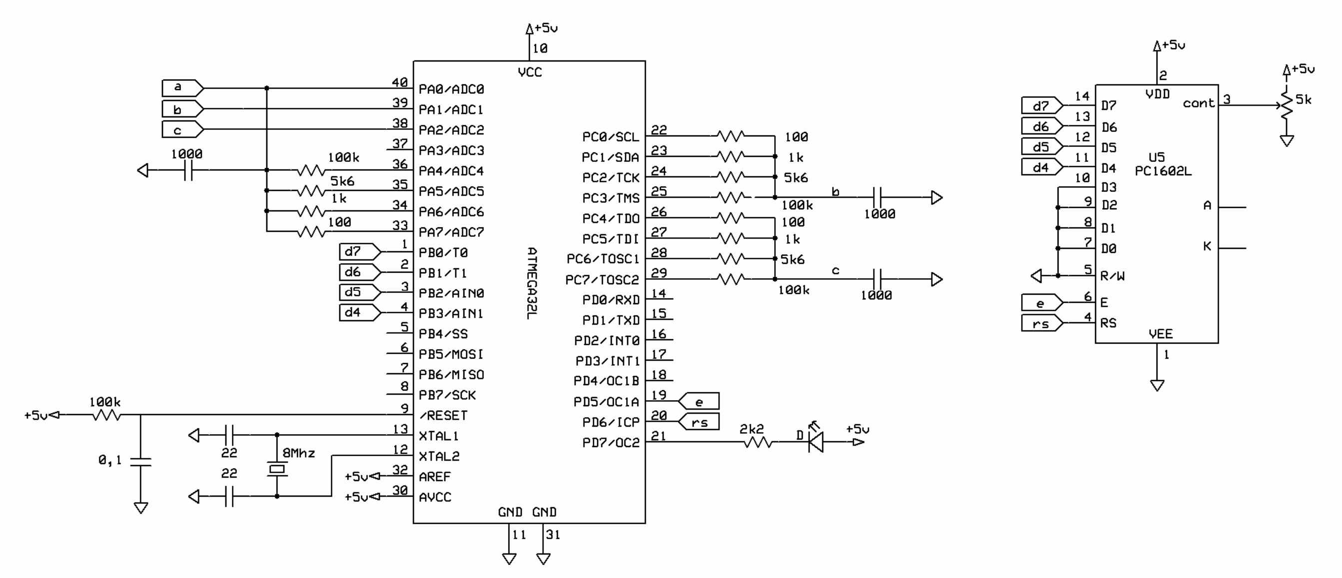


with additional DAC can also produce low frequency sin signal and adjustable strobe signal



firmware: sinp_src.rar

Semiconductor device tester

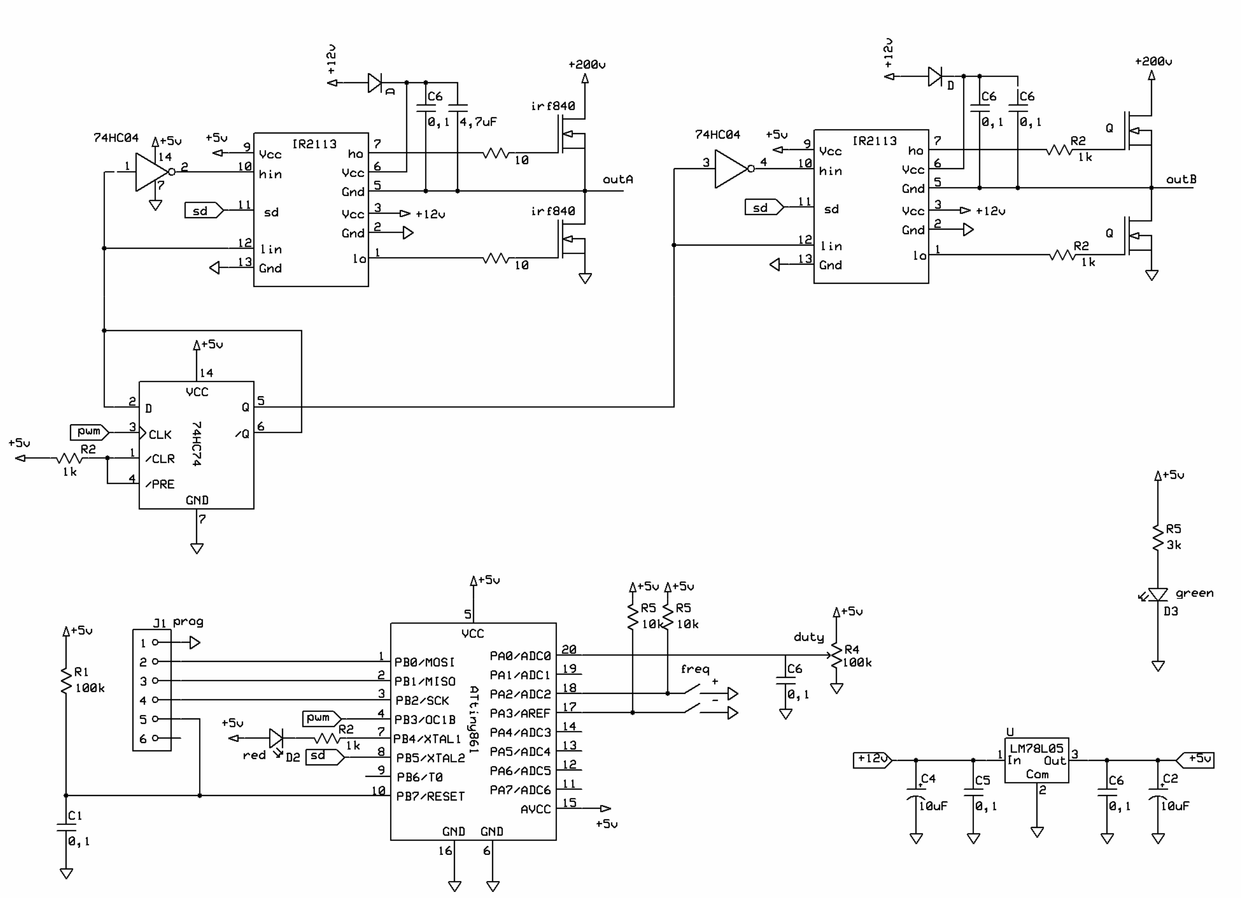


Links:
http://www.elektor.com/magazines/2005/april/sc-analyser-2005.57517.lynkx
http://www.mwinstruments.com/produits.html#AS4002 (in French)

firmware: sct_src.rar

H-bridge

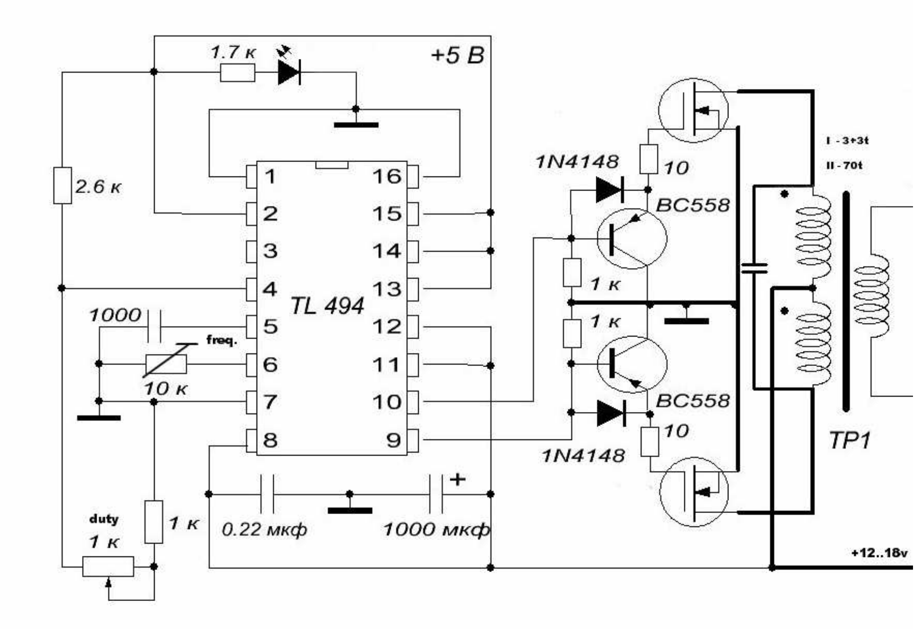
Frequency 10-50KHz
Regulated duty factor 0-50%
Power supply voltage could be 20-400v

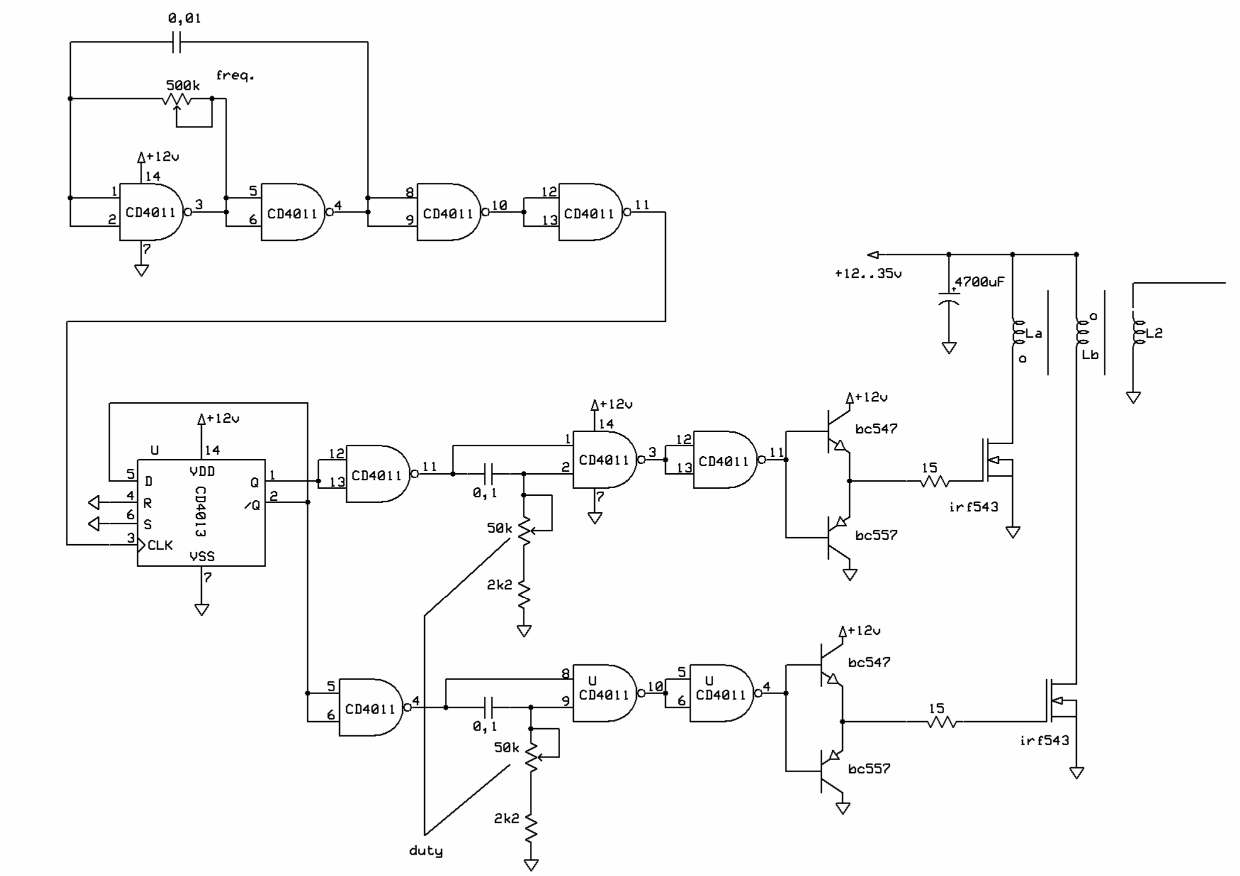


firmware: hb_src.rar

Two PWM drivers

TL494 should be used above 1KHz
use KA7500 for lower frequencies





pic. very simple PWM driver