IC7300 PLL Modification

This is a short description of a simple method to phase lock an Icom IC7300 to an external reference signal such as is provided by a Leo Bodnar GPSDO or N6GN Reference board. In essence this is an injection-locked system. It is passive and uses only energy from the reference and VCXO to generate a correction voltage that drives the two to be in constant phase relationship.

The IC7300 nartively has a good TCXO which has its frequency controlled by an 8 bit DAC. This allow setting of the 41.344 MHz master oscillator within about 1 Hz of correct. Becasue this is a TCXO the frequency stays quite constant over normal ham shack temperature changes. For almost all amteur uses and modes this is probably totally adequate but for the newer FST4W digital modes and for study of the inonosphere by way of careful measurement between two separated amateur stations, higher precision such as is provided by referencing to more precise frequency standards such as local rubidium references or the GPS satellite constellation may be required. This modification is an easy way to achieve this kind of accuracy and stability The basic circuit is shown in Figure 1.
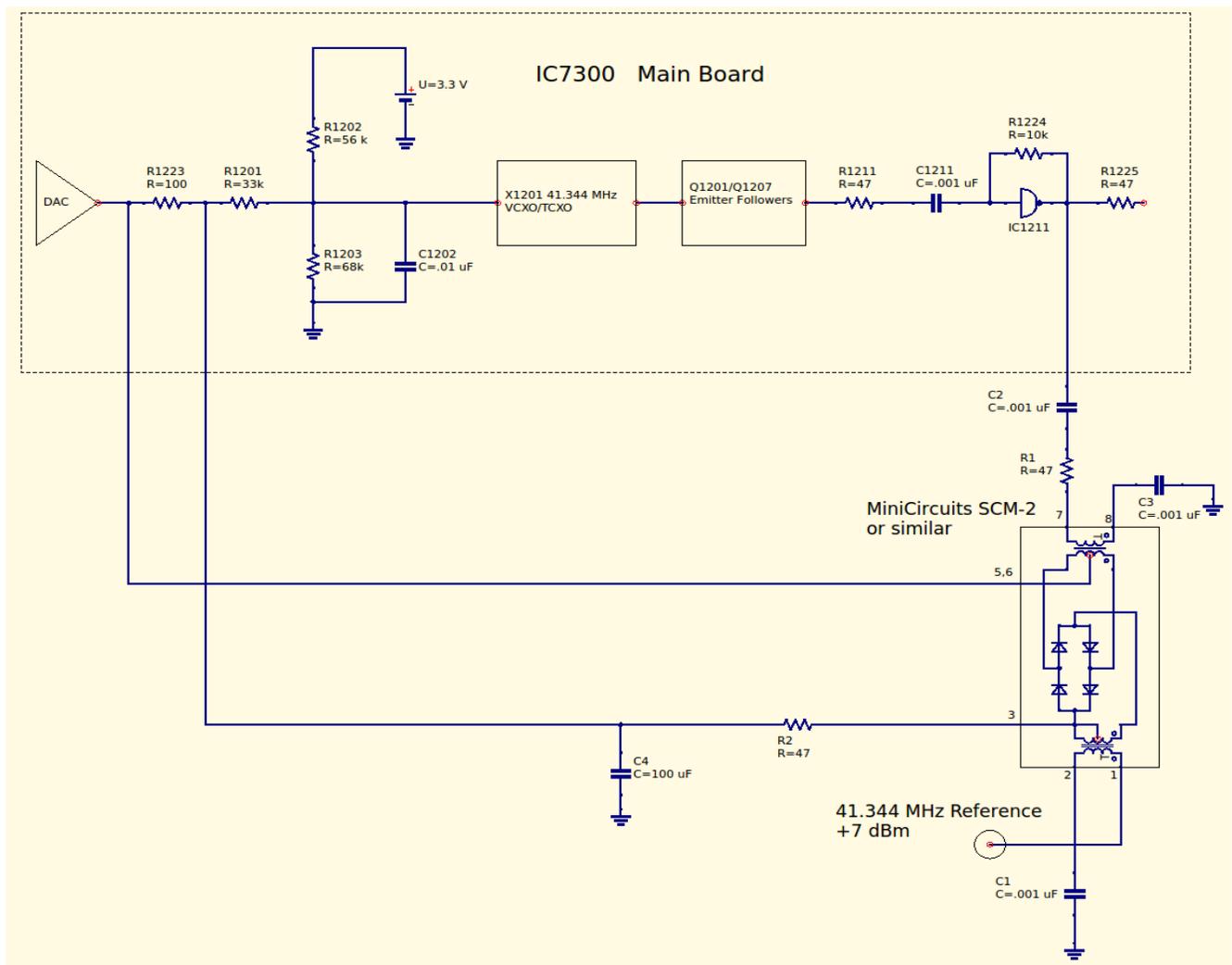

Figure 1: PLL Schematic

Since the modification is entirely passive it requires no additional power from the transceiver. Four connections to the radio must be made, ground and signal from IC211 to sample the TCXO output downstream from the oscillator and two an output signal that injects current into a summing node at the junction of R1201 and R1223.
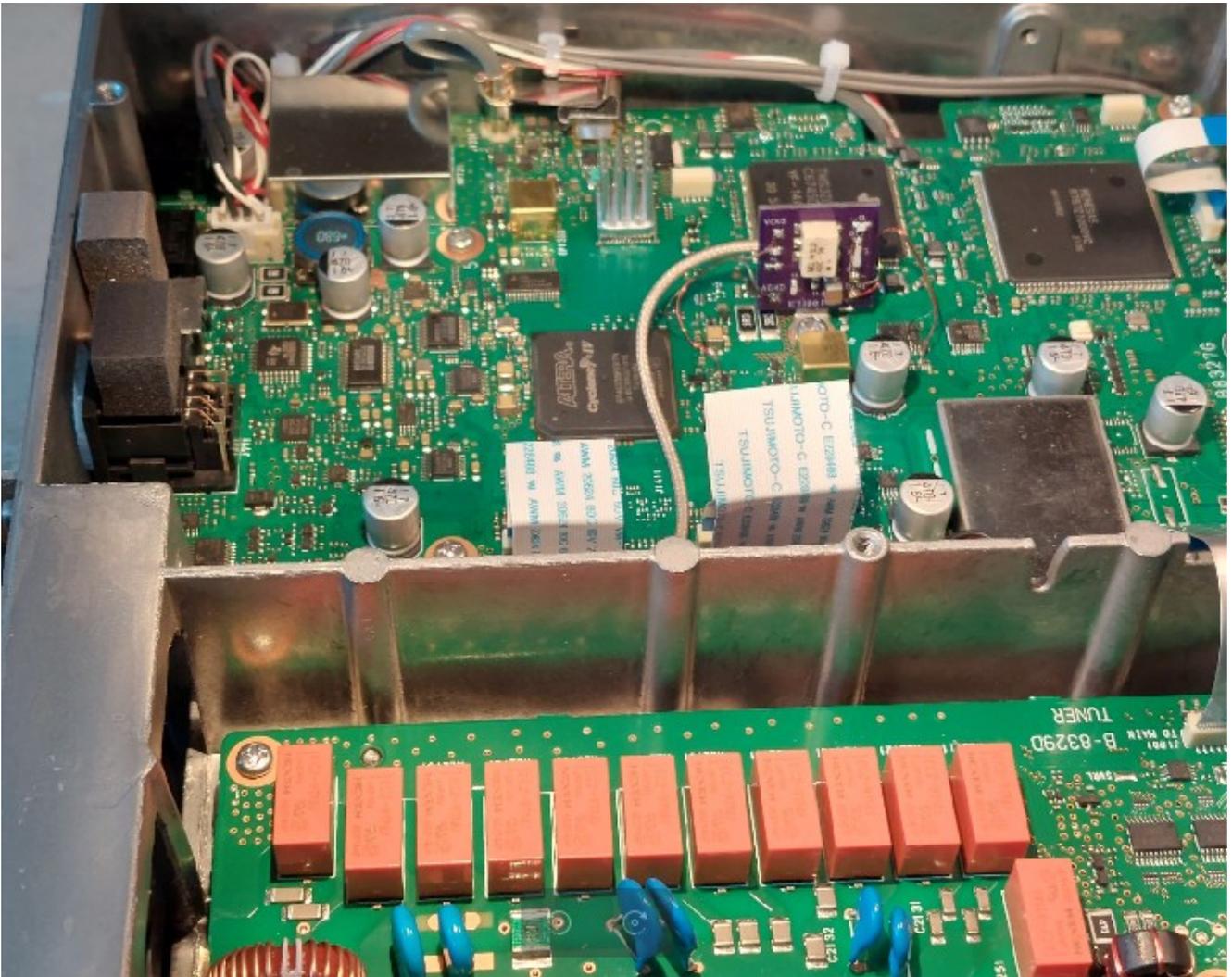
The two 41.3 MHz signals are applied to the R and L inputs of a standard doubly-balanced mixer. The IF output of this part, which here is acting as a simple phase detector, is filtered by an RC lowpass network of R2 and C4 and applied across R1223. In this way, the uncorrected but accurately preset frequency of the system is further steered to cause it and an external reference signal to become in constant phase relationship with each other. There can be a phase offset between them but it is held constant by this PLL circuit which also means that the frequency of the system is held constant as well.

The additional seven components required to create this PLL are mounted on a small PCB which is mounted on the Radio's Main board, inside the radio on the bottom .
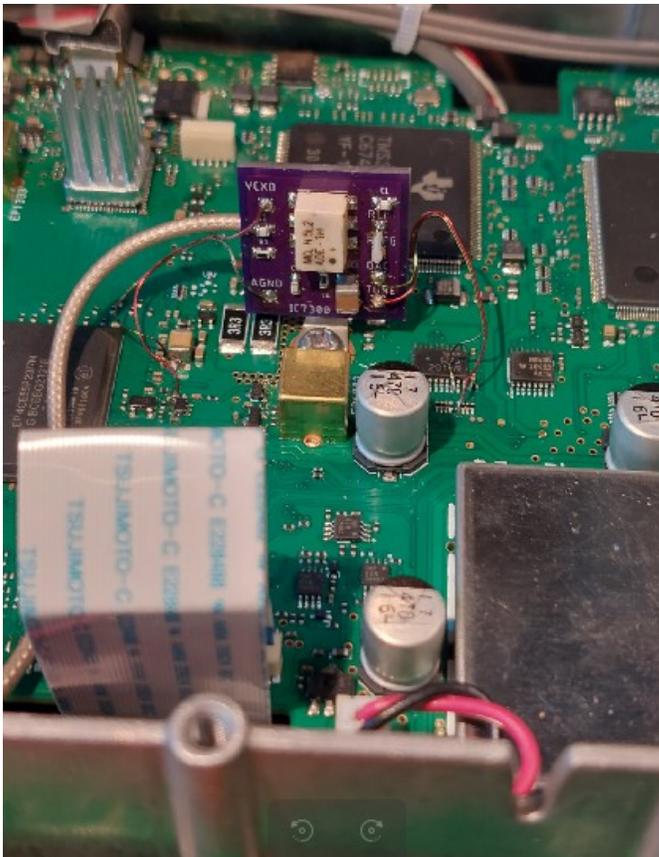
Figure 2: PLL PCB mounts near the center of the IC7300 Main Board on the bottom side of the transceiver. A solder lug is bent at right angles and holds the board securely by way of an existing mounting screw.

Figure 3: Connection points on IC7300 Main Board

Connections to the radio are made by way of small diameter magnet wire and soldered to the PCB and (carefully) soldered to the SMDs of the radio; resister array R1223 (end resistor) near the DAC and IC1211 and ground (attached at nearby capacitor which is also grounded).

Figure 4: IC7300 Main Board

Input from the external reference source attaches to a small coaxial connector on the rear panel, mounted on an aluminum bracket and secured by one of the fan bolts, and runs via small diameter Teflon coax where it solders to the PLL PCB, Figures 2 & 3.

Figure 5: A small coaxial cable is mounted to an aluminum bracket which has small diameter coaxial cable solder to its center and ground.

The two-sided PCB is assembled with the seven components:

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1  100uF    Ceramic   Multilayer Capacitor, 6.3 V @ 5V
3  1000      C0603     C1, C2, C3
2  47        R0603     R1, R2
1  ADE-1+    ADE1      IC1 Double Balanced Mixer
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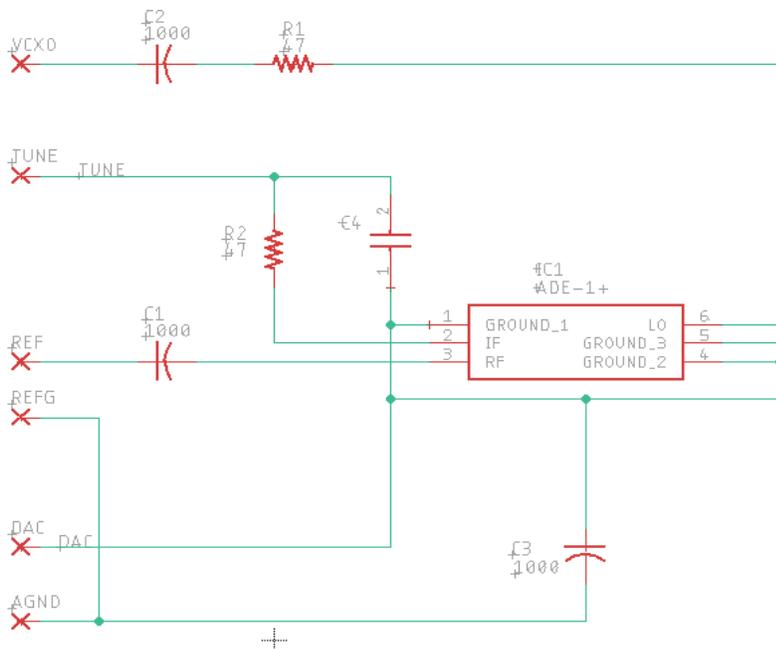*Figure 6: PLL PCB Schematic*

The PCB schematic and board files can be found at
https://www.dropbox.com/sh/5jtvcslfpbgowbh/AACixexnbsuEKOZEBjXInuV2a?dl=0

The .brd file may be dropped on OSHPark.com and a board fabricated and return postage paid in 10 days for under US$1/board.

Operation of the PLL only requires verification of calibration of the IC7300's reference to within 1 or 2 Hz with no external reference present. When a +10 dBm external reference of 41.344000 MHz is applied to the rear panel input, the TCXO should be steered to be in-phase. There's nothing else required. The PLL should be able to capture and maintain phase lock +-15 Hz or so around 41.344000 MHz.
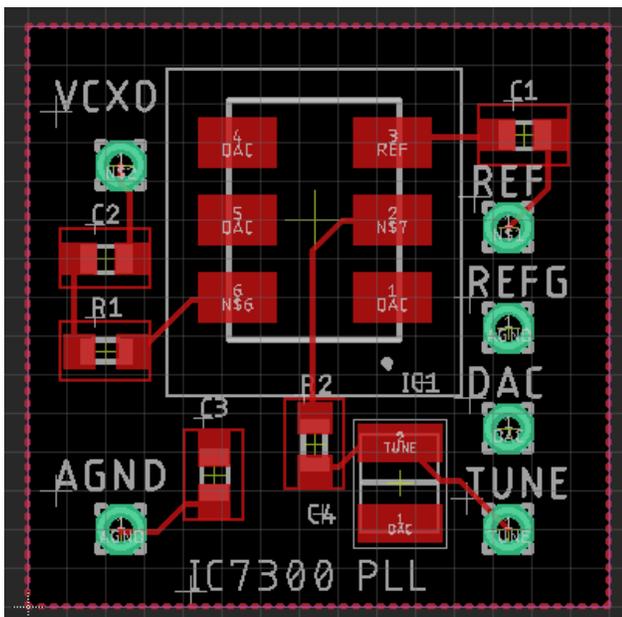

Figure 7: PCB Component side

Early measurements of the resulting performance using an N6GN GPSDO Reference has shown spectrum spreading on 14 MHz, measured using FST4W, to be under 10 milli-Hz including the spreading of a Bodnar mini-GPSDO being used as external LO on the measuring Kiwi receiver.

This is among the smallest spreads measured to date for any 20m FST4W transmitter/receiver combinations.

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