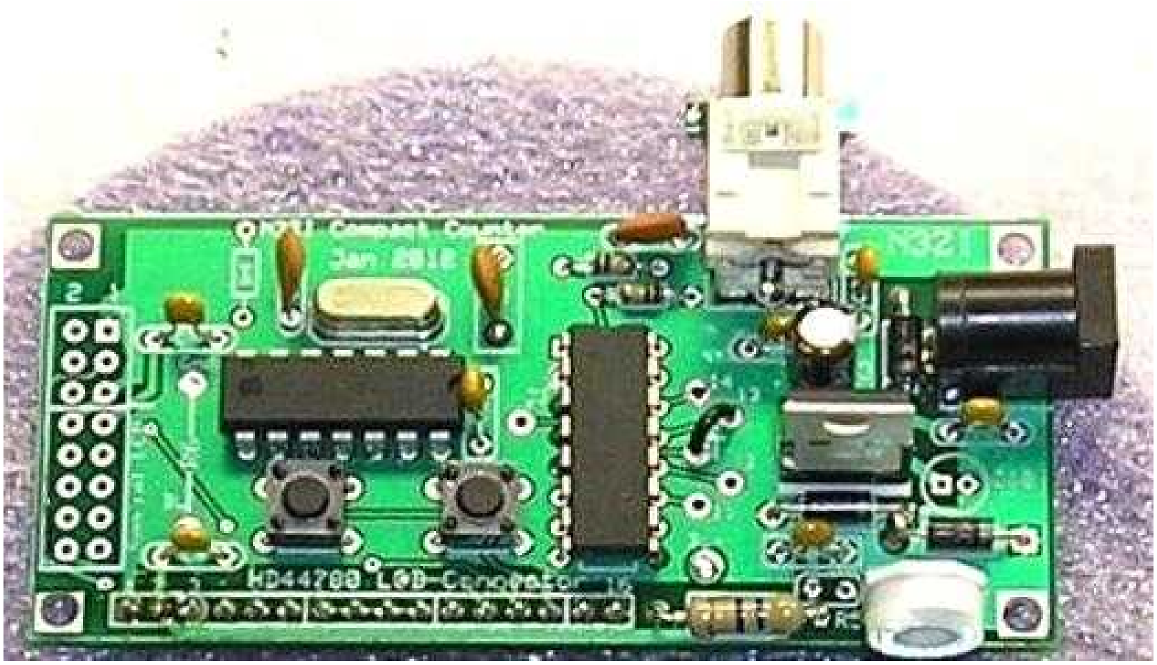
N3ZI Digital Dial Kit
Experimenters Version
Rev 3.8 Jan 2012



Experimenters Kit Components			
Item	**Qty**	**Designator**	**Part Color/Marking**
PCB	1		
LCD Display	0		Not included
Volt Regulator	1	U1	7805, TO-220
Prescaler	1	U2 Prescaler	16 Pin Dip, 74HC161/3
Microprocessor	1	U3 Microprocessor	14 Pin Dip, ATTINY84
XTAL	1	XTAL	20.000 MHz
Electrolytic Cap.	1	C3	Black Electrolytic
Cap 47pF	1	C4	Brown or Orange - 47
Caps, 27pF	2	C5,C6	Brown or Orange - 27
Caps, 0.1 uF	7	C1, C2, C7,C8,C9,CJ1,CJ2	Yellow - 104
Diode	3	D1,D2,D3	Black Epoxy
Resistors, 100K	2	R1,R2	Brown-Black-Yellow
Resistor, 47ohm	1	R3	Yellow-Purple-Black 1/2 Watt
Trimmer 10K	1	VR1	White Trimmer
Switch	2	SW1, SW2	
Power Jack	1	J1	Black 2.1mm Power
Input Jack	1	Input	RCA Jack

The parts included with you kit may differ from the above list. A packing list will be included with your kit, and that list supersedes the above list.

This version of the kit is for highly skilled experiments and consequently detailed assembly instructions are not included.

This kit can interface with a wide variety of LCD types, and generates a negative LCD voltage in a unique way. Refer to the schematic for details. There are two ground planes. The one on the left side of the PCB is used by the IC's and LCD's. The one on the right side of the PCB is the same as a power supply ground. Diodes D2 & D3, maintain a 1.4 volt difference between the two grounds. This is so that the Trim Pot (VR1) will be able to provide an adjustable voltage between -1.4 volts to _5.0Volts to the LCD bias input, when measured relative to the LCD ground.

With the ground probe of a DVM connected to the input power supply ground line, you should measure +1.4 volts on micro pin 14 (ground) and +6.4 volts on Micro pin 1 (+5v) Moving the ground lead of the DVM to a point on the left side ground plane, such as LCD connector pin 1. The Micro pin 1 will measure +5v, and micro pin 14 will measure 0.0v. And the ground on the right side of the PCB will measure -1.4v.

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 you will enter the setup mode.

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. Use 4 to start.

/n 4

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

But if you are just using one IF offset, change this to "1". If you are using this as a straight frequency counter without any IF offset, then set this to "0".

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 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. 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

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.

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 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

With the default setting (Div/4), the maximum VFO frequency that this counter can measure is 32MHz. Operation to 80 MHz is possible, refer to the section on advanced prescaler options.

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.

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	Resolu tion *3	Update Time *4
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	74HC163 *1	2	Div/2	T to 14	100Hz	25ms
16 Mhz	74HC163	20	Div/2	T to 14	10Hz	250ms
32 Mhz	74HC163	4	Div/4	T to 13	100Hz	50ms
32 Mhz	74HC163	40	Div/4	T to 13	10Hz	500ms
64 MHz	74HC163	8	Div /8	T to 12	100Hz	100ms
64 Mhz	74HC163	80	Div /8	T to 12	10Hz	1 Sec
80 MHz	74HC163	16	Div /16	T to 11	100Hz	200ms
100 Mhz	74AC163 *1*2	16	Div /16	T to 11	100Hz	200ms

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

*2) 74AC parts are a little touchy at low frequencies with a sine wave input, so they should be preceded by an external Schmidt trigger if you want to use the counter over a very wide frequency range.

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

*4) 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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