

# RF Toolbox

Version 3.2.0

January 27, 2005

Hi, and thanks for giving RF Toolbox a try!

First things first... What is it?

RF Toolbox is a program that allows you to quickly design antennas, as well as perform many useful RF, electronics, and electrical calculations.

It is not an antenna analysis package (like MININEC) in that it doesn't determine how an antenna design performs. Instead, you select the type of antenna and the desired characteristics, and RF Toolbox gives you the suggested design for the described antenna.

Why? Well, it's a lot faster for one (I'd say by a factor of several hundred times). That's the big benefit.

You can design several types of antennas. These types include:

- Dipole
- Fat Dipole
- Yagi
- J-Pole
- Super J-Pole
- Log Periodic
- Cubic Quad
- Vertical (over a ground plane)
- Helical

You can't design an antenna of an arbitrary design. Of course, I hope to be adding many more types of antennas, in the future.

You can also perform the following additional calculations:

- LC calculations - by entering two of the following: L, C, frequency, the third is calculated.

- Coil design - by entering three of the following: L, diameter, length, number of turns, the fourth is calculated
- Transmission line loss - given the type of cable, length, and band, computes the loss in dB, also computes the additional loss caused by SWR.
- L Network - L matching network
- Pi Network - Pi matching network
- Impedance - Calculate the impedance of a capacitor or inductor at a given frequency
- Wire inductance - Calculate the inductance of a straight piece of wire
- Wire resistance - Calculate the resistance of a length of wire, as well as the voltage drop
- Transmission Line Calculator - Handles many transmission line related calculations, including SWR and impedance transformations.
- db Calculator - Convert between dB and voltage/power ratios.

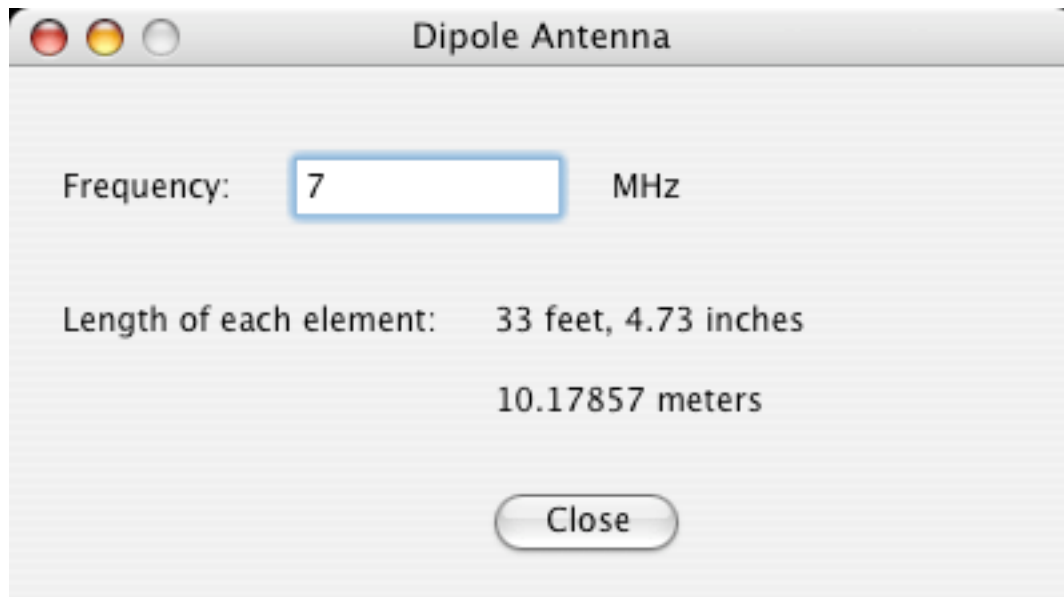
Use:

Just select the desired antenna type from the Antennas menu, or calculation type from the Tool menu, and fill in the requested information.

That's it! It's really that simple.

The following pages show the design window for each of the calculators, and give a brief description of how to use them.

## Dipole Antenna Calculator

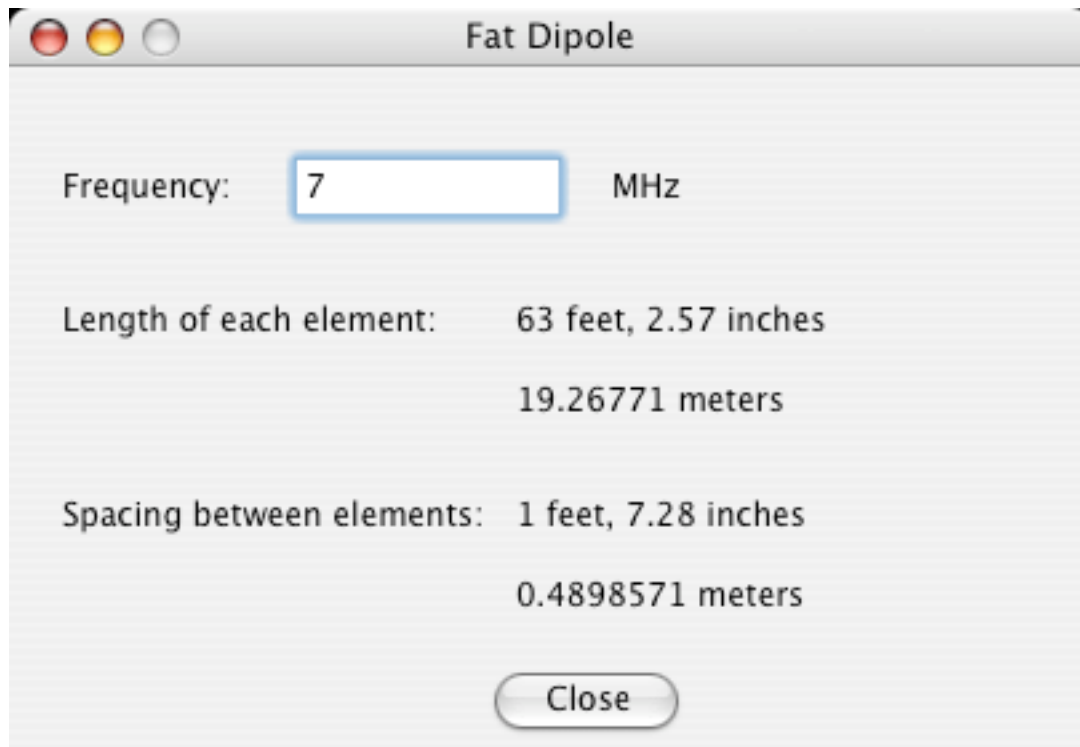


A screenshot of a software window titled "Dipole Antenna". The window has a standard macOS-style title bar with three colored buttons (red, yellow, grey) on the left. Inside the window, there is a label "Frequency:" followed by a text input field containing the number "7", and then the unit "MHz". Below this, the text "Length of each element:" is followed by two lines of output: "33 feet, 4.73 inches" and "10.17857 meters". At the bottom center of the window is a rounded rectangular button labeled "Close".

Input	Output
Frequency (MHz)	7
Length of each element (feet, inches)	33 feet, 4.73 inches
Length of each element (meters)	10.17857 meters

Enter in the desired resonant frequency in MHz, and the length of each element (side) is computed and displayed.

## Fat Dipole Antenna Calculator



A screenshot of a software window titled "Fat Dipole". The window has a standard macOS-style title bar with red, yellow, and green window control buttons. Inside the window, there is a text input field for "Frequency:" containing the number "7", followed by the unit "MHz". Below this, the calculated "Length of each element:" is displayed as "63 feet, 2.57 inches" and "19.26771 meters". Further down, the "Spacing between elements:" is displayed as "1 feet, 7.28 inches" and "0.4898571 meters". At the bottom center of the window is a rounded rectangular button labeled "Close".

Input	Output
Frequency: 7 MHz	Length of each element: 63 feet, 2.57 inches 19.26771 meters
	Spacing between elements: 1 feet, 7.28 inches 0.4898571 meters

Enter in the desired resonant frequency in MHz, and the length of each element (side) is computed and displayed, as well as the necessary spacing between each element.

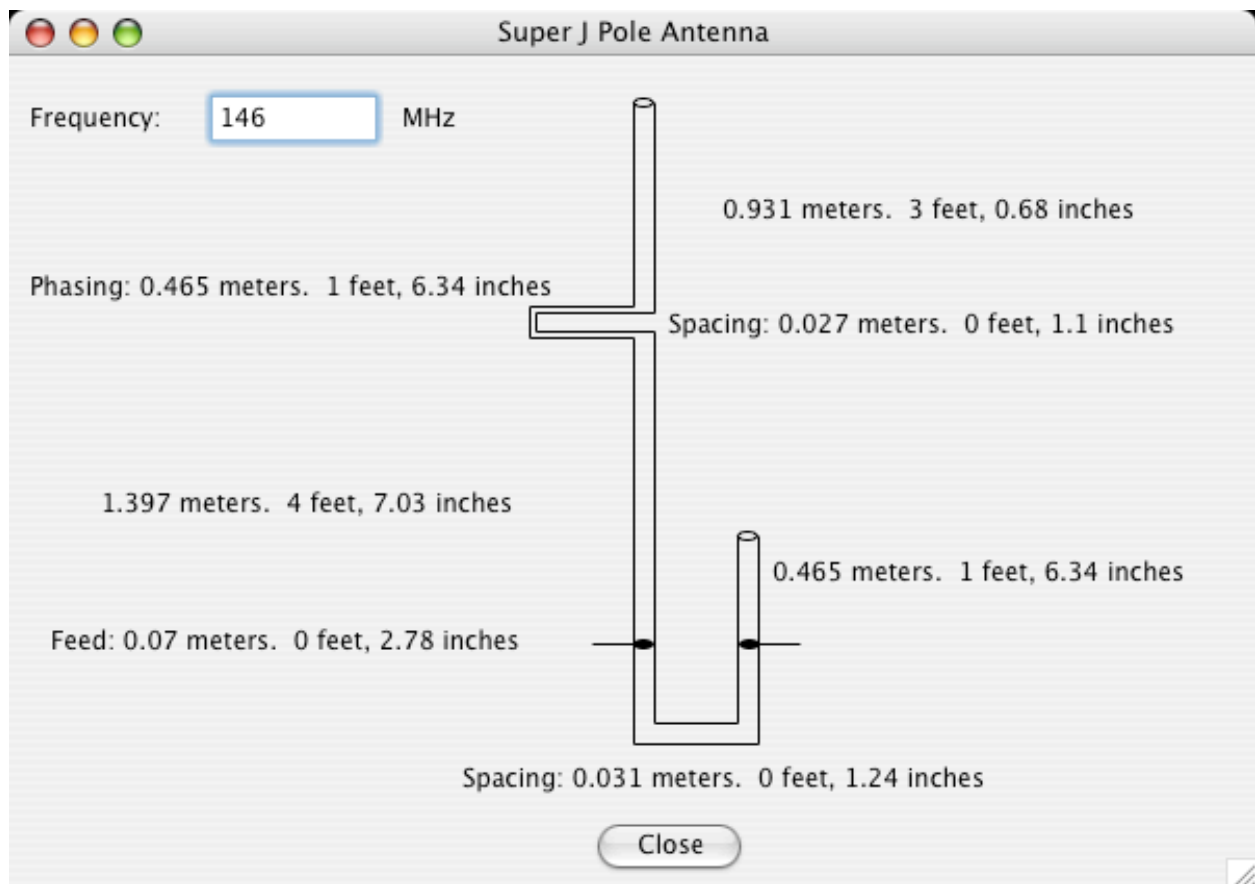
## J Pole Antenna Calculator

The image shows a software window titled "J Pole Antenna". It features a text input field for "Frequency:" with the value "146" and the unit "MHz". Below this, a diagram of a J-pole antenna is shown. The antenna consists of a vertical element on the left and a shorter vertical element on the right, connected by a horizontal base. Dimensions are labeled for each part: the left vertical element is "1.397 meters. 4 feet, 7.03 inches", the right vertical element is "0.465 meters. 1 feet, 6.34 inches", the horizontal base is "0.089 meters. 0 feet, 3.52 inches", and the feed point at the bottom left is "Feed: 0.07 meters. 0 feet, 2.78 inches". A "Close" button is located at the bottom center of the window.

Component	Length (meters)	Length (feet)	Length (inches)
Left Vertical Element	1.397	4	7.03
Right Vertical Element	0.465	1	6.34
Horizontal Base	0.089	0	3.52
Feed Point	0.07	0	2.78

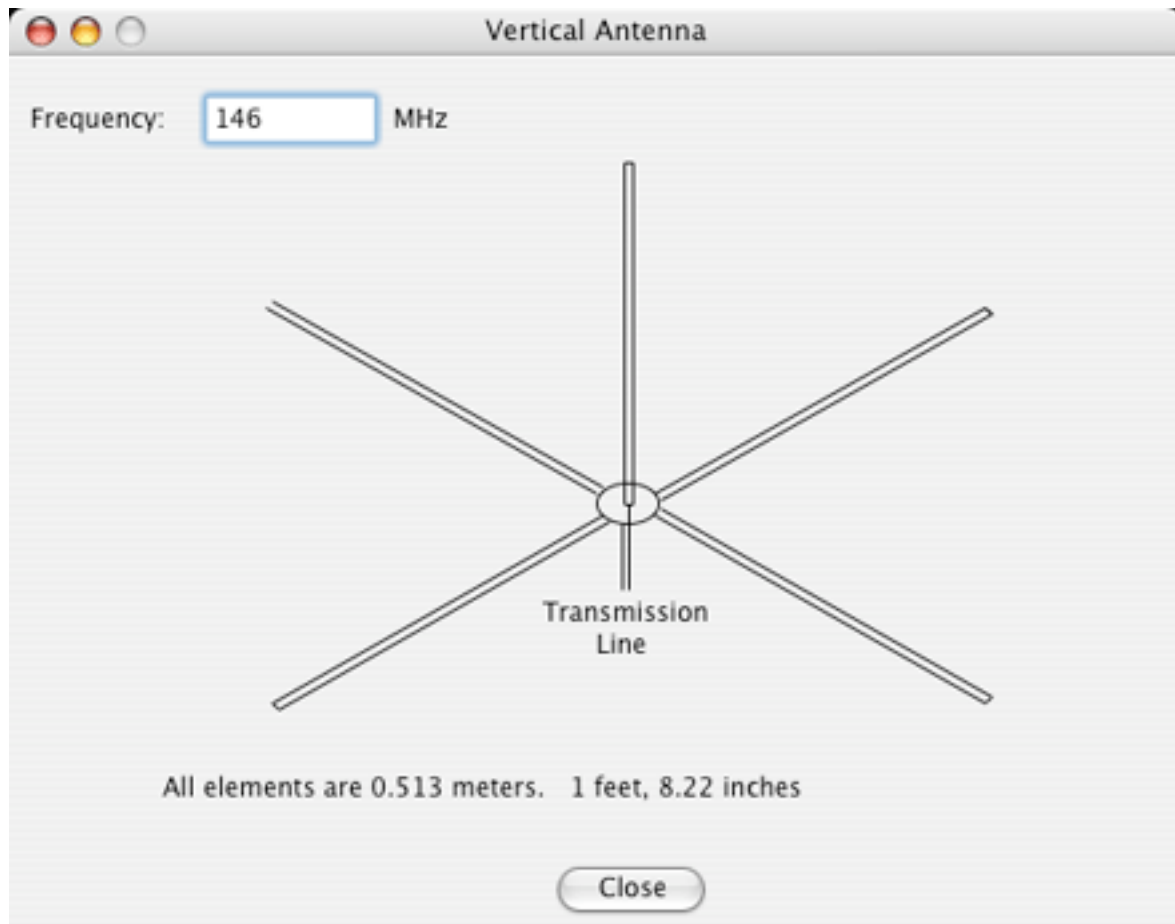
Enter in the desired operating frequency in MHz. The dimensions for the antenna elements are calculated and displayed.

## Super J Pole Antenna Calculator



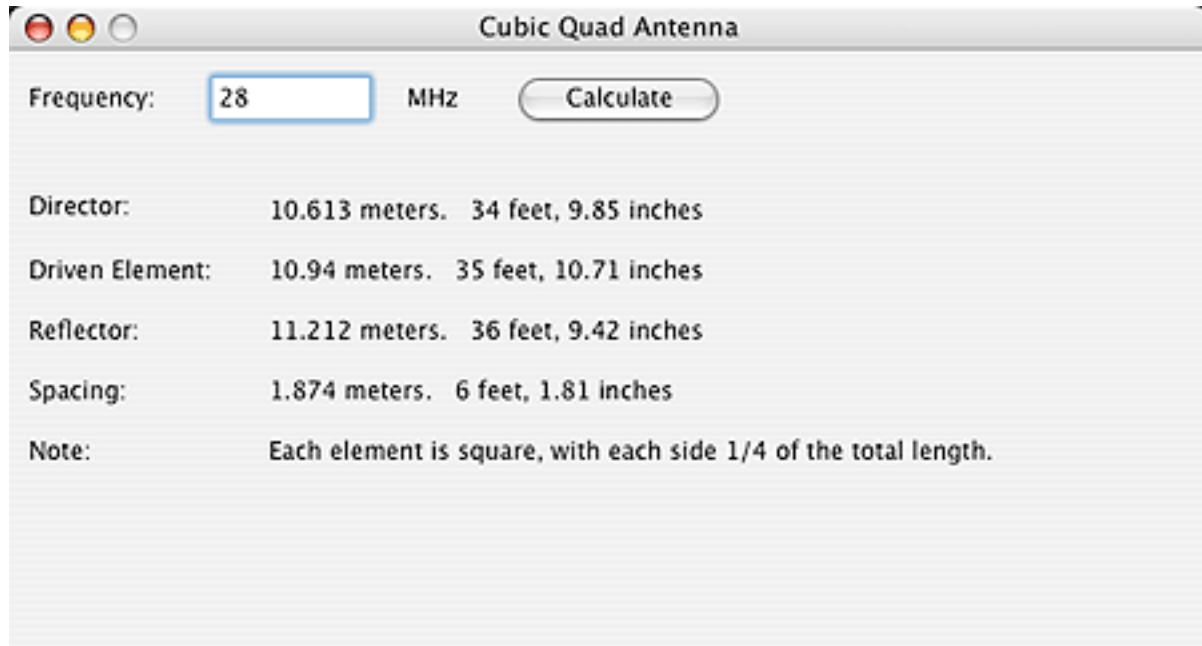
Enter in the desired operating frequency in MHz. The dimensions for the antenna elements are calculated and displayed.

## Vertical (Ground Plane) Antenna Calculator



Enter in the desired operating frequency in MHz. The dimensions for the antenna elements are calculated and displayed.

## Cubic Quad Antenna Calculator



The image shows a screenshot of a software window titled "Cubic Quad Antenna". The window has a standard macOS-style title bar with red, yellow, and green window control buttons. Inside the window, there is a "Frequency:" label followed by a text input field containing the number "28", and the unit "MHz" to its right. A "Calculate" button is positioned to the right of the input field. Below this input section, the results are displayed in a list-like format:

Director:	10.613 meters. 34 feet, 9.85 inches
Driven Element:	10.94 meters. 35 feet, 10.71 inches
Reflector:	11.212 meters. 36 feet, 9.42 inches
Spacing:	1.874 meters. 6 feet, 1.81 inches
Note:	Each element is square, with each side 1/4 of the total length.

Enter in the desired operating frequency in MHz. The dimensions and spacings for the antenna elements are calculated and displayed.

## Yagi Antenna Calculator

The screenshot shows a window titled "Yagi Antenna" with a light gray background. At the top, there are three window control buttons (red, yellow, and gray). Below them, the "Frequency:" label is followed by a text input field containing "146", the unit "MHz", the "Elements:" label, a spinner box set to "6", and a "Calculate" button. The main area displays the calculated dimensions for a Yagi antenna with 6 elements. It lists four "Director" elements, one "Driven Element", and one "Reflector". Each element is represented by a black horizontal bar. To the right of each bar, its length is given in meters and feet/inches. Below each bar, the spacing between elements is given in meters and feet/inches.

Element Type	Length (meters)	Length (feet, inches)	Spacing (meters)	Spacing (feet, inches)
Director	0.92	3 feet, 0.23 inches	0.306	1 foot, 0.08 inches
Director	0.92	3 feet, 0.23 inches	0.306	1 foot, 0.08 inches
Director	0.92	3 feet, 0.23 inches	0.306	1 foot, 0.08 inches
Director	0.92	3 feet, 0.23 inches	0.306	1 foot, 0.08 inches
Driven Element	0.986	3 feet, 2.84 inches	0.306	1 foot, 0.08 inches
Reflector	1.017	3 feet, 4.06 inches		

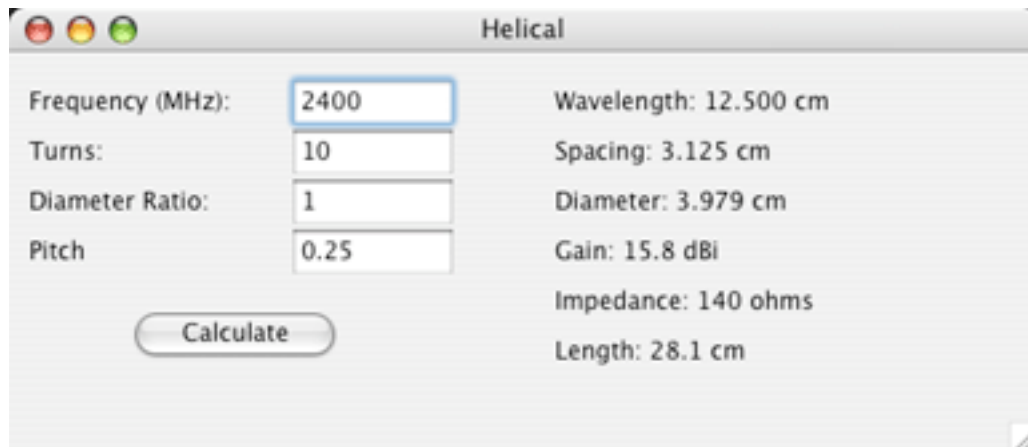
Enter in the desired operating frequency in MHz. The dimensions and spacings for the antenna elements are calculated and displayed.

## Log Periodic Antenna Calculator

Length	Diameter	Spacing
16 feet, 4.85 inches	0.34 inches	4 feet, 11.05 inches
14 feet, 5.22 inches	0.3 inches	4 feet, 3.96 inches
12 feet, 8.44 inches	0.26 inches	3 feet, 9.73 inches
11 feet, 2.14 inches	0.23 inches	3 feet, 4.24 inches
9 feet, 10.05 inches	0.2 inches	2 feet, 11.41 inches
8 feet, 7.88 inches	0.18 inches	2 feet, 7.16 inches
7 feet, 7.41 inches	0.16 inches	2 feet, 3.42 inches
6 feet, 8.44 inches	0.14 inches	2 feet, 0.13 inches
5 feet, 10.79 inches	0.12 inches	

Enter in the frequency range as well as the sigma and tau design parameters (look at the Gain Graph in the window for suggested values), and the design resistance, as well as the diameter of the feeder and shortest elements. Click on the calculate button, and the lengths, diameters, and spacings for each element will be computed and displayed.

## Helical Antenna Calculator



A screenshot of a software window titled "Helical". The window contains input fields for "Frequency (MHz)", "Turns", "Diameter Ratio", and "Pitch", each with a corresponding "Calculate" button. To the right of the input fields, the calculated parameters are displayed: "Wavelength: 12.500 cm", "Spacing: 3.125 cm", "Diameter: 3.979 cm", "Gain: 15.8 dBi", "Impedance: 140 ohms", and "Length: 28.1 cm".

Input	Value	Output	Value
Frequency (MHz)	2400	Wavelength:	12.500 cm
Turns	10	Spacing:	3.125 cm
Diameter Ratio	1	Diameter:	3.979 cm
Pitch	0.25	Gain:	15.8 dBi
		Impedance:	140 ohms
		Length:	28.1 cm

Enter in the desired frequency in MHz, and the number of turns. You can leave the diameter ratio and pitch at the default values, or edit them. Click the calculate button, and the antenna parameters are computed.

## Transmission Line Calculator

The screenshot shows a 'Transmission Line Calculator' window with the following settings and results:

- Cable:** Belden 9258 (RG-8X)
- Ohms:** 50
- VF:** 0.78
- Freq:** 7 MHz
- Band:** 40m
- Matched Loss:** 0.752 dB/100 ft
- Length:** 50 ft
- Attenuation:** 0.376 dB
- Electrical Length:** Modulo 1/2 Wavelength. A progress bar shows the length is approximately 46% of a half-wavelength. The value is 0.4602 wavelengths, 165.68°.
- Load Resistance:** 73
- Impedance:** 0

	Input	Load
R	68.274 ohms	73.000 ohms
X	12.681 ohms	0.000 ohms
Z	69.442 ohms	73.000 ohms

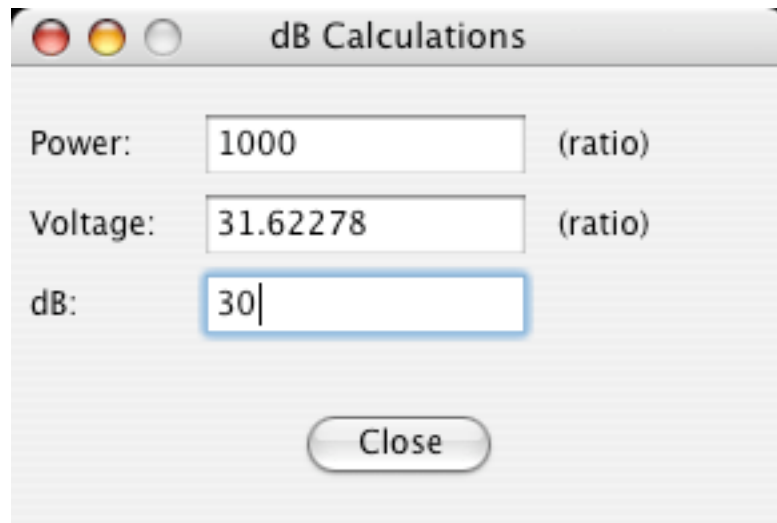
**SWR:** 1.46    **Attenuation due to SWR:** 0.024 dB    **Total Loss:** 0.4 dB

**Input Watts:** 100    **Cable Loss:** 8.29W    **SWR Loss:** 0.51W    **Power Out:** 91.2W

**Close**

This calculator may be used to compute the losses caused by the transmission line (coax or open wire), as well as the SWR from a mismatched load, and the power loss. Select the cable type from the popup menu, as well as the length and operating frequency. Enter in the impedance of the load (antenna). The SWR is calculated, as well as the losses in the cable, both matched and due to the SWR. You can also enter in the transmitter power, and the lost and output power are calculated and displayed.

## db Calculator



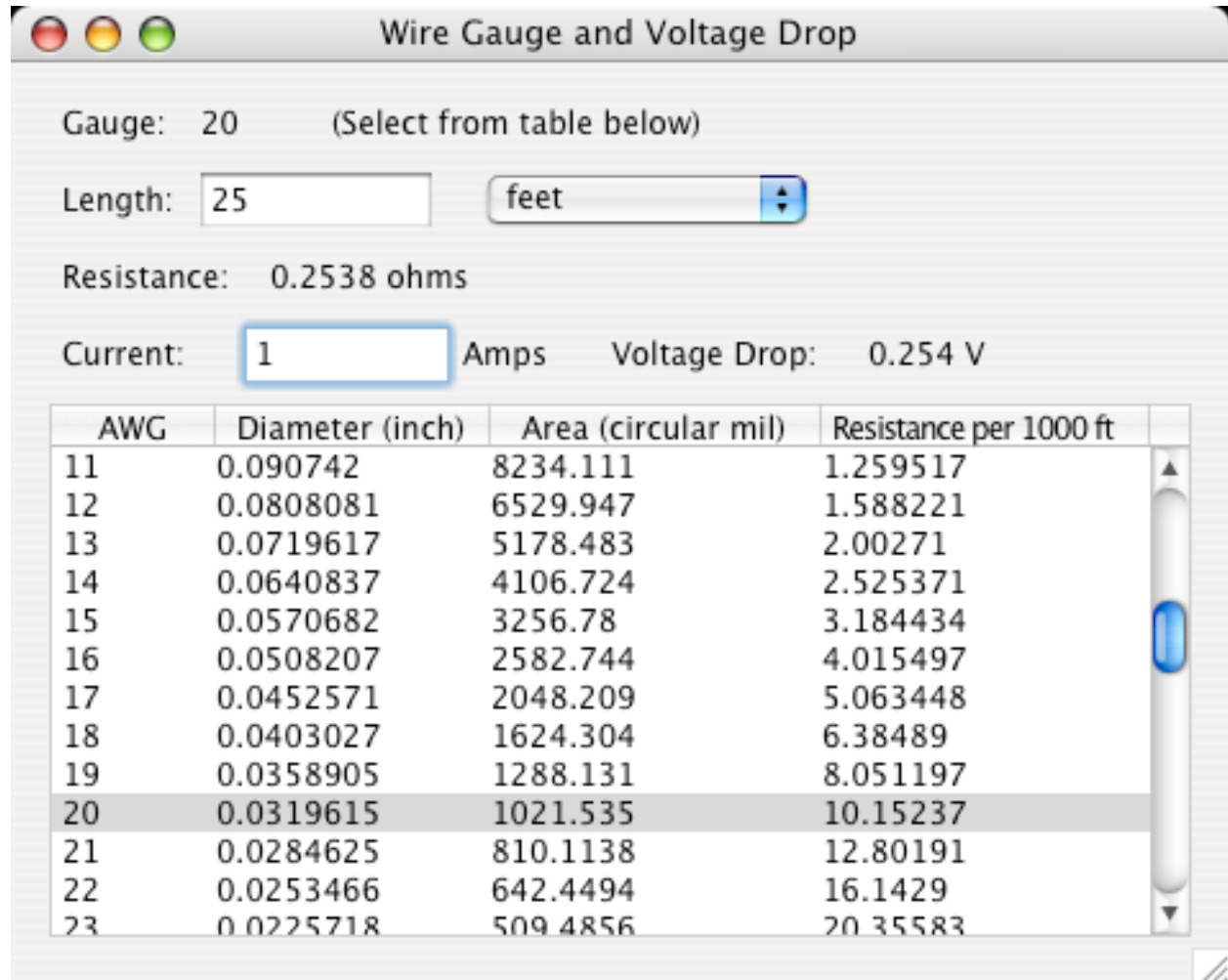
A screenshot of a macOS-style window titled "dB Calculations". The window has a title bar with three colored buttons (red, yellow, grey) on the left. Inside the window, there are three input fields with labels to their left and units to their right. The first field is labeled "Power:" and contains the value "1000", with "(ratio)" to its right. The second field is labeled "Voltage:" and contains the value "31.62278", with "(ratio)" to its right. The third field is labeled "dB:" and contains the value "30", which is highlighted with a blue selection box. Below these fields is a single button labeled "Close".

Field	Value	Unit
Power:	1000	(ratio)
Voltage:	31.62278	(ratio)
dB:	30	

Close

This calculator is used to convert between dB (decibels) and both power and voltage ratios. Type a number into any of the fields, and the values for the other two fields will be automatically computed.

## Wire Gauge and Voltage Drop Calculator



The image shows a software window titled "Wire Gauge and Voltage Drop". It contains several input fields and a table. The "Gauge" field is set to 20, with a note "(Select from table below)". The "Length" field is set to 25, and the unit is "feet". The "Resistance" field displays 0.2538 ohms. The "Current" field is set to 1, with the unit "Amps". The "Voltage Drop" field displays 0.254 V. At the bottom, there is a table with 4 columns: AWG, Diameter (inch), Area (circular mil), and Resistance per 1000 ft. The table lists wire gauges from 11 to 23. The row for gauge 20 is highlighted. A vertical scrollbar is on the right side of the table.

Gauge: 20 (Select from table below)

Length: 25 feet

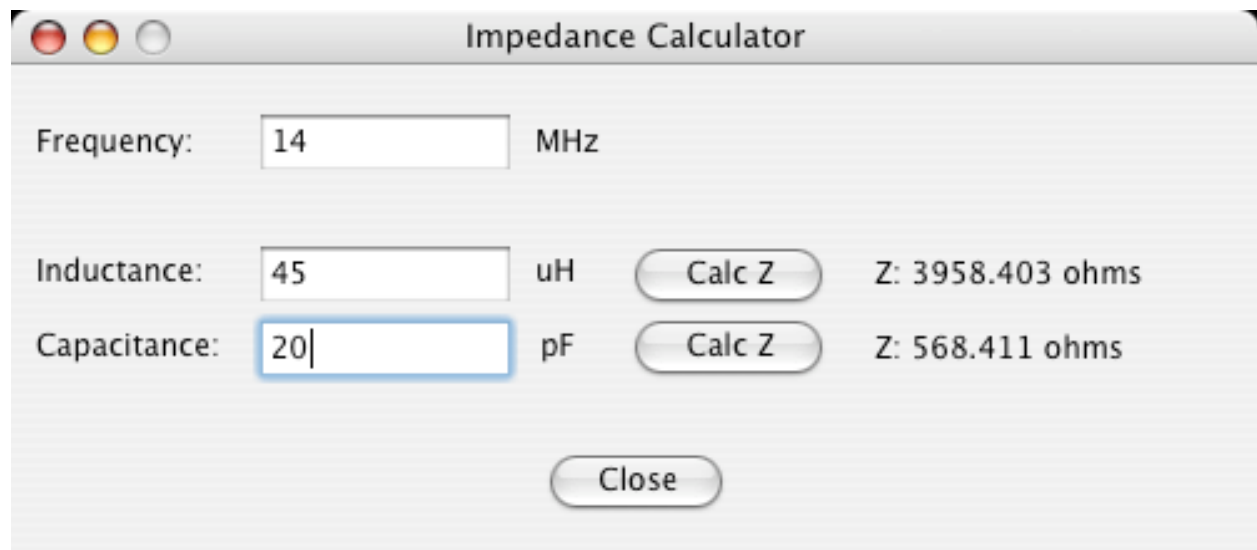
Resistance: 0.2538 ohms

Current: 1 Amps Voltage Drop: 0.254 V

AWG	Diameter (inch)	Area (circular mil)	Resistance per 1000 ft
11	0.090742	8234.111	1.259517
12	0.0808081	6529.947	1.588221
13	0.0719617	5178.483	2.00271
14	0.0640837	4106.724	2.525371
15	0.0570682	3256.78	3.184434
16	0.0508207	2582.744	4.015497
17	0.0452571	2048.209	5.063448
18	0.0403027	1624.304	6.38489
19	0.0358905	1288.131	8.051197
20	0.0319615	1021.535	10.15237
21	0.0284625	810.1138	12.80191
22	0.0253466	642.4494	16.1429
23	0.0225718	509.4856	20.35583

Select a wire gauge from the list at the bottom of the window (which also contains useful information about each gauge). Enter in the length of the wire, and the resistance will be displayed. Enter in the current, and the voltage drop will be displayed.

## Impedance Calculator

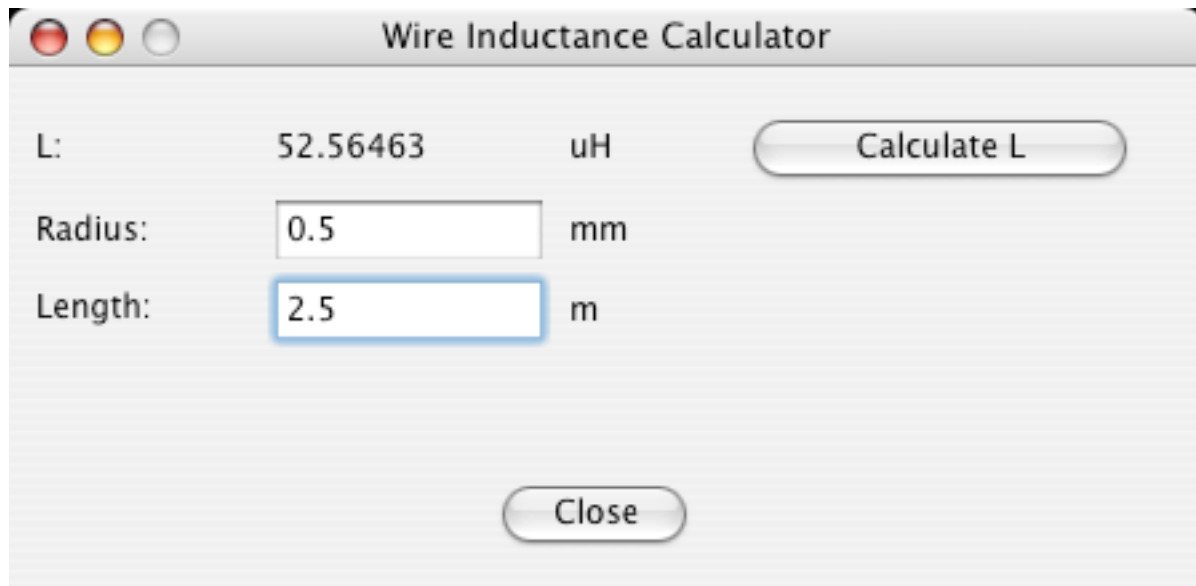


The image shows a software window titled "Impedance Calculator". It has a standard macOS-style title bar with red, yellow, and green window control buttons. The window contains three input fields: "Frequency:" with the value "14" and unit "MHz"; "Inductance:" with the value "45" and unit "uH"; and "Capacitance:" with the value "20" and unit "pF". The "Capacitance" field is currently selected with a blue border. To the right of each input field is a "Calc Z" button. Next to the "Inductance" button is the result "Z: 3958.403 ohms", and next to the "Capacitance" button is the result "Z: 568.411 ohms". At the bottom center of the window is a "Close" button.

Frequency:	<input type="text" value="14"/>	MHz		
Inductance:	<input type="text" value="45"/>	uH	<input type="button" value="Calc Z"/>	Z: 3958.403 ohms
Capacitance:	<input type="text" value="20"/>	pF	<input type="button" value="Calc Z"/>	Z: 568.411 ohms
<input type="button" value="Close"/>				

Enter in a frequency in MHz, and either an inductance in uH or a capacitance in pF (or both), click on the Calc Z button, and the impedance in ohms will be calculated.

## Wire Inductance Calculator



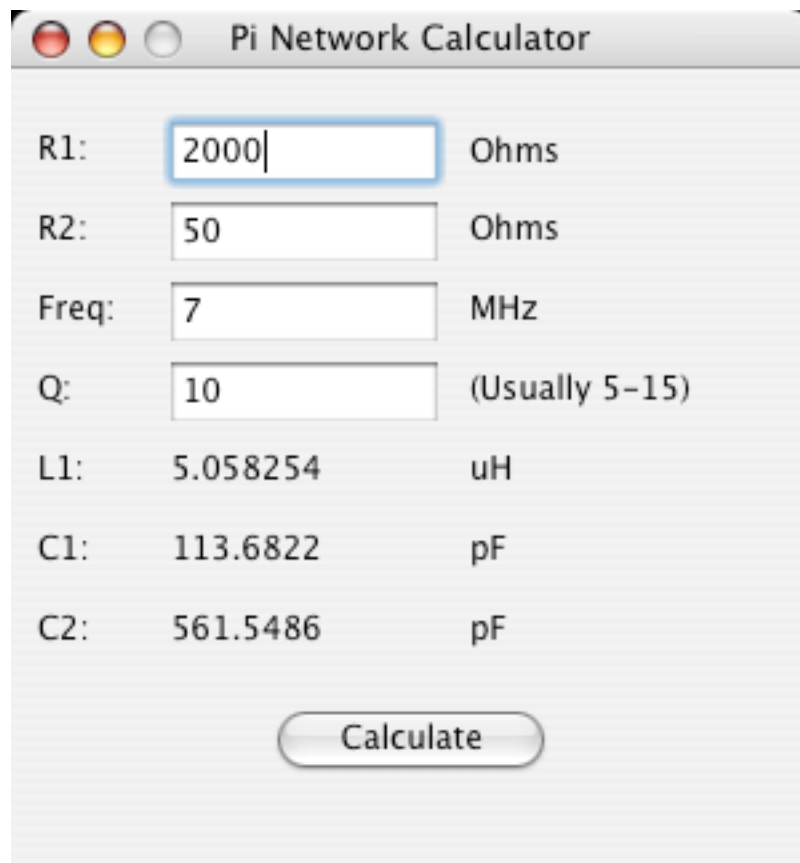
A screenshot of a 'Wire Inductance Calculator' window. The window has a title bar with three colored buttons (red, yellow, grey) and the text 'Wire Inductance Calculator'. Inside the window, there are three input fields: 'L:' with the value '52.56463' and unit 'uH', 'Radius:' with a text box containing '0.5' and unit 'mm', and 'Length:' with a text box containing '2.5' and unit 'm'. The 'Length:' text box is highlighted with a blue border. To the right of the 'L:' field is a button labeled 'Calculate L'. At the bottom center is a button labeled 'Close'.

L:	52.56463	uH	Calculate L
Radius:	<input type="text" value="0.5"/>	mm	
Length:	<input type="text" value="2.5"/>	m	

Close

Enter in a the radius (in millimeters) and length (in meters) of a piece of straight wire, click the Calculate L button, and the inductance (in uH) will be computed and displayed.

## Pi Network Calculator



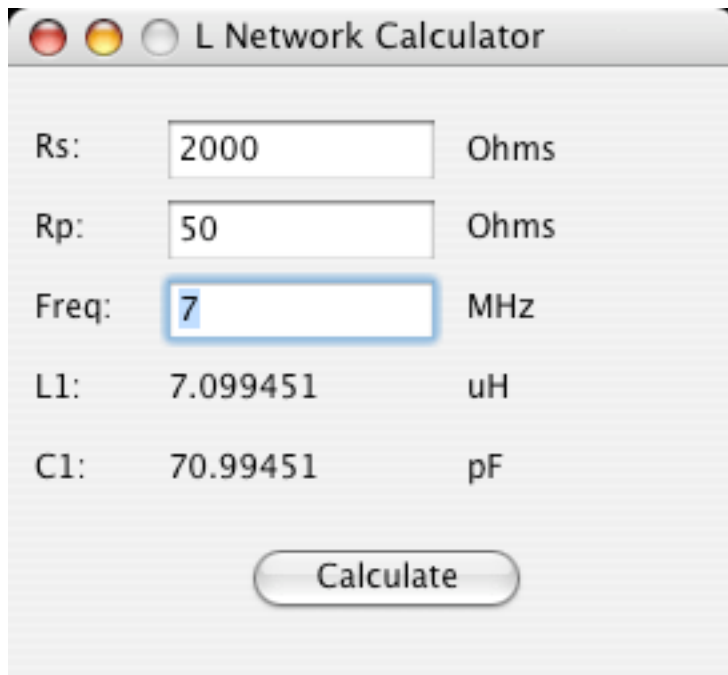
A screenshot of a software window titled "Pi Network Calculator". The window has a standard macOS-style title bar with red, yellow, and green window control buttons. Inside the window, there are input fields for R1, R2, Freq, and Q, and output fields for L1, C1, and C2. A "Calculate" button is at the bottom.

Parameter	Value	Unit / Note
R1:	2000	Ohms
R2:	50	Ohms
Freq:	7	MHz
Q:	10	(Usually 5-15)
L1:	5.058254	uH
C1:	113.6822	pF
C2:	561.5486	pF

Calculate

The inductor and two capacitor values for a Pi Network can be quickly and easily calculated. Enter in the input and output impedance, as well as the operating frequency and desired Q, and click the calculate button.

## L Network Calculator



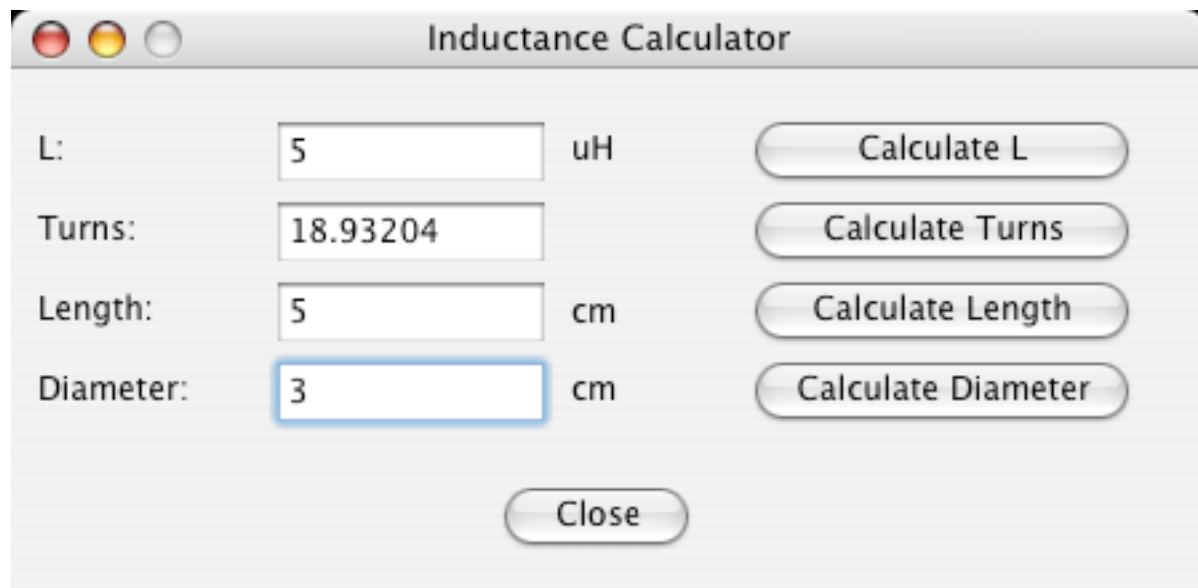
The screenshot shows a window titled "L Network Calculator" with a standard macOS title bar. Inside the window, there are five rows of input fields and labels. The first three rows are for input: "Rs:" with a value of "2000" and unit "Ohms", "Rp:" with a value of "50" and unit "Ohms", and "Freq:" with a value of "7" and unit "MHz". The last two rows show calculated values: "L1:" with a value of "7.099451" and unit "uH", and "C1:" with a value of "70.99451" and unit "pF". A "Calculate" button is located at the bottom center of the window.

Rs:	2000	Ohms
Rp:	50	Ohms
Freq:	7	MHz
L1:	7.099451	uH
C1:	70.99451	pF

Calculate

The inductor and capacitor values for an L Network can be quickly and easily calculated. Enter in the input and output impedance, as well as the operating frequency and desired Q, and click the calculate button.

## Coil Inductance Calculator



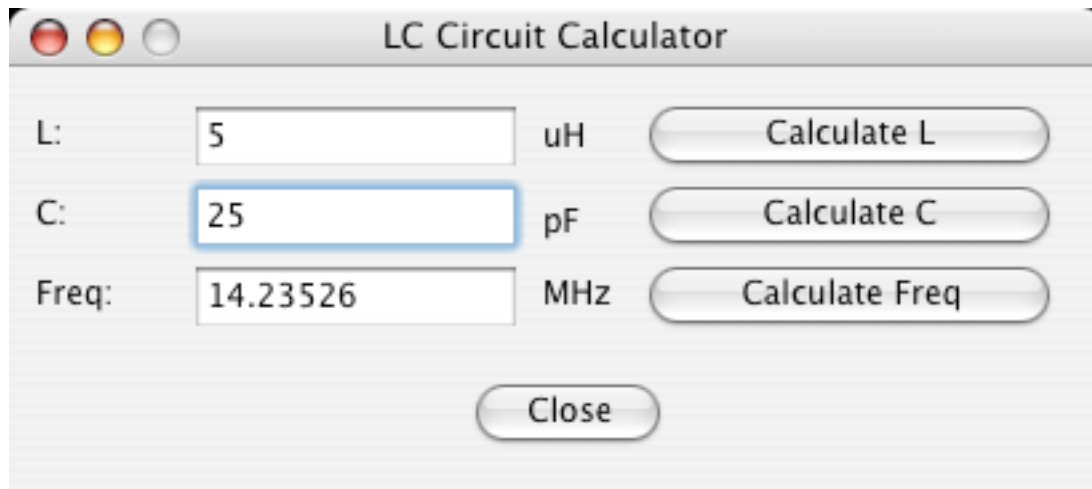
The image shows a graphical user interface for an "Inductance Calculator". The window has a title bar with standard macOS window controls (red, yellow, and grey buttons) and the title "Inductance Calculator". Inside the window, there are four rows of input fields and corresponding buttons:

- Row 1: "L:" label, a text box containing "5", the unit "uH", and a button labeled "Calculate L".
- Row 2: "Turns:" label, a text box containing "18.93204", and a button labeled "Calculate Turns".
- Row 3: "Length:" label, a text box containing "5", the unit "cm", and a button labeled "Calculate Length".
- Row 4: "Diameter:" label, a text box containing "3" (which is highlighted with a blue border), the unit "cm", and a button labeled "Calculate Diameter".

At the bottom center of the window is a button labeled "Close".

Enter in values for three of the four fields (inductance, turns, length, diameter), and click on the Calculate button for the fourth value, and it will be computed and displayed.

## LC Circuit Calculator



LC Circuit Calculator

L: 5 uH Calculate L

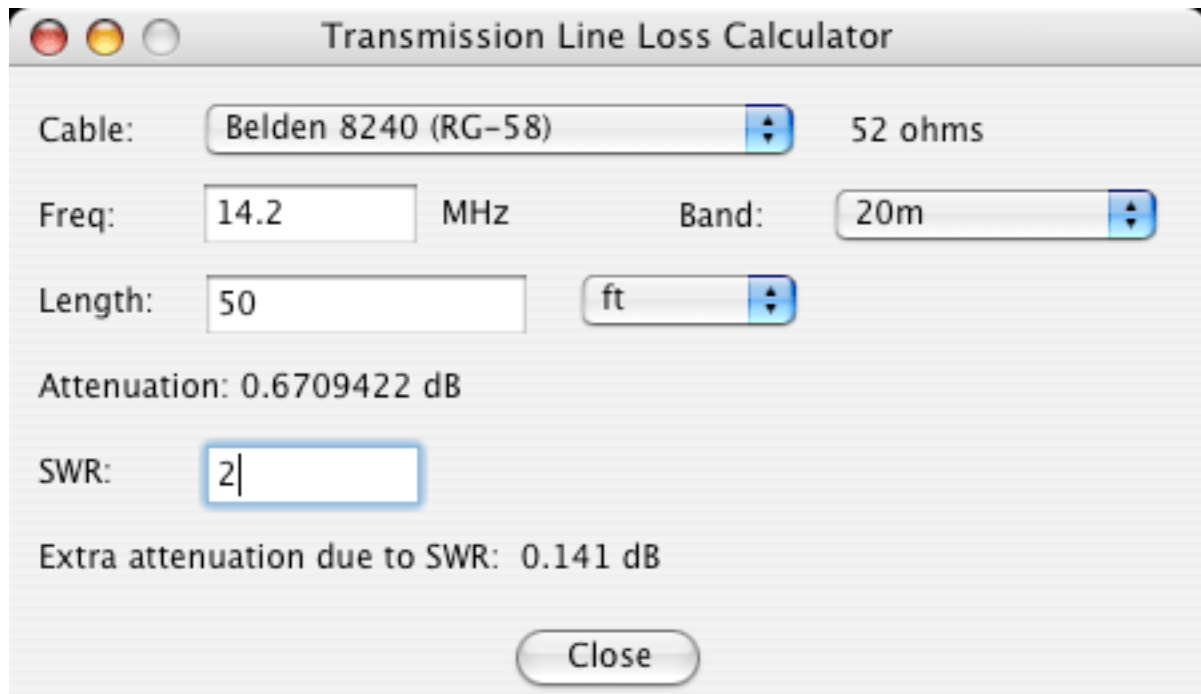
C: 25 pF Calculate C

Freq: 14.23526 MHz Calculate Freq

Close

This calculates resonant values for the LC circuit. Enter in two of the three values (inductance, capacitance, resonant frequency), click the appropriate calculate button, and the third value is computed and displayed.

## Transmission Line Loss Calculator



The screenshot shows a macOS-style application window titled "Transmission Line Loss Calculator". It features several input fields and dropdown menus. The "Cable" dropdown is set to "Belden 8240 (RG-58)" with "52 ohms" displayed next to it. The "Freq" field contains "14.2" and "MHz" is next to it. The "Band" dropdown is set to "20m". The "Length" field contains "50" and "ft" is next to it. Below these inputs, the calculated "Attenuation" is shown as "0.6709422 dB". The "SWR" field contains "2", and the "Extra attenuation due to SWR" is shown as "0.141 dB". A "Close" button is located at the bottom center of the window.

Parameter	Value
Cable	Belden 8240 (RG-58)
Impedance	52 ohms
Freq	14.2 MHz
Band	20m
Length	50 ft
Attenuation	0.6709422 dB
SWR	2
Extra attenuation due to SWR	0.141 dB

Select the cable type from the popup menu, enter in the length and frequency (or select a band from the popup menu), and the cable attenuation in dB is computed. Enter in the Standing Wave Ratio (SWR) and the extra attenuation due to the SWR is also computed and displayed.

## Transmission Line Calculator

The screenshot shows a 'Transmission Line Calculator' window with the following settings and results:

- Cable:** Belden 9913 (RG-8)
- Ohms:** 50
- VF:** 0.89
- Freq:** 7 MHz
- Band:** 160m
- Matched Loss:** 0.323 dB/100 ft
- Length:** 100 ft
- Attenuation:** 0.323 dB
- Electrical Length:** Modulo 1/2 Wavelength. A progress bar shows the length is approximately 0.8067 wavelengths, with a phase of 290.41°.
- Load Resistance:** 73
- Reactance:** 0
- Radio Buttons:** ☒ Load, ☐ Input

	Input	Load
R	37.509 ohms	73.000 ohms
X	8.775 ohms	0.000 ohms
Z	37.765 ohms	73.000 ohms
SWR	1.42	1.46

**SWR:** 1.46    **Attenuation due to SWR:** 0.021 dB    **Total Loss:** 0.344 dB

**Input Watts:** 100    **Cable Loss:** 7.18W    **SWR Loss:** 0.45W    **Power Out:** 92.38W

This calculator allows you to compute several parameters for a transmission line installation. Select the cable type from the popup menu. The impedance and velocity factor are automatically set, you can change them if you wish. Then select the frequency, either directly in MHz, or by selecting the appropriate ham band. Enter the length of the cable run, and select the units of feet or meters. The attenuation and electrical length are computed. Enter the load resistance and reactance and check the Load radio button, or enter the values as seen at the input end of the cable and select the Input radio button. The Input and Load resistance, reactance, impedance, and SWR are calculated, as well as the extra loss due to SWR. Enter the input power in watts, and the loss in watts is also calculated.

## Terms:

If you find RF Toolbox useful, please buy your copy, the price is only \$19.99. This will help encourage the development of future versions of this program.

Please also write me with your comments and suggestions, and any bugs you may find.

Paying for RF Toolbox is fairly simple. If you want to pay by check, money order or cash, you can fill out the Cash/Check/Money Order Form, and mail it directly to me, along with your payment:

Chris Smolinski, N3JLY  
4708 Trail Court  
Westminster, MD 21158

To buy RF Toolbox on the web with a credit card, go to the following URL:  
<http://www.blackcatsystems.com/register/rftoolbox.html>

You'll need to enter your name, email address, and mailing address, and select the program(s) you want to buy (in this case RF Toolbox). Then click the continue button to enter your credit card information (you can use a secure version of the form).

You can always find the latest version of RF Toolbox at this URL:  
<http://www.blackcatsystems.com/software/rftoolbox.html>

If you have any questions, comments, suggestions, or bug reports, please email them to me at:

[info@blackcatsystems.com](mailto:info@blackcatsystems.com)

My snail mail address for directly sending your registration fees (please use email for any questions you want answered) is:

Chris Smolinski, N3JLY  
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4708 Trail Court  
Westminster, MD 21158 USA

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1. It is distributed as an entire package of all files, including all documentation.
2. It may only be distributed without any charge or fee, with the exception below.
3. If it any form of fee is charged, then the distribution package and any documentation must clearly state that any shareware programs must be registered with the author, if they are used beyond the evaluation period.

Thanks again for giving RF Toolbox a try.

Chris Smolinski, N3JLY  
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4708 Trail Court  
Westminster, MD 21158

email: [info@blackcatsystems.com](mailto:info@blackcatsystems.com)

Web: <http://www.blackcatsystems.com/software/rftoolbox.html>

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Please make sure you include your email address with your payment. That way we can send the registration code to you. If you do not send us a valid email address, we have no way to send you the code.

I would like to order \_\_\_\_\_ copies of RF Toolbox at \$19.99 US each.

If you'd like a copy of RF Toolbox (as well as demos of all of our other programs) on a CDROM, please order one:

I would like to order \_\_\_\_\_ Black Cat Systems CDROMS at \$10 US each. (incl shipping)

Maryland residents please add 5% sales tax.

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Computer Model: \_\_\_\_\_ Operating System Version: \_\_\_\_\_

Enclosed, please find my check / money order / cash in the amount of \$\_\_\_\_\_

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4708 Trail Court  
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## Revision History

3.2.0:

Added helical antenna calculations.

3.1.0:

Added Transmission Line calculator.

Added dB calculator.

3.0.0:

Changed name to RF Toolbox

Added impedance calculator.

Added wire inductance calculator.

Added wire resistance calculator.

2.0.1:

Fixed a calculation error in the inductor design tool.

Fixed a calculation error in Yagi antenna design

2.0.0:

Complete re-write, also first OSX and Windows versions.

1.4.0:

Added L and Pi network calculations

1.3.0:

Added transmission line loss calculator

1.2.1:

Fixed bug in Cubic Quad design

1.2.0:

Added Cubic Quad antenna

Fixed bug in Log Periodic display

1.1.0:

Bug fix. Bug caused heap errors on some systems resulting in System Error 33.

1.0.0:

Initial release

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