N3ZI Digital Dial
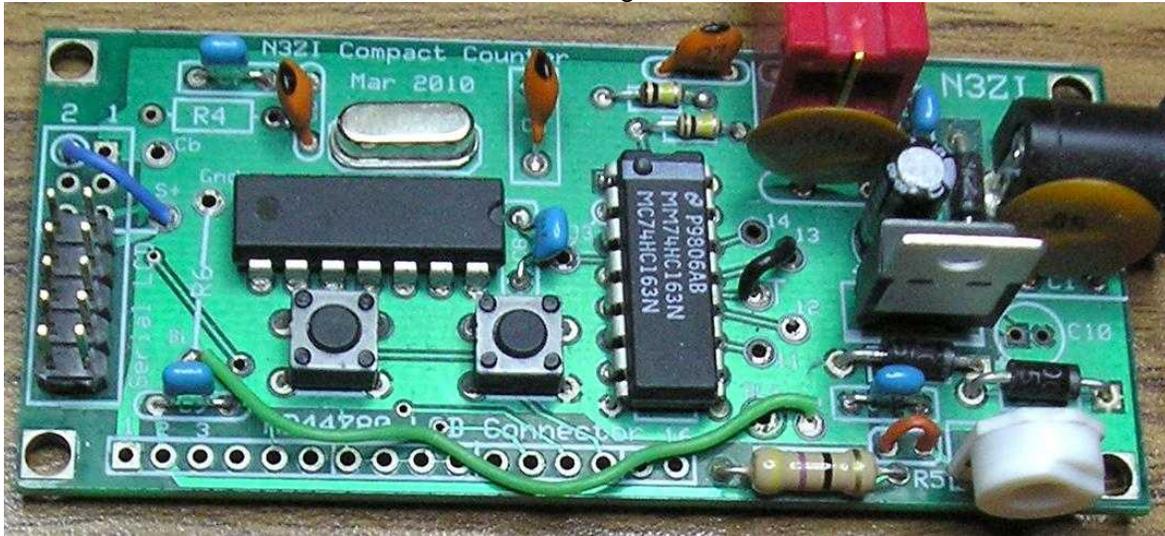**Super Kit Manual(20MHz Version)**
Rev 2.1 Aug 2011

Super Kit, Configured for Serial LCD with Cable Kit.
(Note that the size and color of the parts in your kit may differ from those in this photo)

| SUPER Kit Components			
Item	**Qty**	**Designator**	**Part Color/Marking**
PCB	1		
LCD Display	Opt		KTM-S1201
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
Caps, 27pF	3	C4,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
Jumper	1	R5	Shorting jumper
Trimmer 10K	1	VR1	White Trimmer
Switch	2	SW1, SW2	
Power Jack	1	J1	Black 2.1mm Power
Input Jack	1	Input	RCA Jack

You should start by soldering all of the passive components in the circuit board, but omit R3 for now. R3 is not needed with the serial LCD. Leave the U2, U3 and the LCD module uninstalled for the time being. Solder in the voltage regulator, U1. You may have to cut off the plastic nubs on the bottom of the RCA connector if it does not seat evenly to the PCB.

Jumpers (4): R5 needs a shorting jumper. R5 is located in the lower right hand side of the PCB, note the orange jumper in the photo.   You will also need a prescaler jumper, "T" to "13" Configured this way, the counter will work up to 32MHz. Though you may want to change this later per the "advanced prescaler options" described later. When using the KTM-S1201 Serial LCD you will need 2 additional jumpers. One is the long green jumper shown in the page 1 photo connected from Ca to the lower end of R6. R6 is not used and left open. You also need a power jumper for the LCD. This is the Blue jumper in the upper left corner of the page 1 photo. It connects from "S+" to "2" If you are using a different LCD see the section below "Using other LCDs" for the proper jumper selections.

Connect power to J1. Any DC voltage from 11 to 15 volts will work. Double check your work, and apply power. The design has two ground planes that are approx 1.2 volts different. The micro ground is on the left side of the board, and the ground plane occupies about 3/4 of the PCB. The system ground plane is on the right side of the PCB. The two large mounting holes on the right corners of the PCB are connected to the system ground. (The corner holes on the left side of the PCB are floating.) Connect the ground probe of you DVM to the system ground (the ground side of J1, or either of the corner holes on the right side of the board.) Check the voltage at pin 1 of the microprocessor, you should read +6.2v there. Check the voltage on Pin 14 of the micro and you should read about 1.2v there.   Now put the ground probe of you DVM on the micro ground (you can use Pin 1 of either of the LCD connectors or pin 14 of the micro) and put the positive probe on Pin 1 of the micro, you should read 5.0 volts. With your DVM ground line still on the micro ground connect the + probe of your DVM to the test point labeled Ca (It's just above R3) Now turn the Trimpot(VR1) and you should see a voltage reading that varies from 5.0v to -1.2v as you turn the pot. Set it to +1.5v. When you complete your kit, you can use VR1 to adjust the contrast and viewing angle of the LCD (all types)

As long as that is all OK, disconnect power, and solder the two remaining ICs, U2 and U3. You can use sockets, but my experience is that IC sockets can cause problems, so I recommend that you solder the IC directly into the PCB.
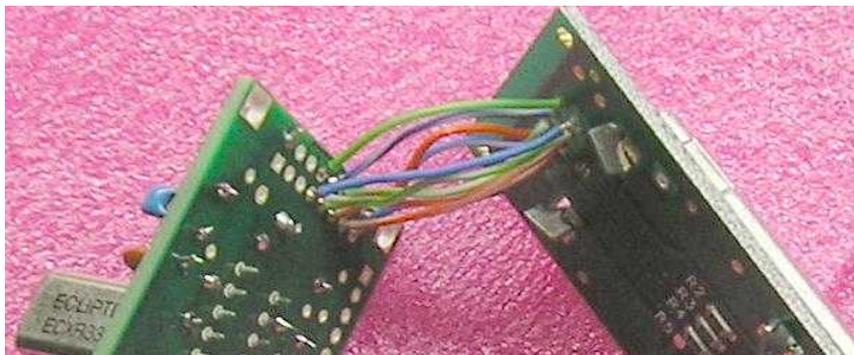

Serial LCD connection: *(If you are using the serial LCD, follow these instructions, if not look below for the section titled "using other LCDs")*

Solder the LCD module in place.   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.
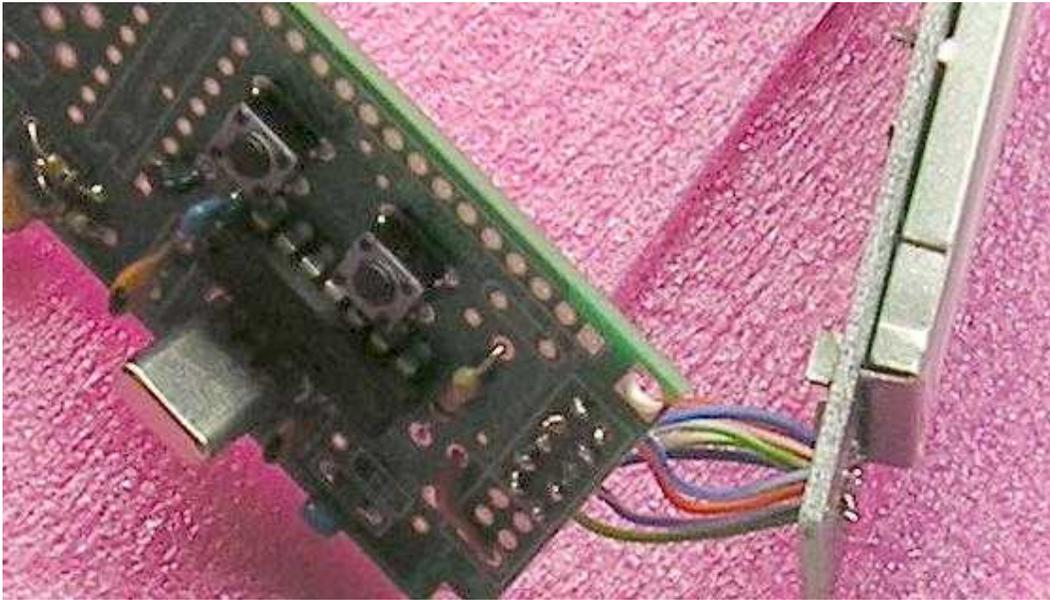
You can also use a removable cable as shown in the photo below. The the 10 pin headers go on the front of the counter PCB and the back of the LCD.
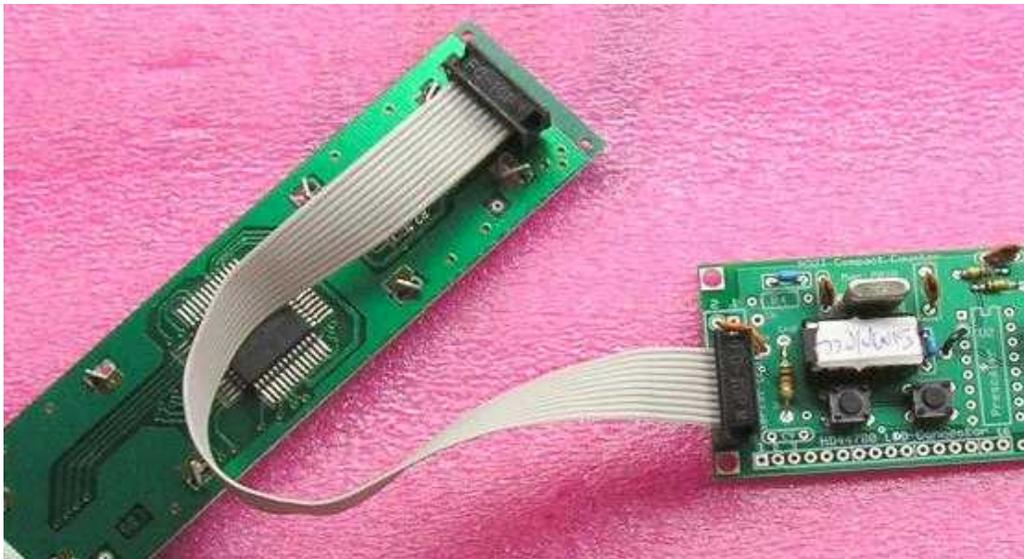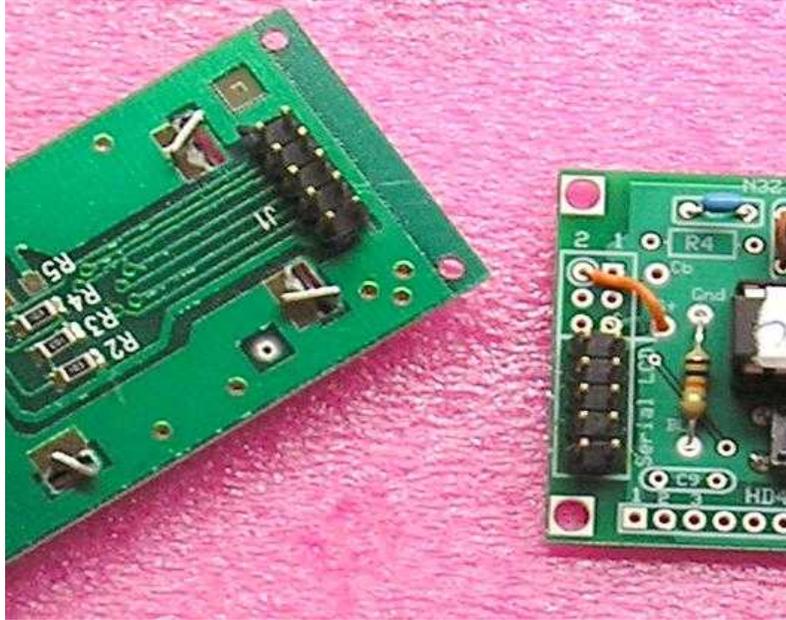
Initial Set Up:

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 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 8 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

Just a note about the switches, if you want to use different, or remotely mounted switches. 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.

With this kit you will end up with a PCB with some unused component positions.

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	Resolution *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.

Using other LCD's

The preceding instructions configure the counter for use with the standard serial LCD. But you can connect an alternate LCD that has a 14 or 16 pin connector, and a HD44780 or equivalent controller chip. Note that the prompts for the set up are a little different and easier to understand.

If you are using an LCD with a 14 or 16 pin single row connector it connects to the single row 16 pin connector.   If the LCD and the PCB are placed back to back the LCD wiring is straight through. Pins 7-10 are not used and can be left open, or if you are using a connector they can be connected, it does not matter. Be careful to make sure that the back of the LCD does not touch the back of the PCB.

If you LCD has a backlight, solder the 47 ohm 1/2 watt resistor at R3. This will provide about 50mA of backlight current which is the maximum that the regulator chip can supply without a heat sink. If this is not sufficient, then you will need to put a heat sink on the 7805, then you can go as low as 10 ohms for R3. Note than some LCD modules have backlight resistors on the board.

If you are using a LCD with a single row connector, you don't need any other jumpers. But If you are using a LCD with a 14 or 16 pin dual row connector you will need a jumper from Ca to Cb. And if it has a backlight, a jumper 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.

N3ZI Digital Dial

N3ZI Kits

Preliminary Schematic Compact Counter

Designer - Doug | Rev 3.0 | 5/02/11

Pin No	Designation
1	Vcc
2	Vss
3	SCK
4	SI
5	C/D
6	RESET
7	BUSY
8	CS
9	Vlc
10	N.C

POLARIZER Reflective	VIEWING DIR.	LCD NO.	DRG. NO. KTM-S1201
VOLTAGE	OPERAT. TEMP. -20 to 70°c	DRAWN BY -	
		SCALE Not in scale	DATE 12-08-98
module house		APP. BY -	REV. 1 SH. OF