Introduction

QRP HomeBuilder is a program to help the homebrew enthusiast create and test homebuilt gear. While some of the programs are useful to quickly calculate mundane formulas, they can also be used to learn more about radio electronics.

CoilBuilder

CoilBuilder is used to calculate the winding data for Inductors using powdered-iron cores. In addition, this program provides data on the maximum number of wire turns per wire guage for the core you selected. Data is provided for 18 through 30 guage wire. Twelve torroid cores are listed using core materials 2, 6 and 7 as they represent the most common and practical to stock and use for the homebrew enthusiast.

Using CoilBuilder:

Enter the desired inductance in microhenries into the white edit box. Select the core you wish to use by pointing to the appropriate radiobutton with the mouse arrow and click the left mouse button. Press Calculate to obtain a result. Press Cancel to exit CoilBuilder . Press Help to bring up this help file.

The values given for maximum number of turns versus wire guage for a given core are approximate. Actual values may vary depending on the skill of the person winding the coil. These values are useful for making descisions on which guage of wire to use for winding a given inductor.

Input Parameters
Construction Hints

Radiobuttons

A radiobutton is a round or triangle shaped button that is usually grouped with other similar buttons. It is used to select an item. Only one radiobutton can be selected at any time.

Input Parameters:

Inductance values entered must be between 0.1 and 80.1 microhenries. Values outside these parameters will result in an error message and program termination.

Construction hints

Many experimenters use number 2 torroid material (example T50-2) for frequencies up to 10.1 MHz. For 10.1 up into the 50 MHz region number 6 material is used (example T50 - 6). For VFO's number 6 material is very popular, however some amateurs are using number 7 material for their VFO inductor cores and that is why they are included in this program.
A general rule popularized in part by Doug DeMaw, W1FB is to leave a 30 degree gap of bare core between the ends of the windings on a torroidal inductor. There are many good references on winding torroids available by mail. Consult the amateur publications for help.

VFO Core Material:

VFO inductors require a temperature stable core to minimize drift. Micrometals number 6 material is very popular in this regard. There has been mention of even better temperature stability with the newer number 7 material but data is sparse for this material in the amateur literature. Consult the construction hints in Universal VFO for more on VFO inductors.

Data Input Edit Boxes

Edit boxes are used in windows programs to get data from the user. All edit boxes in QRP HomeBuilder have error checking to prevent the user from hanging up the program. To type a value in an edit box, a flashing line (carat) must be present in the edit box you wish to type in. By default, the first or only edit box will have the flashing carat present so that you can start typing right away. If there are more edit boxes to fill simply move the arrow cursor to that box and click the left mouse button. A value can be cleared from an edit box by holding the left mouse button down and wiping the input value. This will highlight the input value and it can be cleared by typing in the new value right over top of the highlighted characters. Edit boxes that have a default value in them only need attention if you wish to change the default value.

Capacitor Code Reader

Capacitor Code Reader is used to convert the code on small value capacitors such as Ceramic Disk, Polystyrene or Monolithic Ceramic NP0 types into more meaningful data. The capacitor value is given in both microfarads and picofarads. In addition, the capacitor tolerance value (if any) is given. Many new amateurs find capacitor codes confusing and this program should help you learn the capacitor coding system easily.

Using Capacitor Code Reader

Enter the first two digits of the capacitor in the white edit box. Next, select the third digit (if any) by using the mouse to click on the appropriate radiobutton. Finally, select the letter (if any) after the second (if there is no third digit) or third digit of the capacitor. Press Calculate to obtain a result. Press Cancel to exit the program. Press Help to bring up this help file.

Input Parameters

Consider the first two digits to be a single number such as 10. The number entered in the white edit box cannot be less than 10 or greater than 99.

Universal Diplexer

Universal Diplexer is used to calculate the component values for an excellent bandstop/bandpass diplexer described by Joe Reisert W1JR (see reference 1). This easy to build diplexer has a low parts count and has been tested from 2.5 to 28 MHz. Resistors R1 and R2 present a 50 ohm impedance to the mixer output and a 50 ohm impedance to the input of the post mixer amplifyer. The IF frequency is passed through the diplexer while out of passband RF is given a low impedance path to ground. The capacitance for C1 is generally built up by substituting the nearest standard value capacitor or by placing 2 or more capacitors in parallel with each other to achieve the computed value. The same procedure is then repeated for the C2 capacitance.

Using Universal Diplexer

Enter the IF frequency that you wish the diplexer to be designed for in the white edit box. Press Calculate to obtain a result. Press Cancel to exit Universal Diplexer. Press Help to bring up this help file.

Input Parameters
Construction Hints
Using Universal Diplexer to design a simple low pass filter

Universal Diplexer will accept any frequency between and including 1 to 30 MHz. This diplexer has been only tested form 2.5 to 28 MHz.

Construction Hints

This diplexer has been built on PC board and using Ugly Construction with equally good results. For optimal performance, part of the inductance (L1 and L2) or the capacitance (C1 and C2) should be variable. (See reference article number 2 for an example) An easy method is to wind L1 and L2 on powdered-iron torroids while using parallel values of capacitors including a small variable capacitor to build up to the total value indicated for C1 and C2 seperately. Thus the capacitances of C1 and C2 can be peaked under test conditions. In reference article 1, Joe Reisert uses no variable components and his design works very well so it is up to you if you want to include variable components to allow peaking. Capacitors used should be dipped mica, polyester film or epoxy-coated ceramic types.

Using Universal Diplexer to design a 3 element low-pass filter

As it happens, Universal Diplexer can also be used to generate simple single section low-pass filters that have an input and output impedance of 50 ohms. Such filters could find use as low-pass filters that follow a BFO or VFO. A great example of this filter can be found on page 229 of the ARRL book Solid State Design for the Radio Amateur by Wes Hayward W7ZOI and Doug DeMaw W1FB.

The schematic for this filter can be found in the system menu of QRP HomeBuilder. Rather than build an entire dialog box for the schematic, it was tucked in here.

Method

Instead of entering the IF frequency in the Universal Diplexer edit box, enter the cutoff frequency (fc) that you require. Take values L1, C1 and C2 and use them as the component values for L1, C1 and C2 in the 3 element low-pass filter schematic located in the system menu. Substitute the nearest standard value capacitor or parallelled values of standard value capacitors to achieve C1 and C2 respectively.

2 Ugly Construction

Ugly Construction or ground-plane construction is the process of using either double or single sided copper clad PC board material (copper side up for single sided PCB) to build electronic circuits on. Component leads that require grounding are soldered directly to the copper surface. The copper surface serves as a low impedance ground and a mechanical anchor to components soldered to it. The grounded components serve as mechanical supports for the rest of the circuitry as you build from your schematic. If additional support is needed for components that do not connect to a grounded component, high value resistors (1.1 M or greater) or terminal strips can be soldered to the copper and used as standoffs. Ugly construction allows the experimenter total control over the design of a project and can be a time and money saver as well. See reference article 3 for details on this ugly method of doing things!

Power Converter

Power Converter is used to convert measured voltages into dBm, mW or watt values. This program accepts both peak to peak voltages and RMS voltages from an oscilloscope or high impedance voltmeter respectively. Power Converter is intended to help you test small voltage stages such as VFO buffer/amps where a target dBm value is needed. Although this program is not intended for higher voltages, output results greater than 1000 mW will be automatically expressed in watts.

Observe safe workshop practice at all times!

Using Power Converter

Enter the measured voltage in the white editbox. Select the voltage type by using the mouse and clicking on the appropriate radiobutton. Default is peak to peak. Press Calculate to obtain a result. Press Cancel to exit Power Converter. Press Help to bring up this help file.

Input Parameters

Power Converter will accept voltages from 0.2 to 40 volts. The load impedance can be from 1 to 2001 ohms, with a default value of 50 ohms.

Universal VFO beta version 1

Universal VFO is a program to help the builder design a VFO which will use the variable capacitor he or she has on hand. This program provides considerable flexability in chosing components for the L-C circuit. The heart of this program is a Hartley VFO adaptation by Roy Lewallen W7EL which accomodates a variety of design frequencies and does not draw much current. You can easily substitute your favorite buffer/amp in lieu of Roy's excellent buffer but if you haven't tried this buffer, please give it a go. If you are driving a mixer, don't forget the 51 ohm series resistor between the secondary winding of the transformer and the input of your mixer. The high open loop gain of Roy's buffer, along with the feedback pull the output impedance down to a few ohms. Therefore, the 51 ohm resistor is needed to get the impedance back up. The RIT circuit in the original circuit was omitted as this circuit was designed for 7 MHz. An offset designed by Wes Hayward W7ZOI is used instead and this circuit does an admirable job of shifting the VFO freqency during transmit mode. Please refer to reference article number 4 for full information on this VFO design. This article is considered by many to be essential reading for the QRP homebrewer. If you are using this VFO in a superhet receiver and do not require the offset circuit, simply omit all the parts connected to the L1 center tap via and including the 12 pf variable capacitor.
The offset capacitor (12 pf variable in the schematic) is an arbritary value. The value required for your particular VFO can be calculated , although this method can be unreliable . Many QRPers determine the value by using a trimmer variable capacitor under test conditions (with frequency counter or receiver) and adjust the trimmer until the desired offset is achieved. With some luck, the trimmer may be removed, measured and then substituted for with 1 or more equivalent fixed value NP0 ceramic capacitors.

Please read Example Calculations for important information regarding this beta version program

Using Universal VFO

Enter the lower limit frequency you intend the VFO to be used for in the first edit box. Enter the upper limit frequency that you wish to tune in the next edit box. It is important to limit yourfrequency range to a reasonable level or you may create inappropriate values for C3 and C4 and activate this programs error checking. Select a powdered-iron core for winding the inductor using the mouse to click on the appropriate radiobutton. There are 6 choices representing 2 core materials.

If you like, the inductive reactance of the inductor at the lower limit frequency may be changed. To do this, click on the button marked XL and enter your desired XL in the edit box. The default XL is 160 ohms , although it can be set to 70 - 250 ohms as required. Whenever you open the XL dialog box, it will default to 160 ohms. After changing this value, press exit and do not open this box again unless you wish to change the XL again as each time you open it the number will reset to 160 ohms. You can confirm that your "new" XL was used by noting the value given for XL in the results screen .

Next, enter the variation of your main tuning variable capacitor in the appropriate edit box. This variation is the picofarad difference of your capacacitor and equals (pf when fully meshed minus pf when fully open). Example for a 365pf variable cap with the maximum of 365pf and the minimum of 10pf the variation would be 355pf. Finally, pick a value for C3, the series capacitor that connects your variable capacitor (and its parallel value C2) to Inductor L1. A default value of 47pf is given, however values of 47, 100, 200 or even 1000 can be used as starting points. Experiment with the C3 value to accomodate the parts that you may have on hand.

Press Calculate to obtain a result. Press Cancel to exit Universal VFO. Press Help to bring up this help file.

Input Parameters
Construction Hints
Example Calculations

Universal VFO Construction Hints

It is recommended that the experimenter read reference articles 3, 4 and 6 to become familiar with VFO design. In addition, VFO theory and construction techniques are covered in several books available from the "bookshop" sections of the major amateur radio publications. Meticulous attention to sound construction techniques will reward the QRP enthusiast with a stable end product.
While many authors do not advocate building L-C tuned VFO's above 7 MHz, with sound workshop practice it is possible to build very stable LC VFO's for the 30 meter band and that is why this program allows it.
A brief review of VFO construction follows. All material has been taken from the above reference articles and by numerous articles and the book W1FB's Design Notebook by QRP construction guru Doug DeMaw W1FB. Again we emphasize obtaining and reading these reference articles and books published by the ARRL.

1/ Use number 6 or number 7 core material.

2/ Use the heaviest guage of wire possible to wind your inductor.

3/ Anneal the inductor by boiling it in water for around 5 minutes.

4/ Build the VFO using Ugly Construction above a single sided copper side up ground plane.

5/ Capacitors in the L-C circuit should be NP0 ceramic type.

6/ The variable cap should have double bearings and no backlash.

7/ The VFO should be operated at a lower regulated voltage.

8/ Although an inexpensive J310 is shown in the schematic a 2N4416 JFET may be substituted.

9/ Part of calculated capacitance C4 should be variable to allow trimming of the VFO frequency to set the lower band edge. C2, C3 and C4 maybe built up using parallel values of capacitors or by prudently substituting nearest standard values where appropriate.

10/ Please note this program will give "ballpark" capacitance values for C2 and C4. Actual values may vary from factors such as stray capacitance and parts placement. As a rule however, only C4 may need adjusting to achieve the target minimum frequency of the VFO. C4 it should consist of a minimum of 2- 3 NP0 ceramic caps plus the variable trimmer capacitor.

11/ The VFO should be shielded in an RF tight box. For the Universal VFO shown, all parts of the offset up to 1K resistor should also be in that box. Q5 an its timing components are placed outside the shielded box.

CLICK HERE to return to Universal VFO help

Sample Calculations

Originally, Universal VFO was to be omitted from QRP HomeBuilder.The beta version was ultimately included as it has some merit with regard to learning about building local oscillators. Building rock-solid VFO's takes a bit of practice and hopefully this program can be one of many tools used to that end. The calculated values for C2 and C4 are "ballpark" values which will aid in the design of the L C circuit.

The goal of Universal VFO is simply to build an oscillator that oscillates at a desired frequency range. This program attempts to do this by calculating resonances and determines the values needed. VFO design is a lot more complicated than just calculating resonances and this is the weak point that lurks in the program code. It is certainly possible to design a VFO that does not oscillate with this software! One somewhat good thing is that only a few components will need changing if the VFO does not oscillate: XL and thus L1, C2, C3 or C4 .

The best way to illustrate Universal VFO in action is by studying the following 2 examples:
Refer to reference article 6: A Progressive Communications Receiver by Wes Hayward W7ZOI and John Lawson K5IRK .

Refer to table 1 in the article:

Since the article and Universal VFO use different part numbers for the VFO components, they will be compared to each other for clarity. Note that the authors use one inductor for all frequencies so XL at the lower frequency ranges from 77 to 307 ohms. Universal VFO allows the user to use the same or a different XL for each VFO calculated and many experimenters do this. Doug DeMaw for example in his book W1FB's QRP NOTEBOOK , 2nd edition , published by the ARRL uses an XL of 271 ohms for 1.8 - 2 MHz, 209 ohms for 3.5 - 4 MHz, 157 ohms for 5 - 5.5 MHz and 158 ohms for 7 - 7.3 MHz. Universal VFO would allow all but the XL value used for 1.8 - 2 MHz where an XL of 250 ohms could be substituted. For the following two examples we will set the XL to that of the examples so calculated values can be compared against the values presented in table 1.

Example 1

//

FREQ VARIATION : 7 - 7.2 MHz

XL --> 4.9uH * 6.28 * 7 MHz = 215 ohms

PROGRAM : C1-> 355 C2-> 202 C3-> 50 C4-> 60

TABLE1 : C6-> 355 C5-> 200 C4-> 50 C3-> 60

CORE : USE T50-6

//

This box compares values from Table 1 to those calculated with Universal VFO with the following settings:

C1 (variation) = 355, C3 = 50, FREQ = 7 - 7.2, XL = 215

As you can see they are all within range. With Universal VFO, you can also specify a different frequency variation, XL, or C1 variation and choose the core you wish to wind the inductor on. This example shows the program in action and helps demonstrate that the program code has the greatest accuracy when the frequency variation is narrow.

Example 2

//

FREQ VARIATION : 5 - 6 MHz

XL--> 4.9uH * 5 MHz * 6.28 = 154 ohms

PROGRAM : C1-> 355 C2-> 129 C3-> 200 C4 65.3

TABLE1 : C6-> 355 C5-> 120 C4-> 200 C3 66

CORE : USE T50-6

//

Settings: C1 (variation) = 355,   C3 = 200,   FREQ = 5 - 6 MHZ,   XL = 154
Again values are within a reasonable range.

CLICK HERE to return to Universal VFO help

The following conditions will result in an error message:

The lower limit frequency is less than 2.5 or greater than 10.150 MHz.

The upper limit frequency is less than 2.5 or greater than 10.150 MHz.

The upper limit frequency is equal to or less than the lower limit frequency.

The variable capacitor variation is less than 1 or greater than 1001 pf.

Capacitor C3 is less than 1 or greater than 2001 pf.

If combinations of the above numbers generate a capacitor value for C2 or C3 that is negative NO results will be given and an error message will be substituted for the C2, C3 , C4 and XL values in the results screen.

Inductive Reactance XL

The inductive reactance of a VFO inductor for its lowest operating frequency is usually kept in the 100 to 300 ohm range. In Universal VFO, the default value is 160 ohms. This should suffice for many applications however, the more advanced user may want to change this value. One example would be to use a greater XL for the 80 meter band. All calculated values, including the winding data are built around the XL value and changing the XL value (and thus its uH value) will effect all the calculations in this program. Please note that if you pick an alternate value for XL, it must be between 70 and 250 ohms. XL MUST be an integer

(A whole number with no decimals.)

Frequency Range

Frequency Range = Upper VFO tuning limit - Lower VFO tuning limit.

Many QRP experimenters make there VFO tuning range too large which makes fine tuning and tuning dial calibration difficult. For a CW rig we suggest limiting the VFO tuning range to a maximum of 100 kilohertz (example 7.0 to 7.1 MHz). Depending on which capacitor values are chosen for the capacitor variables (C1, C2, C3 and C4) , as well as the chosen value for XL, the user could easily generate negative values for C3 and C4 with certain frequency ranges.
If this condition occurs, no results for C3 or C4 are displayed and a warning message appears. Practical frequency ranges should not incurr such problems. Be very careful that your VFO operates within the frequency boundaries specified by your Amateur Radio Licence if it is used to drive a transmitter.

Odds and Ends

Reference Articles

A brief list of reference articles is given when the user selects the Articles menu item. This is by no means a thorough list however, but is an attempt at helping the budding experimenter gain knowledge of our fascinating hobby. The user can exit this document by clicking on the exit button or by double clicking on the text list box.

Future Versions

Bring up the document Future Versions from the QRP HomeBuilder menu or speed button. The future of this program will lie in the hands of the QRP experimenters. If you have an idea for a new program that you think would be useful to others drop us an e-mail. You may exit this document by clicking on the exit button or by double clicking on the text list box. Future versions may be distributed as SHAREWARE.

Distribution

 This program is freeware and a small fee to cover the cost of a diskette, shipping and handling is permitted only. Jenna Design will distribute this program via ftp sites on the INTERNET only. We do not distribute this program by post. If you distribute this program, please ship the complete package which includes the following four files:

QRPHB.EXE, QRPHB.HLP, BWCC.DLL, INFO.WRI

Disclaimer

The Disclaimer is found in the Future Versions listbox. If you do not agree with the Disclaimer contents, please delete this program from any disk storage media you have it on.

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73 and good luck with your QRP endeavors!