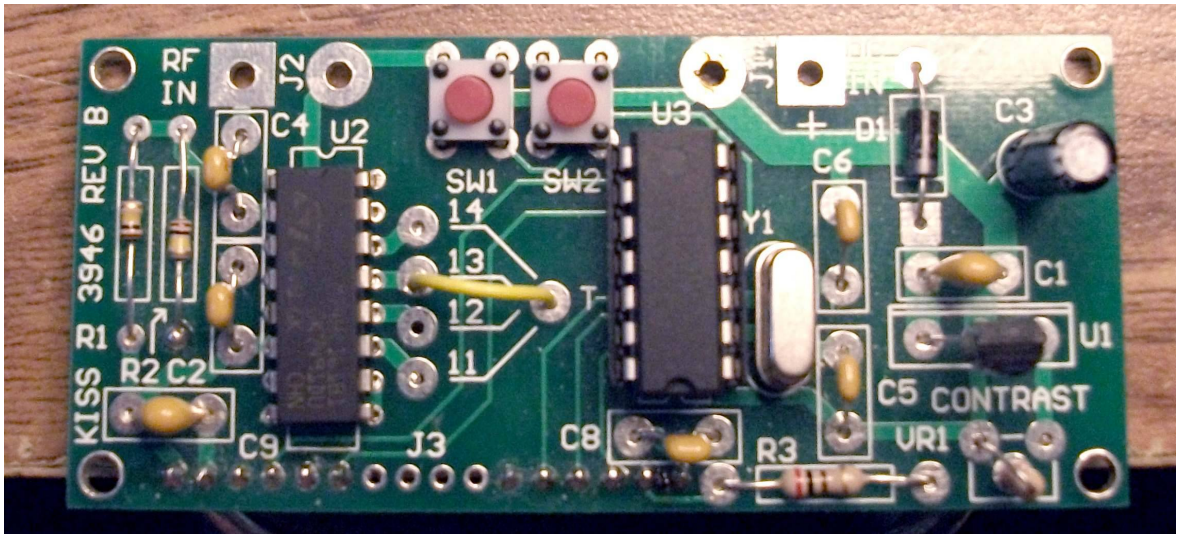
N3ZI Digital Dial Manual

For kit with Backlit LCD
Rev 5.1 Oct 2018



The above photo shows the kit assembled and configured for HF

Kit Components			
Item	**Qty**	**Designator**	**Part Color/Marking**
PCB	1		
LCD Display	opt	J3	1602 (not included in All Kits)
Volt Regulator	1	U1	78L05, Black TO-92
Prescaler	1	U2 Prescaler	16 Pin Dip, 74HC161
Microprocessor	1	U3 Microprocessor	14 Pin Dip, ATTINY84
Socket	1	For U3	14 pin socket
XTAL	1	Y1	20.000MHz
Caps, 0.1 uF	4	C1,C2, C8, C9	Yellow - 104
Electrolytic Cap.	1	C3	Black/blue Electrolytic
Caps, 27pF	3	C4, C5,C6	Yellow 27
Not Used	0	C7	Not used
Diode	1	D1	Black Epoxy
Resistors, 100K	2	R1,R2	Brown-Black-Yellow
Resistor, 200 ohm	1	R3	Red, Black, Brown
3.3K Resistor	1	VR1 (see text)	Resistor: Orange-Orange-Red
Switch	2	SW1, SW2	

Assembly:

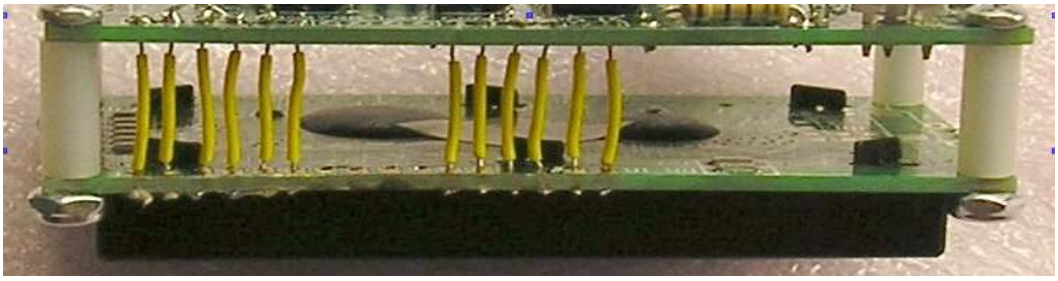
You should start by soldering all of the passive components in the circuit board. Solder in U1, pay attention to orientation of U1, flat side next to C. For now leave U2, U3 and the LCD module uninstalled for the time being. Use care about the orientation of D1, C3, U1.

Jumpers: A prescaler jumper is needed, "T" to "13" (see "Advanced Prescaler Options", below, for other options).

For VR1, your kit includes a 3.3K fixed resistor for contrast setting. The fixed resistor is mounted the place of VR1, upright from the center hole to the ground hole (closest to the corner of the PCB) This value works fine with most LCDs and viewing angles. But if you need to tweak this replace the 3.3K fixed resistor with a 10K or 4.7K trimmer.

Any low impedance voltage source from 10 to 18 volts will work as a power source. (Note: a 9V battery will not work) Double check your work, and apply power to J1. Check the voltage at pin 1 of the microprocessor, you should see +5v there. As long as that is ok, disconnect power, and solder the two DIP ICs, U2 and U3, note that U2 and U3 point in opposite directions.

Lastly solder wires to connect to the LCD module. Your LCD is connected to the 16 pin single row connector near the bottom of the PCB, labeled “J3" Solder insulated wires from the PCB to the LCD module, see photo. The wiring is straight through if you align the board back to back. If you are using stranded wire, twist and tin each end of the wire first. As shown in the photo, you can skip pins 7-10, they are not used.



Prescaler chip: Your kit is supplied with a 74HC161ST Prescaler chip. Jumpers are provided for a number of different Divide by ratios, but in general a Div by 4 setting (jumper from “T” to “13”) should be used. This will give you a counter that will work up to 32MHz. During the setup routine you should set the timebase factor to 4. Your counter will refresh approximately 20 times per second.

Operation up to 80MHz is possible by jumpering T to 11 instead of 13, and change the Div/n setting to 016 This will allow for higher frequency operation, up to 80 Mhz, but the update rate will be somewhat slower, approx 4 times per second.

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 you touch the RF input line (J2 square pad) with your finger, you should see the readout run up a bit as it picks up noise.

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 of the microprocessor crystal, in hertz, divided by 100, minus a few depending on the timebase factor.

CAL 200000

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

The next step is setting the timebase factor. The default is 4.

Div/n 004

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 wish to change to 80Mhz operation change this to 016 and change the jumper. This factor simply slows the timebase down by that factor. When you set it to 016 it causes the counter to count the input 16 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

# of IFs 002

But if you are just using one IF offset, change this to "1". If you don't want to use the IF offset feature i.e use as a straight frequency counter, then set this to "0"

The next step is for setting the decimal point position.

dp Pos 12.345.6

Pressing either button sequences the decimal points through the possible positions, including none, periods or comma. In general you should start with something like the one shown above with a decimal point between the last two digits. The position is strictly cosmetic, but the readout can be quite confusing if they are set wrong. If you want to increase the precision of the counter, simply changing the decimal points is not sufficient, refer to the table below in the, "Modifications and Enhancements" section

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

IF 1 -5.172.0

Simply use the up down buttons to change the IF, for a large change, holding a button down continuously will change the value at an accelerating rate. If the value is negative, a minus sign will appear. 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. 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.

Large changes can take some time, for example It takes about 90 seconds to go from +10.000.0, to –10.000.0 MHz. (Longer to get to the maximum of +/- 99MHz) Once you are close to the value you want, 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 74HC163ST prescaler the input sensitivity is 150mV RMS (~400mV peak to peak) meaning your VFO signal must be above this level. The maximum input signal level 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 are going to use the counter over a wide frequency range then it is better to calibrate it using the "CAL" parameter in the set up. If you want you could use a 50pf trimmer in place of one of the 27pf capacitors, and using that to tweak unit you get exactly the reading you want.

Other Considerations

Anti jitter logic. The s/w 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 (100hz) of hysteresis in the counter.

The readout may show a negative sign, which can be ignored under normal operation. But basically if your radio has a frequency plan that causes the VFO frequency to move in the opposite direction of the operating frequency a minus sign will be shown.

Modifications & enhancements for advanced users

Advanced Prescaler Options: Your kit is supplied with a 74HC163 or equivalent Prescaler chip, although others can be used. Jumpers are provided for a number of different Divide by rations, but in general a Div by 4 setting should be used. This will give you a counter that will work up to 32MHz. To select this option solder a jumper from "T" to "13" And during the setup routine you should set the timebase factor to 4. Your counter will refresh approximately every 50ms, (20 times per second)

The table below shows some other options. The recommended default settings are highlighted in yellow.

Maximum VFO Frequency	Recommended prescaler Chip	Timebase Factor	Div/ by mode	Jumper	Resolution *2	Update Time *3
8 MHz	NONE	001	NONE	T to U2-2	100Hz	13ms
8 Mhz	NONE	010	NONE	T to U2-2	10Hz	130ms
8 Mhz	NONE	100	NONE	T to U2-2	1Hz	1.3 Sec
16 MHz	74HC163 *1	002	Div/2	T to 14	100Hz	25ms
16 Mhz	74HC163	020	Div/2	T to 14	10Hz	250ms
32 Mhz	74HC163	004	Div/4	T to 13	100Hz	50ms
32 Mhz	74HC163	040	Div/4	T to 13	10Hz	500ms
64 MHz	74HC163	008	Div /8	T to 12	100Hz	100ms
64 Mhz	74HC163	080	Div /8	T to 12	10Hz	1 Sec
80 MHz	74HC163	016	Div /16	T to 11	100Hz	200ms

Notes:
**1) In this application '161 chips can be substituted for '163 chips.*

*2) When using the 10Hz or 1Hz resolution you will have to move the decimal points accordingly

*3) The higher the timebase factor, the slower your counter will update. Update rates shown are approximate and do not include the effects of two point averaging and anti-jitter.

Low frequency operation: This counter is designed for amateur radio applications measuring radio frequencies. However, it will also work down to 100KHz with the supplied components. Specifically the limiting factor is C4 the input coupling capacitor. If one was to change C4 to a 1uF capacitor, the low frequency limit would be reduced to approx 10Hz. Below that you would have to use DC coupling.

Using other LCD's: Many different Colors, sizes, configurations of LCD are available for low prices on ebay. The supplied LCD is 16x2 but a 16x1 or 8x2 will also work, and may be a better fit for your application. This kit comes with a 200 ohm backlight resistor (R3). This will provide about 8mA of backlight current, which is sufficient with the supplied LCD and most others. If this is not sufficient for your LCD, you can replace the 78L05 regulator chip with a 7805, and lower the value of R3. Note than some LCD modules have backlight resistors on the board. Also you might want to install a trimmer in VR1 and adjust for nice contrast.

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