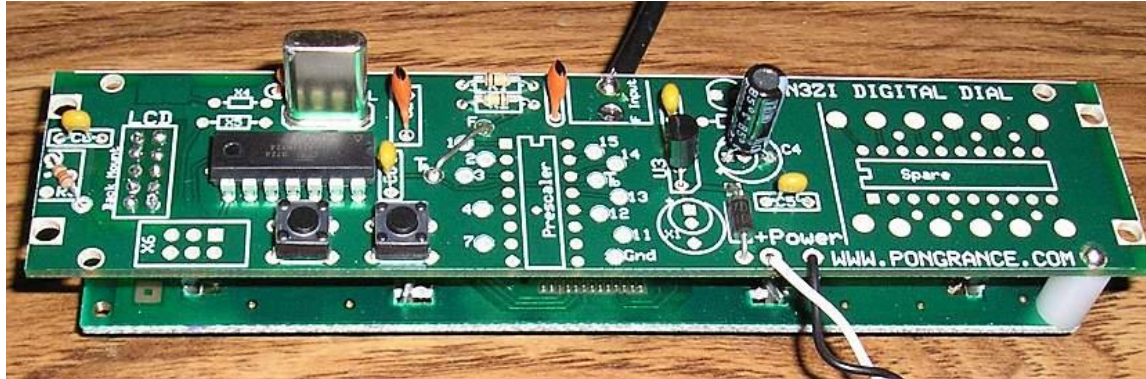


# N3ZI Digital Dial

## Assembly and calibration manual

Vintage Radio Version  
Rev 1.6 12 Feb 2009



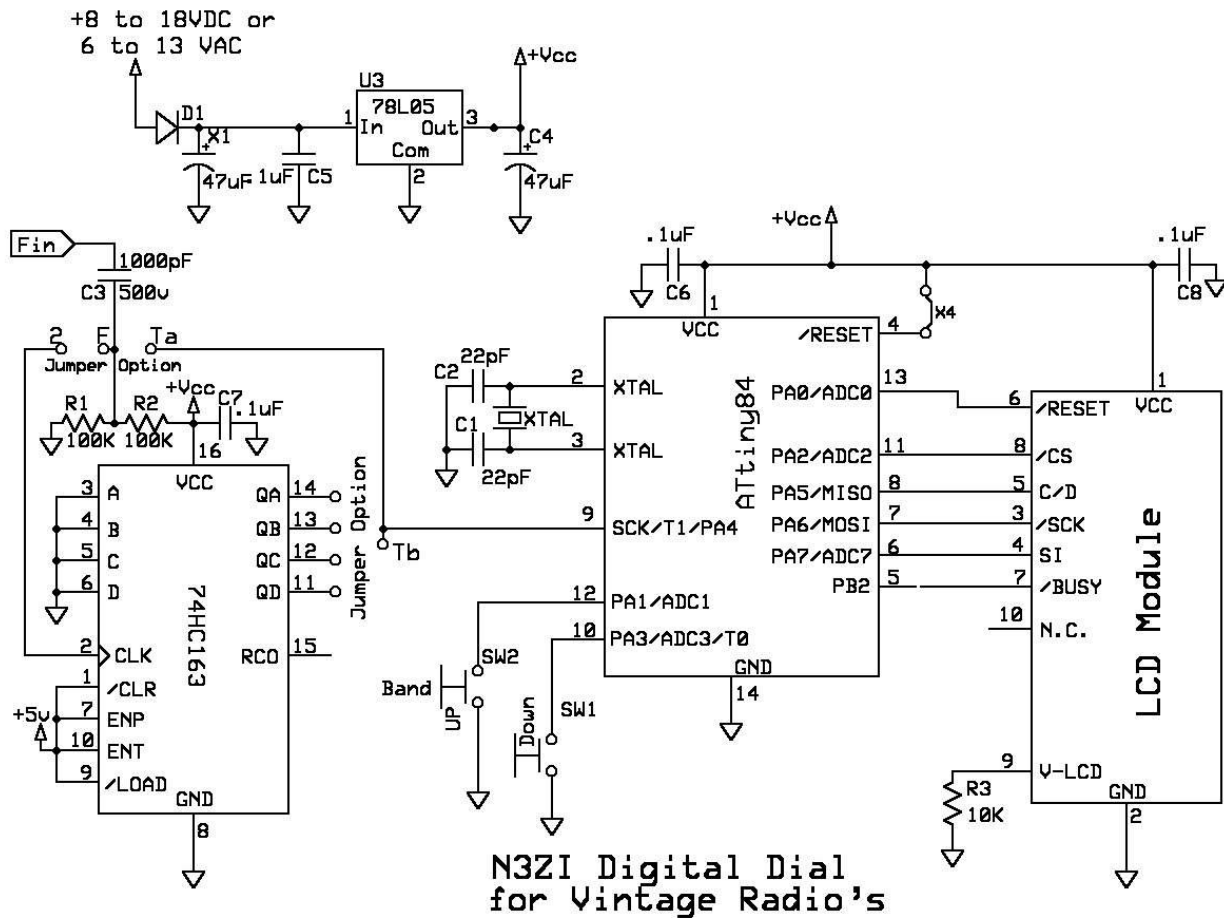
Kit photo (shown without prescaler chip installed)

Vintage Kit Components			
Item	Qty	Designator	Part Color/Marking
PCB	1		
LCD Display	1		
Prescaler	1	Prescaler	16 Pin Dip, 74HC163
Microprocessor	1	Microprocessor	14 Pin Dip, ATTINY84
XTAL	1	XTAL	
Caps, 22pF	2	C1,C2	Orange - 22
Cap, 1000pF	1	C3	Blue 103K
Caps, 0.1 Uf	4	C5,C6,C7,C8	Blue or Yellow - 104
Resistors, 100K	2	R1,R2	Brown-Black-Yellow
Resistor, 10K	1	R3	Brown-Black-Orange
Switch	2	SW1, SW2	
Voltage Reg 78L05	1	U3	To92 - 78L05ACZ
Electrolytic Cap	1	X1	Radial - 47uf 50v
Electrolytic Cap	1	C4	Radial - 47uf 10v
RCA Jack	1	F input	
Diode	1	D1	1N4003

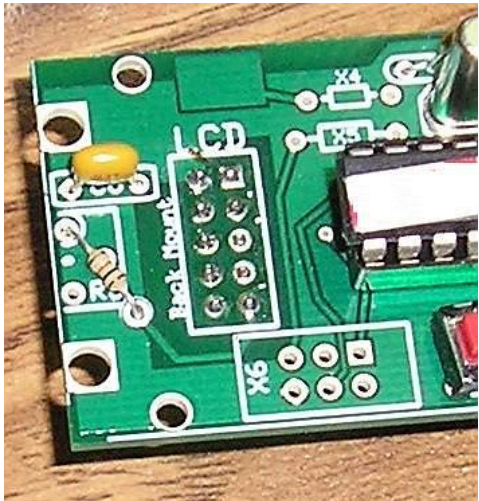
You should start by soldering all of the passive components in the circuit board, followed by the voltage regulator. Leave the two IC's and the LCD module uninstalled for the time being. Double check your work, and apply power. Check the voltage at pin 1 of the microprocessor and pin 16 of the prescaler, you should see very close to 5.0 volts there. Sometimes the color of parts may change. For example in the above photo, the 0.1uF caps were yellow, but the parts now shipping (10/2008) are blue.

Once you've verified that the regulator is working, disconnect power, and solder the Microprocessor and Prescaler IC (if you are using one). You can use sockets for these, but my experience is that IC sockets can cause problems, so I recommend that you solder the IC's directly into the PCB. In general as a starting point I recommend that you use the prescaler and select the Div/4 option which means you will want to solder jumpers from "F" to "2", and from "Tb" to "13"

## N3ZI Digital Dial



Lastly solder the LCD module in place. Solder insulated wires from each position in the 10 pin area from the PCB to the LCD module. Use about 1-2 inches of wire, and this will allow you to fold the two boards apart to get to the back of the PCB if you need to make changes. You should not use a header that's soldered on both ends, that makes it too difficult to get the boards apart to fix any problems. There are some suggestions on my web site if you want to use connectors <http://www.pongrance.com/dd-pcb-lcd.html>



The photo on page 1 shows the assembled counter without a prescaler chip. The PCB is stacked with the LCD module, which is face down on the desk in that photo.

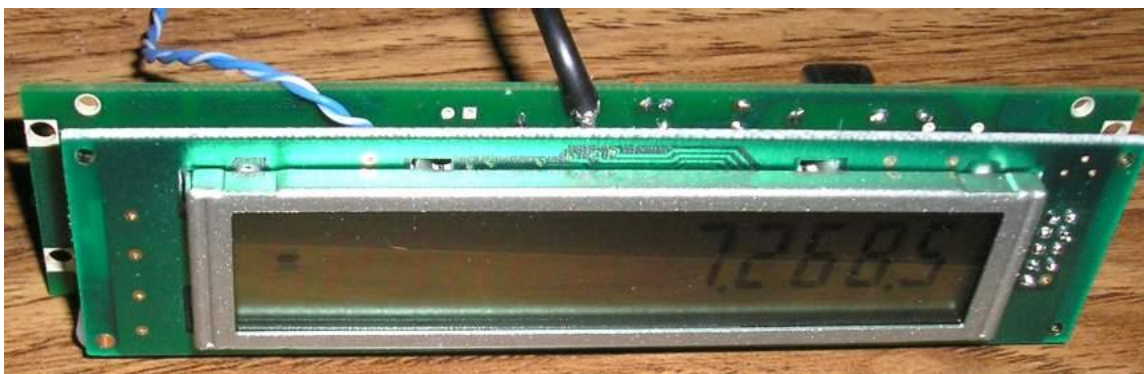
In the photo the 22pF capacitors are the orange caps, the 0.1 uF caps are yellow. The vintage version uses a 1000pF 600volt capacitor for the input signal (C2) just in case you need to connect to a signal with a high DC bias, but don't exceed 150volts or so. This cap is usually blue. Note that R3 is mounted diagonally, you can see in at the far left side of the PCB in the photo.

The LCD Module and the PCB have 4 matching holes. They are rather small for hardware, so I added two holes on the ends which accept 4-40 hardware. 14 Gauge solid wire fits in the LCD

## N3ZI Digital Dial

module holes and the boards can be made into a solid stack by using holes and spacers. All the holes are plated through so you can solder the 14 gauge wire in place. The electrical connection to the LCD module is made with 10 holes (2 rows of 5) on the right hand side of the photo. The wiring is straight through, and I recommend insulated solid wire, which also provides for some mechanical support. If you are planning to change things from time to time, you probably should use insulated stranded wire that is ~2 inches long so you can separate the two boards.

Just a note about the switches, install the PCB mounted switches included in your kit. You may also want a separate pushbutton switch in a more accessible location for band changes during normal operation. There are 4 holes on the PCB for each switch, the upper left is the active signal, the lower right is grounded, the other 2 are not connected. You can simply wire an additional switch in parallel with the PCB mounted ones.



Note that there is an additional ground hole for C4, X1 electrolytic capacitors. This is so it's easy to use a capacitor with 2mm or 5mm spacing. D1 and X1 form a half wave rectifier, so you could use 6.3 or 12 VAC inside your vintage radio if you like.

### Prescaler chip:

This design supports a number of different prescaler (divider) chip settings. The selection is based on the highest VFO frequency the counter will see.

#	Maximum VFO Frequency	Timebase Factor	Div/ by mode	Jumpers	Recommended Radios
A	5.5 MHz or less	1	NONE	Jumper F to Ta	
B	12 MHz	2	Div/2	Jumper F to 2, Tb to 14	HW-101, SB101, and others
C	25Mhz	4	Div/4	Jumper F to 2, Tb to 13	SWAN, and others
D	45 MHz	8	Div/8	Jumper F to 2, Tb to 12	Most S/W radios Receives, pre 1960
E	Above 45 MHz	16	Div /16	Jumper F to 2, Tb to 11	

If you are not sure, use "D" this will work for 99% of radios out there. You can also increase the resolution of your counter to 10Hz, by changing the timebase factor to 10x the value shown above (but no higher than 80) and moving the decimal point to the left one place. The higher the timebase factor the slower the counter will update.

## N3ZI Digital Dial

### Initial Set Up:

When you first power up the counter, a date code should appear for about 2 seconds, then the frequency reading will show. If there is no input, then the IF frequency will be displayed.

If that all looks ok, turn it off, hold one of the push buttons down, and apply power. The date code will appear and stay there until you release the pushbutton.

The first set up item is the calibration factor for the crystal used, in general you don't have to change this, unless you have a real fascination with precision, this value equals the actual oscillating frequency in hertz, divided by 400, minus a few depending on the timebase factor.

**CAL 33584**

Just do nothing to keep the default, it will move to the next step in 5 seconds.

The first step is setting the timebase factor. The default is 1.

**/n 1**

The slash is a tad crooked, the best I could do with a seven segment display, but you'll get the idea. Just do nothing to keep the default, and it will move to the next step in 5 seconds.

The way the setup works, is the buttons increase and decrease the number displayed. Once you've gotten to the value you want. Simply release all the buttons and after about 5 seconds it will proceed to the next step. If you've installed the prescaler chip as above and soldered the appropriate jumpers for divide by 2 operation. Then change this setting to "2" This factor simply slows the timebase down by that factor. When you set it to 2 it causes the counter to count the input 2 times over, thus canceling out the effect of your input divider. Of course this also slows the update rate by the same factor. Decrementing beyond 0 will make it negative, be careful not to accidentally enter a negative value for the timebase factor.

The next step is the number of IF's. The default is usually 2

**IFn 2**

The next step is for setting the decimal point position.

**dp 12.345.6**

Pressing either button sequences the decimal points through the possible positions. The default is with the decimal point between the 1<sup>st</sup> and second digits. You can also turn them off. The position is strictly cosmetic, but the readout can be quite confusing if they are set wrong. Stick with the default, except for some special cases, see table below.

The next parameters are the IF frequencies. You will be promoted for as many IF's as you specified in step 3.

**IF1 -5.172.0**

The way the setup works, is the buttons increase and decrease the number displayed. Once you've gotten to the value you want, simply release all the buttons and after about 3 seconds it

## N3ZI Digital Dial

will proceed to the next step. Holding a button down continuously will change the value at an accelerating rate. If the value is negative, a minus sign will appear. If your radio uses a subtractive frequency plan, you need to enter the IF as a negative number. For example, many swan radios use a 5500 or 5173 KHz IF. You should set one IF to  $-5.500.0$  and one to  $5.500.0$ , for 40m and 80m the SWANs use a subtractive IF, for the higher bands they use an additive IF.

Simply use the up down buttons to change the IF, if you have to change from a positive IF to a negative number just keep reducing the IF value by holding the button down, eventually it will go to zero and the minus sign comes on, and you keep going. It takes about 90 seconds to go from  $+10.000.0$ , to  $-10.000.0$  MHz. Once you are close, release the button, and use the buttons to tweak it in. The change speed slows the instant the button is released. After your satisfied, just release both buttons, and after 5 seconds of no buttons being pressed, it will move to the next IF.

After they are all in the values will be saved in EEPROM. Next time you power up these values will be used.

If you want to use it as a frequency counter, just set one of the IF's to 0. If you are not sure of your IF frequency, set it to zero, then use the device as a frequency counter to measure your radio's BFO frequency. Then go through the setup again using that value for the IF.

### Calibration:

With the 74HC163 prescaler the input sensitivity is 100mV RMS (~300mV peak to peak) meaning your VFO signal must be above this level. The maximum input signal level is equal to your power supply voltage. The maximum is 5v peak to peak (1.8v RMS) There are clamp diodes on the input of the microprocessor which will absorb some excess voltage, but if you overdrive it too much, such as directly with a transmitter, it will be permanently damaged. Even a 1 watt QRP rig puts out 20v peak to peak, which will cause damage.

Once you get it hooked up to your radio's VFO, you may want a fine tweak of the IF, to compensate for a variety of errors, including the frequency error in the crystal. Generally these are less than 1 Khz.

During normal operation, the buttons are used to switch IF's. Pushing SW2 switches to the next IF and displays that value. Pushing SW1 goes to the previous IF. Holding either switch down runs through all the IF's, just stop at the one you want. They both wrap around, so only one is really needed unless you program in a bunch of IF's. These switches are SPST NO switches, so you can add another switch in parallel if you want to be able to toggle through the IF's without reaching around to the back of the counter. If you are going to put the counter in an enclosure, I suggest you put a pushbutton on the front connected to SW1.

Tune your radio to a known frequency, observe the readout, and compute the error by subtracting the readout value from the expected frequency. Then go through the set-up again, and change your IF setting by exactly that amount. Calibrating this way eliminates the need for a trimmer capacitor in the xtal oscillator circuit. If you want you could use a 50pf trimmer in place of one of the 22pf capacitors, and using that to tweak the crystal oscillator to exactly 13.435MHz. But this isn't necessary. There is also a mathematical parameter inside the software related to the oscillator frequency. In my first version of the software there was a setup step which allowed the user to change this. But I found that this was just too confusing, so I removed it. It's easier to simply tweak the IF setting to calibrate.

## N3ZI Digital Dial

### Other Considerations

Anti jitter logic. The S/W is designed so that the last digit will not jitter between two values. Even if you purposely set your VFO on the edge of two readings, it won't jitter. Now if your VFO is very unstable, then you may see some jitter. In essence you have 1 LSD (Least Significant Digit) of hysteresis in the counter.

The LCD module has mounting holes in the corners. They are rather small, but I have found that #14 wire fits through nicely, and they are plated so you can solder the wire in place. They match up with similar holes in the PCB. Alternatively, you could drill them out (at your own risk) or get some very small mounting hardware. The PCB has 2 holes on each side on the ends which protrude beyond the LCD module. You can use 4-40 mounting hardware in these holes.

The S/W was written in 'C' using an optimizing compiler. The lock bit in the device is set, so you cannot copy the code. You can however, erase the chip, but you will then lose the code forever.

In theory there are 9 IF's allowed. But in actuality you can put many more in, and everything will work ok, except that the prompt is a tad confusing. IF's 1 through 9 are labeled as IF1 through IF9, but above that it goes IF-, IFE, IFC, IF=, IFo, IF\_, IF0. Then it repeats. There is memory for 100, and the set up routine does not check limit the value you enter. But I'm only guaranteeing 9, use the rest at your own risk. Keeping track of that many is messy. But somebody that has one of those radios with 4 separate 500KHz bands for 10 meters, plus all the other bands, multiplied by 3 modes (USB, LSB, CW for each) could need about 30

That brings up another point, different modes. If you want the counter to be exactly right for all the modes on every band, then you need to enter a different IF offset for each band and mode. The counter will let you do this, but I don't recommend it. For most SWAN radios, you really only need two IF's one for the low bands (80m and 40m), and another for the higher bands. SW1 or SW2 will toggle back and forth between these two, and the it will be obvious from the display if you are on the right band. You could, in theory program separate IF's for CW for each of these, i.e. 4 total IF offsets. But then it gets confusing as to which is the correct IF setting. And then there's that opposite sideband switch, yes you can program those in, but I don't recommend it.

# N3ZI Digital Dial

