ADF4351 PLL/LO

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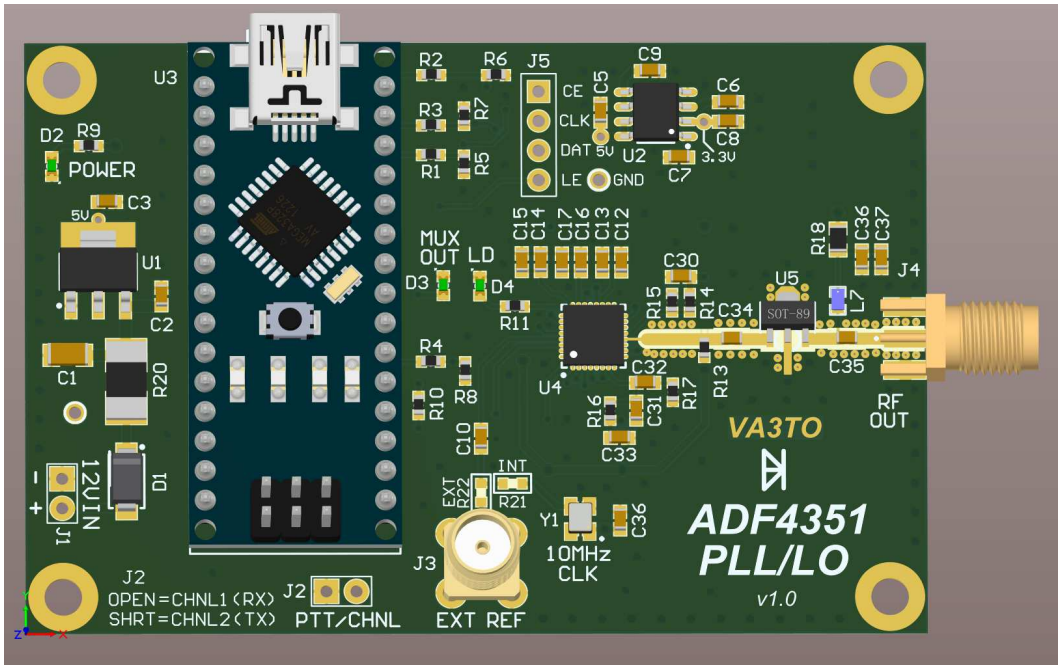
I recently designed an Analog Devices ADF4351 based PLL/LO Board to use as a relatively clean and inexpensive 3.408 GHz local oscillator for W1GHZ's 10 GHz transverter (x3 = 10.224 GHz through one of his multiplier boards). It can also be used to drive Paul's 10 GHz Personal Beacon board, or for other projects requiring an RF signal between 35 ~ 4400 MHz.



The board uses an ADM7150 ultra low noise linear power supply I.C. for the +3.3V with filtered distribution to the different circuits of the PLL. It has an onboard +/-2.5ppm 10 MHz oscillator, or it can be strapped to use an external 10 MHz OCXO or GPSDO. The onboard oscillator is double footprinted to accept options with larger packages and better stability specs. A lot of previously available PLL LO boards come up short on output level to drive a mixer or multiplier so this board has provision for an onboard MMIC amplifier (SOT89 or X package). The GVA 62+ MMIC used on the test board delivers more than +15dBm of RF. The output level can be decreased to more suitable mixer levels by using a lower gain MMIC, by changing the drive level in the ADF4351 registers or by using an outboard attenuator. An inexpensive Arduino NANO compatible board is used as the controller. The board dimensions are 3" x 2" on 0.031" (0.8mm) thick FR4 material. Most of the R's and C's are 0603 size.

ASSEMBLY

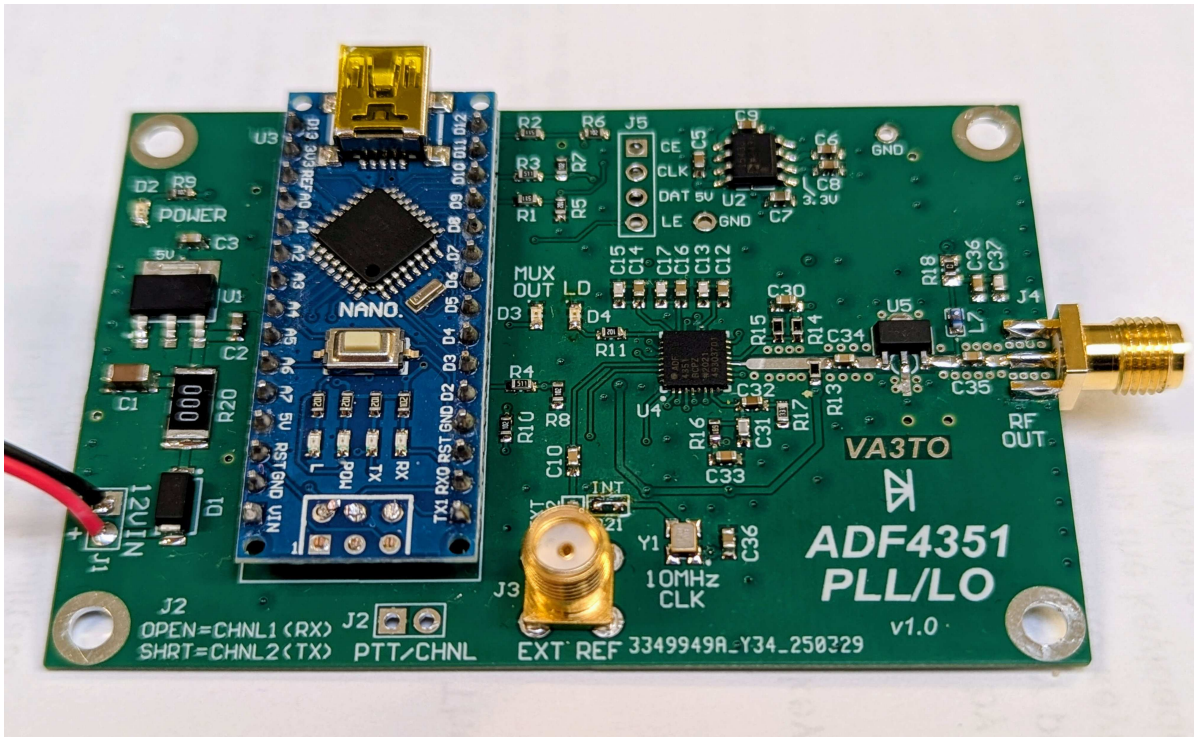
Assembly is pretty straightforward. The ADF4351 needs to be installed first using solderpaste and an oven. All other components can be installed by hand.

Note that there are duplicate designators for C36 on the board. I have appended a “B” (C36B) to identify the 100nF decoupling capacitor at the 10 MHz oscillator on the Schematic and Parts List.

Values for bias components L7 and R18 can be selected depending on the MMIC amplifier that is chosen. The values shown in the parts list work fine for the Minicircuits GVA62+ operating at 3408 MHz. The value of L7 should be increased if the board is operating at lower frequencies. Suggested values are shown on the schematic.

The board can be operated from a DC supply between 8 ~ 12V. A dropping resistor at R20 was included to reduce the dissipation of the regulator however it still runs quite hot at 12V in, so 8V supply is recommended. If you choose to supply it with 8V then change R20 to 0 ohms or solder a jumper across it.

Assembled Board



SOFTWARE

A simple sketch was written by Dino VE7NX to program the ADF4351 registers directly for 3408 MHz at lowest phase noise. It can be downloaded here: va3to.com/Articles & Documents.htm

The ADF4351 Datasheet describes the functions of the 6 registers. To make things easier, the “Analog Devices ADF435x Software” can be downloaded from the internet and used to generate the register data for other frequencies and configurations. The appropriate register data can be replaced in the provided sketch.

Other ADF4351 code examples available on the internet should work on this board with minimal changes.

Programming the NANO is a simple task. Connect the NANO to a computer USB port using an appropriate cable. The board is sufficiently powered by the USB bus for programming so it does not need to be connected to a power supply.

Download and install the latest version of the Arduino IDE onto your computer.
Run the Arduino IDE and configure it as follows:

Tools - Port – COMx (use Device Manager to determine which port is being used).
Tools – Board – Arduino AVR Boards - Arduino Nano
Tools – Processor – ATmega328P. *

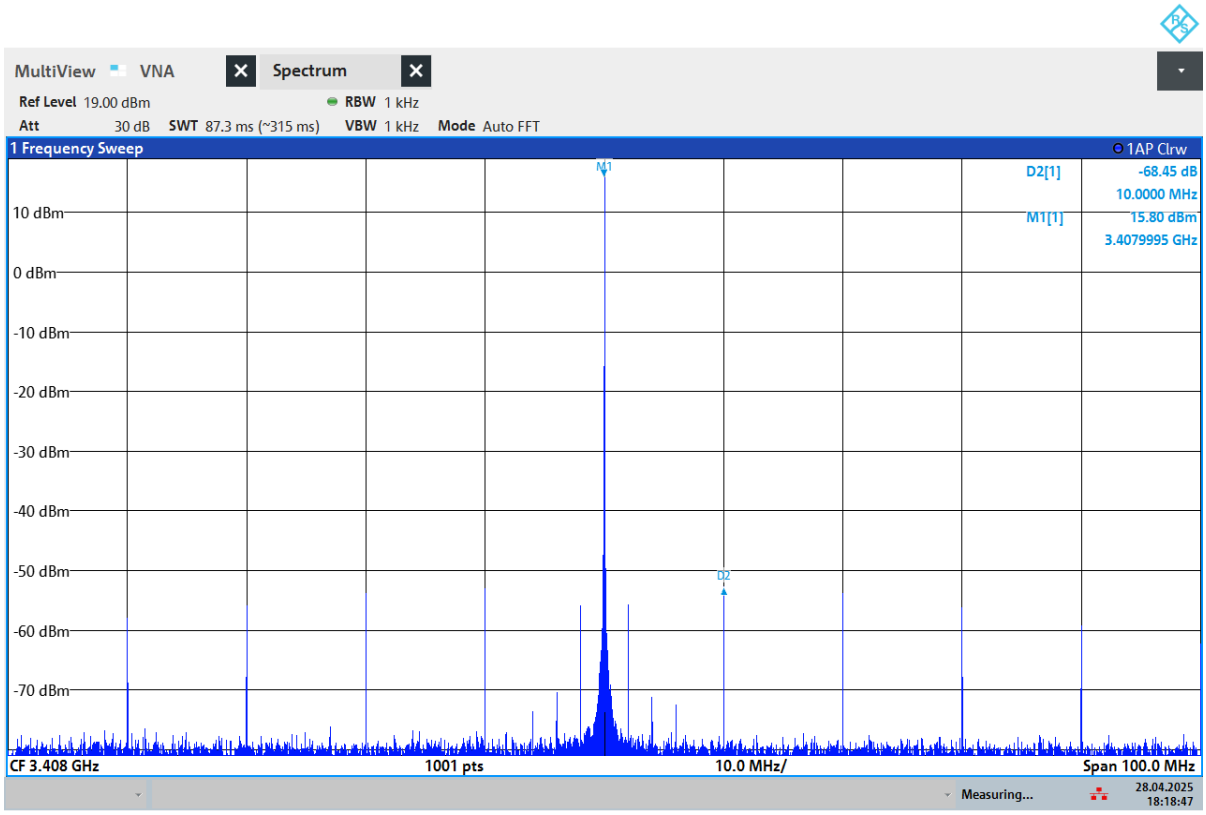
*Note that some Nano compatible boards come with an old version of the bootloader so you may need to select “ATmega328P (Old Bootloader)” if you encounter any errors when attempting to program the board.

Open the LO software sketch in the Arduino IDE and upload it to the board using the round icon with the right arrow. The IDE should report “Done uploading” when programming is completed. Remove the programming cable.

PERFORMANCE

The following spectrum analyzer plots show the 3.408 GHz signal at spans of 100MHz, 10MHz, 1 MHz and 100 kHz. The highest spurs are almost 70 dBc. This compares quite favorably against the Chinese PLL LO boards and even some of the other common offerings.

Spectrum 3.408 GHz @ 100 MHz span



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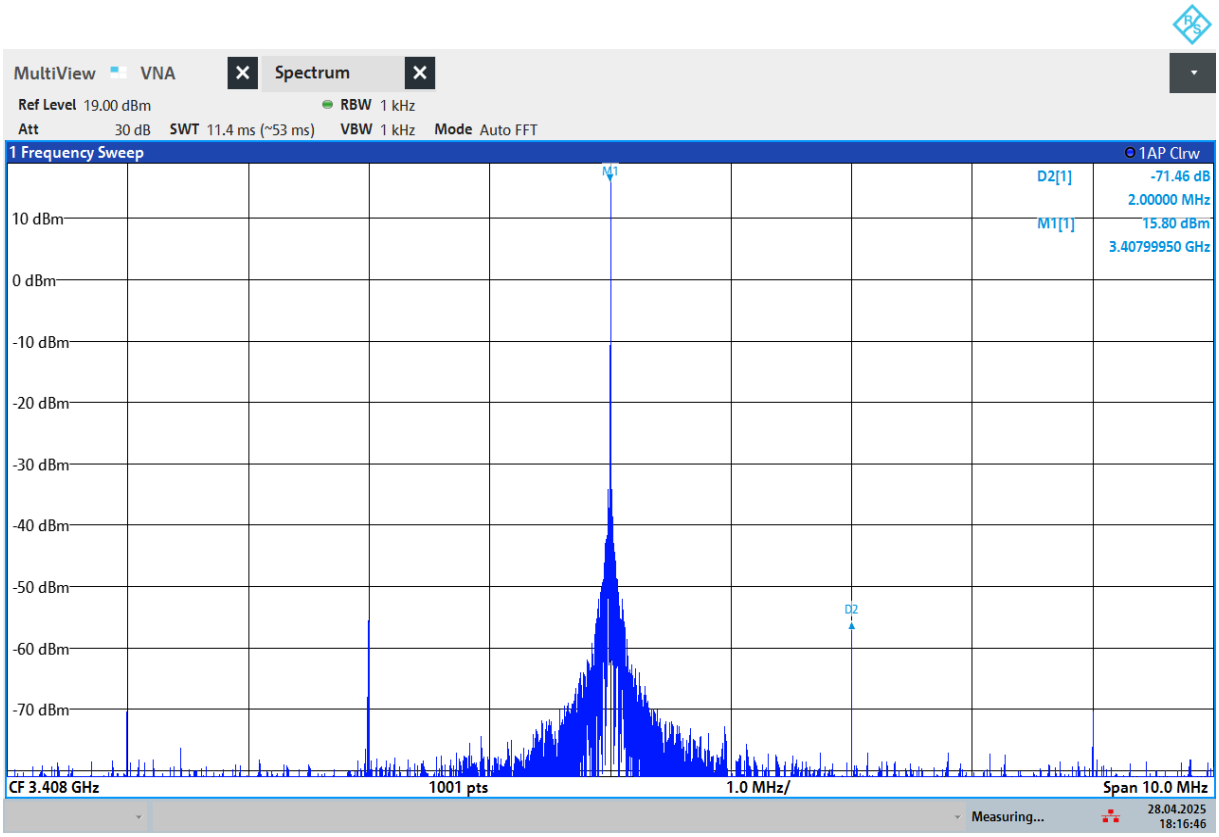
Spectrum 3.408 GHz @ 10 MHz span



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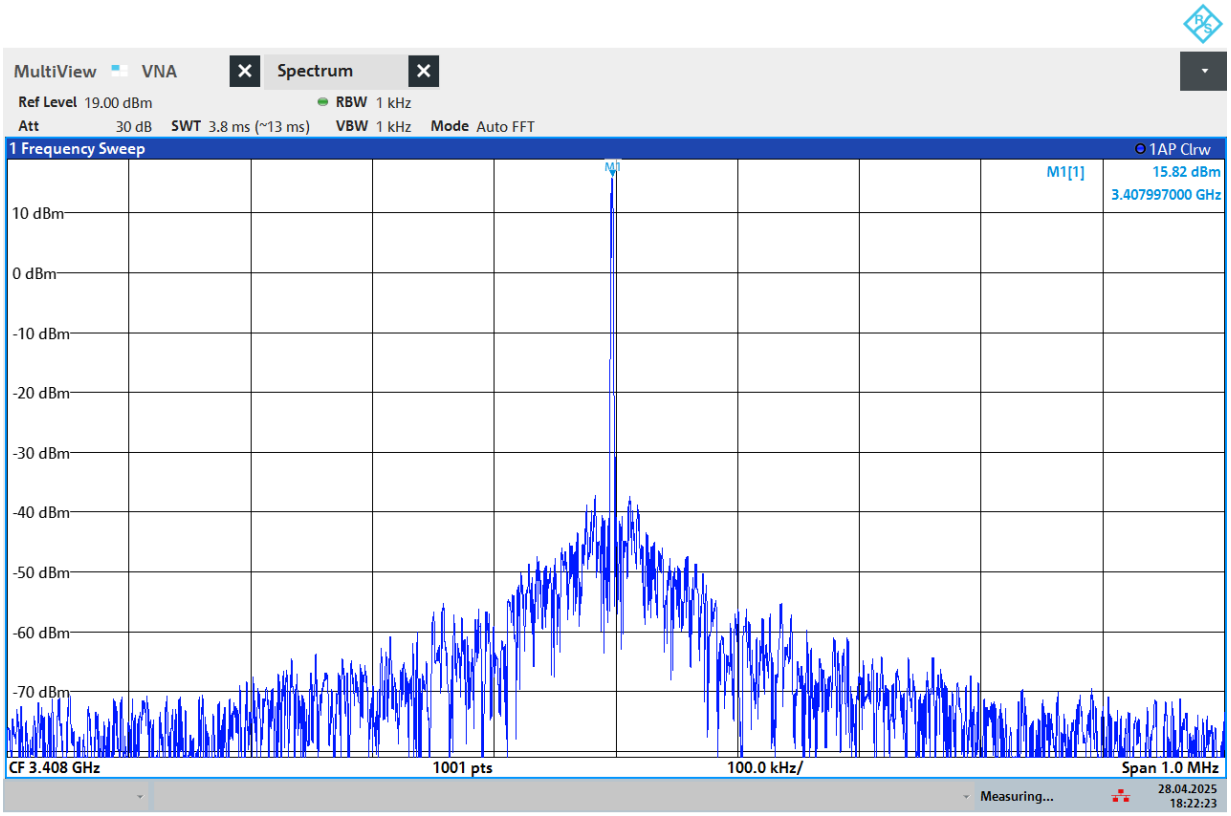
Spectrum 3.408 GHz @ 1 MHz span



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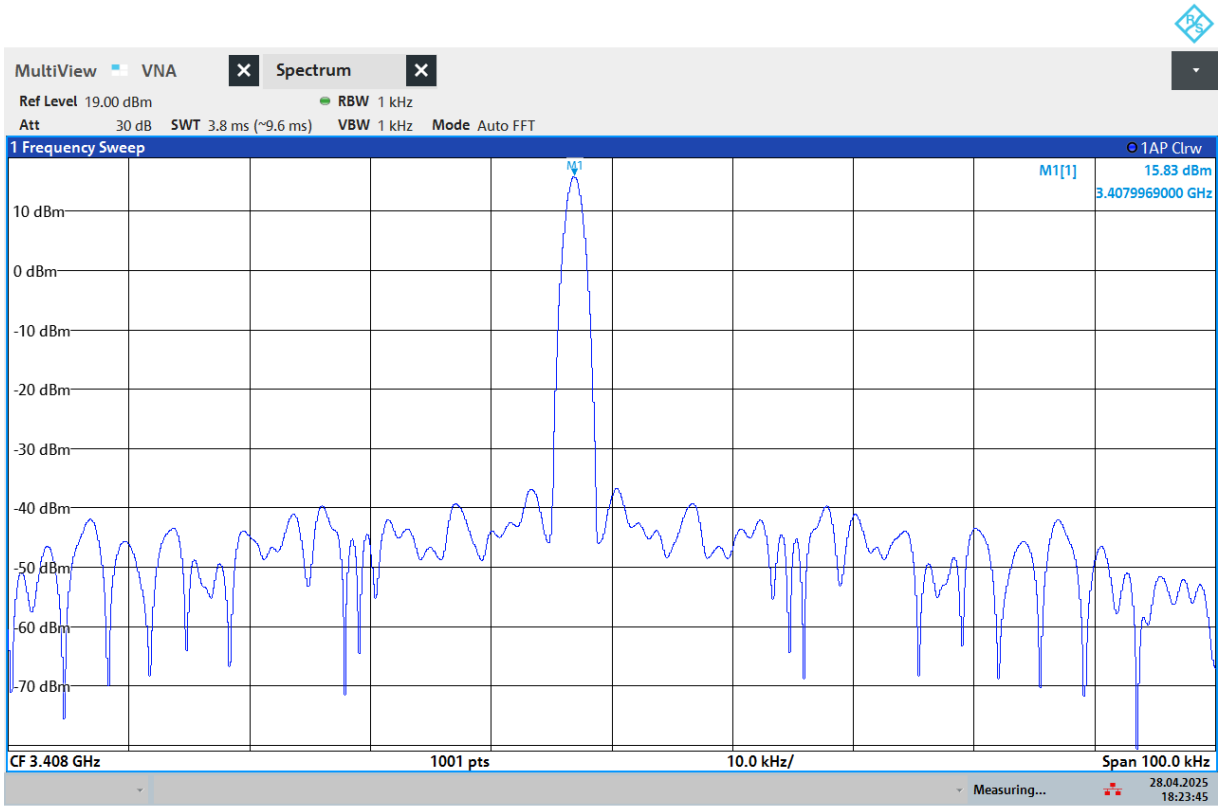
Spectrum 3.408 GHz @ 100 KHz span



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PARTS LIST

Item	Quantity	Designator	Description	Part Number
1	1	PCB	PCB	
2	1	C1	Cap, 47u, 25V, 20%, X5R, 1206	12063D476MAT2A
3	13	C2, C3, C12, C14, C16, C18, C20, C22, C24, C26, C28, C30, C36B	Cap, 100n, 50V, 10%, X7R, 0603	06035C104KAT2A
4	1	C4	Cap, 100n, 50V, 5%, X7R, 0805	08055C104JAT2A
5	3	C5, C7, C8	Cap, 10u, 10V, 10%, X5R, 0603	0603ZD106KAT2A
6	2	C6, C9	Cap, 1u, 16V, 10%, X5R, 0603	0603YD105KAT2A
7	1	C10	Cap, 10n, 50V, 10%, X7R, 0603	06035C103KAT2A
8	9	C13, C15, C17, C19, C21, C23, C25, C27, C29	Cap, 100p, 50V, 5%, COG, 0603	06035A101JAT2A
9	1	C31	Cap, 2.7n, 50V, 5%, COG, 0603	06035A272JAT2A
10	1	C32	Cap, 47n, 50V, 10%, X7R, 0603	06035C473KAT2A
11	1	C33	Cap, 680p, 100V, 10%, X7R, 0603	06031C681KAT2A
12	2	C34, C35	Cap, 1n, 50V, 5%, COG, 0603	06035A102JAT2A
13	1	C36	Cap, 1n, 50V, 10%, X7R, 0603	06035C102KAT2A
14	1	C37	Cap, 10p, 50V, 5%, COG, 0603	06035A100JAT2A
15	1	D1	Diode, 1A, 300V, SMA, On Semi	MRA4003T3
16	3	D2, D3, D4	Diode, LED, Green, 20mA, 0603, Avago	LTST-C190KGKT
17		J1, J2		Do Not Fit
18	1	J3	Vertical Mount SMA, Female	RFPC-SMA28-F
19	1	J4	SMA Female - Board Edge, For .031” PCB	960-EMPCB.SMAFSTJBHT
20		J5		Do Not Fit
21		J6		Do Not Fit
22	6	L1, L2, L3, L4, L5, L6	Bead, 600R, 100MHz, 1A, 200mR, 0603	MH1608-601Y
23		L1, L2, L3, L4, L5, L6 – Alt	Alternate for L1,2,3,4,5,6	742792651
24	1	L7 *	IND, 33nH, 680mA, Coilcraft	0603HP-33NXGE
25		L7 – Alt	Alternate for L7	LQW18CN33NJ00D
26	4	R1, R2, R3, R4	Res, 510R, 5%, 100mW, 0603	CRCW0603510RJNEA
27	7	R5, R6, R7, R8, R9, R10, R11	Res, 1K, 5%, 100mW, 0603	CRCW06031K00JNEA
28	2	R12, R19	Res, 4.7K, 5%, 100mW, 0603	CRCW06034K70JNEA
29	3	R13, R14, R15	Res, 51R, 1%, 100mW, 0603	CRCW060351R0FKEA
30	1	R16	Res, 680R, 5%, 100mW, 0603	CRCW0603680RJNEA
31	1	R17	Res, 330R, 5%, 100mW, 0603	CRCW0603330RJNEA

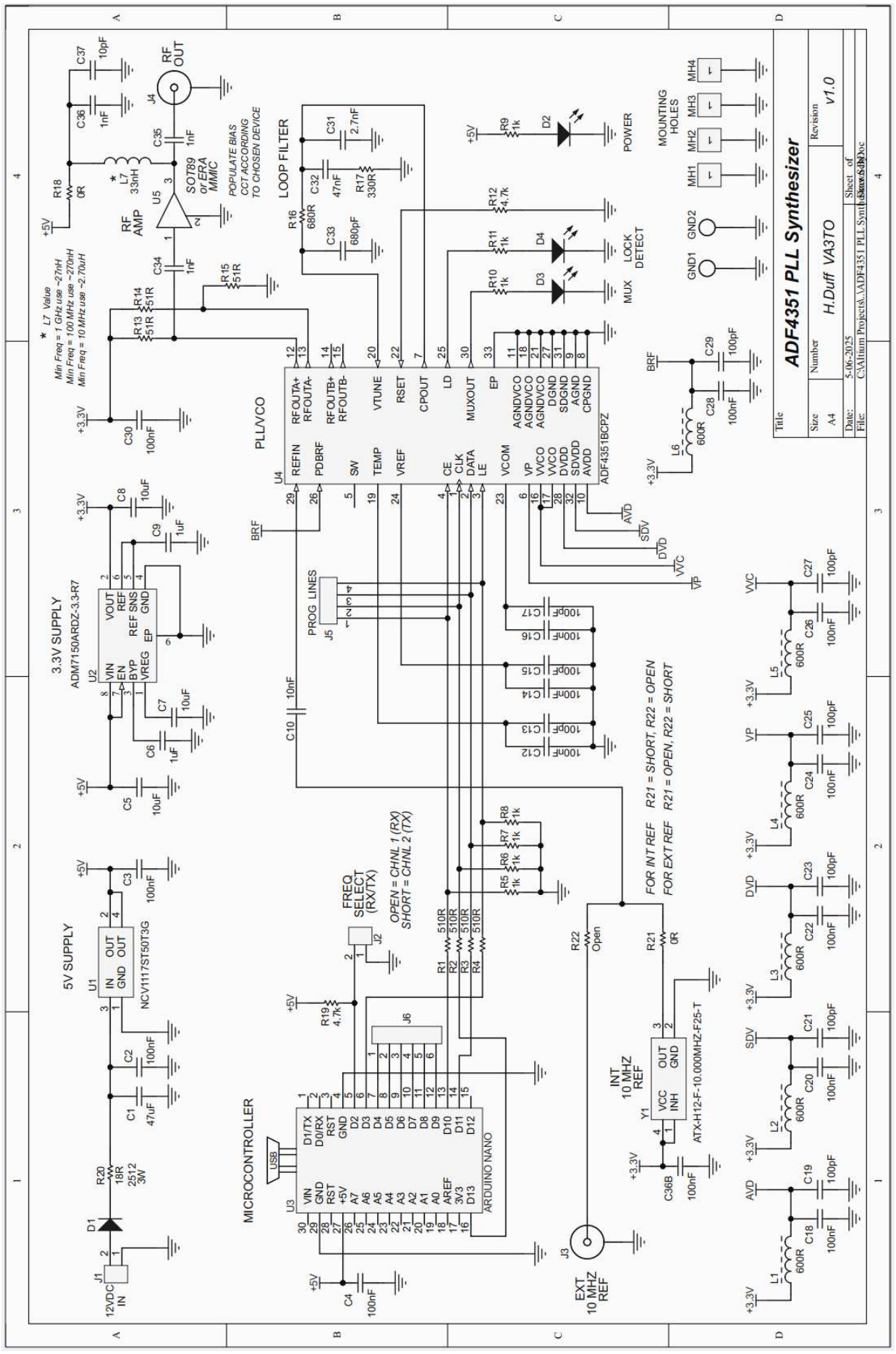
32	1	R18 *	Res, 0R, 5%, 125mW, 0805	CRCW06030000Z0EA
33	1	R20 ***	Res, 18R, 1%, 3W, Metal Element, 2512	352218RJT
34	1	R21, R22 **	0 ohm, populate one or the other to select Int or Ext REF.	CRCW06030000Z0EA
35	1	U1	IC REG LINEAR 5V 1A SOT223	NCV1117ST50T3G
36	1	U2	LDO Regulator Pos 3.3V 0.8A 8-Pin SOIC	ADM7150ARDZ-3.3-R7
37		U2 – Alt	Alternate for U2	ADM7154ARDZ-3.3-R7
38	1	U3	Arduino Nano 3.0 Compatible Microcontroller	Nano Compatible 3.0
39	1	U4	VCO/PLL, 35MHz - 4.4GHz, 32-QFN, Analog Devices	ADF4351BCPZ
40	1	U5 *	RF Amplifier, MMIC, 5V, Matched, SOT89, Minicircuits	GVA-81+
41	1	U5 - ALT	Any SOT89 or X package MMIC	
42	1	Y1	TCXO, 10MHz, 3.3V, 2.5ppm, SMD, Abracon	ATX-H12-F-10.000MHZ-F25-T

* Populate L7 and R18 according to bias requirements of the MMIC chosen for U5.

** Solder a 0603 resistor or jumper wire at R21 for internal Ref. or R22 for external Ref.

*** When supplying the board with 8V use 0 ohms at R20 or solder a jumper across it.

SCHEMATIC


ADF4351 PLL Synthesizer
H.Duff VA3TO
v1.0
5-06-2025
C:\Altium Projects\..\ADF4351 PLL Synth.SchDoc
ADF4351BCPZ
ARDUINO NANO
NCV1117ST50T3G
ADM7150ARDZ-3.3-R7
ATX-H12-F-10.000MHZ-F25-T
SOT89 or ERA MMIC
* L7 Value
Min Freq = 1 GHz use ~27nH
Min Freq = 100 MHz use ~270nH
Min Freq = 10 MHz use ~2.70uH
POPULATE BIAS CCT ACCORDING TO CHOSEN DEVICE
OPEN = CHNL 1 (RX)
SHORT = CHNL 2 (TX)
FOR INT REF R21 = SHORT, R22 = OPEN
FOR EXT REF R21 = OPEN, R22 = SHORT
12VDC IN
EXT 10 MHZ REF
INT 10 MHZ REF
FREQ SELECT (RX/TX)
PROG LINES
MICROCONTROLLER
5V SUPPLY
3.3V SUPPLY
PLL/VCO
LOOP FILTER
RF AMP
RF OUT
MUX
LOCK DETECT
POWER
MOUNTING HOLES