N3ZI Digital Dial Manual

Lightweight Kit

Rev 1.01 Feb 2013

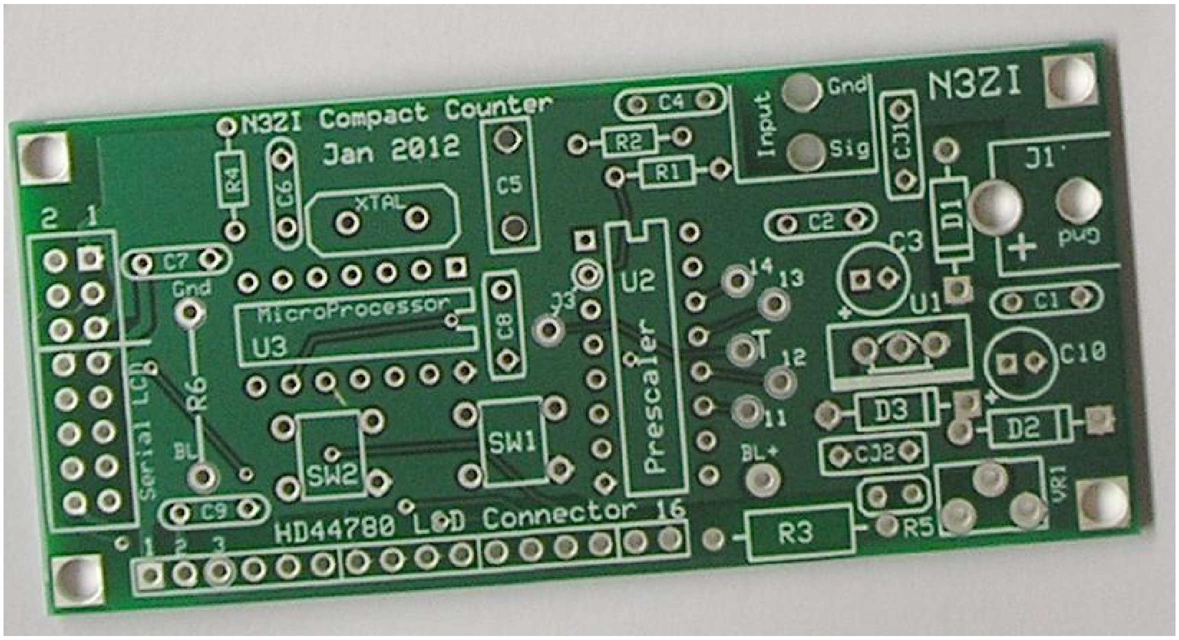


Photo of PCB, note that with this version of the kit, much of the circuitry on the PCB will not be used

Kit Components:

- PCB
- U1, 78L05 5v regulator
- U2 Prescaler, works to 80MHz
- U3 Micro
- C3 electrolytic cap
- C1,C2,C7,C8,C9 0.1uF
- C4 47pF
- C5,C6 22pF
- SW1, SW2
- Crystal, 20MHz.
- R1, R2 100K
- R6, 10K (used with KTMS-1201 type LCD)
- R3 200 ohm (Used with 44780 type LCD)
- R5, 3.3K (Used with 44780 type LCD)

Note that the above list is only a general guide. You will receive a packing list with your kit which may differ from the above list. The list included with your kit supersedes the above list.

You should start by soldering all of the passive components in the circuit board. Solder in U1, but leave U2, U3 and the LCD module uninstalled for the time being.

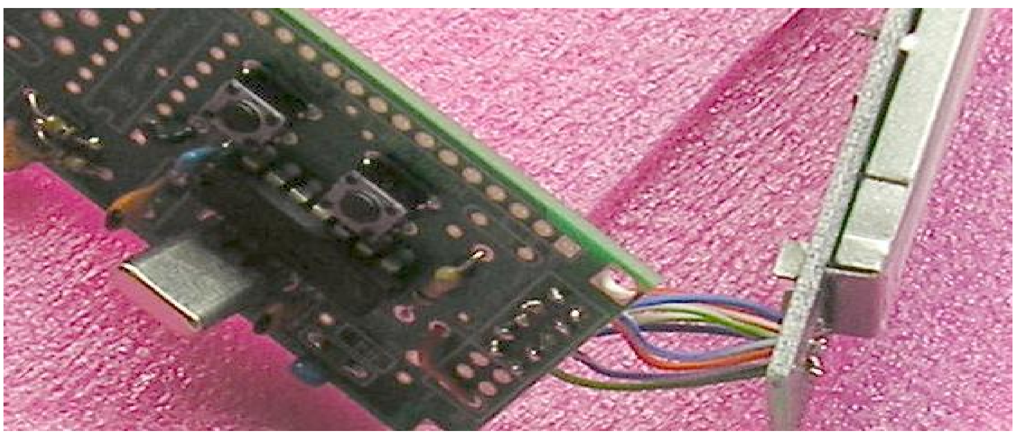
Jumpers: There are 3 jumpers that must be soldered in. CJ1 & CJ2 are marked on the silkscreen. A prescaler jumper is also needed, "T" to "13" (see "Advanced Prescaler Options", below, for other options). J3 is left open.

If you kit includes the RCA and power jacks, solder them to the PCB You may have to cut off the plastic nubs on the RCA connector if it does not seat to the PCB evenly. If your kit does not have the jacks, just solder wires to the holes in the PCB.

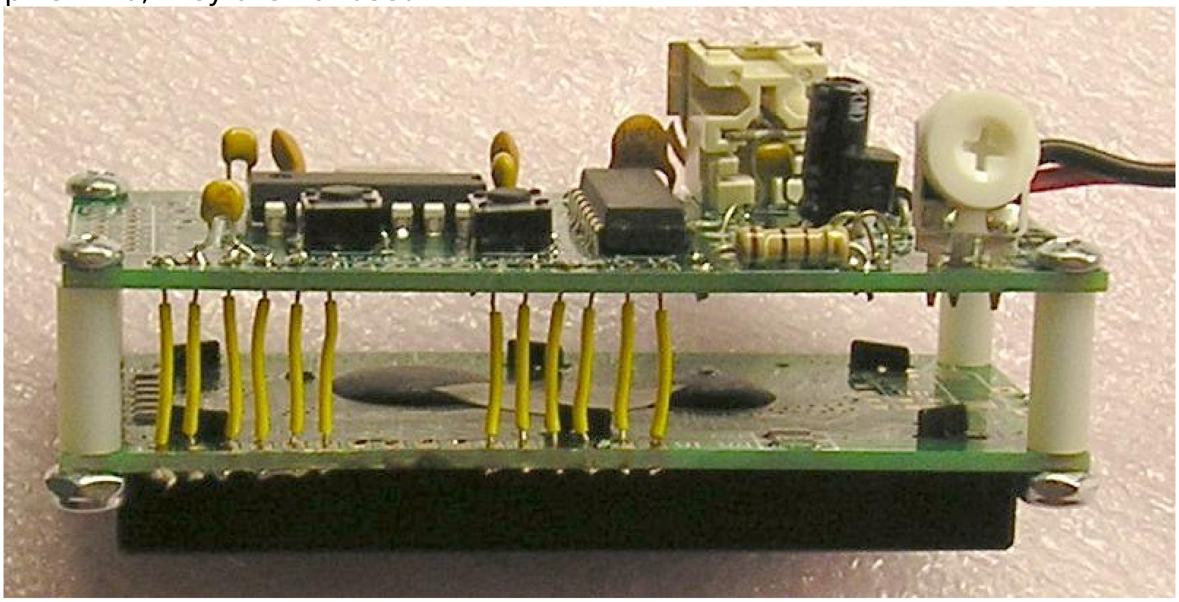
Any low impedance voltage source from 9 to 14 volts will work as a power source. (Note: a 9V battery will not work) Double check your work, and apply power. Check the voltage at pin 1 of the microprocessor, you should see +5v there. As long as that is ok, disconnect power, and solder the two remaining ICs, U2 and U3.

Lastly solder wires to connect to the LCD module. Solder insulated wires from each position in the 10 pin area from the PCB to the LCD module. Note that on the PCB you will be using the lower 10 pins in the 16 pin connector, see photo. 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. The wiring is straight through if you align the board back to back, see photos. If you are using stranded wire, twist and tin each end of the wire first.

Photo below shows connection to KTMS-1201 LCD



If you are using a HD44780 Type LCD solder wires to connect to the LCD as shown below. Your LCD is connected to the 16 pin single row connector near the bottom of the PCB, labeled "HD44780 LCD Connector" 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.



This photo is shown to illustrate with connection to the LCD, the PCB in the above photo shows some additional parts not included in your kit.

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, and then you will enter the setup routine.

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

This value needs to be set to a number equal to the Xtal frequency (with 0.1KHz precision) The default value shown above is for a 20MHz Xtal. If you kit has a 20MHz Xtal, 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

The presacaler 'T' jumper setting must match this setting. The default of Div/4 corresponds to a T-13 Jumper which result in faster updates, but lower maximum frequency. For 10Hz resolution, and higher frequency operation, change to 080 move jumper to T-12

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. 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 IF's 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. The default is with the decimal point between the 1st 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. Use the default for 100Hz resolution change to 1,234.56 for 10Hz resolution.

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

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 74HC161 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 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.

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.

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	1	NONE	J3	100Hz	13ms
8 Mhz	NONE	10	NONE	J3	10Hz	130ms
8 Mhz	NONE	100	NONE	J3	1Hz	1.3 Sec
16 MHz	74HC161*	2	Div/2	T to 14	100Hz	25ms
16 Mhz	74HC161	20	Div/2	T to 14	10Hz	250ms
32 Mhz	74HC161	4	Div/4	T to 13	100Hz	50ms
32 Mhz	74HC161	40	Div/4	T to 13	10Hz	500ms
55 MHz	74HC161	8	Div /8	T to 12	100Hz	100ms
55 Mhz	74HC161	80	Div /8	T to 12	10Hz	1 Sec
80 MHz	ST-M74HC161*	16	Div /16	T to 11	100Hz	200ms

Notes:
**1) In this application '163 chips can be substituted for '161 chips. For 80MHz operation the exact part shown must be used.*

*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.

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Serial LCD Adjustable contrast: Remove R6, install a 10K trimmer in VR1 and add a jumper from BL+(bottom end of R6) to pin 3 of the HD44780 connector (below C9) VR1 will now adjust the contrast and viewing angle of the LCD.

Battery Operation/Low current: This counter can operate off of a battery rather that 12v, and get much lower current draw. The counter and standard micro will work with supply voltages as low as 2.7V. However, you have to make some changes. Obviously the 5v regulator is removed and bypassed. The value of the contrast resistor (R6, 10K) will have to be lowered, possibly as low as 0 ohms (short). And the microprocessor crystal (20MHz) may have to be lowered. The specifications for the micro state that a minimum 4.5v power supply is needed with a 20MHz crystal, at lower voltages, the maximum crystal frequency is specified at 10MHz. However, in practice micro usually run at much higher frequencies than specified. If you change the crystal you have to change the Cal setup value to match. And keep in mind that the micro will only count a VFO frequency no higher than 40% of the crystal frequency. So the maximum frequencies in the above table will be 1/2 what is stated with a 20MHz crystal, and the update times will be double. But reducing the crystal frequency will reduce the power consumption. With a 3.3v power supply and a 10MHz crystal, the current consumption should be less than 3mA.

If you are using a LCD with a 14 or 16 pin dual row connector, that will connect long the side. If it has a backlight you will need a jumper from from BL (low end of R6) to BL+ (near R3) A connector is nice for this type of LCD, but you can also hand wire it.

Photos of some alternate LCD configurations are shown on my web site.

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