

Forty-9er

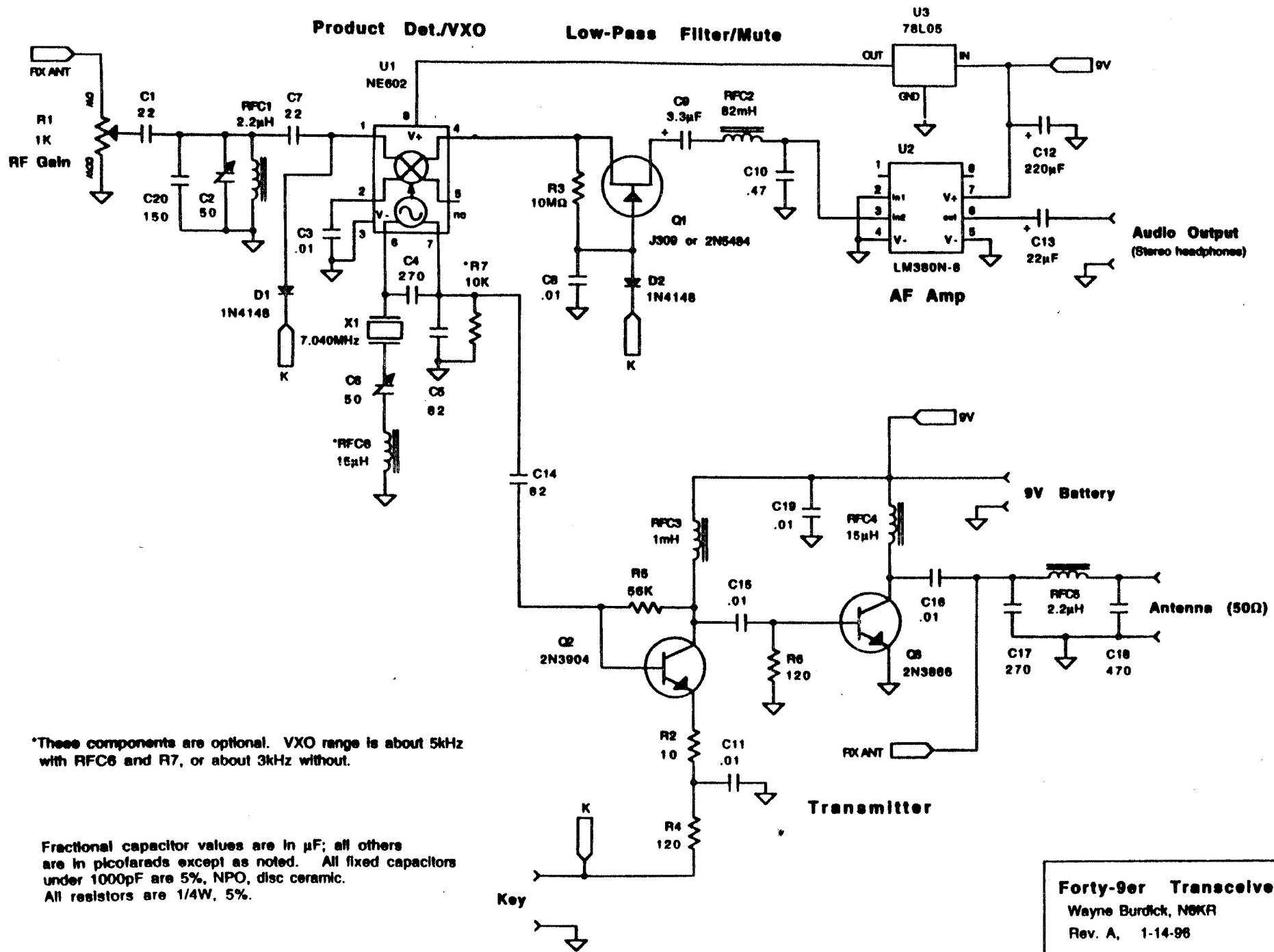
NorCal Talk

9/6/2016

Bob Mix
KF6ABC

NorCal

- Founded 1993 by Doug Hendricks & Jim Cates
- Meetings in Livermore
- Homebrewed QRP focus
- Kitted thousands of radios and accessories
- 1996 49er: 40-meter 9-volt CW full-QSK transceiver kit for \$25
- Designed by Wayne Burdick of Elecraft fame



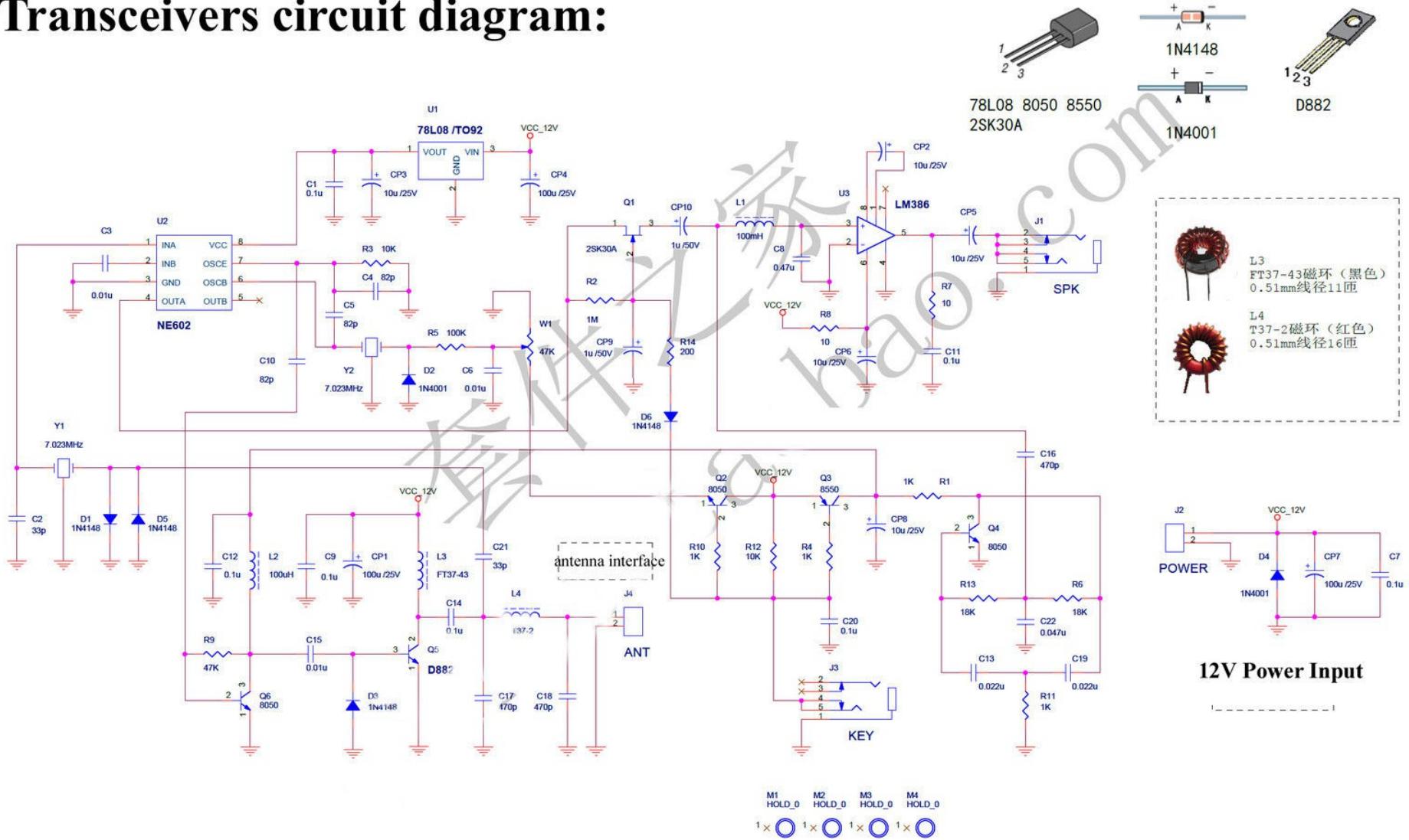
Forty-Ger Transceiver
Wayne Burdick, N6KR
Rev. A, 1-14-98

Chinese 49er

- 20 years later...
- Highly-modified NorCal circuit
- LM386 vs. LM380
- 6 transistors vs. 3
- Transmits at 3(???) watts vs. half a watt
- Twin-T sidetone oscillator
- Jacks for antenna, power, headphones, key
- 7023 KHz crystals (2 vs. 1) in US Extra band
- Zero frequency agility

Chinese 49er

Transceivers circuit diagram:



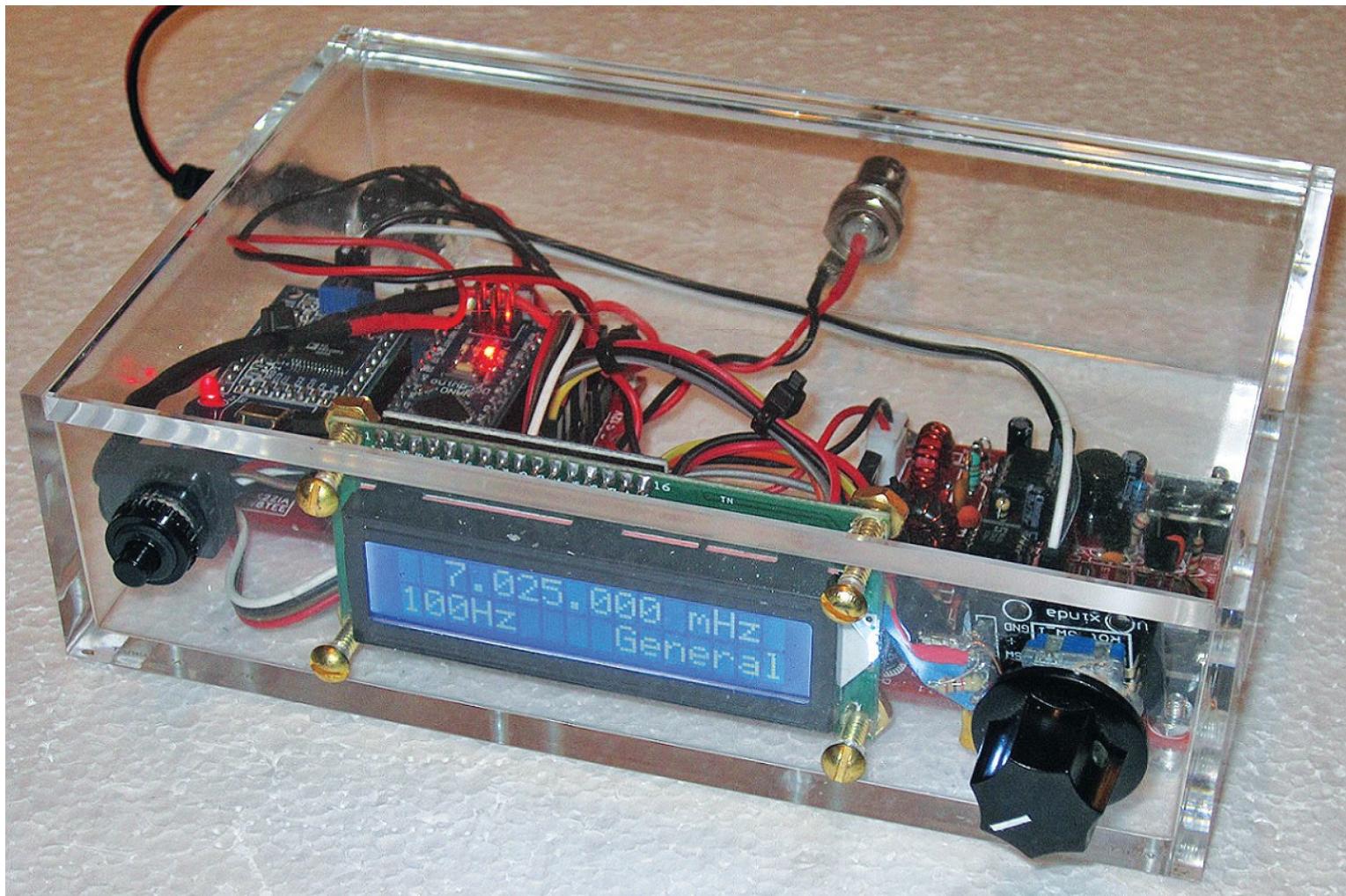
March 2016 QST Article

A Modular 40 Meter CW Transceiver with VFO

This easy-to-build transceiver costs less than \$50
Add a digital display and frequency control to a
popular QRP rig.

Dr Jack Purdum, W8TEE; Farrukh Zia, K2ZIA,
and Dennis Kidder, W6DQ

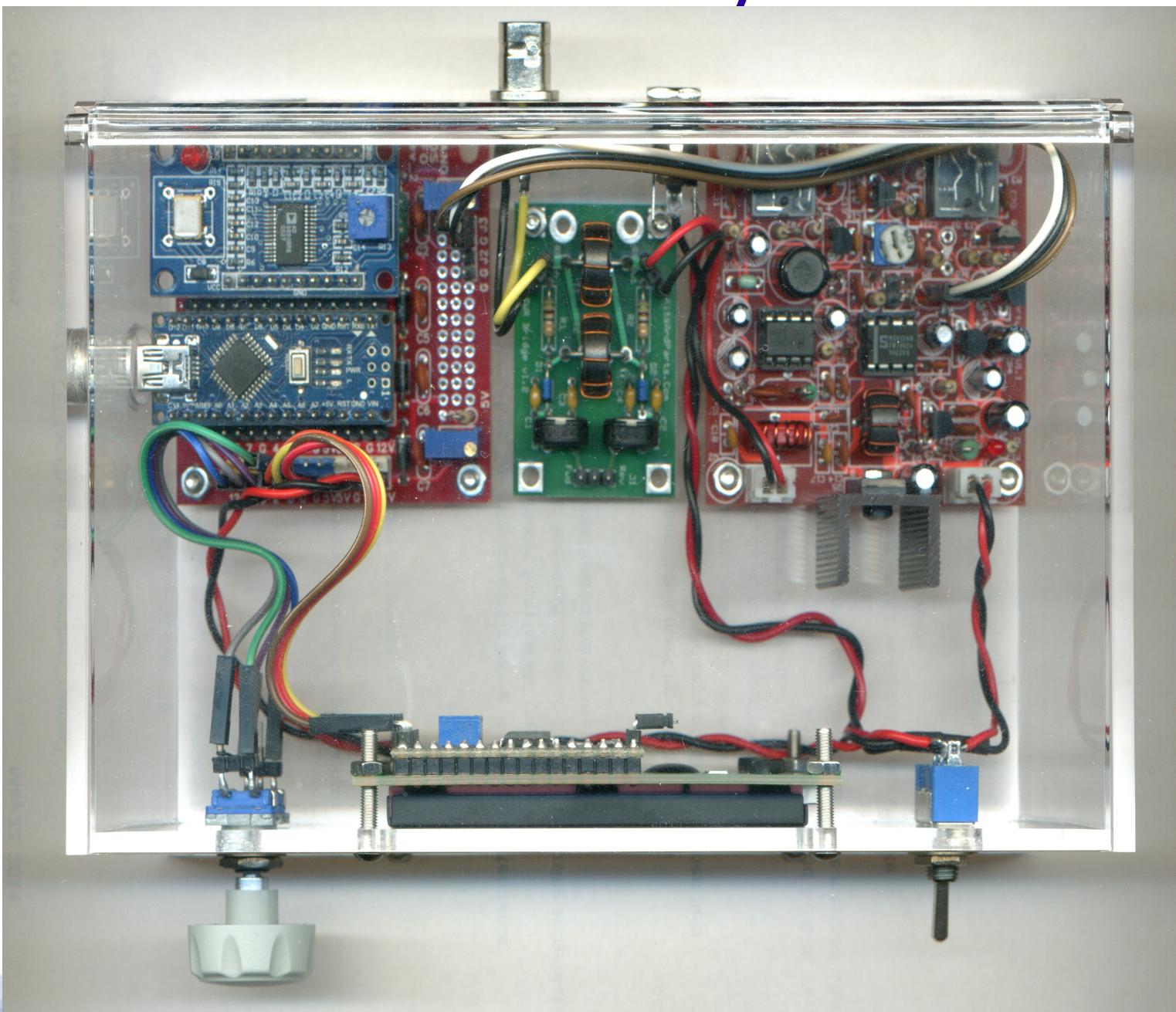
QST Forty-9er



Modular Shopping List

- Chinese Forty-9er \$10 ebay
- Encoder \$1 ebay
- AD9850 DDS \$10 banggood
- Arduino Nano & Mini-B USB \$3 banggood
- I²C LCD \$4 banggood
- K2ZIA mother board: bare \$7, kit \$15
- Few other components: 1N4733, 22uH, 56pF
- Case with wiring; vendors: Jameco, Tayda

K2ZIA Forty-9er



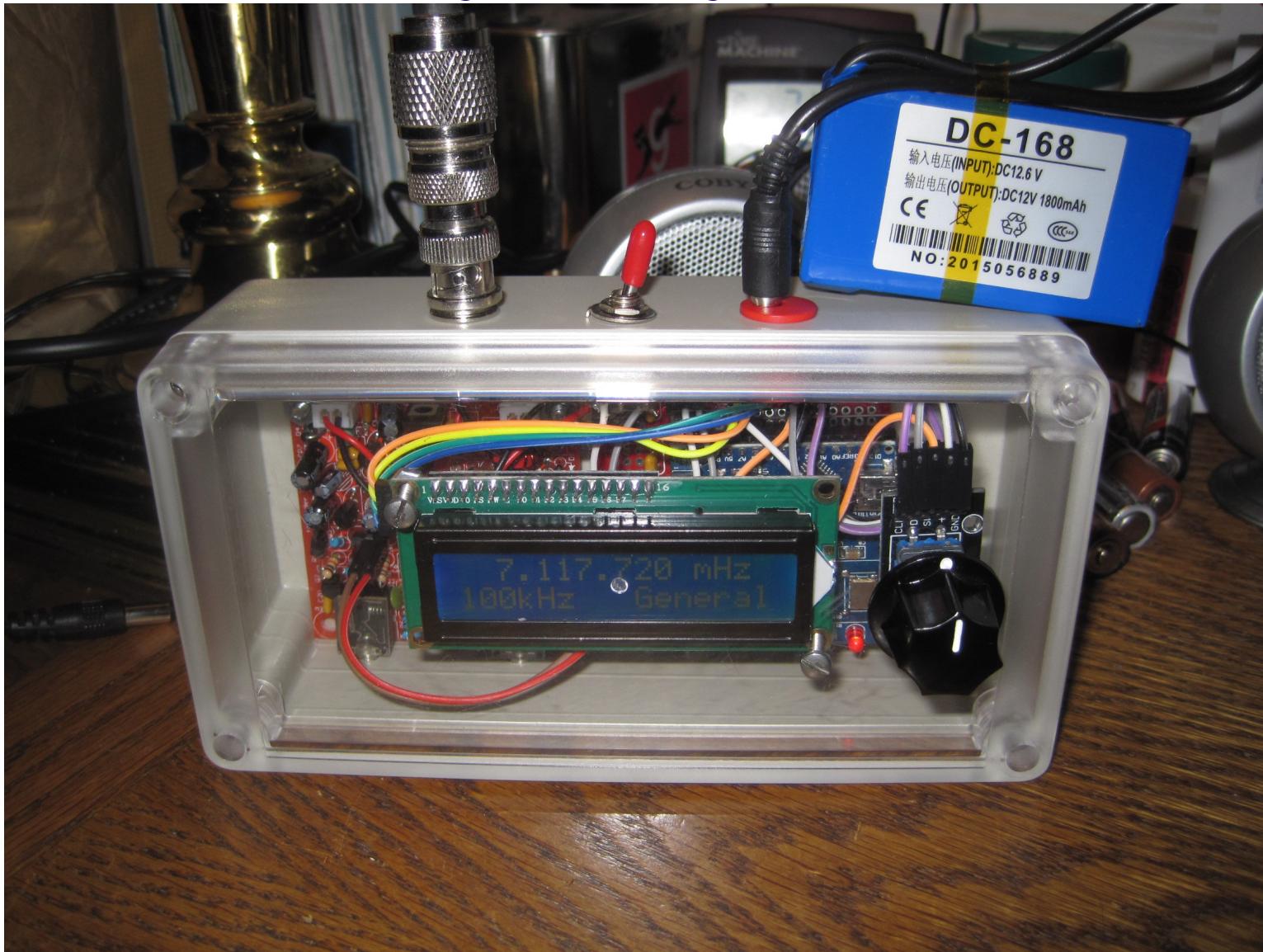
K2ZIA Mother Board

- All modules and power plug into Mother
- Mini360 Buck Regulator for efficient power
- Sockets for DDS and Nano modules
- 2-transistor amplifier for DDS sinewave output
- Headers for power and module interconnects
- Assemble in an hour then adjust regulator

Documentation

- Inferior to Doug's docs at NorCal or QRPKits
- Arrl.org member-only In-Depth QST article 6 pp
- <http://www.farrukhzia.com/k2zia/> 25 pp
- Chinese docs skimpy, erroneous or nonexistent
- Arduino.cc IDE download and C reference
- Norcalqrp.org for original 49er manual
- Purdum, Kidder authors of "Arduino Projects for Amateur Radio"

My Forty-9er



VFO Lab

- All new to me: Nano, I²C, encoder, DDS, Buck
- Plan: digital VFO first, then analog radio
- Funduino \$3 or MB-102 \$5 prototyping board
- Banggood.com Dupont F-F & M-F jumpers
- Wrote (plagiarized) test programs
- Test modules separately then integrate them

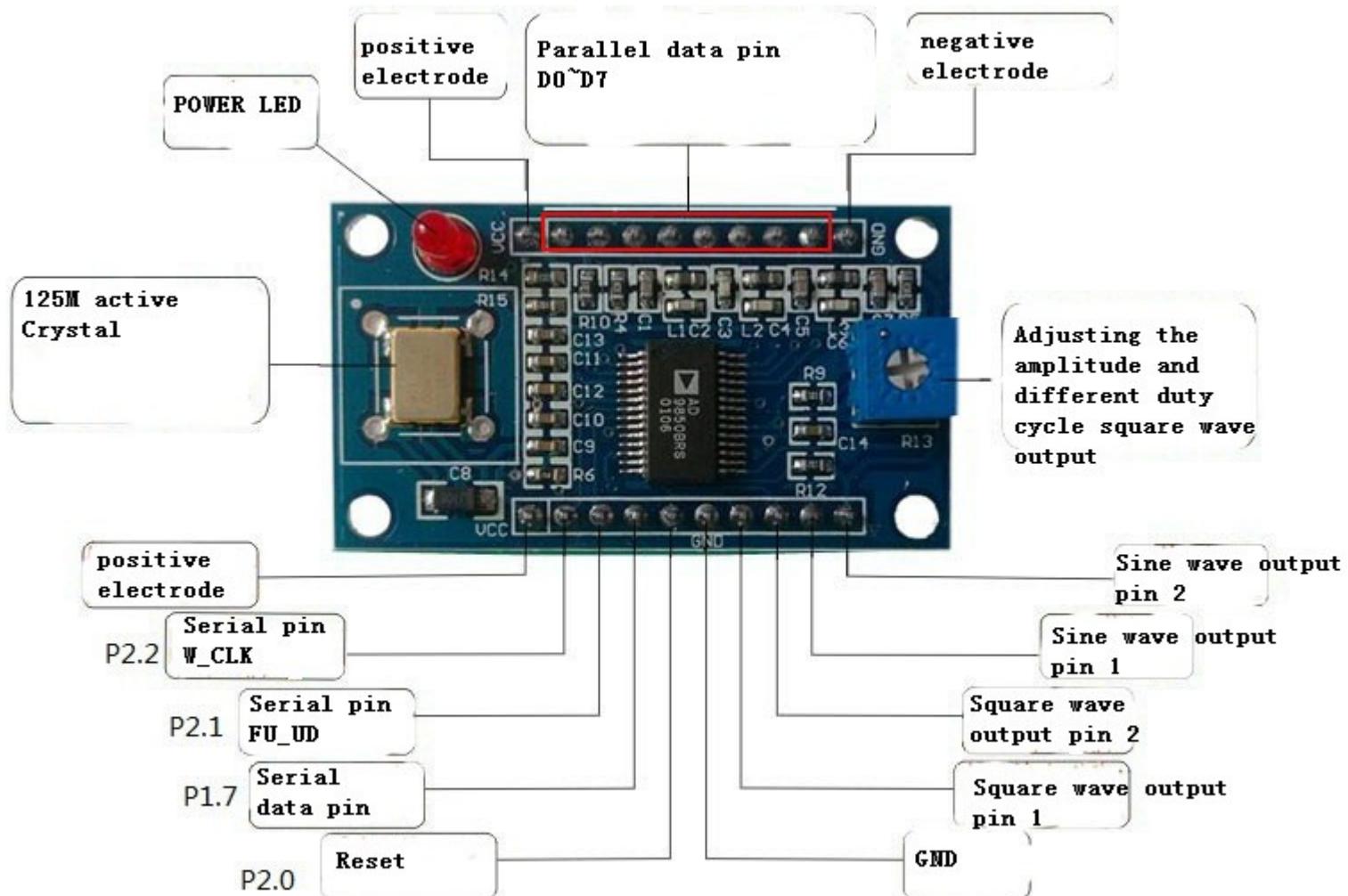
I²C/TWI LCD

- Standard LCD 1602+I²C serial-parallel interface
- I²C: Inter-Integrated Circuit - Philips Semi. multi-master multi-slave single-ended serial computer bus
- TWI: Two-Wire Interface
- SDA & SCK
- +5V & Gnd
- Networked nodes with unique addresses
- Need Wire & NewliquidCrystal libraries

KY-040 Encoder

- Frequency dial control
- DAT & CLK - A&B pulses from 20 detents
- A&B tested to determine CW or CCW
- Pushbutton switch to choose Hz per click
- Debounced with 104 (.1uF) caps to ground
- Gnd connected but not +5V
- Interrupt-driven code

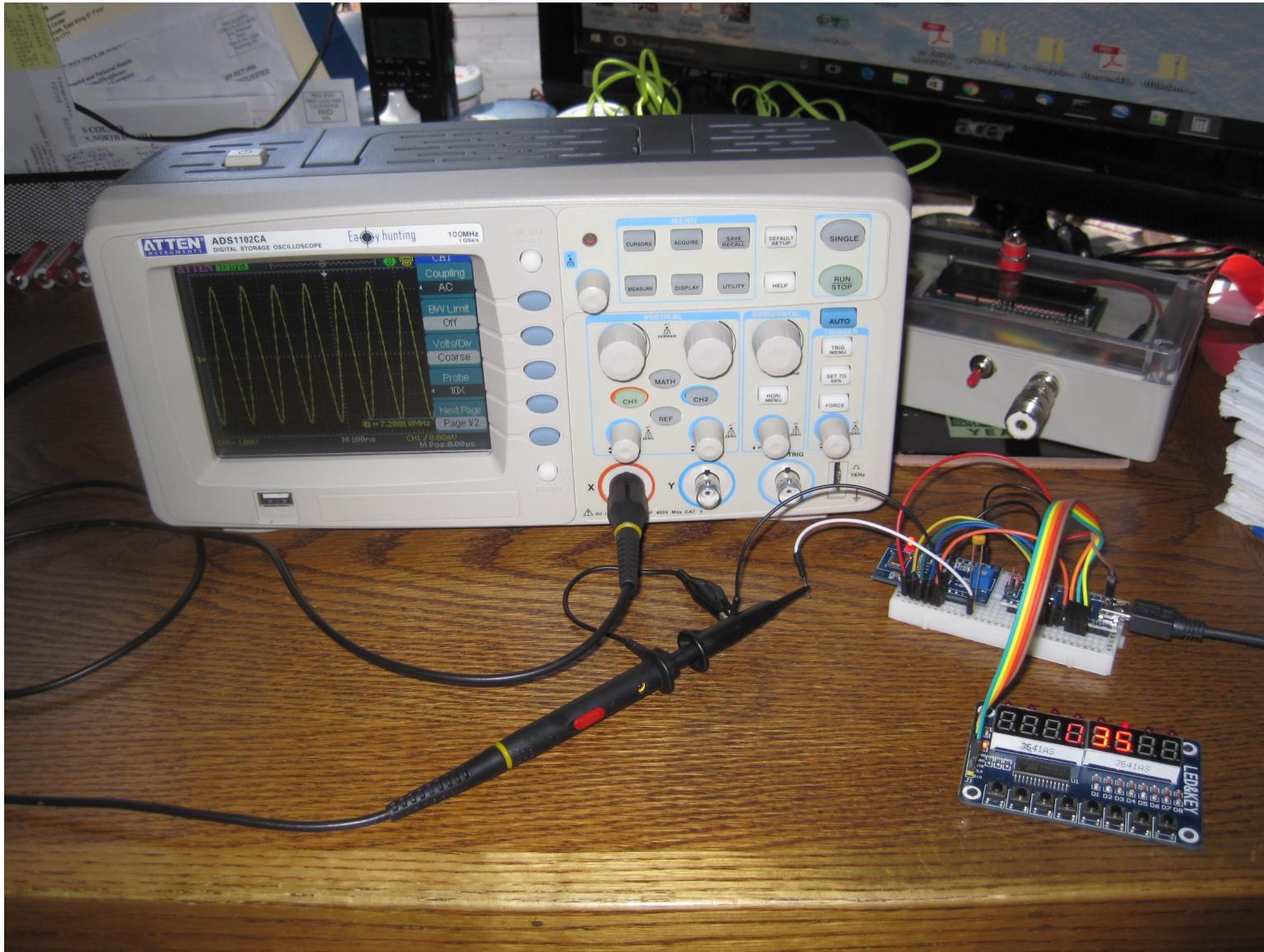
AD9850 DDS



AD9850 DDS

- Analog Devices AD9850
- +3.3V and Gnd
- 4-wire interface (W_CLK, FU_UD, Data, Reset)
- Sine or square wave output
- Programmed by simple code
- Calibrated with a tuning constant

Optional DDS Test Setup

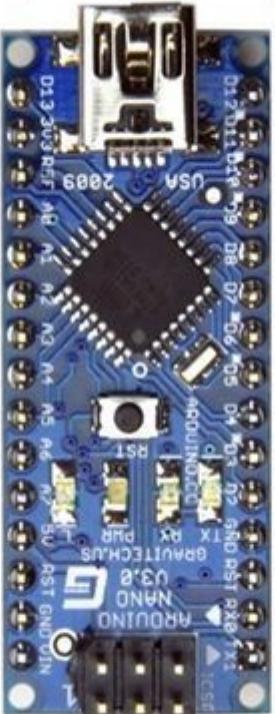


Arduino Nano Hardware

- UNO \$25 from Mouser vs. \$3 Chinese Nano
- Same µP: Atmel (now Microchip) ATMega328p
- 32 Kb Flash(2Kb bootloader), 2Kb SRAM, 1 Kb EEPROM
- Nano has 30 pins, 14 digital (6 PWM), 8 analog
- FTDI serial interface for USB power + upload
- 4 LED's for power, RX, TX, L on pin D13
- Timers, comparators etc.

Arduino Nano V3

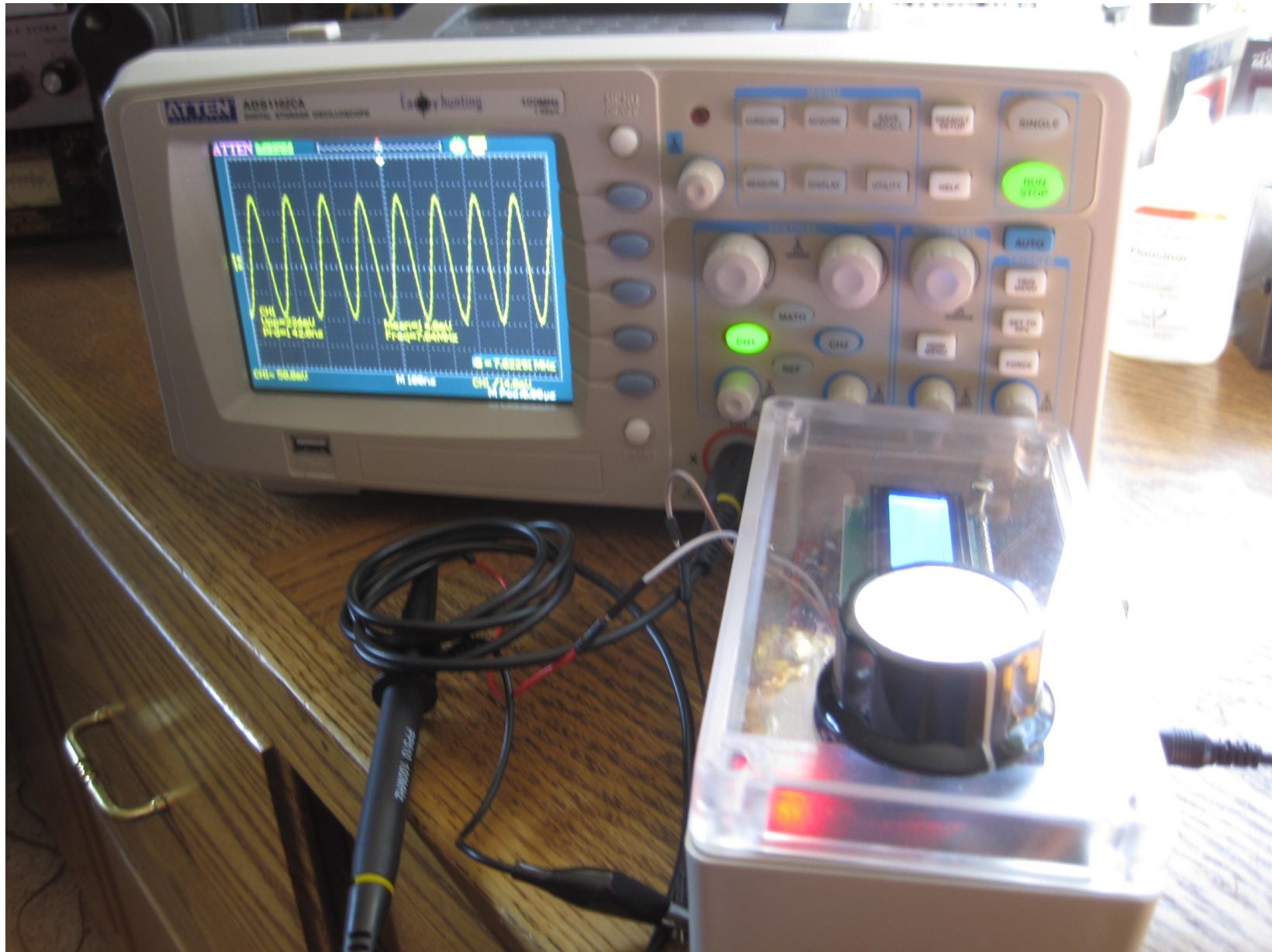
Arduino Nano V 3.0 GRBL Pinout					
Pinout Ref					Pinout Ref
D13	Spindle	Direction	D13		D12
3V3		Not Used	3V3		D11
VREF		Not Used	VREF		D10
A0	Reset/ Abort		A0		D9
A1	Feed Hold		A1		D8
A2	Cycle Star/ Resume		A2		D7
A3	Coolant Enable		A3		D6
A4	(Not Used/ Reserve)		A4		D5
A5	Probe		A5		D4
A6	Not Used		A6		D3
A7	Not Used		A7		D2
			5V	GND	
			RST	RST	
			GND	RX1	
			VIN	TX1	



Arduino Software

- Arduino.cc IDE for Windows, Linux or Mac
- VFOsource from K2ZIA
- NewliquidCrystal_1.3.4 from bitbucket site
- Rotary.h from BrianLow's github site
- Add the 2 (above) zip libraries
- Compile and Upload via USB
- 4 downloads + upload a 15-minute job

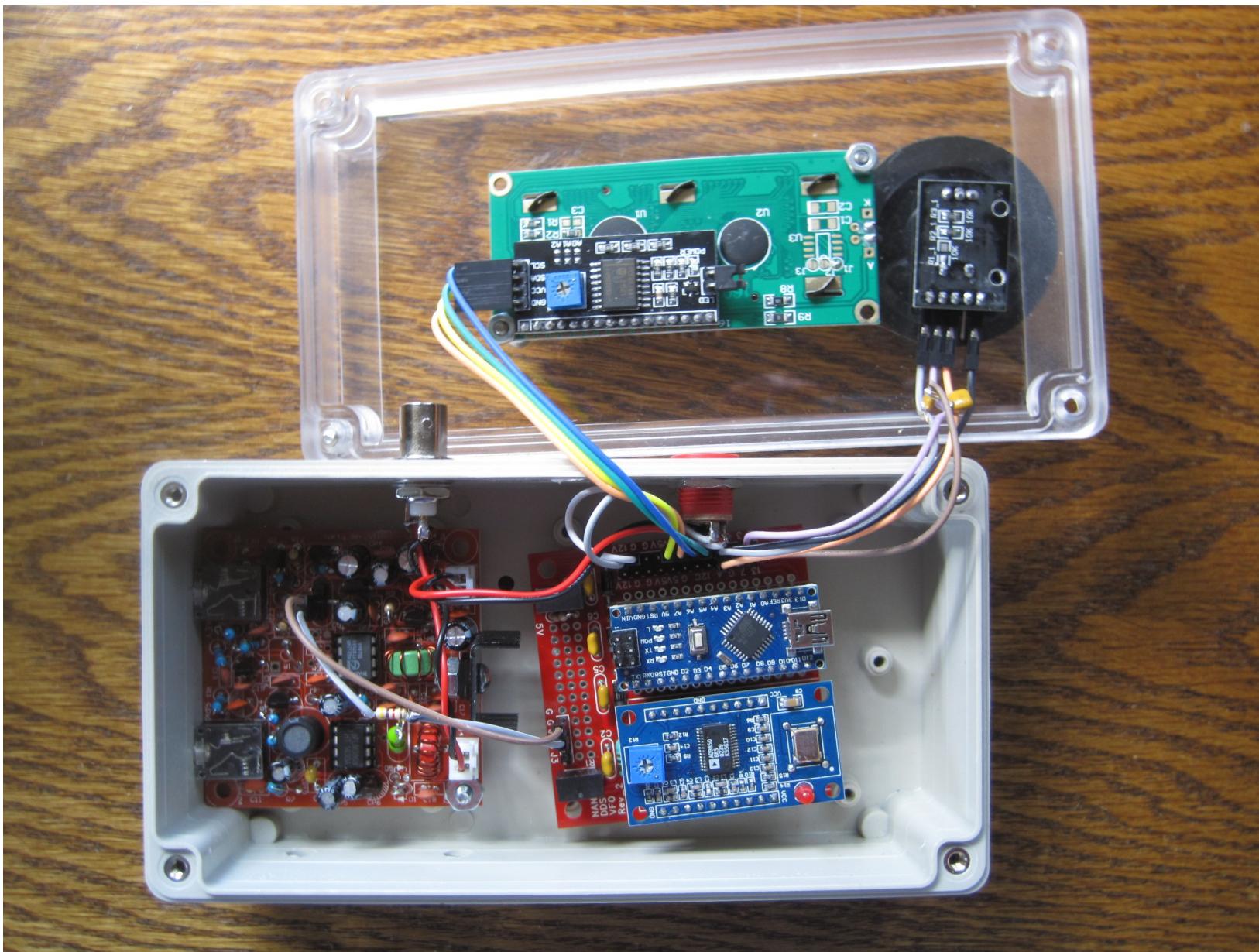
VFO: encoder in LCD & Sine out



Chinese 49er Mods

- 72 parts, including 3 ICs and 6 transistors
- Originally 42, so 30 additional parts
- Wind 2 simple toroids: FT37-43 & T37-2
- Don't install 7 caps & resistors, and 1 diode
- Don't install the 2 crystals – full-band freedom!
- Replace Y1 with antenna filter and zener diode
- Replace Y2 with 3-pin jumper to connect VFO
- Assemble under 2 hours

Interconnections



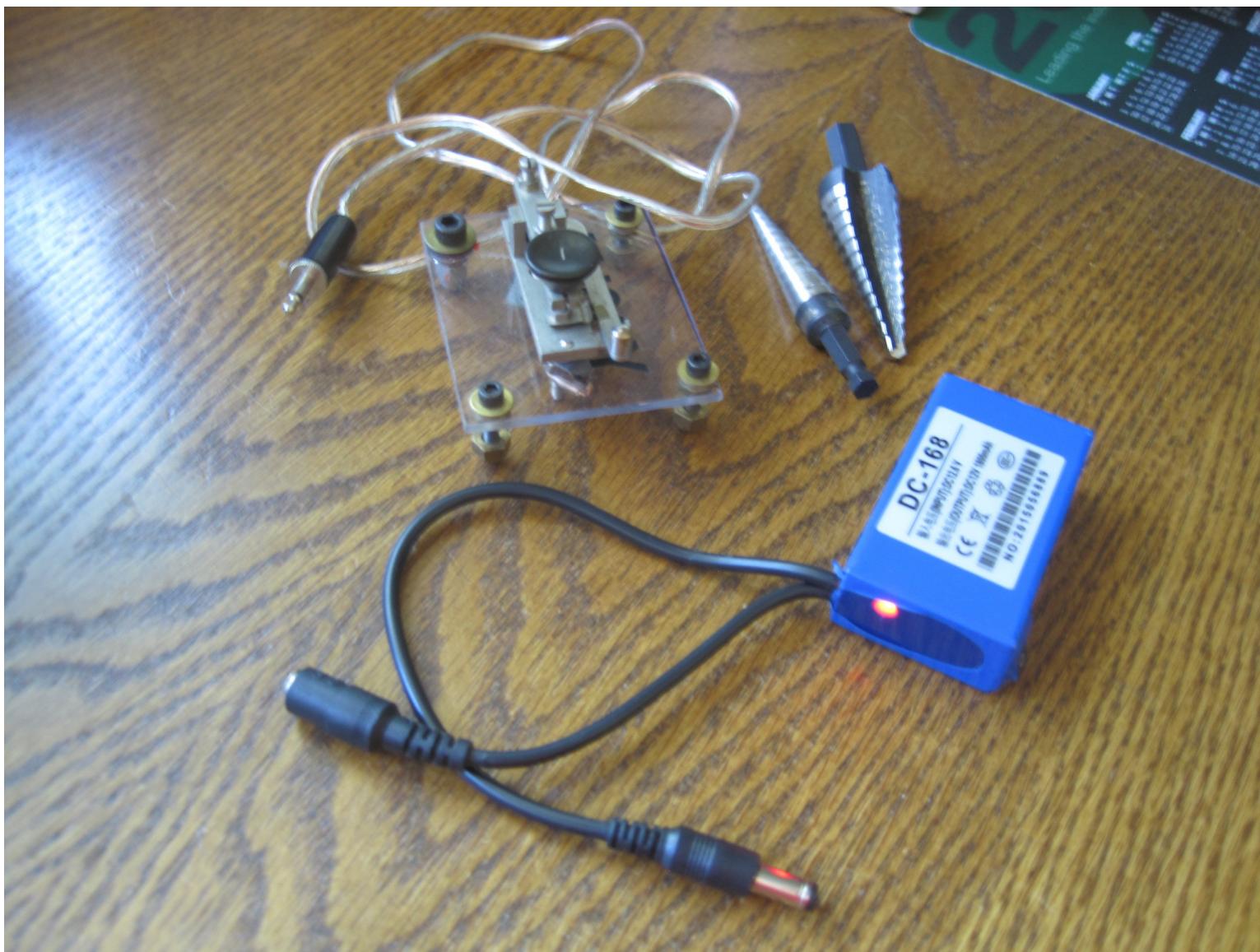
Testing and Calibration

- Visually check power connections
- Adjust pot R1 and ignore R8 (voltage display)
- Calibrate VFO with scope or counter
- Update VFOsource tuning constant & upload
- Attach antenna, twiddle the knob & listen
- Short key jack to hear the nice sidetone
- Transmit to CountyComm GP-5

Boxing Up

- Jameco case, power jack, knob and BNC
- Banggood <\$2 Dupont jumpers
- Banggood \$11 DC-168 12-volt Lion camera battery and charger with switch & LED
- Banggood one step drill bit to drill all holes
- Spacers, screws and nuts from Home Depot
- Get creative, even artistic

Accessories



Operation

- Plug in power, headphones, key, antenna
- Power on
- Push switch for desired initial step rate
- Alternate knob and switch for target frequency
- Listen
- Key CQ

Booboos

- Killed first DDS before regulator set to 5V?
- Soldered power jack and BNC backwards
- Diagram reversed encoder at Mother's 2 & 3
- Phone & key jacks better on short side
- L3 should be ~22 uH with 8 turns, not 11?
- I failed to solder one leg of C10, but did later
- Transmitter 0 watts – replaced Q5 with BD139 & Q6 with 2N3904
- R1 must set so J6 <300 mVPP

Optional Upgrades

- Update software to show battery voltage
- Encoder speed detector to change step rate
- Replace D882 with BD139 and need heatsink
- BCI filter in QRPP
- NorCal touch keyer
- Antenna Analyzer \$50 from the same team

Lessons Learned

- Failure is an option and the path to learning
- Can modernize any old radio with digital display and precise VFO
- Customizing software easier than hardware
- "Nano nano beats UNO" – Mork from Ork
- Made in China cheap but risky; QC suspect
- Merit badges for I²C, DDS, encoder, Nano

Plunk Your Magic Twanger, Froggy



Links

- Yahoo group: SoftwareControlledHamRadio
- www.farrukhzia.com/k2zia for VFOsource
- Arduino.cc for the IDE
- Github.com for NewliquidCrystal
- Bitbucket.org for Rotary.h
- Norcalqrp.org for Doug's original 49er manual
- Bob.Mix@att.net