Nouveau-75A

75 Meter QRP AM Transceiver

Four State QRP Group

David Cripe NM0S

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Manual for Nouveau 75A AM Transceiver

Overview

The Nouveau 75A is a 75 Meter, QRP AM voice transceiver produced by the Four-State QRP Group. This design is simple, yet full-featured, efficient, and easy-to-build. This kit utilizes a hybrid construction, with about 80% of its components pre-installed surface mount devices. The remaining components are large, through-hole connectors, controls, and power devices. The kit includes a pre-drilled, silk-screened enclosure made of PCB material. The finished result is an attractive, functional radio that is easy to assemble and operate.

The name, ‘Nouveau 75A’, is a nod to the legendary ‘Retro 75’, AM transceiver designed by Dave Benson, K1SWL. Since production of the Retro 75 ended, there have been no AM QRP kits available to take its place. This new kit was designed to fill that market niche.

FEATURES:

Power Requirement: 11 to 14 VDC,

Receive current: 120mA, typical

Transmit Current: 600mA unmodulated, 2.5A peak, typical

Antenna: 50 ohms at < 1.5:1 VSWR

Five watt carrier output, with +/- 100% modulation capability. Twenty watts PEP.

Rugged IRF510 PA running Class-E at approximately 95% efficiency

Digital tuning, 1 kHz steps (5 kHz steps outside of ham band)

Four-digit LED frequency readout.

Transmit frequency range 3.605 to 3.995 MHz.

Receive frequency 3.000 to 6.200 MHz.

Highly efficient transformerless Class-G modulator

Built-in speaker, with headphone jack.

Handheld microphone included.

Effective AGC.

Front panel LED AGC and modulation-peak indicator.

Reverse-voltage protection.

THEORY OF OPERATION

The heart of the Nouveau 75A is a microcontroller-driven Si5351 PLL used as the VFO frequency source for both receive and transmit. A rotary encoder interfaces to the microcontroller to control the frequency of the VFO. In the receive mode, DC voltage is removed from the PA MOSFET drain, and the 6 MHz VFO signal applied to the gate of the PA. The PA MOSFET behaves as a switching mixer and downconverts the 75M input signal to the 2MHz IF.

The 6 kHz bandwidth IF filter comprised of three ceramic resonators. This is followed by a two-transistor IF amplifier. The 2MHz IF signal is boosted by a 40 dB IF amplifier, then demodulated by a detector circuit which also provides AGC. The signal is then amplified to speaker levels by an NJM2113 headphone amplifier.

The microcontroller also sends the frequency information to the front panel display, a four digit LED readout, displaying frequency to 1 kHz resolution. The receiver is capable of being tuned outside the 75M amateur band, where the encoder step size increases to 5 kHz.

A handheld microphone is included with the kit. When the push-to-talk switch is pressed, this is sensed and the microcontroller commands the Si5351 PLL to move to the 4 MHz transmit frequency. The output of the PLL is buffered by paralleled gates of a 74AC04 IC and increased to 6 volt levels before being applied to the gate of the IRF510 power amplifier. The power amplifier is tuned to operate in Class-E, converting the drain bias voltage to RF at roughly 95% efficiency. An elliptical band-pass/low-pass filter attenuates all harmonics below 45 dBc.

The microphone signal is amplified and band-pass filtered by an op-amp circuit, limiting modulation frequencies to the 300 to 3000 Hz range. A unique audio power amplifier circuit boosts this signal, creating a 0v to 24v swing in the voltage delivered to the drain of the power amplifier, permitting it to operate in a very efficient mode.

An LED indicator dims according to AGC level during receive, and flashes during overmodulation on transmit.

This kit is a bit of a departure from previous 4SQRP designs, in that this kit uses a majority of SMT components, which have been pre-installed. Large through-hole components and hardware, though, are left for the builder to install. A frustrating trend among manufacturers of electronic components has been a continuing reduction in the size and legibility of component marking to the point that they are very difficult to see and determine the component values. On a kit of this complexity, making small components SMT and preinstalling them greatly reduces headaches both for the builder – and the 4SQRP volunteer who packages the kits.

PREPARATION

Before getting started with building the receiver, take some time to organize and familiarize yourself with the parts provided and check them against the Parts List. Building over a cookie sheet is recommended to minimize parts being lost. If parts are missing in your kit, send an email to the kitter listed on the 4SQRP website. He will promptly provide replacements.

It is helpful to acquire the necessary tools and supplies before beginning. These include:

*Soldering iron – Preferably thermostatically controlled to 700 degrees F.
*Fine 60/40 rosin core solder
*Wire strippers
*X-Acto knife
*Diagonal cutters
*Needle-nose pliers
*Phillips screwdriver
*Electrical tape
*Sandpaper or Emery board

*Clear fingernail polish
*Magnifier
*Rubber Bands
*Digital volt-ohm-meter

Soldering is not hard if the proper procedure is followed. The soldering iron is to be used to heat up the PC pad and component lead, and the solder applied to the pad, where it melts and flows into the hole. Do not melt the solder onto the tip of the iron and then attempt to dab it onto the joint – a defective connection will result! After soldering, check the top (component side) of the board, to be sure the solder has filed the hole completely, and wicked up around the component lead. Re-heat and apply more solder if necessary.

The PC boards used for the circuit and for enclosure are contained in two panels, with the individual boards separated by V-grooves. To begin assembling the kit, the boards must be separated. Placing a panel on a table or workbench so that the v-groove rests over the edge, the boards may be cleanly separated by pressing down firmly on each section. The board edge will be rough at the break, so smooth it with a few strokes of sandpaper or an emery board to clean the edge.

Begin by taking inventory of components supplied in the kit, comparing the contents of the parts bags against the list, checking off items as you go, making note of any shortages. After inventory, return all semiconductors to their anti-static packaging until ready to install.

ASSEMBLY PROCEDURE
Begin by installing the connectors and controls onto the board. Make sure that they are firmly seated to the board before soldering, and aligned straight against the board silk screen.

The Antenna connector is a BNC type. It has been found that it is easier to solder if the plating on the mounting tabs is sanded slightly before installation.

[ ] J1 Antenna BNC
[ ] J2 Coaxial Power Jack
[ ] J3 3.5mm audio jack – Headphones
[ ] J4 3.5mm audio jack – Microphone
[ ] SW1 Slide Switch SPDT
[ ] SW2 Rotary Encoder
[ ] R11 50k pot – Volume
[ ] R25 50k pot – Mic Gain

Next, we install the electrolytic capacitors. Notice that these are polarized, and must be installed in the proper orientation. The capacitor has one lead longer than the other, which must be inserted into the PCB pad with the square outline, marked with a ‘+’ sign on the component silkscreen. There is a stripe on the body of the capacitor, signifying the negative terminal, which should be oriented away from the ‘+’ silkscreen label.

[ ] C5 10uF
[ ] C104 10uF
[ ] C31 100uF
[ ] C41 100uF
[ ] C16 2200uF
[ ] C25 2200uF

There are three orange or blue 2.0MHz ceramic resonators. These form the IF filter.

[ ] X1 2.00
[ ] X2 2.00
[ ] X3 2.00

Next, we install the semiconductors. These must be installed in the proper orientation, double check before soldering.

[ ] D6 SB240 Axial, black plastic body

The LED D5 is installed using the small plastic mounting holder. Holding the LED with its lens facing toward you, orient it so that the longer lead is at the right. Hold the LED clip with the beveled face up and toward the rear, and insert the LED leads through the two holes in the clip. Bend the leads down at a right angle, then install onto the PCB, with the longer lead going through the square solder pad.

[ ] D5 LED Red, T1-3/4

Next, the semiconductors are mounted. Correct orientation of these components is critical, double check before soldering.

[ ] Q2 ZVN3310 TO-92, mount with its large flat face to the left of the board, per the silkscreen symbol

The power MOSFETs have a tab which is oriented toward a heavy line on the component silkscreen on the PCB. Two are installed without heat sinks.

[ ] Q12 IRF510
[ ] Q15 FQP7P06

Locate the three heat sinks. Using diagonal cutters, snip off the three legs on each heat sink flush with the body of the heat sink.

Locate the three remaining TO-220 power transistors, and the adhesive heat sink pads. Carefully apply the heat sink to the backs of each of the three transistors, so that the hole in the pad aligns with the hole in the tab of the transistor. The purpose of these heat sink pads is to make the best possible thermal contact between the heat sink and the power transistor.

To mount the heat sink to the transistor, take a 3/8” 6-32 screw, and place on it a split ring lock washer, a flat washer, and then insert through the back of the heat sink. Place one of the grey heat sink pads over the screw, and then place the transistor over the screw. (The heat sink pad provides an excellent thermal interface between the transistor and heat sink, so that no heat sink grease is necessary.) Place a 6-32 hex nut over the end of the screw, and using the screwdriver, tighten the screw snugly. Repeat for the remaining two transistors. Mount to the board. Make sure that the heat sink does not contact the PCB or any other components. Reposition the transistor in the sink if necessary.

[ ] Q1	IRF510
[ ] Q3	FQP7P06
[ ] Q11	FQP7P06

Install the 14 pin IC socket in the U5 position, being careful to orient the notch in the socket to correspond with the silkscreen. Finally, insert the microcontroller IC. Be certain that the notch at the top of the IC faces the rear edge of the board.

[ ] U5	DIP-14 Socket and Microcontroller

There are two red toroids, and two yellow toroids. Subdivide the enclosed enamel magnet wire into four roughly equal lengths. Wind, counting each turn as passing through the center of the core, being certain that the turns are pulled tight to the toroid, and there is no slack in the turns. When complete, trim the leads to ½ inch long, and use a hobby knife or sandpaper to remove the enamel insulation from the wire leads flush to the body of the toroid.

[ ] L1	18 turns, T50-2 (red)
[ ] L2	17 turns, T50-6 (yellow)
[ ] L3	21 turns, T50-2 (red)
[ ] L4	18 turns, T50-6 (yellow)

FRONT PANEL DISPLAY

Take the LED display, and the ribbon cable. Strip off two of the conductors of the ribbon cable, leaving a four-conductor cable. Separate each of the individual conductors of the ribbon cable back about 1/2” on each end of the cable. Strip the insulation from about 1/4” from the end of each wire.

Locate the LED display. Orient the display before you so that the decimal dots of the LED are at the bottom. Insert the ribbon cable conductors through the back side of the board through the four holes at the right side of the display. Solder, and trim excess wire length. Connect the other and of the ribbon cable to the PCB. Pin 1 of the PCB goes to the LED terminal marked CLK.

Locate the PCB front panel. Insert the four, 4-40 screws through the front side of the panel, and then place the panel face down so that the screws extend vertically from the panel. Place the four nylon standoffs over the screws, and then place the LED display face down over the screws. Screw the four nylon nuts onto the screws finger-tight, and then flip the panel over and tighten from the front with a screwdriver.

ENCLOSURE ASSEMBLY

Take the four, 1.5" long standoffs, and four 3/8" 6-32 screws. Insert the screws through bottom of the board at the four corners, and mount the four standoffs to the top side of the board. Flip the board upside down to rest on the standoffs.

Take the four enclosure side panels. Rest them in place against the main circuit board. Using rubber bands, clamp the board sides in place.   Invert the board, and solder the pads connecting between the main PCB and the four sides. These pads have thermal reliefs, so a regular-wattage iron will provide enough heat to solder. Inspect your work when done, and reheat and adjust any crooked joints as necessary.

Next, flip the unit over, and solder the connecting pads between the four side pieces, and again, resolder and adjust as necessary to get clean looking corners. Remove the screws and standoffs from the corners.

Attach the speaker to the top cover using four 6-32 screws, flat washers, split ring lock washers, and nuts. Strip back the ¼" from each end of the two conductors removed from the ribbon cable, and solder one end to the two terminals on the PCB labeled SP+ and SP-. Solder the opposite ends of the wires to the speaker terminals.

Take the bottom panel, and the four, 6-32 x 5/8" screws. Insert the screws through the four holes, and then flip the board upside down so that it rests on the four screw heads. Place the four ¼" aluminum spacers on each of the four screws. Then, take the assembled PCB, and lower it onto the base so that the screws come up through the four holes in the corners of the PCB. Take the four threaded spacers, and tighten them down onto the four screws. When the four standoffs have been finger-tightened, use a screwdriver to tighten each of the screws from the bottom of the board.

Finally, take the four remaining 6-32 x 3/8" screws, and attach the top cover to the completed PCB assembly.
Attach the three knobs to the MIC GAIN, VOL and TUNER shafts. These use set screws to fix the knobs to the shafts.

You may wire up your own power connector using the provided coaxial power plug. The center conductor of the plug is positive.

OPERATION

Locate a 12v power supply, preferably current limited. If it is current limited, set it for 250 mA initially. With the power switch in the ‘off’ position, connect your station antenna to the BNC, and the 12v power cable. Do not at this time connect the microphone. Switch ON the radio. You should hear some static in the speaker, and as you tune the receiver, notice signals pass as the VFO is tuned. The front panel LED is tied to the AGC voltage, and will dim in the presence of strong signals.

DISPLAY BRIGHTNESS

To adjust the display brightness, depress the rotary encoder knob. The display will read ‘8888’. Rotating the tuning knob will increase or decrease the display brightness. When the display is at the desired brightness, depress the knob again to store the brightness setting.

RECEIVE FREQUENCY CALIBRATION

Because there are unit to unit variations in the center frequency of the ceramic resonators in the IF filter, the receive frequency may not line up with the display frequency. Tune your receiver to the frequency of a known signal. Two possibilities are 5.000 MHz, WWV, or 6.000 MHz, Radio Havana Cuba. If you tune up and down past those frequencies, you may notice that the station is louder at some offset from the proper frequency. To correct this, use the following procedure:

Tune the display to the frequency of a known shortwave signal, such as WWV or Radio Havana Cuba. Depress the Tuning knob for two seconds. The display will read some number near two MHz. Slowly rotate the tuning knob until the desired shortwave signal is heard with greatest clarity. You may also observe the LED dim with the AGC voltage. When this signal has been peaked, depress the tuning knob again to leave the calibration mode.

TRANSMITTING

The Nouveau 75A has been designed to operate with the included microphone. Power down the Nouveau 75A. Connect the Nouveau 75 to a dummy load, or matched, 50 ohm antenna, and plug in the microphone. Reapply power.

The transceiver will enter the transmit mode when the microphone PTT button is depressed. The front panel LED will extinguish, and flash when voice peaks clip. The MIC GAIN adjustment should be set so that the LED flashes only briefly on loud speech intervals. This should be avoided, as the voice amplifier clips during these peaks, leading to distortion and potential signal platter.

With this last setting, the Nouveau 75A is set up and ready to use.

SOFTWARE THEORY OF OPERATION – Adrian Hill KR0NS

The Nouveau 75A software is implemented as a main loop preceded by configuring of the microcontroller, transceiver peripherals, and restoration of configuration settings (VFO, display brightness, and IF offset) from the PIC's non-volatile EEPROM. Two interrupts are utilized. Processing in the interrupt context is minimized. The first interrupt utilized is in response to a 122 Hz periodic interval timer that flags the main loop to execute. The second interrupt updates a counter in response to encoder rotation. Encoder changes are accumulated and processed only during the execution of the main loop.

The main loop is comprised of four tasks. The first task samples inputs to the PIC and eliminates switch bounce by means of a counter. In addition to de-glitching the input this task also keeps track of how long a given input has remained stable. The second task maintains several count-down timers. The third task copies configuration variables from RAM to EEPROM when they differ. The fourth, and most complex, task is a state machine responsible for the operation of the transceiver. Previously maintained glitch-free sampled inputs and count-down timers are used to determine if any transceiver mode or state change is required. Mode and state changes trigger updates of the display, the synthesizer's output, and transitions between TX and RX as appropriate. The PIC's I2C interface is used to communicate with the Si5351A synthesizer and the display's i2c-like protocol is bit-banged with delay-loop timing.

The resulting implementation of this architecture provides software which is reliable, predictable, responsive, and unobtrusive.

SOFTWARE OUTLINE

```
main()
{
    initialize_pic() ;
    initialize_peripherals() ;
    restore_settings_from_eeprom() ;
    while( 1 )

        if( timer_flag )

            task1_sample_inputs() ;
            task2_update_counters() ;
            task3_backup_settings_to_eeprom() ;
            task4_xcvr_state_machine() ;
            update_outputs() ;
            if( display_change_needed )
                update_display() ;
            if( frequency_change_needed )
                update_synthesizer() ;
            timer_flag = 0 ;


}

interrupt periodic_timer()
{
```

```
        timer_flag++ ;
}

interrupt encoder_pin_change()
{
        main_encoder_motion += new_encoder_motion ;
}
```

SOFTWARE SOURCE CREDIT

Si5351A Programming

I used G4SAQ’s routine for Si5351A programming as published on qrp-labs.com as a starting point for my implementation:

http://www.qrp-labs.com/synth/g4saq.html

Further refinements were made using information presented in G0UPL’s article entitled Modern QRP Rigs and Development of the QCX: Part 1, published in the July 2018 issue of *The QRP Quarterly*.

Rotary Encoder Interface

My rotary encoder interface implementation was inspired by this posting:
http://makeatronics.blogspot.com/2013/02/efficiently-reading-quadrature-with.html
Unfortunately it appears that the link to the original posting is broken preventing me from citing the author directly.

Pre-installed Components

C1	1000p		C43	1
C2	1800p		C44	0.1
C3	3300p		C45	0.01
C6	390p		C46	330p
C7	3300p		C47	1000p
C8	3300p		C48	0.1
C9	390p		C49	0.1
C10	0.1		C50	1800p
C11	0.1		C101	0.1
C12	470p		C102	0.1
C13	1		C103	100p
C14	1		C105	0.1
C15	1800p		C106	0.1
C17	0.1		D1	1N914
C18	100p		D2	1N914
C19	0.047		D3	1N914
C20	1		D4	1N914
C21	1000p		D7	1N914
C22	1000p		D8	1N914
C23	0.1		D9	1N914
C24	0.01		D10	1N914
C26	0.01		D101	1N914
C27	470p		Q4	MMBT3904
C28	0.1		Q5	2N7002
C29	0.1		Q6	2N7002
C30	0.1		Q7	2N7002
C32	1		Q8	2N7002
C33	0.01		Q9	MMBT3904
C34	47p		Q10	MMBT3906
C35	0.001		Q13	MMBT3906
C36	220p		Q14	2N7002
C37	0.01		Q16	MMBT3904
C38	0.1		Q17	MMBT3904
C39	0.1		Q101	MMBT3904
C40	1		Q102	MMBT3904
C42	0.1		Q103	MMBT3904
			Q104	MMBT3904

Pre-Installed Components (continued)

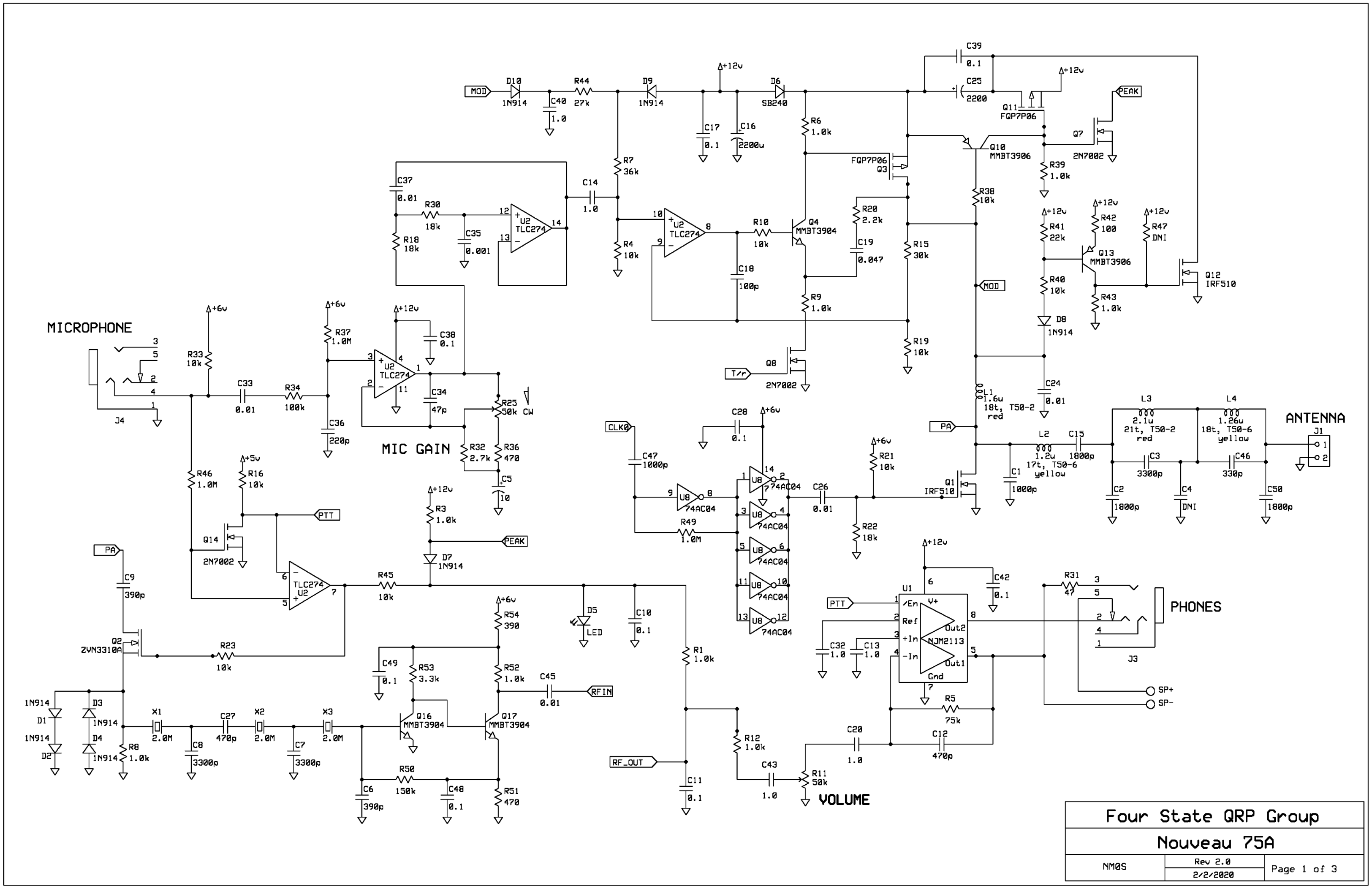
R1	1.0k		R39	1.0k
R3	1.0k		R40	10k
R4	10k		R41	22k
R5	75k		R42	100
R6	1.0k		R43	1.0k
R7	36k		R44	27k
R8	1.0k		R45	10k
R9	1.0k		R46	1.0M
R10	10k		R47	DNI
R12	1.0k		R48	10k
R13	220		R49	1.0M
R14	1.0k		R50	150k
R15	30k		R51	470
R16	10k		R52	1.0k
R17	360		R53	3.3k
R18	18k		R54	390
R19	10k		R55	220
R20	2.2k		R56	680
R21	10k		R57	470
R22	18k		R58	470
R23	10k		R101	39k
R24	180		R102	10k
R26	680		R103	10k
R27	1.0k		R104	1.0k
R28	1.0k		R105	1.0k
R29	1.0k		R106	100k
R30	18k		R107	1.0k
R31	47		R108	220k
R32	2.7k		U1	NJM2113
R33	10k		U2	TLC274
R34	100k		U4	LM317L
R35	10k		U6	Si5351
R36	470		U7	LM317L
R37	1.0M		U8	74AC04
R38	10k		U9	LM317L

Contents of Electronic Parts Kit

√	Qty	Value	Ref Des	Type
	2	10u	C5, C104	Electrolytic
	2	2200u	C16, C25	Electrolytic
	2	100u	C31, C41	Electrolytic
	1	LED	D5	Red, T 1-3/4
	1	SB240	D6	axial
	1	BNC	J1	BNC
	1	Power Jack	J2	5.5x2.1mm
	2	Audio Jack	J3, J4	3.5mm
	2	T50-2	L1, L3	red toroid
	2	T50-6	L2, L4	yellow toroid
	2	IRF510	Q1, Q12	TO-220
	1	ZVN3310A	Q2	TO-92
	3	FQP7P06	Q3, Q11, Q15	TO-220
	2	50k	R11, R25	Potentiometer
	1	Power	SW1	SPDT
	1	Rotary Encoder	SW2	
	1	PIC16F18324-I/P	U5	DIP-14
	3	2.0M	X1, X2, X3	Ceramic Resonator

Contents of Hardware Kit

√	Qty	Part
	1	14-DIP Socket
	3	Heat Sink
	3	Heat Sink Pads
	1	5.5x2.1mm power plug
	11	6-32x3/8 black round head screw
	4	6-32x0.25x1.5" aluminum hex standoff
	4	6-32x 0.25 spacer
	4	6-32x5/8" black round head screw
	4	4-40x 5/8” round head screw
	7	6-32 hex nut
	4	#4x1/4” nylon spacer
	4	4-40 nylon hex nut
	1	LED holder
	1	large knob
	2	small knob
	7	#6 flat washer
	7	#6 lock washer
	4	rubber feet
	1	6”, 6-conductor ribbon cable
	6’	22 AWG magnet wire
	1	microphone
	1	Speaker
	1	4 digit LED display



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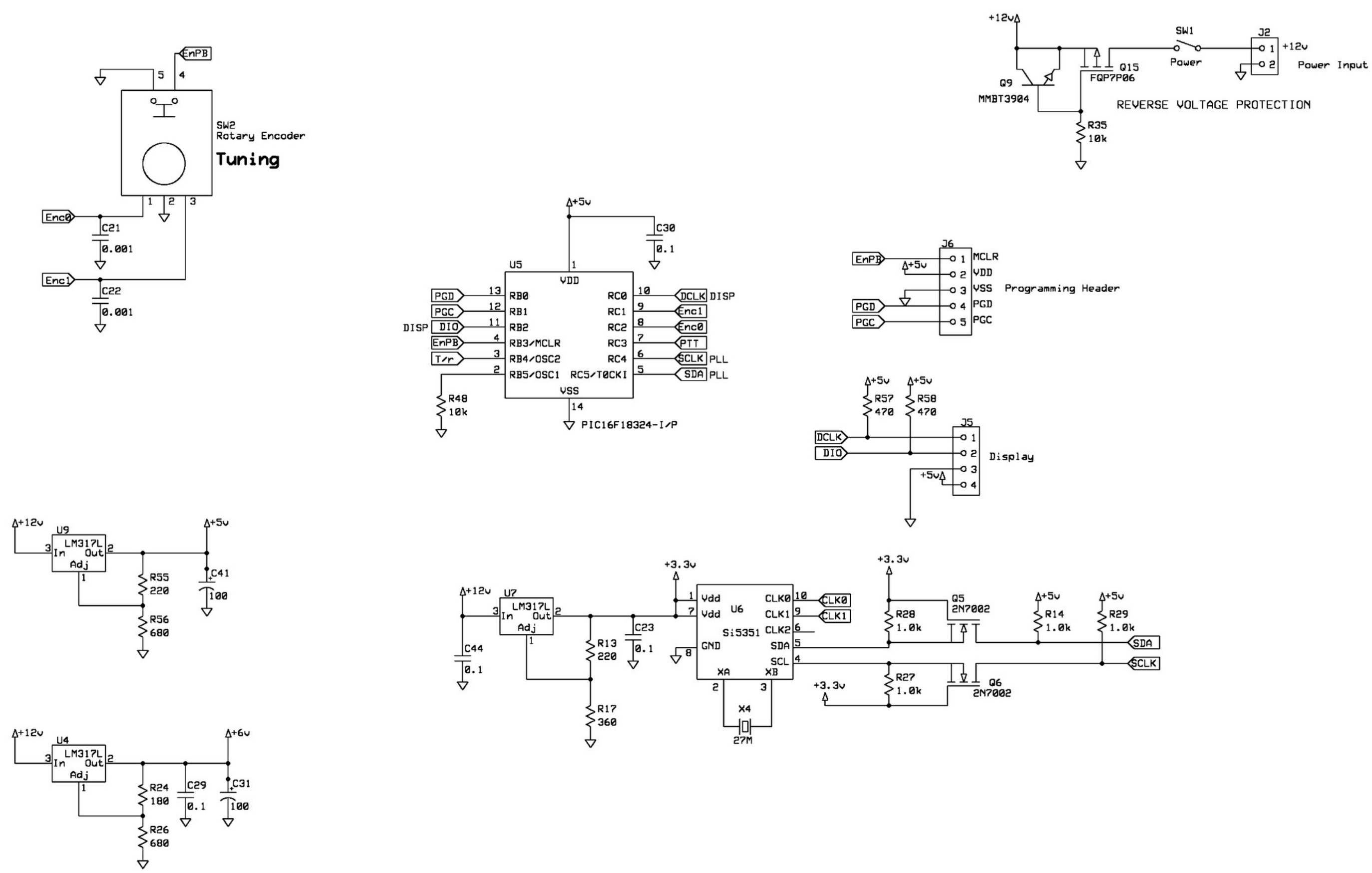
MIC GAIN
VOLUME
PHONES
ANTENNA



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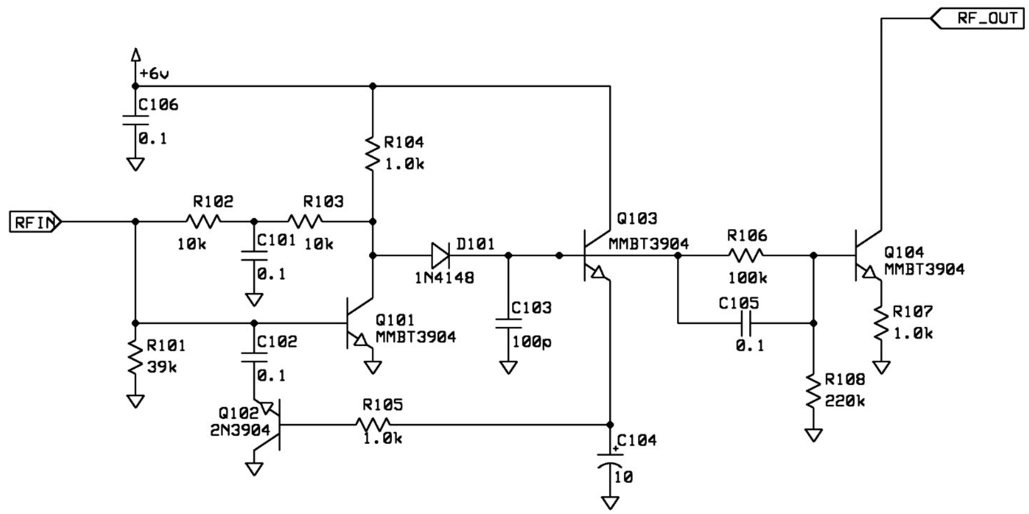

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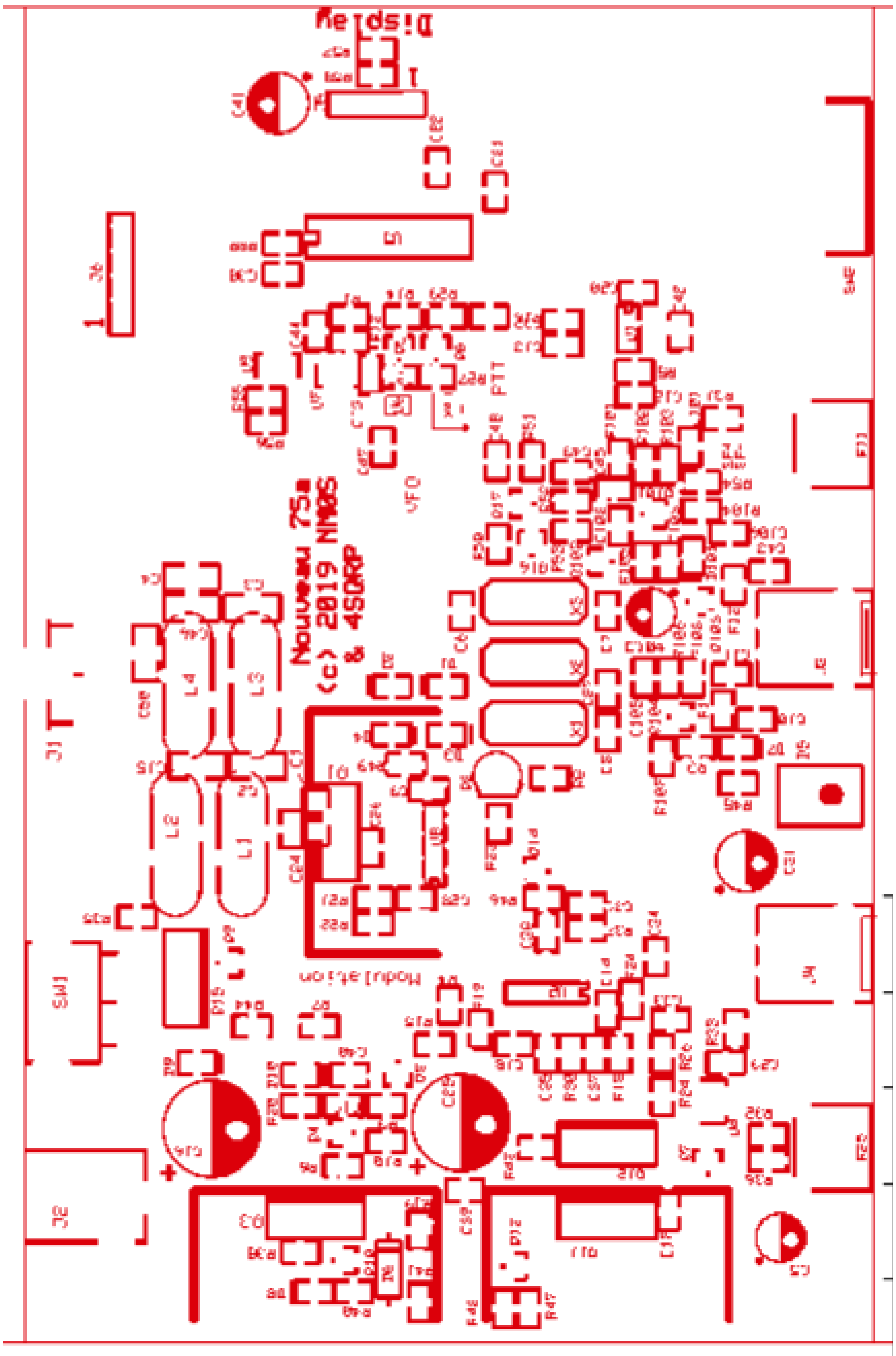
Display
Nouveau 75a
(c) 2019 NM0S
& 4SQRP
VFO
PTT