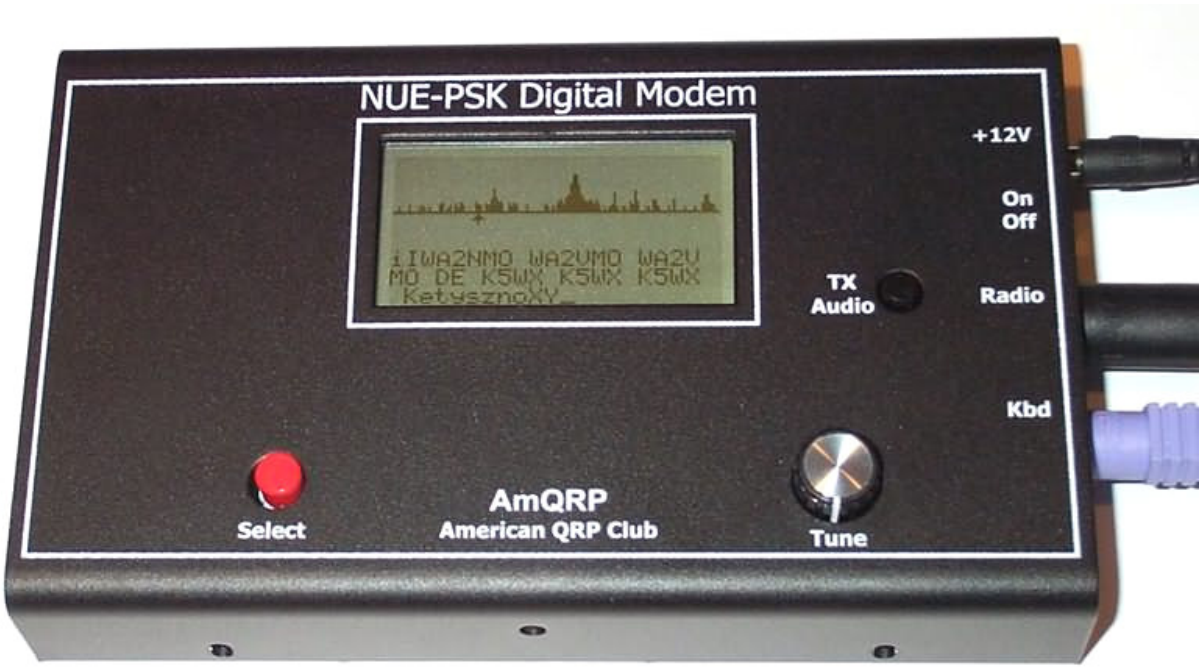
NUE-PSK Digital Modem

KIT MANUAL



Introduction

Thanks for purchasing the NUE-PSK Digital Modem Kit. The NUE-PSK is a standalone, battery-operated digital modem using Microchip dsPIC technology. Weighing about 12 ounces and requiring only 60ma at 12V DC, the modem is easily taken to the field. For easy visibility in high or low ambient light, the NUE-PSK modem's backlit graphic LCD displays transmit and receive text data, as well as band spectrum and tuning indicator. When coupled with a standard PS2 or USB keyboard and an SSB-capable transceiver, you can have an effective portable PSK31 station.

The NUE-PSK Digital Modem is the creation of designer Milt Cram, W8NUE, coupled with some good experimenters in the Austin QRP Club, and George Heron N2APB for the productization of the design.

This documentation package is not intended to be an extensive, step-by-step manual for beginning homebrewers – admittedly, it is somewhat minimal and you will depend on your capabilities as an experienced kit

builder to successfully get it together. The kit has a few tricky SMT integrated circuits; but with some careful attention, steady hands and good eyes, you should do okay.

Be sure to check out the Operator's Manual and the QuickStart Sheet for modem functional guidance. These resources can be downloaded from the modem website at www.nue-psk.com, as can be tons of other useful information and reference material. The software source code is located there too if you are also a software homebrewer.

Kit inventory & Parts Notes

This documentation will be appropriate for those assembling the **full kit** or the **partial kit**. The full kit of course includes everything listed on the Parts List sheet, while the partial kit is just the pc board and the two pre-programmed microcontrollers.

Full Kit

Partial Kit

We were fairly careful to include the correct counts for the items. Nevertheless, let us know if there is a need for any replacements and we'll do our best to accommodate.

From this point forward, I'll discuss the Full Kit … you partial kitters will be getting the parts on your own, but you can of course follow the same guidance as is provided here for the full kitters.

I won't go through a detailed description of everything in the parts bag, but I will point out some of the things to watch out for upon initially opening things up and sorting them all on the bench.

Documents – Here's a list of the printed items included in the kit:

Kit Manual
Schematic
Parts List
Parts Layout
Mechanical Diagram
QuickStart Guide

Hardware – You will find a few small bags containing the required screws, spacers, etc. One bag is located in the main plastic pouch (the larger section on the left in the Full Kit photo shown above), and the other is in the smaller pouch on the right in that same photo. You will ultimately end up not using some of the hardware in the first one, as we initially didn't have the correct screws and spacers for attaching the LCD. You will use the items specified in the Parts List and illustrated in the Mechanical Assembly diagram, and you will not use the ¾" #2 screws, the #2 nuts, and the unthreaded #2 spacer

Main Component Bag

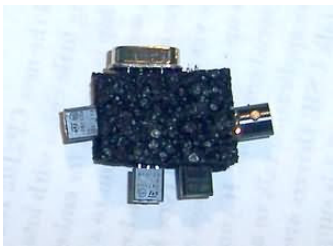
Microcontrollers – Some things to watch out for in this area …

dsPIC – Attaching this 64-pin TQFP surface mount package (U1 on the schematic) is the trickiest part of the whole kit. The first trick is just to get the package open! Shown on the left below, the IC is taped between two pieces of anti-static material. To open, use a razor blade to slide horizontally around the perimeter of the package. The part is pre-programmed with the modem program v1.20e, so once you do get the board assembled, the display should come up with the typical application splash screen. More on this part later.

MC68HC908QY4 – This is DIP package shown below on the right. It is U5 on the schematic and it is preprogrammed with the keyboard controller application, version 1.7. You need to plug this into the corresponding DIP socket in the kit … i.e., do not solder it in place! You may need to remove it later for reprogramming if/when additional features come out in this area.

U1: dsPIC Main Controller

U5: 68HC908QY4 Keyboard Controller

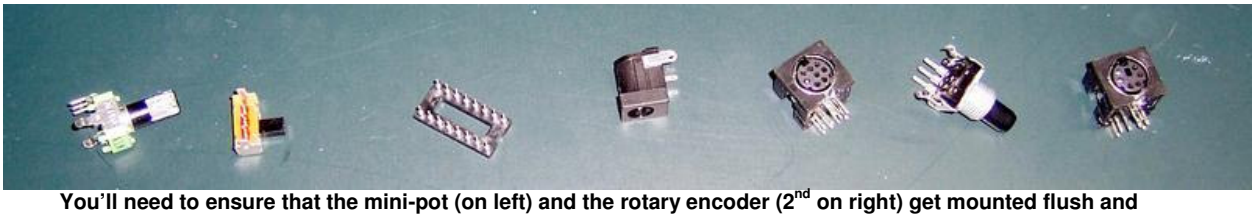


Conductive foam for Q1, Q2, Q3, U10 and the crystal

SMT Bag – We provided the bag below with individual pockets marked and containing the little SMT chip parts. This turned out to be the easiest way to identify the little critters for you. Just cut open the respective packet when you need to install the part.

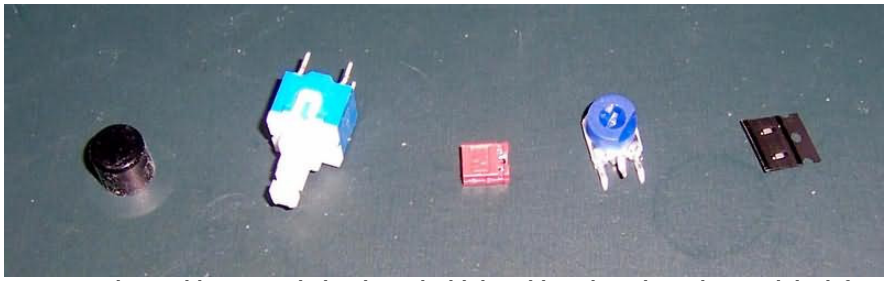
Other Parts – See the photos of some of the other parts in the kit below, with a few guidance notes indicated on each, where needed. Not all the parts are shown here, as some in the package are quite obvious.

The piezo (right) gets mounted on the bottom of the pcb.



You'll need to ensure that the mini-pot (on left) and the rotary encoder (2nd on right) get mounted flush and perpendicular to the pcb. If not, your case will not fit properly.

The flex cable assembly is on the left, followed by the battery cover for the case, the LCD (wrapped in anti-static padding, the IC bag and the switching regulator U9 (in a cut plastic tube mostly for mechanical protection).



Be sure to mount the pushbutton switch oriented with its white tabs oriented toward the left and right.
Don't lose the little red shunt, as you'll need it to select Hi-Drive for the audio output level.
Ensure that the trim pot is oriented perpendicular to the board (in order that the case fits right.)
The package on the right contains D4 and D5 … they are really tiny diodes and you'll definitely need to use tweezers and a magnified lamp to mount them, but they are actually pretty easy to attach once you identify the end marked with a little bar (indicating the cathode).

Assembly Notes

You should assemble the kit generally in this order.

Attach the dsPIC (U1) – If you spend 4 hours assembling this whole kit, spending 3 of those hours on carefully attaching the dsPIC would be quite appropriate. You **need** to get this one right, or nothing else will work. If you are comfortable using the "solder paste and oven" method of attaching SMT chips, this would be a good one to use it on and you will have excellent results. Otherwise, you'll need a very fine tipped soldering iron, a magnified lamp and/or magnified viewer headset, some Solder Wick™ (supplied in the kit), and some of the very thin .015" solder. There is a dot on the IC package that denotes pin 1 and that corner of the chip should mate with the dot on the pcb legend for U1. Next, holding the package with your fingertips or tweezers, carefully ensure that the package leads are all oriented properly over their respective pads and tack solder the lead in one corner to its pad. Then go to the opposite corner and, again ensuring that the IC leads are still properly aligned over their pads, tack down that second lead to its pad. Double, triple, and quadruple check that all pins are properly aligned over their leads. Is the package dot in the bottom right corner where the dot is by pin 1 on the silkscreen? Okay, now go ahead and solder the rest of the pins to the pads. The pins of the IC will need to be kept all in the same plane for best results in attaching each leg to its respective pad. (i.e., don't go bending each leg down to the pad when soldering, but instead let the solder flow up to the lead.) You might need to add a little solder along the way – don't worry about slobbering too much and shorting pins, as you'll be able to go back and draw it off using the solder wick. When you're all done, you should inspect every lead, at every angle, hider the highest power magnification possible to ensure that each is soldered to the pad (and not floating above without connection), as well as ensuring that there are

no shorts between pads. You could clean off the flux now with isopropyl alcohol and a cotton swap, if desired. Whew, that was easy, huh?

Here's another technique, as described by veteran homebrewer Kees Talon, K5BCQ

> *The board appears to have plenty of solder leveling on the large pads, so:*
>
> *1) Wipe the solder flux pen across pads*
> *2) Place the part .....SPEND YOUR TIME HERE, to get it right*
> *3) Tack a few pins by bringing a hot soldering iron to the PAD not to the PIN (don't touch the pin), do a few of these and the part is tacked down. Do NOT use/add any solder. Do not try to hold the part down....you will only move it.*
> *4) After its tacked down, check the registration, recheck the registration.*
> *5) Run the clean, hot, iron tip slowly down one side at a time, up against the ends of the pins, while pressing down on the part. You can see the relevel solder melting as you go. Do NOT use/add any additional solder.*
> *6) Check the solder joints with magnification. Touch up where needed. Do NOT use/add any additional solder.*
>
> *Net result, quick, no bridging, all the pins look good. You can use the same technique for the SOICs but you will probably require a LITTLE solder added to the pins because the pins and pads are larger. Just add a little to the solder iron tip and slowly wipe it across several pins. Works great. Do this after the part is tacked in place and you are satisfied with the registration.*

Attach the two TXB0108 level shifter IC's (U2 and U3) – These packages are smaller than the dsPIC, but I've found them to be equally troublesome in attaching by hand. Again, if you use the oven reflow approach, you're golden. Otherwise follow the same guidance as above with the dsPIC.

Attach the remaining SMT integrated circuits -- Of course, be careful to orient properly for pin 1 in each case.

Attach the SMT chip components -- from the plastic bag with the pouches.

Attach the SMT electrolytics – The negative side of these little silver cans are denoted by a black mark on the top of the case. This negative side should of course be facing away from the + indicator on the silkscreen.

Mount all the rest of the larger components -- Be sure to mount the piezo and P4 on the bottom of the board. Don't solder the piezo beeper until you do the LCD cable (next step) or you will have difficulty soldering the LCD cable. Also make sure no LCD cable pins short anything in the piezo beeper.

The two rotary controls require a lot of force to fully seat them against the board. If you don't do that something may interfere with the covers later.

R14 also requires some force to seat and the middle pin is real easy to "fold up" so you need to watch that.

D4 and D5 are real tiny diodes. They DO have a cathode band (flip the head magnifier loop down) and so does the board silkscreen.

Attaching the 20-lead flex-wire – There is not much length on this cable reaching from the "LCD P6" point on the pcb up to the LCD. So you'll need to just barely insert one end of the 20-wire cable into those 20 holes and solder them. It's best to have the cable barely inserted to the holes and sitting at an angle leaning toward the eventual location of the LCD. If you insert the one end of the cable part-way, and at an angle into the 20 holes in the

PCB, solder them, then bend the cable over to the LCD holes (which you should generously pre-tin), push the cable leads to lay flat across the surface of the LCD pads, and solder each one to the pad. Works like a charm and takes about 1 minute overall to do. (30 sec on the pcb row of holes, 30 sec on the LCD row of holes.)

Insert the keyboard controller U5 -- into its socket.

Attach Battery Leads – Route the battery leads up through the outermost holes in the pcb and then attachg to the proper solder pad. Again,, be sure to follow the guidance indicated on the web page.

Mechanical Assembly – Follow the diagram shown in the Mechanical Assembly sheet to attach the four shorter standoffs to the bottom of the pcb, and the four longer standoffs to the top of the pcb (for the LCD). Screw down the LCD. (Yes, we know the top two mounting holes of the LCD are only half-holes. They were born that way.)

Solder the LCD – Bend the flex-wire assembly over to the LCD and have the leads enter the pads on the LCD board from the bottom side and solder them in place this way. This will give you enough lead length on the flex-wire cable to reach over to the LCD.

Screw the LCD in place, using the Mechanical Assembly diagram as a guide. Use the 3/8"aluminum standoffs, with the 2-56 screws.

TESTING

Okay men, smoke 'em if you got 'em". Just a little war humor here, as now the real challenge begins … getting the modem working.

It's best to use a current-limited power supply on the bench for these kinds of projects, or perhaps one that displays the current being supplied. You should turn on the power and see only about 60 ma being pulled from the supply.

If things are good, you can adjust the contract trim pot to see a lighted display and(ideally) the initial screen sequence on the display. *NOTE: Some kits are supplied with a blue or yellow backlight, or even possibly being a "reverse text" (white text/graphics on colored background) LCD version.*

Using a scope or DVM, you should see 5V on the 5V test point (middle-top of the pcb), and you should see 3.3V at the 3.3V test point (just below the left corner of the LCD area.)

You should see a nice 10 MHz oscillator signal when you touch your scope probe to the outer side of C16.

With batteries plugged in you should see close to 18V at the Batt TP test point (upper left of the pcb.)

FULL CHECKOUT AND MODEM USE

If everything was done as described, I'm sure things are all working just as stated so far. If not, roll up your sleeves for some careful debug and close inspection for proper component placement, solder shorts, open, warm parts, etc. Let us know on the Yahoo NUE-PSK Group reflector what your problems are and we'll work through it.

If things are indeed okay (and it is quite possible – there was a good deal of success in the field trial for this kit), proceed on to reading and following the **QuickStart Guide** (included in this kit) and the **Operator's Manual**, downloadable from the NUE-PSK website (www.nue-psk.com). These documents will describe initial set-up, command and typical operating scenarios.

Good luck with everything and let me know if you have any questions along the way.

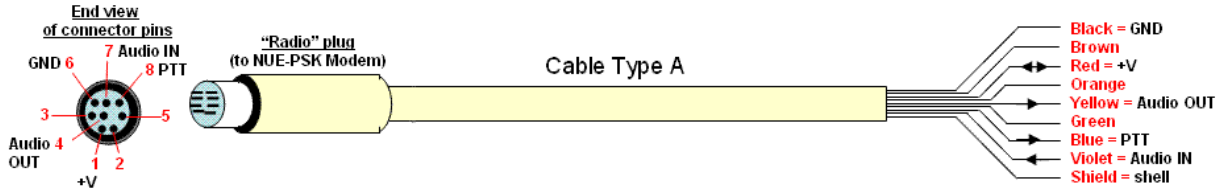
73, George N2APB n2apb@nue-psk.com

Appendix A: The Radio Cable

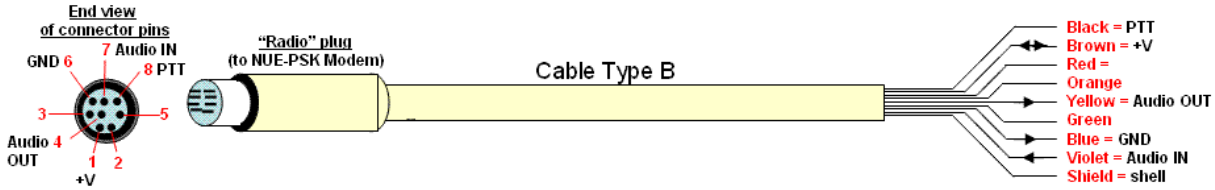
This diagram represents what is shipped with your NUE-PSK modem. Since the modem can interface with literally hundreds of different SSB transceivers, it will be necessary for you to connect the "unfinished end" of the Radio cable to properly interface with your specific radio. Once you have the proper connector in hand for your radio, the task is simple – just use the signal names and wire colors here as a guide to get the PTT signal and audio tones to your rig.

The cable supplied with the modem has color-coded wires on one end, either as shown in Figure A or in Figure B below. You will need to determine which type you have before attaching the connector required for the data connection to your specific radio.

You can easily determine which cable type you have by using a VOM to check for continuity from pin 8 on the molded Radio plug to the blue wire on the other end of the cable. If there is continuity, you have Cable Type A. Otherwise, with pin 8 continuity to the black wire, you have Cable Type B

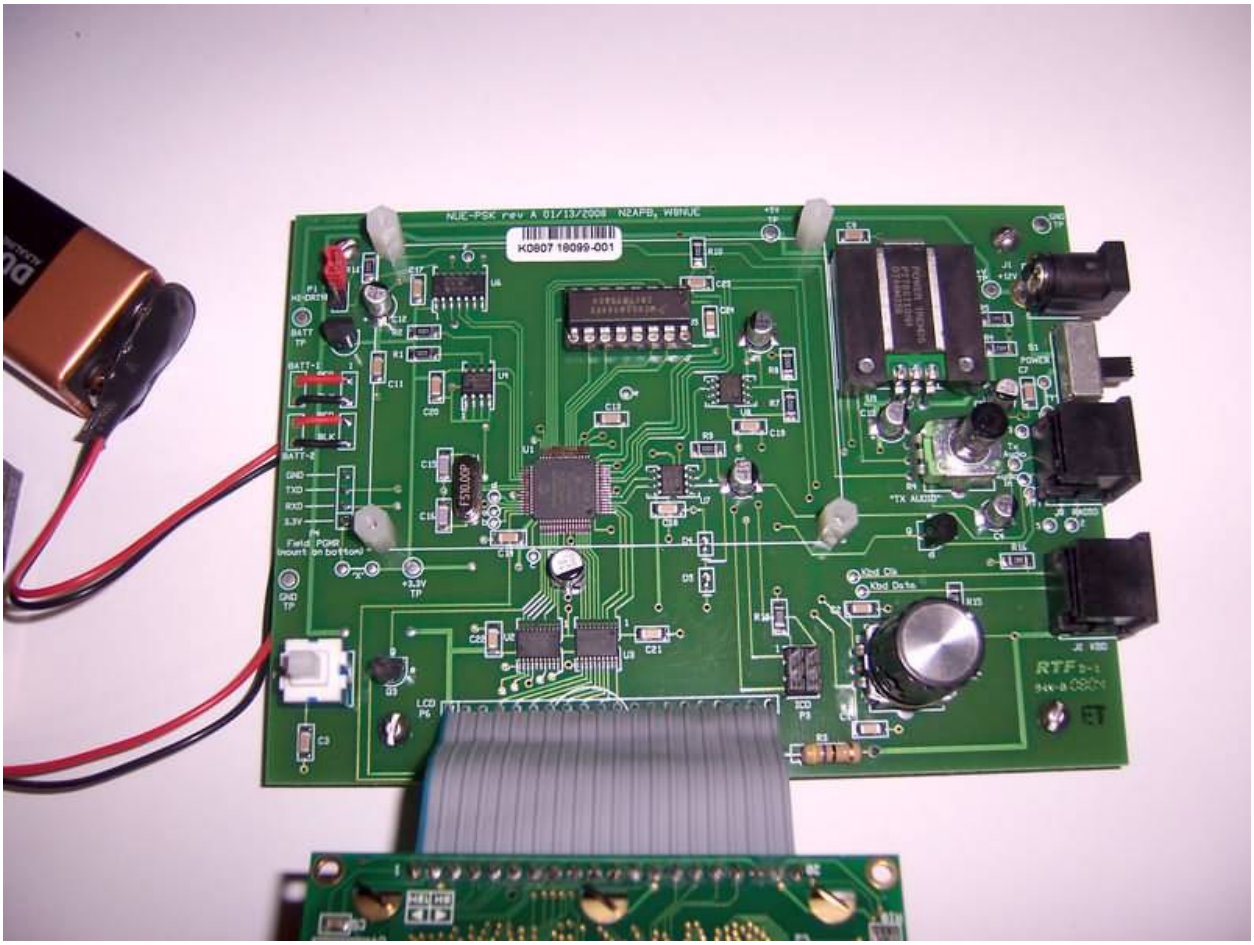


OR …

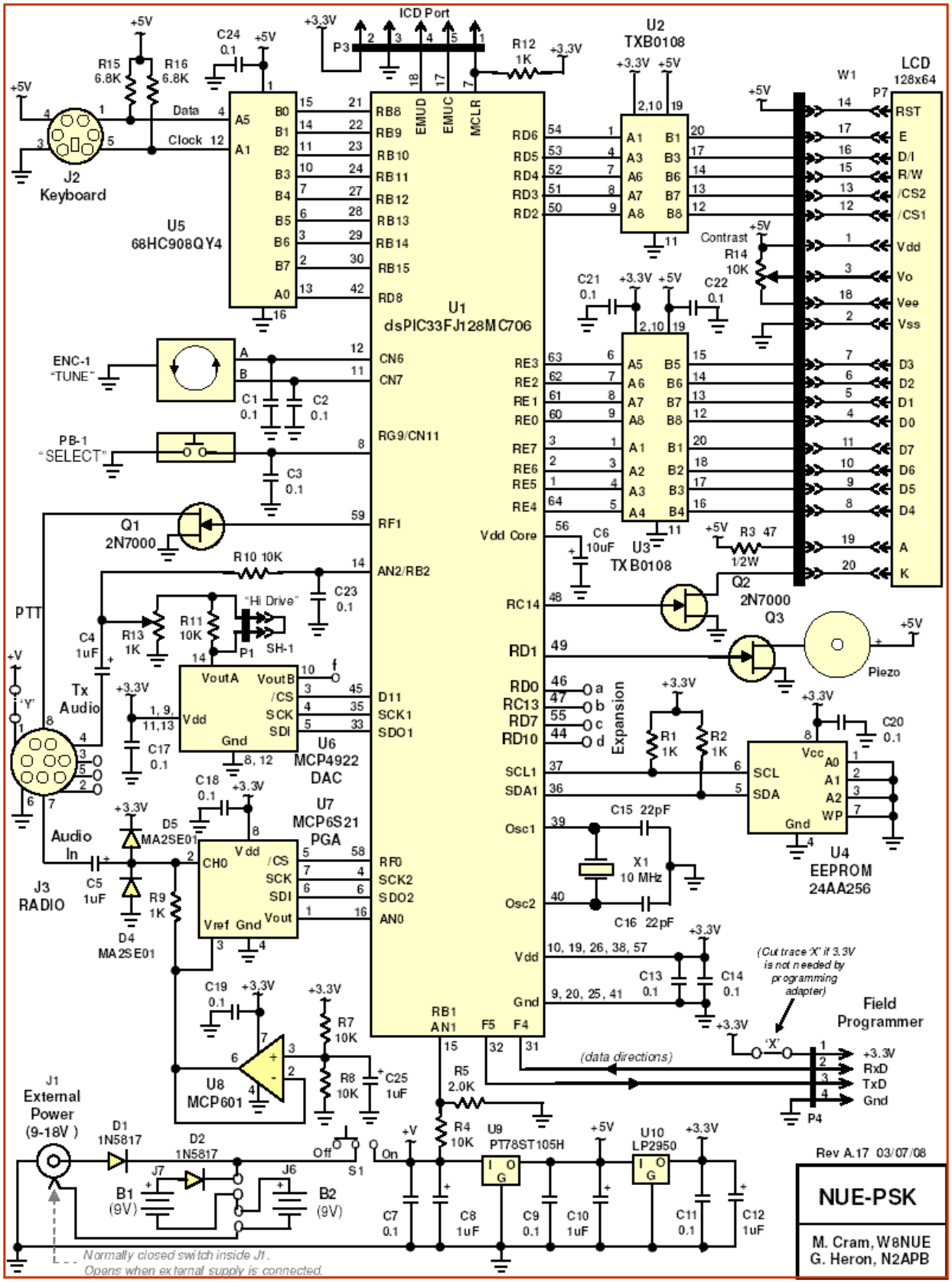


To help owners get on the air as quickly as possible with their new modems, we have made certain custom cables available for purchase from the NUE-PSK website. If interested, see www.nue-psk.com for available options. We also have identified a resource you might call upon to help you make a custom cable for your radio, if desired.

APPENDIX B: Completed Assemblies



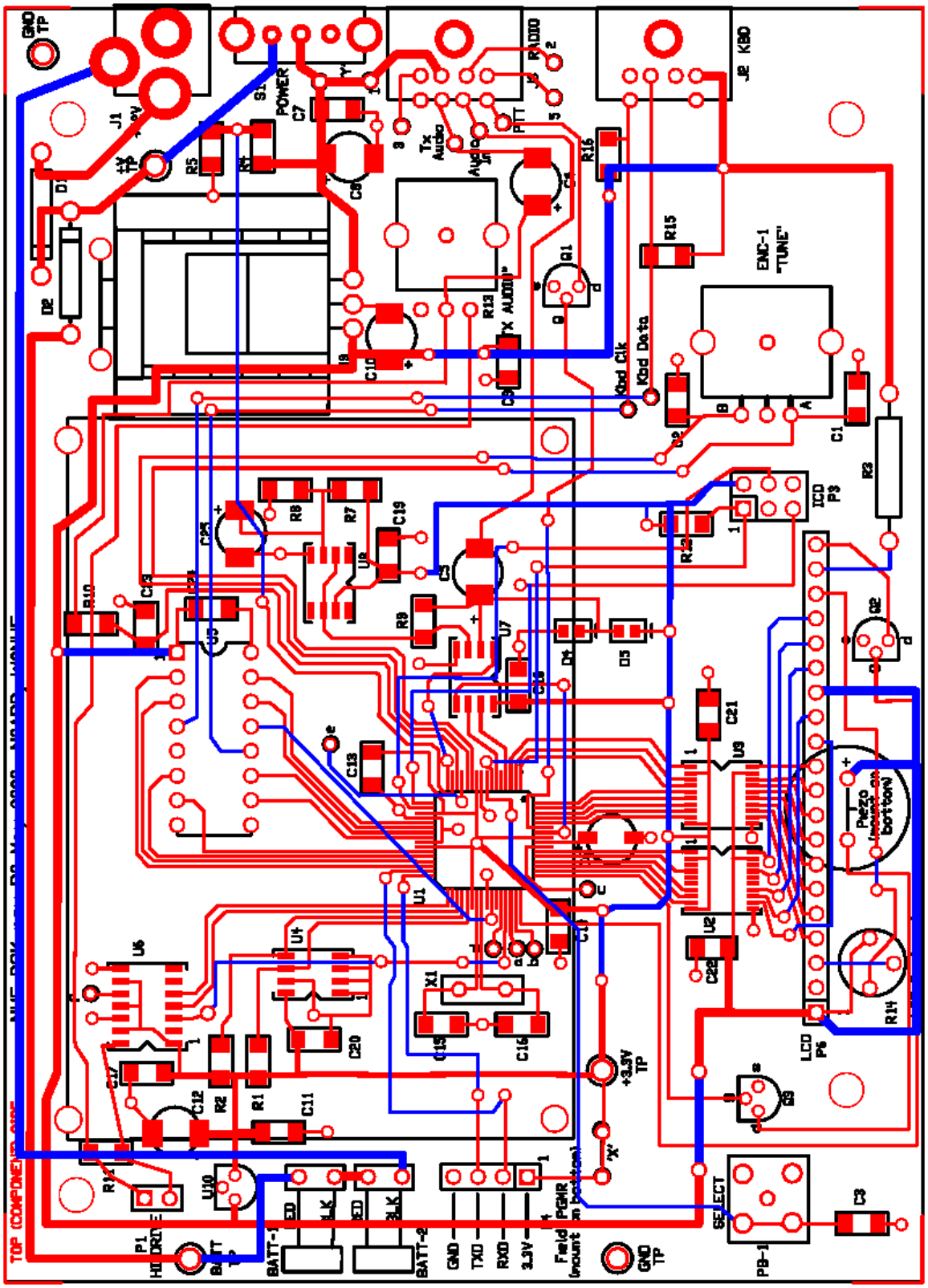
APPENDIX C: Schematic



APPENDIX D: Parts List

Designator	QTY	Description	Source	P/N
C1, C2, C3, C7, C9, C11, C13, C14, C17, C18, C19, C20, C21, C22, C23, C24	16	Capacitor, 0.1uF, 1206 SMT	Digi-Key	PCC1883CT-ND
C4, C5, C8, C10, C12, C25	6	Capacitor, 1uF, 16V, SMT	Digi-Key	PCE3045CT-ND
C6	1	Capacitor, 10uF, 35V, SMT	Digi-Key	PCE3118TR-ND
C15, C16	2	Capacitor, 20pF, 1206 SMT	Digi-Key	311-1153-1-ND
D1, D2	2	Diode, Schottky, DO-41	Digi-Key	1N5817RLGOSCT-ND
D4, D5	2	Diode, Schottky MA2SE01, SMT	Digi-Key	MA2SE0100LCT-ND
ENC-1	1	Rotary encoder	Mouser Digi-Key	688-EC12E2420802 P10860-ND
J1	1	Coaxial DC pow er connector, 21.mm	Mouser	163-5004-E
J2	1	6-pin Mini-DIN	Mouser	161-2206
J3	1	8-pin Mini-DIN	Mouser	161-2208
J5	1	IC socket, 16-pin DIP	Mouser	575-199316
J6, J7	2	9V battery clip	All Electronics	BST-3
LCD	1	LCD, CFAG12864, 128x64, graphics	Crystalfontz	CFAG12864BTFHV
P1	1	Pinheader, 1x2, 0.1"	Mouser	517-834-01-36
P3	1	Pinheader, 2x3, 0.1"	Mouser	517-836-01-36
P4	1	Pinheader, 1x4, 90-deg	Mouser	517-5111TG
PB1	1	Pushbutton, DPST, momentary	New ark	19C6398
PB1-cap	1	Pushbutton cap	New ark	49H6733
Piezo	1	Piezo buzzer	Digi-Key	433-1023-ND
Q1, Q2, Q3	3	Transistor, NFET, 2N7000	Digi-Key	497-3110-ND
R1, R2, R9, R12	4	Resistor, 1K, 1206 SMT	Digi-Key	RHM1.00KFCT-ND
R4	1	Resistor, 10K, 1206 SMT, 1%	Mouser	71-CRCW1206-10K
R5	1	Resistor, 2.0K, 1206 SMT, 1%	Mouser	71-CRCW1206-2K
R7, R8, R10, R11	4	Resistor, 10K, 1206 SMT	Digi-Key	311-10KERCT-ND
R13	1	Mini-potentiometer, 1K	Mouser	317-2080F-1K
R3	1	Resistor, 47-ohms,1/2W axial	Mouser	293-47-RC
R14	1	Trim pot, 10K	Mouser	652-3306W-1-103
R15, R16	2	Resistor, 6.8K, 1206 SMT	Digi-Key	311-6.8KECT-ND
S1	1	Sw itch, SPDT, slide, pcb mount, 90-deg	Digi-Key	EG1917-ND
SH-1	1	Pinheader, 1x2 shunt	Mouser	517-951-00
U1	1	IC, Microchip DSC, 64-pin QFP, dsPIC33FJ128MC706	Mouser	579-33FJ128MC706IPT
U2, U3	2	IC, Octal Level Shifting Buffer, TXB0108 (TSSOP-20)	Mouser	595-TXB0108PWR
U4	1	IC, Microchip 128x8 bit EEPROM, 24AA1025 (8SOIC)	Digi-Key	24AA1025-I/SM-ND
U5	1	IC, Freescale microcontroller, MC68HC908QY4, 16-DIP	Digi-Key	MC68HC908QY4VPE-ND
U6	1	IC, Dual-DAC, MCP4922, 14SOIC	Digi-Key	MCP4922-E/SL-ND
U7	1	IC, Programmable Gain Amplifier, MCP6S21, 8SOIC	Digi-Key	MCP6S21-I/SN-ND
U8	1	IC, Op Amp, MCP601, 8SOIC	Digi-Key	MCP601-I/SN-ND
U9	1	Voltage regulator, 5V Sw itching, PT78ST105H, 5V	Digi-Key	PT78ST105H-ND
U10	1	Voltage regulator, 3.3V, LP2950 (TO-92)	Digi-Key	LP2950CZ-3.3-ND
X1	1	Crystal, 10MHz, 20pF (FOXSLF/100-20)	Digi-Key	631-1101-ND
W1	1	Flex Cable, 20-w ire, 0.1"	New ark	
	8	Machine screw , pan slotted, #2-56x0.25"	Mouser	5721-440-1/4-SS
	8	Machine screw , pan slotted, #4-40x0.25"	Mouser	5721-256-1/4-SS
	4	Spacer, hex tapped, #2, 0.375" (LCD)	DigiKey	1797DK-ND
	4	Spacer, nylon, hex tapped, 4-40x0.25" (PCB)	Mouser	561-L4.25
	1	Knob	Mouser	506-PKG50B1/4
	1	PCB	BAC	
	1	Cable, 8-w ire, mini-DIM connectors (cut in half)	Jameco	10604
	1	Ten-Tec (custom)	Ten-Tec	
	1	Desolder braid	Digi-Key	EB1105-ND
	1	Flux Pen	Digi-Key	KE1804

APPENDIX E: Parts Layout



APPENDIX F: Mechanical Assembly