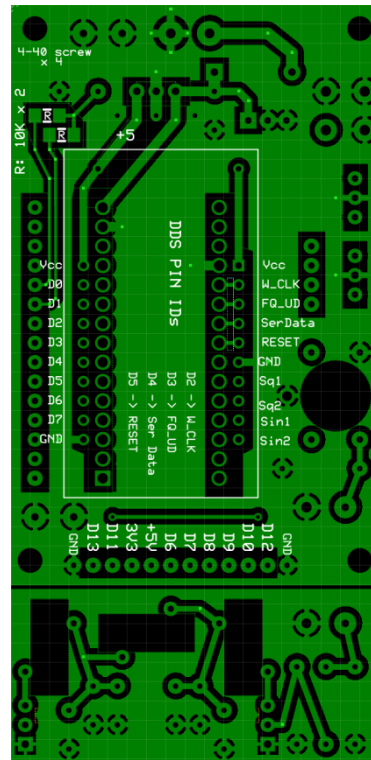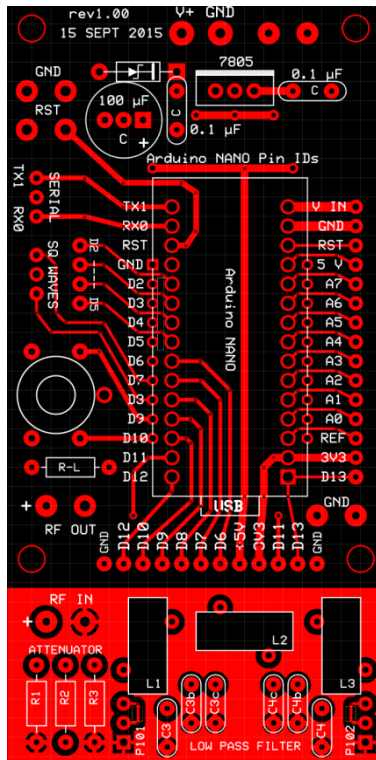# DDS Type-2 and Arduino NANO Experimenter Board
PCB rev1.00   15 Sept 2015

Pictured approximately actual size (3.925" x 1.95")

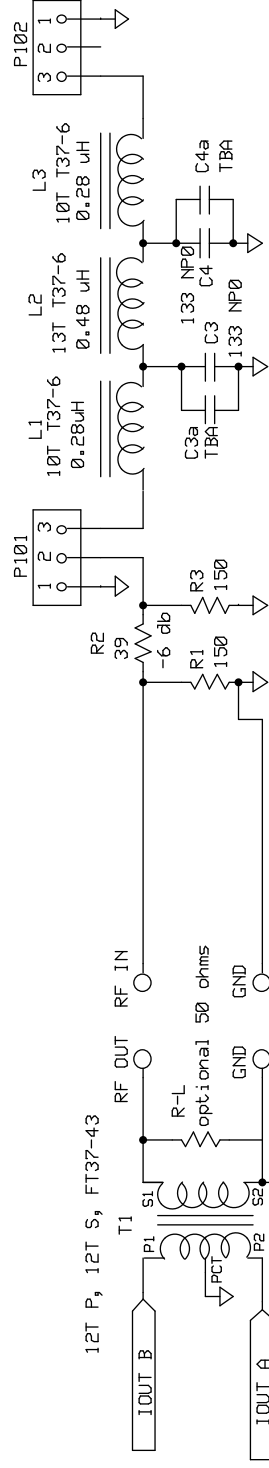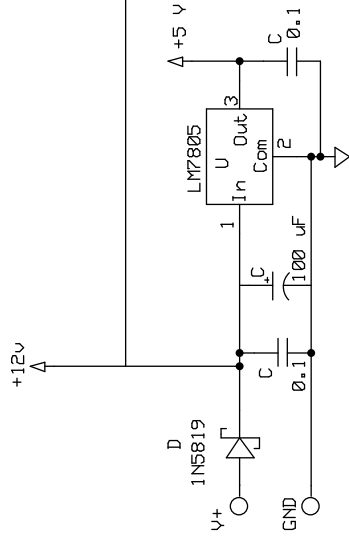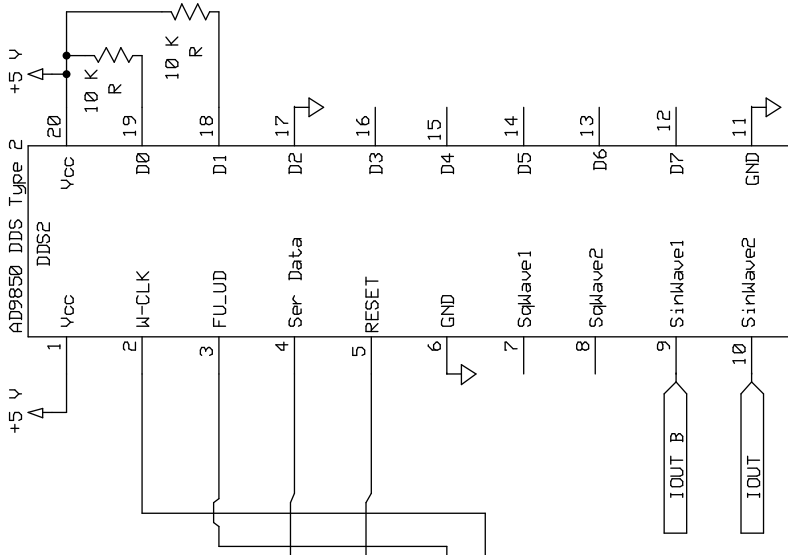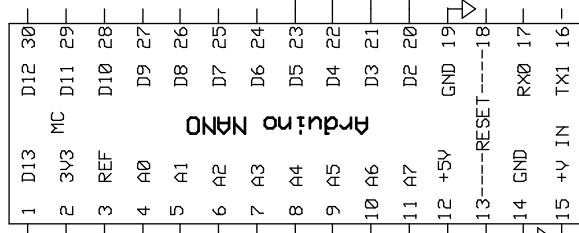TOP COPPER   BOTTOM COPPER

Features: Accepts a Type-2 DDS module and an Arduino NANO processor board
USB connector of NANO is accessible for programming or serial communications
Connections are already made for controlling the DDS with the NANO (NANO D2 – D5)
  *PHSNA software will need to be modified to change the pin assignment(see **Software Modifications**)*
5 V regulator footprint on board, will run on supply of 8 to 14 V
All digital pins not connected to the DDS are brought out to the lower row of 0.1" spaced pads
Analog and other miscellaneous pins are brought out to the right side column of 0.1" pads
DDS pins D0 and D1 have pads available for optional pull-ups (1206 SMT on bottom side)
NANO pins D2 through D5 (used for DDS) are also brought out to a pad set
Traces can be cut to isolate NANO pins D2 through D5 if desired
Serial Rx/Tx, and RST from the NANO are brought out to pads on the left side
Square wave outputs from DDS are brought out to pads on the left side
Sinewave outputs from DDS are connected to pads for a center-tapped transformer (FT37-43)
Transformer output brought out to pads for RF out
Attenuator circuit layout at bottom
Low pass filter circuit (same as Type-2 PHSNA) layout at bottom
  LPF can be used in place, or separated from the main board if desired
Pads provided for installing grounding loops to connect instrument commons

New, just discovered (by Dick, K9IVB) feature:

The pinout and spacing on the board that are designed to accept the Type II DDS modules turns out to be compatible (with some wiring care and attention to software) with the QRP-Labs synthesizer module that utilizes the popular Silicon Labs Si5351A clock generator chip http://www.qrp-labs.com/synth.html See the following schematics for more information.

ONLY THE DEDICATED CONNECTIONS ARE SHOWN
MANY OTHER PINS OF THE NANO
AND SEVERAL OF THE DDS MODULE
ARE BROKEN OUT TO PCB PADS

THE TWO PULLUP RESISTORS ARE OTIONAL

AD9850 DDS Type 2

+5 V

10 K R
10 K R

20 Vcc
19 DDS2 D0
18   D1
17   D2
16   D3
15   D4
14   D5
13   D6
12   D7
11   GND

+5 V

1 Vcc
2 W-CLK
3 FU_UD
4 Ser Data
5 RESET
6 GND
7 SqWave1
8 SqWave2
9 SinWave1
10 SinWave2

IOUT B

IOUT

Arduino NANO

1 D13   D12 30
2 3V3   MC D11 29
3 REF   D10 28
4 A0   D9 27
5 A1   D8 26
6 A2   D7 25
7 A3   D6 24
8 A4   D5 23
9 A5   D4 22
10 A6   D3 21
11 A7   D2 20
12 +5V GND 19
13 ----RESET---- 18
14 GND   RX0 17
15 +V IN   TX1 16

LM7805
1 In Out 3
   U   Com
        2

C 0.1

+5 V

C 100 uF
C 0.1

+12v

D 1N5819

V+
GND

P102
3 2 1

L3
10T T37-6
0.28 uH

C4a
TBA

L2
13T T37-6
0.48 uH

133 NP0
C4

C3
133 NP0

L1
10T T37-6
0.28uH

C3a
TBA

P101
1 2 3

R2 39
-6 db
R3 150
R1 150

RF IN

GND

USE C3a AND C4a AS NEEDED TO OBTAIN PRECISE VALUES

RF OUT

R-L
optional 50 ohms

GND

T1
12T P, 12T S, FT37-43

S1
P1
PCT
P2
S2

IOUT B

IOUT A

THIS IS THE SAME LPF CIRCUIT USED ON THE TYPE I AND TYPE II PHSNA
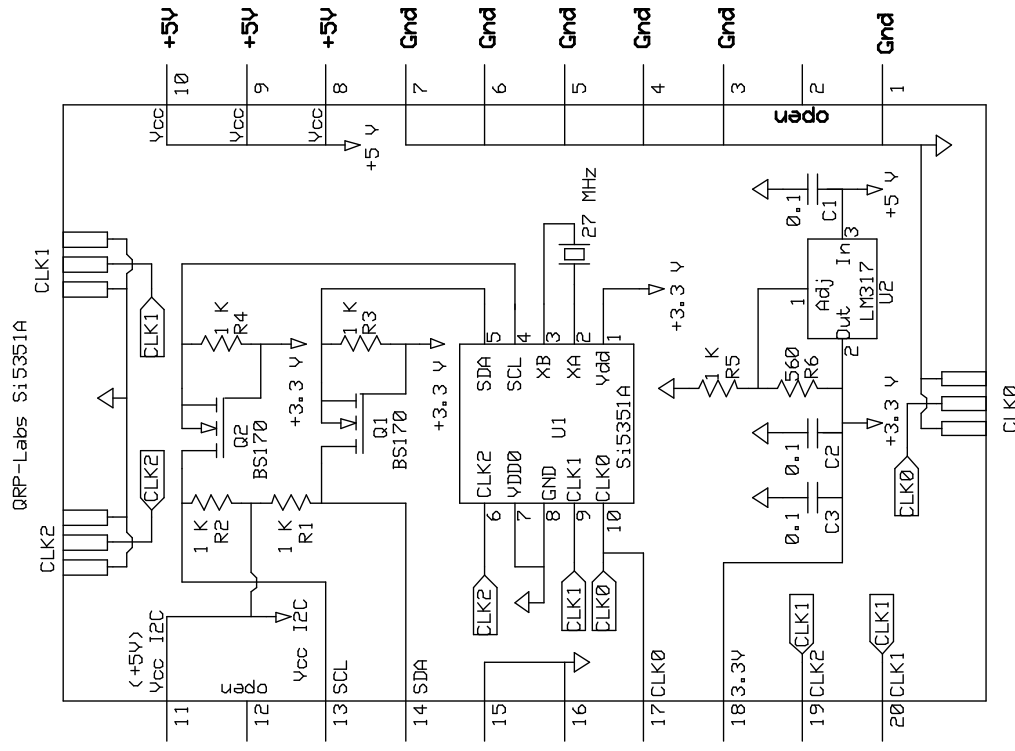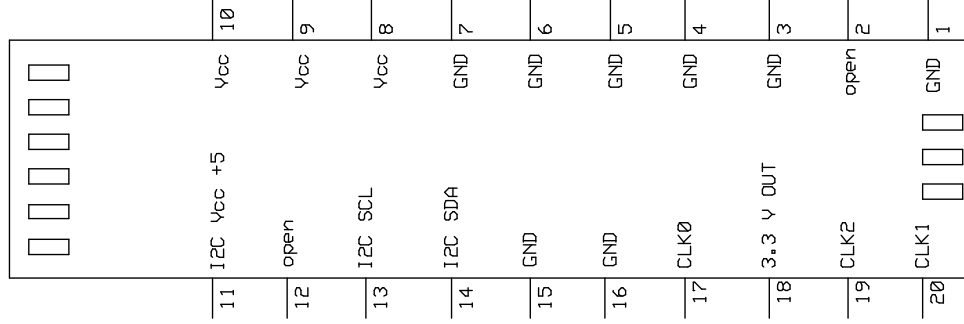VALUES SHOWN ARE FOR 32 MHz CUTOFF

FOR THE NANO AND THE DDS THE PHYSICAL PIN NUMBERS ARE AN ARBITRARY ASSIGNMENT
BUT THE LOGICAL PIN IDs CONFORM TO GENERALLY ACCEPTED NOMENCLATURE

E&M Solutions, LLC

Type II DDS / NANO Experimenter Board

Jim Giammanco N5IB

Rev 1.00
12 Sept 2015

Page 1 of 3

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AD9850 DDS Type II

OSC

20	Vcc
19	D0
18	D1
17	D2
16	D3
15	D4
14	D5
13	D6
12	D7
11	GND

1	Vcc
2	W-CLK
3	FU_UD
4	Ser Data
5	RESET
6	GND
7	SqWave1
8	SqWave2
9	SinWave1
10	SinWave2

BLUE POT

QRP-Labs Si5351A

10	Vcc
9	Vcc
8	Vcc
7	GND
6	GND
5	GND
4	GND
3	GND
2	open
1	GND

11	I2C Vcc +5
12	open
13	I2C SCL
14	I2C SDA
15	GND
16	GND
17	CLK0
18	3.3 V OUT
19	CLK2
20	CLK1

QRP-Labs Si5351A

10	+5V	Vcc
9	+5V	Vcc
8	+5V	Vcc
7	Gnd	
6	Gnd	
5	Gnd	
4	Gnd	
3	Gnd	open
2		
1	Gnd	

+5 V

CLK1

CLK2

R4 1 K
Q2 BS170
+3.3 V
R2 1 K

R3 1 K
Q1 BS170
+3.3 V
R1 1 K

U1 Si5351A
SDA 5
SCL 4
XB 3
XA 2
Vdd 1
CLK2 6
VDD0 7
GND 8
CLK1 9
CLK0 10

27 MHz

+3.3 V

R5 1 K
R6 560

C1 0.1
U2 LM317
Adj In
Out
+5 V

C2 0.1
C3 0.1
CLK0
+3.3 V

CLK0

11	Vcc I2C (+5V)
12	Vcc I2C
13	SCL
14	SDA
15	open
16	
17	CLK0
18	3.3V
19	CLK2 CLK1
20	CLK1 CLK1

Arduino NANO Connections

AD9850 Type II DDS Connections

J4 Pin #

10 ZOUT2	10 SinWave2
9 ZOUT1	9 SinWave1
8 QOUT2	8 SqWave2
7 QOUT1	7 SqWave1
6 GND	6 GND
5 Reset	5 Reset (D5)
4 Serial Data	4 Ser Data (D4)
3 FQ_UD	3 FQ_UD (D3)
2 W_CLK	2 W-CLK (D2)
1 Vcc (+5V)	1 Vcc

J1 Pin #

1 Gnd	11 Gnd
2 D7	12 D7
3 D6	13 D6
4 D5	14 D5
5 D4	15 D4
6 D3	16 D3
7 D2	17 D2
8 D1	18 D1 [Res to +5V]
9 D0	19 D0 [Res to +5V]
10 Vcc	20 Vcc

QRP LABs Arduino Shield wiring

Schematic labels:

CLK1 20 CLK1, CLK2 19 CLK2, 3.3V 18, CLK0 17 CLK0, 16, 15, SDA 14 DATA SDA, SCL 13 SCL, WCLK 12 WCLK, 11 +5V

U2 LM317 — In Out Adj
C1 0.1, C2 0.1, C3 0.1
R6 560, R5 1K
+5V, +3.3V

Si5351A U1 — CLK0 10, CLK1 9, GND 8, CLK2 6, Vdd 1, XA 2, XB 3, SCL 4, SDA 5, VDD0 7
27 MHz
QRP-Labs Si5351A

BS170 Q1, BS170 Q2
R1 1K, R2 1K, R3 1K, R4 1K
+3.3V
Vcc I2C (+5V)
open

CLK0, CLK1, CLK2

Redrawn QRP LABS Si5351 Circuit
More like physical representation

Building and Application notes (more to come)

The key to getting the Arduino NANO and a Type II DDS module to "piggyback" is the selection of pins and sockets for connecting the three circuit boards.

A DRY FIT TEST IS AN ABSOLUTE NECCESSITY TO MAKE SURE THERE WILL BE ENOUGH CLEARANCE. __DO THE DRY FIT BEFORE SOLDERING ANYTHING__.

Many NANOs come with the header pins supplied, but not yet installed. That's the kind you want to obtain, since you will want to use a different type of pin strip than the one supplied. Most of the Type II DDS modules already have the pin header strips installed. We have to work with what we have.

First we'll deal with the NANO. The goal is to cozy it up as close to the top surface of the PC board as possible, without touching. To do this we'll use those breakaway strips of machined pins and sockets. They are available at the usual parts houses, or from eBay vendors. The tinned ones are fine – no need to splurge on the gold plated ones.

At **E** in the photo at right is a breakaway strip of machined pins. Notice that the pins are slightly larger in diameter on one side of the strip. The row of larger pins will be inserted into the holes on the Arduino NANO board as in the next photo. Of course, you'll be using a strip of 15 pins on each side. The short strip shown here is just for illustration. Be sure to insert the pins from the bottom of the board (the USB connector and reset switch are on the top). Remember – NO SOLDERING until the dry fit test is passed.

Two sets of 15-pin sockets will be installed on the main carrier board into the inner two rows of pads. As usual, there is a quick easy way, and there is a better way. You'll notice that the holes in these pads are larger than normal. That is to allow the body of the pins to nestle down close to the board, gaining you an extra mm or so of clearance. The quick easy way is circled in yellow in the photo at right, The sockets – as shown at **B**, still in their plastic carrier strip – are installed so that the plastic is flush down against the board. The plastic carrier strip should sit down flush against the PC board's top surface.

The better way is circled in blue. The individual sockets (**C** in the photo) have been removed from the plastic carrier strip by cracking the plastic with wire nippers and carefully pulling out the sockets. They fit down into the holes and form a much lower profile than if left in the plastic.

Now for the DDS Type II module. It has to sit high enough off the main board so that its underside will not touch the metal housing of the USB connector on the NANO. To accept the header pins from the DDS module we'll use a pair of 10-pin strips of socket pins designed to fit the 0.025" square posts. There are two possible choices for the socket strips. Pictured at **A** in the top photo, is a *stacking header*. It's commonly used when building *Arduino shields*, since the long tail pins plug into a lower board, while an upper board can plug into the sockets. The conventional header socket strip is pictured at **D**.
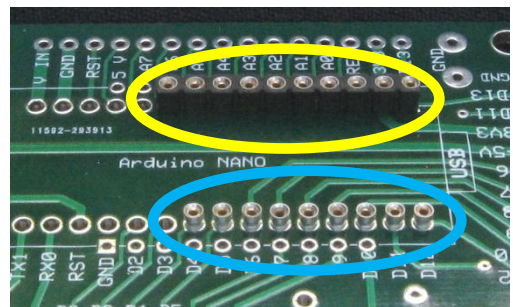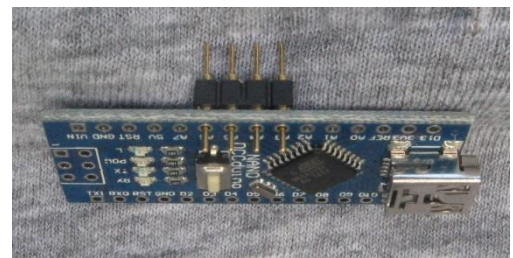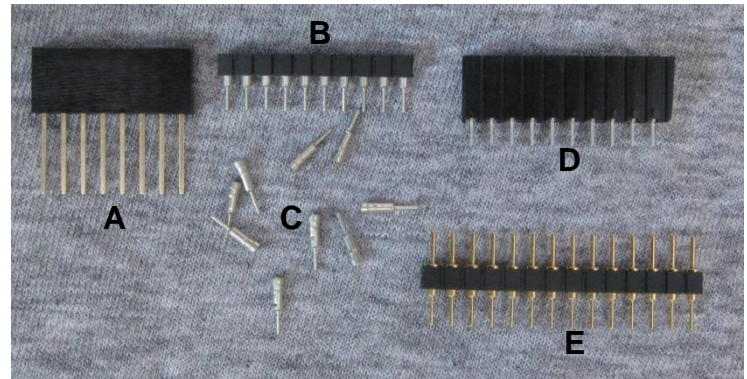
Now is the time when the choices you made for the NANO's sockets will come into play. If you chose to do the better (blue circled) arrangement, you should be able to use the conventional pin header for the DDS module, and install it either in the normal fashion as shown in the top photo at right, or spaced above the board as in the second photo. You can let the pins be just flush with the bottom surface of the board, which will elevate the header a mm or so.

I found that spacing the header was necessary if I wanted to be able to fully seat the NANO into its socket. Remember, these holes are plated through. So when you do solder them the plating will carry the connection from the top to bottom of the main board. Depending on your particular header, you may, or may not, be quite able to seat the DDS fully into the socket, but it will still be a solid connection.

If you took the easy way out (yellow circled), there will not be enough clearance between the bottom of the DDS and the top of the NANO. You will need to use a stacking header strip and stand off the header above the board an amount sufficient to clear the USB connector shell, as shown in the third photo. Remember if you chose the stacking header for the DDS connection, it really doesn't matter how you mounted the NANO, the long tail pins will allow you to raise the DDS module as much as needed. You can cut off any excess protruding beneath the board.
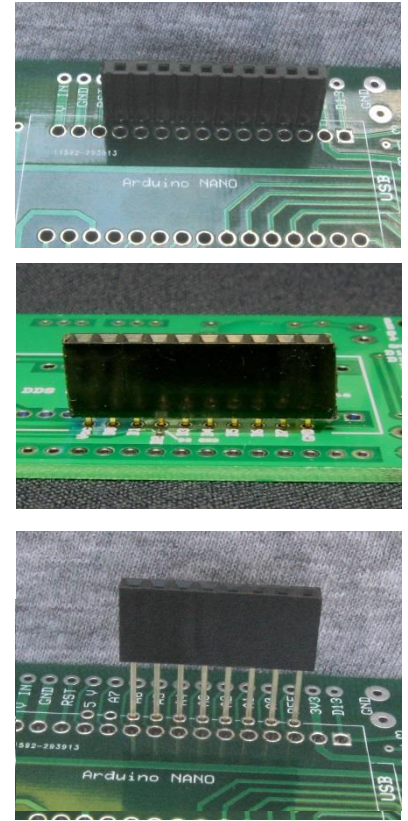
ONE MORE WARNING – DRY FIT BEFORE SOLDERING.

Once you're satisfied with the fit and clearance, go ahead and solder in the pins and sockets. It's usually better to have all the mating parts assembled together and solder the pins while they are assembled. This maintains the spacing and alignment of the pins even if soldering heat softens plastic carrier strips.

Now you can continue with the remaining assembly of the board. Remember – this is an *Experimenter's* board, so the choice of how to make connections to off board devices and circuits is up to you. Plain hookup wire is an obvious option. But there are a couple of things to watch out for if you want to use header pins or sockets.

You can't use a straight (vertical) header in the row of pads next to the low pass filter. It would block access to the USB connector on the NANO. A right-angled header can work, but not if the low pass filter section stays attached to the main board – but a header, either straight or right-angled, will work is mounted on the **BOTTOM** of the main board. Just build the low pass filter **BEFORE** installing a right-angled header strip there. You could sever the low pass filter section from the main board if you wished. Notice that the bottom side ground plane is interrupted between the main board and the filter section. So the circuit grounds are **NOT** connected, and a jumper (at the RF IN / RF OUT pads) is required to establish an overall circuit common.
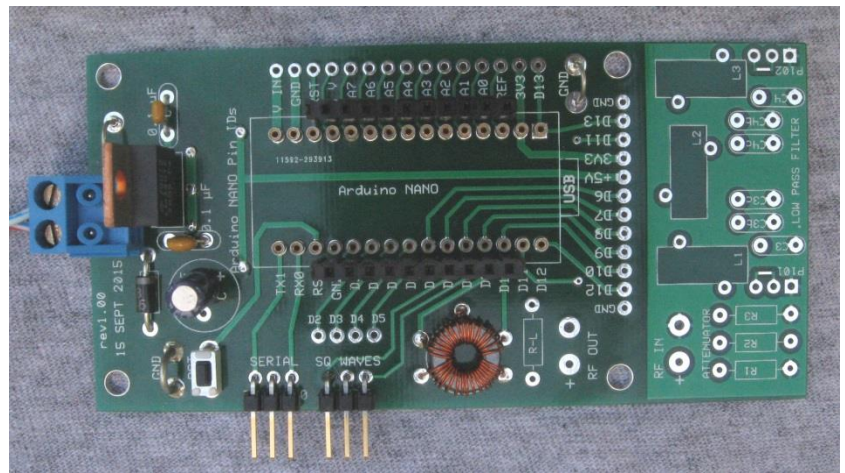
Software modifications

See the PHSNA Yahoo Group for more information about software
https://groups.yahoo.com/neo/groups/PHSNA/info

If you wish to construct a version of the Poor Ham's Scalar Network Analyzer (PHSNA) using the Experimenter Board, you can use the either the Terminal or Windows Versions of Nick's (WA5BDU) software that's posted on the Yahoo Group, but it will be necessary to change the four lines of code that assign Arduino pin numbers to the DDS control lines.

In either *PHSNA_standard_rev_3r02.ino* (the Terminal Version) or *PHSNA_VB.ino* (the Windows Version)

Locate these lines of code – the lines to be changed are in **BOLDFACE**:

#define NICK 0 // Special compile modes just for me -- set to zero for general distribution 1r10

#if NICK
#define DATA 11   // ***** NRK ONLY BAD PIN 8 USE 11 *******
#else
#define DATA 8   // for the rest of the world: Pin 8 - connect to serial data load pin (DATA or D7)
#endif

#define W_CLK 9   // Pin 9 - connect to AD9850 module word load clock pin (CLK)
#define FQ_UD 10   // Pin 10 - connect to freq update pin (FQ)
#define RESET 11   // Pin 11 - connect to reset pin (RST)
#define LEDpin 13   // Pin 13 - on board LED to be used as "heartbeat"

Edit the code to as shown below (the changed lines are, again, in **BOLDFACE**)


#define NICK 0 // Special compile modes just for me -- set to zero for general distribution 1r10

#if NICK
#define DATA 11   // ***** NRK ONLY BAD PIN 8 USE 11 *******
#else
**#define DATA 4   // for the rest of the world: Pin 4 - connect to serial data load pin (DATA or D7)**
#endif

#define W_CLK 2   // Pin 2 - connect to AD9850 module word load clock pin (CLK)
#define FQ_UD 3   // Pin 3 - connect to freq update pin (FQ)
#define RESET 5   // Pin 5 - connect to reset pin (RST)
#define LEDpin 13   // Pin 13 - on board LED to be used as "heartbeat"

No other software changes are needed.

Photos of first prototype (homebrew etched) PC board with Type II DDS and Arduino NANO installed. Right-angled socket strips, whose pins had been straightened, were used to accept the DDS module pins.
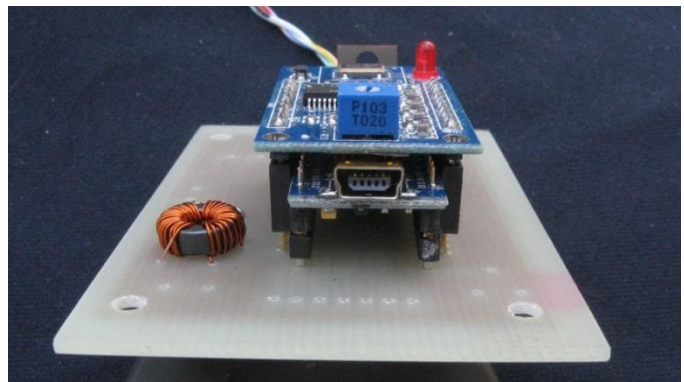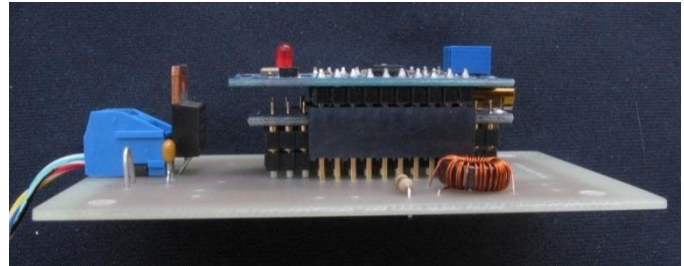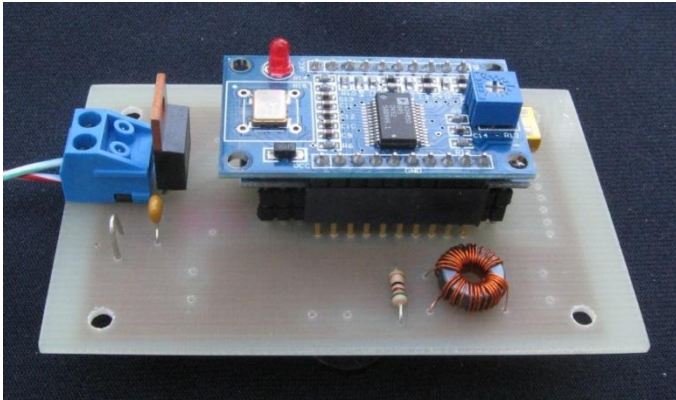
Photos of the production board, with NANO installed, and with DDS Type II installed. Note that the DDS is not fully seated, to be sure there is no contact with the metal shell of the USB connector. Insulating tape could be place on top of the USB connector and beneath the pins of the potentiometer.
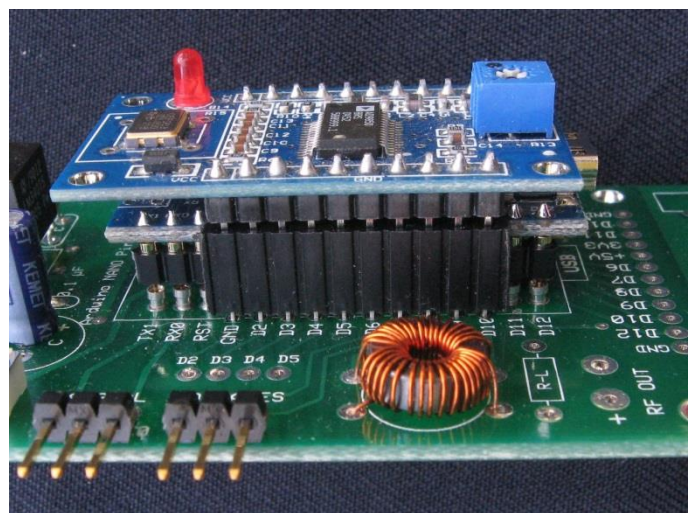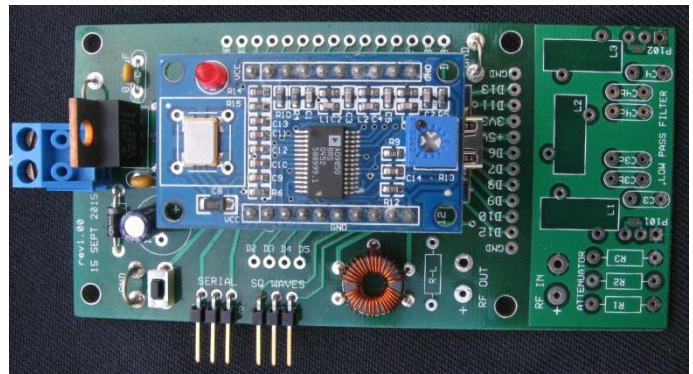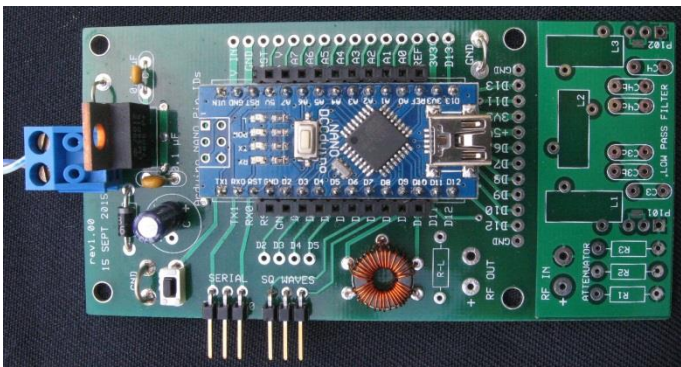
New Version: Supplemental Information
Experimenter Board – version 1.20 – for Arduino NANO and Type-2 DDS
PCB rev 1.20   5 May 2016
Jim Giammanco, N5IB

There are a few minor changes from the original version 1.00, mostly for convenience.
   Extra pads have been added to access the +5 V regulated supply line
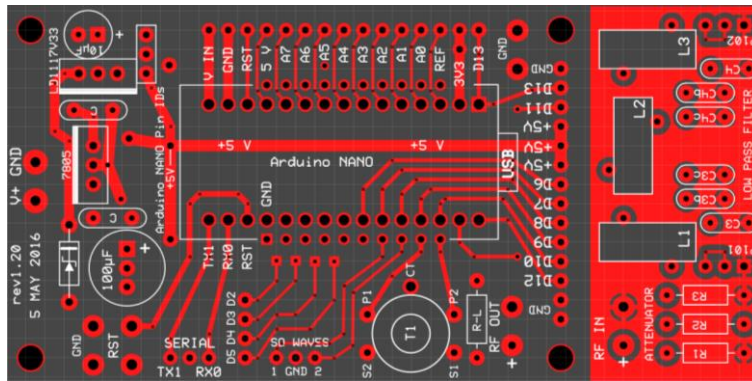   Space for a 3.3V Regulator has been added
   Vcc supply for the DDS is jumper-selectable to be either +5 V or +3.3 V
   Pads have been added for 0805 SMT resistors to implement voltage division logic level conversion for NANO-to-DDS

Approximately actual size: 3.925" x 1.950"

Top Copper

Bottom Copper
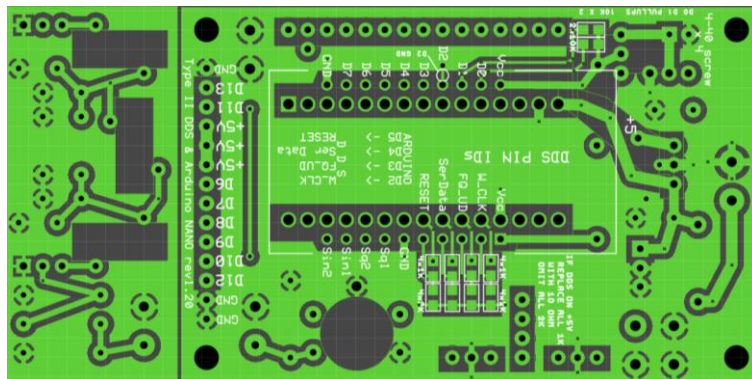
Information regarding use with the Si5351A can still be found in the documentation for the original rev1.00 PC board.

Bill of materials:

No detailed bill of materials is compiled. There are very few components other than the Arduino NANO and the DDS module. Part IDs and values are called out on the schematic. Notes on the schematic describe several options for power and filtering.

AD9850 DDS Type 2

| Pin	Name		Name	Pin
1	Vcc	DDS2	Vcc	20
2	W-CLK		D0	19
3	FU_UD		D1	18
4	Ser Data		D2	17
5	RESET		D3	16
6	GND		D4	15
7	SqWave1		D5	14
8	SqWave2		D6	13
9	SinWave1		D7	12
10	SinWave2		GND	11

R4 10 K
R5 10 K
+5 V

P102   1 2 3

IOUT B
IOUT

Filter

L3 10T T37-6 0.28 uH
L2 13T T37-6 0.48 uH
L1 10T T37-6 0.28uH

C4a TBA
C4 133 NP0
C3 133 NP0
C3a TBA

P101   1 2 3

R3 150
R2 39
-6 db
R1 150

USE C3a AND C4a AS NEEDED TO OBTAIN PRECISE VALUES

THIS IS THE SAME LPF CIRCUIT USED ON THE TYPE I AND TYPE II PHSNA

Arduino NANO

Pin	Name	Name	Pin
1	D13	D12	30
2	3V3	MC	D11 29
3	REF	D10	28
4	A0	D9	27
5	A1	D8	26
6	A2	D7	25
7	A3	D6	24
8	A4	D5	23
9	A5	D4	22
10	A6	D3	21
11	A7	D2	20
12	+5V	GND	19
13	----RESET----		18
14	GND	RX0	17
15	+V IN	TX1	16

J1   +3.3 V
+5 V
3 2 1
DDS Vcc SELECT

IF DDS Vcc = +5 V :
OMIT ALL Rb
Ra = SHORTING JUMPER OR VERY LOW VALUE (~10 ohm)

IF DDS Vcc = +3.3 V :
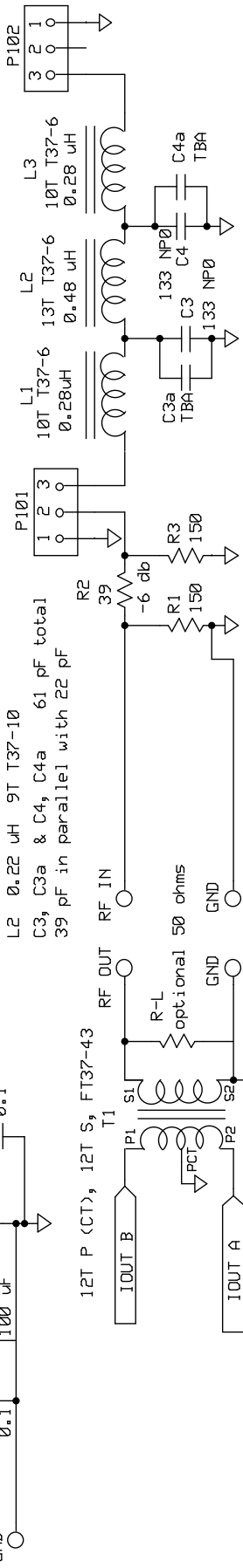ALL Ra = 1 K, ALL Rb = 2 K

Rb Ra (×4)

ONLY THE DEDICATED CONNECTIONS ARE SHOWN
MANY OTHER PINS OF THE NANO
AND SEVERAL OF THE DDS MODULE
ARE BROKEN OUT TO PCB PADS

THE TWO PULLUP RESISTORS (R4, R5) ARE OTIONAL

U2 IS OPTIONAL WHEN THE DDS REQUIRES A 3.3 V SUPPLY
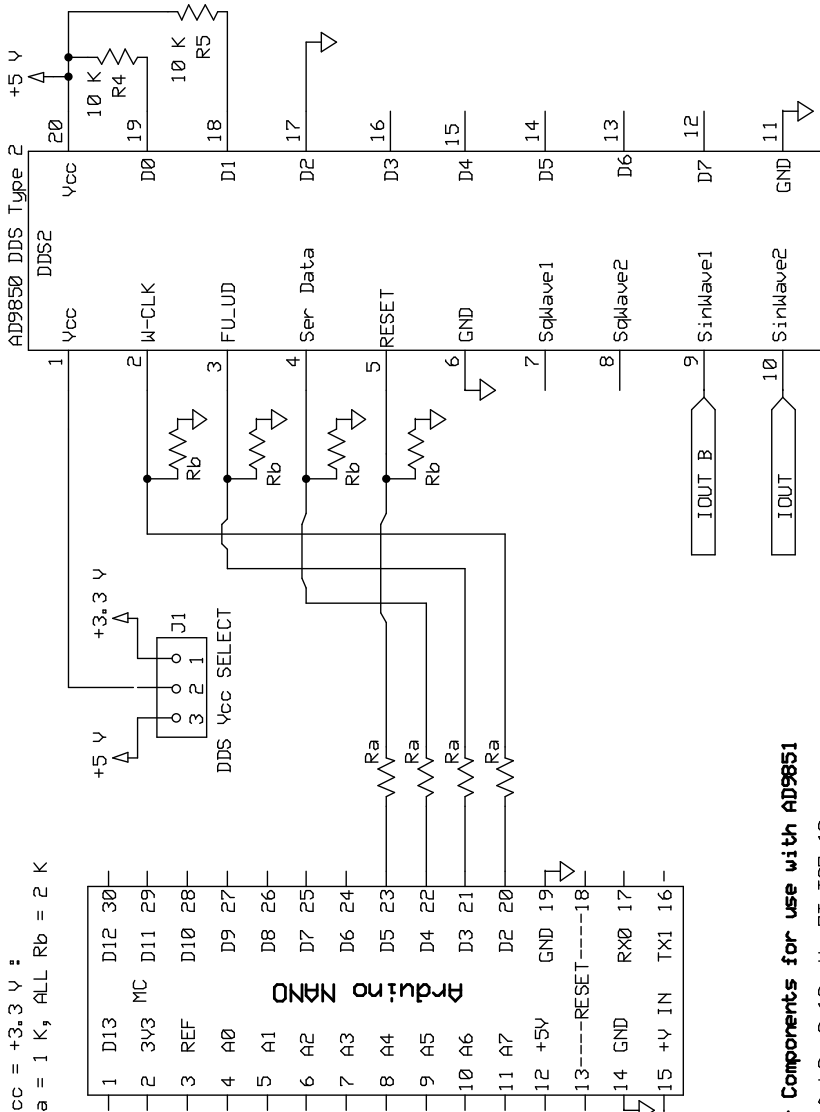
Filter Components for use with AD9851

L1 & L3 0.13 uH 7T T37-10
L2 0.22 uH 9T T37-10

C2, C3a & C4, C4a 61 pF total
39 pF in parallel with 22 pF

Power

U2 LD1117V33
IN 3 OUT 2
COM 1

+3.3 V
C6 10 uF

U1 LM7805
In 1 Out 3
Com 2
C5 0.1
+5 V

C2 100 uF
C1 0.1
+12 V
D1 1N5819
V+
GND

T1 12T P (CT), 12T S, FT37-43
RF OUT RF IN
R-L optional 50 ohms
GND GND
S1 S2
P1 PCT P2
IOUT B
IOUT A

E&M Solutions, LLC

Type II DDS / NANO Experimenter Board

Jim Giammanco N5IB	Rev 1.20	Page 1 of 3
	27 APRIL 2016	

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FOR THE NANO AND THE DDS THE PHYSICAL PIN NUMBERS ARE AN ARBITRARY ASSIGNMENT
BUT THE LOGICAL PIN IDs CONFORM TO GENERALLY ACCEPTED NOMENCLATURE

VALUES SHOWN ARE FOR 32 MHz CUTOFF

Here is an adapter board that allows a Type I DDS to be used in place of a Type II, and vice-versa. It will also allow a QRP-Labs Si5351A module to be used where a Type I DDS is ordinarily installed. Shown approximately actual size (1.900" x 1.125")

TOP COPPER

BOTTOM COPPER