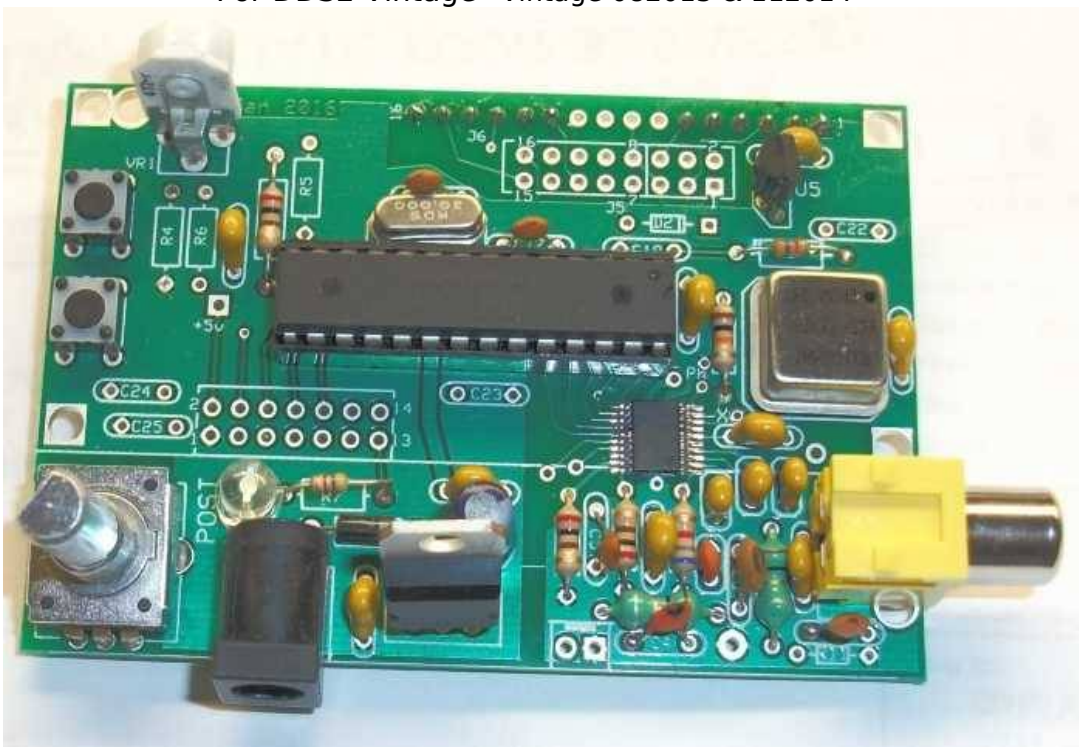
Manual for the N3ZI DDS2 2016
WWW.PONGRANCE.COM
Version V1.3 Apr 7 2017
For DDS2 Vintage "Vintage 082013 & 112014"



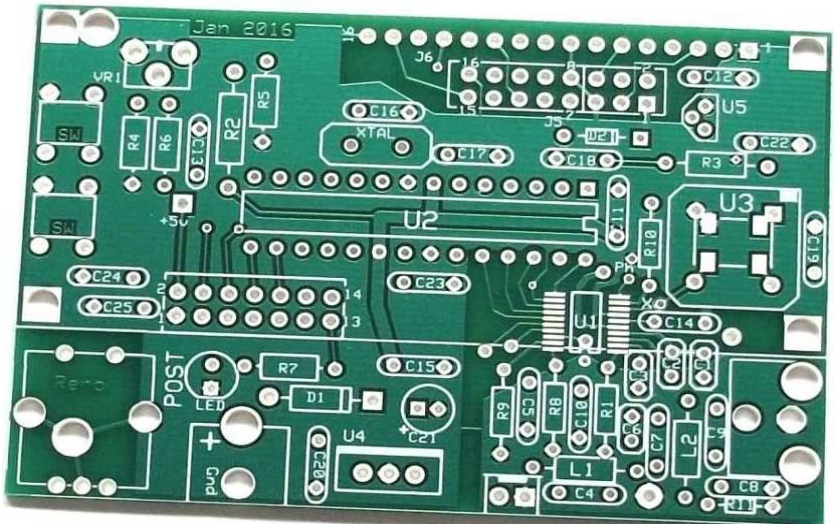
Assembly

This kit is intended for qualified individuals with extensive, from scratch, home brew experience, not just with other simple kits. Please read this manual in it entirety prior to starting construction. If you then feel that you cannot assemble this kit please return it to us for a refund.

Verify Parts: Verify that you have all the correct parts for your kit by checking the parts against the **printed packing list included with your kit**. Although there is a list of materials further down in this manual, The packing list included with your kit is the most up to date. Many of the parts are static sensitive, and you should use industry standard techniques for proper handling of all parts. The above photo should only be used as a general guide. Parts shipped with your kit may be of a different color or size, and not all the items shown in the photo are included in all kits.

Test Equipment Needed: You will need a Digital Voltmeter to measure Resistance, DC voltage and current, and a low current 12v power source. The maximum current draw for a properly assembled kit is 100mA so you should limit you source current to 100mA during the assembly process, that way the damage from any errors or faults will be minimized. You will also need some circuit board cleaner.

PCB Check: Before you solder any parts in, I recommend a check of the microprocessor pins. There have been instances were one of the micro pins were inadvertently shorted to the PCB ground plane. This is very rare, but difficult to debug and repair after the board has been built. Check the continuity to ground for each of the 28 pins of U2. Only pins 8 and 22 should show a continuity to ground, the rest should show open circuit. There is a thin fusible link on the back of the PCB under the power connector. This fuse will blow at ~1 Amp. If you do blow this, correct the problem that caused the fault, then replace that connection with a piece of 40ga wire. However, keep in mind that any fault with a semiconductor device will likely incur damage in a few nanoseconds, long before any copper wire fuse will heat up an blow.



Start by soldering in the power supply components. D1, U4, C15, C20, C21 The PCB is laid out to accept a 2.1mm power connector, but it isn't really needed. This is a 2.1 mm coaxial power connector, +12v inside, ground outside. These connectors usually have 3 pins, there is no PCB hole for the side pin, just break it off. If you don't have a power connector, just solder your power wires directly into the PCB holes. This connector can be soldered to either side of the board. Double check the polarity on D1, C21, the LED (short lead is Gnd) and the orientation of U4.

Power supply current Check#1: Apply 12VDC power using a power supply with a current limit set to 100mA. Check to see if 5VDC is present at U2 pin 7. Measure and record the current draw, it should be less than 10mA at this point.
Assuming your DDS Chip has been previously soldered to the PCB, Next install the 4 capacitors next to the DDS chip, C1, C2, C3, C14 be careful with these to avoid any solder shorts, and trim the leads neatly.

Power supply current Check#2: At this point you should check the 5v power supply and current draw. Apply 12VDC power using a power supply with a current limit set to 100mA. Check to see if 5VDC is present at U2 pin 7. Measure and record the current draw, it should be less than 15mA at this point. Also check and record the voltage across C14, it should be 2.5V.

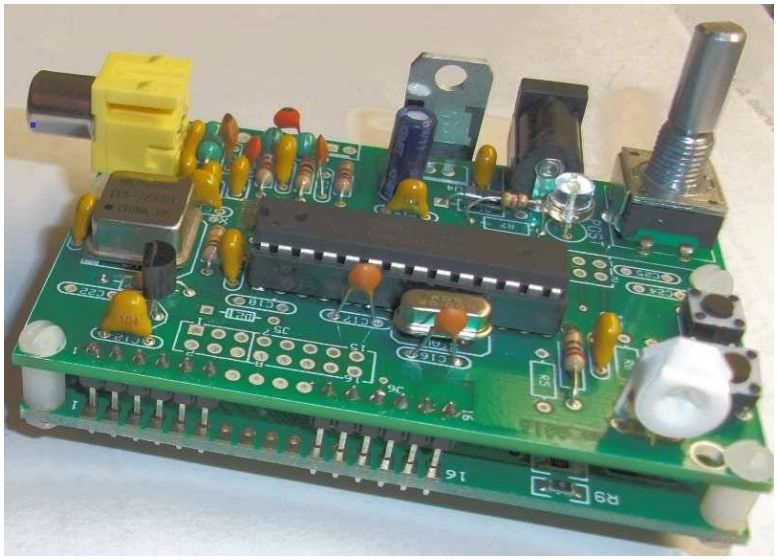
The RCA jack can be mounted on the back if you like. Note that you may have to cut the plastic nubs off of the RCA connector to get it to fit properly, or the pins can be bent such that the nubs hang off the end of the PCB.

The push-buttons are simple SPST switches, and you can remotely mount another switch in parallel if you like. You could use a single SPDT switch to replace both SPDT switches. One that is momentary with a center off position is a very slick setup.

Encoder and Switches: The SPDT Switches and the connections for the Encoder all are routed to the 14 pin connector if you want to mount them remotely. It's ok to use the pushbutton switches on the PCB and have another set remoted. But you can only have one encoder connected. The encoder can be mounted remotely or soldered to the PCB. If soldered to the PCB it can be soldered on either side of the PCB. You should consider this carefully before you solder it in, because it's very difficult to unsolder without damage. Also there is no need to solder the side tabs to the PCB. Just solder the 5 signal pins (3 on one side 2 on the other) There are also spaces to capacitors to filter the remote Encoder signal if needed (C24, C25)

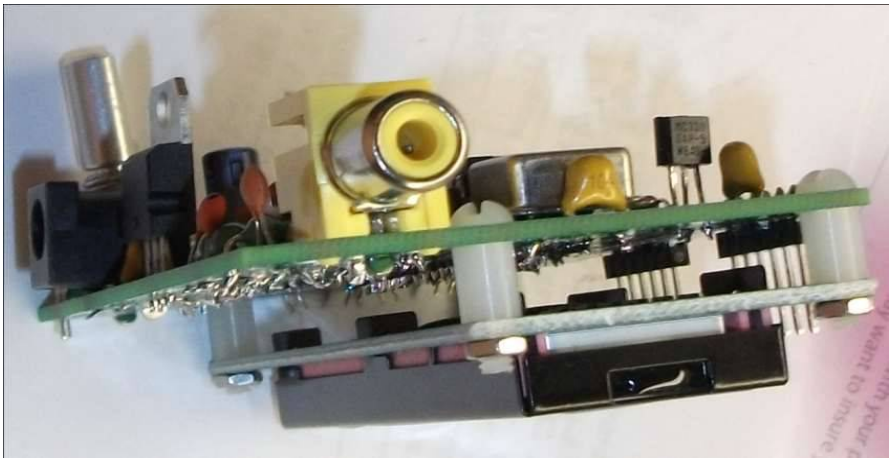
Finish Soldering: Solder in the rest of the components. Kits normally include a socket for the micro. Solder in the remaining components except the 80MHz oscillator can, and the encoder. Note the polarity of the LED, the short lead is ground. The ground hole, is the next to the power connector. Completely clean the PCB using appropriate solvent.

Power supply current Check#3(a,b,c):
(a)At this point, with everything installed except the following: Micro, 80MHz Oscillator can, LCD. Apply 12v power and check and record current draw. It should be less than 15mA.
(b) Remove power and put the micro in, now current draw should be less than 35mA. At this point the POST (power on self test) LED will function. Normal LED operation is as follows, after power is applied, it's off for short period of time while micro boots up, generally less than 0.2 seconds, then goes dim for while running the self test for 1-2 seconds, then switches to full on indicating everything OK. If test fails it will turn off.
(c) Remove power and solder in the 80MHz oscillator can. Apply power current draw should be, between 40 and 80mA

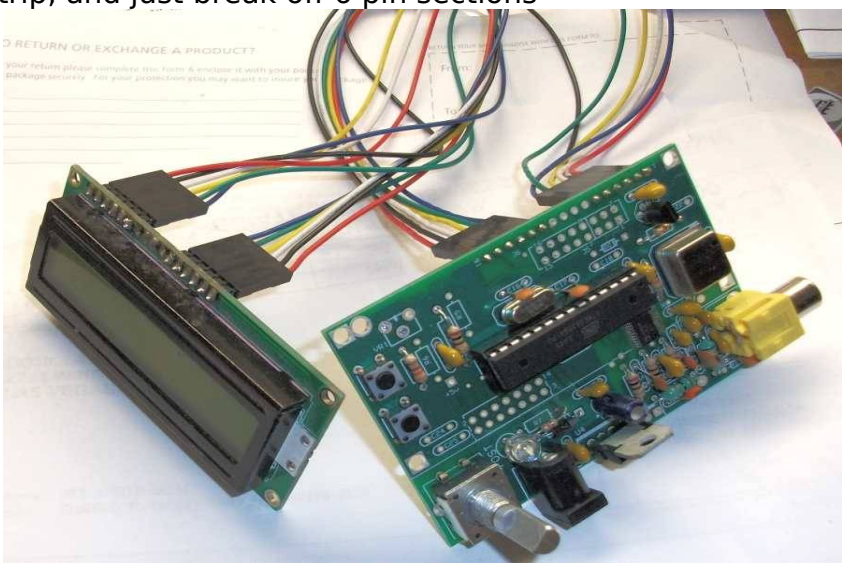


LCD: The next step is to connect the LCD. LCDs supplied have a single row of 16 I/O connections, but only 12 of the connections are used, you can skip connection for pins 7-10. R2, 200 ohms, sets the current to the LCD backlight at 7mA. You can decrease this resistor to increase the brightness of your backlight, but do not use a resistor less than 100 ohms (10mA). Kits are shipped with a 4.7K pot for contrast adjustment, which works

well with all supplied LCDs. There are other component holes in the area for use with different LCDs
There are matching holes on the PCB to mount the main PCB and LCD together if you wish. This makes it a little easier to solder the connections, since they are all straight through. The above picture shows solid pins making the connection. Although very easy to solder, it's very difficult to access for service, because they don't bend and are difficult to unsolder, if you need to get to the back of the PCB or correct some soldering error. Consequently I recommend using individual wires for each connection. This takes a bit more time, but it will allow you to bend the LCD out of the way if you need to get access. The mounting hardware shown in the photos is not included in the kit, but both Lowes and Home Depot stock 4-40 hardware like this.



Another option for LCD mounting is remote, as shown in the picture below. You will need 4 6 pin strips, and two 6 pin jumper cables. Pre made 6 pin jumper cables are sold by many suppliers on ebay. Pins are soldered on both the DDS PCB and the LCD, then they are connected using jumper cables. Generally you can get these pins as a 40pin breakaway pin strip, and just break off 6 pin sections



Final Current check: With the LCD connected and all parts installed, check and record the current draw, it should be less than 100mA. No parts should be getting hot, except the 80MHz oscillator can may get slightly warm but not hot. The 7805 may get slightly warm, but not hot. If the power on self test LED is working properly, but the LCD is not on check the bias voltage (LCD Pin 3) and wiring to the LCD.

SETUP:

To enter the setup mode, apply power while holding encoder push switch down.
Wait for the LCD to show SETUP MODE, then release pushbutton.

Then it will sequence though all the setup modes.
Press the push switch to enter that mode.

The setup modes will be displayed in this order:

1. **Cal. Bands** (Do this last)
2. **Set # of Bands**
3. **Set IF Offsets**
4. **Set Band Freq**
5. **Reset/Clear?** (Do this first)

Reset/Clear? : DOING THIS WILL DELETE ALL OFFSETS AND FREQUENCIES
It is recommended that you do this when you first power up the DDS, to clear out any settings or frequencies that may be in place from testing, and let you start with a clean slate. When the "Reset/Clear" message appears, Push the Encoder Push Switch button. You are asked to confirm with another Encoder Push Switch button press. All IF Offsets and Band Frequencies are set to 0.0. Progress is displayed on the LCD. If you do nothing when it asks "Confirm" then after a few seconds it will say "Nothing Done" In either case it proceeds to normal operation.

Set # Of Bands: The reset/clear function will set this to 30 bands. But you probably won't need that many, so it's best to change this to however many you need. If you decide you need more bands later, you can change this at any time. When the "Set # Bands" message appears, Push the Encoder Push Switch. Use the Band up/down switches to set the number if bands to anything from 1 to 30. When finished, press Encoder Push Switch button to exit, then it will go to normal operation.

Set IF Offsets: (Indicated by an "F")
A reset/clear will set all the IF's to 0.0, if you are not sure what to set the IF to, don't use this function, and the IF's will all stay set to 0.0, then the LCD will simply show the VFO output frequency. To set the IF offsets, enter setup mode, and when the "Set IF Offsets" message appears, Push the Encoder Push Switch button. Select the desired band, and enter the IF OFFSET `needed for your radio. The normal tuning step is 50KHz in this mode. Step to the next band and enter the offset. Next push the Up or Down switch to store the last entry, then Power Down the VFO. If's can be set to positive or negative numbers to accommodate additive and subtractive IF schemes. (If you need to set you Ifs to a more precise frequency, Press and hold the encoder push switch, while briefly pushing the up or down button to get 1Khz or 1 Hz steps.) When finished double check all settings then cycle power to restart the DDS normally.

Set Band Freq. (Indicated by an "S")
The Band Frequencies are the starting point for each band. The last frequency used on a band is stored and becomes the starting point the next time that band is selected. So you can set your band frequencies with the DDS in normal mode, but this mode allows you to set them with 50Khz steps, so it's easier to change frequency a lot. When the "Set Band Freq" message appears, push the Encoder Push Switch button. Select the desired band number and enter the desired BAND FREQUENCY. Repeat this procedure for all bands. Next push the Up or Down switch, then Power Down the VFO.

Cal Bands: Don't attempt this until you have set up all the other parameters. And Operate the DDS normally and accurately tune to a station to calibrate against. You can calibrate against WWV or an AM shortwave station using the SSB mode and it will be very accurate. If the display is not reading correct, wait 30 seconds and power Down the VFO. The VFO frequency will be saved. Then power up in Setup Mode. When "Cal. Bands" is displayed, push the When Encoder Push

Switch. Using the TUNING KNOB, tune the display to read the proper frequency of the known signal. The VFO frequency will not change, only the display changes. Next push the Up or Down switch to store the correction, then Power Down the VFO. That band is now calibrated. Repeat this for any other bands you wish to calibrate. Calibration compensates for aging Crystals in your radio, and should not be more a few Khz off. If you need to move more than that, then something else is wrong.

RIT Operation: Tie Aux connector pins 3 and 7 together. Normally leave open, When grounded RIT is activated. The RIT value starts at 0.0, but as you tune with the Rit input grounded, the frequency will move as shown on the LCD. When you release the Rit input, the frequency will return to the original frequency. For example, a DX station is transmitting on 7.010 but listening on 7.030. You first would tune to 7.030, then ground the RIT input and tune down to 7.010 to listen. When you transmit, you would release the RIT control input, and the DDS will jump to 7.030. The RIT shift will be cleared to 0.0 anytime you change bands.

Operation.

Memories: There are a total of 30 memories each memory holds a Frequency and an IF. In many cases all the IF's will be set the same. You can set any or all IF's to 0.00. Memories are selected using the two pushbuttons (up/down) and are tunable. That is, if you turn the dial while at that memory the frequency will change. When you switch to the next memory, the last used frequency will be saved for the prior memory location.

Tuning Step Size: The DDS powers up with a 10Hz step. Tapping the encoder push switch will toggle between 10Hz and 100Hz steps. If you press and hold the push switch down, then push the up or down button you can select 1Hz or 1Khz step sizes.

Dial Direction: If your encoder is remotely mounted, you can interchange the A & B connections to reverse direction. The dial direction may be reversed because of the use of negative IF's and/or high vs. low VFO injection. Reversing the sign will reverse the direction. For example if you have 0.0 IF and are tuned to 7.000.000 and you want to reverse the direction of tuning, tune down in frequency towards 0.000 then keep turning the encoder (in the same direction) and the frequency will start to increase, when you get back to 7.000.000 the tuning direction will be reversed. If you have an IF set, then you will also need to change the sign of that.

Output: The output signal is not amplified, and the level is approx. 250mV peak to peak which works well with SA612 or similar mixers. Output impedance is 200 ohms. It does not need to be matched, but the output filter is flatter if the output is matched. With vintage radios, or other applications, you may need a separate buffer amplifier.

Output filer: This DDS uses a D/A converter to generate the sine wave output. This D/A converter is clocked at 80Mhz. The theoretical maximum output frequency is 40Mhz, this is refereed to the Nyquist rate. All D/A converters have an image output above the Nyquist frequency. (If you go to wikipedia, and search for Nyquist you will find a nice article describing the theory) So if you generate a 39Mhz signal, which is 1 MHz below the Nyquist frequency, there will be a mirror image exactly 1 MHz above the Nyquist rate, at 41Mhz. If you generate a signal at 25Mhz the mirror will be at 55Mhz. Normally an output filter is used to filter out this signal. The output filter included in your kit, will allow operation up to 34MHz, with about 40db of attenuation of the 46MHz mirror.

14 pin Aux Connector

This is a 14 pin connector located between U2 and the power connector. Carefully note the pin numbering. Pin numbers are on the front silk screen and back copper.

Pin #	Name	Type	Function
1	Gnd (D)	Ground	Digital Ground
2	+5v	Power	+5v test line
3	RIT-b	Digital Input	LOW Causes RF output to shift in frequency by the RIT value (DDS Pin 9) (Normally tie pin 3 and 7 together)
7	RIT-a	Digital Input	LOW causes LCD to display Freq + RIT (Micro pin 23) (Normally tie pin 3 and 7 together)
4,8	SW1,2	Inputs	Upper, Lower Switch, Used to connect remote switch
5	Reset	Digital Out	Active low reset output
6, 12	ENC-A, B	Inputs	For remote encoder connection, interchange ENC-A and B to reverse the direction of the encoder.
10	ENC-Push	Input	Remote Function Switch (Encoder push switch)
9	Not Used	Not Used	Not Used, make no connection to this line
13	Not Used	Not Used	Not Used, make no connection to this line
11	Not Used	Not Used	Not Used, make no connection to this line
14	Not Used	Not Used	Not Used, make no connection to this line

Use reasonable caution when connecting to the input control pins (3,4,7,8,10). All inputs have on chip pullups to +5v, so only a contact to ground is needed. You can connect a switch, relay, open collector, but any voltage over 5v, or negative, will likely damage the microprocessor. Use an opto isolator to connect to protect against any possible ground differences, or voltages over 5v. Pins 6 and 12 are input lines, but should only be driven if the encoder is not mounted on the PCB. C24 and C25 can be used for filtering of the remote encoder lines if needed.

Pin 5 is a totem pole digital outputs that swing from 0 to 5v, and can drive or sink no more than 2 mA.

Pins 7 and 3 control RIT. Pin 3 causes to DDS to actually shift by the RIT frequency. Pin 7 causes the LCD to display that frequency. Normally you would tie these together. But you could keep them separate and it would give you the ability to look at the RIT frequency is without actually changing the frequency. When you are adjusting the RIT by using the tuning knob function switch the output of the DDS will only reflect this frequency if the RIT is turned on, i.e Pin 7 is low.

RIT is an offset to the main frequency. So for example if the RIT is set to 1.000KHz, and the main frequency is set at 7050.000, when you lower the RIT control line (Pin 3) the frequency will shift to 7051.000 and if you also low control line #7, the LCD will display that new frequency. If you then change the main frequency, to, for example, 10,110.00, then lower the RIT control line the output frequency will move up to 10,111.00. You do not have to set the RIT offset again after you change the main frequency. The RIT can be set to pretty much anything, positive or negative.

DDS Chip Solder

Most kits are shipped with the DDS chip soldered down, If not then you will have to solder it down. It's a tiny 20 pin chip AD9834CRUZ. It will be easier to solder it down if the rest of the board is nearly empty. The best method I have found for this chip is the use a 15 watt soldering iron, with a fine tip. Carefully align the chip in the right location. Make note of the direction. Pin 1 goes in the lower right. Pin1 on the chip has a dot indent in the plastic package. I normally use tape to temporarily hold the chip in place while I'm soldering it. Under no circumstances should you glue the chip to the PCB. Carefully align the chip to make sure it's centered, both left/right and up/down then hold the chip down with a piece of tape leaving one side of the chip exposed. Solder down one of the exposed corner pins. Remove the tape, re-align the chip, and solder the opposite corner. Then solder all the remaining pins, use plenty of solder and don't worry about solder bridging. After you are done use solder wick to remove excess solder and any solder bridges. (Flux will help the solder wick.) If the solder wick becomes frozen (soldered) to the board, don't rip it off, heat it up with your iron and pull it up carefully. Inspect it carefully by eye under a magnifying glass. Clean it with flux remover, and make sure there is no debris under the chip or elsewhere. Use a DVM or continuity tester all the connections are made by testing right as the lead exits the package, then on the PCB at the appropriate point. Also make sure there are no pin to pin shorts and no shorts to power or ground. Note than pins 4 and 5 will show as shorted because they are both connected to +5v. And pins 7, 10, 12, and 18 are hardwired to ground, so all should show continuity to ground. Pin to pin solder shorts are fairly common, frequently they appear OK visually, but show up shorted on the continuity check. Just lay some wick down apply heat, and you should wick up the excess solder causing the short. I that doesn't work, you can try running the blade of an exacto knife between the leads to clear out any short. If that doesn't work apply some more solder, then wick it up again.

Other LCD Types

This DDS can only work properly with a 16x1 LCD.

Other Encoder Connections

The standard kit includes a mechanical encoder that mounts to the PCB, with an integrated push switch (5 pins). If you want to use an optical encoder, such as the EM14 series from Bournes. Mount it remotely, the pushbutton switch can be a push switch on the encoder, or a separate pushbutton. C24 and C25 can be used to filter the encoder lines, if you pick up noise or RF on the remote wireing.

Most Optical Encoders have 4 pins usually Pwr, Gnd, A, B , if there are 6 pins, the two extra are for the push switch.

- Connect Encoder Power pin +5v on the PCB Aux Connector Pin 2
- Connect Encoder pins A, B to Aux connector pins 6 & 12 Note: Reversing these will reverse tuning dial direction
- Connect the encoder ground pin to Aux Connector pin 1
- Connect a SPST-NO pushbutton from Aux connector pin 10 to ground(1)

Bill of Materials

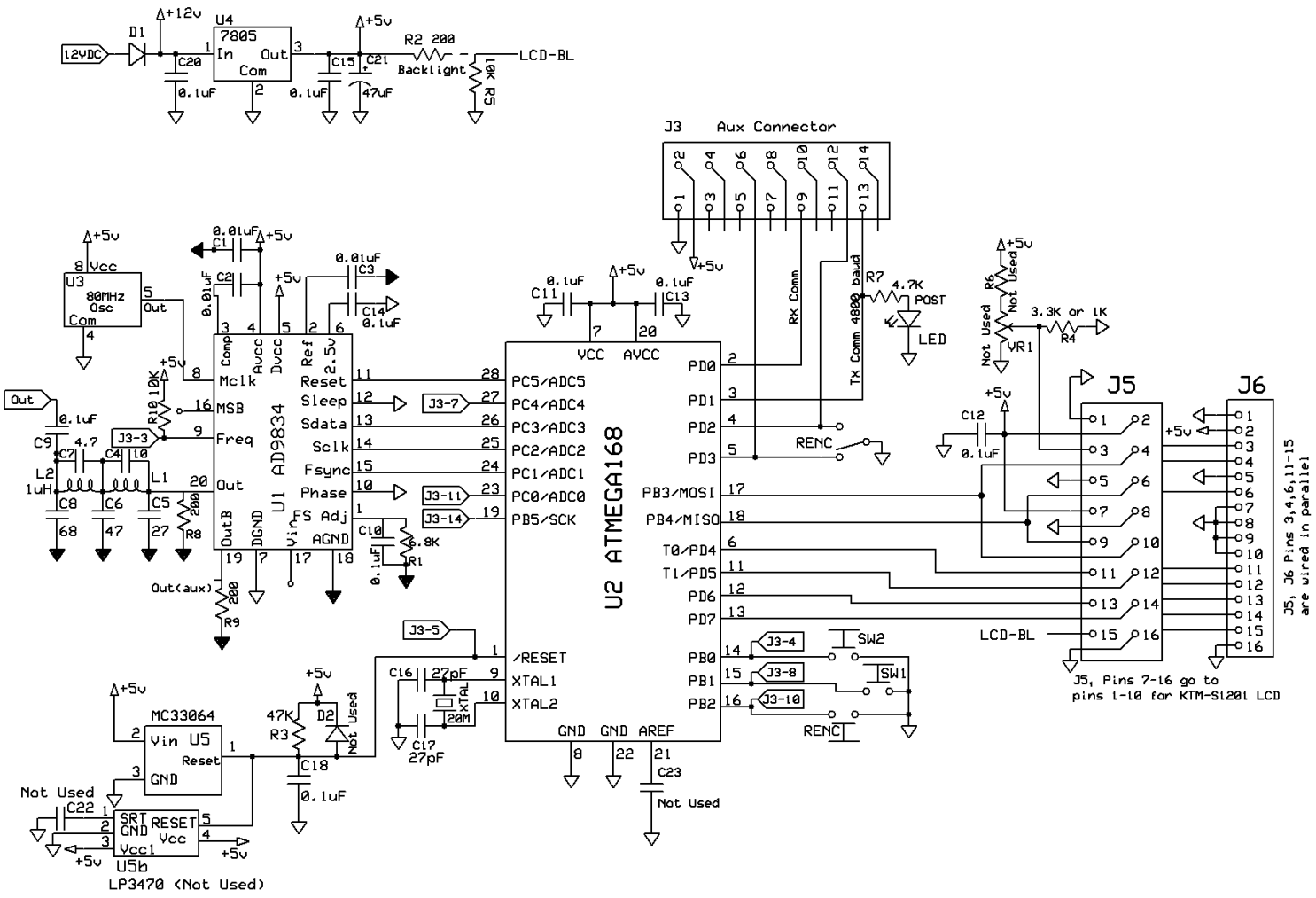
(Note: The packing list included with your kit supersedes this list)

Designator	Part	Qty	Description / Appearance
PCB	Circuit Board	1	N3ZI DDS
J6	LCD Module	1	Varies
U1	DDS Chip AD9834	1	Tiny 20 pin TSSOP (normally soldered to PCB)
U2	Micro ATMEGA168	1	28 Pin Dip
U2	Socket for Above	1	28 Pin DIP socket
U3	Oscillator	1	Metal can 80MHz
U4	Volt Reg	1	7805
U5	MCP100 or Equiv	1	TO-92
D1	Diode	1	Black epoxy
LED	LED	1	POST LED (Polarity: Short lead is Ground)
L1,L2	1.0uH Inductor	2	Brown, Black, Gold
XTAL	20 MHz XTAL	1	Short Can 20.000
C1,C2,C3	0.01uF Capacitor	3	Yellow 103
C4	10pF Capacitor	1	Brown/Orange 10
C5, C16, C17	27pF Capacitor	3	Brown 27
C6	47pF Capacitor	1	Brown/Orange 47
C7	4.7pF Capacitor	1	Brown/Orange 4.7
C8	68pF Capacitor	1	Brown/Orange 68
C9, C10, C11, C12, C14, C15, C19, C20	0.10uF Capacitor	8	Yellow 104
C21	Electrolytic Cap	1	Black Radial
R1	6.8K Resistor	1	Blue, Grey, Red
R2, R8, R9	200 Ohm	3	Red, Black Brown
R7	4.7K Resistor	1	Yellow, Purple, Red
R10	10K Resistor	1	Brown, Black, Orange
VR1	4.7K Vari Resistor	1	White
R-ENC	Encoder	1	See Text
SW1,SW2	Push button Switch	2	
J1	RCA Jack	1	Output Signal
J2	Power 12v	1	2.1 mm power

Note: the appearance color and value of some parts change from time to time with differences from various suppliers. You should receive a packing list with your kit, which should have a current description for the parts in your kit, and it supersedes this list.

The following PCB locations are not used: R3, R4, R5, R6, R11, D2, C18, C22, C23, C24, C25

(Explanation: VR1, R2, R4, R5, and R6 control the bias and backlight of the LCD. With the LCD type I am currently shipping, only VR1 and R2 are used. If you want to use a different type of LCD, those may be helpful. D2,C18,C22, and R3 are related to the microprocessor power up reset. With the reset chip I am currently including in the KIT (U5, MCP100) none of these are needed. These may be useful If you want to operate at a lower voltage or have an external reset. C24, and C25 are filter caps on the encoder lines. If you remote the encoder and are picking up noise or RF, you might want to put filter caps in these locations. C23 is a filter cap for the analog section of the micro, the current programming does not use this section of the chip so it's not needed. R11 is an optional output load resistor. Not normally needed.)


+12v
U4
7805
In
Out
Com
D1
12VDC
C20
0.1uF
C15
0.1uF
C21
47uF
+5v
R2 200
Backlight
10K
R3
LCD-BL
J3 Aux Connector
U3
80MHz
Osc
Vcc
Out
Com
U1 AD9834
Mclk
MSB
Freq
Out
OutB
DGND
Vin
AGND
Comp
Avcc
Dvcc
Ref
2.5v
Reset
Sleep
Sdata
Sclk
Fsync
Phase
FS Adj
U2 ATMEGA168
VCC
AVCC
PC5/ADC5
PC4/ADC4
PC3/ADC3
PC2/ADC2
PC1/ADC1
PC0/ADC0
PB5/SCK
PB3/MOSI
PB4/MISO
T0/PD4
T1/PD5
PD6
PD7
PB0
PB1
PB2
/RESET
XTAL1
XTAL2
GND
AREF
PD0
PD1
PD2
PD3
RX Comm
TX Comm 4800 baud
R7
4.7K
POST
LED
RENC
SW1
SW2
R6
Not Used
VR1
3.3K or 1K
R4
J5
J6
J5, J6 Pins 3,4,6,11-15 are wired in parallel
J5, Pins 7-16 go to pins 1-10 for KTM-S1201 LCD
MC33064
Vin U5
Reset
GND
U5b
LP3470 (Not Used)
Not Used
XTAL
20M
N3ZI
Schematic - DDS 2016 PCB
Doug
Rev 2.0
1/1/2016