

Inside Digital TV/VCR Tuners

Part 5: Decimal-to-binary conversion program.

The four previous sections have discussed the tuner types, a data transmitter, a data receiver, and methods for controlling and testing the digital tuner. It sometimes seems that getting ready to do a project takes longer than actually doing the "work" on it, and working with digital tuners is no exception to the rule.

When it comes to communication with a digital tuner, we must use a language that is understood by the tuner, and that includes the format of the data presented. That brings us to the objective of the BASIC program that's discussed here. We, as hams, deal with frequencies in a decimal number format, but the digital tuner can only handle information in a binary format. Therefore, it is necessary for us to convert from decimal numbers to the equivalent in binary.

Converting numbers from decimal to binary is quite easy and may be done using pencil and paper as was discussed in part four of this series. But for those who would rather let the computer do the "work," then the BASIC program shown here will do that and will provide the data in the correct binary format as shown in **Fig. 1**. **Fig. 2** shows the data flow pattern of the BASIC program with decision points.

The program generates and formats the data that can be entered directly into the tuner with the data transmitter switches.

The conversion process is done by sequencing a series of subtraction steps and assigning a "1" or a "0" to each, depending upon the success of the subtraction. As the program runs, ones and zeroes are assigned to number variables and stored until the end of the conversion process. The steps in the process start with determining the desired frequency of the tuner's VCO (local oscillator). Entering either the desired oscillator frequency or the desired receiver input frequency finds the other frequency by calculation. An intermediate frequency (IF) of 47 MHz has been used in the calculation. Although 47 MHz is the frequency that I've chosen to use, TV and VCR systems use approximately 43 MHz (midpoint between 41.25 and 45.75 MHz). Actually, the tuner doesn't care about the specific IF that's chosen, and any

IF frequency between 41 and 50 MHz can be accommodated at the tuner's output.

The second step in the calculation process is to divide the VCO frequency by the synthesizer step frequency, which is 62.5 kHz for most digital tuners. The result of the division is a number representing the synthesizer divide ratio that's needed by the synthesizer to "lock" the VCO to the desired frequency.

The third step in the calculation process is to convert the divide ratio from a decimal to a binary format that can be clocked serially into the digital tuner's register.

Upon completion of the calculation and conversion, the program will display the original decimal frequency information along with the formatted binary data that will set up the main frequency divider for the tuner's frequency synthesizer.

For simplicity, printout of the final data has been formatted for display on the monitor in preference to a paper printout.

The program

The BASIC program shown in **Fig. 3** is divided into four main parts, with

MSD																		LSD
4	3	2	1	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Band Selectors				Frequency Select Data in a Binary Format														

Fig. 1. Data format required for controlling a digital TV/VCR tuner.

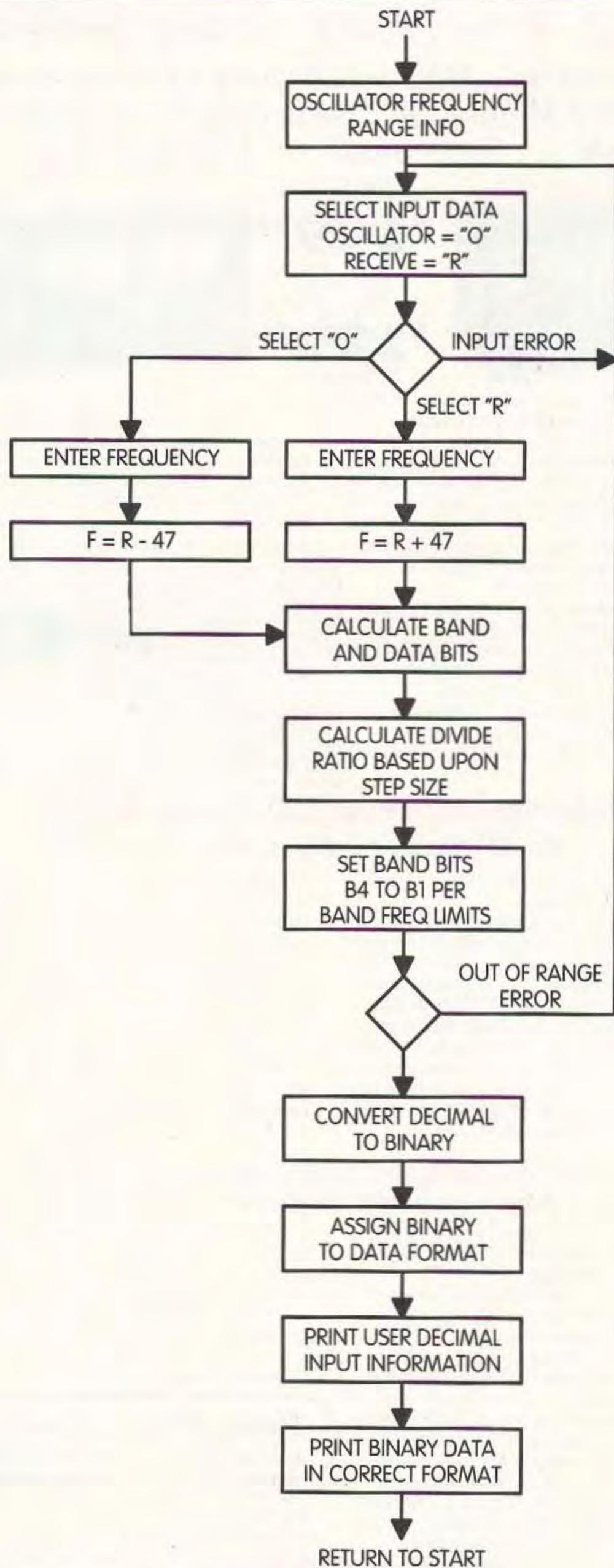


Fig. 2. Flow diagram for a BASIC program that converts decimal frequency numbers to binary and prints data in a digital tuner's required format.

the first being the user interface and input. The second part sets the four band select bits into a binary format. Band bits, as used by the tuner, are not binary, but are "pass-through" one-out-of-four data bits, meaning that the bits represent which synthesizer output band port is to be selected.

The third section of the program performs decimal-to-binary conversion of the divider ratio by a sequence of subtractions and makes the assignment of binary numbers to the number variables. The last section formats the data for display on the monitor.

When I laid out my data transmitter, I used three 8-switch dip switches making for a maximum of 24 binary data entry possibilities. However, the digital tuner can use only 19 of the 24 switches. In an attempt to keep things positioned correctly for minimum data entry into the data transmitter, the binary printout is formatted with the four band bits shown on the left followed by the 15 main frequency divider bits. Spacing is provided between the switch groupings to aid user readability by matching the three blocks of switches. Because of the two-digit offset between the data transmitter switches and the tuner's register, adjusting the placement of the data bit pattern on the transmitter switches is required.

The BASIC code that's used in the program has been done in the most general format possible so that it is suitable for most all BASIC interpreters. Very little conversion of the program lines should be required for it to operate on even the most difficult of BASIC interpreters.

Program changes

There are always changes to be made, so as you work with digital tuners, changes in the way the program presents data will occur. One of the anticipated changes is the step frequency of the synthesizer that you might encounter. As used in TVs and VCRs, the step frequency is 62.5 kHz and is used as such in program line 110. When the tuner can be reprogrammed to operate on a different step

```

10 DIM A$(1)
20 REM 3-WIRE DIGITAL TUNER BINARY CONVERSION PROGRAM
30 REM WRITTEN BY HUGH WELLS W6WTU 9/99
40 PRINT:PRINT:PRINT "TUNABLE RANGE OF THE OSCILLATOR IS": PRINT "96 TO 863 MHZ."
50 PRINT:PRINT "ENTER THE OSCILLATOR OR RECEIVE FREQUENCY IN MHZ."
60 PRINT:PRINT "ENTER (O) FOR OSC OR (R) FOR RECEIVE...":INPUT A$
70 IF A$="O" THEN PRINT:PRINT "ENTER OSC FREQ...":INPUT F:R=F-47:GOTO 100
80 IF A$="R" THEN PRINT:PRINT "ENTER RECEIVE FREQ...":INPUT R:F=R+47:GOTO 100
90 GOTO 50: REM WRONG ENTRY
100 REM CALCULATE BAND AND DATA BITS
110 N=F/0.0625:REM SETS STEP FREQUENCY
120 IF F<=160 THEN B4=0:B3=0:B2=1:B1=0:GOTO 150:REM VHF LOW
130 IF F<=384 THEN B4=0:B3=0:B2=0:B1=1:GOTO 150:REM VHF HIGH
140 IF F<=864 THEN B4=0:B3=1:B2=0:B1=0:GOTO 150:REM UHF
150 IF F<96 OR F>863 THEN GOTO 50:REM VCO OUT OF RANGE CHECK
160 IF N>16384 THEN 180      340 IF N>256 THEN 360      520 IF N>4 THEN 540
170 N14=0:GOTO 190          350 N8=0:GOTO 370          530 N2=0:GOTO 550
180 N14=1:N=N-16384        360 N8=1:N=N-256          540 N2=1:N=N-4
190 IF N>8192 THEN 210     370 IF N>128 THEN 390     550 IF N>2 THEN 570
200 N13=0:GOTO 220         380 N7=0:GOTO 400         560 N1=0:GOTO 580
210 N13=1:N=N-8192        390 N7=1:N=N-128         570 N1=1:N=N-2
220 IF N>4096 THEN 240    400 IF N>64 THEN 420     580 IF N>1 THEN 600
230 N12=0:GOTO 250        410 N6=0:GOTO 430         590 N0=0:GOTO 610
240 N12=1:N=N-4096        420 N6=1:N=N-64          600 N0=1
250 IF N>2048 THEN 270    430 IF N>32 THEN 450     610 PRINT:PRINT:PRINT
260 N11=0:GOTO 280        440 N5=0:GOTO 460         "OSC F = ";F;" MHZ","REC F
270 N11=1:N=N-2048        450 N5=1:N=N-32          = ";R;" MHZ"
280 IF N>1024 THEN 300    460 IF N>16 THEN 480     620 PRINT B4;B3;B2;B1;
290 N10=0:GOTO 310        470 N4=0:GOTO 490         630 PRINT
300 N10=1:N=N-1024        480 N4=1:N=N-16          N14;N13;N12;N11;"
310 IF N>512 THEN 330     490 IF N>8 THEN 510     ";N10;N9;N8;N7;N6;N5;N4;N3;"
320 N9=0:GOTO 340         500 N3=0:GOTO 520         ";N2;N1;N0
330 N9=1:N=N-512         510 N3=1:N=N-8          640 PRINT:PRINT
                          650 RUN

```

Fig. 3. BASIC program that generates and formats the required data for controlling a TV/VCR tuner.

value, the step number in line 110 can be changed to accommodate the new step frequency.

Also, I've used an intermediate frequency (IF) of 47 MHz when working with TV/VCR tuners because I've found that frequency to be interfered with less in my local area than perhaps 45 to 46 MHz. The actual center IF frequency for tuners is approximately 43 MHz. Because of the wide bandwidth of the tuner's output resonator, most any receiver tuned to the IF between 41 and 50 MHz should work well. But should the calculation of an IF other than 47 MHz be desired, program lines 70 and 80 may be changed accordingly.

Another possible change is the band bit selection based upon the band of frequencies. The tuner designer has the

freedom to choose which of the band bits that he may use for whichever band that is to be turned on. As a result, the band select bits may end up not being in a logical sequence. Program lines 120 through 140 may be changed as desired to provide the band data for the tuner being controlled.

When considering changes to the BASIC program, you should refer to the flow diagram as a reference for where the changes need to be made. The flow diagram provides an overall map of the processes and adding or changing details within the program should "fit" into the map.

Parts six and seven, the last in this series, will discuss a simple process for making printed circuit boards for the data transmitter and data receiver that I used for controlling digital tuners during the study.

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