Digital Display for the Icom IC202: New Life for an Old Friend

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Introduction

The Icom IC202 is a portable battery powered 2 meter SSB/CW radio. While it is now going on four decades old, there are still a number in use especially as an IF transceiver for microwave systems. Its clean continuous tuning variable crystal oscillator LO is one of its selling points but one of its biggest limitations is the inaccuracy of its analog frequency readout. A digital frequency display would be an welcome addition.

Display Design by G4DHF

An Internet search turned up a digital display design by G4DHF. Unfortunately the original posting is no longer available but it is still available at:

https://f6bgr.pagesperso-orange.fr/pdf/affichage_digital_pour_IC202.pdf

This design uses Intersil counter chips that are now long obsolete and a divide by 100 Plessey ECL prescaler that is even harder to find. The Plessey part draws a whopping 45 mA all on its own not counting the display current. The need for obsolete parts and the high current drain were discouraging so this digital display idea got shelved.

As a footnote, there is a potential for confusion in this design. The paper (and the picture) shows an ICM7207A to generate the gating signals for the ICM7217A frequency counter. However, a 7207 is shown on the schematic and on one of the drawings. The "A" and the "non A" parts are not the same. The two parts use different crystals and produce different gating periods. The non A part could be used but it would require some redesign. A data sheet for both parts is available.

PIC Based Counter by DL4YHF

A 50 MHz PIC based counter kit sold as a "crystal tester" was found on eBay. Do an eBay search for "crystal tester." Several Chinese vendors offer it for $7-$8. A couple were purchased and they worked more or less as advertised. The kit included a programmed PIC, a PCB and a LED display but be careful as there is no buffering on the PIC input. Any input voltage less than 0 or more than Vcc will destroy the PIC. Like many eBay items from China, it is a knock off of someone else's work and there was no acknowledgment of the original designer. A continued Internet search turned up the original design by Wolfgang "Wolf" Büscher DL4YHF. Thanks Wolf!

https://www.qsl.net/dl4yhf/freq_counter/freq_counter.html

The design is worth studying as it can be programmed to include an IF offset. It appears to have been originally intended for use as a digital readout for home brew QRP rigs. DL4YHF's website contains information on a number of variants of his counter including an input buffer circuit. The original design had 4 digits and it was expanded to 5. An additional modification by F8FII extends the readout to 6 digits and he has software to support the extra digits:

http://f8fii.com/ModFreqe.html

Also see:

https://www.py2bbs.qsl.br/freq_dl4yhf.php

for a complete schematic of the 6 digit F8FII variant. This page is in Portuguese but Google translator does a fair job.

Application of the DL4YHF and F8FII Counter to the IC202

The F8FII 6 digit variant offers a possible IC202 digital display. The 202 has an IF filter centered on 10.7 MHz. The 202 transmits USB. The actual BFO carrier frequency is 10.6985 MHz. The LO runs on the low side so, for 144 MHz, it is 133.3015 MHz. A divide by 10 prescaler will result in a 1 kHz resolution display and it brings the LO frequency within the 50 MHz range of the PIC. The PIC counts the LO and adds 1.0699 MHz to the count. That is the IF BFO frequency scaled by 10. With the prescale and the offset, the six digit F8FII version will display 144000 for 144 MHz in the 202. If only the last 4 digits are displayed, you have 4000. Caution: if you only use 4 of the 6 digits, part of the programming message will not appear. See DL4YHF 's website for offset programming instructions.

The prescaler is a MC12080. This part is set to divide by 10. It can also divide by 20, 40 or 80. It is available from Mouser, DigiKey (MC12080DG) or on eBay. It is specified to operate from 100 MHz to 1100 MHz and, best of all, it draws only 3-4 mA.

The part that is most problematic is the display. The original G4DHF design used a 0.11" (2.8 mm) LED display unit. The display is in a DIP package and you really need a display that small. My display uses the four digit HP QDSP-6064 but it appears that this part is no longer available. The HP 5082-7404, HP 5082-7414 or the Siemens DL-340M displays are possibilities. There may be others. The 5082-7414 is currently available on eBay (#185697903516)(01/2023) for about $25 with shipping or for a heart stopping $43 (plus $20 shipping)! The DL-340M is also available on eBay (#224463963162)(01/2023) for around $30 with shipping. Whatever you use, search for the data sheet. The decimal point is in different places in these displays but my 202 display does without the decimal point. Maybe you can find a display in a defunct calculator at a hamfest but the display must be common cathode. There are some 3 and 5 digit displays available on eBay with the same sized digits. However getting a 5 digit display in the 202 space would be tough. If you can do without the MHz digit, a 3 digit display may work and it will result in somewhat lower current. The 4 digit display, as Goldilocks said of the porridge, is “just right” for the opening in the 202.

The DL4YHF and F8FII design both use a 20 MHz crystal for the PIC clock oscillator. The PIC clock is also the counter reference. This is easy to implement and probably adequate but the PIC clock determines the stability and accuracy of the counter. An easy upgrade replaces the crystal with a TCXO. My design uses a 5V Vectron 20 MHz TCXO. It is a T1175 (OSC-3AO on the datasheet) TCXO with +/-2.5 ppm stability for -30C to 75C and a clipped sine wave output. This TCXO is available on eBay (#181032108148)(01/2023). The TCXO will drive the PIC clock directly. No PIC reprogramming was necessary. Given the TCXO temperature range, the operator will probably fail long before the TCXO goes off frequency but it is nice to know you are on frequency.

A DIP 16F628A PIC processor was programmed with the software downloaded from the F8FII website. F8FII’s software supports the 6 digits. The software assembled and programmed with no changes using Microchip’s MPLAB 8.70 assembler and the Picstart Plus programmer. Both of these are last generation but they work well for older DIP parts. Those of you more experienced with PIC’s can use the newer MPLAB-X and PicKit-3 programmer or your own favorite flavor of PIC assembler/programmer.

Display Schematic

Figure 1 is the schematic for the display. F8FII’s design was configured to display only the last 4 digits. Q1 is a P-channel MOSFET that is used to turn the display on and off. Grounding the gate will turn the display on. The point on the front panel rotary switch that grounded one end of the dial light is used to turn the display on. The lead that went to the light was disconnected, taped and put out of the way. Since power is supplied through the FET switch, 12V is taken directly from the battery. D6 is a protection diode. A Shockley diode was used, that was what was available, but any of the 1N4000 series diodes should work.

R8-R14 limit the display segment current. The value chosen was a reasonable trade off between brightness and current drain. 0.001uF chip capacitors are connected from the display end of R8-R14 to ground on the board. Theses capacitors don’t appear on the schematic drawing as there wasn’t room to include them but they help reduce RF hash from the PIC.

The addition of the digital display required little modification of the 202 itself. The counter was tucked under the speaker on the VCXO side of the radio. See Figure 2. The board for the prescaler and PIC was cut to fit around the speaker and it is mounted with ¼” spacers using existing holes in the 202. These holes require metric threaded screws. The prescaler is a SMT part and many of resistors and capacitors are chip parts mounted on the back of the board. Traces for the chip parts were cut with an Xacto knife. The diodes and transistors are leaded parts. R8-R14 are 1/10 w leaded resistors. A 1/10" grid perf board was used a temple for drilling holes for the machined pin DIP sockets used for the PIC and the interconnects. Given the ¼ " spacers, it is important to mount everything close to the board. The 1000 uF 16V capacitor across the battery that was under the speaker was replaced with a much smaller part of the same value. The external VFO jack was removed. There are two very small coax cables that carry the LO connected to this jack. A terminal to connect these two cables together was placed on the counter board and a 1k resistor (R2) connects that cable junction to the counter input. This prevents loading of the VCXO output. The signal level is approximately 1 mW.

The small panel on the upper left of the front bezel where the 202 power led is located was cut out to show the LED display. See Figure 3. The opening in the frame behind the bezel will accept the QDSP-6064 display. The display is in a DIP package with 12 pins. Two 6 pin machined pin IC sockets were used for connections. A small drop of super glue holds sockets in place. The boss on the lower right of the tuning knob was drilled out for the power LED that was originally on the upper left of the bezel. A bit of super glue holds its terminal board in place behind the front panel.

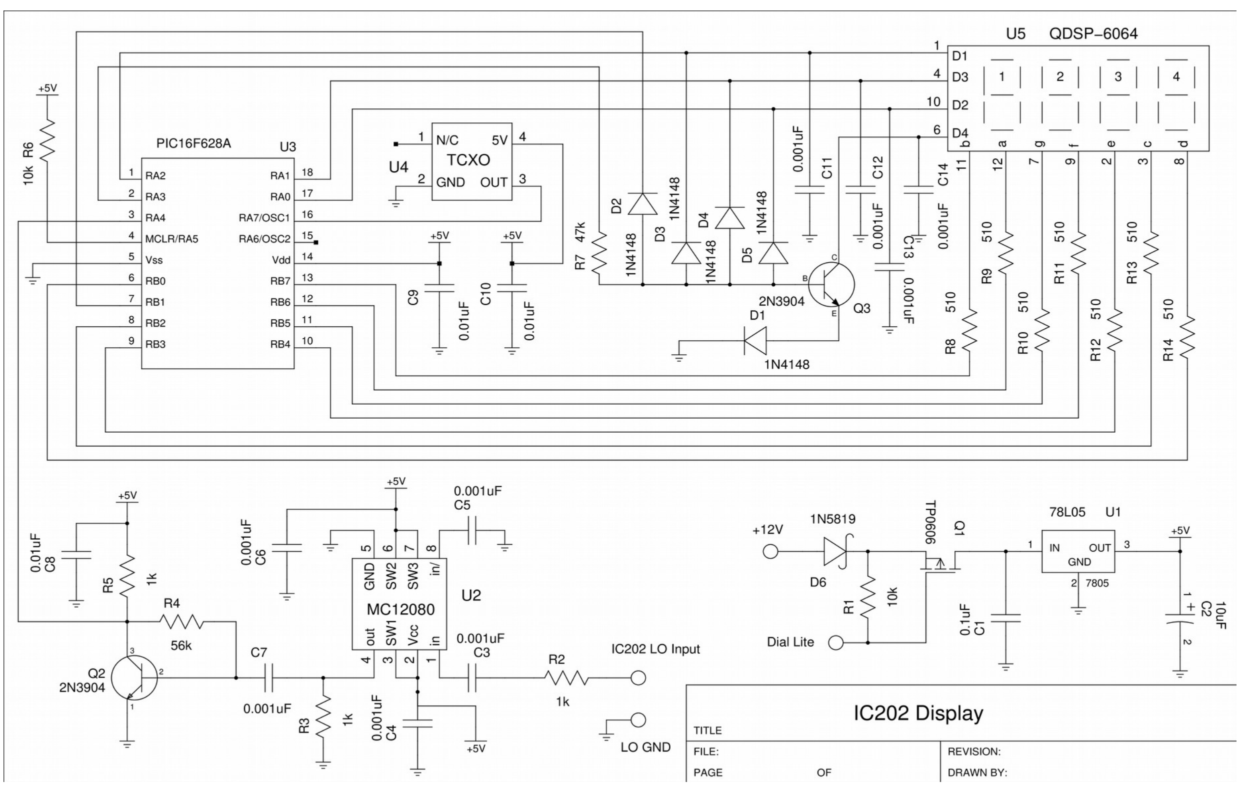

Figure 1: Display circuit

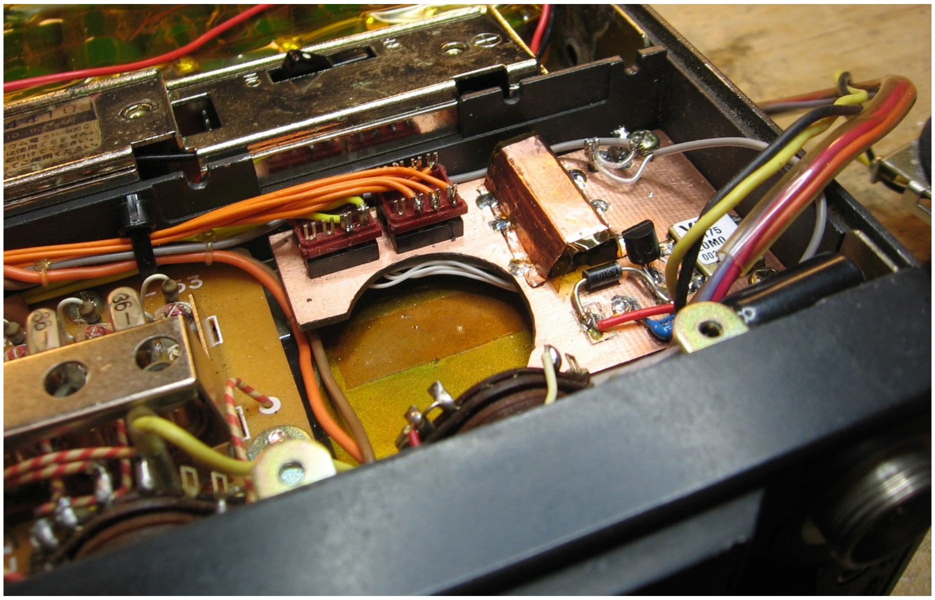

Figure 2: Display board under the speaker. The PIC in the upper right center is covered with Kapton and copper foil tape to reduce computer hash. The TCXO is the white object to the right. The LO junction terminal is just to the upper right of the PIC. The white wire visible on the wafer switch in the front goes to the MOSFET gate.

Figure 3: The display opening is on the upper left and the LED to right under the tuning dial is the power LED that was once on the upper left.

Modification of the IC 202 as a Microwave IF

Since the 202 was destined for transverter use, some additional circuitry is required. See Figure 4 for the control circuit. The PIN diode T/R switch in the 202 was replaced with a small 12V relay: Omron G5Y-1-H. It is available from Jameco or eBay (#115350403551)(01/2023). The G5Y is characterized for RF use through 900 MHz and it requires only about 16 mA to operate it. The G6K-2P-RF DC12 is available from Mouser. It is smaller with half the current drain but it is more expensive. Using the relay results in about a 3 dB improvement in receiver sensitivity because it removes the PIN diode and the TX LPF from the receiver signal path. A short length of small diameter co-ax was used to connect the receiver directly to the relay. A blocking capacitor (C3) is required in the RX connection since the current for the PIN T/R switch was fed through the RX input circuit.

Separate RX/TX ports for transverter operation can be selected with jumpers. The separate transmit path includes a 6 dB attenuator to reduce the output power to approximately ½ watt. The attenuator was built with ½ watt resistors so it could absorb the appropriately 2½ watt output from the 202.

Two connectors, CONN1 and CONN2, are used to select normal or transverter operation. Short pins 1 and 2 on each connector for normal operation. In normal operation, the PTT line goes high and Q1 energizes the relay. The RX and the TX are routed through the relay to a BNC connector for the antenna. Pins 2 and 3 are shorted for transverter operation. During transverter operation, the T/R relay is not energized and the transistor that controlled it is configured to pull the center pin of TX output to ground via a RF choke. This is used to key the microwave transverter. The RX goes through the relay to the antenna connector and the TX goes through the attenuator to a separate connector.

See Figure 5 for the placement of the transverter parts. A jack for charging the battery was placed in the hole once used for the internal antenna.

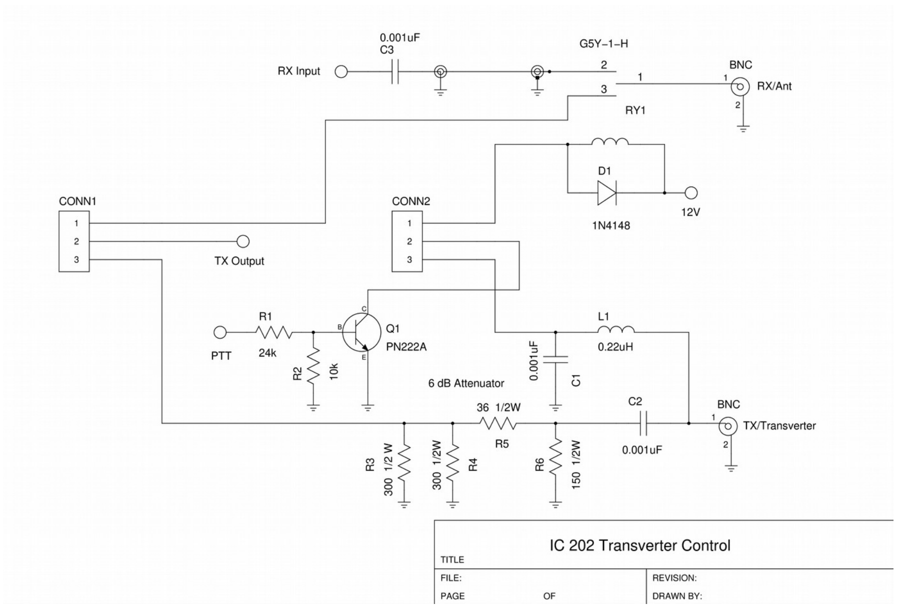

Figure 4: Transverter control circuit.

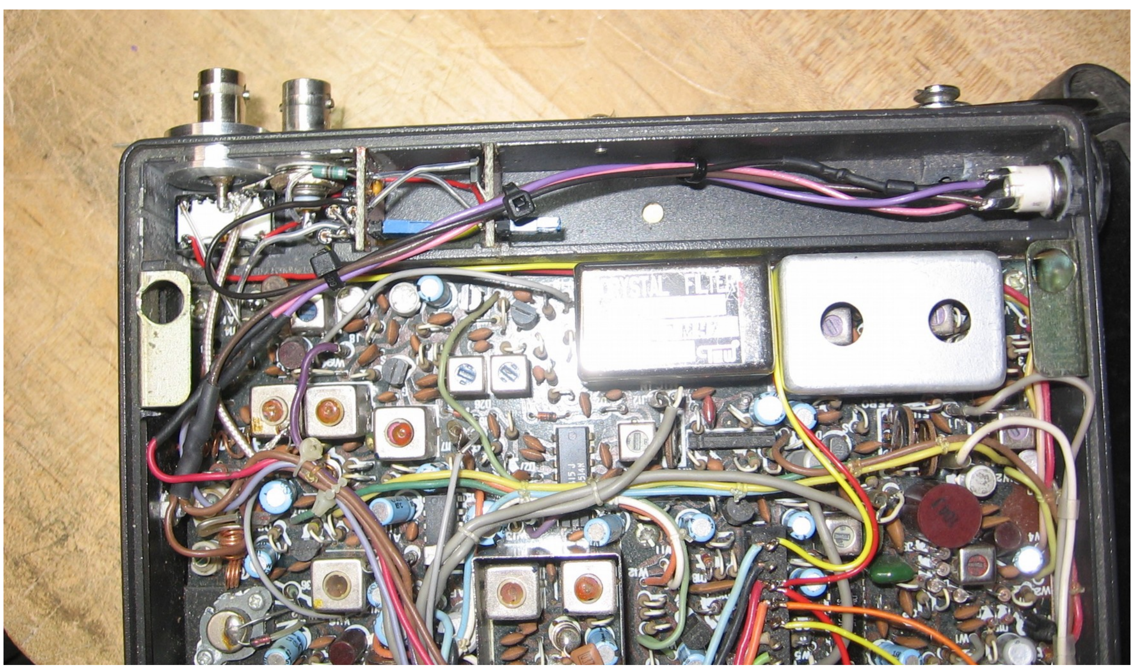

Figure 5: T/R relay and transverter circuitry. The relay is in the far upper left corner.

Final Comments

The counter and display consume only about 30 mA total and they work well but there is one minor problem. The PIC produces enough computer hash to create weak birdies in the receiver every 50 kHz or so. They are not very strong but you know they are there. In an effort to control this, the PIC processor was covered with Kapton tape (to prevent shorting its pins) and then covered with copper foil tape soldered to the board as a shield. 0.001uF chip capacitors were soldered to the ends of R8-R14 to ground on the pins of the connectors that go to the display. All of that helps but the spurious never entirely go away. The real problem is that the receiver is wide open with little shielding. The internal antenna made things worse but it was removed to make way for the additional circuitry required for transverter use. When the 202 is used with a microwave transverter, the noise from the transverter tends to mask the birdies. At least, you should know where they are. To address this problem, the dial light was disabled and the counter controlled through the dial light circuit. That way you can turn the counter off to get rid of the spurious and save a bit of current drain as well.

While the IC202 is probably the most common of these radios, there is an IC502 for 6 meters and an IC402 for 432 MHz. The IC402 may also be useful as a microwave IF. The counter/prescaler were tested with a signal generator and they worked fine for 432 MHz with no modification of the hardware or software. The IC402 would benefit from the TCXO upgrade.